COCIR SELF-REGULATORY INITIATIVE FOR MEDICAL IMAGING EQUIPMENT

X-RAY EQUIPMENT MEASUREMENT OF ENERGY CONSUMPTION 2014

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COCIR
SUSTAINABLE COMPETENCE IN ADVANCING HEALTHCARE

European Coordination Committee of the Radiological, Electromedical and Healthcare IT Industry

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1. INTRODUCTION

The Energy-related Products (Ecodesign) Directive, 2009/125/CE, enables the European Commission (EC) to set Ecodesign requirements through new regulations for any group of products which uses energy or is related to energy consumption. In 2007, Medical Devices were identified as a "Priority A" product group by the European Commission for future regulation.

COCIR Companies presented in 2009 a Self-regulatory Initiative for Medical Imaging Equipment, driven by the Ecodesign Steering Committee, committing to improve the environmental performances of their products.

As the Steering Committee has done for magnetic resonance and computed tomography, a working group was formed to determine a measurement methodology and ecodesign goals for x-ray.

The outcome is an agreed upon procedure for measuring typical energy consumption of X-ray equipment. This procedure defines specific states of system operation and instructions for determining a set of scanning protocols to be analysed.

2. SCOPE

This methodology can be used to measure all X-ray systems. Equipment and accessories beyond a basic X-ray product and not required for a basic scan, or customer-provided equipment, are outside the scope of this procedure.

The methodology is not suited for the measurement of technologies combining X-ray with other imaging modalities.

3. DEFINITIONS

12h day-time: time from 7 am to 7 pm.

12h night-time: time from 7 pm to 7 am.

Energy: The capacity to do work. In this document, the unit of energy is kilowatthours (kWh).

Power: The rate at which energy is generated or consumed. In this document, the unit of power is kilowatt (kW).

Procedure Type: An examination is the collection of a scan for an individual patient. "Procedure Type" refers to an exam for a specific anatomy or type of exam. (e.g. Abdomen or Vascular).

Off mode: The system is shut down, AC mains off, according to the user manual. The system consumes no energy.

Low-power: The system functions into the minimum energy consumption state that the user can select according to the user manual.

Ready-to-scan: A state of the system when fully powered and ready to acquire image.

Scan mode: A state of the system during scans. This mode includes tube rotor rotation, x-ray generation and generation of image.

4. SYSTEM POWER MODES

The operation modes are defined as "Off", "Low power", "Ready-to-scan", and "Scan". The energy consumption differs between the modes and the transition between modes occurs by operator selection.

The anticipated power of these modes, from high to low, is:

Scan* > *Ready-to-scan* > *Low power* > *Off

The table below shows a possible state transition order, for an X-ray system.

Initial State	Transition To	Method
Off / Low-power	**Ready-to-scan**	Operator starts system
Ready-to-scan	**Scan**	Operator starts a scan
Scan	**Ready-to-scan**	Scanning completes
Ready-to-scan	**Off / Low Power**	Operator selection

5. USE MODES OVERVIEW

Typical daily system operation is set as follows:

Time period	Mode	Duration
12h night-time	**Off or Low Power**	12 hours
12h day-time	**Ready-to-scan**	12 hours
12h day-time	**Scan**	Minutes

The typical daily energy consumption of an X-ray system is the sum of the energy consumption for each of the two time periods.
Time in scanning mode is irrelevant on a daily basis as it can account for a few seconds in most modalities. The associated energy consumption has been estimated to be around 4% for energy intensive sub-modalities such as interventional systems.

This methodology does not consider the energy consumed in scan mode as it can be considered irrelevant compared to the daily energy usage in the other modes.

6. RESOURCES FOR MEASUREMENT PROCEDURE

The following personnel are recommended:

- An engineer or technician familiar with the power distribution of the system and power electronics safety.
- An engineer or applications specialist familiar with system operation.

7. UNIT UNDER TEST (UUT)

System Voltage: The system should be installed according to the manufacturer's installation instructions at an input voltage of 380-415 VAC.

Installation: The system shall be installed and calibrated according to its specification, including all system-critical items needed to perform a basic scan, e.g. x-ray generator and tube, required electronics such power supplies, controllers, console/computer, and patient table.

Any equipment and accessories beyond the basic product offering that is not required for a basic scan shall not be included in the measurement.

Environmental Conditions: The measurements are to be taken at a steady-state operating temperature within manufacturer's specified ambient temperature and humidity limits.

Measurement: Prior to each mode's measurement, the equipment shall remain in that mode for sufficient time to allow temperature and other pertinent transient conditions to stabilize.

8. POWER MEASUREMENT DEVICE

The measurements shall be recorded using a device capable of measuring 3-phase voltage and current, and calculating the integral of power with respect to time (energy) or a power meter able to sample average power ratings.

The power measurement device shall be installed onto the input to the AC Mains disconnect panel of the system to ensure that all energy consumption of the X-ray equipment is captured, including any cooling equipment provided by the X-ray supplier as part of the base system.

9. MEASUREMENT OF POWER

The power measurement of different system states described in the following sections shall finally allow calculating the complete 24h power consumption according to formulas in chapter 10.

9.1. LOW-POWER POWER MEASUREMENT

1) Switch the system to Low-power mode according to the user manual.
2) Wait to ensure that all system elements have established a static low-power power operation
3) Start the power measurement on the measurement device. Continue the measurement to include possible cyclical variation in the power

Record the power consumption in low-power state.

9.2. READY-TO-SCAN POWER MEASUREMENT

1) Switch the system to ready-to-scan mode according to the user manual.
2) Allow the system to stabilize in ready-to-scan mode
3) Start the power measurement on the measurement device.

Record the power consumption in ready-to-scan mode

10. ENERGY CONSUMPTION CALCULATION

The 24h energy consumption has to be calculated out of the measured power and energy consumption of the different system states and transitions, with the following formula for the 3 scenarios:

Scenario-Off: The X-ray scanner is in Off mode for 12h during night time

$$\mathbf{E_{tot} = P_{off} \times 12h + P_{ready} \times 12h}$$

Scenario Low : The X-ray scanner is in low-power mode during 12h night time

$$\mathbf{E_{tot} = P_{lowpower} \times 12h + P_{idle} \times 12h}$$

Scenario-ready-to-scan: The X-ray scanner is in ready-to-scan mode for 24h as it is never switched to off or low-power modes.

$$\mathbf{E_{tot} = P_{ready} \times 24h}$$