

**RECOMMENDATIONS
REGARDING
LIABILITY**

- ASSURED
PROPERTIES
- PUBLICATIONS
- FUELS

**RECOMMANDATIONS
CONCERNANT
LA RESPONSABILITE**

- CARACTERISTIQUES
GARANTIES
- PUBLICATIONS
- COMBUSTIBLES

**FOR
GAS TURBINES**

C I M A C

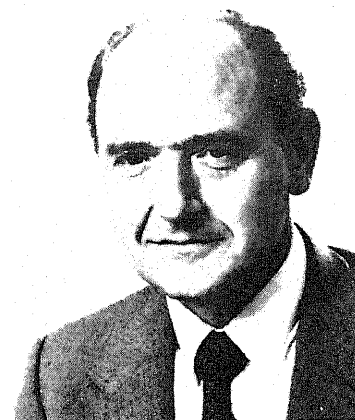
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Foreword of the President

Following the successful launching of CIMAC's Recommendations regarding LIABILITY in the field of reciprocating internal combustion engines, it was felt that a companion document dealing with the subject of gas turbines was desirable and indeed equally well needed.

Consequently a Working Group was set up under the chairmanship of Mr H. Maghon (Germany) to formulate it. The resulting document covers a wide field of subjects typical of those found in undertakings to supply and install gas turbines and I am sure will be most useful in assisting both the supplier as well as the purchaser (and user) to avoid unnecessary misunderstandings in the initial documentation of a project and in its fulfillment.

I strongly recommend the use of these Recommendations and at the same time would like to express our appreciation to the Working Group under Mr Maghon for the excellent work they have done.

M. SHIBATA President.



Avant-propos du Président

Après le succès rencontré par la publication des Recommandations de la CIMAC en matière de RESPONSABILITÉ dans le domaine des moteurs à combustion interne à pistons, le besoin d'un document d'accompagnement relatif aux turbines à gaz s'est également fait sentir.

Un groupe de travail a donc été constitué sous la présidence de M. H. Maghon (République fédérale d'Allemagne), et chargé d'élaborer ce document. Ce dernier constitue un vaste recensement de circonstances typiques rencontrées lors de la fourniture et de l'implantation de turbines à gaz. Je suis sûr qu'il sera d'une aide précieuse tant aux fournisseurs qu'aux acheteurs et aux exploitants, et qu'il leur permettra d'éviter d'inutiles malentendus susceptibles d'apparaître dans la documentation initiale d'un projet et au cours de son exécution.

Je vous conseille fortement de consulter ces Recommandations. Je tiens également à exprimer nos remerciements au groupe de travail sous la présidence de M. Maghon pour l'excellente tâche accomplie.

M. SHIBATA Président

Summary

In the United States as in Europe legislature attaches increasing importance to questions of liability and it is the duty of the manufacturers to guard themselves against these new demands.

The present recommendation tries to determine the limits of the liability and compiles a list of precautions to be taken by the Gas turbine manufacturer starting from drafting a contract and the certification for the product.

These precautions refer to the following:

- The guaranteed characteristics, such as power output, fuel consumption, consumption of lubricants, quality of exhaust gas, pollution, noise, vibrations, etc.
- The published papers, such as installation guide, operation handbook, maintenance book, etc.
- The fuels used and their treatment.

Résumé

Aux Etats-Unis comme en Europe, le législateur attache une importance grandissante aux questions de responsabilité et il est du devoir des constructeurs de se prémunir face à ces nouvelles exigences.

La présente recommandation s'efforce de fixer les limites de la responsabilité et dresse une liste des précautions à prendre par le constructeur de turbines à gaz lors de la rédaction des contrats et de la documentation fournie avec le produit.

Ces précautions concernent:

- les caractéristiques garanties telles que puissance, consommation en combustible et en lubrifiant, qualité de gaz d'échappement, pollution, bruit, vibrations, etc..
- les documents publiés tels que Guide l'installateur, Manuel de conduite, Manuel d'entretien, etc..
- les combustibles utilisés et leur traitement.

CONTENTS

TABLE DES MATIERES

	Page		Page
Foreword	7	Avant-propos	7
General remarks	7	Remarques générales	7
A. Recommendations regarding assured properties	8	A. Recommandations concernant les caractéristiques garanties	8
Introduction	8	Introduction	8
Retesting	8	Répétition des essais	8
Compensation	8	Compensations	8
Cancellation	8	Annulation	8
General limitation of liability	8	Limitation générale de la responsabilité	8
1. General	8	1. Généralités	8
2. References	8	2. Références	8
3. Power and testing of gas turbines	9	3. Puissance et essai des turbines à gaz	9
4. Specific fuel consumption and method of measurement	9	4. Consommation spécifique de combustible et méthode de mesure	9
5. Lubricating oil	10	5. Consommation d'huile de lubrification	10
6. Exhaust gas temperature and exhaust gas flow	10	6. Température et débit des gaz d'échappement	10
7. Chemical composition of emission gases	11	7. Composition chimique des gaz d'échappement	11
8. Airborne sounds	11	8. Niveau de bruits aériens	11
9. Vibration	11	9. Vibrations	11
10. Operation characteristics	12	10. Caractéristiques d'exploitation	12
11. Availability and reliability expectations	12	11. Disponibilité et fiabilité	12
12. Life expectancy of components	12	12. Durée de vie des composants	12
13. Heat rejection	13	13. Rejets thermiques	13
14. Start-up period	13	14. Phase de démarrage	13
B. Recommendations regarding publications	13	B. Recommandations concernant les publications	13
Introduction	13	Introduction	13
I. Installation manual	13	I. Instructions pour l'installation	13
1. Definition	13	1. Définition	13
2. General	13	2. Généralités	13
3. List of recommended instructions	14	3. Instructions recommandées	14
II. Operation manual	15	II. Manuel d'exploitation	15
1. Definition	15	1. Définition	15
2. General	15	2. Généralités	15
3. List of recommended instructions	15	3. Instructions recommandées	15
III. Maintenance manual	17	III. Manuel d'entretien	17
1. Definition	17	1. Définition	17
2. General	17	2. Généralités	17
3. List of recommended instructions	17	3. Instructions recommandées	17
IV. Spare parts manual	18	IV. Catalogue des pièces de rechange	18
1. Definition	18	1. Définition	18
2. General	18	2. Généralités	18
3. Contents of spare parts manual	18	3. Contenu du catalogue des pièces de rechange	18
C. Recommendations regarding fuel and fuel treatments	18	C. Recommandations concernant les combustibles et leur traitement	18
Introduction	18	Introduction	18
1. General	18	1. Généralités	18
2. Contract	18	2. Contrat	18
3. Installation instructions	18	3. Instructions d'installation	18
4. Operation	19	4. Exploitation	19
5. Documentation	19	5. Documentation	19

FOREWORD

Because of growing concern amongst manufacturers regarding the developing situation in the United States and Europe on changes in the law in respect of liability for defective or dangerous products, CIMAC requested a Working Group to elaborate recommendations in reaction to these developments to reduce liability exposure.

The harsher attitude of law and court towards the manufacturer regarding defective and dangerous products extends especially to the non-contractual relation (product liability), but could also have an impact on the contractual side.

Product liability is often defined as the liability for damage to property or personal injury caused by defects *) in a product, apart from damage to the product itself.

Claims of product liability are generally raised by a third party without any contractual relationship to the party claimed to be liable. Consequently, it is not possible to disclaim or limit the product liability by a provision of contract. According to the legislation in many countries, no statute of limitations applies to product liability, so a claim may be raised several years after the product has been brought onto the market.

In cases of product liability, certain legal systems decide the liability question still on a tort base in which proven fault of the manufacturer is a necessary element, while other systems favour in the same case the theory of strict liability in tort, that is, liability irrespective of fault. Strict

liability in those countries is imposed for reasons of public policy, which requires that the loss caused by defective products be placed on those who create the risk and reap the profit by placing a defective product in the stream of commerce. Between these extremes of judgement on liability, there are several differences in degree.

The change to a less favourable attitude by the Law and the Courts towards manufacturers in product liability cases does, regretfully, have its repercussions in cases of contractual liability.

Contractual liability can be defined as a liability of the contracting party towards the other party for damages caused by non attainment of parameters stipulated in the contract (including product specifications, possible governmental regulations, warranties, etc.).

A consequence of the change to the law detrimental to the manufacturer is that it has given rise to a multitude of claims against manufacturers.

At this stage of the developing situation it is not possible to state precisely the extent of legal obligations likely to be placed on manufacturers.

There are however, steps which can be adopted in preparation for such changes, some which have a direct bearing on the likely legal consequences of the changes in law, and others which could be described as steps for the avoidance of problems in future.

GENERAL REMARKS

This recommendation applies to open cycle gas turbines using normal combustion systems and also includes closed cycle and semi-closed cycle gas turbines for electric powers generation and mechanical drives.

This recommendation excludes gas turbines used to propel aircraft, road construction and earth-moving

machines, agricultural and industrial types of tractors and road vehicles.

Even if the initial negotiation is in the language of the customer, it is recommended that the contract documentation should be in the language of the manufacturer or in English.

*) The term defect is used here in a legal sense and may have a different meaning in many countries.

A. RECOMMENDATIONS REGARDING ASSURED PROPERTIES

Introduction

The manufacturer has to supply product in accordance with contractual specifications and regulations.

Owing to the consequences which might result from the non-attainment of certain properties, expressly stipulated in the contract or assumed, the parties should take particular care to determine and specify in detail the technical conditions on which their transaction is based.

The contracting parties should, among other things, be particularly aware of their responsibilities when quoting properties which they agree to guarantee and should make only such commitments as they really believe they can fulfil and which can be verified. For this reason, application of this CIMAC Recommendation as well as international and national standards is advisable.

The assurance of properties of the product involves substantial financial risks to the manufacturer, which makes it necessary to define the consequences of noncompliance and to make provisions in the contract with respect to such closely connected subjects as retesting, compensation and cancellation, which become important in that situation especially as the law differs from country to country.

Retesting

When at the first test(s) the manufacturer is unable to attain the contractual performances, he should have the right to undertake at his expense the necessary repairs and improvements to attain the performances specified in the contract.

Insertion of provisions for the guarantee of assured properties of the product beyond the time of successful passing the acceptance tests, raises extremely complex problems and should be avoided.

If by reason of any act or omission of the purchaser the manufacturer is prevented from carrying out the acceptance tests, the consequence should be that the purchaser be obliged to take over the product without acceptance tests.

Compensation

The legal/financial consequences should be fixed in the contract, in case certain assured properties are not

reached in retests, generally by stipulating payment of a pre-determined rate of compensation (liquidated damages), with stipulation of the basis of calculation of the compensation and the maximum amount per assured property and the total amount which may become due with respect to all assured properties together, all this to the exclusion of any actual damage.

The word "penalty" or any such wording should be used only if it is stipulated simultaneously that the penalty is agreed to be the exclusion of any further damages.

Payment of any compensation should be excluded when the purchaser has not sustained or will not sustain any damages. Compensation shall be to the exclusion of any further damages in respect of the manufacturer's default.

Cancellation

The consequences of a possible rejection of the product in the case of non-attainment of assured properties should be seriously considered.

In the event of non-attainment of assured properties beyond certain limits, which non-attainment could upset the basis of the transaction, the possibility of cancellation becomes eminent.

It is very important to define stated limits carefully and to define also the financial consequences of cancellation. Cancellation should only be possible when the non-attainment of the assured properties concerned bear influence on the usefulness of the product and the basis of the transaction.

In general the financial consequences should be limited to the repayment of the purchase price. In certain exceptional cases, an additional payment of a fixed amount might be agreed upon.

General limitation of liability

It is strongly recommended and accepted within the gas turbine industry to stipulate in the contract that the manufacturer, in case of default, should not be liable for any consequential loss and/or indirect damage, such as, but not limited to, loss of profit, loss of production and cost of replacement of supplied equipment by other alternative.

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1 General

For a clear, comprehensive and detailed statement on gas turbine properties CIMAC recommends that the substance of this document be followed.

The specified properties shall as far as possible be based on international standards. The applicable standards shall be clearly stated.

Furthermore, it is recommended that in each case the properties are assured only if all of the following conditions are complied with, namely:

- the gas turbine is correctly installed and commissioned
- the gas turbine is in a properly clean and good overall condition
- maintenance has been properly carried out in accordance with the manufacturer's instructions
- operation has always been in accordance with manufacturer's instructions.

2 References

- ISO 2314 Gas turbines – Acceptance tests
- ISO 3977 Gas turbines – Procurement
- ISO/TC 43 Acoustics
- ISO 1996 Acoustics – Description and measurement of environmental noise – Part 1: Basic quantities and procedures
- ISO 1999 Acoustics – Assessment of occupational noise exposure for hearing conservation purposes
- ISO 3448 Industrial liquid lubricants – Iso viscosity classification
- ISO 6190 Acoustic measurement of sound pressure levels at gas turbine installation for evaluating environmental noise

3 Power and Testing of Gas Turbines

3.1 Power

3.1.1 Definition of power

- Form of power output: e. g. output at the turbine coupling, electrical power at the generator terminals of isentropic gas power in the case of a gas turbine or gas generator producing gas or compressed air (bleed air from a compressor).
- Conditions of power output: e. g. base load, peak load etc.
- Reference conditions for power output covering ambients: e. g. ISO power, site power etc.
- Corresponding gas turbine speed(s)
- Type and specification of the fuel used (see section “C”)
- Inlet and exhaust duct pressure losses should be clearly defined when site power is stated.

3.1.2 Tolerances on power output

- If neither a tolerance is specified nor a standard given which includes tolerances, the value of power output shall be deemed to be the minimum value achievable.
- If a power tolerance is stated, it shall depend on the measuring tolerances of instruments specified by ISO 2314.

3.1.3 Quality of fuel

The gas turbine can deliver the stated power output using a fuel as specified by the gas turbine manufacturer (see also section “C”).

In case when the specified fuel is not available for the test at the site, the gas turbine shall be deemed to comply with the guaranteed performance if the test result meets the estimated performance based on the method proposed by the manufacturer.

3.2 Testing of gas turbines

3.2.1 Category of test

- Acceptance test
- Special test, e. g. performance test, endurance test, efficiency test, mechanical run (spin test), string test, full load test including driven equipment.
- Type test

e. g. according to the relevant ISO standard

The acceptance tests shall normally be carried out immediately after the completion of the setting up period by the manufacturer and in any event within a period of three months unless otherwise agreed by both parties. In any case, before the test are undertaken the machine shall be placed at the disposal of the manufacturer for examination and cleaning. (*)

3.2.2 Number of gas turbines to be tested for power output

If a number of gas turbines are purchased under one contract the contract should state which of the following alternatives apply:

- A representative gas turbine of the production line (sampling)
- One gas turbine of the total number of gas turbines of the contract
- A percentage of the gas turbines of the contract
- Each gas turbine of the contract.

3.2.3 Place of test

- Gas turbine manufacturer's test bed.
- Driven equipment manufacturer's test bed.
- At an independent test laboratory.
- On site.

(*) In accordance ISO 2314 chapter 4.1

3.2.4 Test method

The following shall be specified using the relevant ISO standards:

- Extent of test
- Load cycle
- Duration of test
- Test conditions
- Measurement technique
- Measurement tolerances
- Test procedure.

3.2.4.1 Method of power measurement

- Speed and torque (hydraulic brake, electric brake or other specified torque measuring system)
- Electric power measured at the generator terminal provided the exact generator efficiency is known
- and/or isentropic power of air or gas.

3.2.4.2 Supply of instruments and devices for power measurement.

In case the gas turbines are not tested on the manufacturer's test bed, the party which is responsible for supplying shall be agreed.

The gas turbine manufacturer has the right to check the instruments and devices for power measurements supplied by others.

Calibration shall be undertaken:

- in accordance with the Quality Assurance System of gas turbines manufacturer (preferred course)
- in accordance with a specified standard
- at time intervals specified by the gas turbine manufacturer or especially for the gas turbine test.

3.2.4.3 Testing requirements

The particulars and quantities of fuel, electricity, water etc. needed for the test shall be specified together with a statement of who is to be responsible for providing them and for their cost.

The loading system for site test should be provided by the purchaser. In case when the load available is not sufficient for site test, the machine should be deemed to have complied with the guaranteed performance. Alternatively the estimated performance based on the actual load test results and the method used by the manufacturer shall be deemed to be equivalent to the test result at the guaranteed condition.

3.2.5 Method of power correction

The appropriate method of power correction from actual test conditions to ISO reference conditions and/or guaranteed conditions and the corresponding calculation method shall be specified by the gas turbine manufacturer.

4 Specific Fuel Consumption and Method of Measurement

4.1 Specific Fuel Consumption

4.1.1 Declaration of specific fuel consumption

The specific fuel consumption shall be guaranteed only for one specified load. The following are to be stated:

- The power output
- The corresponding gas turbine speed
- The lower heat value (LHV) of the fuel
- The fuel temperature
- Ambient reference conditions (barometric pressure, air temperature, relative humidity, intercooler coolant flow and temperature)

- Maximum inlet air pressure drop
- Maximum exhaust gas back pressure
- Tolerance.

4.1.2. Method of correction

An appropriate method of correction from actual test conditions to ISO reference conditions shall be specified by the gas turbine manufacturer.

A correction shall be made for any difference between the LHV of the fuel used in the test and that specified under 4.1.1.

4.1.3 Quality of fuel

The gas turbine can only meet the stated specific fuel consumption if the fuel quality and the fuel treatment are specified by the gas turbine manufacturer (see also section „C”).

4.2 Method of Measurement

4.2.1 Test fuel

- Test on the gas turbine manufacturer’s test bed or in an independent laboratory: fuel chosen by the gas turbine manufacturer, depending on availability of supplies, test facilities and legal restrictions.
- Test on site: fuel supplied by the purchaser in accordance with 4. 1. 3.

4.2.2 Number of gas turbines to be tested for fuel consumption

If a number of gas turbines are purchased under one contract the contract should state which of the following alternatives apply:

- A representative gas turbine of the production line (sampling)
- One gas turbine of the total number of gas turbines of the contract
- A percentage of the gas turbines of the contract
- Each gas turbine of the contract.

4.2.3 Measurement procedure for specific fuel consumption

4.2.3.1 The basis for measurement of the specific fuel consumption shall be stated with reference to § 3.2.4 regarding power.

The measurement of quantity of the fuel consumed shall be carried out by using:

- a balance
- a flowmeter
- or other specified means.

4.2.3.2 It shall be specified that the characteristics of the fuel consumed shall be determined by

- test samples: number and quantity
- evaluation of the LHV in accordance with Item 6.4 of ISO 2314.

4.2.4 Instruments and apparatus

It shall be specified that the instruments and apparatus used for the fuel consumption measurement

- are supplied by a named party (e. g. gas turbine manufacturer or the purchaser)
- have accuracy tolerances in accordance with an agreed standard (e. g. an ISO standard)
- are calibrated either
 - (a) in accordance with the Quality Assurance System of the gas turbine manufacturer or
 - (b) in accordance with a specified standard at time

intervals specified by the gas turbine manufacturer or (c) in an agreed procedure especially for the gas turbine test.

5 Lubricating Oil(s)

5.1 Oil Specification

Physical and chemical properties of oil will be specified by the turbine manufacturer. The use of oils with normalized characteristics is recommended (e. g. ISO VG 46).

If special chemical additives are needed, the turbine manufacturer shall specify them (anti-oxidation dope, anti-corrosion dope, anti-foam).

5.2 Oil Consumption

If any figures in grams per hour (g/h) are given by the turbine manufacturer, it will be clearly stated they are approximate figures for guidance only.

The consumption rate of a turbine is generally determined by periodic level checks. To maintain the level, addition of fresh oil is authorized and the quantity of this make-up oil equals the amount of oil consumed.

5.3 Oil Contamination

Different kinds of contamination can occur in the oil of a gas turbine due to:

- Liquid fuel high pressure pump leaks
- Oil cooler leaks
- Seal leakage in the driven machine (water of a pump, gas of a compressor. . . .) if the same oil tank is used for turbine and driven machine
- Dirty ambient air penetration into the bearing housings (or through pressuring air/cooling air)
- contamination attributable to inadequately cleaned transport or storage oil tanks or reservoirs.

Periodic analysis of oil should be performed to check lubricating oil quality.

6 Exhaust Gas Temperature and Exhaust Gas Flow

6.1 General

The exhaust gas temperature and flow are given for the purpose of

- designing the exhaust ducting systems
- designing heat recovery systems (if any).

6.2 Measurements

When the exhaust gas temperature and mass flow rate have to be stated, these values shall be measured or calculated at the manufacturer’s test bed or at site and the following shall be specified:

- Location on the gas turbine where the temperature and flow are measured
- Power and speed range
- Inlet air conditions
- Specification of fuel
- The effect of steam or water injection and the extraction air should be taken into account
- Inlet air pressure drop
- Exhaust gas back pressure
- Exhaust gas temperature measured with thermocouples
- Method of determining exhaust gas flow (e. g. by calculation with thermodynamic balance)
- Tolerances

6.3 Corrections

The turbine manufacturer should assist the customer with appropriate corrections for exhaust gas flow and exhaust gas temperature in respect of actual ambient conditions inlet air pressure drop and exhaust gas back pressure.

7 Chemical Composition of Emission Gases

7.1 Scope of Information

The chemical composition of emission gases shall only be stated to the extent required by the customer or by applicable regulations normally limited to one or more of the following:

- Nitrogen oxides (NO_x) : } g/kWh or ppm cor-
- Carbon monoxide (CO) : } rected to 15 volume %
- Hydrocarbons (HC) : } oxygen on dry basis

- Particles : g/kWh or mg/m³ at normal conditions (*)
- Smoke intensity : Von Brand reflective smoke number or smoke spot (Bacharch) number as per ISO 3977
- Sulfur oxides (SO_x) : g/kWh or ppm calculated depending on the sulphur content of the fuel used
- Ash : mg/m³ at normal conditions (*) calculated on the basis of ash content of fuel used

Specified limitations are valid only at specified operating conditions.

(*) 0 °C; 1,013 bar

7.2 Tolerances

- Either : specified values shall not be exceeded
- or : specified values have a tolerance of + % or – %

7.3 Measurements

- At the time of the acceptance test
- Accurate position of sampling the exhaust gases to be recorded
- Analysis of the fuel consumed, whether it is reference fuel or other fuel.

7.4 Regulations for Emissions

Regulation requirements of emissions may differ widely depending on size, place and application of gas turbines.

7.5 Steam or Water Injection

To reduce NO_x contents, steam or water injection could be used. Subject to prior agreement the turbine manufacturer will specify:

- The steam or water flow in percentage (mass) of fuel flow
- The chemical properties of water (degree of hardness, PH-level, etc.).

8 Airborne Sounds

If the gas turbine manufacturer is not supplying a turnkey installation he is not in a position to specify the sound or

sound pressure level inside the turbine hall, in the surrounding grounds and in the vicinity of installation, as he may not have information about the relevant stereoscopic and acoustic conditions or have any influence on them.

If, due to special requirements of the customer, inspecting and/or legal authorities and/or classification societies restrictions to the max. permissible sound level exist, which might impose special measures (for example the use of special sound attenuation arrangements), such requirement shall be specified by the customer.

The objective should be to achieve an acceptable sound level satisfactory for the health of the operator, operator communication, and for nearby residential, business or industrial areas (*). The formulation of the sound requirements for the gas turbine is to be modified relative to the part of the total plant in which it is included.

If the manufacturer is to state the airborne sound level of the gas turbine then he shall declare:

- the octave bands corrected sound pressure level indications in dB (re) 0.0002 microbar, for compressor inlet, turbine exhaust and gas turbine main body respectively, together with the distance and directional condition, in accordance ISO 6190.
- the associated power output, shaft speed and relevant operating conditions, together with tolerances.

(*):

It should be recognized that sound can be due to equipment other than the gas turbine, for example such associated equipment as fans, diesel starting engines, driven equipment, transformers, generators, etc.

In order to achieve the objectives, both the user and the manufacturer must integrate their design for the total sound contributors while recognizing environmental factors (such as the background noise) which affect the overall sound level.

Refer ISO 1999 for the operator's health protection and communication, and ISO 1996 for the acceptable sound levels outdoors.

9 Vibration

If required, the following shall be stated in the contract:

- The following alternatives shall be acceptable for determining vibration:
 - Acceleration method
 - Amplitude method
 - Velocity method
- It should be clarified as to which supplier, i. e. gas turbine or driven equipment, is responsible for the calculation or guarantee of vibration levels. Necessary data for calculation have to be supplied by the parties involved.
- The following shall be made clear:
 - the location of vibration detector(s), bearing cap or shaft etc.
 - the rotational speed at the load at which measurements are made
- Vibration statement is to be made on the basis of a properly installed plant as to be assessed by the gas turbine manufacturer.

10 Operation Characteristics

10.1 System Requirements

If required, the following shall be stated in the contract:

- Start-up time
- Acceleration rate
- Load-up rate
- Speed and/or load response time
- Frequency-range
- Load pattern
- Start-up and shut down frequency

10.2 Information about Driven Machines

It is recommended that the following information about the driven machines be obtained, when such machines are supplied by others:

- Short circuit torque or other torque caused by the special operating circumstances such as high speed reclosing of the transmission line breakers
- Rotor displacements during operation
- Relevant thermal expansions
- Critical speed(s)
- Responsibility for supply coupling

11 Availability and Reliability Expectations

11.1 Information about Planned Maintenance and Shutdowns

When requested, and as part of an equipment supply Contract if appropriate, the Manufacturer shall provide full operation and maintenance instructions in the form of a manual(s).

Schedules of maintenance activities and guidance on the number of days when the plant is expected to be shut down in each year for maintenance shall form part of the Operation and Maintenance Instructions.

Such information on the anticipated availability of the plant for power production in each year shall not form the basis for contract guarantees or be subject to financial penalties or liquidated damages.

11.2 Information about Reliability of the Equipment

When requested by a customer, but not as part of an equipment supply Contract, Manufacturers shall provide information on the average periods of time that similar plant has been shut down due to reasons other than planned maintenance or client requirements. Such figures shall be based on actual records of similar plant, and shall constitute expectation only of future reliability of plant in operation.

Such figures shall be based on strict adherence by the customer to the Operation and Maintenance Instructions of the Manufacturer, but shall in no event form the basis for contractual guarantees or be subject to financial penalties or liquidated damages.

11.3 Separate Operation and Maintenance Contracts

Customers may seek to ensure high standards of availability and reliability of plant by employing the Manufacturer to undertake Operation and Maintenance of the plant, and Manufacturers shall be free to enter into such service contracts under appropriate terms and periods.

Such Operation and Maintenance contracts may be for

- Operation only
- Maintenance only
- Operation and Maintenance combined
- Responsibility for supply of spare parts on a fixed price or "cost-plus" basis but shall always be separate from the main supply contract.

A manufacturer's responsibilities under such Operation and Maintenance contracts shall be strictly limited to the performance of his obligations under the separate contract for example

- Provision of competent personnel in a timely manner
- Provision of spare parts and other equipment called for against an agreed programme
- Operation and Maintenance of the plant by use of the plant owner's personnel and equipment.

Performance of obligations under such separate Operation and Maintenance contract, may be guaranteed by financial penalties if so requested by the customer. The level of such penalties that may be levied in any given period of time shall be set against the total value of the Operation and Maintenance contract in such period of time, and the maximum financial penalty shall be determined by mutual agreement between the parties. Penalties for secondary and indirect damages shall be specifically excluded from such Operation and Maintenance contracts.

12 Life Expectancy of Components

The life expectancy of components should not be guaranteed since a number of factors which influence the life expectancy are conditions beyond the reasonable control of the manufacturer.

For example these may include:

- Operational conditions
- Load pattern conditions
- Frequency of start up and shut down
- Ambient conditions
- Inlet air filtering system
- Compliance with the operating and maintenance instructions
- Quality of maintenance
- Fuel and lubricating oil system
- Fuel and lubricating oil quality and treatment
- Cooling system and cooling water quality
- Injection water and steam quality
- Monitoring system
- etc.

Guide values of the life expectancy of equipment and parts shall be based on mean values.

Operation and maintenance records shall be logged and maintained and made available in such a manner as to enable the turbine manufacturer to analyze the effect of the above mentioned factors on the life expectancy of the equipment and the components.

13 Heat Rejection

The heat rejection from gas turbine to the surrounding circumstance should not be guaranteed because many factors are to a large extent outside the control of gas turbine manufacturers.

If, due to special requirements of the customer, the manufacturer has to state the heat rejection of gas turbine, he should clarify the surrounding condition and state that it is only for estimation.

14 Start-up Period

The start-up time of gas turbine should not be guaranteed because many factors influence the start-up period.

If, due to special requirements of the customer, the manufacturer has to state the start-up time of gas turbine, he should clarify the meaning of start-up time and state the conditions which are required to achieve it, e. g.

- Site ambient conditions
- The gas turbine condition, e. g. cold or hot etc.
- The synchronizing duration
(this depends on the system fluctuations)
- The loading rate etc.

B. RECOMMENDATIONS REGARDING PUBLICATIONS

Introduction

The manufacturer should be aware of the legal aspects and consequences of the contents of his publications.

A duty of instruction and warning may arise under the contract or from the law. In the case of the former, the duty to “instruct and warn” the customer is a secondary contractual obligation with the duty to supply as a principal obligation.

In the latter case the duty to “instruct and warn” follows from the general duty to exercise ordinary or reasonable care with regard to the safety of life and property.

Therefore if a product is brought onto the market it should be provided with adequate instructions for use involved by operators of suitable competence and with the necessary warnings regarding special dangers.

The instructions of warnings can be given in any suitable form (Instruction Manuals, Inserts, Stickers, etc.). They should comply with recognized standards of clarity, legibility, accuracy, etc., must be easily observed and suitable for the user for whom the instructions or warnings are intended. A wording should be used which is as simple, as clear and unambiguous as possible. Furthermore,

whenever applicable, the words “shall”, “shall not”, or “must” and “must not” should be used for mandatory requirements. The terms “should” and “should not”, should be used to mean recommendations.

Attention should be paid to define the split of the responsibilities between the manufacturer and the purchaser or any other contractor of the installation of the product.

The original version of the publication should be supplied in the language of the manufacturer or in English, and should be made clear in the contract.

Any requirements of the purchaser for translation into another language to meet the needs of the user should be part of the contractual arrangements.

In the event of ambiguities between original texts and possible translations, the wording of the former shall prevail unless otherwise agreed.

It is advisable to make use of this CIMAC Recommendation when formulating the contents of publications.

I. Installation Manual

1 Definition

The Installation Manual is a publication by which the gas turbine manufacturer specifies certain requirements for the installation of his gas turbine in order to achieve satisfactory functioning of the gas turbine and to minimize the risk of personal injury or damage to property or the environment.

2 General

The Installation Manual shall only be provided when the installation of the equipment is not part of the gas turbine manufacturer's obligations.

When the installation is included under the gas turbine manufacturer's obligations and consequently no installation manual is provided the manufacturer shall carefully specify all the interfaces, such as connections for fuel, electric power, operating air as well as the foundation, etc. After installation and commissioning he shall prepare and deliver an installation/ commissioning report as specified under Item 3.3. c below.

The Installation Manual shall be based on the assumption that the installation contractor is familiar with the installation of gas turbine in general and with the use of tools and commonly used elements, materials and methods therefore.

For an instructive, comprehensive, clear and detailed publication by the gas turbine manufacturer, it is recommended that the following general introduction in the Installation Manual should be included:

- No one should be permitted to install the gas turbine unless thoroughly familiar with the "Installation Manual".
- The manufacturer is only responsible for the contents of Installation Manual insofar as this is applicable to his contractual area of responsibility.
- The Installation Manual is to be prepared using the manufacturer's best knowledge and experience up to the date of contract, taking into account safety and environmental aspects.
- Failure to comply with the Installation Manual may result in malfunction of the gas turbine, shortened lifetime of components, personal injury or damage to property or environment.
- Opening, taking apart, fitting, lifting or transporting in an incorrect way may cause damage or personal injury. It is therefore essential that no one attempts to do any work on the machinery unless he has the necessary experience of the various items of equipment used in this type of machinery and is familiar with the use of both ordinary tools and special tools necessary to handle the various parts safely.
- If the installations contractor is of the opinion that a part of these Installation Manual is incomplete, doubtful or not useful, he must immediately contact the manufacturer to obtain clarification.
- The manufacturer will not be responsible for any consequence resulting from incorrect translation or interpretation of the original text handed to the purchaser or user.

3 List of Recommendations and Instructions

This list will not be a complete list of requirements included in the Installation Manual. It merely emphasizes some items which may be particularly important, depending on the user as well as on the type of application of the gas turbine involved.

Attention should be drawn to safety precautions in suitable ways (symbols, colours, different printing, etc.).

3.1 Instructions to prepare the installation

- General arrangement drawing
- Space requirements for maintenance, safety and access
- List of weights and dimensions of gas turbine
- Requirements for the gas turbine foundations
- Schematic diagrams with essential data for the layout of the following systems:
 - gas turbine air intake and exhaust system
 - lubricating oil system
 - ventilation, fire fighting and gas detection system
 - fuel system
 - cooling system

- control system
- compressed air system
- electrical wiring system
- Positioning drawing of gas turbine connections such as piping, air intake and exhaust, drive flange, governing, monitoring and controlling equipment, etc.
- Schematic plan for the electric systems of auxiliaries
- Information on auxiliaries to be delivered by the gas turbine manufacturer
- List of special tools and devices to facilitate handling and commissioning
- Information on pipe supports and clamps
- Information on insulation and shielding to satisfy gas turbine design requirements.

Note: The purchaser and the installation contractor must supply to the manufacturer all relevant data in time to enable the manufacturer to meet his contractual obligations. However, this shall not be regarded as transfer of the responsibility to the manufacturers.

3.2 Instructions for installation

The installation contractor must inform the manufacturer immediately when he is required to deviate from any instruction. This also applies to unforeseen deviations discovered during the installation.

a) Piping and ducting system

Manufacturer should

- state quality requirements for the different systems (e. g. welding standards, heat treatment, cleaning, non-destructive test).

Installation contractor should be responsible for ensuring:

- that the installed piping is correctly tightened
- that the flexible connections are correctly set for working conditions
- that the drain cocks are correctly positioned
- that the requirements for insulation and shielding are met.

b) Cabling, wiring and connections

Manufacturer must

- state quality and quantity requirements for the different systems.

Installation contractor must

- ensure that all equipment is correctly wired and connected
- ensure that the requirements for insulation and shielding are satisfactory.

c) Alignment of the gas turbine and the gas turbine driven equipment

Manufacturer must

- state the procedure and sequence of alignment adjustments for gas turbine driver, main drive equipment and gas turbine driven auxiliaries.

Installation contractor must ensure on site correct alignment of same according to the above

- before the gas turbine is finally bolted down (where applicable in presence of an inspector)
- of the gas turbine driven auxiliaries after the gas turbine is correctly aligned to the driven equipment.

3.3 Commissioning

a) Preparation for commissioning

- The installation contractor must certify that the installation is complete including painting, cleaning, anticorrosive measures, etc.

- The purchaser must supply at the time specified in the contract, the fuel, lubricating oil, water, electric power and all other site facilities needed.
- The purchaser must provide load to absorb the power delivered during the commissioning operation.
- The purchaser must arrange for the gas turbine user's technical personnel who will be responsible for the operation after commissioning, to attend the commissioning operations.
- The manufacturer must make available the Operation Manual for the plant supplied.
- The party responsible for procuring and/or installing of the auxiliary equipment must ensure that this is in a properly working condition.

b) Completion of commissioning

The installation contractor should appoint an engineer with appropriate qualifications and the personnel necessary to take charge of the commissioning.

Among other things the commissioning team shall

- strictly follow the Installation Manual submitted by the gas turbine manufacturer
- carry out thorough cleaning of all pipeline systems after disconnection from the gas turbine until filters remain clean
- check that protective materials for transport and

storage have all been removed

- follow the starting procedure in the Operation Manual and run the gas turbine strictly in accordance with manufacturer's operating instructions
- check that all auxiliaries and safety devices are functioning satisfactorily
- check the installation in operation for abnormal vibrations and noise.

It is for the installation contractor to decide whether the gas turbine and installation is ready for final acceptance tests.

When an engineer is appointed by the manufacturer to attend the commissioning, he shall assist the installation contractor as an advisor but shall take no responsibility for the execution of the installation work done by the installation contractor.

If the engineer appointed by the manufacturer is not satisfied with the installation and his advice is not followed by the installation contractor, he shall immediately notify the purchaser.

c) Documentation

The installation contractor must furnish to the purchaser and the manufacturer all relevant documents regarding installation and commissioning.

II. Operation Manual

1 Definition

The Operation Manual is a publication by which the gas turbine user is informed about how to start, run and stop the gas turbine, including trouble shooting, recommended maintenance schedules and maintenance work deemed to be within the scope of work and capacity of the operators.

The Operation Manual also informs the user on checks and work that must be carried out before starting and after stopping or for longer periods of standstill of the gas turbine.

Instructions for heavier maintenance work and for certain repair works are described in chapter III "Maintenance Manual".

2 General

For an instructive, comprehensive, clear and detailed publication by the gas turbine manufacturer, it is recommended that the following general introduction in the Operation Manual be included:

- No one should be permitted to operate or work with the gas turbine unless he is familiar with the "Operation Manual".
- The Operation Manual should be prepared using the manufacturer's best knowledge and experience, taking into account safety and environmental aspects.
- To ensure the gas turbine and gas turbine components efficiency, reliability, safety and life expectancy, only the manufacturer's approved spare parts should be used.
- Failure to comply with the Operation Manual may result in a malfunctioning of the gas turbine, shortened lifetime of components, personal injury, damage to property or the environment.

- Opening, taking apart, fitting, lifting or transporting in an incorrect way may cause damage or personal injury. It is therefore essential that no one attempts to do any work on the machinery unless he has the necessary experience of the various items of equipment used in this type of machinery and is familiar with the use of both ordinary tools and special tools necessary to handle the various parts safely.
- During operation or repair of the fuel system(s) special care shall be taken to avoid risk of initiation of fire or explosion in a hazardous environment in the gas turbine itself, its enclosure and its ancillary systems.
- The manufacturer shall not be responsible for any consequences resulting from incorrect translation or interpretation of the original text handed to the purchaser or user.

3 List of Recommended Instructions

This list is not a complete list of information to be included in the Operation Manual. It merely emphasizes some items which may be particularly important, depending on the type and application of the gas turbine used.

Recommendations regarding fuel (see section "C"), lubricating oil and water treatment (if applicable) shall be included in the Operation Manual.

The gas turbine manufacturer shall clearly state and describe which minor maintenance and repair work may be carried out by the operating personnel and shall provide the necessary safety instructions for this work.

Other maintenance work which cannot be carried out by the operating personnel, shall be described in the Maintenance Manual and must only be carried out by trained personnel.

Attention should be drawn to safety precautions in a suitable way (symbols, colours, different printing, etc.).

Special warnings shall be given, e. g.:

- not to disassemble or readjust speed governors, overspeed devices or any other component which controls or limits the dynamic conditions of the gas turbine unless this is expressly allowed and the procedure described in the manual is observed.
- to avoid use of temporary substitutes instead of clamps, holders, supports, fastenings or other general machinery equipment.
- not to open fuel systems – in particular gaseous fuel systems – and use cleaning solvents, oils, esters etc. unless all relevant confined spaces are well ventilated. To avoid hazardous environment gas detection instruments should be used during the operation/repair work.

3.1 Starting procedure of the gas turbine

The manual should contain at least the following information and checks:

3.1.1 Definition of person authorized to start the gas turbine

3.1.2 General start up instructions:

Check that:

- start up order has been received from a higher plant operating authority
- all safety protection items have fitted (e. g. covers for moving parts)
- connections of the fuel systems have been tightened
- tools or other loose parts have been removed from the gas turbine interior and its associated systems
- all shutoff devices in the exhaust gas passages are in open position
- all stop-cocks and valves are in their correct positions
- all specified fluids necessary for the operation of the gas turbine are present to the required levels.
- speed control and other gas turbine protection are in working conditions and correctly set
- independent essential auxiliaries are fully operational
- the driven machinery is ready for operation
- external system is ready to receive output of driven machine and is in specified starting position
- no person is in the vicinity of any moving parts
- no inflammable fluids are in the vicinity of the gas turbine
- the gas turbine area is free from fuel vapors or other flammable gases.

3.1.3 “Cold gas turbine” Start up instructions

- Necessary system and process parameters data for definition of “Cold gas turbine”
- Cold gas turbine start up check list

3.1.4 “Hot gas turbine” Start up instructions

- Necessary system and process parameters data for definition of “Hot gas turbine”
- Hot gas turbine start up check list.

3.2 Gas turbine running

The manual should contain at least the following instructions and check lists:

- Instructions for normal load increase and decrease.
- Instructions for possible abnormal load increase and decrease.
- Instructions for gas turbine condition monitoring and reporting.
- Instruction and check list for actions to be taken upon abnormal running conditions.
- Alarm reporting.
- Keeping of gas turbine log book.
- Instructions for:
 - a) Simple trouble shooting and
 - b) Planned and corrective maintenance that can be performed during normal operation.
- Visual inspection of gas turbine during operation.

3.3 Stopping procedure of gas turbine

The manual should contain at least the following information and checks:

- Except for emergencies, check that stopping of gas turbine is ordered or accepted by higher plant authority.
- Instructions for normal load decrease and shutdown.
- Check list for normal run down and cooling of
 - a) Gas turbine
 - b) Auxiliary systems.
- Check that unintentional restart is not possible (e. g. interlock).
- Instructions and check list for operations and precautions to be taken in case of automatic or manual emergency stop.
- Reporting and keeping of gas turbine log book.
- Check list and warnings for dangerous situations connected with maintenance work on hot or semi-hot gas turbine.

3.4 Gas turbine preservation

- Instruction for gas turbine preservation during longer standstill periods.
- Instructions for periodical checks of preservation.

3.5 Trouble shooting

- Instructions and check list of trouble shooting to be performed by operators upon abnormal conditions.

Note: Refer also to chapter III “Maintenance Manual” for a more detailed list of trouble shooting and maintenance operations to be performed by operating personnel and maintenance personnel.

3.6 Recommended maintenance schedule

- List of recommended preventative maintenance actions with intervals.
- Instructions for recommended maintenance actions deemed to be within the operators’ obligations.

3.7 Fuel treatment

- Fuel specifications
- Fuel treatment check list.

III. Maintenance Manual

1 Definition

The Maintenance Manual is a publication by which the gas turbine user is informed about how and when to carry out heavier maintenance work and how to carry out trouble shooting beyond what is referred to in clause 3.5 above.

The Maintenance Manual should be concentrated on the type of repair and maintenance work on the gas turbine or auxiliary system components that is carried out by the user's maintenance personnel. Minor maintenance work, which is suitably carried out by the operating personnel is dealt with in the Operating Manual.

2 General

For an instructive, comprehensive, clear and detailed publication by the gas turbine manufacturer, it is recommended that the following general introduction in the Maintenance Manual be included:

- No person should be permitted to carry out any maintenance work on the gas turbine unless he is thoroughly familiar with the "Maintenance Manual".
- The Maintenance Manual should be prepared using the manufacturer's best knowledge and experience, taking into account safety and environmental aspects.
- To ensure the gas turbine and gas turbine components efficiency, reliability, safety and life expectancy, only "original" spare parts or those approved by the manufacturer should be used.
- Failure to comply with the Maintenance Manual may result in a malfunctioning of the gas turbine, shortened lifetime of components, personal injury or damage to property or the environment.
- Opening, taking apart, fitting, lifting or transporting in an incorrect way may cause damage or personal injury. It is therefore essential that no one attempts to do any work on the machinery unless he has the necessary experience of the various items of equipment used in this type of machinery and is familiar with the use of both ordinary tools and special tools necessary to handle the various parts safely.
- Ensure that all equipment and tools for maintenance are in good and clean condition.
- The maintenance work described in the Maintenance Manual shall only be carried out by trained personnel except where otherwise stated.
- During operation or repair of the fuel system(s) special care shall be taken to avoid risk of initiation of fire or explosion in a hazardous atmosphere in the gas turbine itself, its enclosure and ancillary systems.
- The manufacturer will not be responsible for any consequences resulting from incorrect translation or interpretation of the original text handed to the purchaser.

3. List of Recommended Instructions

This list is not a complete list of information to be included in the Maintenance Manual. It merely emphasizes some items which may be important, depending on the type and application of the gas turbine used.

The gas turbine manufacturer shall clearly state and describe which maintenance and repair work may be

carried out by the operating personnel and shall provide the necessary safety instructions for this work. See Operation Manual.

If certain maintenance work shall not be carried out by the maintenance personnel, the manufacturer should give information on how to contact the authorized maintenance centre.

Attention should be drawn to safety precautions in a suitable way (symbols, colours, different printing, etc.).

Special warnings shall be given e. g.:

- not to disassemble or readjust speed governors, overspeed devices or any other components which controls or limits the dynamic conditions of the gas turbine unless this is expressly allowed and the procedure described in the manual observed.
- to avoid use of temporary substitutes instead of clamps, holders, supports, fastenings or other general machinery equipment.
- not to open fuel systems – in particular gaseous fuel systems – and use cleaning solvents, oils, esters etc., unless all relevant confined spaces are well ventilated. When necessary gas detection instruments should be used continuously during the operation/repair work.

Before any maintenance work is begun, make sure that the gas turbine cannot be started (e. g. good visible warning plate on the control panel).

3.1 Maintenance schedule

The manufacturer must provide a maintenance schedule listing all planned maintenance items with their recommended periodicity assuming that the gas turbine is running at normal operation conditions.

Recommended maintenance schedules shall be included in the "Operation Manual".

Note: The manufacturer should include the following sentence after the maintenance schedule:
The maintenance schedule and periodicity intervals are manufacturer's recommendations having the objective to maintain the best possible efficiency, reliability, safety and life expectancy. Periodicity intervals are based on manufacturer's experience.

3.2 Description of the maintenance

The description of the maintenance should include among others:

- Work procedure required
- Time required at manufacturer's work
- Essential spare parts
- Special tools and materials
- Number of persons involved
- Lifting means
- Weights of components
- Dimensional limits for further use (wear limits clearance, etc.)
- Tightening and other methods to be used (torque, elongation, wrench angle special grinding of valve seats, etc.)
- Provide diagrams of figures for complex operation
- Safety rules for maintenance personnel.

IV. Spare Parts Manual

1 Definition

The Spare Parts Manual is a publication by which the gas turbine manufacturer provides information to the user for identification of spare parts. It enables the user to order the parts needed for the operation, maintenance and repair of the gas turbine.

2 General

It is recommended to include the following general introduction in the Spare Parts Manual:

- To ensure the gas turbine and gas turbine components efficiency, reliability, safety and life expectancy, only "original" spare parts or those approved by the manufacturer should be used.

3 Contents of Spare Parts Manual

Spare Parts Manual shall include:

- Name of parts
- Code number of parts
- Illustration of each part
- Name, address, telex number, telephone number, etc. of the manufacturer and service stations
- Guidance for ordering parts.

C. RECOMMENDATIONS REGARDING FUELS AND FUEL TREATMENTS

Introduction

In order to minimize the effects of incorrect fuel supply and therefore the number of potential disputes between gas turbine manufacturers and purchasers it is important that gas turbine manufacturers provide sufficient information to the purchaser regarding fuel specifications, installation specifications and requirements for fuel documentation in use. This CIMAC Recommendation should be used for this purpose.

The following recommendations are only applicable to fuel related effects but as there are also influences from the ambient air, injected steam or water, consideration must also be paid to these in regard to their quality.

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1 General

The manufacturer cannot be held responsible for damages caused by the use of fuels outside the contractual specifications or by fuels uncorrectly treated.

As there is little standardization for gaseous fuels available, properties of gaseous fuels shall be specified between manufacturer and customer with special emphasis on properties having adverse effects on materials and operation.

2 Contract

It is recommended that the following wording in the contract regarding fuel specification be included:

- The liquid fuel (if used) shall be specified between manufacturer and purchaser, as well as between purchaser and fuel supplier, according to the forthcoming ISO Specification DP 4261 or national standards for petroleum products.
- Special emphasis is drawn to the Appendix of ISO Specification DP 4261, which gives details of the effect of fuel properties on gas turbine operation and sampling procedures.
- The purchaser shall make available to the gas turbine manufacturer an analysis of the fuel(s) to be used or if so requested by the gas turbine manufacturer a sample at the earliest opportunity in order to allow him to design the fuel system suitably and to issue proper recommendations for installation and operation.

3 Installation Instructions

In case some portions of the fuel system are not supplied by the gas turbine manufacturer, it is recommended to include installation instructions regarding the fuel systems, based on manufacturers practice. Such instructions should include the following items, as applicable.

3.1 Liquid Fuels

- At least 2 storage tanks are recommended. Storage tanks shall normally have provision for settling. Liquid fuels with high contamination potential shall be withdrawn from tanks by floating suction. The capacity of the tanks shall be adequate to allow sufficient settling of dirt and water and the construction shall allow bottom drainage of settled dirt and water.

- The storage system must ensure prevention of agitation of tank bottom during the tank filling. This can be achieved by proper design of inlet piping.
- Minimum capacity for service or day tanks, if required, shall be stated.
- Heating of the tanks shall be adequate to achieve the required viscosity of the fuel at the outlet and shall avoid solidification and wax formations of the fuel in the tanks.
- Heating of fuel in connection with waterwashing, separation or filtration and viscosity controlled endheating shall be in accordance with those specified by the gas turbine manufacturer.
- Fuel washing systems shall be so designed as to take care of the effluent water quality and be in accordance with the applicable standards or regulations regarding oil content in the effluent water.
- The minimum capacity of the washing plant must satisfy the gas turbine manufacturer requirements.
- The tank's identification shall state the distinction between "raw" fuel tanks and "treated" fuel tanks.
- Filtering only is insufficient for most ashbearing fuel operation; it is good practice to install appropriate filters upstream of the fuel injection system.

3.2 Gaseous fuels

- The gas supply pressure as well as the allowable pressure fluctuations shall be stated in the contract and within the manufacturers specifications or recommendations.
- The gas temperature shall be such that neither the hydrocarbon nor the water dewpoint can be reached in any region of the turbine fuel system. Provisions to avoid condensate or removal of condensate shall have sufficient capacity to ensure condensate-free gas entering the turbine fuel system.
- In order to eliminate dirt from the fuel system, filtering of the gas should be incorporated wherever possible.
- In the case of gases with low and medium calorific value, originating from chemical processes, measures should be implemented to ensure manufacturers limits regarding dust particle size and dust concentration.

4 Operation

In order to ensure a good performance of the gas turbine plant the operator shall observe the following:

- Confirm that the fuels used comply with the gas turbine manufacturer's specifications.
- Strictly follow the manufacturer's maintenance instructions for the fuel systems.
- Avoid filling of a tank and operating from this same tank at the same time. Allow sufficient settling time before withdrawing fuel from a newly filled tank.
- Keep different fuels in separate storage tanks. Before using a dedicated tank for another fuel, consult gas turbine manufacturer for compatibility.
- When blending of fuels is intended by the customer the compatibility of two fuels shall be tested. In case of incompatibility sufficient storage of compatible fuel should be provided.

5 Documentation

In order to minimize the possibility of disputes about origin of defects it is recommended that the Operation Manual or any appropriate documentation supplied with gas turbine should include the following wording regarding fuel documentation:

- Establish and maintain a record of quantity and quality data obtainable from the fuel's suppliers and of analyses available or have possibilities to perform fuel analyses at a laboratory.
- Fuel shall be sampled and analyzed at periodic intervals. Since these intervals can sensibly vary due to transportation fuel system design, analytical facilities available at the plant, they should be established on a case by case basis.
- In the event that fuel treatment is considered necessary by the manufacturer
 - a site fuel laboratory is strongly recommended. Only continuous analyses of the fuel will enable the treatment to be adjusted according to the actual fuel characteristics.
 - check fuel quality and keep records of the quality downstream of the fuel treatment plant.
- Fuels requiring fuel additives should be checked periodically for additive content versus fuel quality.
- Details on the extent of the analyses which are important for the operation shall be stated by the manufacturer.
- It is recommended to check the analyses obtained on site periodically by allowing the gas turbine manufacturer to conduct his own analyses.

Previous publications

1. Recommendations for Internal Combustion Engines Acceptance Test – 1961 *)
(out of print)
German version is available

*) Contents of these CIMAC Recommendations is more or less completely adopted in ISO 3046, part 1 – 5
2. Recommendations for Gas Turbine Acceptance Test – 1968
(English and French version)
Price: ffrs. 35.00 (plus postage)
3. Recommendations for the Measurement of the Overall Noise of reciprocating Engines – 1970
(English and French version)
Price: ffrs. 35.00 (plus postage)
4. Recommendations for SI Units for Diesel Engines and Gas Turbines – 1975:
(English and French version)
Price: ffrs. 35.00 (plus postage)
5. Recommendations for Supercharged Diesel Engines: *)
Part I – Engine De-rating on Account of Ambient Conditions
Part II – Engine Acceptance Tests
(English and French version)
(not printed)
6. Lexicon on Combustion Engines, Technical Terms of the Internal Combustion Engine and Gas Turbine Industries – 1977
(in Dutch, English, French, German, Italian, Spanish)
Price: ffrs. 80.00 (plus postage)
7. Recommendations regarding liability
– assured properties, publications, fuels
(English version)
(French version is available in Paris)
Price: DM 30.00 or ffrs. 90.00 (incl. postage)
8. Recommendations regarding Requirements for heavy fuels for Diesel engines
(English version only)
Price: DM 30.00 (incl. postage)
9. Recommendations concerning the design of Heavy fuel Treatment Plants for Diesel engines
(English version only)
Price: DM 50.00 (incl. postage)

Publications jusqu'à présent

1. Recommandations pour les Essais de Réception des Moteurs à Combustion Interne – 1961 *)
(épuisé)
Version allemande est à la disposition

*) Contenus des CIMAC Recommandations sont impliquées plus ou moins dans le ISO 3046, part 1 – 5
2. Recommandations pour les Essais de Réception des Turbines à Gaz – 1968
(textes français et anglais)
Prix: ffrs. 35.00 (port non compris)
3. Recommandations pour la Mesure du Bruit total des Moteurs à Combustion Interne – 1970
(textes français et anglais)
Prix: ffrs. 35.00 (port non compris)
4. Recommandations pour l'Emploi des Unités SI dans la Technique des Moteurs Diesel et des Turbines à gaz – 1975
(textes français et anglais)
Prix: ffrs. 35.00 (port non compris)
5. Recommandations pour les Moteurs Diesel suralimentés *)
Part I – Détarage de la puissance en fonction des conditions ambiantes
Part II – Essais de réception des moteurs
(version anglaise seulement)
(pas imprimées)
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