Electric motors for hazardous locations

Technical section

2203E

BROOK CROMPTON

Electric motors for hazardous locations

Brook Crompton

Brook Crompton is a leading manufacturer of electric motors for the global industrial market, with motor solutions which benefit a wide range of customers.

Our products are used in almost every industrial activity including water treatment, building services, chemical/petrochemicals, general processing and manufacturing where they drive fans, pumps, compressors and conveyors, amongst other things.

Brook Crompton incorporates many well known names including Brook Motors, Crompton Parkinson, Electrodrives, Newman, Bull Electric and Hawker Siddeley Electric Motors.

We have extensive stocks of motors around the world, backed-up by a network of distributors, ensuring excellent local support wherever needed.

We have over 90 years' technical and design experience in this most specialised market and are able to ensure the correct selection of motors for any application, taking into full account the two most important factors to be considered – safety and economy.

All motors are of the highest quality, built to the latest national and International standards and certified by the relevant national authorities for use in almost every country.

The motors are operating in hostile environments throughout the world, on offshore oil and gas rigs and production platforms, onshore terminals, oil refineries, chemical works, coal mines and petrol stations, safely and efficiently delivering power with minimal attention over long periods.

Oil refineries in Abu Dhabi, chemicals and aromatics plants in Malaysia and the world's largest grain terminal in China are just a few of the recent projects in which we have been involved with the major energy companies, main specifiers and contractors – testimony enough to the expertise and reputation of the motors we manufacture and to the people who make it all work.

Quality assurance

Stringent quality procedures are observed from first design to finished product in accordance with the ISO9001 documented quality systems.

All of our factories have been assessed to meet these requirements, a further assurance that only the highest possible standards of quality are accepted.

The W range

This catalogue includes the 'W' range of motors, the result of a major development programme which involved a fundamental redesign. The principal design objective was low lifetime cost. This is achieved by high efficiency for reduced energy consumption, ease of installation and low maintenance requirements.

Benefits include:

- higher efficiency – lower running costs
- low noise levels
- 'Eurovoltage' – 400 volts ± 10% 50Hz
- dual frequency – 50Hz and 60Hz details on stock motors
- high power factors
- high torque with smooth acceleration and low current
- ease of maintenance
- IP55 protection
- IEC, NEMA and Japanese standards
- Multi-Mount versatility
- simple foot to flange conversion
- up to sixteen cable entry positions
- large easy access diagonally split terminal box
- clean modern lines
- full two year guarantee

Efficiency

Brook Crompton are an approved manufacturer of ac electric motors within the UK Government's Enhanced Capital Allowance scheme (ECA). A wide range of single and multi-speed motors are included on the UK Energy Technology List. Please check the ECA scheme website: www.eca.gov.uk at time of purchase for current listing.

Special projects division

The special projects division provides a fully comprehensive service at all stages of turnkey development. Our experience in special engineering projects extends throughout the world and embraces natural resource exploration, refining, power generation, raw material manufacture, food processing and transport engineering.

Our team of project co-ordinators have in-depth knowledge and experience of handling this type of work. Informed and technical advice is available from initial exploratory enquiries and carefully followed through to completion of contract. Liaison with main and sub-contracting companies, investigating special technical and commercial requirements, submission of proposals and, of course, competitive estimates are all part of the very special service we offer.

Our reputation has been built on the experience and customer satisfaction gained through involvement with a number of most impressive international and UK-based projects. This includes many different plant applications for some of the world's leading industrial companies. Recent examples of our success in this field are listed opposite:

Oil & Gas

Contractor	Plant/location	Client
JGC	Hawaya Natural Gas - Saudi Arabia	Aramco
Kvaerner Oil & Gas	Captain Field Development - North Sea	Texaco
LG/Lurgi Consortium	NODCO Expansion Project - Qatar	NODCO
Snamprogetti	Ruwais Refinery Expansion - Abu Dhabi	ADNOC
Snamprogetti	ASAB Gas Development - Abu Dhabi	ADNOC
SNC Lavalin	Volgograd Refinery Modification - Russia	Lukoil
Kvaerner Oil & Gas	Abbot Field - North Sea	Amerada Hess
Terra Nova Alliance	FPSO - Offshore Canada	Petro-Canada
Chiyoda/Foster Wheeler	LNG Project - Oman	Oman LNG
JGC/Kellogg JV	LNG Plant - Qatar	Ras Laffan LNG Co
Brown & Root	ETAP Project - North Sea	BP
Daelim Engineering	Compressor Station - Iran	National Iranian Gas
Brown & Root	Alba Field - North Sea	Chevron
AMEC	Curlew Field - North Sea	Shell
AMEC	Britannia Field - North Sea	Conoco
Engineers India	Bombay High Platform - India	ONGC
Brown & Root	Liverpool Bay Development - Irish Sea	BHP Petroleum
Brown & Root/Aker Engineering	Ula Field - Norwegian North Sea	Phillips
R M Parsons	Kalundborg Condensate - Denmark	Statoil
AMEC	Bonga Field - Nigeria	Shell Nigeria
Technip Italy	Haradh Gas - Saudi Arabia	Saudi Aramco
AMEC	Berri Gas - Saudi Arabia	Saudi Aramco
Snamprogetti	Bhit Field - Pakistan	Lasmo Oil
Bechtel/Snamprogetti	Karachaganak - Kazakhstan	BG/Agip/Lukoil
Parsons/Fluor Daniel	Tengiz - Kazakhstan	Tengizchevroil

Chemicals and petrochemicals

Toyo Engineering	Kerteh - Malaysia	Aromatics Malaysia
Toyo Engineering	Kerteh - Malaysia	Vinyl Chloride (Malaysia)
Snamprogetti	Fertiliser Plant - Venezuela	Pequiven-Koch
Foster Wheeler	PTA Plant - Pakistan	DuPont
Bechtel	PTA Plant - Saudi Arabia	Arabian Industrial Fibres
Snamprogetti	Alpha-Alcohols Plant - China	Jilin Chemical Ind
JGC	Sriracha Base Oil - Thailand	Thai Lube Base Co
Kvaerner	PTA Plant - Indonesia	Petrokema
Jacobs Engineering	Pharmaceuticals - Ireland	Wyeth-Ayerst
Jacobs Lend Lease	Pharmaceuticals - Singapore	Pfizer/Parke Davis
ABB Lummus Global	Moerdijk - Netherlands	Shell Chemie BV
Kvaerner Engineering	Seal Sands - UK	Ineos Acrylics
ABB Lummus Global	Seraya - Singapore	Seraya Chemicals
Kvaerner Process	Swords Laboratories - Ireland	Bristol Myers Squibb
Foster Wheeler	Pharmaceuticals - Singapore	Schering Plough
Jacobs Engineering	Avon - Bristol	Astra Zeneca

General

ASC Materials Handling	Grain Terminal - China	Dalian Xizui Grain Terminal
Yarrow Shipbuilders	Offshore Patrol Vessels - UK	Royal Brunei Navy
Meyer Werft	Aurora Cruise Liner - Germany	P & O Cruise Liners
Kilborn - ENKA	Gold Mine - Kyrgystan	Kumtor Gold
Bi-water	Mafraq Water Treatment - UAE	Government
Drake & Skull	Jubilee Line - UK	London Underground
Metro de Caracas (In house)	Caracas Metro - Venezuela	C A Metro de Caracas
Fluor Daniel	Paper Mill - UK	Bridgewater Paper
Fives-Cail Babcock	Cement Plant - Qatar	QNCC
Davy McKee	Kwang Yang Steel Works - Korea	Pohang Iron & Steel
Andritz AG	Sludge Drying Plant - Scotland	Scottish Water
MHI	Nagasaki Shipyard - Japan	P & O Cruise Liners
Ford (In house)	Puma & Lynx Engine Plants - UK	Ford Motor Co
GE Supplies	Engine Plants - UK & Germany	General Motors

Power

GEC Alstom PP	Ling Ao Power Station - China	Ling Ao Nuclear Power
Alstom Power Plants	Power Station - Taiwan	Ho-Ping Power
GEC Alstom PP	Sual Power Station - Philippines	Pangasinan Electrical Co
IHI	Seraya Power Station - Singapore	Public Utilities Board
Alstom Automation	Tamnin - Mexico	TEG
Mitsubishi Heavy Ind	Kangol - Turkey	TEK
Alstom Power	Can - Turkey	Turkish Electricity
Alstom Energy	Manjung - Malaysia	TNB Janamanjng

ATEX Directive 94/9/EC

General
A potentially explosive atmosphere is one which **could** become explosive under certain conditions (the danger is a potential one).

An explosive atmosphere is one where a mixture with air, under atmospheric conditions of flammable substances in the form of gas, vapour, mist or dusts exist in such proportions that they can be ignited by excessive temperature, arcs or sparks (the danger is a real one).

Safety
Safety is of paramount importance in the use of electrical equipment in flammable or potentially flammable atmospheres. Correct selection of motors for hazardous atmospheres is therefore essential, bearing in mind the economics of the various types of motor available.

The notes which follow are taken mainly from the CENELEC/EURONORM standards EN 50 014 and EN 50 018. Reference is made to other standards where applicable.

ATEX
ATEX (**AT**mosphères **EX**plosible) is the European Directive 94/9/EC. It applies to all equipment either electrical or mechanical used in hazardous atmospheres both dust and gas. The directive was introduced in 1994 and allowed a ten year period for introduction. All equipment manufactured after 30 June 2003 must comply with ATEX.

The main purpose is to remove barriers to trade throughout the European Community. It also lays down specific requirements for users of such equipment.

The essential elements of ATEX involve:- Notified Bodies, Standards, Conformity Assessment, Marking and Documentation.

The ATEX Directive is complementary to other directives such as Machinery Directive, Low Voltage Directive and Electromagnetic Compatibility. To show compliance with any of these directives, equipment is CE-marked accordingly. It is further complemented by the 'USE' Directive (1999/92/EC) which sets down the requirements for the safety and health protection of workers potentially at risk from explosive atmospheres.

Notified Bodies
These were previously referred to as Testing Authorities. European Notified Body provides Brook Crompton's ATEX approval and certification to the appropriate standard. This includes category 2 and 3 equipment even though the latter could be self certified.

Standards
Standards must be current. This may mean, as with dust, entirely new standards. In the case of others, eg EEx d motors, the standards have remained the same in substance – the latest editions contain only small detail changes.

Zones
Equipment categories
Equipment categories are another change which has been introduced. Equipment will now have a category number appropriate to the Zone for which it is intended to operate (see table on page 5).

Zones remain the same as previously for gas *but in the case of dust,* a new system using Zones 20, 21 and 22, has been introduced.

Certification
Certification by a Notified Body is only mandatory for equipment categories 1 and 2. For category 3 equipment manufacturers are allowed to issue their own certificate of compliance. Our motors for category 3 however will have a type examination certificate issued by EECS/BASEEFA.

Conformity assessment
A process identical with the current certification procedure. In addition Quality Assessment (or Verification module) is carried out by a Notified Body - in our case EECS/BASEEFA.

Marking
This is the area of greatest visible change and is detailed on opposite page. Motors for gas hazards will contain the familiar marking (EEx de IIC T4 for example) preceded by a string of symbols (see opposite page).

Documentation
Specific installation and maintenance instructions are a mandatory part of obtaining approval and must be supplied for ATEX equipment.

CENELEC/Euronorm standards
Before the existence of these standards, each country had its own national standards. The EU member countries now have a common standard for flameproof motors: EN 50 014 and EN 50 018. The standard can be certified by any of the notified bodies (certifying authorities) of the member countries. These motors are therefore acceptable in all EU countries and most other European countries. Countries outside Europe which often base their standards on British Standards are expected to follow in due course.

Motors thus certified are prefixed EEx – eg flameproof motors, EEx d.

Hazardous atmosphere motor marking

	European Directives	ABBV	Ref Nos	Items covered
CE MARKING	Low Voltage Directive	LVD	73/23/EEC 93/68/EEC	Electrical equipment Range 50 - 1000 volts, ac
	Electromagnetic Compatibility	EMC	89/336/EEC 92/31/EEC 93/68/EEC	EN 60034-1
	Machinery Directive	MD	89/392/EEC 91/368/EEC 93/44/EEC 93/68/EEC	Not applicable to electric motors as they are 'components'
	ATEX Directive	ATEX	94/9/EC	Hazardous atmosphere Equipment - mandatory after 30/6/2003

Compliant with European Directives

EC Mark
for electrical equipment in hazardous atmospheres

Notified body (test house), identification number **(0600 = EECS/BASEEFA)**

Equipment group

Group	*Application*
I	Mining
II	Non-mining

E - European certification

Ex - Explosion protection

Temperature class	*Maximum surface temperature*
T1	450°C
T2	300°C
T3	200°C
T4	135°C
T5	100°C
T6	85°C

Note: EEx d and EEx de - external temperature only, EEx e and EEx nA - internal and external temperatures

CE 0600 Ex II 2 G EEx de IIC T4

Note re numerals

Numerals	*Arabic*	*Roman*
Categories	1, 2, 3	-
Zones	0, 1, 2	-
Equipment Groups	-	I, II

G = Gas ***OR*** **D** = Dust

d - Flameproof to EN 50018
e - Increased safety to EN 50019
nA - Non-sparking EN 50021
de - Flameproof with increased safety terminals EN 50018 & 19

Dust - EN 50281-1-1

Flameproof symbol	*Typical gas*
A	Propane
B	Ethylene
C	Hydrogen

NB *EEx e and EEx nA are suitable for all gases subject to temperature and other operating conditions, this symbol is therefore omitted*

Equipment category

Gas symbol G		*Dust symbol D*		*Zone Criteria Presence of Gas or Dust*
Category 1	Zone 0	Category 1	Zone 20	Continuously or very long period
Category 2	Zone 1	Category 2	Zone 21	Present in normal operation
Category 3	Zone 2	Category 3	Zone 22	Unlikely but if present, then only for a short time

Note: Category 1, Zone 0 and Zone 20 are not applicable to ***electric motors***

Dust are marked differently, eg:
CE 0600 Ex II 2 D T125°C
T125°C = certified external surface temperature

Standards, directives and approval authorities

European Directives

Four European directives apply in varying degrees to AC induction motors. Brook Crompton comply in the following manner:-

Compliance with European directives applying to AC induction motors

Directives	Low voltage (LV)	Machinery (MD)	Electromagnetic compatibility (EMC)	ATEX
Reference numbers	73/23/EEC 93/68/EEC	89/392/EEC 91/368/EEC 93/44/EEC 93/68/EEC	89/336/EEC 92/31/EEC 93/68/EEC	94/9/EC
Motor CE marked	Yes	No	No	YES
Standards	EN 60034	Not applicable	EN 60034-1	EN 50014 EN 50018 EN 50019 EN 50021 EN 50281
Documentation for customers' technical file	Declaration of conformity	Certificate of incorporation	Statement[1]	Declaration of conformity
Safety instructions with every motor	Yes	Yes	Yes	Yes
Comment	Relevant electrical equipment operating between 50 to 1000 volts AC	Statement[2]	Component	Hazardous atmosphere equipment - mandatory after 30/6/2003

[1] Motors operating from a correctly applied, sinusoidal (AC) supply meet the requirements of the EMC directive and are within the limits specified in standard EN 60034-1

[2] When installed in accordance with our customer safety and installation and maintenance instructions, they can be put into service only when the machinery into which they are being incorporated, has been declared to be in conformity with the machinery directive in accordance with Article 4(2) and Annex IIB of that Directive (98/37/EEC)

Standards

Hazardous atmosphere motors are manufactured to the standards of the countries listed below.

Standards

Range	*National standard* *UK*	*European*				*International*	*North American*
Standard	**BS**	**BS**	**VDE**	**DIN**	**NF**	**IEC**	**NEMA***
Outputs	BS 5000 part 10, appendix A	BS 5000 part 10	–	DIN 42673, DIN 42677	NF C51-110	–	MG1 part 10
Performance	BS 4999 Part 101	BS 4999 part 101	VDE 0530 part 1	–	NF C51-111	IEC 60034-1	MG1 part 12
Dimensions	BS 4999 part 141	as DIN and NF	–	DIN 42673, DIN 42677	NF C51-105, NF C51-120	IEC 60072-1	MG1 part 4
Mounting	EN 60034-7	EN 60034-7	–	DIN 42950	NF C51-117	IEC 60034-7	MG1 part 4
Degrees of IP protection	EN 60034-5	EN 60034-5	–	DIN 40050	NF C51-115	IEC 60034-5	MG1-1.26B
EEx d Flameproof	EN 50014 EN 50018	EN 50014 EN 50018	VDE 0171	–	–	IEC 60079-0 IEC 60079-1	–
EEx de Flameproof with increased safety terminals	EN 50014 EN 50018 EN 50019	EN 50014 EN 50018 EN 50019	VDE 0171	–	–	IEC 60079-0 IEC 60079-1 IEC 60079-7	–
EEx e Increased safety	EN 50014 EN 50019	EN 50014 EN 50019	–	–	–	IEC 60079-0 IEC 60079-7	–
EEx nA Non-sparking	EN 50014 EN 50021	EN 50014 EN 50021	–	–	–	IEC 60079-15	–
Dust hazard	EN 50281 - 1-1 EN 50281 - 1-2	EN 50281 - 1-1 EN 50281 - 1-2	–	–	–	–	–

standard motor complies *optional*

*Motors complying with IEC 60034-1 also comply with many of the national standards of other European countries, eg CEI 203 (Italy), NBN7 (Belgium), NEN 3173 (Netherlands), SEN 2601 01 (Sweden) *Motors to NEMA standards have CSA approval and generally comply with Canadian (EEMAC) standards.*

IEC standard 60079

This gives practical help in the selection, installation and maintenance of electrical apparatus for use in potentially explosive atmospheres. It deals with the installation and maintenance requirements appropriate to one of the types of protection that may be used to achieve electrical safety or with basic requirements and considerations that are fundamental to the use of electrical apparatus in potentially explosive atmospheres. The parts which concern electric motors are:
EN 60079 – 14 – Types d and e.

The classification of hazardous areas is detailed in EN 60079.
Dust hazards are detailed in EN 50281-1-1
EN 50281-1-2

Approval Authorities

European

EECS/BASEEFA and MECS

Approvals are through the Electrical Equipment Certification Service (EECS) of the Health and Safety Laboratory based at Buxton, England or other notified bodies. This service covers approvals by EECS/BASEEFA, the Electrical Equipment Certification Service/British Approvals Service for Electrical Equipment in Flammable Atmospheres which is a notified body for all types of motors for use in hazardous atmospheres in surface industries. MECS, is the Mining Equipment Certification Service for motors in mines.

Both BASEEFA and MECS issue certificates stating that equipment meets the requirements laid down in EURONORM Standards, these supersede the formerly recognised 'Buxton' certificate.

Mines

For mines susceptible to firedamp, flameproof motors enclosure Group I designated and marked MEx are used (formerly FLP).

Australian

NSW – New South Wales Mines Approval is held and motors to AS 2380.2–1991, and certificate Ex 230 for non-mining applications.

South African

Certified motors for both industry and mines can be supplied.

S. Commission

Motors for S Commission (former Yugoslavian territories). We can supply EEx de motors with increased safety terminals fitted with sealing chamber as required by the S Commission.

North American standards

Hazardous location electrical equipment is dealt with in:

USA: by the National Electrical Code – NEC articles 500 to 516.

Canada: by the Canadian Electrical Code – C22.1 – Part 1 – Section 18.

Canadian

CSA – Canadian Standards Association. Motors with CSA approval to imperial or metric dimensions are available. These are certified for Class 1 Division 1 or Class 1 Division II.
NB CSA motors are often acceptable in the USA. EMR – Energy, Mines and Resources Canada – certified motors are available.

German

PTB – Physikalisch-Technische Bundes-anstalt certify a full range of flameproof (pressure-tight) motors to German Standard VDE 0171/2-61 can be supplied.

Russian

Motors certified by Glavgosenergonadzor (State Power Inspectorate Body) for general surface use can be supplied.

Marine

The Brook Crompton Ex range of certified motors can be supplied to the requirements of most major Marine specifications. Table 3 lists the main requirements.

VIK

Motors built to VIK (Verband der Industriellen Energie- und Kraftwirtschaft e.V.) comply with the requirements of this specification.

Marine motor specifications

Classifying authority	*Service*	*Ambient temp °C*	*Permissible temp rise K* ≤*Class B*	≤*Class F*	*Key special requirements Normalised shaft steel*	*Witnessed tests for essential service*
Lloyds register of shipping (LRS)	Restricted Unrestricted	40 45	75 70	90 90	≥75kW	≥100kW
Det Norske Vertitas (DNV)	Restricted Unrestricted	35* 45	80 70	100 90	≥65mm shaft dia	≥100kW
Germanischer Lloyd (GL)	Restricted Unrestricted	40 45	80 75	100 95	≥75kW	≥100kW
American bureau of shipping (ABS)	Essential Non-Essential	50 40	70 80	95 105	–	≥100kW
Korean register of shipping (KRS)	Essential Non-ssential	50	70	90	All motors	All motors(1)
Chinese Classification societies (CCS)	Essential Non-essential	50	70	90	**	**
Bureau vertitas (BV)	Essential Auxiliaries	50 40 45	70 80 75	90 100 95	≥100kW	≥100kW essential
Registro Italiano Navale (RINA)	Essential Non-Essential	50 40	70 80	90 100	All motors	≥100kW
Nippon Kaiji Kyokai (NKK)	Essential Non-essential	45	75†	95†	–	All motors for essential service

** Refrigerated holds only; † 5°K allowed on non ventilated, totally enclosed motors*
*** Refer to Brook Crompton*
(1) Discretion of local surveyor
Other classifications available on request. Please contact Brook Crompton for details

Protection concepts

Licence and mark

This document is issued by the Notified Body (Certifying Authority), allowing the use of the Authority's distinctive mark. The licence is only issued after surveillance has been completed at the place of manufacture.

The licence is issued for a period of three years and on-going surveillance and random checks can be carried out by the Notified Body.
The marks include:

Ex – Group II
Equipment for surface industry issued for BASEEFA by EECS

Ex – Community Mark
This is issued in conjunction with the above to indicate that motors comply with the CENELEC/EURONORM standard

Ex
PTB for surface industry

MEx (Previously FLP)
Group I equipment for mines issued for MECS by EECS

CSA
Canadian Standards Association

A
Trade Agents

CE 0600 Ex II 2 G

Typical ATEX marking

Documentation

Licence – EEx d, EEx e EEx nA and dust
Issued by the certifying authority for a period of three years allowing use of the EECS/BASEEFA Ex mark.

Certificate of Conformity – EEx d
These motors comply with the relevant CENELEC/EURONORM standard.

Prime certificates
Result from new submissions made for certification.

Supplementary certificates
Result from submissions for variations of certified equipment.

EC Type examination Certificate – EEx e and Dust Category 2
Similar to certificate of conformity, but giving details of the construction of the motor and the various parts.

Type examination Certificate – EEx nA and Dust Category 3
These motors comply with the ATEX Directive.

Impact test

As part of the certification procedures for all Hazardous Atmosphere Motors, tests are carried out to ensure that motors will withstand a specified impact. The test involves dropping a test mass with a hemispherical head of 25mm diameter, and a mass of 1kg, a distance of 0.7 metres onto all parts of motors. Particular areas for attention are fan covers, terminal boxes and cable entries. Minimum clearance of fans and covers must be maintained after the test and terminal boxes must maintain the IP55 enclosure.

Flashpoint vs ignition temperature

Auto Ignition Temperature is the temperature at which a gas, vapour or mist will ignite **without the presence of a spark or flame**. The temperature at which ignition occurs due to a spark or flame is known as the **Flashpoint** – see examples below.

Flashpoint vs ignition temperature

Gas/vapour/liquid	*Flashpoint*	*Auto ignition temperature*
Acetal	-20°C	230°C
Acetadol	66°C	245°C
Acetone	-18°C	535°C
Benzyl Alcohol	100°C	435°C
Benzene	-17°C	560°C
Petrol	-45°C	220°C
Paraffin	38°C	210°C

Motor selection must therefore ensure that the maximum surface temperature class must not exceed the **Auto Ignition Temperature** of the explosive mixture.

Temperature considerations

The minimum temperature at which a gas, vapour or mist ignites spontaneously, at atmospheric pressure, is known as the **Auto Ignition Temperature**. To avoid the risk of explosion, the temperature of any part or surface of the motor exposed to the surrounding atmosphere must always remain below the **Auto Ignition Temperature** of the mixture.

The classification of the maximum motor surface temperature is detailed in the table below. Motors to EN 50014, EN 50018, EN 50019 and EN 50021, have a temperature 10°C lower than T1 and T2, and 5°C lower than T3 and lower temperature classes.

Temperature classification

Temperature class	*Maximum surface temperature (°C)*
T1	450
T2	300
T3	200
T4	135
T5	100
T6	85

Ambient temperature

The reference ambient temperature to be taken into consideration in the design of these motors is 40°C. Standard certification covers ambient temperatures down to minus 20°C.

Motors can be offered suitable for ambient temperatures of between -55°C and +80°C. In such cases the temperature is indicated on the certification plate attached to the motor.

Very low ambient for EEx d

EEx d motors have been tested at very low ambient temperatures by EECS/BASEEFA. They are available as follows:

Enclosed group	Ambient temperature
IIA/IIB	-55°C
IIC	-20°C

Groups

Electrical apparatus for potentially explosive atmospheres is divided into:

Group I: Mines.

Group II: All potentially explosive atmospheres other than mines.

Categories and zones

The degree of danger varies from extreme to rare. Hazardous areas are classified into three **Categories** and six **Zones** as follows:

Category 1- Zone 0 in which an explosive gas-air mixture is continuously present or present for long periods.
NB No motors may be used in Zone 0.

Category 2 - Zone 1 in which an explosive gas-air mixture is likely to occur in normal operation.

Cateogory 3 - Zone 2 in which an explosive gas-air mixture is not likely to occur in normal operation and if it occurs it will exist only for a short time.

Category 1 - Zone 20 in which a combustible dust-air mixture is continuously present or present for long periods.
NB No motors may be used in Zone 20

Category 2 - Zone 21 in which a combustible dust-air mixture is likely to be present during normal operation.

Category 3 - Zone 22 in which a combustible dust-air mixture is not likely to occur in normal operation, but if present them only for a short period of time.

By implication, an area that is not classified Zone 0, 1, 2, 20, 21 or 22 is deemed to be a non-hazardous or safe area.

Hydrogen

EEx e motors are suitable for use in Zone 1 hydrogen atmospheres subject to the usual conditions appertaining to EEx nA motors – S1 duty, T1, T2 or T3 surface temperatures, no prolonged run-up time involved and control gear to disconnect within the t_E time.

EEx nA motors are suitable for use in Zone 2 hydrogen atmospheres subject to conditions appertaining to the use of EEx nA motors, ie as for EEx e, but special control gear is not mandatory.

EEx de, IIC W range motors and flameproof (pressure-tight) PTB certified (Ex)d 3n G4 motors are suitable for use in Zone 1 hydrogen atmospheres. These have EEx e increased safety terminals with weatherproof IP55 terminal boxes.
NB the terminal box is not flameproof.

Protection concepts

Sub-division and enclosure group or apparatus group: flameproof motors

For hazardous atmospheres in surface industry (ie **not** in coal mines), apparatus Group II equipment is used. In the case of flameproof motors -EEx d and EEx de, which are designed to contain a gas explosion within the motor, it is necessary to take account of the different explosive forces and flames which various gases produce.

Using the maximum experimental safe gap, the standards-making bodies specify safe working dimensions for particular gases which are sub-divided and grouped into A, B or C. These sub-divisions are in ascending order of increasing explosive force/energy levels. This means that motors eg Group IIB are suitable for IIA also. In North American standards, the groups are reversed compared to European standards and this is detailed on page 16.

The table shown on page 12, details gases and chemical compounds together with temperature classification and ignition temperature. This table shows the appropriate sub-division, apparatus or enclosure group for flameproof motors.

Certification plate group markings - flameproof motors

Flameproof motors are marked WITH a suffix letter after the group symbol II to indicate the sub-group:-
EEx d IIB T4 or
EEx de IIB T4.
(T4 relating to the T class)

Non-flameproof motors

EEx e, and EEx nA motors are totally enclosed (TEFV or TENV) type - NOT flameproof and NOT designed with flamepaths. The enclosure or apparatus groups A, B and C therefore have no relevance to these motors - only to flameproof EEx d and EEx de types.
In the case of EEx nA motors complying with the requirements of EN 50021 -Electrical apparatus with type of protection “n”, the suffix letter A indicates non-sparking requirements for ac motors and should not be confused with enclosure or apparatus groups. These motors therefore are marked WITHOUT a suffix letter after the group symbol II, to indicate that they are suitable for all gases within the
T class, as follows:-
EEx nA II T3 or
EEx e II T3

Explosion tests

Flameproof motors are submitted to the testing authority who carry out proving tests in an explosion chamber. During these tests, motors are filled with a gas/air mixture and placed inside a chamber containing a similar gas/air mixture. The gas inside the motor is ignited by means of an electrical spark. A number of tests are conducted and only when the authority can witness that a secondary explosion on the outside of the motor will not occur, does the motor pass the explosion test.

Type of protection for Zone 1 areas: d flameproof

A type of protection in which the parts which can ignite an explosive atmosphere are placed in an enclosure which can withstand the pressure developed during an internal explosion of an explosive mixture and which prevents the transmission of the explosion to the explosive atmosphere surrounding the enclosure.

Flameproof theory

A gap between metal surfaces or flame-path need not be totally closed to stop the passage of a flame. The smallest gap or flame-path necessary to prevent the passage of a flame varies according to the gas or vapour involved. Gases and vapours are sub-divided according to experimental data which has been established to determine the maximum experimental safe gap (MESG). In the case of metal to metal joints in a flameproof motor, eg endshield to frame, these will consist of a long metal spigot fitting into a long recess which will normally be clamped tight by the fixing bolts.

A gap/flamepath, however, will always exist between the shaft and the motor interior. Safety is therefore achieved in a flameproof motor by ensuring that all the gaps/flamepaths in the motor can never exceed mandatory dimensions and that the motor is physically capable of withstanding an internal explosion without transmitting this to the external atmosphere.

Type of protection for Zone 1 areas: e increased safety

The method of protection by which additional measures are applied to electrical equipment so as to give increased security against the possibility of excessive temperatures and of the occurrence of sparks and arcs during the service life of the apparatus. It applies only to equipment no parts of which produce sparks or arcs or exceed the limiting temperature in normal service.

These motors are **not** flameproof and **not** built to withstand an internal explosion. They are designed to ensure safety by means of a number of special features to ensure freedom from arcs, sparks or dangerous surface temperatures under all conditions of operation. They resemble standard motors in appearance, but have special increased safety terminals within an IP55 terminal box. The main features of the Increased Safety motors are:

1. special attention to air gap concentricity and clearance of all rotating parts
2. components subject to impact tests
3. temperature rise 10°C lower than the permitted maximum for that class of insulation
4. maximum internal or external surface temperature T1, T2 or T3
5. compliance with t_E characteristic
6. special terminal board to accommodate specified creepage and clearances, with non twist terminations and vibration proof cable fixing
7. terminal box with IP55 enclosure

The maximum surface temperature T, applies to all surfaces of the motor, both internal and external. Under locked rotor conditions, the rotor temperature in certain designs increases faster than that of the stator windings. In either event, this is catered for in conjunction with compliance with the t_E time.

t_E time

This is defined as the time taken for ac windings when carrying the starting current I_A to be heated up from temperature reached in rated service and at maximum ambient temperature to the limiting temperature.

In the graph below, OA represents the maximum ambient temperature and OB is that reached in normal working. If a fault should occur and the rotor becomes locked, then the conditions shown in part 2 of the graph will apply. The motor temperature will increase very rapidly to OC which is just less than the T classification for the motor. The motor will reach point OC in time t_E.

Control gear must be provided to disconnect the motor from the supply within this time t_E. These motors are EECS/BASEEFA certified and suitable for use in Zone 1 areas and have a maximum temperature of T1, T2 or T3. They are intended for S1 duty, ie continuous running, and are unsuitable for those involving frequent starts/stops or long run-up times.

Type of protection for Zone 2 areas: nA non-sparking

A type of protection applied to electrical apparatus such that, in normal operation, it is not capable of igniting a surrounding explosive atmosphere and a fault capable of causing ignition is not likely to occur.

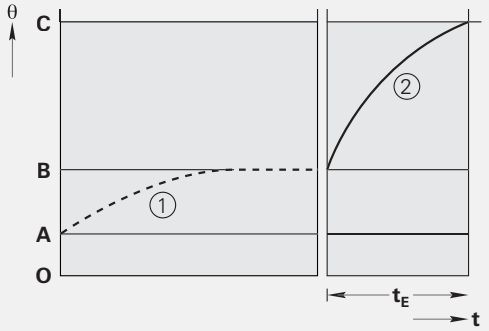
These motors are for use in Zone 2 hazardous locations. The EEx nA motors are very similar in construction to the standard TEFV machine. The main points of difference are:

1 special attention to air gap concentricity and clearance of all rotating parts
2 components subject to impact test
3 maximum internal or external surface temperature T3
4 type examination approved

It will be seen that many of the above features are similar to Type e except that standard outputs are obtained from the motors, ie no derating is involved. Because these motors are used in Zone 2 locations, internal and external surfaces are limited to T3 at all times except during the starting period.

Special conditions of operation

EEx e and EEx nA motors do not produce arcs or sparks but have limited (internal and external) surface temperatures. It is this surface temperature which determines the gas atmosphere in which they can operate together with limitation to S1 duty only, and in the case of EEx e motors, no prolonged acceleration period, together with control gear to disconnect the motor within the t_E time. These motors can be used in the appropriate zones with any gases subject to these restrictions.



Comparison of types d, e and nA methods of protection

Zone *Type of protection design*	*1 or 2* *d* *Flameproof*	*1 or 2* *e* *Increased safety*	*2 only* *nA* *Non-sparking*
Object of construction	To contain any explosion and ensure it is not transmitted	To ensure that arcs and/or sparks cannot occur in normal service	To ensure that arcs and/or sparks cannot occur in normal service
Temperature limitations	External surface at all times	Internal and external surfaces at all times	Internal and external surfaces at all times except during the starting period
t_E Time	Not applicable	Arrangements must be made to ensure motor is disconnected within the t_E time	Not applicable
Method of construction	Ferrous metal frame with long flamepaths on all mating surfaces	Similar to standard motor with close attention to clearances of all rotating parts	Similar to standard motor with close attention to clearances of all rotating parts
Frame/speed/output relationship	Standard	Reduced	Standard
Terminal box	Flameproof* Enclosure is IP55	Increased safety terminals within an IP55 enclosure	Terminal board material ensures anti-tracking giving a minimum CTI[r] of 175 Enclosure is IP55

** NB motors described as EEx de and PTB certified (Ex)d 3n motors have increased safety terminals written on IP55 box (not a flameproof box).*
[r] Comparative tracking index
Provided the temperature classification is correct a motor for use in Zone 1 areas can be utilised in Zone 2 or safe areas.
A Zone 2 motor may also be used in safe areas.

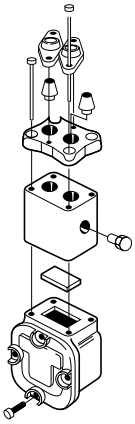
Properties of some gases, vapours and liquids*

Compound	Ignition temp (°C)	T class	Apparatus group	Compound	Ignition temp (°C)	T class	Apparatus group
acetaldehyde	140	T4	IIA	ethanolamine	-	-	IIA
acetic acid	485	T1	IIA	ethoxyethanol	235	T3	IIB
acetone	535	T1	IIA	ethyl acetate	460	T1	IIA
acetylacetone	340	T2	IIA	ethyl acrylate	-	-	IIB
acetyl chloride	390	T2	IIA	ethylbenzene	431	T2	IIA
acetylene	305	T2	**†	ethyldigol	-	-	IIA
acrylonitrile	480	T1	IIB	ethylene	425	T2	IIB
allyl chloride	485	T1	IIA	ethylene oxide	440	T2	IIB
allylene	-	-	IIB	ethyl formate	440	T2	IIA
ammonia	630	T1	IIA	ethyl mercaptan	295	T3	IIA
amphetamine	-	-	IIA	ethyl methyl ether	190	T4	IIB
amyl acetate	375	T2	IIA	ethyl methyl ketone	505	T1	IIA
amyl methyl ketone	-	-	IIA				
aniline	617	T1	IIA	formaldehyde	424	T2	IIB
				formdimethylamide	440	T2	IIA
benzene	560	T1	IIA				
benzaldehyde	190	T4	IIA	hexane	233	T3	IIA
benzyl chloride	585	T1	IIA	hexanol	-	-	IIA
blue water gas	-	T1	IIC	heptane	215	T3	IIA
bromobutane	265	T3	IIA	hydrogen	560	T1	IIC
bromoethane	510	T1	IIA	hydrogen sulphide	270	T3	IIB
butadiene	430	T2	IIB				
butane	365	T2	IIA	isopropylnitrate	175	T4	IIB
butanol	340	T2	IIA				
butene	440	T2	IIB	kerosene	210	T3	IIA
butyl acetate	370	T2	IIA				
butylamine	(312)	(T2)	IIA	metaldehyde	-	-	IIA
butyldigol	225	T3	IIA	methane (firedamp)	595	T1	I
butyl methyl ketone	(530)	(T1)	IIA	methane (industrial) X	-	T1	IIA
butyraldehyde	230	T3	IIA	methanol	455	T1	IIA
				methoxyethanol	285	T3	IIB
carbon disulphide	100	T5	**†	methyl acetate	475	T1	IIA
carbon monoxide	605	T1	IIB	methyl acetoacetate	280	T3	IIA
chlordimethyl ether	-	-	IIA	methyl acrylate	-	-	IIB
chlorobenzene	637	T1	IIA	methylamine	430	T2	IIA
chlorobutane	(460)	(T1)	IIA	methylcyclohexane	260	T3	IIA
chloroethane	510	T1	IIA	methylcyclohexanol	295	T3	IIA
chloroethanol	425	T2	IIA	methyl formate	450	T1	IIA
chloroethylene	470	T1	IIA				
chloromethane	625	T1	IIA	naphtha	290	T3	IIA
chloropropane	520	T1	IIA	naphthalene	528	T1	IIA
coal tar naphtha	272	T3	IIA	nitrobenzene	480	T1	IIA
coke oven gas	-	-	‡	nitroethane	410	T2	IIB
cresol	555	T1	IIA	nitromethane	415	T2	IIA
cyclobutane	-	-	IIA	nitropropane	420	T2	IIB
cyclohexane	259	T3	IIA	nonane	205	T3	IIA
cyclohexanol	300	T2	IIA	nonanol	-	-	IIA
cyclohexanone	419	T2	IIA				
cyclohexene	(310)	(T2)	IIA	octaldehyde	-	-	IIA
cyclohexylamine	290	T3	IIA	octanol	-	-	IIA
cyclopropane	495	T1	IIB				
				paraformaldehyde	300	T2	IIB
decahydronaphthalene	260	T3	IIA	paraldehyde	235	T3	IIA
diacetone alcohol	640	T1	IIA	pentane	285	T3	IIA
diaminoethane	385	T2	IIA	pentanol	300	T2	IIA
diamyl ether	170	T4	IIA	petroleum	-	-	IIA
dibutyl ether	185	T4	IIB	phenol	605	T1	IIA
dichlorobenzene	(640)	(T1)	IIA	propane	470	T1	IIA
dichloroethane	440	T2	IIA	propanol	405	T2	IIA
dichloroethylene	(440)	(T2)	IIA	propylamine	(320)	(T2)	IIA
dichloropropane	555	T1	IIA	propylene	(455)	(T1)	IIA
diethylamine	(310)	(T2)	IIA	propyl methyl ketone	505	T1	IIA
diethylaminoethanol	-	-	IIA	pyridine	550	T1	IIA
diethyl ether	170	T4	IIB				
diethyl oxalate	-	-	IIA	styrene	490	T1	IIA
diethyl sulphate	-	-	IIA				
dihexyl ether	185	T4	IIA	tetrahydrofuran	(260)	(T3)	IIB
di-isobutylene	(305)	(T2)	IIA	tetrahydrofurfuryl alcohol	280	T3	IIB
dimethylamine	(400)	(T2)	IIA	toluene	535	T1	IIA
dimethylaniline	370	T2	IIA	toluidine	480	T1	IIA
dimethyl ether	-	-	IIB	town gas (coal gas)§	-	T1	IIB
dipropyl ether	-	-	IIB	triethylamine	-	-	IIA
dioxane	379	T2	IIB	trimethylamine	(190)	(T4)	IIA
dioxolane	-	-	IIB	trimethylbenzene	470	T1	IIA
				trioxane	410	T2	IIB
epoxypropane	430	T2	IIB	turpentine	254	T3	IIA
ethane	515	T1	IIA				
ethanol	425	T2	IIA	xylene	464	T1	IIA

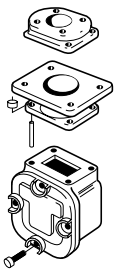
** Extracted from BS5345 Part 1 (now superseded by IEC 60079-14). ** Not yet allocated to a subgroup*
† For C_2H_2 and CS_2 flameproof equipment is not specified, but intrinsically safe equipment of group IIC may be used. ‡ Apparatus group will depend on the relative proportions of the constituent gases
X Industrial methane includes methane mixed with not more than 15% by volume of hydrogen
§ Containing not more than 57% by volume of hydrogen and not more than 16% by volume of carbon monoxide, the remainder being mixture of paraffin hydrocarbons and inert gas

Flameproof motor termination and cabling arrangements

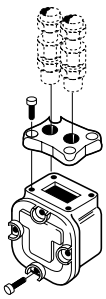
HA/1



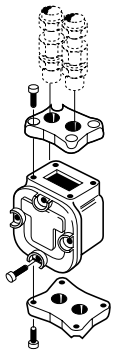
HA/4



HA/5



HA/6



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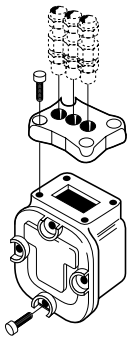

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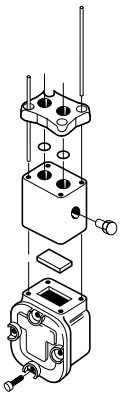
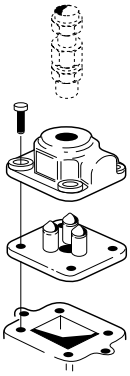
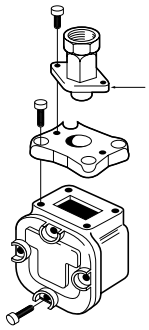


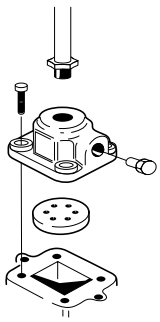
HA/9



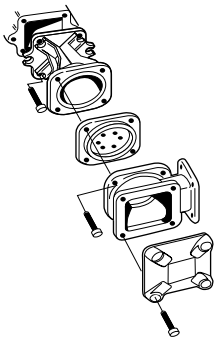
HA/10



HA/12



HA/13



Flameproof motor termination and cabling arrangements

Frame sizes 90-180

Chart reference	*Description*
HA/1[1]	Sealing chamber with double gland and clamp for armoured cable. Sealing chamber must be filled with BICC compound, ref G101, when connected to supply.
HA/4	Terminal box adaptor designed to suit 'HUWOOD' or 'VICTOR' 30-50 and 200 amp plug and socket bolted or restrained type.
HA/5	Gland plate with single or double threaded entry to take certified compression gland.
HA/6	Gland plate with threaded entry to take certified compression gland, up to 6 entries.
HA/7	Gland plate with three threaded entries to take certified compression gland.
HA/8[1]	Sealing chamber with single or double entry screwed gland for seamless conduit or certified compression gland. NB Other end of conduit must be terminated in accordance with relevant code of practice. This arrangement can be repeated at base of terminal box giving up to four entries.
HA/9	Threaded adaptor box for cable between motor terminals and certified remote box. Certified glands to be used at each end of cable. Remote flameproof or increased safety terminal box fitted with duplicate certification plate or certified box of other manufacture.
HA/10	CMP or Hawke G470/C adaptor. One or two entries direct to adaptor plate to take certified compression gland to suit above adaptors.
HA/11	Barrier gland for cable or Kopex stopper (barrier) cable gland ref HCM for flexible conduit. 1, 2 or 3 threaded entries into flush-mounted gland plate (fitted in place of terminal box) (Groups IIA and IIB). See page 15 for details.
HA/12	Conduit adaptor box for loose leads (via seamless conduit) to customer's termination. Adaptor box sealed with compound by manufacturer. NB Other end of conduit must be terminated in accordance with relevant code of practice.
HA/13	SG Iron extension piece, 150mm or 200mm long, fitted in place of standard terminal box. The terminal box is NCB design and can be fitted with a special 150A or 200A plug and socket.

Frame sizes 90-315

Chart reference	*Description*
HA/5	Gland plate with single or double threaded entry to take certified compression gland.
HA/11	Barrier gland for cable or Kopex stopper (barrier) cable gland ref HCM for flexible conduit. 1, 2 or 3 threaded entries into flush-mounted gland plate (fitted in place of terminal box) (Groups IIA, IIB or IIB). See page 15 for details.

[1]Frames 132 to 180

HA arrangements available for flameproof motors

Flameproof motor standards	*Chart reference*										
	HA/1	HA/4	HA/5	HA/6	HA/7	HA/8	HA/9	HA/10	HA/11	HA/12	HA/13
	Surface industry group II (other than mining)										
EEx d	✓	NA	✓	✓	✓	✓	✓	NA	✓	✓	NA
EEx de	NA	NA	✓	✓	✓	✓	NA	NA	NA	NA	NA
(Ex)d 3n G4	NA	NA	✓	✓	✓	NA	NA	NA	NA	NA	NA
CSA	NA	NA	✓	✓	✓	NA	NA	NA	NA	NA	NA
SAA (Australia)	NA	NA	✓	✓	✓	✓	NA	NA	NA	NA	NA
Yugoslavia	NA	NA	NA	NA	NA	✓	NA	NA	NA	NA	NA
South Africa	NA	NA	✓	✓	✓	✓	NA	NA	NA	NA	NA
	MEx group 1 (mines)										
UK	✓	✓	NA	NA	NA	NA	NA	✓	NA	NA	✓
EMR Canada	NA	✓	✓	✓	✓	✓	NA	NA	NA	NA	✓
South Africa	NA	NA	✓	✓	✓	✓	NA	NA	NA	NA	✓
NSW Mining specification (Australia)	✓	OA	✓	✓	✓	✓*	NA	NA	NA	NA	✓

NA = *not applicable* OA = *on application* * = *not for conduit*

Barrier gland for cable or barrier cable gland ref HC threaded entries into flush-mounted gland plate (fitted in place of terminal box) (Groups IIA, IIB and IIC).

The required length of loose leads will extend beyond the gland and the installer will pass these loose leads through an approved flexible conduit, which he supplies.

The installer will attach one end of the flexible conduit to the gland. Great care is needed in this operation to make absolutely sure that the ferrule is held firmly to prevent rotation when the flexible conduit is being screwed into it.

Tightening of nut will secure the flexible conduit to the gland.

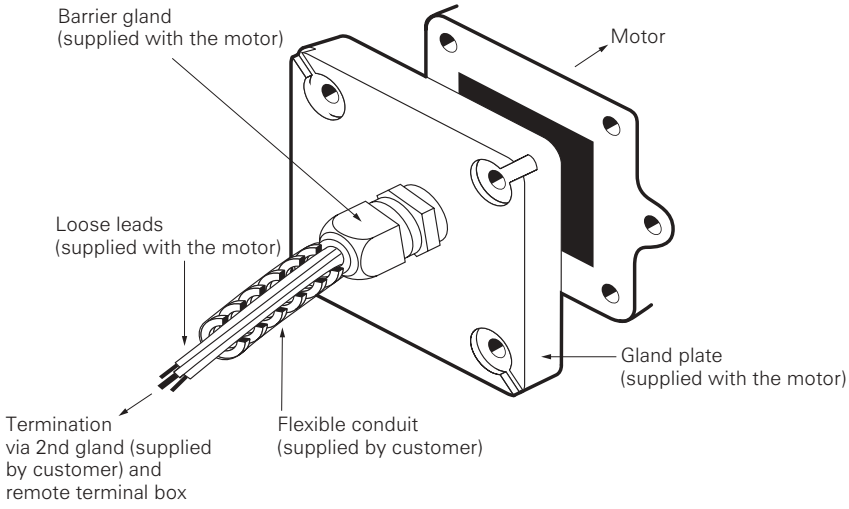
The other end of the flexible conduit is attached to a second gland for termination of the cables in the remote terminal box outside the fan ducting (or other machinery).

See manufacturer's instructions for the fitting of the second gland.

Termination of the cables on the outer periphery of the fan ducting (or other machinery) would then normally be by means of an EEx e or EEx d remote terminal box.

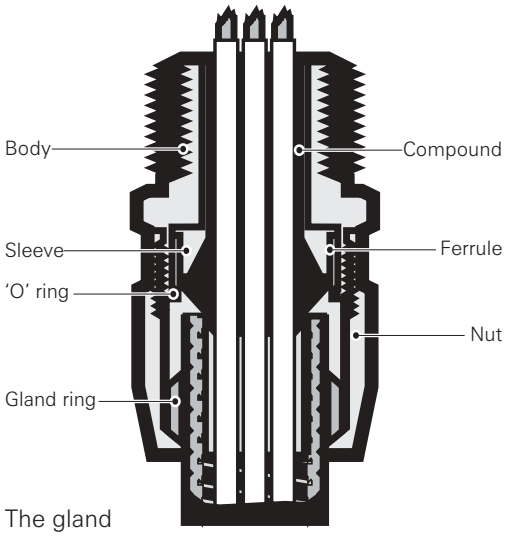
The remote box should be purchased from a supplier of ATEX approved terminal boxes.

HA/11



HA/11

NB *Illustration shows Kopex flexible conduit arrangement. Alternative barrier glands for armoured or braided cable can be used*



The gland

North American practice divisions

Instead of the word *Zone**, the word *Division* is used. Division 1 corresponds to European Zone 1 and flameproof motors for Division 1 are described as Explosion Proof.
Division 2 corresponds to European Zone 2 and TEFC (NOT EXP) motors are used.

*The word Zone is now recognised in the NEC code and its use is permitted.

Classes and groups

Gases, dusts and flyings are divided into three classes:

Class I: Flammable gases or vapours.
The classification of gases is different to that used in European standards. The table opposite (top) shows the comparison of North American groups A, B, C and D with European standards.

Class II: Combustible dusts.
These are sub-divided into E, F and G.

Class III: Easily ignitable fibres and flyings.

Temperature classes

Temperature classes follow the European basis, but have further sub-division as shown in the table opposite (bottom).

Some of the gases in North American group C have temperature classes T3A, ie 180°C. Care must therefore be taken in selecting motors for Division 2 to ensure that this situation is clear to the user.

Explosion Proof motors

Explosion Proof motors are certified by CSA to CSA Standards C.22.2 No 145 with dimensions according to EEMAC standards. They are fitted with thermal protectors and are suitable for:

Class I: Groups C and D
Class II: Groups E, F and G.

North American groups v European standards

North American Group	*Representative gas*	*European enclosure group*
A	Acetylene	IIC
B	Hydrogen	IIC
C	Ethylene	IIB
D	Propane/Methane	IIA

Temperature classes

Maximum temperature °C	*T Classification*
450	T1
300	T2
280	T2A
260	T2B
230	T2C
215	T2D
200	T3
180	T3A
165	T3B
160	T3C
135	T4
120	T4A
100	T5
85	T6

Notes

Explosion proof motors are described on rating plate as TEXP instead of TEFC

Class I (Fibres) We have no certification for Division 1 or Division 2

*** Class 1, Division 1. We have no certification for groups A & B**

** These Class I and Class II motors are identically constructed

† IF heaters are required only groups C & D can be supplied

§ Because certain group C gases ignite at lower temperatures

Certification for N. America CSA approval

Class Atmosphere	Class I †Gas & Vapour			Class II Dust		
Division	**Division 1**	**Division 2**		**Division 1**	**Division 2**	
Groups	Groups C & D*	Groups A & B, C & D	Groups C & D	Groups E F & G	Groups E & F	Groups G
		Point out T3 temperature class (200°C)§				
Construction	Explosion proof (similar to British flameproof) Thermostats fitted to E143 to E286	Standard TEFC (N.B. not type nA) **Without heaters**	Standard TEFC (N.B. not type nA) **With heaters**	Explosion proof (similar to British flameproof) Thermostats fitted to E143 to E286	Explosion proof (similar to British flameproof) Thermostats fitted to E143 to E286	Standard TEFC with thermistors (N.B. not type nA)
Certification UK Manufacture		Non hazardous	Non hazardous			Non hazardous
143-286	LR 17512	LR 10159	LR 10159	LR 17512	LR 17512	LR 10159
324-587	-	02-1001096	02-1001096	-	-	02-1001096
Canadian Manufacture						
143-286	LR 69304	LR 69305	LR 69305	LR 69304	LR 69304	LR 69305
Rating plate Marking	Approved AC Motor for Hazardous Locations **Class I C & D with additional thermostat/ thermistor warning plates	CSA monogram but no Hazardous Location Marking	Div 2 Class I and either Group C, or Group D ALSO Heater Wattage. with additional plate detailing heater voltage	Approved AC Motor for Hazardous Locations **Class II E F & G with additional thermostat/ thermistor warning plates	Approved AC Motor for Hazardous Locations **Class II E & F with additional thermostat/ thermistor warning plates	"Thermistors to be connected to controller" CSA monogram but no hazardous location marking. Additional thermistor/ thermostat warning plates

Speed control

The effective speed control of AC electric motors has long been regarded as an adaptable and economical means of cutting costs and saving energy. A comprehensive range of designs to meet individual needs and applications is available. This embraces the more traditional designs of tapped (Dahlander) winding, PAM winding, and dual winding as well as variable speed drives.

Multi-speed - *Pole change (Tapped or Dahlander)*

These have a single winding and two speeds in a ratio of 2:1. They can be supplied for constant torque or variable torque (fan or centrifugal pump) applications.

PAM (Pole Amplitude Modulation)

Similar to the above except that pole variations can be 6/4 or 8/6 pole. Other variations such as 10/6 pole are also available.

Dual wound

Motors have two separate windings and can be supplied for any two speed combinations. NB A combination of dual and pole change windings can give 3 or 4 speeds from one design.

Variable speed - *Inverters*

The development of inverter technology enables standard or near-standard AC cage induction motors to become variable speed drive machines. The ratings of such motors must however take account of:

- increased heating due to the harmonic content of the inverter waveforms
- reduced cooling arising from motor speed reduction
- the power or torque requirements throughout the speed range
- other limiting factors such as maximum motor speed, ambient temperature, altitude etc.

Correctly applied, the benefits of variable speed motors include significant energy saving potential and process control improvement.

Basic inverters permit operation over a typical speed range of 20:1. With increasing sophistication such as 'vector' control, eg field oriented control utilising closed loop feedback, the effective speed range can be increased to 1000:1.
For applications using variable torque loads such as fans and centrifugal pumps where the absorbed power is proportional to the cube of the speed, very little derating will be required.

For applications using constant torque loads, the level of derating will depend on the speed range required.

Inverter operation of motors in Zone 1, Zone 2, Zone 21 or Zone 22 adds a further complication to a subject where considerable attention is required to safety. It is therefore essential to ensure correct motor selection and determine that certification either exists or can be obtained. Our preferred method is to use EEx d motors for both Zone 1 and Zone 2.

Our EEx e motors are **not** offered for inverter operation.

Frequency range

The frequency range of EECS/BASEEFA certified motors is specifically included in the scope of each certificate. The range covered for ES89 frames is 2-100Hz for Temperature Class T3 (T4 on application), frames A-EF90 to A-EF180 is 2-100Hz and for frames W-EF200 to W-EF315 is 2-60Hz, Temperature Classes are T1 to T4 inclusive.

Inverter operation of EEx nA motors is possible, but is invariably much more costly than the use of EEx d motors. This is due to the need for lengthy testing of the motor with its specific inverter at our works and the cost involved in obtaining individual EECS/BASEEFA certification.

Inverter parameters

Total harmonic distortion	6.0%
Peak voltage	1400V max
Max dv/dt	5600V/microsec
Max carrier switching frequency	15kHz
Max cable length	100m

There are often good reasons to operate outside these parameters in which case please refer details to Brook Crompton to confirm the motor frame size.

Certification

Blanket certificates have been obtained for inverter operation of our cast iron range of EEx d or EEx de IIB or IIC motors as detailed. This allows for operation from **any** variable frequency source. These motors are fitted with appropriate thermistors at the manufacturing stage and it is a mandatory requirement of certification that they are connected into a control circuit (eg Thermot control as supplied by Crompton Controls Ltd) such that the motor is isolated from its supply before the external surface temperature reaches its T class. An additional requirement of the EECS/BASEEFA Certification is that under fault conditions the Inverter should also be disconnected from the mains supply. An X is added to the certificate number and motor rating plates are marked with details of output, speed, voltage range, maximum current and clearly identified 'Inverter rated'.

Derating

Derating is required in all cases to allow for additional losses caused by non-sinusoidal output waveform of inverters and loss of cooling at low speeds.

Data required to determine motor size for use on inverters

To select the correct motor inverter duty establish:

- What Zone the application is in
- What enclosure or apparatus group – IIB or IIC is required for the application
- What Temperature Class the application is in
- Will tripping of thermistors result in isolation of motor from its supply
- 2, 4, 6 or 8 pole
- Load type (variable or constant torque or constant kW)
- Speed range required
- Maximum absorbed power of the load referred to the base frequency or speed

Combustible dusts

Dust hazards

A surprisingly large number of dusts are capable of being ignited by external ignition sources and will continue to burn at atmospheric temperatures. They will, however, only spontaneously ignite above a certain temperature. The list of dusts includes natural products such as wood, flour, cocoa, sugar, milk powder and tea, as well as various metals and chemicals including bronze, zinc, sulphur and toner. The table on page 19 indicates the properties of combustible dusts.

We have a complete range of motors to European standard EN 50281 for electrical equipment working in dust hazards. Cast iron is the standard material. This standard uses Zone 20, 21 and 22 (Motors are not supplied for Zone 20).

These motors are **not** flameproof design but are TEFV with either IP6X or IP5X protection depending on the Zone and type of dust:

European standard motors (EN 50281)		
*Dust hazard**	*Zone 21*	*Zone 22*
Equipment category	Category 2	Category 3
Conductive dusts	IP6X	IP6X
Non-conductive dusts	IP6X	IP5X

* Motors supplied by Brook Crompton are of enclosure classification IP65 or IP55.
The specification takes account of dust present in a cloud in normal operation and a layer up to 5mm thick. Dust is therefore excluded from the motor and only the external surface temperature of the motor is exposed to the dust cloud or layer. It is necessary for the user to practice good housekeeping and ensure that this layer thickness is not exceeded. Examination at intervals not greater than three months is required. This range of motors has a maximum surface temperature of 125°C in an ambient of 40°C. Thermistors are **not** mandatory but **are recommended** in all cases.

ATEX approval has been obtained and certification is compliant with EN 50281

Marking of the motors will include the new system required by ATEX which is detailed on page 5.

The previous British standard for motors in dust hazards was BS 6467 which used zones Z and Y. There had also been German standard VDE 0165 which referred to zones 10 and 11. Both of these standards are superseded by EN 50281.

Testing

Motor testing to determine IP category is carried out in a dust test chamber where French chalk/talcum powder, having a minimum particle size of 1 micron, is blown around the motor which is itself subjected to a partial vacuum. Motors which are too large for the dust chamber are designed and manufactured in an identical manner to those which are type tested (cf EN 60529 cl 11.2). Based on type tests, declaration of conformity documents are issued.

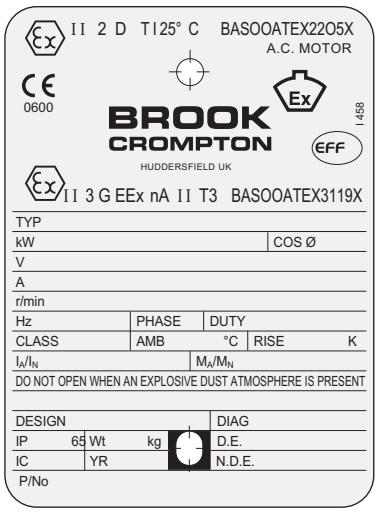
Tests are carried out to ensure that motors will withstand a specified impact as stated in EN 50281.

Some installations may be subjected to more than one type of hazard. The presence of combustible dusts may occur along with gases, vapours etc. Under these circumstances it is possible to incorporate certification covering both types of hazard. The motor would carry a dual certification rating plate.

The motor would be required to comply with the more stringent of the two applicable hazard protection. E.g. a EEx e motor certified for use in a Zone 1 (category 2) T3 gas hazard and a Zone 21 (category 2) dust hazard. This motor would need to be IP6X enclosure protected, with an external surface temperature of 125°C, whilst its internal surfaces would be required to comply with the temperature limits of T3 (200°C).

The dual certification gas/vapour and dust concept can be applied to all ranges of hazardous areas motors as detailed below.

Zone 1 EEx d and dust Zone 21 – IP65
Zone 1 EEx e and dust Zone 21 – IP65
Zone 2 EEx nA and dust Zone 21 – IP65



Properties of combustible dusts

Dust	*Particle size distribution* <500µm	<125µm	<71µm	<32µm	<20µm	*Median µm*	*Ignition temperature of cloud °C*	*of layer °C*
	Percentage by mass							
Natural products								
Wood, flour			55	23		65	490	340
Cork			83	19	7	42	470	300
Cellulose			75	31		45	520	410
Grain, mixed dust from filter			63	48	40	37	510	300
Cocoa/sugar, mixture of milkshake, most of oil removed	53	20				500	580	460
Milk powder, skimmed, spray dried			35	18	11	90	540	340
Soya meal			85	63	50	20	620	280
Starch, cornstarch			99	85	65	15	460	435
Tea, black, from dust separator		64	48	26	16	76	510	300
Sugar, milk			98	64	32	27	490	460
Caramel, dried		93	46	16		75	490	455
Organic products								
Activated charcoal			86	56		29	660	400
Lignite			76	50	29	32	380	225
Bituminous coal medium-volatile			99	84	60	17	550	260
Phenolic resin			98	93	80	11	530	No glowing to 450°C
Synthetic rubber		66	46	18	9	80	450	240
Polyacrylonitrile			99	66	38	25	540	No glowing to 450°C
Polyethylene, low pressure				95	86	10	420	Melts
Polymethacrylate, from filter			90	70	48	21	550	Melts
Polyvinyl acetate, copolymerized			66	22	8	52	570	Melts
Polyvinyl chloride, from cyclone		41	35			98	700	No glowing to 450°C
Methyl cellulose			45	12		75	420	320
Paraformaldehyde			89	65	41	23	460	No glowing to 450°C
Calcium stearate			99	90	75	12	560	No glowing to 570°C
Detergent raw material, based on olefin sulphonate		60	28			105	390	No glowing to 590°C
Dye, phthalocyanine, blue			98	86		10	770	355
Metals								
Aluminium, from extraction system			65	47	37	36	530	No glowing to 450°C
Bronze powder (gold bronze)				97	60	18	390	260
Sponge iron			88	74	65	12	470	390
Zinc dust, from separator					99	10	570	440
Inorganic products								
Molybdenum disulphide			92	75	53	19	520	320
Sulphur			96	70	51	20	280	-
Soot from filter (lampbalck)						10	810	570
Sintering powder, from filter	46		66	37	20	44	520	380
Immersion polishing medium						600	580	340
Toner					98	10	470	No glowing to 450°C

Extracted from BS 6467: Part 2 1998 now superseded by EN 50281

Paint treatments

Paint treatments

All Brook Crompton hazardous area motors are completed with a standard paint finish, which can be used in total confidence in many hostile environments.

However, there are certain industrial applications, which demand a stronger, more superior paint system to deal with more rigorous environments. Alternative paint finishes, which all incorporate the brand name 'Argus', are Argus Super Seal, Argus Super Chem and Argus Monsoon.

Standard specification

All hazardous area motors are finished with a standard paint treatment, which is suitable for most industrial environments.
All motors have the following features as standard:-

The paint treatment specification is as follows:

- primer - frames, endshields and terminal boxes/lids are dipped or sprayed with anticorrosive primer with a minimum DFT (dry film thickness) of 15 microns
- top coat - completed motors are sprayed with a final coat with a minimum DFT thickness of 50 microns in colour RAL 5021 (Water Blue)

Finished motors will have a minimum DFT of 70 microns.

Argus® Super Seal
WASHDOWN PROTECTION

Argus Super Seal

Argus Super Seal is the ideal finish where 'wash down' conditions are required such as the food and pharmaceutical industries, and general wet temperature conditions such as quarries etc.

The motors are designed to meet the guidelines of the German VIK (Verband der Industriellen Energie – und Kraftwirtschaft e.V.), and many other major user specifications.

In addition to the paint treatment, each motor has internal tropic proof treatment and enclosure protection to IP56 (higher degrees of protection available on request).

The paint treatment specification is as follows:

- primer - frames, endshields and terminal boxes/lids are dipped or sprayed with anticorrosive primer with a minimum DFT (dry film thickness) of 15 microns
- top coat - completed motors are sprayedwith a final coat with a minimum DFT thickness of 50 microns in colour RAL 5021 (Water Blue)

Finished motors will have a minimum DFT of 70 microns.

Argus® Super Chem
CONTAMINATION PROTECTION

Argus Super Chem

Argus Super Chem offers a treatment suitable for operation in such arduous conditions such as chemical and petrochemical plants, pulp, salt laden, dockside duty, sewage works and cooling towers.

In addition to the paint treatment, each motor has internal tropic proof treatment, metal cooling fan for IC411 cooling, thermistor protection and enclosure protection to IP56 (higher degrees of protection are available on request).

The three part paint treatment specification is as follows:

- completed motors are grit blast to SA 2.5 microns
- primer – 50 microns epoxy zinc rich
- intermediate – minimum 125 microns high build epoxy
- top coat – minimum 50 microns high build epoxy

Finished motors will have a minimum DFT of 225 microns.

Tropical protection

Standard motors will operate satisfactorily in tropical environments.

Where ambient conditions are conducive to the formation of fungal growth, algae or condensation, an extra tropic proof treatment is recommended as additional protection. The use of drain holes to assist in the draining of any condensation is also recommended.

Where the motor is to be left standing for long periods of time in damp conditions or subject to condensation forming atmospheres, it is recommended that anti-condensation heaters are fitted and energised to prevent condensation forming in the motor enclosure. Motor controls should be provided to activate the heaters, only when the motor is de-energised.

The heater cables are terminated to a separate terminal block inside the motor terminal box normally with a single phase supply to the heaters of 220-240 volts. 110 volt heaters available on request.

Argus® Monsoon
TROPICAL TREATMENT

Argus Monsoon Tropical Treatment

Motors operating in tropical climates are invariably subjected to the hot, humid and wet conditions which produce considerable amounts of condensation on internal surfaces.

In these areas, fluctuating temperatures can vary between 25-40°C (76-105°F), with relative humidity often reaching 100%. Intermittent periods of tropical rainfall are also part of the natural environment.

Condensation occurs when the surface temperature of the motor is lower than the dew-point temperature of the ambient air and, if motors do not have special internal protec-tion, resulting corrosion can cause irreparable damage to stator windings and moving parts. In such conditions, motors are most at risk from deterioration when not in use – particularly when stored in humid or un-ventilated areas.

For motors operating in such arduous conditions, Brook Crompton has developed Argus Monsoon Tropical Treatment – an enhanced form of protection which ensures that both internal and external surfaces are free from corrosive attack. This same treatment is also suitable for motors subjected to frequent deluge and heat/thermal cycling, as is often experienced in the petrochemical, paper, glass-making and textile industries.

Paint treatments/Fumex

During manufacture, the surfaces of external components are grit blasted to Swedish standard SA 2.5 and various parts of the motor's enclosure, including stator frame, endshields, bearing caps and terminal box, are coated with etch primer.

All internal components of the motor are treated with a specially developed tropic proof varnish, which is carefully applied to ensure complete coverage to all surfaces.

Machined surfaces, which are particularly vulnerable, are treated with a rust inhibitive primer and a proprietary non-setting liquid gasket material.

Following the standard impregnation of stator windings with electrical varnish, the complete stator assembly, including winding overhangs, wound pack end faces and stator bore, are treated with tropic proof varnish.

As standard, all motors are supplied with tapped holes in drive-end shafts, to facilitate assembly, securing and removal of fitments. Internal and external earth terminals are provided to ensure maximum safety and bearings with C3 diametrical clearances are fitted to ensure long life and optimum reliability in service.

Every motor has a stainless steel name plate for ease of identification, even after lengthy periods of operation in hostile and corrosive atmospheres.

All Argus Monsoon Tropical Treatment motors are covered by a 2-year guarantee.

External paint system

All treatments are well in excess of requirements for exterior, exposed, polluted and coastal atmospheres for medium term (5-10 years), as specified in BS5493* 1977 Section 2, Part 3.

Treatment is as follows:

- Grit blast SA 2.5
- 50 microns J984 Epoxy zinc rich primer coat
- 250 microns L653 High build epoxy intermediate coat
- 50 microns M137 overcoatable polyurethane finish coat

Total thickness: DFT 350 microns

The final high quality paint system meets the standard required for offshore use by all leading oil company operators.

** BS5493: Code of Practice for protective coating of iron and steel structures against corrosion.*

Testing

To ensure that Brook Crompton Argus Monsoon Tropical Treatment motors fully comply with various international requirements (defined under IEC 68-2-28: 1990 Environment Testing, Part 2.2 Guidance, Tests C and D Guidance for damp heat tests) a number of samples were exposed to independent accelerated testing procedures at the UK laboratories of a leading international testing organisation – ERA Technology, Leatherhead, Surrey, England.

Under controlled conditions, carried out in an environmental test chamber, motors were subjected to temperatures between 25°C and 65°C and much greater levels of condensation than would normally be experienced in actual tropical climates.

Rigorous tests were also carried out to accelerate the rate at which changes in the condition of the motor would occur in practice, but without radically changing the degradation mechanisms. Acceleration of these test conditions was achieved by increasing the maximum rapid changes in temperature; maintaining high humidity and increasing the number of environmental cycles per day. The capability of the stator winding insulation to withstand these same conditions was carefully monitored.

Tests were designed to increase and decrease temperature by 20°C per hour, ie twelve times the rate of change for category B2 – Wet Hot, experienced under the most extreme tropical conditions described in UK defence standard Def Stan 00-1/2.

The extent of any degradation was determined by measuring the winding insulation resistance during the test and by post-test inspection of all internal and external surfaces of the motor.

Test results, received from ERA, in its Report 94-0421, proved the exceptional quality, not only of the motor's external paint system – which remained totally free from corrosion – but also of the special treatment given to all internal surfaces.

The quality and effectiveness of the treatment given to the stator windings ensured that insulation resistance, at the end of the test period, was at least an order of magnitude greater than the minimum values which could normally be expected from a new motor working at 25°C.

Applications

A substantial number of Brook Crompton Argus Monsoon motors are currently operating in extreme climatic conditions in a number of Middle and Far Eastern countries, providing cost-effective solutions to drive applications in a wide range of chemical and process industries.

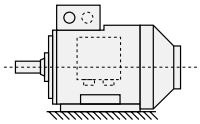
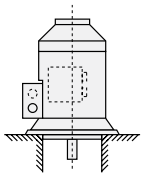
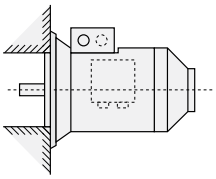
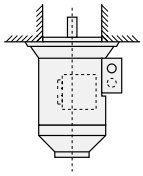
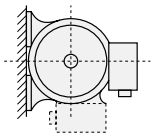
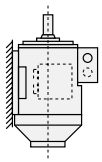
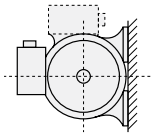
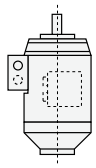
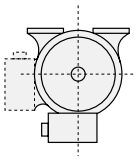
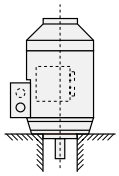
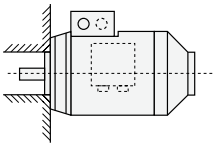
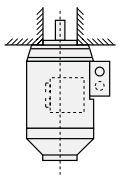
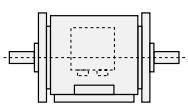
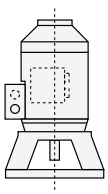
Fumex motors

Fan-powered ventilation systems – designed to remove heat and smoke during 'fire emergency' situations – are being increasingly installed as potential life-savers in all kinds of commercial and industrial buildings. Some of these systems serve the dual purpose of providing effective air ventilation under normal conditions and smoke/heat extraction duty in the event of a fire, whilst others are installed specifically as 'fire emergency' safety systems.

Fumex EEx d, EEx nA, EEx e or dust ignition proof motors are suitable for installation on most types of extraction fan, including both axial flow and bifurcated systems.

It must be noted that during the emergency duty, the zone and temperature classification will be exceeded, therefore by implications the certification becomes invalidated.

General specification applicable to all motors

Mounting Horizontal shaft arrangements		Mounting Vertical shaft arrangements	
B3 IM 1001 *Foot mounted*		**V1 IM 3011** *Flange at DE* *Shaft down* *No feet*	
B5 IM 3001 *Flange at DE* *No feet*		**V3 IM 3031** *Flange at DE* *Shaft up* *No feet*	
B6 IM 1051 *Foot wall mounted with feet on left-hand side when viewed from DE*		**V5 IM 1011** *Vertical foot* *Wall mounted* *Shaft down*	
B7 IM 1061 *Foot wall mounted with feet on right-hand side when viewed from DE*		**V6 IM 1031** *Vertical foot* *Wall mounted* *Shaft up*	
B8 IM 1071 *Ceiling mounted with feet above motor*		**V18 IM 3611** *Face at DE* *Shaft down* *No feet*	
B14 IM 3601 *Face at DE* *No feet*		**V19 IM 3631** *Face at DE* *Shaft up* *No feet*	
B17 IM 2302 or IM 2202 *2'C' or 'D' type flanges* *Foot mounted*		**V22 IM 3811** *Skirt mounting* *Shaft down* *No feet*	

Combinations of the above and customer specials are possible e.g. B3/B5, B9 (IM9101) etc.

Enclosure description

	Brief description		
	1st numeral Protection against solid objects		*2nd numeral Protection against liquids*
5	Protection against the harmful ingress of dust	5	Motor enclosure protected against the harmful ingress of water, when water is sprayed against the motor enclosure (12.5L/min @ 0.3 bar)
6	Dust tight. No ingress of dust	6	Motor enclosure protected against the harmful ingress of water, when water jets or heavy seas are directed against the motor enclosure (100L/min @ 1.0 bar)
7	N/A	7	Protected against the effect of immersion for a minimum of 30 minutes, with the lowest part of the motor at depth of 1 metre
8	N/A	8	†Protected against the effects of submersion for a minimum of 24 hours at a depth of 7 metres

†- not specified in EN 60034

Enclosure

All motors are totally enclosed with a minimum ingress protection of IP55. Higher IP protection can be supplied as detailed in the table above.

Motor cooling

Motors are cooled in accordance with IEC 60034-6. The normal arrangement is IC411 (Totally Enclosed Fan Ventilated) via a fan mounted at the non-drive end. Methods of cooling are detailed in the table opposite.

Insulation and thermal rating

Standard motors will operate satisfactorily in an ambient temperature range of –20°C to +40°C (Class B temperature rise) and at altitudes up to 1000 metres above sea level.

The use of a UL approved class F insulation system with only Class B temperature rise (80°C) ensures an exceptional margin of safety and longer life even in abnormal operating conditions.

Class F insulation system material includes 'Nomex' meta-aramid paper and 'Mylar' polyester film (Nomex and Mylar are registered trademarks of Du Pont.)

High ambient temperatures and high altitudes

Ratings listed in associate catalogues apply to standard motors operating in ambient temperatures not exceeding 40°C and altitudes up to 1000m above sea level.

When operating EEx d/de, EEx nA or dust ignition proof motors, in higher ambient temperatures or at higher altitudes, derating may be necessary in order to maintain its operating temperature (Class B or Class F). The factors detailed in the tables opposite, should be used for derating.

For EEx e motors, please refer full application details to Brook Crompton.

The actual performance figures, of a derated standard motor, will differ from those published. The larger the derating, the further the motor performance will be from the optimum.

In many circumstances (and for all EEx e) it is recommended that a motor is wound for the specific derated output. When the above factors are used, the actual performance figures will differ from those published. Please refer to Brook Crompton.

Duty cycle

All Ex motors are suitable for SI Duty as described in IEC 60034-1. For duties other than SI, EEx d motors should be specified.

Electrical characteristics

Voltage

Ex motors are manufactured to the requirements of IEC 60034-1. In January 1995 the first steps to a harmonised 'Eurovoltage' of 400V ±10%, target date 2003, were taken. The current situation is detailed in Table 23.

All 'W' motors are wound for the 'Eurovoltage'. Motors up to and including 3kW are normally supplied 230/400V, 4kW and above supplied 400V and are suitable for ±10% tolerance in line with the post 2003 Voltage Harmonisation requirements.

Cooling arrangements

Code	*Arrangement*
IC411	Totally Enclosed Fan Ventilated (TEFV) motor cooled by an externally mounted fan
IC410	Totally Enclosed Non Ventilated (TENV) self cooling, no externally mounted fan
IC418	Totally Enclosed Air Over Motor (TEAOM) motor cooled by the airstream

Derating for high ambient temperature

Ambient temperature	45°C	50°C	55°C
Class B temperature limits	96%	93%	87%
Class F temperature limits	100%	100%	100%

Derating for altitude

Altitude	2000m	3000m	4000m
Class B temperature limits	94%	85%	75%
Class F temperature limits	100%	100%	95%

Timetable relativity to European & British voltage changes

Date	*Location*	*Voltage (V)*	*Comments*
Pre 1995	Mainland Europe	380 ± 5%	–
1.1.95	Mainland Europe	400 +6/-10%	–
2003	Mainland Europe	400 ± 10%	–
Pre 1995	UK	415 + 6%	–
1.1.95	UK	400 + 10/-6%	No real change to supply voltage range
2003	UK	400 ± 10%	–

General specification applicable to all motors

Protection devices

To protect motor windings against a variety of operational malfunctions, motors and associated control gear can be fitted with protection devices. Thermistors are fitted as standard on frame sizes 200 to 355. Based on substantial practical experience, the table opposite is designed to help with selection.

Thermistors

Thermistors to IEC 60034-1, DIN 44081/440823 are temperature-dependant, semiconductor devices embedded in the motor windings. They are selected to protect the motor windings from damage and internal/external surface temperatures do not exceed those permitted by the appropriate standard.

Thermostats or thermal switches

These are bi-metallic devices embedded in the motor windings. They have non-adjustable temperature switching point and are rated at 250 VAC (max), 1.6A, Cos Ø 0.6.

Effectiveness of various types of protection device

Application problem	*Control gear*		*Embedded in motor windings*	
	Thermal overload	*Magnetic overload*	*Thermostats*	*Thermistors*
Sustained overload	G	G	G	G
Excessive or incorrect duty cycle	A	A	A	G
Prolonged reduced or over voltage or incorrect frequency	A	A	G	G
Excessive ambient temperature in motor location	P	P	G	G
Restricted or impaired ventilation	P	P	G	G
Single phasing	P	P	A	G
Stalled or locked rotor	G	G	A	G

Key:
G – good, A – acceptable: P – poor/little or no protection

Shafts

Shafts are produced from:

- 460/540MN/m² tensile steel for frames 63 to 180
- 550MN/m² tensile steel for frames 200 to 355

Drive end shafts are provided with a tapped hole to DIN 332 Form D and a closed profile keyway as standard.

Vibration

All motors are dynamically balanced, to ISO 2373 (BS4999 Part 142) with key convention to IEC 60034-14 ie half key. For grades of balance available, see table opposite.

Bearings and grease arrangements

Bearings are pre-packed with Lithium complex based grease (or equivalent). This has a temperature range of –20°C to +140°C.

Alternative makes, types and temperature ranges of greases can be supplied on request. Lubrication arrangements are detailed in the table opposite.

Standard bearing sizes, replacement/re-lubrication intervals are detailed in the appropriate catalogues for EEx d, EEx e, EEx nA and dust hazard motors.

Tests

Every motor is tested in the course of manufacture and in accordance with IEC 60034-1 before despatch.

Noise levels

Listed noise levels are mean sound pressure levels, measured at 1 metre on no-load, with a sinusoidal supply and are subject to an upward tolerance of 3dB.

Rating plate

All motors are fitted with a stainless steel rating and certification plate to ensure easy identification even after long periods of operation in corrosive atmospheres.

Bearings and grease arrangements

Frame size	*Standard arrangement*	*Regreasing facility*
63 to 90	Greased for life	Not available
100 to 180	Greased for life	Lubrication Points
200 to 355	Lubrication points	–

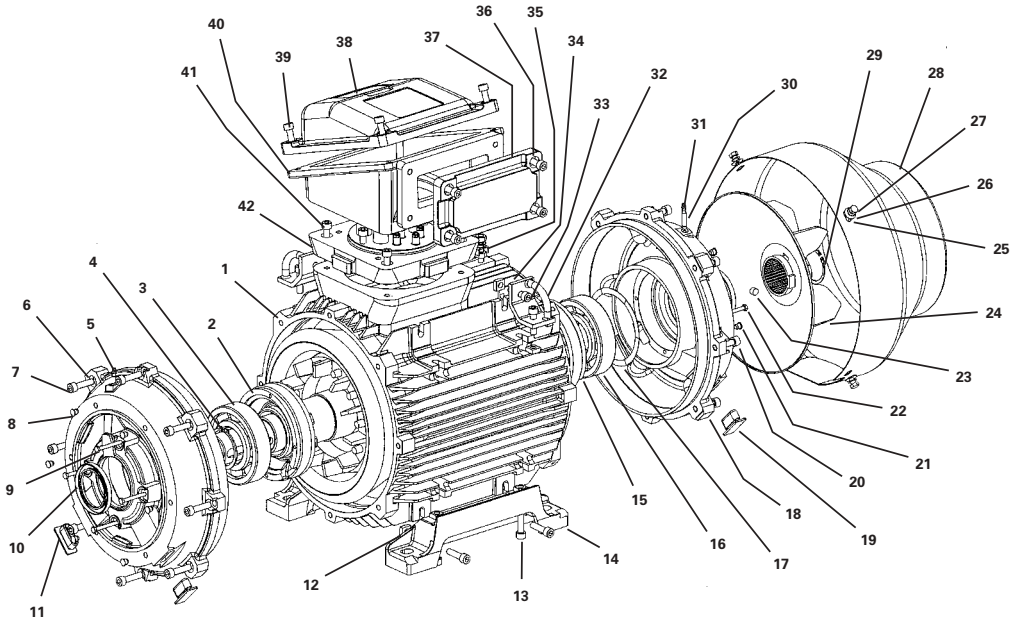
Balance

Frame size	*Standard*	*Reduced*	*Special*
63 to 180	Std	Alt	Alt
200 to 355	N/A	Std	Alt

Std - standard Alt - alternative

Spare parts, installation and maintenance

Typical Zone 1 EEx d motor



Ref	Part description
1	Stator frame
2	Drive end inner bearing cap
3	Drive end bearing
4	Drive end bearing circlip
5	Drive end grease nipple
6	Drive end endshield
7	Drive end endshield fixing screws
8	Drive end endshield plug
9	Drive end bearing cap fixing screws
10	Drive end oilseal
11	Drive end endshield grease plug
12	Stator foot fixing nut
13	Stator foot fixing screws
14	Stator foot

Ref	Part description
15	Non-drive end inner bearing cap
16	Non-drive end bearing
17	Non-drive end bearing wave washer
18	Non-drive end endshield
19	Non-drive end endshield grease plug
20	Non-drive end endshield fixing screws
21	Non-drive end endshield plug
22	Non-drive end bearing cap screws
23	External fan key
24	External fan
25	Fan cover fixing flat washer
26	Fan cover fixing shakeproof washer
27	Fan cover fixing screw
28	Fan cover

Ref	Part description
29	External fan circlip
30	Non-drive end grease nipple extension
31	Non-drive end grease nipple
32	Lifting lug
33	Lifting lug fixing screw
34	Lifting lug fixing nut
35	External earth stud
36	Gland plate fixing screw
37	Gland plate
38	Terminal box lid
39	Terminal box lid fixing screw
40	Terminal box
41	Terminal plate fixing screw
42	Terminal plate c/w terminals

⚠ Warning

All motors are supplied with safety and installation and maintenance instructions. This should be read carefully immediately on receipt of the motor.

It should be passed on with the motor to the end-user.

Fully detailed Spare Parts, Installation and Maintenance leaflets are available on request.

Spare parts, installation and maintenance

⚠ ***The certificate issued with the motor may contain special conditions of use. We strongly recommend that the certificate for the motor being installed is carefully studied before any installation work is started.***

Installation

Location

Motors must be installed with adequate access for routine maintenance. A minimum of 0.75m of working space around the motor is recommended. Adequate space around the motor, particularly at the fan inlet (50mm), is also necessary to facilitate airflow.

Where several motors are installed in close proximity, care must be taken to ensure that there is no recirculation of exhausted warm air. Foundations must be solid, rigid and level.

Bearings

Ball and roller bearings are despatched from the works fully charged with grease. Shielded bearings have sufficient grease for an operating life of at least two years in normal ambient temperatures, providing there is little or no grease leakage.
On motors with re-lubrication facilities, replenish with a lithium based grease but take care to avoid overfilling the bearing housings. It should be noted that overgreasing presents a far greater hazard to trouble-free service than undergreasing but careful attention is nevertheless required. Bearings without re-lubrication facilities will eventually need replacing.

Re-lubrication

Recommended re-lubrication intervals are detailed available on request.

⚠ Warning

Tapping of fitments onto the motor shaft, with a hammer or mallet, causes bearing damage. This results in an increase in bearing noise and a significant reduction in bearing life.

Fitting pinions, pulleys and couplings

These should be bored to our standard limits (details supplied on request) and fitted on the shaft with a screwing motion. **On no account should they be driven on**. Attention must be paid to correct guarding of all moving parts.

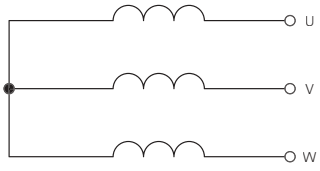
⚠ Electrical connection

Electrical installation must be carried out in accordance with current regulations.

The connection diagram is shown on the leaflet enclosed in the motor terminal box or the diagram inside the terminal box lid. The cables used should be capable of carrying the full load current of the motor (see motor rating-plate) without overheating or undue voltage drop.

Single voltage (eg 400 volts)

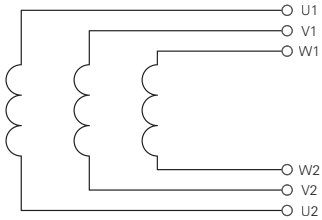
Internally star connected



Connect supply to U, V, W

Dual voltage

Delta/star (eg 230/400 volts or 400/690 volts) connected

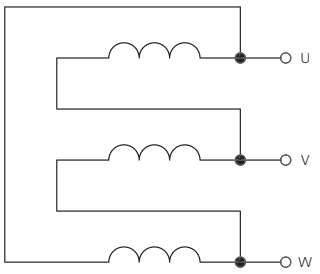


Low voltage
Link W2 to U1; U2 to V1; V2 to W1
Connect supply to U1, V1, W1

High voltage
Link W2 to U2 to V2
Connect supply to U1, V1, W1

Single voltage (eg 400 volts)

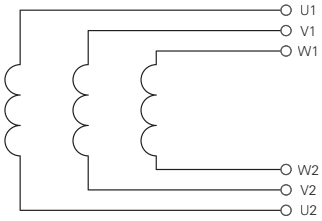
Internally delta connected



Connect supply to U, V, W

Single voltage star delta

(eg 400 volts) star-delta connected. Star-delta starting on low voltage for 400/690 volts



Connect all 6 leads
(U1, V1, W1, U2, V2, W2)
to star-delta starter

Repair of Ex certified motors

The enacting of the Health and Safety at Work Act focused attention on the responsibility of all parties, manufacturers, users and repairers on the repair of certified atmosphere equipment.

In 1978 the first authoritative publication, the 'BEAMA/AEMT Code of Practice for the Repair and Overhaul of Electrical Apparatus' for Use in Potentially Explosive Atmospheres was issued. The drafting committee, comprised of leading representatives from the principal UK manufacturers, repairers and users. This code has now been accepted as sound authoritative practice and introduced with little change by the International Electrotechnical Commission in 1993 as Standard IEC 60079-19

To date the adoption of these Codes of Practice are in no way mandatory nor is there any direct legal requirement therefore to comply with them, but they could conceivably be called up as a reference work to good established practice in any litigation process. As a measure of their standing, the IEC standard No 79-19 has received recognition by the Health and Safety Executive who called it up as repair practice in their licensing scheme. The careful study of these documents is therefore essential to all engaged in the management of repair and overhaul of this class of equipment.

Brook Crompton introduced an intensive training course on the repair of this class of machine in 1978. Over 1000 attendees have participated in the course from over 250 repair and user establishments.

The Brook Crompton training course is structured to meet the training requirements for repairers detailed in Section 4 of the BEAMA/AEMT Code, and also gives specialist knowledge of our hazardous area products and procedures, including recognition and use of authorised spares. To further emphasise the importance of using correct spares and their fitting by trained repairers, the sample label is attached to all spares for use on hazardous area motors.

The course also applies the engineering principles of the BEAMA/AEMT (and IEC) Code of Practice, however some practices are a reconciliation of divergent views and are contrary to our recommendations for repair. We do not therefore give specific training for 'Repair to the standard', we strongly recommend that repairs should be carried out to the original certification using authorised replacement parts where necessary.

Flameproof FLP, EEx d, EEx de, Ex d, MEx, FLP
Increased Safety EEx e, Ex e
Non-Sparking Ex N, Ex nA, EEx nA
Dust Ignition Proof

Spares for our above motor ranges are quoted/supplied on the understanding that the subsequent validity or certification of any repair* work and/or fitting of spares or replacement parts, rests with the user or repair establishment.

The repair establishment must be one where either:
A. Personnel have attended our Hazardous Atmosphere Motor Repair course AND the repair establishment is considered suitably equipped for this class of work, and accredited by Brook Crompton.
B. Personnel have attended the AEMT course 'Repair and Overhaul of Ex Electrical Apparatus' AND are in possession of our Hazardous Atmosphere Repair Manual.
OR
C. The repairer meets the requirements of the BEAMA/AEMT Code or IEC60079-19 and has an approved quality assurance system, e.g. ISO 9002

Where a motor has been originally repaired as indicated by symbols Ⓐ, Ⓑ or Ⓒ in accordance with code or IEC60079-19*, details of the repair shall be obtained from the user before proceeding with repair.

*See AEMT/BEAMA Publication 300, Code of Practice For Repair and Overhaul of Ex Electrical Apparatus, or IEC79-19.

Training Videos
A set of three videos covering the theory, design and construction, repair of electric motors for use in hazardous areas is available from the above address.

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Course participants will receive a detailed manual and on satisfactory completion of the course, attendees are presented with a Certificate of Training. This in conjunction with the repair workshop facility meeting our required standard assessed by inspection, gives the repairer accredited status for the repair and overhaul of Brook Crompton motors.

Full details of the Brook Crompton repair course can be obtained from the marketing department at Brook Crompton or visit our website at **www.brookcrompton.com**

Repair workshops

As detailed in the repair of Ex certified motors, the repair and maintenance of Brook Crompton hazardous area motors should only be undertaken by repair establishments equipped to handle these types of motor. Brook Crompton has a large number of world-wide approved repair establishments to undertake the maintenance and repair of Brook Crompton hazardous area motors. Details of particular agents are available from Brook Crompton.

Videos

Brook Crompton has produced a set of three training videos covering the theory, design and construction and repair of electric motors for use in hazardous areas, available from the marketing department at Brook Crompton or visit our website at **www.brookcrompton.com**

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