Design Guideline for Auxiliary Fans

MDG 3

Produced by Mine Safety Operations Division,
New South Wales Department of
Primary Industries

June 1996

NSW DEPARTMENT OF
PRIMARY INDUSTRIES

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FOREWORD

MDG 3 was initially published in January 1991 to provide manufacturers of auxiliary fans with the construction and safety features for fans required to be approved under the Coal Mines Regulation Act, 1982.

This revised issue contains more information pertaining to design safety aspects for auxiliary fans as a result of:-

(a) Investigations conducted into reportable occurrences associated with the operation of these fans; (see Appendix A)

(b) Advice and comment from representatives of industries, manufacturers / suppliers and those involved in assessment of designs for approval; and

(c) Results of fan failure data collated from a survey conducted subsequent to a major fire that occurred as reported in SIR96/7 (refer to Appendix B).

The preparation of the document involved input and support in particular from Greg Venticinque (Engineering Safety Services) and Stan Maginnis (Department of Mineral Resources). Contribution were received from representatives of coal mines, manufacturers and industry which provided valuable input, feedback and guidance in the documents formulation. All contributions are gratefully acknowledged.

The edition of this guideline dated May 1996, replaces MDG 3, January 1991. As required from time to time the document will be reviewed to reflect current safety expectations.

Comments on any aspect of this guideline should submitted be in writing to:

Mr. Leo Roberts
Senior Inspector of Mechanical Engineering
Coal Mining and Inspectorate Branch
Department of Mineral Resources

B. R. McKensey
Chief Inspector of Coal Mines

1996

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1.0 Scope

1.1 The Coal Mines Regulation (Ventilation - Underground Mines) Regulation 1984, under Clause 5(1) states:

A "auxiliary fan" means a fan of an approved type used wholly or principally for ventilating a heading, drift or dead end.

This guideline specifically addresses the safety issues considered relevant for the type approval of an auxiliary fan as per the Coal Mines Regulation (Ventilation - Underground Mines) Regulation 1984, under Clause 5(1).

The document also provides some information considered to be relevant for the installation of the auxiliary fans in underground coal mines which should be of assistance to manufacturers of this equipment.

1.2 The following guidelines are intended primarily to help fan designers by indicating those factors which will be taken into account in the mechanical assessment of fans submitted for approval to the Chief Inspector of Coal Mines.

Additionally, reference is made to certain factors associated with the operation of the fan which must be considered at the design stage so that operational requirements can be met.

The guidelines do not generally give quantitative information as it is not intended to restrict innovative design. Where a manufacturer seeks test procedure information or proposes variation from the guidelines, advice should be sought from Inspectors of Mechanical Engineering, Coal Mining and Engineering Branch of the Department of Mineral Resources (DMR) or an appropriate Accredited Assessing Authority.

NOTE "shall" and "should"

(a) "shall" means that the requirement is strongly recommended if it is applicable to the type of equipment under consideration unless it is used in association with a legislative requirement then it is mandatory.

(b) "should" means that the requirement is recommended.

If any of the parameters as recommended under a "shall" or "should" instruction are not adhered to, the approval applicant shall justify the alternative to the recommendation through a process of technical assessment, risk assessment and risk management.

1.3 Unless otherwise specified, the appropriate Australian Standards shall apply.

1.4 Please note that this guideline does not in any way negate the requirements of the Coal Mines Regulation Act, 67/1982 or the NSW Occupational Health and Safety Act, 1983 No. 20.

2.0 Definitions

2.1 **APPROVED:** approved by the Chief Inspector of Coal Mines in accordance with the Coal Mines Regulation Act, 1982.

2.2 **CONTROLS - PRIMARY:** Controls that are used to prevent an unsafe condition.

2.3 **CONTROLS - SECONDARY:** Controls that are used to indicate only.

2.4 **DMR:** Department of Mineral Resources (NSW).

2.5 **EMERGENCY STOP:** a machine mounted device using fail-safe componenets that override all other machine (ie, feeder breaker) controls, removes power from the machine (ie, auxiliary fan) actuator(s), and causes all moving parts to stop.

2.6 **ERGONOMICS:** is the design of equipment, processes and environments so that tasks and activities required of humans are within their limitations but also make the best use of their capabilities. More simply, ergonomics is designing for people in the workplace. The application of ergonomics enhances people's ability to work safely and efficiently.

2.7 **MDG:** Mechanical Design Guideline,
Note: Refer to Appendix D for a list of relevant MDGs and Australian Standards

2.8 **O.E.M.:** refers to the Original Equipment Manufacturer.

2.9 **RISK ASSESSMENT:** The overall process of risk analysis and risk evaluation, refer to AS4360 - Risk Management and AS/NZS 3931 Risk analysis of technological systems - application guide.

2.10 **RISK MANAGEMENT PROCESS:** the systematic application of management policies, procedures and practices to the tasks of analysing, evaluating and controlling risk.

2.11 **FAIL TO SAFETY (fail safe):** any failure of the machinery (ie, auxiliary fan), its assoicated safeguards, control circuits to its power supply that leaves the machinery (auxiliary fan) in a safe condition.

3.0 Fan Design And Construction

3.1 General

3.1.1 The fan housing should be of robust construction with external stiffening around the impeller casing to reduce the potential for damage to occur during moves underground, transport or handling.

3.1.2 The fan housing shall have the design direction of rotation prominently and permanently marked. There shall be a means whereby any official of the mine can check the direction of rotation.

3.1.3 Aluminium or light metal alloys as defined by MDG 11 shall not be used for any external surfaces of the fan/motor assembly.

3.1.4 Surface protection coatings shall not contain in metallic form any light metals or alloys of light metals. (Refer to MDG 11)

3.1.5 The recommended grade and type of grease should be indicated on the motor or bearing housing.

3.1.6 Fan housing sealing shall be such that air drawn through the fan cannot flow over fan/motor assembly bearings.

3.1.7 A method for draining water from the fan housing should be provided.

3.2 Motor

3.2.1 Where foot mounted motors are used positive means shall be provided additional to holding down bolts to prevent relative movement between the motor and fan housing.

3.2.2 The motor shall be ventilated and cooled by air other than that which passes through or leaks from the fan.

3.2.3 The grade of the winding insulation for the electric motor shall be indicated on the motor.

3.2.4 When the fan is not energised, provision shall be made to eliminate the risk of dangerous voltages being generated inside the explosion protection enclosure at the motor terminals due to windmilling of the impeller. (See Appendix D- Reference 7).

3.3 Guarding

3.3.1 Guarding should be provided at the fan inlet to prevent particles of stone, ventilation tube seals, coal or other material from entering the impeller. Maximum width of opening in the guard to be not more than 50mm.

3.3.2 Access to the guard for cleaning purposes should be provided.

3.3.3 Every inspection or access cover attached to the fan or associated material traps shall be provided with positive locking devices and appropriate danger signs.

3.3.4 All exposed rotating components shall be effectively guarded as per AS4024.1 - Safeguarding of Machinery - General Principles

3.4 Noise

The Noise level requirements in this section are related to noise generated by the fan itself. They are not intended to cover noise sources produced by other equipment in the underground mine environment. However, the designer should consider reduction measures that cater for the general environment the fan will operate in, in addition to those generated by the fan.

Noise levels shall not exceed:-

(1) A continuous (A) weighted sound pressure level, LAeq 8h, of 85dB(A).

(2) A peak level, Lpeak, 140dB(lin).

Noise tests of the completed unit (for a particular design) should be conducted in accordance with Australian Standard AS1269-1989 “Acoustic-Hearing Conservation”.

3.5 Impeller

3.5.1 Accurate and positive locating and locking of the impeller on its support shaft shall be provided.

3.5.2 Fan impellers should be designed to ensure that pockets in which dust can collect are minimised.

3.5.3 The fan impeller shall be made of a material which cannot produce a spark capable of igniting methane during normal operation. Note: Impellers shall not be manufactured from aluminium or light metal alloys (Refer 3.1.4).

3.5.4 Impellers manufactured from non-metallic materials shall be fire resistant and anti-static. Fire resistant and anti-static properties shall meet the requirements of the appropriate standard.

3.5.5 The fan impeller and surrounding components shall be designed to prevent the generation of sparks which may ignite methane under any condition of operation. The design shall be such that a position change of the impeller and its support shaft will not permit steel parts of the unit to rub or strike.

As a minimum the following design, installation and operational conditions for the fan shall be assessed:

(a) Axial movement of the shaft or impeller;

(b) measurable wear, but not collapse of impeller or bearings;

(c) incorrect setting of shaft or guards during assembly;

(d) limited damage to the external drive guard and unit casing.

3.5.6 Those parts of the fan which would first came into rubbing contact shall have one part made of either copper or brass (lined with copper or brass is acceptable).

3.5.7 The fan impeller shall not be driven by V Belts or toothed belts.

3.6 Drive Train

3.6.1 Anti-friction bearings for the electric motor and fan impeller shall be designed for a L10 working life of at least 50,000 hours and to accept the combined axial and radial loadings and normal acceptable fan out of balance (as nominated by the manufacturer).

3.6.2 All surfaces likely to generate heat and possible rubbing surfaces shall be prevented from reaching 150°C under any circumstances. (See Appendix D-Reference 8).

3.6.3 The selection of bearings shall include consideration of the type of bearing cage material. The cages of anti-friction bearing shall not be manufactured from non-metallic materials such as polyamide. (See Appendix D - Reference 2).

3.6.4 Bearing seals should be suitable for use in dusty yet moist conditions.

3.6.5 The motor and all bearings in any drive train shall be mounted on a single drive frame. This does not preclude:

(a) Use of flange mounted motors

(b) Mounting of the impeller directly onto the motor output shaft.

3.7 Controls

3.7.1 Automatic protection devices shall be fitted to detect abnormal:

(a) Temperatures of ALL bearings;
(b) Temperature of windings in the electric motor;

Automatic protection devices should be fitted to detect abnormal vibration of critical elements.

NOTE: If the O.E.M. does not install an automatic vibration protection device then he shall make provision in the design of the fan for routine testing and assessment of vibration levels.

These devices should indicate when variations to the norm occur and shall trip the power to the fan motor before unacceptable operational limits are exceeded.

The interval and type of test should be stated in the operation and service schedule.

A nameplate indicating alarm and shut down levels shall be fitted to the fan control.

NOTE: Bearing temperature monitoring shall be carried out by means which minimise response time.

External contact type temperature sensing devices mounted on the bearing cap may not have adequate response time to detect the sharp rise in temperature which can occur when cage and rolling elements break up.

A means to minimise response time is to position the temperature probe as close as possible to the bearing by using the greaseway access point using an adaptor which still allows the bearing to be greased.

3.7.2 Provision shall be made to isolate power to the section of the underground mine where the fan is installed in the event of a fan stoppage.

3.7.3 The fan assembly shall be fitted with a minimum of one (1) emergency stop that isolates power at the gate end box outlet.

3.7.4 Provision shall be made to provide means of checking the electrical system phase rotation by indication only. Manufacturers should consider fitting to their control system a means to automatically check the phase rotation to prevent incorrect rotational operation of the fan.

3.7.5 Provision shall be made for the quantity (volume), quality (gas content) and pressure of the moving air to be monitored either by permanently installed instrumentation or by easily accessed tapping points for attachment of instrumentation.

3.7.6 An hours run meter should be fitted that has the following features:

(a) Indication of total time and time to next service.
(b) Tamper proof security system.
(c) A tamper proof service reset.
(d) A service alarm for excessive hours run from last service.

3.7.7 Adequate monitoring and cut-offs shall be installed to allow fail to safety philosophy to apply.

3.7.8 A risk assessment shall be carried out to examine failure modes of the fan and its components.

3.8 Accessories

3.8.1 Attachments for lifting and towing shall be fitted to the frame on which the fan / motor assembly has been installed. All attachments shall be adequate for the loads applied and have minimum factor of safety of 2:1.

3.8.2 A durable engraved or stamped nameplate shall be fitted in a permanent location on the fan assembly and shall include the information as per Appendix C - Part B.

3.8.3 An operating procedure nameplate as per 3.8.2 shall be fitted and shall include fan performance information.

3.8.4 Frames fitted with wheels for ease of towing shall be fitted with a means to prevent inadvertent movement when parked.

3.8.5 Inlet fan volume control devices where fitted shall be capable of being locked in position. The open circuit volume for each position shall be identified on the fan.

3.8.6 Trickle stone dusters are commonly used as part of auxiliary fan installations. Where this device is included as an integral component of the fan/motor assembly the relevant sections of this guideline will be utilised in the assessment for the auxiliary fan type approval.

3.8.7 Auxiliary fans where used to draw air from an area that may contain gas shall be fitted with a means to safely dilute the concentration of the gas to acceptable limits.

One means of achieving this is a gas dilution valve which does the following:-

(a) Opens a bypass so that air surrounding the fan enters the fan inlet, effectively bypassing the main inlet ductwork to the air which may contain gas;

(b) restricts the inlet ducting so that more air enters the fan through the bypass them through the main inlet ductwork;

(c) links the bypass valve with the restricting valve so that when the bypass is fully open the restricting valve is fully closed and vice versa;

(d) has at least four (4) distinct setting positions for the dilution control with means for locking the fan in any of the positions.

Where this device or an equivalent is included as an integral component of the fan/motor assembly the relevant section of this guideline will be utilised in the assessment for the auxiliary fan type approval.

3.9 Ergonomics

The ergonomic design in this section of the guidelines is based on the following fundamental premise:

3.9.1 Ergonomics use the process of Risk Identification, Risk Assessment and Risk Control to examine the likelihood of risks associated with a job or a piece of equipment and how these might cause harm to a person. Ergonomics applied using this process enables the compilation of information on how risks might be minimised or eliminated, particularly at the design stage.

3.9.2 The O.E.M. shall provide a procedure for safe access and maintenance.

3.9.3 It is the responsibility of the user to determine how site specific safety issues should be addressed.

3.9.4 All controls and their direction of movement shall be clearly and permanently marked with durable engraved or stamped nameplates.

4.0 Installation and Use

4.1 Under Clause 24 of the Coal Mine Regulation (Ventilation - Underground Mines) Regulation 1984, it is required that prior to installation of an auxiliary fan in any part of the mine, it shall be approved by the Chief inspector.

The District Inspector can impose conditions in the approval in relation to the installation, use and maintenance of the auxiliary fan.

4.2 Provision shall be made in the scheme for systematic examination and testing of the fan unit as required by Section 103 of the Coal Mines Regulation Act, 1982 to include:-

(a) Inspection of the fan housing for undue deformation or other defect; and

(b) The measurement and recording of vibration in motor/fan bearings at regular intervals.

Accordingly, fan design shall be such to permit these inspections and measurements;

4.3 Where the management plan for the operation of the fan identifies risks requiring hard barriers associated with the auxiliary fan, an engineering risk assessment shall be carried out to ensure the safety of such barriers (eg methane monitoring).

5.0 Documentation

5.1 Refer to Appendix C Part A:- Documentation required to be supplied by manufacturers to approval authority.

5.2 Refer to Appendix C Part B:- Documentation required to be supplied by manufacturers to customers.

W.J. Koppe
Acting Senior Inspector of Mechanical Engineering
FOR CHIEF INSPECTOR OF COAL MINES

APPENDIX A

INVESTIGATION OF REPORTABLE OCCURRENCES ASSOCIATED WITH FAN OPERATION

Mine: CORDEAUX | Sub Type: OTH | System:
Date: 3/14/93 | IncidType: AHU | SubSystem:

An arc occurred external to the sheath of a cable when a deputy conducting a preshift inspection put the power on to an ancillary fan. The deputy had walked some 40 metres away when he heard a bang and saw a small flash. As no damage to cables or fan could be found, the equipment was taken to the surface for examination. A phase to phase fault and a small pinhole type hole was found on the fan cable and it is believed that this was the site and cause of the arc. It is not known how the damage to the cable occurred.

Mine: CORDEAUX | Sub Type: OTH | System:
Date: 6/08/95 | IncidType: AHU | SubSystem:

During a production shift a loud bang was heard from the auxiliary ventilation fan. A three phase fault had occurred in the gland area of the supply plug. The fault arced and flashed external to the flameproof faces of the plug and receptacle before power tripped at the substation. During the investigation it was found that the earthing cable from the current limiting reactor was not connected to the substation earth. Further investigation of other substations revealed a loose connection and an unrestrained connection. Further investigations are continuing. The absence of continuous monitoring of this crucial area of protection will be followed up through standards. All personnel responsible for the inspection, maintenance and design of this critical area of protection should be made aware of this type of incident.

Mine: TOWER (Refer to SIR 94/7) | Sub Type: MEC | System: BRG
Date: 4/29/94 | IncidType: OFU | SubSystem:

A fire was observed inside an auxiliary fan after it had gone off on an earth leakage trip. Various persons had noted a slightly "different" intermittent noise being generated by the fan over a 5 1/2 hour period preceding the incident but the noise was not considered significant. The fan was directly mounted on the motor shaft and the fire occurred when a combination of motor bearing failure and motor shaft deformation occurred.

Mine: WEST CLIFF | Sub Type: FRA | System:
Date: 2/14/91 | IncidType: SFS | SubSystem:

A deputy was recovering a workman’s helmet from within the dilution chamber of an auxiliary fan when he slipped and fell against the side of the aperture striking his right side and sustaining a fractured tenth rib. The accident may have been avoided had the auxiliary fan been stopped before carrying out the manoeuvre.

APPENDIX B

RE: SIGNIFICANT INCIDENT REPORT No.: 94/7

The attached significant incident report has been prepared to highlight a case in which a fire still occurred in an auxiliary fan despite several experienced workers being involved over a considerable period of time in inspections that should have identified the problem during its development.

The potential for this incident to re-occur is considered to be great if engineering barriers are not in place.

To assist the Inspectorate in obtaining statistics and data on the use and failures of auxiliary fans, I require you to complete and forward the attached plant register and failure analysis tables to your Senior Inspector of Coal Mines by 1 August 1994.

Please provide historical data on failures in table 2 and 3 over a long a period as possible from your maintenance records. If you have any questions regarding the questionnaire contact S. Maginnis (063 -513053) or J. Bout (042-268349).

In addition to the above you are also advised that the existing Mechanical Design Guideline for Auxiliary Fans is to be reviewed as a consequence of this incident. The active participation of the industry in the industry in this process is encouraged. Advice and/or comments should be forwarded to the Senior Inspector of Mechanical Engineering Mr L.J. Roberts at the above address no later than August 1994.

B R McKensey
Chief Inspector of Coal Mines

APPENDIX B continues

Coal Mining Inspectorate, Department of Mineral Resources NSW

SIGNIFICANT INCIDENT REPORT

Report No: 94/7
File No: C94/0165

FIRE IN AUXILIARY VENTILATION FAN

An auxiliary ventilation fan suffered a catastrophic failure. The motor shaft (carrying the fan impeller) became so hot the shaft bent and jammed the impeller against the housing and the power tripped off. A fire inside the housing had to be extinguished.

CIRCUMSTANCES
During a non production period two deputies, a leading hand and two fitters had cause to inspect the fan due to odd noise concerns. The inspections were spread over a five hour period. The removal of the fan from service was not considered necessary. The mine operates in the Bulli Seam and is considered to be gassy.

INVESTIGATION
The fan was of a type where the impeller is directly mounted on the shaft. The fan system was found in the following conditions: The motor shaft was bent 8 to 10 degrees, there was substantial wear to the shaft and housing where the shaft passes through the housing, severe damaged occurred to the motor bearing housing and flamepath, paint adjacent to bearing housing was burnt and the drive end bearing cage and inner race was destroyed.

Sufficient heat had been generated to cause plastic deformation of the failed bearing and the motor shaft. The original quantity and quality of the bearing lubricant are unknown, but expert advice had confirmed that even slight increases in operational temperature can cause a decrease in the bearing running clearance and a reduction in the film strength of lubrication, increasing in severity over a number of hours. Ultimately this result in the bearing failing catastrophically.

There was no monitoring equipment in the use on the fan system other than normal electric motor protection.

RECOMMENDATIONS
Due to the potential for similar incidents to occur in any auxiliary fan immediate steps should be taken to ensure that automatic protection devices are fitted to all auxiliary fans.

These protection devices should be, as a minimum:

(i) Detect increases in bearing temperature.
(ii) Detect abnormal vibration.
(iii) Isolate power to the fan motor when acceptable operational levels are exceeded.

B R McKensey
CHIEF INSPECTOR OF COAL MINES

APPENDIX B continues

MINE:
CONTACT PERSONS:

TABLE 1: AUXILIARY FAN PLANT REGISTER

Style of Aux Fan	Make	Qty	Motor Details			Fan Approval Number	Comments
			Make	Volts	Rating (kW)		
Impeller Direct Coupled to Motor							
Impeller Mounted on "Jack" Shaft							
Other (Provide Details)							

* "Auxiliary fan" means a fan of an APPROVED type used underground wholly or principally for ventilating a heading, drift or dead end. [Coal Mines Regulation - (Ventilation - Underground Mines) Regulation 1984]

APPENDIX B continues

MINE:
CONT ACT PERSONS:

TABLE 2: AUXILIARY FAN MOTOR FAILURE ANALYSIS TABLE

Make of Motor	Style	Rating (kW)	Volts	Qty of Failures	Cause of Failure/ Additional Comments

Please from which statistics are gathered: 19 to 19

TABLE 3: AUXILIARY FAN COMPONENT FAILURE ANALYSIS TABLE (Exclude Motor Failure)

Failed Component	**Frequency of Failure**	**Detailed of Failure Mode**	**Cause of Failure/ Additional Comments**

Period from which statistics are gathered: 19 to 19

Note: Please provide as much engineering information as possible regarding modes of failures experienced. Attached additional reports of documentation if available.

APPENDIX B continues

Statistical Results of Survey

Make of Fan and Motor (Distribution Listing)

Table A: Impeller Direct Coupled to Motor

	Toshiba	Western	Newman	C.P	CMG	Unknown[1]	Total	Failure
ABB Richardson	42	15	15	19	-	1	**92**	**41**
GW Aial	-	-	-	-	2	-	**2**	**-**
Buffalo	-	-	-	3	-	-	**3**	**-**
Wheeler	-	-	-	-	-	-	**nil**	**-**
Eagle & Globe	1	-	-	-	-	-	**1**	**-**
Whyte Hall	-	-	-	-	-	1	**1**	**-**
Aergx	-	-	-	-	-	-	**nil**	**-**
Others	1	-	-	-	-	-	**1**	**-**
TOTAL	**44**	**15**	**15**	**22**	**2**	**2**	**100**	**41**

A total of 41 fans failed (all ABB Richardson)

Table B: Impeller Mounted on Jack Shaft

	Toshiba	Western	Newman	C.P	CMG	Unknown[1]	Total	Failure
ABB Richardson	19	10	4	1	-	3	37	13
GW Aial	-	-	-	-	-	-	nil	-
Buffalo	-	-	-	-	-	-	nil	-
Wheeler	1	1	-	-	-	-	2	-
Eagle & Globe	1	-	-	-	-	-	1	-
Whyte Hall	-	-	-	-	-	-	nil	-
Aergx	-	-	-	-	-	-	1	-
Others	-	1	-	-	-	-	nil	-
TOTAL	21	12	4	1	0	3	41	13

A total of 13 fans failed (all ABB Richardson)

A total of 54 fans failed (from 141). Table C & D , shows the analysis of the motor failure for Impeller Direct Couple to Motor and Impeller Mounted on Jack Shaft, respectively.

[1] Note the Unknown Motors have not been considered in the analysis of Table C and Table D.

APPENDIX B continues

Table C: Impeller Direct Coupled to Motor

	Total No of Motors	Bearing	Earth-Leakage	Vibration	Burnt out Motor	Thermistor	TOTAL FAILURES
Toshiba	44	8	1	4	3	-	**16**
Crompton Parkinson	22	6	-	2	-	2	**10**
Western Electric	15	4	2	-	-	-	**6**
Newman	15	7	2	-	-	-	**9**
CMG	2	-	-	-	-	-	**0**
TOTAL	**98**	**25**	**5**	**6**	**3**	**2**	**41**

Table D: Impeller Direct Coupled to Motor

	Total No of Motors	Bearing	Earth-Leakage	Vibration	Burnt out Motor	Thermistor	TOTAL FAILURES
Toshiba	21	7	1	2	-	-	**10**
Crompton Parkinson	1	-	-	-	-	-	**0**
Western Electric	12	2	-	1	-	-	**3**
Newman	4	-	-	-	-	-	**0**
CMG	-	-	-	-	-	-	**0**
TOTAL	**38**	**9**	**1**	**3**	**0**	**0**	**13**

Table E: Component Failure Analysis

	Make of Fan		
Fan Component	Richardson	Wheeler	Airgx
Shaft	1	-	-
Bearing	18	1	3
Coupling	2	-	-
Impeller	14	-	-
Copper Ring	1	-	-
Hub	1	-	-
Bearing House	2	-	-
Blades	2	-	-
Cowl	1	-	-
Bed Plate	4	-	-
Mounting of Motor	1	-	-
TOTAL	47	1	3

APPENDIX C

AUXILIARY FAN DOCUMENTATION REQUIREMENTS

PART A

MANUFACTURER TO SUPPLY TO APPROVAL AUTHORITY

In addition to the requirements of this guideline, the following information shall be supplied with an application for approval and for each new auxiliary fan supplied in NSW.

1. General arrangement drawing. Commonly know as the approval drawing. This drawing shall include:

    1.1 The overall dimensions mounting of the fan.
    1.2 Indication for the position of the:
        * Locations of all controls
        * location of all indicators
        * Fan specifications to include:
            Motor power rating .
            Motor speed.
            Fan flow and performance.
            Fan rotation (direction).
            Unit mass.
            Maximum recommended. bearing temperature.
            Maximum vibration limits.
        * Cross section through fan showing:
            Blade Clearances
            Rubbing material
            Fan retaining method
    1.3 Type of grease for bearings
    1.4 The results of noise testing
    1.5 Electrical approval numbers
    1.6 Position of all inlet, outlet and control ducts
    1.7 Details of fault and shutdown devices fitted
    1.8 A reference to electrical schematic
    1.9 All fans shall be fitted with correct rated lifting points.
    1.10 The manufacture to supply calculations for approvals purpose.

2.0 Electrical approval schematic shall include:

    2.1 The complete base operating systems for the fan
    2.2 All safety related voltages, currents, fuse ratings, overload settings etc.
    2.3 A list of associated approvals for components including approvals numbers

3.0 A letter of compliance including:

3.1 The manufacturer's letter head
3.2 A statement indicating compliance with MDG 3
3.3 The fans model number, serial number, date of manufacture and approval number
3.4 An authorised person's signature indicating compliance

4.0 The application for approval shall also include:

4.1 A marked up copy of MDG3 showing compliance and non compliance
4.2 The noise test report
4.3 All relevant approval letters and drawing for associated items including electric components
4.4 Letters or test reports for attachments
4.5 Other test reports as may be required by the approvals authority.
4.6 An electrical system letter of compliance and relevant approvals.
4.7 A credible Risk Assessment report which effectively identifies , assesses and controls hazards relating to the safety of persons associated with the operation, maintenance and testing of the equipment and the potential for the fan to ignite methane or generate sufficient heat to result in a fire.

PART B

APPROVAL HOLDER (MANUFACTURERS) TO PROVIDE TO CUSTOMER(S)

Manufacturers are required to supply a copy of:-

* Approval letter
* Approval drawings
* Letter of Compliance
* Requirements for Parts, Service, Maintenance and Inspection
* Operators manuals

* Approval Nameplate showing:-
  (a) Approval Number
  (b) Serial and Model Number
  (c) Date of manufacture
  (d) Suppliers name / make
  (e) Gross weight of the fan/motor assembly

APPENDIX D

List Of Standards, Guidelines And References

Australian Standards

AS 1319 Safety Signs for the Occupational Environments

AS 2012.2 Acoustics - Measurement of airborne noise - Operator's position

AS 2595 Electrical Equipment for Coal Mines - Electrical Requirements for Underground Coal Mining Machines and Accessories

AS 2660 Hose and Hose Assemblies - Air/Water for Underground Coal Mines

AS/NZS 3931 Risk Anaylsis of technological systems - application guide

AS 4024.1 Safety Guarding of Machinery - General Principles

AS 4360 Risk Management

Mechanical Design Guidelines

MDG 11 Design Guidelines for the Use of Aluminium Underground

MDG 29 Guideline for Diesel and Operator Environment Testing in Underground Coal Mines Appendix D - Noise Assessments

References

1 Testing Station Report - Electrical Generated Energy in the powered Rotating Motors - See Stan Maginnis

2 ICI Technology - Technical Information Note - Design Procedure 10 - Prohibition of Plastic Cage Bearing.

3 A review of auxiliary and booster fan ventilation practice in mines - British National Committee Report to Her Majesty's Stationary Office re: Houghton Main Colliery explosion, 12th June, 1975 (41 pages).

4 B.H.P. - Guideline for Auxiliary Face Fan Design and Associated Maintenance Practice that reduce the risk of Combustibles Ignition - DOC Control No. G19 053 EM 0065.

5 Department of Mineral Resources - Significant Incidents - Operator reported

a Fire at Entry fan impeller shaft to fan housing;
b Cable damage due to feet breaking off motor;
c Bearing failure giving rise to 150 degrees plus external surface temperatures (both motor and shaft)

6 Exerts taken from Mining Technology - May 1995 - Examples of How the U.K. Mining Electrical Engineering Industry Respond to the Challenge presented by Major Disasters'

"THE VENTILATION OF BLIND HEADINGS USING ELECTRICALLY DRIVEN AUXILIARY VENTILATING FANS"
by G. Goodlad, HM Inspector of Engineering in Mines, Health and Safety Executive

7 SIMTARS Investigation into energy of EMF produced by 1100V/110kw motor after supply disconnection report No E94/0513 dated 16-5-94.

8 Bearing Design Procedure 10 - 2nd Edition, 14 December 1992 (LH071).

APPENDIX E

U.K PRECIS ON AUXILIARY FANS

Tower Explosion

In considering the development of electrical engineering applied to auxiliary ventilation systems, one has to turn firstly to the explosion and the loss of nine lives in the MC3 heading at Tower Mine, Glamorgan, on 12 April 1962.

The ignition was caused by the application of mains power to a damaged paper insulated lead covered double wire armoured (PILCDWA) cable which had been newly installed to service electrical apparatus in the heading. At the time the auxiliary fan was not operating and an explosive mixture of firedamp had built-up inside the heading. During the investigation it became apparent that the electrical staff had not bothered to test the insulation of the cable before applying mains power to it.

In his report, Mr C Leigh, HMDI Mines, stated that PILCDWA was not a suitable cable for use in mining situations where movement from place to place was needed.

He therefore recommended that it should be banned from use in advancing headings. He also recommended that a method of inter-locking should be introduced, in which a circuit breaker was arranged to remove power from the heading apparatus if the ventilation fan was not operating.

This method of interlocking was subsequently dealt with in the NCB Production Instruction 1963/3 and is still often referred to as 'Tower Interlocking'. As auxiliary ventilation systems became more complicated, with the introduction of over-lap fan and dust removal fans, the interlocking became more complicated and the instruction had to be revised many times. Four ignitions of firedamp in subsequent years had an effect on the philosophy of fan interlocking and the ventilation of blind headings:

Cronton Explosion

The first of these was an explosion at Cronton Colliery in 1972 in which an electrician and a deputy lost their lives. No public inquiry took place, however the North Western Divisional Inspector's Annual Report condemned the use of a limit switch arrangement to defeat the ventilation interlocking and allowing power to be put into the C1 heading without the fans operating.

Houghton Main Explosion

The second was the ignition at Houghton Main Colliery, in which five miners lost their lives on 12 June 1975. The ignition of firedamp was caused by incendive sparking between the fan blades and outer casing of an auxiliary fan which had been reported as 'defective' some hours before. This was the first mine disaster investigated by the newly formed 'Health and Safety Executive' and the public inquiry recommendations led to the introduction of the 'British Coal Fan Acceptance Scheme' and a formal method of identifying and immobilising defective apparatus by the use of coloured 'defect locks'.

Golborne Explosion

The third explosion was at Golborned Colliery on 18 March 1979 in which ten miners lost their lives. In this explosion electricians attempted to find a fault on the fan circuit breaker interlock cable with the circuit energised. Unfortunately, the circuit was not intrinsically safe and was sighted at the entrance of the blind heading which was being de-gassed at the time. This led to the recommendations, that, in places where flammable gas may occur, no exposed circuit should be tested unless the circuit and method of test are intrinsically safe. Secondly, that in order to assist electricians, IS and non-IS circuits should be clearly identifiable.

Bevercotes Ignitions

The fourth and more recent, was a double ignition at Bevercotes on 4 May 1989. There were no fatalities, however two men were lucky to escape injury when flames of burning firedamp were ignited by a road header and travelled along the roadway roof. This led to the issue of the British Coal's document on the 'Continuity of Ventilation', which set down the general philosophy, that in future, every effort should be made to maintain ventilation to headings. This was to be achieved by avoiding unnecessary tripping of fans in the first place and introducing automatic restarting of fans where this could be done without danger.

In an attempt to prevent unnecessary tripping, the document called for the fan circuit to be different from that of the other heading apparatus and to avoid the use of multi-point earth leakage protection, because of its known disadvantageous sympathetic tripping characteristic.

With regard to automatic restarting, it called for continuous monitoring and immediate restart of healthy ventilating apparatus which had stopped, either because of a short duration interruption of the supply, or a momentary dip in the supply voltage.

The next phase in the development is being pursued in the Notinghamshire coalfield. This is the automatic de-gassing of a gas fast heading using a special fan and duct arrangement which automatically adjusts the quantity of fresh air blown into the heading according to a computed relationship with the quality of the gas-laden air being forced out of the heading.