
Code for Air Compressors – Underground Use

MDG 18



NSW DEPARTMENT OF
PRIMARY INDUSTRIES

Produced by
Mine Safety Operations Division
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Department of Primary Industries

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24 October 2006

This MDG is no longer supported as a code under current legislation. As such, it is a guidance document only for technical assistance.

Code For Air Compressors
Underground Use

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DEPARTMENT OF MINERAL RESOURCES

SYDNEY

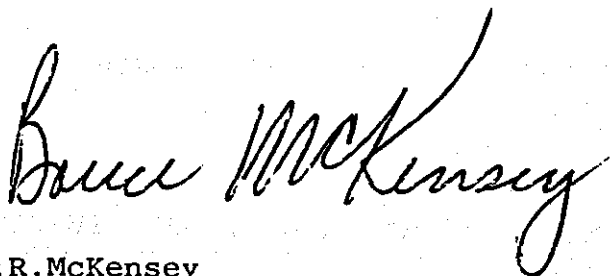
COAL MINES REGULATION ACT, 1982, AS AMENDED

NOTICE OF REQUIREMENT FOR AIR COMPRESSORS

FILE NO.: CM83/2300
DATE: 2 December 1993

It is hereby notified that the Chief Inspector of Coal Mines pursuant to the provisions of Clause 33 of the Coal Mines Regulation (Mechanical - Underground Mines) Regulation, 1984 SPECIFIES that Air Compressors which absorb more than 4kw of power and are operated underground in a coal mine comply with a code for the design, construction, installation, operation, inspection and maintenance.

The Code for Air Compressors - Underground Use - MDG 18, dated September, 1993, under File Reference CM83/2300 shall apply to all air compressors supplied from 1 June 1994 and to all air compressors by 31 December 1996.



B.R. McKensy
CHIEF INSPECTOR OF COAL MINES

Code For Air Compressors
Underground Use

FOREWORD

This code has been compiled to assist Manufacturers, Purchasers and the Department of Mineral Resources Coal Mining Inspectorate when assessing safety aspects of air compressors for underground use at N.S.W. Coal Mines.

The constructive evaluation and input provided by Mine Mechanical Engineers (In Charge), Manufacturers, Electrical and Mechanical Inspectors is gratefully acknowledged.

Date: 26 August 1992
revised 24 September 1993
File Ref: CM83/2300

CODE FOR AIR COMPRESSORS

Section One: General

Scope

- 1.1 Clause 33 of the Coal Mines Regulation (Mechanical - Underground) Regulation 1984 states that:-

"The Manager of a mine shall ensure that any hydraulic or compressed air-operated machinery or air compressor used at the mine, in its design, construction, installation, operation, inspection and maintenance, complies with any code or requirement specified from time to time by the Chief Inspector."

- 1.2 This Code for Air Compressors is in accordance with the provisions of the above clause.

- 1.3 The Code does not generally give quantitative information as it is not intended to restrict innovative design. Where specific values or test procedures are required, advice should be sought from Inspectors of Mechanical Engineering, Coal Mining Inspectorate and Engineering Branch of the Department of Mineral Resources.

NOTE "shall" and "should"

(a) "shall" means that the requirement is mandatory if it is applicable to the type of equipment under consideration.

(b) "should" means that the requirements are not mandatory, but serious consideration should be given to adopting the recommendations.

- 1.4 This Code does not in any way negate the requirements of the Coal Mines Regulation Act 67/1982 nor the Occupational Health and Safety Act 1983, No 20.

Manufacturers/suppliers shall take particular note of section 18 Division 1 Part III of the above Act No 20.

- 1.5 The Code shall apply to all air compressors used underground as follows:-

(a) delivered to mine sites from 1 June 1994

(b) all air compressors in service at N.S.W. Coal Mines by 31 December 1996.

1.6 International Standard ISO 5388 - "Stationary Air Compressors - Safety Rules and Code of Practice" shall be complied with as part of this Code unless otherwise noted and shall be referred to in conjunction with any amendments contained in this Code.

1.7 Compliance Statement

The manufacturer shall provide to the purchaser the following:-

- (A) A brief statement of compliance, variation or reason for non compliance with each item mentioned in this code. A marked up and signed copy of the code may be used.
- (B) Any further information requested within this code or as considered to be appropriate to ensure the safe operation and maintenance of the compressor.
- (C) Results of tests and a statement of compliance with all requirements in accordance with Australian or other relevant standards.
- (D) Any information as required by the Acts and regulations listed in clause 1.1 and 1.4 of this document.

1.8 All electric apparatus and mechanical equipment including diesel engines shall comply with the requirements of the Coal Mines Regulation Act 67/1982, subsequent Regulations and relevant Australian Standards.

1.9 Review of Codes

To keep abreast of progress in industry, Codes are subject to periodic review and are kept up to date by the issue of amendments or new editions as necessary. It is important therefore that users ensure that they are in possession of the latest edition, and any amendments.

Suggestions for improvements of Codes, addressed to the Senior Inspector of Mechanical Engineering are welcomed.

Notification of any inaccuracy or ambiguity in any Code should be made without delay in order that the matter may be investigated and appropriate action taken.

AMENDMENTS TO ISO 5388
APPLICABLE TO UNDERGROUND COMPRESSORS

1.1 Add: This code applies to all air compressors which absorb more than 4 kilowatt including those mounted on wheeled or tracked vehicles or trailers.

7.2 Add: An hours run meter with a range of at least 20,000 hours shall be provided.

Include new clause 7.7 as below

7.7 The use of Vee belts is not permitted on compressors above, 4kW.

9.1 Add: Metal pipes should be used where ever possible. Where movement of pipes occurs heat resistant flexible joints shall be used.

Any hose used shall be suitably heat resistant and shrouded by a metallic covering.

Elastomeric (rubber type) hose shall not be used between an air compressor and air receiver. Teflon lined hose with steel braid may be satisfactory.

9.6 Add:- All Pressure Vessels of capacity 30 litres or greater shall comply with AS1210 - Unfired Pressure Vessels

Pressure vessels whose capacity is less than 30 litres which do not comply with AS 1210 shall comply with at least one of the following:-

AS 2971 - Serially Produced Pressure Vessels
SAE.J10 - Automotive and Off - Highway Air Brake Reservoir Performance and Identification Requirements.

A drain line with a manual valve shall be provided to drain the lowest point of all air receivers. This line and valve shall be suitably protected against accidental damage during transport.

Use of an automatic drain valve in addition to the manual valve is recommended.

11.1 Amend by Adding: and the applicable Regulations and Requirements for the use of electric power in underground coal mines as required by the Regulatory Authority.

Refer to Annex F for a list of requirements for electrical devices and systems.

12.1 Add: All compressors shall be so designed that the maximum temperature of air or air/oil mixture in the compressor is at least 30⁰C below the flashpoint of the compressor lubricating oil; (ref 1)

Include new clauses as below

- 12.1a All compressors shall be designed and manufactured to operate satisfactorily using non toxic lubricants.
- The use of fire resistant lubricants is recommended.
- 12.1b The external surface temperature at any point on the compressor shall not exceed 150^o C under any condition of compressor operation.
- 12.1c Protection devices to prevent overheating of the compressor shall include as a minimum all items as listed below:-

**LIST OF PROTECTIVE DEVICES FOR COMPRESSORS WHICH STOP
THE DRIVE MOTOR / PRIME MOVER**

DEVICES REQUIRED ON OIL FLOODED COMPRESSORS

1. air delivery overtemperature, after air/oil separator in accordance with clause 12.1f
2. element discharge overtemperature, monitored as close as possible to the element (monitors air/oil mixture overtemperature in accordance with Clause 12.1)
3. air/oil mixture overpressure
4. oil overtemperature in accordance with clause 12.2
5. a means of detecting any significant reduction in oil flow to critical components in accordance with Clause 12.2a
6. low oil level in accordance with Clause 12.2b
7. surface overtemperature in accordance with Clause 12.1g
8. air/oil separator excessive differential pressure

DEVICES REQUIRED ON RECIPROCATING COMPRESSORS

1. discharge air overtemperature on each compressor stage
2. surface overtemperature
3. oil overtemperature
4. low oil pressure, where an oil pressure system is used for lubrication
5. low oil level
6. high cooling water temperature (and low cooling water flow if necessary, see Clause 12.1h)

This list applies to all compressors, including both electric motor and diesel motor driven compressors with an input power exceeding 4kW. (ref. 3 differentiates at 15kW)

- 12.1d All protective devices shall be fail safe and include adequate levels of multiple redundancy.
- 12.1e The manufacturer shall conduct a risk assessment to ensure that adequate protective devices are installed to ensure that the compressor and prime mover will not catch fire.

NOTE 1 Some typical causes of fires are listed in ANNEX J

- NOTE 2 The connection between protective devices and potential causes of fires arrived at from a risk assessment exercise is included in ANNEX G, TABLES 1, 2, 3, 4
- 12.1f A temperature switch shall be provided at the final delivery point or flange of all compressors at the end of each stage to measure the internal air temperature. The trip point shall be as recommended by the manufacturer, but shall not exceed 160°C at an ambient temperature of 30°C for reciprocating compressors (ref 3) nor 110°C for oil flooded rotary compressors.
- 12.1g A temperature sensitive device shall be provided to monitor the surface of all compressors. The device/s shall be located where the maximum surface temperature would be expected. The device shall shut the compressor down before it reaches 150°C.
- 12.1 Delete the NOTES In this clause. Increased temperatures are not acceptable.
- 12.1h Add: Where water is used for cooling purposes a thermal protective device shall be fitted in the cooling water circuit which will cause the compressor to be stopped if the water temperature exceeds 71°C. Where such a device does not give protection under no water or no water flow conditions then a water flow protective device shall be fitted in addition. (ref 2&3)
- 12.2a Add: A means of detecting a significant oil flow reduction to critical components shall be provided on all compressors. Some of the possible methods to achieve this are as follows:-
- An oil pressure switch on compressors which require pressurised oil for their operation.
- A flow switch on the oil supply to critical components
- Systems not fitted with an oil pump in which oil pressure or flow may be difficult to monitor shall be fitted with a switch trip device to monitor high differential pressure across the oil filter.
- The trip set point for any device shall conform with the manufacturer's recommendations.
- 12.2b Add:- A low oil level oil switch/trip facility shall be provided on all compressors.(ref 2)
- 12.2c Add: All reciprocating compressors shall have an automatic shut-down device to prevent the temperature of the oil in the sump from exceeding 80°C. (ref 1).
- 12.2 Delete the NOTES In this clause. Increased temperatures are not acceptable.
- 12.3 Delete this clause: Electric Immersion heaters to heat lubricant are not recommended for use in underground coal mines.

Include new clause 12.3 as below

12.3 Output Regulation
Each constant speed compressor shall be provided with suitable automatic control equipment so that the amount of free air delivered by the compressor is monitored and controlled to meet demand to the maximum capacity of the compressor.(ref 3)

12.4 ADD Tamper resistant protection

Temperature, pressure and flow devices shall be fitted with tamper resistant devices where an unauthorised alteration to temperature, pressure or flow can cause a hazard.

Include new clause, 12.5, 13.4 and 13.5 as below

12.5 The oil filling system for compressors should be designed to ensure that overfilling with oil does not occur. Means shall be provided for the identification of the actual and required oil level.

13.4 Cooling fans shall be non aluminium, non light metal alloy and those made from non metallic materials shall have an electrical resistance not exceeding 1G ohm when measured in accordance with AS 2380.1.

13.5 Light Metals No external items shall be made from light metal unless the compressor system manufacturer can demonstrate that no reasonable, practical alternative is available, in which case the items shall be protected by means of a steel enclosure or be surface protected with a metal coating, not being a light metal coating.(For further details see ref 4)

Any openings in the steel enclosure shall not permit a straight test bar of 13 mm diameter to contact the light metal.

14.7 Add: The emergency button shall be pushed to stop the compressor and shall retain the compressor in the stationary state.

14.8 Delete this clause. Not permitted in underground coal mines.

14.9 Add : The compressor protective devices shall stop the prime mover when required to do so.

The prime mover shall include sufficient protective devices to ensure its safe operation.

ANNEX F lists the requirements for electrical devices and systems

ANNEX H lists the requirements for diesel driven compressors used in underground coal mines

14.12 Change: "200kW" to 4kW.

Include new clause 14.14 as below

14.14 All valves used in the air distribution system shall comply with the appropriate Australian Standard, AS 1628 is suitable for some applications.

15.1 Replace with:

Each compressor shall be placed in a position where the ambient air is cool and clean. Care should be taken to minimise the entry of moisture with the inlet air.

Use of a compressor in a place containing dangerous dust as defined in the Coal Mines Regulation Act (Flammable Dust - Underground Mines) Regulation, 1984 is not permitted.

15.3 Add: The ventilating quantity without recirculation is to be at least 30 times the delivery capacity of the compressor.(ref 3)

15.9 ADD:-Air intake filters shall be designed to suit the considerable dust and moisture that may be present in the underground environment.

15.10 Change: "100kW" to 4kW

Include new clause 15.12 as below.

15.12 New Clause Refer to ANNEX I for specific requirements when locating compressors underground.

Include new clause 15.13 as below

15.13 All air oil separators shall be fitted with multiple earth connections to ensure that static electricity can not build up to a dangerous level.

16.2 Add: The acceptable Australian Standard is AS 1657.

17.4 Change: "75kW" to 4kW

20.8 Delete: this clause for underground applications.

An automatic device to shut down the compressor on extended non demand should be provided.(ref 2)

23.8 Change: "100kW" to 4kW.

23.14 Add: The acceptable maximum sound pressure level without hearing protection is 85dBA. A warning that "hearing protection must be worn" shall be affixed to each compressor if noise levels exceed 85dBA when measured at a distance of 1 metre from any point from the sides of the compressor and drive assembly. The compressor shall be on maximum demand when noise measurements are taken.

23.15 Replace with new Note 1. Operation in dusty atmospheres is not permitted. The cooler shall be cleaned regularly enough to prevent any significant deterioration in performance.

Add: Oil should be periodically sampled and analysed to monitor the suitability of the intervals between oil changes.

23.16 Delete: is now covered by additional clause 12.1h

24.1 Change: "annually" to monthly.

24.6 Replace with:

When maintenance is carried out on electrically driven compressors, power shall be isolated in accordance with the Manager's Rules/Requirements.

24.8 Add: This check shall incorporate insitu simulation of the fault symptom wherever practicable and safe to do so.

24.10 Replace with: "When compressors are being repaired, steps shall be taken to prevent inadvertent starting, and the control power supply shall be disconnected in accordance with the Manager's Rules / Requirements for isolation of power.

24.13 Add: The frequency of inspections shall not exceed 6 months. (Note ref 1 specifies 3 months whilst ref 3 specifies 12 months).

ANNEX F

COMPRESSOR ELECTRICAL DEVICES AND SYSTEMS

Where electricity is used to supply the prime mover or control the operation of the compressor the following principles shall be incorporated in the design, installation and maintenance of the electrical system:-

1. The design installation and maintenance of the electrical system shall be suitable for the compressor location, use, duty cycle and electrical parameters (transient and steady state) that may be expected at the point of installation within the electrical system.
2. Any device used to monitor or control any operating condition of the compressor shall have the following attributes:-
 - (A) be adequately rated for its duty,
 - (B) in the event that any operating parameter of the compressor being outside the manufacturers recommendations then the device shall be capable of:-
 - (a) disconnecting the prime mover energy source,
 - (b) latching out the prime mover energy source, such that the compressor cannot be restarted automatically,
 - (c) providing indication as to which parameter is outside the recommended operating range, and
 - (d) be designed on the failure to safety principle.
3. All electrical components and cables shall be adequately rated and in the event of any fault or combination of faults, the electrical energy source shall be automatically disconnected from that circuit.
4. Any electrical device or system where the consequence from failure is a hazardous situation, shall have included levels of redundancy to reduce the probability of the failure leading to the hazardous situation.
5. The compressor electrical system shall be compatible with the mine electrical system such that both systems will interact in a reliable manner to maintain a safe condition.
6. Any electrical device or system that requires maintenance to maintain it's reliability shall be maintained at the frequency necessary to ensure the level of reliability necessary to minimise the probability of the hazard occurring.
7. A system of review to ascertain the effectiveness of the above selected parameters shall be initiated to ensure the risk or hazard level has not altered.

ANNEX "G"

Protection Devices - Oil Flooded Rotary Screw Type Compressors

Table 1

ISO 5388 Amendment Clause Nos	Condition Barrier	Low Oil Level	Low Oil Pressure	Separator Blockage	Blocked Oil Cooler (fan failure)	Compressor Unit Failure (bearings/ clearance)	Valve Failures (oil)	Oil Cooling Fan Motor
12.1d	Air/oil overtemp/trip	3	3	3	2	1	3	3
12.2	Oil temp/trip	2	2	2	1	2	1	2
12.1d	Discharge air overtemp/trip	4	4	4	3	5	2	5
	Oil pressure/trip	-	1	-	5	-	5	6
12.2	Air/oil overpressure/trip	-	-	1	-	6	-	-
12.1	Oil level/trip	1	-	-	4	-	4	5
	Motor overload* (*separate tripping devices)	5	5	5	6	3	6	7
	Motor thermistor*	6	6	6	7	4	7	8
	Motor interlock*	-	-	-	-	-	-	1

Note: Numbers indicate anticipated order in which each device will trip the compressor, this may vary for different compressor designs.

see tables 3 and 4 for further details of electric power supply protection devices.

Protection Devices - Reciprocating Compressors

Table 2

ISO 5388 Amendment Clause Nos	Condition Barrier	Low Oil Level	Low Oil Pressure	Blocked Intercooler	Compressor Unit Failure	Valve Failure	After Cooler Fan Motor Failure	Cooling water failure
12.1d	Discharge air temp/trip	-	-	1	2	2	1	2
12.2	Oil temp/trip	3	2	3	4	3	-	
12.2	Oil pressure trip	2	1	-	3	-	-	
	Surface temp/trip	-	-	2	5	1	-	3
12.1	Water flow trip							1
12.2	Low oil level trip	1						
	Motor overload* (*separate tripping devices)	4	3	-	1	-	-	
	Motor thermistor*	5	4	-	-	-	-	
	Motor interlock*	-	-	-	7		-	

Note: Numbers indicate anticipated order in which each device will trip the compressor, this may vary for different designs.

see tables 3 and 4 for further details of electric power supply protection devices.

**Electric Motor and Power Supply - Protective Devices
Oil Flooded Rotary Air Compressors**

Table 3

Barrier	Condition	Short Circuit Motor	Stalled Motor	Motor Overload	Under Voltage	Contractor Failure	Fault Signal	Short Circuit Cabling	Cooling Fan Stall /Fail	Fault Control Card Failure	Fault Card Detached
	Circuit breaker (fuses)	1	-	-	-	-	-	1	-	-	-
	Thermal overloads	2	1	1	2	-	-	2	-	-	-
	Phase failure reverse	-	-	-	1	-	-	-	-	-	-
	Motor thermistors	-	2	2	-	-	-	-	-	-	-
	Cooling fan fuse	-	-	-	-	-	-	-	2	-	-
	Cooling fan overload	-	-	-	-	-	-	-	1	-	-
	Contactor* * Signal "user"	-	signal via (v)	v	v	-	1	-	3	-	1
	Contactor failure protection					1					
	Fault control card*	-	v	v	v	-	v	-	v	-	-
	Transformer protection	3	3	3	-	2	-	3	-	1	-

Note: Numbers indicate anticipated order in which each device will trip the compressor, this may vary for different systems

Electric Motor and Power Supply - Protective Devices Reciprocating Compressors

Table 4

Condition	Short Circuit Motor	Stalled Motor	Motor Overload	Under Voltage	Contractor Failure	Fault Signal	Short Circuit Cabling
Barrier							
Circuit breaker (fuses)	1	-	-	-	-	-	1
Thermal overloads	2	1	1	2	-	-	2
Phase failure reverse	-	-	-	1	-	-	-
Motor thermistors	-	2	2	-	-	-	-
Contactors* * Signal "user"	-	signal via (v)	v	v	2	-	-
Contactors failure protection					1		
Transformer protection	3	3	3	-	3	-	3

Note: Numbers indicate anticipated order in which each device will trip the compressor, this may vary for different systems

ANNEX "H"

Diesel Engine Protection Device Requirements

1. Automatic Safety Shut Down System which fails to safety and operates in the event of any of the following functions (ref AS3584)
 - (a) Excessive engine cooling water temperature
 - (b) Loss of engine cooling water pressure or level
 - (c) Insufficient water in the exhaust - water conditioner system.
 - (d) Loss of engine oil pressure below the required set point
 - (e) Excessive exhaust emission temperature or a back up for insufficient water in the exhaust water conditioner.
2. Comply with Annex G. When Locating Compressors Underground as detailed herein.

- Note:
1. For Underground Coal Mines all Diesel Engine shall comply with Australian Standard AS3584 - Diesel Engine systems for Underground Coal Mines unless otherwise stated.
 2. Diesel Engines used in Underground Coal Mines generally require approval by the Regulatory Authority.

ANNEX I

GENERAL REQUIREMENTS WHEN LOCATING COMPRESSORS
UNDERGROUND (ADDITIONAL TO ISO 5388 SECTION 15)

1. Compressors shall not be placed in the hazardous zone as defined by Clause 5.1 of the Coal Mines Regulation Act (Ventilation - Underground Mines) Regulation, 1984. This includes but is not limited to:-
 - (a) areas in the vicinity of a coal mining face,
 - (b) all return airways and
 - (c) areas where flammable gas and vapours may be present in quantities sufficient to produce explosive or ignitable mixtures.
2. Location of means to isolate the compressor prime mover shall be installed within 20 metres on the intake airway side of the compressor and prime mover.
3. Install on a level floor.
4. Raise the unit sufficiently to facilitate cleaning.
5. Provide drainage, containment and collection methods for spilled or leaked oils.
6. Use non combustibile floor/wall/roof materials.
7. Ensure adequate wall/roof support.
8. Provide sufficient clearance for access to and around the unit to facilitate inspection, servicing, maintenance and ventilation in accordance with the manufacturer's instructions.

Note:- This includes sufficient external access to allow visual inspection all around any air receivers.
9. Ensure ventilation is adequate to maintain manufacturer's recommended ambient temperature, refer to ISO 5388 amendment clause 15.3.
10. Provision should be made to route the ventilating air passing over the compressor to the return airway as near as is practicable after passing the compressor.
11. Siting of compressors in proximity to combustibile materials or pipe lines which transport flammable fluids shall be avoided. e.g. methane drainage lines, diesel fuel lines.
12. Provide automatic fire detection and suppression systems for unattended compressor stations.

13. Water and fire-fighting equipment as required by Clauses 20 & 27.3 (g) of the Coal Mines Regulation Act (Fire Control - Underground Mines) Regulation, 1984 is to be supplied to within 20 metres of the intake side of the compressor site.
14. Surface monitoring of unattended underground compressors safe operation should be provided as listed below.

Surface Monitoring of Unattended Underground Compressor Stations

1. discharge air temperature
2. compressor maximum surface temperature
3. discharge air pressure *
4. ventilation air flow
5. load current
6. vibration level
7. ambient temperature *
8. smoke detection
9. Oil Separator differential pressure (rotary screw type only) *

Items marked * are not mandatory

15. Compressors installed in multiples must be adequately separated in accordance with manufacturer's recommendations.
16. A means of isolating all non-intrinsically safe electric power at the compressor site shall be installed within 20 metres on the intake airway side at the compressor site.
17. No rubbish or flammable material is to be stored or left in the compressor station.
18. A suitable means of communication which conforms with the requirements of Clause 55 of the Coal Mines Regulation (Electrical - Underground Mines) Regulation, 1984 shall be installed within 20 metres of the compressor site on the intake airway side of the compressor site.
19. The following signs in addition to those required by regulations shall be provided:-
 - (a) Instructions for restarting of the compressor after any trip
 - (b) Minimum visual inspection check-list
 - (c) Emergency procedure in the event of a fire
 - (d) Required settings of all protection devices.
20. Rules for the isolation and restoration of electric power are required to conform with the requirements of Clause 20(5) Coal Mines Regulation (Electrical - Underground Mines) Regulation, 1984.
21. It is a condition of approval under Clause 40 of the "Coal Mines Regulation (Mechanical - Underground Mines) Regulation, 1984" that stationary diesel engine driven air compressors require a person in attendance within audible and visual range of the unit at all times whilst it is in operation.

ANNEX JTYPICAL CAUSES OF COMPRESSOR FIRESN.S.W. UNDERGROUND COAL MINES

- 03.80 BRIMSTONE, RECIPROCATING Problems - oil coke in air receiver ignited, external oil hose ignited, receiver not level, automatic drain not operational, intercooler dirty. (File not available)
- 01.81 CORRIMAL, RECIPROCATING Problems - oil coke in rubber delivery hose ignited, small compressor without any temperature devices on diesel personnel car. (File not available)
CORRECTIVE ACTION - wire braided teflon hose or metal pipes required on all compressor discharge lines, regular cleaning of discharge pipework required.
- 09.81 SOUTH BULLI, PROBLEMS - short circuit on compressor starter, electrical overloads set to high, other protective devices set incorrectly. (File not available)
- 06.83 INVINCIBLE, RECIPROCATING Problems, small compressor without any compressor temperature devices, on diesel vehicle, compressor cooling water supply pump failed, diesel cooling water temperature probe failed, rubber hose on compressor discharge burnt. (File not available)
- 05.84 WYEE, ROTARY SCREW Problems - dirty oil cooling radiators, air / oil separator element displaced and found in bottom of receiver, neoprene hose between air receiver discharge and compressor inlet manifold melted as did other air lines and hoses adjacent to receiver, oil temperature interlock not connected so compressor did not shut down
Corrective action - circulating oil temperature protective device fitted. (not adequate)
- 07.84 STOCKTON BOREHOLE, ROTARY SCREW Problems - Oil leaks, oil level low, cooling radiators not clean enough, high air temperature shut down interlock did not operate.
Corrective actions - discharge thermal probe fitted, air receiver / oil separator thermal probe fitted, oil flow sensor fitted, nylon control lines replaced by steel tubes with teflon / wire braided steel flexible hoses where required for movement.
- 10.84 TAHMOOR, RECIPROCATING Problems - small compressor without any temperature devices on a P.J.B. cruiser, rubber hose on discharge of compressor overheated, burst and flame was emitted. (File not available)
- 03.89 GRETLEY, Problems electric motor contactors arched severely when closed resulting in fire, protection equipment not adequate . (File not available)

- 07.89 WEST WALLSEND, RECIPROCATING PROBLEMS - Fatigue failure of big end bolts after 8000 hours service, hole punched in side inspection cover, separation of components within crankcase generated heat which resulted in fire.
Corrective action - replace crankshaft bearings at 6000 hours service. (not adequate)
- 09.91 APPIN, ROTARY SCREW PROBLEMS - excessive oil consumption, oil leaks, failure of contactors on a number of occasions, exposed hoses in vicinity of compressor, electric wiring not suitable for exposure to heat, reasons for overheating not properly investigated prior to fire, lack of training.
Corrective actions - risk assessment conducted, frozen contactor protection fitted, maintenance system upgraded, training improved, reporting system improved, back up protective devices fitted generally as per the enclosed code. MEN EVACUATED
- 12/92 METROPOLITAN, RECIPROCATING PROBLEMS - small reciprocating compressor without any temperature devices on a rail man transporter, non return valve on discharge line blocked with coal and carbon so compressor would not unload, wire braided teflon hose overheated and failed, inlet valve restricted with coal dust.
Corrective action - improved air filters fitted, valve between compressor discharge and unloader removed.
- 06.93 AVON, ROTARY SCREW PROBLEMS - broke drain line whilst being relocated, overfilled with oil, fire in oil separator from possibly spontaneous combustion within separator, overheating was not detected due to poor location of the temperature switch i.e. it was located in a blind spot. MEN EVACUATED THROUGH SMOKE

OTHER UNDERGROUND COAL MINES

- 00/00 UTAH U.S.A., RECIPROCATING PROBLEMS maintenance neglected, protection overruled. 32 MEN DIED

N.S.W. COAL MINES SURFACE INSTALLATIONS

- 03/84 HEXHAM COAL PREPARATION PLANT, ROTARY SCREW PROBLEMS - oil cooling channels previously blocked causing overtemperature, temperature switch failed to operate, bearing on rotor shaft failed so rotors touched generating heat which caused fire.

00/90 HOWICK OPEN CUT, ROTARY SCREW PROBLEMS - not positively identified but probably (a) spontaneous combustion on the filter which can be sensed by a temperature probe or (b) initiated by electro static discharge due to the inherent design of the reclaiming element assembly which should have a more reliable series of earth connections.

OTHER LOCATIONS

00/92 OPEN CUT GOLD MINE PROBLEMS - Abraded flexible delivery line, feeding an oil - mixture into the accumulator ruptured. As a result, the oil - mixture was sprayed into the compressor control cubicle and possibly ignited due to an electrical switching operation.

00/63 GERMANY RECIPROCATING PROBLEMS - build up of carbon in discharge lines which ignited and exploded KILLING 19 MEN

00/80 U.S.A. PROBLEMS compressor started against closed valve, operating pressure exceeded, lack of other pressure relief or thermal shut-down valves, carbon deposits in discharge lines resulted in explosion CAUSING FATALITY

00/79 U.S.A. ROTARY SCREW, PROBLEMS suspected end bearing failure resulted in fire.

00/79 U.S.A. PROBLEMS oil overheated due to dirty operating environment and failure of discharge air high temperature switch.

00/78 U.S.A. PROBLEMS fire in oil separator, fuel tank explosion, failure of shut down switch allowed discharge air temperature to become excessive and ignite oil in separator.

00/77 U.S.A., ROTARY SCREW, PROBLEMS inadequate maintenance, explosion in compressor receiver separating tank.

00/76 U.S.A., PROBLEMS discharge valve failed, carbon deposits in discharge pipework ignited which in turn ignited external materials.

References

- ref 1 Safety and Health In Coal Mines - International Labour Office Geneva Code of Practice 1986.
- ref 2 Previous Guide-lines for the use of air compressors in Underground Coal Mines - Dept. of Mineral Resources N.S.W. Coal Mining Inspectorate.
- ref 3 Reciprocating Air Compressors - surface and underground N.C.B. (Production) Codes and Rules.
- ref 4 The use of light metals has been copied from clause 2.2.1 of Australian standard AS3584 Diesel engine systems for underground coal mines
- Design guide-lines for the use of aluminium underground MDG 11 as issued by the Department of Mineral Resources N.S.W. Coal Mining Inspectorate provide further information including a definition of light metal alloy.

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