

DIESEL GENERATING SETS

INSTRUCTION MANUAL

EDITION JULY 2005

T E C H N O L O G I C A L E X C E L L E N C E

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MOTORS**



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1. INTRODUCTION

1.1. AIMS AND APPLICATION OF THE MANUAL

The aim of this manual is to provide the instructions and information necessary for the correct and safe installation, operation and maintenance of the generating set throughout its operational life from delivery to final disposal.

The content of the manual applies to the entire range of Iveco Motors diesel generating sets.

For information on the characteristics of the various models of generator sets and the relative motors, refer to the applicable Iveco Motors publications. Similarly, for information on the generators themselves, refer to the specific manufacturers' publications.

This manual and other reference documents supplied with the set are intended for the use of all those involved in the operational life of the unit. They constitute a useful and necessary source of information for those actually carrying out the relative activities and their supervisors, setting out the logistics and access requirements for the location where the set will be installed and used.

As will be explained in greater detail, the generating set is **NOT** a machine which can be operated by non-professional users. All activities linked to the operational aspects of its service life must be carried out by suitably trained specialist personnel with experience in diesel engines, mechanical plant, hydraulics and electricity generation. This manual, together with its other reference documents, are indispensable for the training of these specialists.

1.2. USING THE MANUAL

1.2.1. IMPORTANCE OF THE MANUAL

DO NOT underestimate the importance of this Manual!

This manual, together with the associated reference documents, forms an integral part of the generating set. It must be carefully preserved for the entire operational life of the equipment and protected from humidity and any other hostile agent which may lead to its deterioration. The documents must also accompany the set when and if it is sold or transferred to another user.

The content of the manual and the associated reference documents must be read thoroughly, and the instructions and suggestions contained therein scrupulously followed (see 1.3). Only by doing this is it possible to guarantee the correct operation and reliability of the set, and prevent damage or injury.

Iveco Motors will not be held liable for any damages resulting from the incorrect installation, use or maintenance of the set.

Should any doubts, problems or difficulties arise, do not hesitate to contact the Iveco Motors Technical Assistance for their advice or intervention.

Note: The information contained in this publication is regarded as being correct at the time of printing, though the content may be modified without prior notice when necessary in line with improvements introduced by Iveco Motors to its products.

Unless otherwise provided for by exceptions or amendments to the supply documents, the information contained in this document is valid for the Generator Set for which it has been supplied.

1.2.2. DEFINITIONS

The following definitions will assist in understanding the terms used in the manual. For definitions reported in standards or other documents, the reference sources have been written in brackets.

1.2.2.1. ELECTRICITY PRODUCTION SHOP (STANDARD CEI 11-20, JANUARY 1991, POINT 1.3)

One or more closed rooms or open areas enclosed by a single fence containing plant performing one or more of the following functions: generation, conversion, transformation, regulation and distribution of electricity.

An electricity production shop incorporated in a civil building or industrial premises is intended as being only those rooms or open areas containing the electrical plant associated with it.

In line with that provided for by Standard CEI 11-20 (and consequently valid for the purposes of this manual), electricity production shops shall also be those premises housing electricity conversion systems (such as, in our case, generating sets) made up of prefabricated units, including those not enclosed in fenced-off areas or rooms (for example, units installed in cabins).

1.2.2.2. MACHINERY (EC DIRECTIVE 89/392, ARTICLE 1)

For the purposes of the Directive, MACHINERY is intended as a number of items or units, at least one of which is mobile, connected together, and fitted with actuators, control and power circuits, etc. rigidly connected for a well-defined application, A group of machines or equipment which, in order to provide an explicit function are laid-out and controlled in a manner that enables their combined operation;

For the purpose of this manual, the term machine is used to indicate the generating set complete with its command and control panels. Consequently, the terms Set, Generating Set and machine are to be regarded as synonyms.

1.2.2.3. SYNCHRONOUS GENERATOR

In this document, the main rotating electric power machine, coupled to the diesel engine, is the three-phase Synchronous Generator which is occasionally also simply called the Generator, and sometimes the Alternator.

The alternator should **not be confused** with the battery charger alternator, which is an auxiliary component of the diesel engine and which is always identified as either the *Battery Charger Alternator* or *Battery Charger Generator*.

1.2.3. SYMBOLS

The following symbols have been inserted in the text to draw the user's attention to important warnings. These symbols, wherever possible comply with the relevant international technical standards.

1.2.3.1. PARTICULARLY IMPORTANT WARNINGS



Particularly important warnings

1.2.3.2. DANGER SIGNS



Danger



Danger: Flammable material



Danger of electrical discharge



Danger of burning: Hot surfaces



Danger: Suspended loads



Danger of burning: Hot water under pressure



Danger: Noise

1.2.3.3. COMPULSORY SIGNS



General obligation



Eye protection must be worn (wear goggles)



Protective headgear required (protective headgear must be worn)



Hand protection required (protective gloves must be worn)



Feet protection required (safety shoes must be worn)



Protective clothing required (overalls must be worn)



Ear protection required (ear protectors or plugs must be worn)

1.2.3.4. PROHIBITION SIGNS



Prohibited



No smoking or naked flames



Do not use water for fire-fighting



Do not clean, lubricate, repair or manually adjust moving parts



No access to unauthorised persons



No access to persons with pace-makers



Do not use (Sign placed on switching mechanisms during maintenance)

1.2.4. WARNING LABELS

A number of graphic warning labels are attached to the generating set. These are listed below.

N.B. The labels bearing an exclamation mark indicate the presence of danger.



Lifting point



Fuel inlet



Lubricating oil inlet



Lubricating oil dipstick



Risk of burns: Possible spurting of hot water under pressure



Risk of burning: Hot surfaces



Fire risk: Presence of combustible



Risk of snagging or cutting material: Rotating parts (pulleys, belts, fan)

1.3. REFERENCE DOCUMENTS

The Operating Instructions supplied with each generating set consists of a collection of documents, of which this manual constitutes the General Part. In general, the following documents are supplied.

- a) EC Conformity Declaration.
- b) Standard technical data sheet for the set and its main components.
- c) Iveco Motors Instruction Manual for Diesel Generating Sets - General (this manual).
- d) Control panel wiring diagram (inserted in the control panel itself together with any specific manuals when required).
- e) Iveco Motors Diesel Engine Operating and Maintenance Manual.
- f) Operating and Maintenance manual issued by the generator Constructor.
- g) Other manuals relating to optional accessories issued by the respective manufacturers.
- h) List of Iveco Motors Service Centres (Service Network Booklet).
- k) Starting Electric Generator sets.

1.4. FACSIMILE OF THE EC CONFORMITY DECLARATION

Iveco Motors Generating Sets destined for member states of the European Community comply with applicable EEC Directives (see 1.5).

In general, generating sets destined for countries outside the Community will not fully comply with the Directives unless this has been specifically agreed and included in the contract and order documents.

Iveco Motors Generating Sets complying with the applicable EEC Directives will be provided with an EC Conformity Declaration, as follows:

Iveco SpA PowerTrain Viale dell'industria, 15/17 20010 Pregnana Milanese MI - Italy	IVECO MOTORS Tel. 02 935101 Fax 02 93590029
<h2>DICHIARAZIONE DI CONFORMITÀ PER GRUPPO ELETTROGENO</h2>	
Macchina tipo Type of machine – Type de machine – Maschine Typ – Máquina modelo – Máquina tipo Machine type – Maskintyp – Maskintype – Laitteen tyyppi – Τύπος Μηχανήματος	
Numero di matricola Serial number – N° de série – Nummer – Número de matricula – Número de série Registratienummer – Seriennummer – Serienr. – Sarjanumero – Αριθμός Μητρώου	
Data di costruzione Date of manufacture – Date de fabrication – Herstellungsdatum – Fecha de construcción Data de fabrico – Bouwjaar – Tillverkningsdatum – Fabrikationsdato – Valmistuspäivä – Ημερομηνία Κατασκευής	
1 – Tabella direttive direttive – directives – directives – die Vorschrift – directivas – directivas richtlijnen – direktiv – direktiverne – direktiivit – οδηγίες 73/23 CEE 93/68 CEE 98/37 CEE 89/336 CEE 92/31 CEE	
DICHIARAZIONE N. 008821	
Un Procuratore	
Nome Name – Nom – Name – Nombre – Nome – Naam – Namn Navn – Nimi – Όνομα	
Posizione Position – Fonction – Position – Posición – Posição – Functie Befattning – Stilling – Asema – θέση	
Firma Signature – Signature – Unterschrift – Firma – Assinatura – Handtekening Underskrift – Underskrift – Allekirjoitus – Υπογραφή	
Pregnana Mil.se,	
Iveco SpA a socio unico - Capitale Sociale € 858.400.000 - Sede in Torino Registro imprese Ufficio di Torino 01053960017 - REA n. 488477 - CCIAA Commercio con l'Estero M TO023290 Codice fiscale e partita IVA IT 01053960017 - Direzione e Coordinamento ex art. 2497 c.c.: Fiat SpA ivecomotors.com	
TECHNOLOGICAL EXCELLENCE	

Figure 1-A EC Conformity Declaration Facsimile

1.5. RELEVANT LEGISLATION

All Iveco Motors diesel generating sets are designed and manufactured in compliance with laws currently in force and are type approved, where required, by the principal Controlling and Certification Bodies.

a) The electric generator set and its components are built to comply with the following applicable Directives and Standards:

73/23/CEE	Low voltage.
89/336/CEE	Electromagnetic compatibility.
93/68/CEE	CE marking.
98/37/CEE	Machine Directive.
2000/14/CEE	Acoustic Emissions.
ISO 3046	Reciprocating internal combustion engines.
ISO 8528	RIC engine driven AC generator sets.

b) Synchronous generators used on Iveco Motors generating sets comply with the following standards:

IEC 34-1 / CEI 2-3 / VDE 0530 / BS 4999-5000 / NF 51-100.

They are also available with certificates issued by the following classification bodies:

BUREAU VERITAS / DET NORSKE VERITAS / GERMANISCHER LLOYD / LLOYD'S REGISTER / RINA.

c) Any plant provided by the user, including its selection and construction criteria, must be in line with the Standards, Laws and Regulations in force in the country of installation and governing various aspects such as:

- noise;
- emissions;
- operation in hazardous environments;
- limitations on installed power;
- electrical plant and safety devices;
- quantity of fuel present at the installation.

1.6. MARKING

Rating plates attached to the bases of the generating sets contain all the identification data required by Standard ISO 8528 and, where provided for, by CE Marking requirements. A facsimile of the identification plate is shown below:

The CE mark is only present on sets complying with all the applicable Directives facsimile

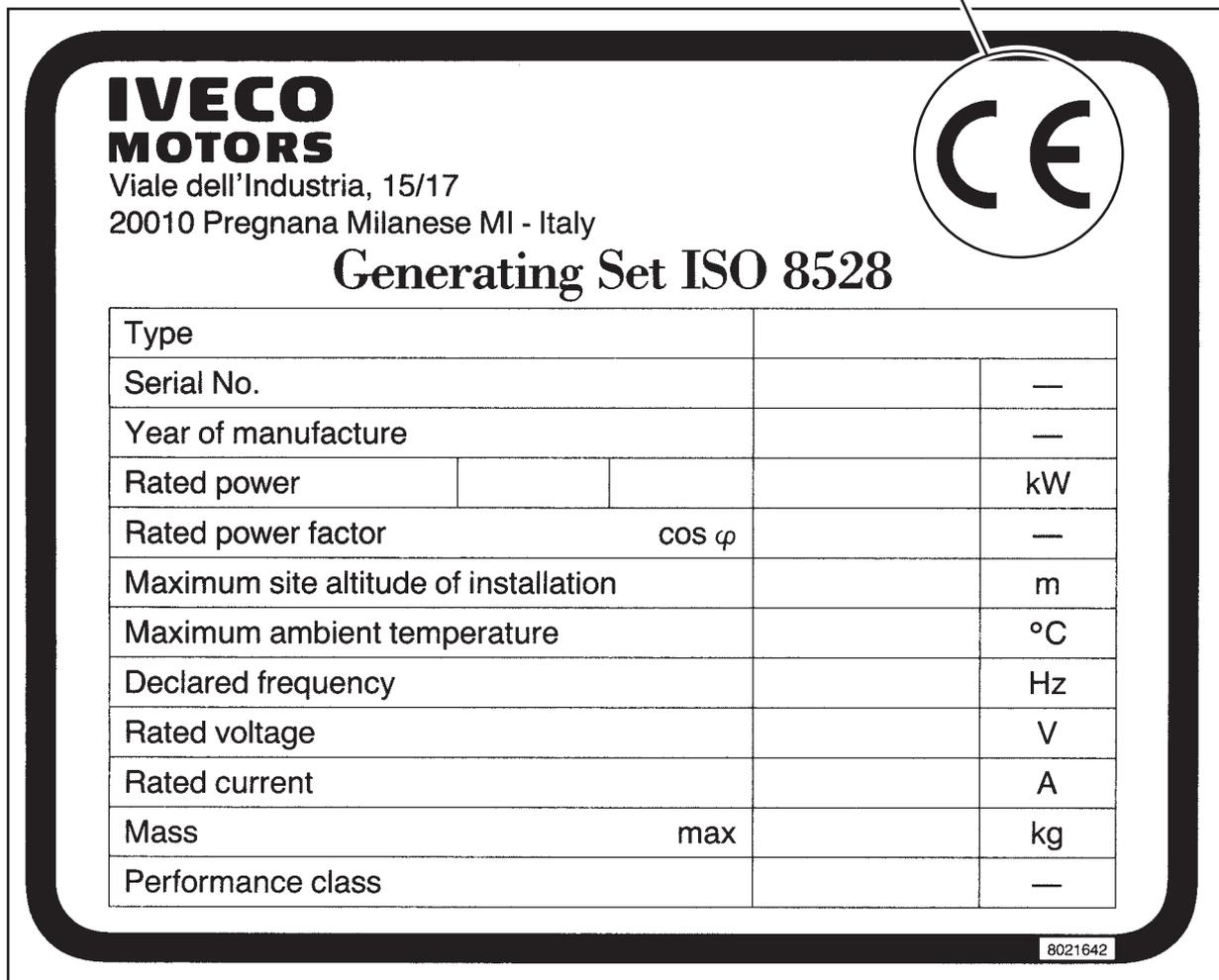


Figure 1-B Generating Set Identification Plate

1.7. GUARANTEE

Any non-compliance with the installation requirements or the operating and maintenance standards specified by Iveco Motors for the Generating Set and its components may render the guarantee null and void.

The guarantee period for the Generating Sets is specified in the contractual documents.

The general guarantee conditions applicable to industrial products apply in this case also. Any claims for repairs under this guarantee must be made immediately to the official Iveco Motors Dealer or Agency.

1.8. SPARE PARTS

For spare parts, refer exclusively to authorised spare part dealers or to the Iveco Motors Service Network.

In order to be able to correctly identify spare parts, always communicate the information reported on the rating plate fixed to the base of the set, plus the type of motor and/or synchronous generator together with the relative serial numbers.



In order to be able to correctly identify the spare parts required, refer exclusively to the official documentation supplied by Iveco Motors (Spare Parts Catalogue, Service Information, etc.).

Any other source of information not approved by Iveco Motors for its own applications may be misleading or incorrect.

2. OPERATING CONDITIONS AND LIMITS

2.1. GENERAL

The influence of the factors described in this section must not be considered individually, but in combination with the effects produced by other factors.

2.2. ENVIRONMENTAL LIMITS

2.2.1. STANDARD ENVIRONMENTAL CONDITIONS

2.2.1.1. DIESEL ENGINES

Important: In accordance with Standard ISO 3046/1, the power ratings of diesel engines for stationary applications refer to the following environmental conditions:

- ambient temperature 25°C;
- ambient pressure 1000 mbar (750 mm/Hg);
- relative humidity 30%.

2.2.1.2. SYNCHRONOUS GENERATORS

In accordance with standards IEC 34-1, ISO 8528-3 and CEI 2-3, the standard environmental conditions for synchronous generators for stationary applications are:

- ambient temperature 40°C (30°C acc. NEMA)
- altitude 1000 metres a.s.l (674 mm/Hg).

2.2.2. DERATING FOR ENVIRONMENTAL CONDITIONS

In the case of ambient installation and operating conditions that differ from the standard conditions reported in 2.2.1, the engine and the generator coupled to it must be derated to reduce the power output.

The effective prevalent environmental conditions in which the Generating Set will be installed must be clearly defined by the User/Client during the offer stage. Any derating, in fact, must be established as early as the contractual stage so that the engine and generator can be set-up from the start.

In particular, the User/Client must indicate the environmental conditions in which the Generating Set will operate, i.e.:

1. upper and lower ambient temperature limits;
2. height above sea level or, preferably, the maximum and minimum barometric pressure at the installation site. In the case of mobile sets, the minimum and maximum heights above sea level must be indicated;
3. humidity values in relation to temperature and pressure at the installation site, with particular attention to the relative humidity at maximum temperature;
4. maximum and minimum temperatures of cooling water for those sets equipped with water/water heat exchangers (specials available on request) as opposed to radiators;
5. any other particular environmental condition which may require the adoption of special measures or more frequent maintenance cycles such as:
 - dusty or sandy atmospheres;
 - marine type environments;
 - environments with risk of chemical pollution;
 - environments affected by radiation;
 - operating conditions subjected to heavy stresses or vibration (e.g. seismic activity or external vibration generated by adjacent machinery).

In the case where the effective operating conditions are not specified during the contractual stage, the power rating of the set will refer to the standard conditions for diesel engines reported in 2.2.1.1.

If the effective environmental conditions subsequently change, the Iveco Motors organisation should be informed in order that new derating calculations can be made and the machinery recalibrated.

For Diesel engines, refer to the engine documentation to determine these deratings.

The derating of synchronous generators is less critical than diesel engines. Therefore, the derating of the generating set generally coincides with that of the diesel engine.

The values reported in table 2-A constitute a guide for the determination of the derating figures for synchronous generators. For more accurate values, refer to the manufacturer's documentation.

Ambient temperature - °C	30	35	40	45	50
Reduction coefficient - K1	1,06	1,00	1,00	0,96	0,93
Height above sea level - m.	1000	1500	2000	2500	3000
Reduction coefficient - K2	1,00	0,96	0,93	0,90	0,86

Table 2-A Indicative power reduction coefficients for an air-cooled, self-ventilated, IP21 synchronous generator according to various environmental conditions.
In order to obtain the power rating under different environmental conditions to the standard, both coefficients K1 and K2 must be applied to the nominal power of the generator.

For example:

A 64 kW (80 kVA) generating set with standard operating conditions for the engine at 25°C, 100 m a.s.l and 30% relative humidity.

The Set consists of:

one supercharged engine outputting 72 kW under the above conditions;

one alternator with P = 80 kVA output up to 40°C and 1000 m a.s.l; the efficiency of the alternator is assumed to be 89%.

We need to check the maximum possible output of the Set at 1500 m a.s.l and at 45°C.

Assuming the derating coefficient of the engine to be 0.75, Therefore, the engine rating under the above conditions will be $0.75 \times 72 = 54$ kW. Taking into account the efficiency of the alternator, the total power rating of the set will be $54 \times 0.89 = 48$ kW.

In order to determine whether the alternator is adequate: the derating value for the alternator is given by the two coefficients K1 and K2 obtained from Table 2-A. The apparent power will be given by $K1 \times K2 \times P$:

That is: $K1 = 0.96$, $K2 = 0.97$. The maximum apparent power will be $0.96 \times 0.97 \times 80 = 74.4$ kVA and the active power at $\cos \varphi 0.8$ will be $74.4 \times 0.8 = 59.2$ kW. Consequently, the alternator is correctly sized for the required output of the set (48 kW).

Height m a.s.l.	Atmos. press. mmHg	Induction air temperature [°C]																					
		with 60% relative humidity										with 100% relative humidity											
		0°	5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	0°	5°	10°	15°	20°	25°	30°	35°	40°	45°	50°
0	760	111	110	108	106	104	102	100	97	95	92	89	111	109	107	105	103	100	98	95	92	88	84
100	751	110	108	106	104	102	100	98	96	93	91	88	110	108	106	104	101	99	96	93	90	87	83
200	742	108	107	105	103	101	99	97	95	92	89	87	108	106	104	102	100	97	95	92	89	86	81
300	733	107	105	104	102	100	98	96	93	91	88	85	107	105	103	101	98	96	94	91	88	84	80
400	725	106	104	102	100	98	96	94	92	90	87	84	105	103	102	99	97	95	92	89	86	83	79
500	716	104	103	101	99	97	95	93	91	88	86	83	104	102	100	98	96	93	91	88	85	82	77
600	708	103	101	99	98	96	94	93	89	87	85	82	103	101	99	97	95	92	90	87	84	81	76
700	699	101	100	98	96	94	92	90	88	86	83	80	101	99	97	95	93	91	88	86	83	79	75
800	691	100	98	97	95	93	91	89	87	85	82	79	100	98	96	94	92	90	87	84	81	78	74
900	682	99	97	95	94	92	90	88	86	83	81	78	98	97	95	93	91	88	86	83	80	77	73
1000	674	97	96	94	92	90	89	87	84	82	80	77	97	95	93	91	89	87	85	82	79	76	71
1100	666	96	94	93	91	89	87	85	83	81	79	76	96	94	92	90	88	86	83	81	78	74	70
1200	658	95	93	91	89	88	86	84	82	80	77	74	94	93	91	89	87	85	82	80	77	73	69
1300	650	93	92	90	88	87	85	83	81	79	76	73	93	91	90	88	86	83	81	78	75	72	68
1400	642	92	91	89	87	86	84	82	80	77	75	72	92	90	88	86	84	82	80	77	74	71	67
1500	634	91	89	88	86	84	82	81	78	76	74	71	91	89	87	85	83	81	79	76	73	70	66
1600	626	90	88	86	85	83	81	79	77	75	73	70	89	88	86	84	82	80	77	75	72	69	65
1700	618	88	87	85	84	82	80	78	76	74	72	69	88	86	85	83	81	79	76	74	71	67	63
1800	611	87	86	84	82	81	79	77	75	73	70	68	87	85	83	82	80	77	75	72	70	66	62
1900	604	86	84	83	81	80	78	76	74	72	69	67	86	84	82	80	78	76	74	71	69	65	61
2000	596	85	83	82	80	79	77	75	73	71	68	66	84	83	81	79	77	75	73	70	67	64	60
2100	589	84	82	81	79	77	76	74	72	70	67	65	83	82	80	78	76	74	72	69	66	63	59
2200	582	83	81	79	78	76	74	73	71	68	66	63	82	80	79	77	75	73	71	68	65	62	58
2300	574	82	80	78	77	75	73	71	69	67	65	62	81	79	77	76	74	72	69	67	64	61	57
2400	567	81	78	77	75	74	72	70	68	66	64	61	80	78	76	75	73	71	68	66	63	60	56
2500	560	79	77	76	74	73	71	69	67	65	63	60	78	77	75	73	72	69	67	65	62	59	55
2600	553	78	76	75	73	72	70	68	66	64	62	59	77	76	74	72	71	68	66	64	61	58	54
2700	546	76	75	74	72	71	69	67	65	63	61	58	76	75	73	71	69	67	65	63	60	57	53
2800	539	75	74	73	71	70	68	66	64	62	60	57	75	73	72	70	68	66	64	62	59	56	52
2900	532	74	73	71	70	68	67	65	63	61	59	56	74	72	71	69	67	65	63	61	58	55	51
3000	526	73	72	70	69	67	66	64	62	60	58	55	73	71	70	68	66	64	62	60	57	54	50
3100	519	72	71	69	68	66	65	63	61	59	57	54	72	70	69	67	65	63	61	59	56	53	49
3200	513	71	70	68	67	65	64	62	60	58	56	53	71	69	68	66	64	62	60	58	55	52	48
3300	506	70	69	67	66	64	63	61	59	57	55	52	70	68	67	65	63	61	59	57	54	51	47
3400	500	69	68	66	65	63	62	60	58	56	54	52	69	67	66	64	62	60	58	56	53	50	46
3500	493	68	67	65	64	62	61	59	57	55	53	51	67	66	65	63	61	59	57	55	52	49	45
3600	487	67	66	64	63	61	60	58	57	55	52	50	66	65	64	62	60	58	56	54	51	48	44
3700	481	66	65	63	62	60	59	57	56	54	51	49	65	64	63	61	59	57	55	53	50	47	44
3800	474	65	64	62	61	59	58	56	55	53	51	48	64	63	62	60	58	56	54	52	49	46	43
3900	468	64	63	61	60	59	57	55	54	52	50	47	63	62	61	59	57	55	53	51	49	46	42
4000	462	63	62	60	59	58	56	54	53	51	49	46	62	61	60	58	56	55	52	50	48	45	41
4100	456	62	61	59	58	57	55	54	52	50	48	45	61	60	59	57	55	54	52	49	47	44	40
4200	451	61	60	58	57	56	54	53	51	49	47	45	61	59	58	56	55	53	51	49	46	43	39
4300	445	60	59	58	56	55	53	52	50	48	46	44	60	58	57	55	54	52	50	48	45	42	38
4400	439	59	58	57	55	54	53	51	49	48	45	43	59	57	56	55	53	51	49	47	44	41	38
4500	433	58	57	56	54	53	52	50	49	47	45	42	58	56	55	54	52	50	48	46	43	41	37
4600	427	57	56	55	53	52	51	49	48	46	44	41	57	55	54	53	51	49	47	45	43	40	36
4700	421	56	55	54	53	51	50	48	47	45	43	40	56	54	53	52	50	48	46	44	42	39	35
4800	415	55	54	53	52	50	49	48	46	44	42	40	55	53	52	51	49	48	46	43	41	38	34
4900	410	54	53	52	51	50	48	47	45	43	41	39	54	53	51	50	49	47	45	42	40	37	33
5000	405	53	52	51	50	49	47	46	44	42	40	38	53	52	51	49	48	46	44	42	39	36	33

Table 2-B Percentage power reduction coefficients for induction engines as a function of the environmental conditions.

2.3. OPERATING LIMITS

2.3.1. GENERAL

During the offer request stage, the User/Client must communicate all the operating conditions which may influence the operation of the Generating Set. In addition to the environmental conditions reported in item 2.2, the information must also include the characteristics of the load to feed, i.e. power, voltage and power factor. Particular attention must be paid to the determination of the load insertion sequence in line with that illustrated in item 2.3.7.

2.3.2. POWER RATING

The power output of the electric generator sets is the apparent power, expressed in kVA, delivered at the generator terminals, at the nominal voltage and frequency and in the established environmental conditions (see also 2.2.1.1). The power ratings are in accordance with the provisions of Standard ISO 8528/1 and 3046/1. The relative definitions are reported below:

2.3.2.1. CONTINUOUS POWER (COP/ISO 8528-1 PAR. 13.3.1)

This is the power that the generating set is capable of continuously outputting for an unlimited number of hours per year, between the maintenance intervals specified by the manufacturer and under the predetermined environmental conditions (see also 2.2.1.1).

An overload of 10% is permissible for regulating purposes only (temporary loads and sudden load variations) and not for normal feeding to the users.

2.3.2.2. PRIME POWER (PRP/ISO 8528/1 PAR. 13.3.2)

This is the maximum power available for one cycle at variable power that the generating set is capable of generating for an unlimited number of hours, between the maintenance intervals specified by the manufacturer and under the predetermined environmental conditions (see also 2.2.1.1). The mean power obtainable during a 24 hour period must not exceed 80% of the PRP.

An overload of 10% is permissible for regulating purposes only.

2.3.2.3. MAX STAND-BY POWER (ISO 3046 FUEL STOP POWER)

This is the maximum power available for use with variable loads for a limited number of hours per year (500 h), in the established environmental conditions (see also 2.2.1.1), with an average load factor of 90% of the declared stand-by power.

No overloads are allowed.

2.3.3. FREQUENCY

Iveco Motors generating sets are normally designed to operate at 1500 rpm and at 1800 rpm at a frequency of 50 Hz and 60 Hz respectively (4-pole generator).

The engines are fitted with either a mechanical regulator or electronic control unit.

The mechanical rev regulator is incorporated within the injection pump, it is normally adjusted for a tolerance of 5% to enable a full load frequency of 50Hz and an off-load frequency of 52.5Hz.

Under stable conditions, the standard speed governor is generally accurate to within $\pm 0.5\%$.

These performance figures correspond to that provided for by Standard ISO 3046/IV - Class A1 and 8528-5 Class G2.

The engines with an electronic control unit operate asynchronously with accuracy of $\pm 0.25\%$, complying with Standard 8528-5 Class G3/G4.

2.3.4. VOLTAGE

The generator voltage regulator is ELECTRONIC and is designed to check the voltage at the terminals as required by Standard 8528-5.

2.3.5. POWER FACTOR

As mentioned earlier, the power output of the electric generator sets is the Apparent power, expressed in kVA, delivered at the generator terminals. The nominal power factor is $\cos \varphi = 0.8$; as a result, the Active Power will be 0.8 times the Apparent Power. The value of the Power Factor depends on the electrical characteristics of the load. Iveco Motors generating sets equipped with synchronous generators are capable of supplying both the active power and the reactive power requested by the load. However, while the active power is supplied by the diesel engine (transforming mechanical power into electrical power through the generator itself), the reactive power is supplied by the synchronous generator. Consequently, when considering operation at values other than $\cos \varphi = 0.8$, the following aspects must be taken into account:

2.3.5.1. LOAD WITH $\cos \varphi$ BETWEEN 0.8 AND 1

At Nominal Active Power, the synchronous generator functions perfectly with $\cos \varphi$ values between 0.8 and 1.

2.3.5.2. LOAD WITH $\cos \varphi$ LESS THAN 0.8

With a given rating value, in relation to $\cos \varphi = 0.8$, in a synchronous generator, the more the value of $\cos \varphi$ tends towards 0, the more the overload on the excitation system increases. In fact, the reactive power to output increases as $\cos \varphi$ decreases. The generator must, therefore, be derated according to the manufacturer's instructions.

Under these conditions, the diesel engine is generally producing excess power.

Table 2-C shows an example of these derating coefficients. For more detailed information, refer to the generator constructor's documentation.

Power Factor - $\cos \varphi$	1	0,8	0,7	0,6	0,5	0,3	0
Reduction coefficient	1,00	1,00	0,93	0,88	0,84	0,82	0,80

Table 2-C Examples of generator power reduction coefficients as a function of $\cos \varphi$.

2.3.6. SINGLE-PHASE LOAD

The generating sets can be loaded with unbalanced loads up to the maximum rated current in each phase.

This means that no more than $\sqrt{3/3} = 0,58$ of the nominal three-phase power output of the set can be inserted between two phases (for example, between L1 and L2). Similarly, no more than 1/3 (i.e. 33%) of the rated three-phase power can be inserted between one phase and neutral (for example, between L3 and neutral).

It must be remembered that during single-phase operation, or when the loads are unbalanced, the voltage tolerances described in 2.3.4 can no longer be maintained by the voltage regulator.

2.3.7. LOAD TAKE-UP

2.3.7.1. GENERAL

When a load is applied to a generating set, temporary variations in voltage and frequency are created. The amplitude of these variations depends on the value of both the active power (kW) and reactive power (kVAR) of the load variations and the characteristics of the set (power and dynamic characteristics). The characteristics of the set are a combination of the characteristics of the diesel engine and those of the synchronous generator.

If and when the load take-up capacity is an important requirement, it must be clearly specified by the Client/ User who must provide Iveco Motors with all the information relating to the different loads to be fed, their possible division into groups and the relative take-up sequence. This is to allow the sizing of the set to be optimised and avoid uneconomic oversizing and dangerous undersizing.

The characteristics of the Iveco Motors sets comply with that provided for by the ISO 8528 series. The load take-up possibilities are a function of the mean effective pressure (Pme) of the diesel engine. The Pme values are indicated on data sheets for the sets at standard ratings.

The graph shown in Figure 2-C has been taken from Standard ISO 8528-5.

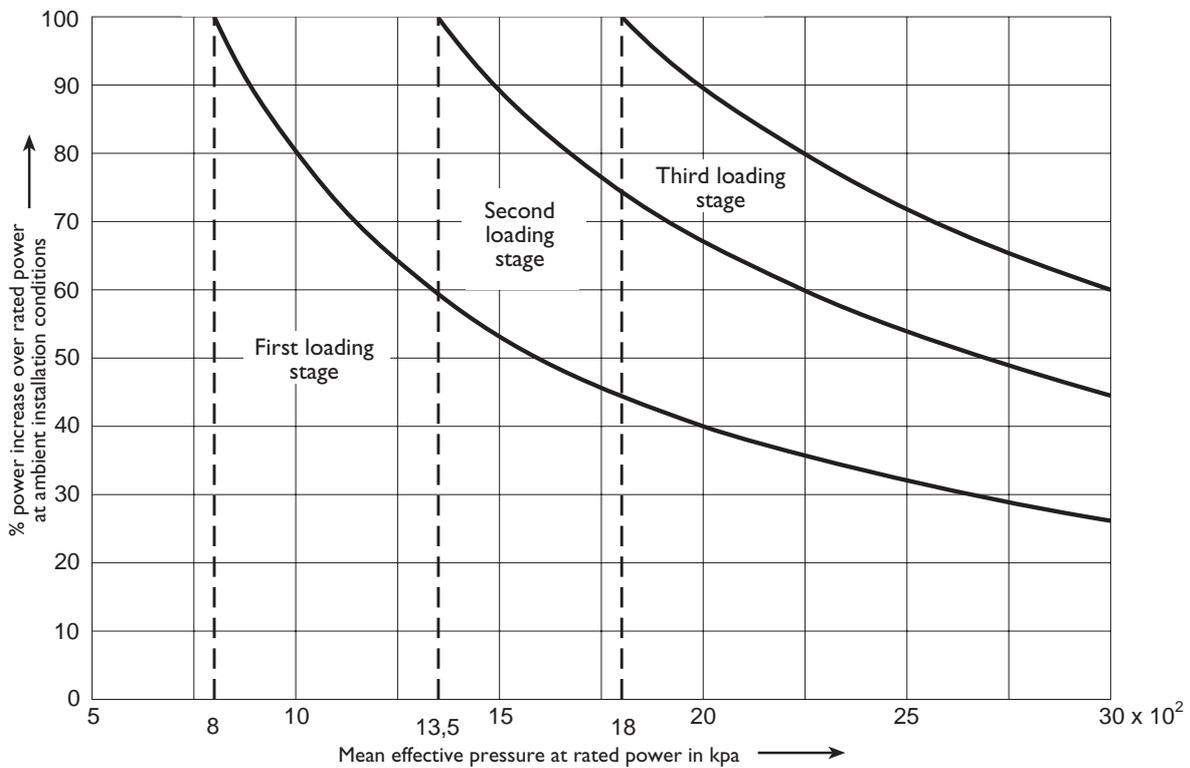


Figure 2-C Examples of maximum possible sudden load increases as a function of Pme at rated power (valid for 4-stroke engines).

2.3.7.2. STARTING-UP ASYNCHRONOUS MOTORS

The start-up of asynchronous motors by a generating set presents a number of problems, in that the motors, in particular those with cage type rotors, have high pickup currents when starting ($I_{start} =$ up to 8 times the nominal current (I_n) with low power factors.

Under these conditions, the current absorbed by the asynchronous motor (or by motors which start-up simultaneously) during start-up must not exceed the maximum current that the generator is able to provide in the short-term, with an acceptable voltage drop, nor must it exceed the overtemperature limits.

In order to prevent excessive oversizing of the generating set, the following solutions can be adopted:

- a. In the case of several motors, divide them into groups which start-up according to a predetermined time sequence of between 30 - 60 seconds.
- b. In the case of a single motor, if the coupled operating machine allows this to be done, adopt a reduced voltage start-up system (star/delta, autotransformer) or, for higher powers, use motors with wound rotors and rheostat starters.

In the case of star/delta start-up, the voltage on each phase is reduced and the start-up current (I_{start}) is reduced in proportion (to $1 / \sqrt{3} = 0,58$).

It thus becomes evident that, in the case of a motor with $I_{start} = 6 I_n$ and with direct start-up, with star/delta starting, I_{start} reduces to $\sim 3.5 I_n$, with the result that the generating set needs to deliver less power in the ratio of 6/3/5.

In all cases, whether with direct start-up or reduced voltage start-up, the equipment and users connected to the user circuit must be checked to prevent problems (e.g. contactors opening) caused by transitory voltage drops at pick-up.

2.4. IMPROPER USE

The Generating Set you have bought is designed to be used for the production of electricity under the conditions and within the operational and environmental limits expressed in items 2.2 and 2.3, or under the conditions and within the limits otherwise agreed in the contract. Iveco Motors must be informed of any changes in these conditions or limits, either directly or via authorised service centres, in order that the necessary approval can be given and, if necessary, any modifications and/or recalibration work required to the set can be done.

The Generating Set is a machine which transforms potential heat energy contained in the fuel into electricity. The set is destined to feed distribution plant manufactured according to the relevant specifications by specialist personnel. Even though the amount of power involved is substantially less than that supplied by a public grid system (mains), the hazardous nature of electricity remains unaltered. In fact, a generating set not only produces electricity, with its inherent dangers, but also has additional hazards caused by the presence of combustible materials (the fuel used and the lubricating oils involved), rotating machinery and secondary waste products (exhaust gas, heat from the cooling system and irradiation).

Even though it may be possible to make use of the heat contained in the exhaust gases and cooling circuit, and thereby increase the efficiency of the generating process, any such operation must be performed by specialised personnel in order to obtain a reliable and safe plant and to avoid jeopardising the guarantee.

Unless previously agreed with Iveco Motors, any use other than that specified will be considered as improper, and as such not permissible.

2.5. MODIFICATIONS TO OPERATING DATA

2.5.1. FREQUENCY CHANGE

Iveco Motors generating sets are normally supplied with speed governors fitted to the engine for operation at 50 Hz (1500 rpm) or at 60 Hz (1800 rpm).

With regard to the instrument panel, it should be noted that:

- automatic control unit panels are already set-up for dual frequency.
- in the case of control boards for manual units, the switches are not always calibrated to bear the increase in power at the same voltage due to the increase from 50 to 60 Hz; this must be verified in advance before connection to the supply cables.

It is possible, nevertheless, to change from 60 Hz to 50 Hz on a set originally supplied for operation at 60 Hz.

To change the frequency of a non electronically controlled pump, it is necessary either to have the injection pump re-calibrated by a member of the Iveco Motors organisation, or to regulate the revs by adjusting the accelerator lever; to change the frequency of an electronic unit requires a simple adjustment.

The voltage output from the generator must also be calibrated to the required operating value.

It should be remembered that if the output voltage is not recalibrated, the increase in frequency will result in a proportional increase in the output voltage itself.

For example, switching from 50 Hz to 60 Hz will result in an increase in the output voltage from 400 V to 440 V.

In order to be able to output 400 V at 60 Hz, refer to an authorised service centre who will check whether this particular changeover is possible.

When modifying frequencies, it should be remembered that:

- the changeover from 50 to 60 Hz produces a slight increase in power output. This can be seen in the Iveco Motors Data Sheets for the sets;
- the changeover from 60 to 50 Hz produces a reduction in power output;
- the nominal voltage can be calibrated by adjusting the control rheostat;
- frequency: check that the frequency meter has been adjusted to operate at the new frequency.

2.5.2. VOLTAGE CHANGE

The operating voltage of generators with 12 wire terminal boards can be varied by following the manufacturer's instructions in the generator manual.



Warning: a variation in voltage at a given power rating will result an inversely proportional variation in the current. Therefore, check that the rated capacity of the electrical equipment downstream can support the new current and/or provide the plant with a suitable protection system.

2.6. TYPES OF OPERATION

Iveco Motors generating sets are designed for use as either manually controlled or automatically controlled units.

Switching from one service type to another requires the replacement of the control panel (a simple procedure, in that the auxiliary services are installed via connectors) and, when switching to the automatic version, the installation of the water pre-heater.

The engine wiring is already set-up for these connections.

3. SAFETY

3.1. GENERAL

Before starting the Electric Generator set and before any lubrication or maintenance operation, it is essential that the personnel responsible must have read and understood all the WARNINGS AND CAUTIONARY NOTICES contained in the leaflet "START-UP OF THE ELECTRIC GENERATOR SETS".

The constructor, however, cannot foresee all the possible circumstances which may lead to possible risk during the actual operation of the generating set.

Any maintenance operations or procedures not strictly provided for in the operating manual must be reported to the constructor beforehand for approval.

When the need arises to follow a procedure which has not been specifically recommended, the user will be responsible for ensuring that said procedure is safe and does not lead to damage or injury.

The following instructions must be followed closely to ensure safe operation.

3.2. ACCESS TO THE PLANT

Rooms or areas in which a generating set is installed are to be considered as an Electricity Production Shop (see 1.2.2.1). As such, the installed plant must be managed exclusively by specialised and suitable trained personnel.



Access must not be allowed to unauthorised persons.



Access is denied to persons wearing a pace-maker, due to possible electromagnetic interference to cardio-stimulation equipment.

In the case of automatic start-up sets:

- install a red light in a clearly visible position which lights-up when the set is operating;
- provide a sign warning of the danger of sudden automatic start-up of the machine;
- provide a sign stating that "All maintenance operations must be carried out with the set shut-down".

If the set needs to be stopped in an emergency, press the "emergency stop" button located on the panel or (when provided) the stop button positioned outside the generator room.

3.3. SAFETY REQUIREMENTS DURING INSTALLATION AND COMMISSIONING



Only allow authorised personnel to have access onto the site where the Generating Set is to be installed by providing "Work in Progress" signs.



Always wear a safety helmet.

Always wear safety shoes and overalls.

Replace wet overalls immediately.

Wear safety gloves.



Do not remove protection devices mounted over moving parts, hot surfaces, air intakes, drive belts or live components.

Do not leave dismantled components or tools on the engine, or any other equipment not forming part of the plant in the same room or area occupied by the Generating Set.



Never leave flammable liquids or rags soaked in flammable substances near to the generating set, electrical equipment (including lamps) or electrical parts.

Every possible precaution must be taken to prevent electrocution. Check that the earthing system is connected and according to standard.



Affix a sign “DO NOT OPERATE” on all switching devices isolating the parts on which maintenance is to be carried out. Whenever possible, use key operated locking devices to prevent accidental or dangerous manoeuvres.



- Install the necessary safety devices on the outer parts of the plant.
- Insulate all connections and loose wires. Do not leave the power terminal box on the generator open.
- Inspect and check that the electrical power connections and auxiliary service connections have been correctly made.
- Ensure that the phase cyclic direction of the generator agrees with that of the mains.
- Check that the devices for stopping the set function correctly. In particular, check the overspeed shutdown device (if fitted), the low oil pressure and high engine water temperature devices and the emergency stop button installed by the user outside the generating room.
- Check that the ventilation of the room in which the Generating Set is installed is correctly ventilated. Check that the engine exhaust is unobstructed and that the exhaust piping evacuates the gas correctly. Also check that the exhaust pipe and silencers are adequately supported, fitted with expansion joints and protected against accidental contact.
- Check that the exhaust gases are discharged to atmosphere outdoors at a safe location, away from doors, windows and air intakes.
- Check the oil pipes and fuel lines (diesel oil) and ensure that there are no leaks.



Preliminary safety checks

Prior to initiating any start-up procedure, it is of extreme importance to familiarise oneself with the generating set and with the plant. A visual inspection must also be carried out with regard to the safety aspects of the machine's work station and its installation. This inspection must include all the items listed below and any other which may be of importance for the installation. Any source of danger, actual or potential, must be eliminated prior to proceeding.

1. Identify the positions of the emergency stop buttons, emergency fuel shut-off valves, switches and any other emergency shut-down systems on the plant
2. Be aware of any special emergency procedures appertaining to the installation in question
3. Identify the positions of the fire extinguishers and any other safety or emergency equipment and know how to use them
4. Identify any possible source of danger, such as fuel leaks, lubricating oil leaks, acid spills, condensate in the drip feeds, high voltages, high pressures, and other dangers.
5. Ensure that the set is clean, that the surrounding area and emergency exits are clean and free of any obstructions. Check that none of the inlet openings or breathers are blocked.

6. Check whether people are working on other equipment in the zone and whether the work is dangerous or prevents the plant from operating.



Never start the set if it is not in a condition of maximum safety.

3.4. SAFETY REQUIREMENTS DURING MAINTENANCE

3.4.1. GENERAL PRECAUTIONS



Do not allow unauthorised access to zones in which maintenance work is being carried out by fixing the “Work in Progress” sign.

Place a “DO NOT OPERATE” sign on all switchgear isolating the parts of the plant on which work is to be carried out. Whenever possible, use a key operated lock to prevent undesirable or dangerous manoeuvres.



Never wear loose clothing, rings or chains when working near to moving parts or motors.

Use safety gloves and goggles:



- during battery maintenance;
- when topping-up inhibitors or antifreeze;
- when changing or topping-up lubricating oil (hot engine oil can cause burns when being drained. Allow it to cool to below 60°C);
- when using compressed air (in this case, the maximum pressure for cleaning purposes must be less than 2 atm (30 psi, 2 kg/cm²)).



Use a safety helmet when working in an area with suspended loads or with plant located at head height.



Always wear safety shoes and overalls.



When working on parts which may become live, always keep hands and feet dry. Where necessary, carry out operations using an insulated footboard. In all cases, if insufficiently experienced in this type of work, call specialised personnel to perform the operations or adjustments.



Replace wet overalls immediately.

Use a barrier cream on hands.



Replace used rags in a flameproof container.

Never leave rags on the engine.

Keep used oil in a suitable safe container.



Do not attempt to carry out repairs that are unfamiliar. Always follow the instructions; if instructions are not available, contact the supplier or qualified personnel.

When starting the engine after repairs have been carried out, take suitable measures to enable the air intake to be shut-off if the machine starts out of synch.

Always keep the engine clean, removing any oil, diesel or cooling liquid spills.

Never start the engine with the speed governor lever disconnected.



Work requiring two or more persons must not be carried out by one man, especially when performing operations on moving parts such as switches, fuses or other live equipment.

3.4.2. ENGINE COOLING CIRCUIT

- Never add coolant to a hot engine; allow the engine to cool down first.
- Periodically check the level of cooling liquid and top-up if necessary. Use the correct fluid as specified in the engine operating and maintenance manual.



Remove the radiator cap slowly. Cooling circuits normally operate under pressure and any hot liquid may spurt out if the pressure is released too quickly.

- Periodically check the tension and degree of wear in the pump/fan drive belt.

3.4.3. LUBRICATING CIRCUIT

- Periodically check the oil level in the sump with the engine cold. Top-up if necessary in line with the instructions reported in the engine operating and maintenance manual.



Do not smoke or use naked flames when topping-up the oil.

3.4.4. FUEL CIRCUIT



Do not smoke or use naked flames when refuelling.

3.4.5. EXHAUST CIRCUIT



Carry out a visual check of the exhaust system and identify any exhaust gas leaks. Carry out any necessary repairs immediately; exhaust gas is a source of danger and a fire hazard.



Warning: very hot surfaces. The parts of the plant pre-assembled in the factory are protected against accidental contact. Installation components such as ducts conveying exhaust gas from the building, silencers supplied separately, etc. must be insulated and/or protected by the installer.

3.4.6. ELECTRIC START SYSTEM



Disconnect the negative pole from the battery before working on the engine. This is to prevent accidental starting. Ensure that the engine's automatic start-up system does not come into operation and start the engine while work is being carried out on it.

- Make sure that all connections are tight and check that the insulation on the wires is in a good condition.

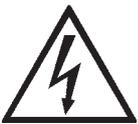


When batteries are being recharged, a potentially explosive gas is emitted. The room, therefore, must be well ventilated and naked flames or smoking not allowed in the vicinity of the batteries.



In order to prevent the arcing, it is advisable to connect the positive terminal to the battery first, and then the negative (normally earth).

3.4.7. SYNCHRONOUS GENERATORS



Do not carry out any maintenance while the generating sets are running. Before carrying out any work, ensure that the set is SHUT-DOWN and cannot restart.

Clean the air intakes on the generators ventilation system and, on some models, lubricate the bearings. In particular, check the tightness and positions of the electrical connections.

3.4.8. ELECTRIC PANEL



Before carrying out any work on the electric panel, disconnect the unit from the mains power supply and SHUT-DOWN the system.

As with all electric equipment, the electric panels are particularly sensitive to humidity and dust. Consequently, ensure that the anti-condensation heaters are working correctly and, when fitted, clean the ventilation air intake.

Periodically check the tightness of the electrical connection bolts.

3.5. DURING OPERATION



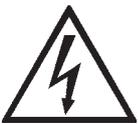
Allow authorised operating staff only to have access to the Generating Set installation by affixing the appropriate signs.



Never wear loose clothing, rings or chains when working near to motors or moving parts.



In order to prevent damage to the hearing, always wear ear protectors when spending any length of time in the room while the Generating Set is in operation.



Do not touch the generating set, in particular the wiring or connections to the alternator while it is turning; it is live. Periodically check all the connections, both with regard to tightness and insulation.



Never leave flammable liquids or rags soaked in flammable liquid near to the set, near to electrical equipment (including lamps) or electrical parts of the plant.

4. DESCRIPTION OF THE MACHINE

4.1. GENERAL

Diesel generating sets are independent complexes used for the generation of electricity. Basically they consist of a synchronous constant voltage electric generator driven by an internal combustion diesel engine.

The sets are used for two principal types of service:

a) Sets for normal service

Used for the production of electricity for a multitude of uses (motive power, lighting, heating, etc.) in an area where there are no other electricity sources.

b) Sets for emergency service

Used to meet electricity demands in the case of an interruption in the mains supply, when said interruption could create serious problems for persons or cause material or financial damage (hospitals, continuous cycle industrial plants, etc.), or help meet demand during peak consumption periods.

Depending on their location, generating sets are divided into:

- land use;
- marine applications (on-board sets).

Land use sets are divided into two types:

- stationary sets (fixed installation);
- mobile sets (mobile installation).

These two types are, in turn, further divided into a vast range of types according to their operating methods, i.e.:

1. manual start-up;
2. automatic start-up.

4.1.1. SPECIAL APPLICATIONS

4.1.1.1. SETS CONNECTED IN PARALLEL

In order to obtain greater operating power, two or more sets can be connected in parallel.

The requirements to observe for each set are reported in this manual, while the specifications for the control panels, which vary according to the paralleling, are reported in the manuals supplied with the panels.

4.1.2. ON-BOARD SETS

(Excluded from the range of applications provided for by Machinery Directive - 89/392/CEE and subsequent amendments).

Even though this manual has been prepared specifically for land sets, the following paragraphs provide information which is also relevant to on-board generating sets, in that many of the maintenance and safety requirements are applicable to both types of application.

On-board sets can be divided into two distinct categories:

- a) Primary service sets, destined for the production of electricity for on-board services (on passenger ships, cargo ships, ferries, tugs, platforms, etc.).

Marine engines are normally used for these types of sets and have closed-circuit fresh-water cooling systems and fresh water/sea water heat exchangers for keel cooling.

- b) Emergency generating sets which cut-in automatically to feed essential services when the auxiliary sets shut-down.

These sets are located in the upper parts of the vessel. The engines are derived from industrial engines and are equipped with radiator type cooling.

Refer to specific commercial documentation for the characteristic data of the entire range.

4.1.2.1. TESTING

Sets used for marine installations must comply with the standards and tests provided for by the Marine Classification Body chosen by the shipyard.

4.1.2.2. MISCELLANEOUS INFORMATION

The information on exhaust pipes, room ventilation and exhaust silencers provided for land-based sets is also valid for marine applications. The start-up and maintenance procedures are also similar. For further information and/or connections (e.g. cooling circuit, fuel lines, etc.) on marine engines, refer to the Iveco Motors marine engine installation manual.

Special attention must be paid to electrical connecting wires, in that their insulation and cross-section must comply with the provisions of the various Marine Classification Bodies.

4.2. COMPOSITION OF STANDARD IVECO MOTORS GENERATING SETS

A standard stationary generating set generally consists of:

- diesel engine;
- synchronous generator;
- flex-plate coupling joint;
- steel chassis with vibration-proof supports, starter batteries and auxiliary services;
- fuel tank incorporated in the base;
- control panel (on request);
- exhaust silencers (on request);

A detailed description of the set and its components is reported on the relevant data sheet.

5. TRANSPORT AND HANDLING



All transport and handling activities must be carried out by organisations of proven experience in the transport and handling of machinery and industrial equipment. These organisations must employ specialised personnel and use the appropriate equipment in line with the dimensions and weight of the package and the logistics of the sites.

Do not use the lifting eyes of the individual components (engine, alternator) to lift the entire Generating Set, in that they are not designed to take the overall weight of the Generating Set.



Do not allow personnel to stand near to the Generating Set during the lifting and handling operations.



Safety helmets, gloves and safety shoes must be worn during unloading and handling operations.

Cranes, overhead gantries and lift trucks can be used for unloading, handling and positioning the generating set. Ensure that the available equipment is of suitable capacity for the weight of the set to be moved and the characteristics of the site.

The weights of the generating sets are reported on the data sheets.

Check that the dimensions of the set are compatible with the sizes of the openings through which it will pass during its journey. The lifting means must be operated by qualified, trained and authorised personnel only.

Loads must be lifted vertically without oscillation.

Do not:

- lift obliquely;
- jerk anchored parts;
- leave loads suspended even for short periods of time;
- lift or transport personnel using lifting devices designed for materials.

When performing handling operations, the loads must be kept as close to the ground as possible and must not be transported over work stations or passage ways, unless suitable measures have been taken to prevent people standing along the route.

Check that all lifting equipment and associated safety devices are in perfect working order before using them (limit switches, brakes, signalling devices, etc.).

The slinging of the loads must be carried out by qualified and trained personnel.

It is advisable to use the slings provided by specialised companies who are able to guarantee the indicated capacity.

The stresses on the individual cables of a sling must vary according to the shape of the load, the position of its barycentre and the oscillations occurring during movement. In particular, the stress on the cables increases as the internal angle between the cables at the apex increases. Under normal circumstances, this angle must not be greater than 60° and, under no circumstances, must it be greater than 120° (it is, nevertheless, not advisable to exceed 90°). In this case, use longer slings or, even better, spreader bars.

The capacity of the cables must therefore be checked in accordance with the selected lifting angle.

Cables and chains must be protected against contact with any sharp corners on the load.

Hooks must be fitted with safety closing devices and must bear the maximum allowed capacity. If this capacity is different to that of the lifting equipment to which it is attached and the cables used, then the weight which can be lifted must not exceed the least of these capacities.

Spreader beams or other hook-up devices reduce the forces on the cables, thus reducing their inclination and increasing the stability of the load, provided that they have been designed by a qualified engineer for the type of load to lift.

Special attention must be paid to the position of the barycentre of the load.

5.1. USING STATIONARY, MOBILE OR BRIDGE CRANES

Only those lifting eyes provided for the purpose by Iveco Motors must be used to lift the Generating Set. These lifting eyes are normally located on the steel base, as shown in Figure 5-A. The positions of the lifting points are marked with yellow-black labels, also shown in Figure 5-A.

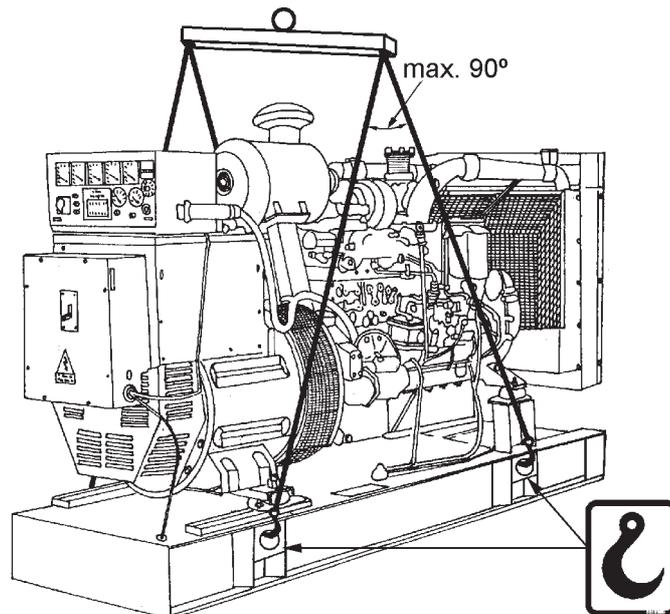


Figure 5-A Slinging method for lifting a generating set.

In order to prevent damage to the set, always use a spreader beam or a rigid slinging device.

When using a mobile crane, check that the ground over which it will pass is capable of supporting the combined weight of the set and crane.

5.2. USING A FORK LIFT TRUCK

Check that the ground over which the truck will pass is capable of supporting the combined weight of the set and the truck.

Position the forks under the base and widen the arms as much as possible in relation to the width of the load in order to increase its stability.

5.3. UNPACKING

The removal of packaging material must be carried out as carefully as possible to prevent damage.



All materials forming the packaging must be collected, recycled and/or disposed of according to that provided for by existing laws in that country, in particular, those requirements deriving from the adoption of directive 94/62/CE on packaging and waste material obtained from packaging.



Similarly to normal refuse, it is absolutely forbidden to abandon packaging materials and any waste products resulting from said packaging materials. Refuse is a source of danger and environmental pollution.

6. INSTALLATION

6.1. GENERAL INSTALLATION CRITERIA

The installation of one or more Generating Sets must be designed by specialised engineers qualified for the design of this type of plant.

The installation must be carried out by qualified organisations employing specialised personnel and using suitable equipment.

The installation must be carried out in line with current working practices, and the installer must, on completion of the installation, issue the Client with a Declaration of Conformity of the plant with the design and reference standards.

The following basic criteria must be taken into account for the installation:

- a) Correct selection of the set in relation to the electrical load requirements and the environmental operating conditions (temperature, altitude, humidity) of the site.
- b) The Generator Room, if the set is installed in an enclosed environment, must be suitably sized to allow good accessibility to the engine and to the generator for ordinary maintenance operations and repair works.
- c) Again, when installed in an enclosed environment, provision must be made for the intake of a suitable quantity of air necessary for combustion in the engine, for cooling (radiator and generator) the set, and for ventilating the room (clean and fresh).
- d) Correct use of fuels and lubricants.
- e) Careful attention to problems linked to the safety of supervision personnel or operators.
- f) Careful attention to problems linked to noise emission.

6.2. IMPORTANT INFORMATION

6.2.1. INSPECTION OF MATERIALS

On receiving the set, it is advisable to check that the materials correspond to that listed on the delivery note accompanying the shipment. Some of the packages may be opened at random to check that no damage has occurred during transit.

If damage is noted, the carrier must be informed immediately to enable the relevant claims procedure to be started.

6.2.2. PRELIMINARY INSTALLATION PROCEDURES FOR AUTOMATIC GENERATING SETS

In order to prevent undesired start-ups of automatic sets while carrying out preliminary installation operations and when making electrical connections, the following requirements must be respected:

- the starter batteries must be disconnected from the set;
- the operation selector on the control panel must be in the "OFF" position.

6.2.3. SAFETY STANDARDS FOR DIESEL ENGINES

The location and installation of the generating set (foundations, fuel tank, air intake, gas exhaust) must comply with the "Safety Standards" in force in the country of installation.

6.3. INSTALLATION

There are two types of installations for stationary generating sets:

- a. outdoor installations;
- b. indoor installations.

N.B.: The instructions that follow are necessary for the correct installation of the generating set, and remain valid unless otherwise provided for by the more rigid requirements of safety standards and other plant regulations (fire department, local authority, nuclear standards, etc.) in force in the country of installation.

6.3.1. OUTDOOR INSTALLATIONS

Sets installed outdoors (excluding those housed in cabins or containers for which they have been specifically designed) must be protected against atmospheric agents such as rain, dust, etc. and must not be located in direct sunlight, as this may cause overheating. One possible solution to this may be to construct a roof over the set.

For temporary short-term installations, the sets need only be installed on level ground. For longer installation periods, the sets should be mounted on concrete foundations (see also 6.3.2.1).



The area in which the generating Set is to be installed must be suitably fenced-off to prevent access by unauthorised persons. No entry signs and warnings of the possible dangers must be affixed to the fencing similarly to that provided for indoor installations (see item 3. - Safety Requirements).

6.3.2. INDOOR INSTALLATIONS

The installation of indoor sets must comply with the following requirements:

- Suitably sized room to enable normal operation of the set with easy access to components for ordinary maintenance and eventual repair works.

Figure 6-A shows typical solutions for manual and automatic start-up sets.

The figure also shows the minimum recommended dimensions for working space around the set and height of the building. The size of the room must take into account the dimensions of the sets reported on the data sheets.

- Access to the rooms must be such to allow the entire set to be transported by normal transport and handling vehicles generally available on site.
- Openings must be of a suitable size to allow an efficient air change to be effected.
- The exhaust system must be such that the exhaust gas travels the shortest possible distance and through the minimum number of bends.
- The set should be arranged with sufficient space on a minimum of three sides to facilitate access and comply with safety standards (as shown in Figure 6-A).
- The control panel (in the case of automatic sets) should be located in a position that allows an operator working on the set to have an unobstructed view of the instruments.

The basic factors to consider in line with the above requirements are:

- foundations;
- ventilation exhaust system;
- fuel system;
- electrical connections;
- earthing system;
- heating.

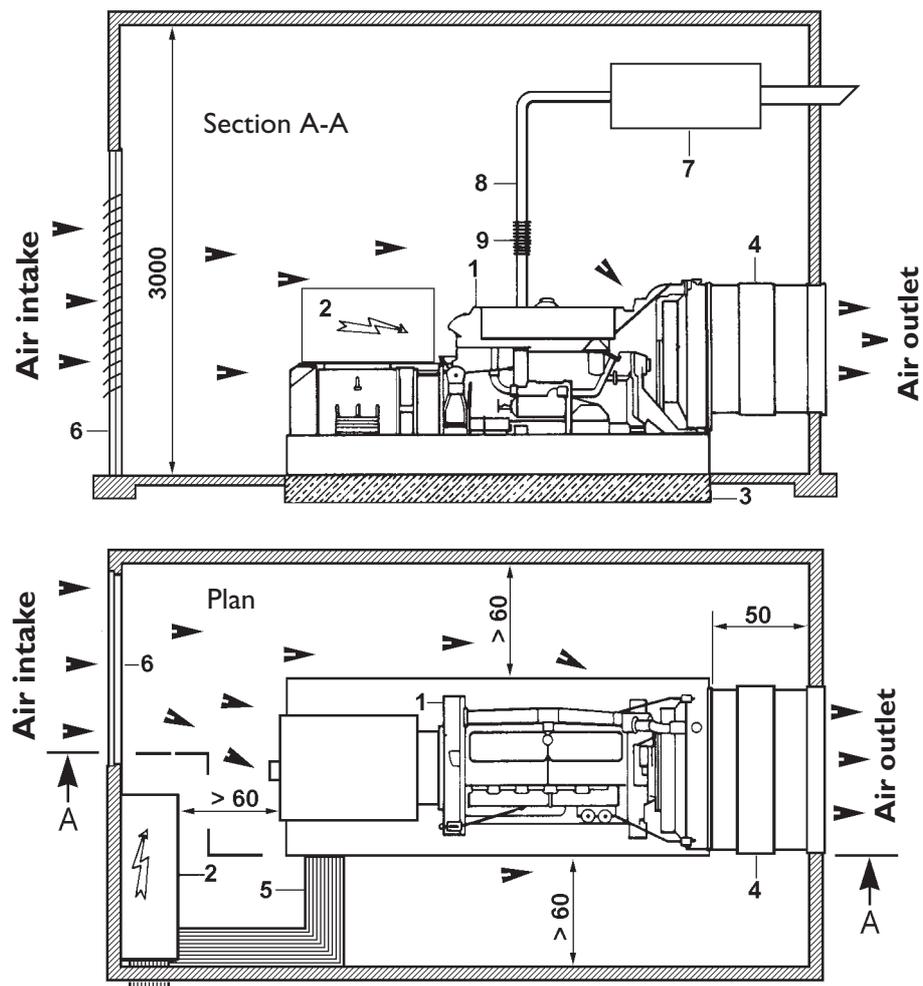


Figure 6-A Plan and section of a typical indoor installation - Air flows.

- 1 Generating Set.
- 2 Instrument panel (Manual, mounted on the set - Automatic, remote).
- 3 Foundation.
- 4 Air exhaust duct.
- 5 Cable duct.
- 6 Access door, with ventilation grill.
- 7 Exhaust silencer.
- 8 Exhaust pipe.
- 9 Expansion joint.

6.3.2.1. FOUNDATIONS

The foundations must be calculated and designed by civil engineers, taking maximum care to avoid the transmission of vibrations and noise to other parts of the structure.

6.3.2.2. EXHAUST SYSTEM

6.3.2.2.1. EXHAUST PIPES

Exhaust pipes are normally manufactured from smooth seamless steel tube (UNI 1293), though in some special cases they may be fabricated from stainless steel.

The exhaust pipe must convey the exhaust gas to a zone where it will not cause damage or harm, and away from doors, windows and air intakes. The outlet must be provided with a fixed protection to prevent the ingress of rainwater.

Sections of pipes passing through walls must be suitably insulated to prevent the transmission of heat to the walls themselves.

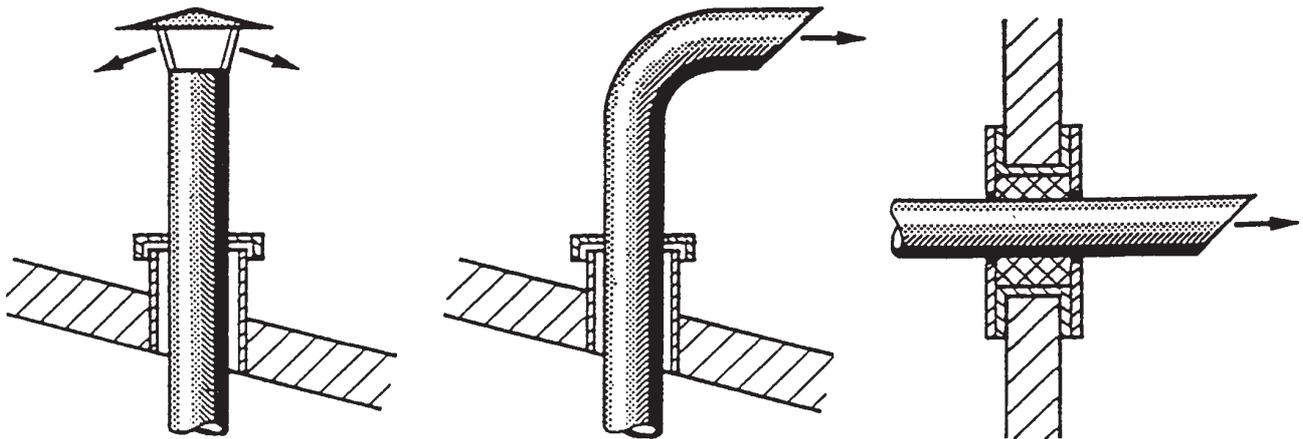


Figure 6-B

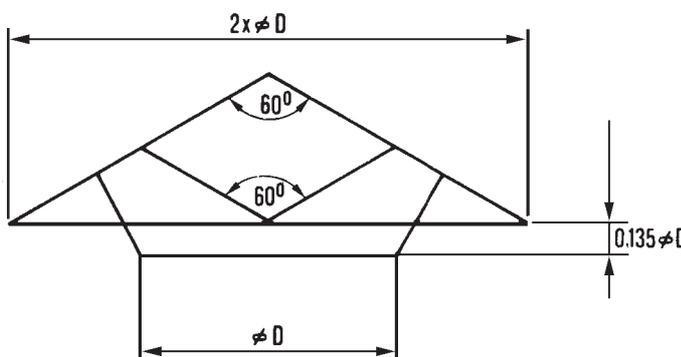


Figure 6-C Rain protection cap

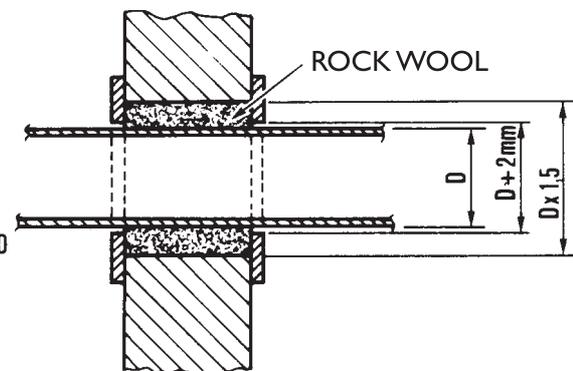


Figure 6-D Wall crossing

The above figures illustrate a few of the exhaust outlet options.

The joints between the various pipe sections must provide a perfect seal to prevent any exhaust gas leaks; flanged joints with gaskets provide the best solution. The configuration of the vertical piping must be such that enables a condensate collection chamber to be fitted at the lowest point. This chamber must be fitted with a drain plug for periodic emptying.

A flexible stub pipe must be fitted between the engine exhaust manifold (or turboblower on supercharged sets) and the downstream pipes. This is to ensure that the movements induced by the generating group and the thermal expansion of the pipes themselves is absorbed by the pipes without causing any damage to the attached units.

The use of a flexible pipe also means that the exhaust pipe must be supported independently from the generator set. The exhaust pipes, therefore, must be fixed to the walls or ceiling of the generator house using brackets. These brackets must be able to support the entire weight of the exhaust pipes to prevent them bearing on other parts of the engine (exhaust manifold, turboblower), while at the same time allowing for their thermal expansion.

N.B.: The expansion joint supplied with the generating set must be mounted with the flanges concentric and parallel without any precompression (see Figure 6-E).

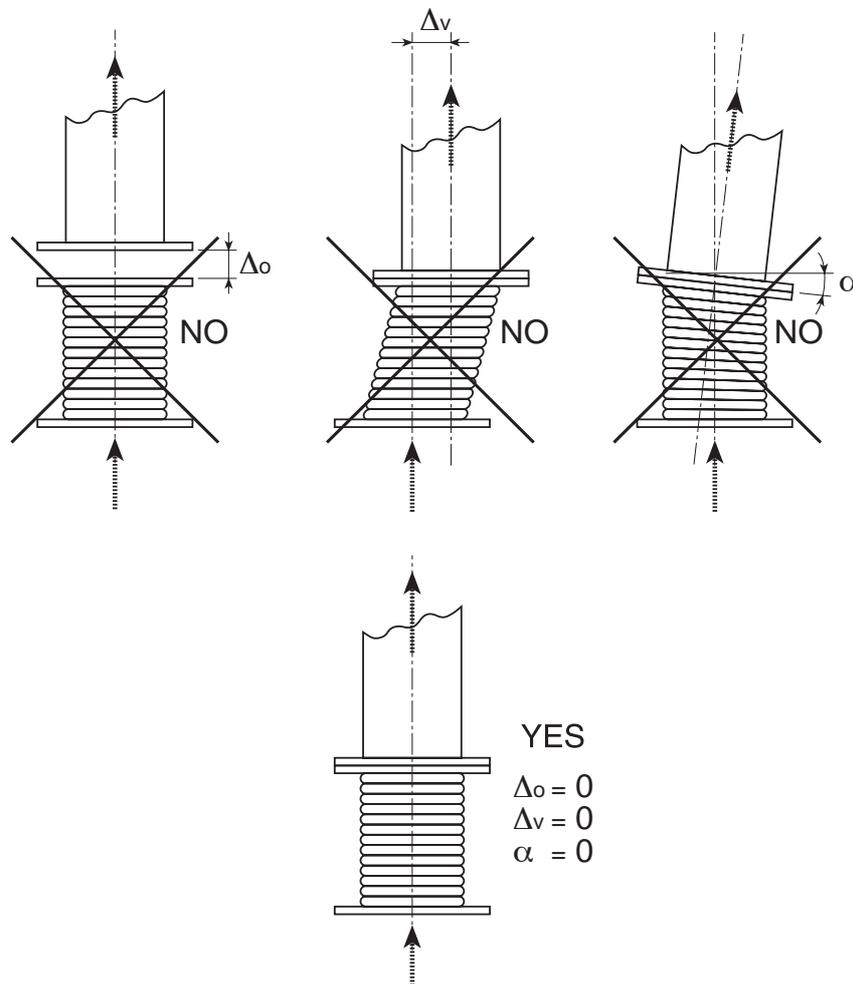


Figure 6-E Correct assembly of the expansion joint.

Expansion joints consisting of flexible sealed elements must be inserted in long stretches of exhaust pipe.

When designing the layout of the exhaust system, ensure that the pipes are not located too near the engine air filters in order to prevent the intake of hot air.

All exhaust pipes must nevertheless be insulated to prevent overheating of the generator room and, above all, to prevent accidental contact with hot surfaces.

In multiple set applications, the individual exhaust lines must not be conducted into a single outlet: this situation would create problems; for example, when only one set is operational, the exhaust gases would tend to flow towards the inactive units.

6.3.2.2.2. EXHAUST PIPE DESIGN

The back pressure on the engine exhaust greatly influences the power delivered by the engine and its thermal load.

Any excessive back pressure (measured on the outlet side of the exhaust manifold for induction engines and on the turbine outlet side for turbocharged engines) causes a decrease in power, an increase in the temperature of the exhaust gases, produces smoke, increases fuel consumption and superheats the cooling water, with subsequent deterioration in the lubricant and consequences for other engine parts.

The recommended limits (referring to maximum power delivery conditions under full service operations) on Iveco Motors sets are:

- 150 mbar (1500 mm H₂O) for induction engines
- 50 mbar (500 mm H₂O) for turbocharged engines.

Iveco Motors will supply the exhaust gas flow and temperature values of its engines (see technical data sheets) necessary for the design.

As an example, Figure 6-G shows a nomogram for calculating the diameter of an exhaust pipe. Starting with the length of the pipe and proceeding up through the number of bends (90° bends with $r = 2.5d$) and gas flow (in m³/h)*, then, assuming a fixed backpressure value, it is possible to determine the diameter of the pipe (either insulated or non-insulated) from the top right scale of the nomogram. Of course, this backpressure only refers to the pipe length and does not include the effect of the silencer. The need, therefore, is to perform the exercise so that the total backpressure (pipe plus silencer) is contained within the above limits for induction or turbocharged engines.

These limits can be respected by suitable sizing of the exhaust system: pipe and silencer.

* The flow of exhaust gas is obtained from the data sheets in kg/h. Initially, this value can be divided by 0.42 to obtain the flow in m³/h.

The exhaust pipes must be as short as possible with the minimum number of bends.

When bends need to be installed, they must be formed with a large radius of curvature (on average 2.5 to 3 times the diameter of the pipe).

In order to calculate the total length of the exhaust pipe, required for the exhaust backpressure calculation, the equivalent length (l_0) of the bends must be added to the straight length. The equivalent lengths are obtainable for various pipe diameters from Figure 6-F.

Internal diameter mm.	40	50	65	80	100	125	150	200	250	300
Equivalent length 10 m.	0,5	0,7	0,9	1,2	1,7	2,2	2,8	4,0	5,4	6,7

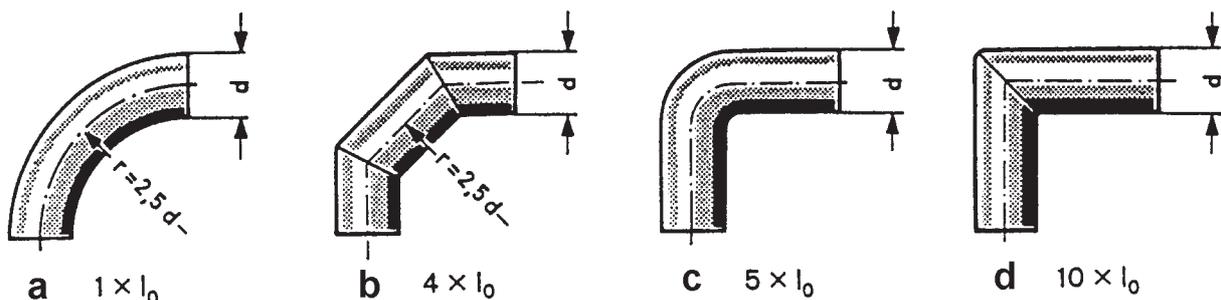


Figure 6-F

The table shows the various types of bend and their equivalent lengths.

Bends with a radius of curvature of less than $2.5d$ are more detrimental and should be avoided, or calculated directly.

In all cases, the exhaust pipe should never have a diameter less than that of the engine manifold.

When the diameter of the pipe is greater than the manifold, a reducer of taper angle not greater than 30° must be used to prevent excessive head loss.

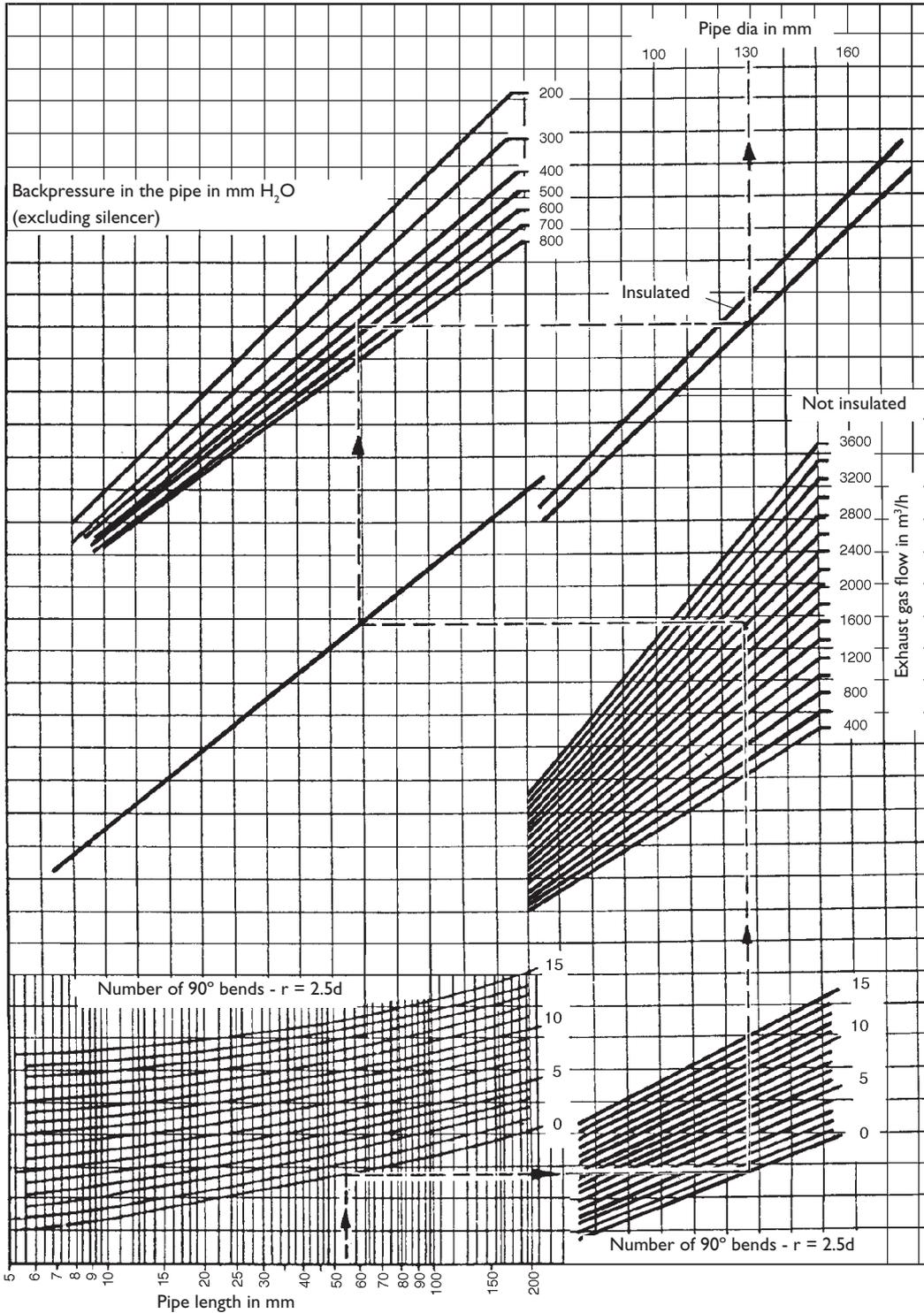


Figure 6-G Nomogram for the determination of exhaust pipe diameter.

It is also worthwhile checking the total backpressure generated by the pipe and silencer experimentally. The measurement is taken near the outlet flange of the engine manifold (or turbine), if possible along a straight section of pipe. Iveco Motors engines are normally fitted with a screwed socket for fitting the pressure gauge (vacuometer). If this instrument is not available, it is possible to use a simple transparent plastic tube bent into a U shape and partially filled with water. One end of the tube is inserted in contact with the exhaust gas at the above point, and the other end is held free in the air. The difference in water level between the two legs of the U is the backpressure value in mm H₂O.

6.3.2.2.3. EXHALIST SILENCER

The exhaust silencer is normally fitted on the section of pipe installed in the diesel engine room.

When possible, it can also be installed outside the room.

This positioning refers to industrial type applications in which the silencer reduces the noise level by 15 - 20 decibels.

The position of the silencer can create pulsation resonance of the gas with the piping, producing noise that can be reduced by varying the distance of the silencer from engine along the piping itself.

In special circumstances, or where more effective damping of exhaust noise is required (hospital installations, residential areas, etc.), special silencers should be used which can reduce the noise by as much as 25-30 decibels, or alternatively, suitable plenum chambers should be constructed.

Exhaust silencer back pressure values, however, can vary considerably depending on the type of construction, dimensions and damping characteristics.

For sizing aspects, these values can be obtained from the manufacturer.

6.3.2.3. VENTILATION

Ventilation of the room in which the generating set is installed is of fundamental importance for the proper operation of the set itself.

The ventilation system must be able to:

- dissipate the radiated and convected heat produced by the set during operation;
- provide the correct amount of incoming air required for combustion;
- remove the heat transferred to the engine cooling water via the radiator;

thus maintaining the environmental operating temperature of the atmosphere from which the engine sucks the combustion air within adequate safety limits (see note after Figure 6-H).

Figure 6-A illustrates a valid solution to the problem: the radiator fan sucks in the cooling air from the room, and the hot air is expelled through the radiator and conveyed outside.

Under no circumstances should the hot air leaving the radiator flow back into the room. It is therefore advisable to thoroughly check the airtightness of the extraction system.

In this manner, the air in the room is continuously changed. The sizing of the intake can be calculated by summing the cooling air flow and combustion air flow.

Special care must be taken in atmospheres containing suspended particles in order to prevent blocking the filters and radiator. If necessary install a pre-filtering device.

The fresh air needed to create the proper air flow will normally enter the room through openings in the lower part of the room, preferably on the opposite wall to the radiator. In this way, the air will flow over the whole set before being expelled by the fan.

Make sure that stale air cannot accumulate in any parts of the room. This situation occurs more frequently when several sets are in service in the same room.

Should this be the case, each set should have its own air intake whenever possible.

The air flows necessary for the various types of Iveco Motors sets and the amount of heat put back into the room by them (engine irradiation + generator cooling) can be found on the “Data Sheets” applicable to the set.

For safety reasons, in rooms containing continuous service sets or installations with high ambient temperature, it is advisable to check that the cooling air reaching the radiator, after having crossed the room and been heated by the cooling air from the generator, does not exceed the allowable temperature required for the radiator (refer to the set data sheets). If it becomes necessary to reduce the temperature of the air arriving at the radiator, an auxiliary extractor fan should be installed of capacity calculated using the same formula as that used for the original temperature check, this time using the maximum Δt that allows the radiator to function correctly.

The head value of the fan must be sufficient to overcome the depression created in the room by the radiator fan. The fan should be positioned in the upper part of the room, if possible on the same wall through which the radiator discharges.

The basic formula to use is the following: $\Delta t_v = \frac{Q}{V_R * c_p}$ and therefore $V_T = \frac{Q}{\Delta t_{max} * c_p}$ where:

$Q =$ Total heat put into the room by the generator cooling system plus the engine irradiation in kcal.

$c_p =$ Specific heat at constant air pressure in kcal/m³ °C, obtainable from Figure 6-H, reading the value on the centre scale where it is intersected by a straight line running from the room temperature on the left hand scale to the air pressure in the room on the right hand scale.

$V_R =$ Radiator fan air flow in m³/h.

$V_T =$ Total air flow: radiator fan plus extractor fan in m³/h.

$\Delta t_v = t_v - t_a =$ Difference between the air temperature hitting the radiator (t_v) and the outside air temperature entering the room (t_a) in °C, considering the radiator fan flow only (V_R).

$\Delta t_{max} = t_{max} - t_a =$ Difference between the maximum air temperature which can hit the radiator (t_{max}) and the outside air temperature entering the room (t_a) in °C, to calculate the total flow of air necessary, equal to the sum of the flows of the radiator fan and the extractor fan ($V_T = V_R + V_E$).

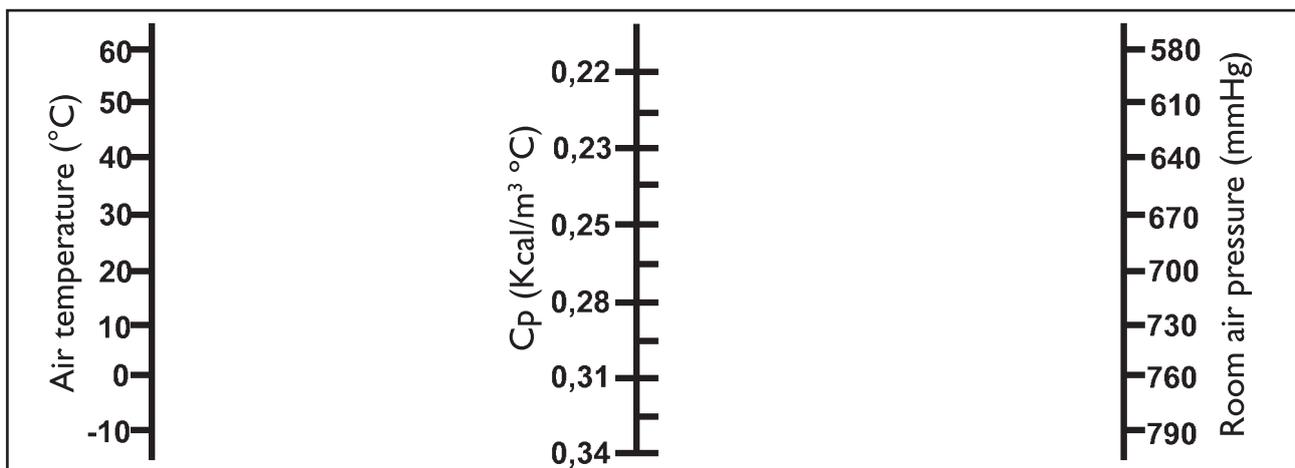


Figure 6-H Specific heat at constant air pressure at the installation conditions.

NOTE: This formula can also be used to calculate the temperature of the combustion air which is sucked by the engine filter. If the air flow is correct, i.e. the fresh air first hits the alternator and is then sucked by the radiator fan after passing over the engine (see Figure 6-A), the combustion air temperature sucked by the engine filter can be calculated using the above formula, considering only the amount of heat removed from the air (taking the overall flow into account, and not just that sucked by the air filter) along the entire path. In some cases, therefore, only the heat due to the alternator cooling can be considered, and is equal to:

$$V_T = \frac{A_g * \cos \varphi * (100 - \eta_g) * 860}{\eta_g} \quad (\text{in kcal/h}); \quad \text{where:}$$

- A_g is the nominal apparent power;
- $A_g * \cos \varphi$ is the active power;
- η_g is the alternator output.

In other cases, consideration must also be given to the amount of heat irradiated by the engine (e.g. the turbine), according to the position of the suction filter. If the combustant air temperature arriving at the filter is too high, the performance of the engine will be adversely affected (see Derating in 2.2.2). In this case, suitable ducting for the combustant air must be provided to carry air from outside directly to the filter. This ducting must be sized such that the additional head loss is kept to a minimum: the maximum total allowable depression between the duct and a clean filter is 250 mmH₂O.

6.3.2.4. VENTILATION IN HARSH ENVIROMENTS

In particularly harsh environments, a low temperature in the generator room (less than 10°C) due to an excessive flow of cold air could create problems. The solution, in this case, is to use a shutter system with thermostatically controlled louvers to maintain an acceptable room temperature for the operation of the generating sets, without any detriment to the air required to feed the respective engines (see position 1 of Figure 6-I, which shows a schematic representation of this type of solution). The thermostatic control must be designed case by case, and can either be controlled by the ambient temperature inside the room and/or the temperature of the engine water.

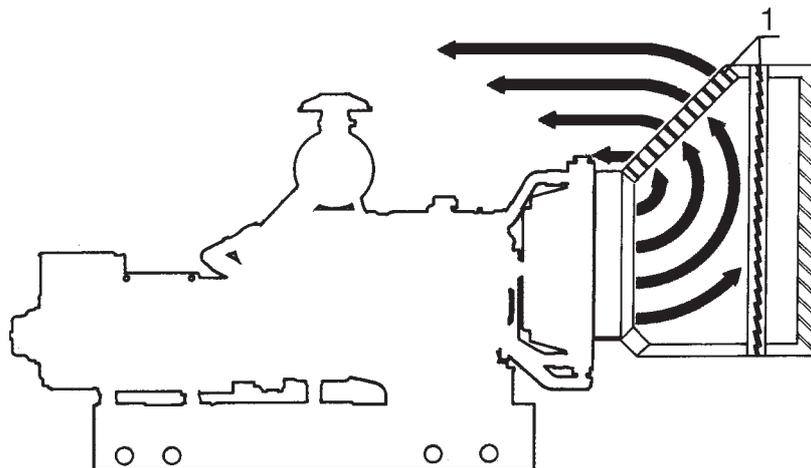


Figure 6-I Installation in cold climates.

6.3.2.5. FUEL SYSTEM

The standard Generating Sets normally supplied by Iveco Motors are fitted with a complete fuel system from the engine to the standard fuel tank incorporated in the base of the unit.

In order to satisfy particular requirements or standards, a special separately mounted tank of the required capacity can be provided. In this case, the new tank is connected to the engine by flexible couplings and pipework anchored by suitable brackets. The capacity of the service tank must be proportional to the rated power of the diesel engine and must take into account the limitations provided for by safety laws in the country of installation.

The fuel lines include:

- fuel delivery to the engine injection pump;
- fuel overflow from the injection pump;
- fuel injector overflow return.

The above fuel lines must be in seamless steel, iron or copper. **Galvanised steel pipe must not be used.**

The diameter of the pipes can be obtained from information supplied in the engine installation diagrams which are generally valid for pipe lengths of less than 5 metres. For longer lengths, the pipes must be sized case by case.

The flexible couplings, necessary for isolating the fixed parts of the new tank and fuel system from the effects of vibrations induced by the engine, may be of the following types depending on the type of engine:

- short lengths of rubber hose, reinforced with inert fabric and diesel oil and flame resistant, according to the standards in force in the country of installation, for connecting to ribbed hose connectors using screw tightened hose clips;
- low pressure hoses, diesel oil and flame resistant according to the standards in force in the country of installation, protected by metal sheathing with the ends fitted with special threaded sealed couplings.

Synthetic resin hoses must be avoided at all costs.

When installing the ancillary components of the plant, maximum attention must be paid to the following aspects:

- well-spaced pipe support brackets to prevent vibration resonance and bending due to self-weight, especially in the case of copper pipe;
- installing the least number of joints possible and with sufficient airtight properties to prevent the infiltration of air, to which components under vacuum are frequently exposed (fuel delivery line), an aspect which is frequently neglected in many problematic start-ups;
- fuel lines to and from the tank must terminate below the level of fuel at a distance of 20 - 30 mm from the bottom to prevent air entering and shutting-down the circuit.

These extensions must also be sufficiently spaced apart (~ 30 cm) to prevent the return flow of fuel disturbing the delivery by raising impurities from the bottom of the tank or drawing a fuel-air mixture.

- ensure that the pipes used have been thoroughly cleaned;
- ensure that there are no sudden variations in the pipe sections and use large radii of curvature when forming bends in the pipes.



The construction and installation of the storage tanks must comply with the standards in force in the country of installation governing the prevention of fire and pollution.

The position of the storage tanks depends on the topography of each individual installation and must satisfy the following requirements:

- minimum difference in level between tank and suction pump;
- minimum length of piping;
- located far from heat sources;
- easy access to the filler nozzle.

The pumping system must consist of one electropump, plus one standby manual pump for emergency situations. The electropump must be automatically controlled by level switches inserted in the service tanks being fed.

The sizing of the pumping system will be in accordance with the hourly flows to provide, the topographic characteristics of the installation and the head losses in the pipes.

Pipes and fittings will be sized in line with the flows required and the distances covered. Pipes may be in copper or drawn black tube. **Galvanised steel pipe must not be used.**

It is advisable to fit a rapid action shut-off valve which can be operated from outside the room in an emergency.

The return pipes from the engine to the service tank and from the service tank to the storage tank must not be provided with valves or shut-off systems of any kind.

The breather valves on the tanks must discharge outdoors and at least 2.5 m from ground or walkway level and away from doors, windows and air intakes. The end of the pipe must be protected by a flame-trap.

6.3.2.6. ELECTRICAL CONNECTION

The generating sets are supplied already set-up for connection to the user.

The function of the generating set is to substitute the mains electricity supply, and as such, must be considered as an external source of energy. For this reason, the safety devices on the users are not included with the generating set and must be provided by those installing the plant.

All electrical connections must be made in accordance with the connection diagrams supplied with the set.

6.3.2.6.1. MANUAL START-UP SETS

The electricity supply cables will be connected to the existing line terminals inside the control board and can be accessed through the lower part of the control board.

6.3.2.6.2. AUTOMATIC START-UP SETS

Cables from the sets, the external mains system and the users must be connected to the respective terminal boards in the control panel.

The set's power cables must be connected directly to the set itself at the generator terminal board.

Connections for the auxiliary services between the set and the control panel must be effected using a multicore cable and the multiple connector supplied with the set.

The wiring diagram for the connector is supplied with the set.

6.3.2.6.3. BATTERIES

The starter batteries, which are shipped disconnected, must be reconnected according to the wiring diagram supplied with the set, i.e. with the starter motor cable connected to the positive terminal of the battery and the earth cable to the negative terminal.

6.3.2.6.4. CABLE SIZES

The choice and size of cables to use is the responsibility of the plant installer.

It should be emphasised that using smaller sections than that recommended will cause excessive voltage drops and lead to dangerous overheating of the wiring.

6.3.2.6.5. CABLE LAYING

All set-user connecting cables on manual sets and set-control panel-mains connecting cables on automatic start-up sets must be laid in suitable channels or ducts.

6.3.2.7. EARTHING

Metal parts of the plant with which people can come into physical contact and which, due to an insulation fault or other reasons, may become live, must be connected to an earthing system.

The generating sets mounted on bases and control panels are equipped with an earth terminal.

The sizing of the earth wires to the earthing system and the relative contact resistance must comply with current laws and standards.

N.B.: The earthing system must be located as far as possible from railway/tram lines in order to prevent electro-corrosion of the internal components of the engine in contact with water.

6.3.2.8. HEATING

The rooms in which automatic start-up generating sets are installed must be suitably heated during the cold season. The heating system must ensure that the ambient temperature does not fall to below 10°C.

These sets must also be provided with thermostatically controlled electric heaters which maintain the water temperature in the engine base at acceptable values, to enable rapid start-up and load take-up without adversely affecting the engine.

7. START-UP



Before starting up the set, take note and comply with the standards and warnings contained in the “use and maintenance” documentation for the engine and generator making-up that particular set (see 1.3). We strongly recommend that you read the leaflet “START-UP OF THE ELECTRIC GENERATOR SETS” **carefully**.

The first start-up, or commissioning, must be performed by specialist personnel.

8. ESERCIZIO

8.1. PROCEDURES FOR THE OPERATION OF MANUAL AND AUTOMATIC UNITS

Referring to the specific documentation supplied with each manual or automatic control board.

9. MAINTENANCE

In order to ensure that the generating set provides good service and maintains good performance levels, it is essential that the maintenance operations specified by the manufacturer are carried out.

It is also good practice to prepare service cards which programme the various operations to be carried out, including day-by-day reporting of hours run, adjustments made, any topping-up of oil, water or fuel, maintenance work or repairs carried out.

Maintenance must be carried out by specialised personnel using the proper equipment.



All maintenance operations must be carried out while the set is shut-down and with the function selector in the “OFF” position.

For automatic sets, the battery checks and non-automatic refuelling, water and oil topping-up operations can only be carried out with the selector in “Manual” (never in Automatic or in “Test” mode).

The set must nevertheless always be shut-down.

Maintenance operations on the Electric Control panel must be carried out taking all the necessary precautions against the risk of contact with live components and, in particular, with the set shut-down, the function selector in the “OFF” position and the panel isolated from the mains.

9.1. MANUALLY CONTROLLED SETS

- I. ENGINE - perform the necessary periodic maintenance operations as specified for that particular engine, in particular, replace the filter cartridges (fuel and oil) and clean the air filter.
- II. GENERATOR - perform the necessary operations in line with the requirements for that particular generator.
- III. Periodically check the fuel, water and oil levels according to the number of hours run.
- IV. BATTERY - check the liquid and charge level. If necessary top-up the acid solution with distilled water.
- V. CONTROL PANEL - check the condition of the fuses weekly.
- VI. Check the connections, contact wear and thoroughly clean once a month.

Special care must be taken in environments with suspended particles in the air in order to prevent clogging the filtration and cooling systems.

NOTE: When a set is installed outdoors, in dusty or desert locations, or in the presence of suspended particles in the air, special care must be taken in cleaning of the sets. Any dust or particles preventing the irradiation of generated heat can cause overheating.

Special attention must be paid to:

- the air filter and pre-filter, which must be kept very clean;
- the radiator, to prevent air passages from becoming blocked and thus reducing its cooling capacity;
- the generator, which must be periodically cleaned internally with dry compressed air to prevent clogging and insulation losses. NEVER use compressed air to clean the electronic voltage regulator, use a vacuum cleaner;
- the control panel, which must be cleaned using a vacuum cleaner only. Do not use compressed air in the control panel.

When carrying out these operations, it may be necessary to remove parts of the casing. This should only be done after having checked that the set cannot start-up accidentally. At the end of the operation, first replace the casing and then prepare the set for start-up.

9.2. AUTOMATIC SETS

In addition to carrying out the same operations specified for the manual sets, in view of the particular nature of the type of service, i.e. start-up at any moment even after long periods of inactivity, automatic generating sets also require the following additional periodic maintenance operations to be carried out:

- I. **BATTERY:** check the liquid and charge level once a week.
The rectifier used to maintain the battery charge must always be set on “automatic”.
If necessary, place the battery on “full charge” for the required period.
Check the specific gravity of the electrolyte every 45 days.
- II. **LIQUID LEVELS:** check the fuel, oil and water levels weekly.
- III. **LUBRICANT:** even if the number of service hours required for an engine oil change has not been reached, it is good practice to perform an oil change at least once a year.
- IV. **SET CHECK:** perform a running check at idling speed once a week and, if possible, with a load once a month.
- V. **ELECTRICAL CONNECTIONS:** check the connections between the engine’s electrical components and the control panel once a month, making sure they are tight.
- VI. **CONTROL PANEL:** check the entire unit once a year, checking the tightness of all terminals.
Carry out a general cleaning using a vacuum cleaner.
Check the wear and cleanliness of the relays and remote switches.
- VII. **WATER HEATER:** during winter, check that the engine pre-heater is working correctly once every 2 days.

MISCELLANEOUS:

- Regularly inspect the condition of the suction circuit filter. The maintenance intervals vary depending on the season and operating conditions. In particularly dusty environments, a more frequent maintenance is necessary.
- Periodically check the electrolyte level in the batteries and, if necessary, top-up with distilled water only.
- Keep the battery clean.
- Always try to keep fuel tanks as full as possible to prevent condensation.
- Periodically drain the water and sediment from the tank.
- Periodically replace the fuel filter when a pressure drop is noticed or when there is a deterioration in the performance of the Generating Set.
- Periodically check the voltage and condition of the alternator drive belts.

9.2.1. INSTRUCTIONS FOR IDLING TEST

- place the function selector in “Test” mode;
- check that the start-up operations are correct, except for switching the set to the mains;
- check the rating data (voltage, frequency, etc.);
- check operation at nominal speed for 10 - 15 minutes;
- replace the function selector in “Automatic”;
- check that the shutdown operation are correct and that the set is ready for a new start-up.

NOTE: *If, during idling tests, the mains power fails, the generating set in operation will take-up the load in a fraction of a second, switching-off the mains remote controlled switch and switching on the set remote controlled switch.*

9.3. STARTER BATTERIES AND AUXILIARY SERVICES

9.3.1. GENERAL REQUIREMENTS

The lead batteries used by the Iveco Motors sets are the reduced maintenance type. Consequently, they only require a periodical check of the electrolyte level and the occasional topping-up with distilled water. In general, the acid level should be between the level lines marked on the body of the battery measured 2 hours after charging.

In the case of manual sets, remove the key from the starter switch during periods of set shutdown.

Do not provoke short-circuits by placing spanners or other tools on the battery or cable connections.

9.3.2. CLEANING

The terminals and connections must be kept dry and clean. To prevent oxidation, clean and coat the terminals with Vaseline.

Check and clean-up any acid spills as this will result in the corrosion of the steel chassis

9.4. TROUBLESHOOTING

The following table constitutes a guide to resolving some of the problems which may occur during the running of a generating set.

In all cases, we strongly recommend that the troubleshooting guides contained in the manuals supplied by the manufacturers of the engine, alternator and other components are followed.

Any operations carried out to resolve problems must be effected by qualified personnel or by an authorised workshop.



Before carrying out any checks or repairs, carefully read chapter 3 “Safety Requirements” and the documents referred to therein.

Problem											Troubleshooting			
Will not start	Tries to start but stops	Does not reach running speed or hunts	Voltage and/or frequency low or zero	Auxiliary services not functioning	No output from generator	Low oil pressure	High water temperature	Overspeed	Low fuel level	Flat battery	Black smoke	Noisy engine	Possible cause	Remedy
●													Set tripped due to malfunction.	Determine the cause and, if necessary, call Iveco Motors service centre.
●	●												Battery flat.	Check and recharge batteries. If necessary, replace.
●	●												Battery connections corroded or loose.	Check cables and terminals. Replace cable terminal and nuts if corroded. Tighten well.
●										●			Poor connections, faulty battery charger or battery .	Check battery charger and battery connections.
●													Defective starter motor.	Call Iveco Motors service centre.
	●								●				No fuel.	Check the fuel tank and fill if necessary.
	●												Air in the fuel line.	Bleed the fuel system.
	●	●	●										Fuel filter blocked.	Replace filter.
	●	●	●								●	●	Fuel system malfunction.	Call Iveco Motors service centre.
	●										●		Air filter blocked.	Replace filter.
	●												Low ambient temperature.	Check specific viscosity SAE of lubricating oil and fuel characteristics.
	●	●	●						●				Speed governor malfunction.	Call Iveco Motors service centre.
●	●												Starter control circuit fault in the control panel.	Check the set start and stop control circuits in the automatic control panel.
		●											Low ambient temperature. The engine will not pre-heat.	Wait until the engine reaches a suitable running temperature with no load. Check the pre-heating system.
		●	●		●								Voltage regulator malfunction.	Call Iveco Motors service centre.
		●	●										Speed too low.	Check the speed governor.
			●										Instrument malfunction.	Check and replace if necessary.
			●										Instrument connections.	Check instrument connections.
					●			●					Overload cut-out trips.	Reduce load.
							●				●		Overload.	Check that the set is not working under overload conditions. Also check if ambient temperature is higher than normal.
				●	●								Relative switch trips. Short circuit or earth fault.	Check the circuits downstream troubleshooting connected equipment and wiring.
				●									Auxiliary service malfunction.	Call Iveco Motors service centre.
				●									No feed.	Check the feed circuits.
											●		High oil level.	Eliminate excess oil.
						●							No oil.	Top-up oil level in the sump. Check for leaks.
						●							Blocked filter.	Replace filter.
						●							Oil circulation pump malfunction.	Call Iveco Motors service centre.
							●						No water.	Wait for the engine to cool down and check water level in the radiator, if necessary top-up. Check for leaks.
							●						Water circulation pump malfunction.	Call Iveco Motors service centre.
						●	●	●	●	●			Relative alarm malfunction: sensor fault, panel or connection fault.	Check connections between sensor and panel. Check that the electrical connections of the sensor are not earthed. Check the sensor and replace if necessary.
							●						Radiator / Intercooler dirty or blocked.	Check the cleanliness of the radiator / Intercooler. Check that there is nothing preventing the air flow and that the air cannot recirculate between the fan intake and the outlet.
●	●	●	●	●	●	●	●	●		●	●	●	Other causes possible.	Call Iveco Motors service centre.

10. DEMOLITION



The Generating Set and its components contain materials which, if not disposed of in the correct manner, can create serious ecological damage.

The following materials must be delivered to authorised collection centres for disposal:

- starter batteries;
- used lubricating oil;
- water and antifreeze mixtures;
- filters;
- auxiliary cleaning materials (e.g. greasy rags or rags soaked in fuel and/or chemical cleaning products).

A generating set which is no longer serviceable must be delivered to an organisation approved for the demolition of industrial machinery.

All component materials must be collected, sorted, recycled and/or disposed of in line with that provided for by laws in force in the country of installation. In particular, all requirements appertaining to directives 91/156/CEE and 91/689/CEE relating to refuse and hazardous waste respectively.

Waste products must not be disposed of in an unauthorised manner.

All waste products are potential sources of danger and environmental pollution.