IEC TS 62257-6

Edition 2.0 2015-12

TECHNICAL SPECIFICATION

Recommendations for renewable energy and hybrid systems for rural electrification –
Part 6: Acceptance, operation, maintenance and replacement

IEC TS 62257-6:2015-12(en)

International Electrotechnical Commission

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

About the IEC
The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications
The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

IEC Catalogue - webstore.iec.ch/catalogue
The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

IEC publications search - www.iec.ch/searchpub
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,…). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and also once a month by email.

Electropedia - www.electropedia.org
The world's leading online dictionary of electronic and electrical terms containing more than 30 000 terms and definitions in English and French, with equivalent terms in 15 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary
More than 60 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

IEC Customer Service Centre - webstore.iec.ch/csc
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: csc@iec.ch.

IEC TS 62257-6

Edition 2.0 2015-12

TECHNICAL SPECIFICATION

Recommendations for renewable energy and hybrid systems for rural electrification –
Part 6: Acceptance, operation, maintenance and replacement

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 27.160

ISBN 978-2-8322-3069-5

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

____

RECOMMENDATIONS FOR RENEWABLE ENERGY AND HYBRID SYSTEMS FOR RURAL ELECTRIFICATION –

Part 6: Acceptance, operation, maintenance and replacement

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

The main task of IEC technical committees is to prepare International Standards. In exceptional circumstances, a technical committee may propose the publication of a technical specification when

- the required support cannot be obtained for the publication of an International Standard, despite repeated efforts, or
- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC 62257-6, which is a technical specification, has been prepared by IEC technical committee 82: Solar photovoltaic energy systems.

This second edition cancels and replaces the first edition issued in 2005. It constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

– redefine the maximum AC voltage from 500 V to 1 000 V as well as the maximum DC voltage from 750 V to 1 500 V; and
– removal of the limitation of the 100 kVA system size. Hence the removal of the word “small” with regard to the title and related references in this document.

This technical specification is to be used in conjunction with the IEC 62257 series.

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
82/951/DTS	82/1002A/RVC

Full information on the voting for the approval of this technical specification can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 62257 series, published under the general title *Recommendations for renewable energy and hybrid systems for rural electrification*, can be found on the IEC website.

Future standards in this series will carry the new general title as cited above. Titles of existing standards in this series will be updated at the time of the next edition.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- transformed into an International standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

INTRODUCTION

The IEC 62257 series intends to provide to different players involved in rural electrification projects (such as project implementers, project contractors, project supervisors, installers, etc.) documents for the setting up of renewable energy and hybrid systems with AC voltage below 1 000 V and DC voltage below 1 500 V.

These documents are recommendations:

- to choose the right system for the right place;
- to design the system;
- to operate and maintain the system.

These documents are focused only on rural electrification concentrating on, but not specific to, developing countries. They should not be considered as all inclusive to rural electrification. The documents try to promote the use of renewable energies in rural electrification; they do not deal with clean mechanisms developments at this time (CO_2 emission, carbon credit, etc.). Further developments in this field could be introduced in future steps.

This consistent set of documents is best considered as a whole with different parts corresponding to items for safety as well as sustainability of systems aiming at the lowest life cycle cost as possible. One of the main objectives is to provide the minimum sufficient requirements, relevant to the field of application, that is: renewable energy and hybrid off-grid systems.

The purpose of this technical specification is to propose a methodology to achieve the best technical and economic conditions for acceptance, operation, maintenance and replacement of equipment and complete system life cycle.

RECOMMENDATIONS FOR RENEWABLE ENERGY AND HYBRID SYSTEMS FOR RURAL ELECTRIFICATION –

Part 6: Acceptance, operation, maintenance and replacement

1 Scope

This part of IEC 62257, which is a technical specification, intends to describe the various rules to be applied for acceptance, operation, maintenance and replacement (AOMR) of decentralized rural electrification systems (DRES) which are designed to supply electric power for sites which are not connected to a large interconnected system, or a national grid, in order to meet basic needs.

The majority of these sites are:

- isolated dwellings;
- village houses;
- community services (public lighting, pumping, health centers, places of worship or cultural activities, administrative buildings, etc.);
- economic activities (workshops, micro-industry, etc.).

This technical specification proposes a methodology to achieve the best technical and economic conditions for acceptance, operation, maintenance and replacement of equipment and complete system life cycle.

It does not substitute for technical manuals provided by manufacturers for each equipment. The complexity of the system and application will dictate the level of required AOMR documentation.

2 Normative reference

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 62257 (all parts), *Recommendations for renewable energy and hybrid systems for rural electrification*

IEC TS 62257-1, *Recommendations for renewable energy and hybrid systems for rural electrification – Part 1: General introduction to IEC 62257 series and rural electrification*

IEC TS 62257-2, *Recommendations for renewable energy and hybrid systems for rural electrification – Part 2: From requirements to a range of electrification systems*

IEC TS 62257-3, *Recommendations for renewable energy and hybrid systems for rural electrification – Part 3: Project development and management*

IEC TS 62257-4, *Recommendations for renewable energy and hybrid systems for rural electrification – Part 4: System selection and design*

IEC TS 62257-7, *Recommendations for renewable energy and hybrid systems for rural electrification – Part 7: Generators*

IEC TS 62257-8, *Recommendations for renewable energy and hybrid systems for rural electrification – Part 8: Batteries and converters*

IEC TS 62257-9 (all parts), *Recommendations for renewable energy and hybrid systems for rural electrification – Part 9-XX: Integrated systems*

IEC TS 62257-12-1, *Recommendations for renewable energy and hybrid systems for rural electrification – Part 12-1: Selection of lamps and lighting appliances for off-grid electricity systems*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
AOMR actions
acceptance, operation, maintenance and replacement actions
key processes that are required for the overall successful implementation of an isolated electrification system

3.2
implementation contract
contract between project developer and project implementer usually the result of a competitive sollicitation for proposals developed by the project developer on the basis of the general specification

3.3
electric equipment
item used for such puposes as generation, conversion, transmission, distribution or utilization of electric energy, such as electric machines, transformers, switchgear and controlgear, measuring instruments, protective devices, wiring systems, current-using equipment

[SOURCE: IEC 60050-826:2004, 826-16-01]

3.4
REN
renewable energy
energy from a source that is not depleted when used

[SOURCE: IEC TS 62257-2:2015, 3.1]

4 General aspects

4.1 Introduction to AOMR actions

Isolated electrification systems are designed to supply power to those individuals, communities or loads located in remote areas not connected to national grids.

These systems can be broken down into three categories:

- process electrification systems (for instance for pumping);
- individual electrification systems (IES) (single user, load or application);

- collective electrification systems (CES) (multiple user load or application).

In order to satisfy the various energy requirements both in terms of quality and quantity, six types of isolated micropower systems have been identified (see IEC 62257-2).

AOMR actions are introduced in Table 1.

A basic system acceptance process description is given in Table 2.

Table 1 – AOMR actions

Acceptance	• checking the process to ensure that the system installation meets the requirement set forth in the implementation contract between the project developer and the project implementer • testing the process to ensure that the micropower system operates according to the functional part of the implementation contract • once the parties have come to agreement, transfer the responsibility of the system
Operation	• managing the business of system operation • monitoring "normal" system operation ("normal" operation = system supplies the power complying with all the characteristics of the expected service, with the original designed configuration) • managing system electrical operation = executing actions on electrical circuits (configuration changes) • response to abnormal operating conditions = to provide service outside of the boundaries of the implementation contract (prolonged absence of REN sources) • response to abnormal system operation corrective actions (manual or automatic), troubleshooting and repair system or system components (diagnosing the cause(s) for failure); fault finding = to service the plant and restore its operating conditions following an unpredictable failure • guaranteeing safety while performing (servicing) actions on the plant • performing analysis and retrofit of the system to account for new operating conditions
Maintenance	• preventive maintenance: keeping and maintaining the system to its «normal» operating state • corrective maintenance: adjusting, fixing or replacing components after fault recognition • conducting periodic tests and inspection
Replacement	• replacing the equipment on «normal» life cycle completion • replacing the equipment for upgrading purposes • dismantling and recycling at end of life cycle

Table 2 – System acceptance process description

Acceptance process		Objective	Responsible party	Implementers	Content of a suggested data sheet
Phase 1	Preparation	To collect all information on the system	Project implementer	Project implementer/ subcontractor	List of contractual documents to be provided
Phase 2	Check of existing documentation, contract clauses	To check that all non operational contractual requirements are met: Documentation, manuals, spare parts, drawings, procedures, warranty contracts, etc.	Project developer	Consultant engineer	List of contractual documents to be provided
Phase 3	Commissioning step 1: Evaluation of the conformity of the installed system with the accepted design	To check that the equipment complies with the contractual accepted design and that any differences are explained	Project developer	Consultant engineer	Equipment list: Initial design list/as built list/comments
	Commissioning step 2: Evaluation of qualification of the installation	To check that the system is ready to be operated	Project implementer	Project implementer/ subcontractor	Letter
	Commissioning step 3: Preliminary tests	To test that the system components operate correctly	Project developer	Consultant engineer	Component by component, verification: Proper type and reference according to the as built list Proper installation: check list of key points Proper operation: list of tests with targeted performances to be obtained
	Commissioning step 4: Performance testing	To check all the operating performances of the whole system	Project developer	Consultant engineer	List of system tests with targeted performances to be obtained
Phase 4	Agreement	Transfer of responsibility	Project implementer/ developer/ operator/ owner		Letter of acceptance

4.2 Conditions impacting AOMR actions and guidelines

4.2.1 Characteristics of the project/systems to be managed

The characteristics of systems and their installation environment will have an influence on the organizational schemes to perform AOMR actions.

Among these influence factors the following are highlighted:

- geographical layout: the number of systems, their location and dispersion will determine spare parts and tool requirements, technician and equipment transportation means, mean time to repair and perhaps the methodology for collecting money;
- systems size and technology will have an influence on the maintenance program, the skill level of technician, and the final user's involvement;
- the degree of multiple system standardization will impact the training and skill levels for operators and maintenance staff;
- the importance of specific applications (health, water pumping, telecommunications) can be considered more critical and managed more carefully.

4.2.2 Organization of AOMR personnel and responsibilities

The following different parties to be involved in the rural energy systems may be involved in the AOMR activities:

- owner;
- project developer;
- engineering consultant;
- project implementer;
- subcontractor;
- operator;
- maintenance contractor;
- training provider;
- user.

The specific roles of each party are described in greater detail in IEC TS 62257-3.

AOMR activities are dispatched according to the contractual responsibilities of the different parties as shown in Table 3, considering that one person may have several roles.

Table 3 – AOMR participant involvement

Nature of participant	AOMR actions				Responsibilities versus AOMR concerns
	A	O	M	R	
Owner	I			I	Long term financial and contractual responsibility for the system.
Project developer	I	C	C	C	Responsible for defining operating rules, maintenance policy and replacement time schedule.
Engineering consultant	I	C	C	C	On the basis of a service to be supplied and under the project developer's responsibility, defines AOMR rules and levels which will allow the provision of this service.
Project implementer	I				May provide information relevant to AOMR to the project developer.
Subcontractor	I		I	I	Specific to warranty of equipment.

Nature of participant	AOMR actions				Responsibilities versus AOMR concerns
	A	O	M	R	
Operator		I	I	I	Upon acceptance of the work, gives his consent and declares the micropower plant "accepted for operation". Is then responsible for the application of AOMR rules on site. Responsible for ensuring the proper maintenance of the production, distribution and demand subsystems including earthing arrangements.
Maintenance contractor			I		Committed to visiting the system at regular intervals for checking the condition of those components subjected to aging. Performs maintenance and reconditioning operations. Committed to informing the participants and mainly the operator about major events regarding the operation of the system.
Training provider		T	T		Provides relevant knowledge and related training actions to enable people to perform their allocated AOMR actions.
User		I	I		By applying instructions provided, the user can supply feedback to the operator and may perform simple operation and maintenance actions depending on the system design. Reports any maintenance issues to the operator.
C = conceptual role I = implementation role T = training role					

As described in IEC TS 62257-2, a system is structured into three subsystems (production, distribution and demand).

The different subsystems may be owned by the same or different bodies or individuals. The different functional roles described here are the responsibility of and may be performed by or delegated to other participants designated by the owner.

All the functional roles shall be defined for all parts of the system and covered by contractual arrangements.

Each participant category represented in Table 3 shall be fulfilled although more than one category may be fulfilled by the same individual or group. An important example of this is that the user and the operator may be the same in many systems.

4.2.3 Needed technical capabilities of AOMR participants

Two kinds of skill levels are defined:

- the skill level necessary for safety considerations;
- the skill level for management and technical issues.

It may occur that a number of operating features will be provided for using logic control. This may be the case for monitoring, operating and diagnostic tasks.

Table 4 gives the level of skill necessary for safety considerations.

Table 4 – Levels of skill for safety

Level 1	Skilled person	Person with relevant education or experience to enable him/her to perceive risks and to avoid hazards which electrical, chemical or mechanical equipment may create.
Level 2	Instructed person	Person adequately advised or supervised by skilled persons to enable him/her to perceive risks and to avoid hazards which electrical, chemical or mechanical equipment may create.
Level 3	Ordinary	Person who is neither a skilled person nor an instructed person.

Table 5 gives the level of skill necessary for management and technical issues.

Table 5 – Levels of general skill

Management issues		
Level 0	Person with relevant education or experience to enable him/her to conduct management operations (staff management, customer management, etc.).	
Technical issues		
Level 0	Engineering	Person with relevant education or experience to enable him/her to elaborate a maintenance plan and comprehend the interaction between components.
Level 1	Skilled person	Person with relevant education or experience to enable him/her to conduct or supervise detailed actions on the system.
Level 2	Instructed person	Person adequately advised or supervised by skilled persons to enable him/her to perform specific tasks of operation and maintenance.
Level 3	Ordinary	Person who has no skill relevant to system operation and maintenance.

Specific tasks or service items that require specific skills should be identified as such in the project documentation.

4.3 Training

The training plan, defined under the responsibility of the project developer, shall take into account the different levels of skill described in Table 4 and Table 5. Some specific considerations are:

- some verification shall be implemented to ensure proper training is being carried out and that the personnel understand how to perform the required duties;
- training manuals shall be provided in the appropriate languages and quantity to ensure use;
- training is a continuous process, people shall be periodically retrained and updated as necessary.

5 Rules for systems

5.1 System identification and operational data record keeping

The following minimum information shall be prominently and legibly displayed on the indelibly marked system nameplate that shall be installed on a critical component of the micropower system:

- manufacturer's name and/or brand name;
- model and serial number, revision number of power system;
- installation date.

The accompanying documentation shall contain the manufacturer’s name, address and contact information.

The general specification shall specify all information needed to properly define the system.

During the commissioning process, this information shall be transferred to the person or group identified by the owner to be responsible for updating this data (including upgrading, design changes, replacement, history of failure, history of maintenance, replacement, repairs, etc.). This individual or group is likely to be the consulting engineer or the operator.

5.2 Organizational issues

5.2.1 System limit definition of the AOMR domain

A clear definition of the physical limits of the three parts of the system (production, distribution, demand) in relation to operation, maintenance and replacement actions shall be drawn up. The identification of the relevant personnel or organizations responsible for the different subsystems is also required. This is required for both organizational and safety reasons.

5.2.2 Planning of AOMR actions

AOMR actions shall be planned and conducted in accordance with a set schedule. A list of specific system level tasks associated with each AOMR action is provided below.

a) The acceptance date shall be clearly confirmed as it is a starting point for the warranty.

b) Operation activities shall be managed in order to guarantee the service contractually defined. When faults occur, spare parts and manpower shall be available to conduct repairs.

c) Maintenance activities shall be planned for technical and economic reasons. It is necessary to have an overview of all the expected maintenance actions to be implemented for the life of the system to guarantee its availability

Based on information provided by the manufacture and consulting engineer, a table as illustrated in Table 6 shall be developed by the project implementer and updated by the operator as needed.

Table 6 – Maintenance actions planning -example

System component	System lifetime					
	Period 1	Period 2	...	....	...	Period N
PV field	• Action • Actor • Cost			• Action • Actor • Cost		
Batteries	• Action • Actor • Cost		• Action • Actor • Cost	• Action • Actor • Cost		• Action • Actor • Cost
Charge controller				• Action • Actor • Cost		
Inverter			• Action • Actor • Cost		• Action • Actor • Cost	
Genset	• Action • Actor • Cost	• Action • Actor • Cost	• Action • Actor • Cost	• Action • Actor • Cost	• Action • Actor • Cost	• Action • Actor • Cost
...						

d) Replacement activities shall be planned in a similar fashion.

For some components it is possible to determine the loss of performance and decide when replacement will be needed. The project implementer shall provide a recommendation for each piece of equipment or component in order to enable the operator to decide on the relevant replacement actions.

5.2.3 Traceability of AOMR actions

Information on any change or action within the systems shall be recorded in order to trace the technical life of the system and the relationship with the user. This document will be required to support any warrantee claims and should be kept in duplicate.

5.3 Technical issues

The equipment concerned pertains to either of the following voltage domains as indicated in Table 7.

Table 7 – Voltage domains

Voltage domain	Nominal voltage (U_n in volts)	
	Alternating current	Smoothed direct current
ELV	$U_n \leq 50$ V	$U_n \leq 120$ V
LV	50 V $< U_n \leq$ 1 000 V	120 V $< U_n \leq$ 1 500 V

Operation actions shall be conducted according to the local safety regulations. If these do not exist, the following rules should be followed:

- all electrical work or work where there is the potential for electrical shock will be performed with the power shut off;

- disconnecting supply leads from a terminal strip as the sole procedure for disconnecting this part of the system is not acceptable;
- all the equipment from which disconnecting device operation has to be inhibited shall be provided with a padlocking or lockout mechanism;
- disconnecting devices shall be located in a secure enclosure accessible by authorized people. It shall be accessible in all circumstances without having to enter a private property.

5.4 Acceptance issues

The commissioning procedure shall verify the technical performance of the system in two steps:

a) verification of the performance of each piece of the system (equipment or component):
   - check the conformity of the design of the piece of equipment to the implementation contract. Examples of commissioning sheets are provided in the relevant technical specifications IEC TS 62257-7, IEC TS 62257-8-1, IEC TS 62257-9-XX, and IEC TS 62257-12-1;
   - perform the tests according to the implementation contract. Examples are provided in the relevant technical specifications IEC TS 62257-7, IEC TS 62257-8-1 and IEC TS 62257-9-XX;

b) verification of the performance of the whole system:
   - perform the system tests according to the implementation contract.

5.5 Recommended practices for intervention

Due to the interlinked nature of the many potential different energy producing devices typically found in micropower stations, it is important to carefully consider issues of component isolation in the initial design and construction of the power system. Due to both the nature of renewable energy devices and the degree of automated system operation typical in micropower plants, it is possible for devices to start and/or produce energy without warning.

A clear and concise isolation plan should be developed to ensure that each component of a micro-power plant can be safely separated from the power system to allow maintenance, repair or replacement. In some cases it may be more appropriate to shut down the complete system instead of separating individual components.

It is the responsibility of the project developer to see that this is completed and will likely be conducted by the consulting engineer or project implementer.

It should be noted that the presence of capacitors incorporated into any component of the micro-power system may result in voltage even if completely disconnected from external sources.

5.6 Maintenance actions

Within most micropower systems maintenance shall be completed on each component as well as the system as a whole. In most cases, equipment manufacturers will provide maintenance guidelines for their specific component but no general maintenance guideline will be provided for the complete system.

Examples of specific non-component maintenance items include:

- cleaning wire conduits of animal or insect nests;
- maintenance of site access, grounds and buildings;
- building cooling system;

- site and systems communications;
- fuel delivery and storage systems.

A system wide maintenance plan should be developed to ensure that timely maintenance is completed for all system elements.

Maintenance of all three subsystems (production, distribution, demand) shall be coordinated to ensure proper system operation.

Two types of maintenance are generally required:

- Preventive maintenance: maintenance that is completed on a scheduled basis and is conducted to ensure that the piece of equipment or system continues to operate effectively. Examples of preventative maintenance would include changing the oil in diesel generators at a specific frequency or checking the torque of the bolts on a wind turbine tower annually. This type of maintenance is conducted to ensure the expected life of the system components.
- Corrective maintenance: maintenance completed to repair or fix a problem that was identified as part of regular service or preventive maintenance but that would occur as part of normal operation prior to an actual failure. An example of corrective maintenance is the replacement of a bearing in a piece of rotating equipment or a failing cooling fan in a power converter. Corrective maintenance is designed to repair a known problem before it is allowed to propagate into many or larger problems.

5.7 Replacement factors

In most cases, replacement actions will be required for individual power plant components as compared to the complete system. In this case, a specific component will be replaced, potentially with a different but compatible component if required to maintain system performance requirements, but the remainder of the system will be left unchanged. Although generally not the case, occasionally the complete micropower system may need to undergo replacement. A number of cases are identified as follows:

a) End of the useful life of the majority of the system: if most of the system components have reached the end of their useful life it may be more cost effective to replace the complete power system compared to replacing each individual component.
b) Quality of the supply is no longer sufficient: changes in the community require a higher quality of supply than could be provided by the previous system.
c) Load has grown: the load in the community has grown to the extent that the system is no longer capable of providing sufficient power. In this instance it may be more cost effective to replace the whole power system. The old power system may then be moved to another community with lower power needs.
d) Step change in technology: a step change in technology may warrant the replacement of the complete system with a technology that provides higher quality of service at a lower cost.
e) Change in plant location: if the plant location shall be changed for any reason.

5.8 Analysis of the conformity of the delivered service to the contractual commitments

It is necessary to implement a means to assess the adherence of the systems to fulfil the contractual commitments as defined for the project. Although this may be difficult, some level of performance criteria should be established.

Contractual commitments between the contractor and the owner (as defined in IEC TS 62257-3) are a function of the different types of systems (as defined in IEC TS 62257-2).

Adhering to the commitments means that provisions shall be made to prepare a balance data report of the delivered service (e.g. in terms of energy, operating days, pumped volume of water, etc.) within the commitment reference period.

This is carried out with AOMR actions as a function of the system type as illustrated in Table 8.

Table 8 – Verification of the adherence to commitments

Actions	System types					
	T1	T2	T3	T4	T5	T6
Check that appliance specifications are identical to those for initially installed appliances	x	x	x	x	x	x
Check that the delivered service at least equals the service defined under the contract	x					
Compare measured energies (production and consumption) for the contractually defined period (for this comparison, user-consumed a.c. and d.c. energies shall be metered)		x	x	x	x	x
Compare the fraction produced by the generator set against the fraction produced by REN if the contract requires a partial contribution of the genset			x	x		
For collective systems: check contract managers/meters function (power limiters, energy limiter, etc.)		x	x	x	x	x

6 Rules for electric equipment

6.1 General aspects

Acceptance, operation, maintenance and replacement rules shall be defined for each part of the system, in accordance with the contractual commitments related to the service provided and also in relation to the recommendations of the equipment manufacturers.

In case of a lack of recommendations by manufacturers or installers, some practical guidelines on AOMR for different equipment are attached in the relevant parts of the IEC 62257 series (IEC TS 62257-7, IEC TS 62257-8-1, IEC TS 62257-9-XX, and IEC TS 62257-12-1).

Other technologies may exist and may be applicable but are not included in this technical specification.

6.2 Specific aspects related to electric equipment

6.2.1 General

For each piece of equipment, some considerations shall be applied in relation to the technology.

The project implementer will point out rules relative to

- the acceptance test;
- recommended practices for intervention;
- maintenance actions;
- replacement factors.

6.2.2 Acceptance test

For each piece of equipment some considerations including safety aspects related to the technology are provided in the relevant part of the IEC 62257 series (IEC TS 62257-7, IEC TS 62257-8-1, IEC TS 62257-9-XX, and IEC TS 62257-12-1).

6.2.3 Recommended practices for intervention

For each piece of equipment some considerations including safety aspects related to the technology are provided in the relevant part of the IEC 62257 series (IEC TS 62257-7, IEC TS 62257-8-1, IEC TS 62257-9-XX, and IEC TS 62257-12-1).

6.2.4 Maintenance actions

For each piece of equipment some considerations including safety aspects related to the technology are provided in the relevant part of the IEC 62257 series (IEC TS 62257-7, IEC TS 62257-8-1, IEC TS 62257-9-XX, and IEC TS 62257-12-1).

6.2.5 Replacement factors

6.2.5.1 General

Equipment shall be replaced in the following cases:

a) it is damaged to such an extent that its safe operation is no longer possible; or
b) it is defective and it is irreparable; or
c) it is no longer meeting the service requirement; or
d) it has been planned in the contractual preventive maintenance plan.

NOTE The proportion of down-time leading to replacement will vary depending on the particular case. Reference values can be included in the contracts covered by IEC TS 62257-3.

Following the decision to replace a component, a suitable replacement should be identified. The following compatibility criteria with the existing system shall be considered:

1) technical criteria:
   – ratings (e.g. voltage, current, frequency, power);
   – control and communication functions;
   – mechanical and electrical interface (e.g. coupling, sockets, plugs, mounting arrangements);
2) economic criteria:
   – cost versus lifetime (life cycle cost analysis);
3) contractual criteria:
   – contractual quality of service.

If the operator proposes the replacement of a piece of equipment, the owner shall decide what action is to be taken.

6.2.5.2 Replacing equipment

During the replacement of equipment, the following points should be considered:

a) before replacing an item of equipment, it is essential to disconnect it from all sources of power. In very small systems, this may lead to the shut-down of the whole system and thus service technicians will need to be trained in handling all parts of the system. In larger systems, service staff should be able to isolate items from the remaining system without having to shut down the whole system. The system documentation mentioned in IEC TS 62257-4 should be checked to ensure this is possible;

b) before removing equipment, a backup of all logged data, parameter settings, status memories and hardware settings (e.g. by jumpers, switches, potentiometers, etc.) should be carried out. If this can't be done via an electrical interface, it should be performed by noting all reachable data found in display menus and by checking internal switches, settable devices, etc. All the latest settings should be identified and recorded. The recording of configurable parts inside the device should only be done after the device has been properly disconnected from the system;

c) brand, model, type and serial number data from the original and replacement equipment shall be identified and recorded;

d) after any new device is installed, the hardware configuration (if provided) shall be carried out in accordance with the records as previously made. For devices controlled by software, the software configuration (if provided) shall be installed as previously recorded. Quite often devices will have to be partly connected to the system for this purpose. The instructions given in the manufacturer's technical documentation should be followed. If equipment is not identical, it is the responsibility of the service technician to configure the new equipment properly and record the settings;

e) after being correctly configured and installed into the system, as required in the manufacturer's instructions, an acceptance procedure, as defined in the appropriate technical specification (IEC TS 62257-7, IEC TS 62257-8-1 and IEC TS 62257-9-XX), shall be performed;

f) the replacement of a specific component may require system level acceptance testing to ensure proper system operation;

g) environmental issues criteria need to be adhered to for the proper disposal of removed equipment (e.g. proper disposal of sulphuric acid from replaced batteries).

Bibliography

IEC TS 62257-5, *Recommendations for renewable energy and hybrid systems for rural electrification – Part 5: Protection against electrical hazards*

___

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

3, rue de Varembé
PO Box 131
CH-1211 Geneva 20
Switzerland

Tel: + 41 22 919 02 11
Fax: + 41 22 919 03 00
info@iec.ch
www.iec.ch