I.3. METHODS FOR IMPROVEMENT OF SOME PARAMETERS OF MEDICAL X-RAY DIAGNOSTIC EQUIPMENT. BASIC FAULTS IN SELECTION OF APPROPRIATE NEW OR USED UNITS.

M. Tonev, N. Danev, B. Constantinov
Medicom 2000 Ltd, Sofia, Bulgaria

It's well known that the use of X-ray equipment in medicine is a large field that allows wide range of diagnostic and therapeutic's methods. What is special here is the equipment's and spare parts relatively high price, its huge size, and the complicated and costly installation. For a high quality maintenance the service personnel should be qualified as well as in electronics and in electrical and mechanical engineering. The other peculiarity is the licensing of the equipment and considerably longer average period of amortization. These entire factors make choosing, buying, designing and licensing procedures complicated.

Now when the health system grows, the X-ray equipment demand of the new and already existing health institutions has increased many times more. In many cases they don't have enough information and specialists to choose the right X-ray equipment for their need. The mistakes made can be summed up to two groups. The first group has a purely medical aspect and is connected to a lack of compatibility between the chosen equipment and the application it's meant for. The second group refers to the technical aspects of the chosen equipment.

When in the first group the mistakes that can be made more or less due to the unclear perspective for the methods that will be used, the specifics of the health institution surely has to be taken notice of.

The second group is not widely known and creates the major problems in purchasing the X-ray equipment. The medical physicist who knows well both fields should be one of the consultants on choosing X-ray equipment and accessories. Unfortunately we still have very little, if any, high qualified physicists in the X-ray diagnostics field. The complexity in determining the requirements which the delivered X-ray units, new or used, have to meet, imposes the participation of radiologists, medical physicists and X-ray engineers. In this way, after a consultation with highly qualified health institutions, having the necessary experience and highly qualified specialists the mistakes on choosing can be avoided. Another common mistake is that, due to financial reasons, some essential elements and accessories, the companies offer as an option, are not delivered.

The second group, hides big danger, including the fact that although the licensing, many importers provide equipment not corresponding to the European and Bulgarian normes. That's the reason for the second group to be of interest for a thorough analysis. Parts of this analysis are the circumstances in which the purchasing is performed. Due to the license rate, the purchasing is made with offering types which sometimes don't correspond to the actual parameters.

A special consideration should be taken in when used equipment is purchased. In rare cases only, the importer performs the de-installation himself. Practically he doesn't know the technical condition of the unit and cannot control the de-installation process. Theoretically this control should be performed over the documentation of the imported equipment, which needs to possess the requisite certificates verifying its technical condition. That's just a good wish. The reason is that most of the parameters of the X-ray unit are too discrete and can be controlled with specialized equipment only, that the ones who perform the de-installation, usually don't have. In many cases the purchased X-ray equipment has spent several years in a warehouse and practically no information can be given about it. Still the law does not make the importer to certify the correspondence between the imported equipment and the legal

requirements. Generally the actual condition of the x-ray unit cannot be found out, before installation and the results of the starting tests. The certificates required at present, that the unit has been corresponding to the European standards, practically does not guarantee its real performance.

The factors determining the quality and performance of a **conventional radiographic and fluoroscopic X-ray unit** to purchase can be separated in two major groups. The first one can include:

X-ray tube - the number of the exposures (or the total exposure time) made and the real amortization are parameters that are very difficult to assess. Of course there are parameters, as the size of the focus, that can be controlled after the X-ray tube is set to work. Even a new tube is hard to be defined about its life span. Very often for new tubes a proportional guarantee is given. It is reasonable in a contract for purchasing a used X-ray tube a guarantee to be given not only about its physical working order, but also that during the whole period of the guarantee its parameters will conform to the requirements

*Automat*ic e*xposure control (AEC) - v*ery often the *AEC* is in non-working condition and this contradicts the regulations. Its restoring is obligatory, although often requires replacement of defect measuring chambers, which costs a lot.

kV rate - this parameter is of high importance to reach the needed diagnostics value or the necessary therapeutic effect. This parameter also cannot be controlled by the importer and controlling and adjustments can be made only after the unit is set in working condition.

Dose - most of the imported equipment has a dose control device in a direct or indirect way (with mAs). Importers as well as purchasers should be aware of such a requirement, approved by our law regulation. It's a strict requirement, directly connected with patient’s protection against unnecessary and over exposure.

TV image. - it concerns diagnostics TV image. When importing unit equipped with a fluoroscopic TV system, it should be taken into consideration that amortization is not as much connected to the intensity of exploitation as to the date of manufacture. Usually these are not digital TV, but are equipped with vacuum image intensifiers and TV cameras with vacuum receiving tubes. When the photocathode technology of the image intensifier is based on CeJ, usually there are no problems with image brightness reduction and other processes due to aging. With the CaS ones, in time, there is, so called poisoning of the photocathode, due to which, there is a reduction of the image brightness (light emission intensity). The longer such an image intensifier stays, especially without exploitation, the more is the negative effect. Aging of the CeJ photocathode is practically reduced to minimum. There are others specialties especially crucial - if an Image intensifier has stayed a long time without using - it is obligatory to be put under geter procedure. During the period of not using, the number of the free ions in the image intensifier balloon increases and if it is plugged to a nominal high voltage, usually the poisoning of the photocathode is a fact. Direct sign of it is the luminance brightness reduction and resolution deterioration. The TV camera for the fluoroscopy X-ray TV can be equipped with a "fast" or "slow" transmitter tube (vidicon). The "fast" is the one that can reproduce on the TV screen the fast changes of the shadow image situation. The "slow" vidicons and respectively TV's are inappropriate to trace fast changing processes due to the so called dynamic image sharp less effect.

Tomo attachment - practically, with the introduction of the computer tomography, one can say the need for this attachment reduces. It's not especially necessary the completing of the X-ray unit with such a system.

These were ones of the basic aspects of the conventional X-ray equipment. What about the **special X-ray units?**

Lets start with one of them, that lately is a leader in the list of the X-ray diagnostics of nearly every health department equipped with a full range of X-ray diagnostics. This is the **X-ray computer tomograph (CT).** Intentionally we'll skip the medical aspects of the query, which are subject of treatment by the X-ray methods specialists. Here the mistakes made on purchasing, definitely have unpleasant financial consequences and limit the possibility for optimal application. The usual questions arising on purchasing are: spiral or non spiral, fast or standard, with crystal or gas detectors, with two, four or six millions heat units, gantry opening - big or small, laser printer or multi-format camera, which software products, multi-slice etc.. The professional approach in these cases is to provide independent consultants in both fields - medical and technical. Nevertheless we can say CT is a very dynamically developing and equally fast aging system, where the criteria is that the medical requirements are met satisfactorily on a possibly lowest price with high reliability. The present analysis does not aim comparing different manufacturers, based on that criterion. Usually the service personnel can give quite precise assessment to such a comparison.

Angiographic X-ray equipment - are seldom of interest to some large health institutions. The reason is the necessity of a structure in the institution securing the angiographic examinations. When these examinations have a routine nature it is advisable to use angiographs based on C-arm support construction. They are mobile and favorable concerning the price. The classical stationary angiographic type is very seldom purchased, usually by the very big health institutions. In these cases precising the medical and technical requirements of the unit is a complicated procedure needing the participation of very good specialists, mastering medical and technical specifics of this kind of equipment.

Mammographic X-ray equipment - with this kind of equipment of utmost importance is the size of the focal spot: small structures (e.g. micro-calcifications) should be visualized. This is the reason for the requirement that the focal spot should not be bigger than 0,4 mm^2 . It is desirable for the x-ray tube to be dual focus 0,1/0,3 mm^2 or 0,1/0,4 mm^2 . Because these units are very often used in screening examinations, the x-ray tubes should also have a high heat capacity. It is desirable that there is an automatic decompression and adjustment of the automatic compression. The AEC device is absolutely obligatory.

Densitometric X-ray equipment - it's accepted more difficult because of the competitive echo graphic densitometric diagnostics. The high price and expensive service limits it's purchasing. There are also software versions, which with a good scanner and computer can quite successfully diagnose ordinary x-ray pictures, made by the conventional x-ray units. The not so high price of the used densitometrical equipment in most cases shows an x-ray tube with exhausted resources.

Dental x-ray equipment - represented by two major types of units. One of them is for sector pictures. Institutions usually purchase new equipment. The reason is the low price and the guarantee. When there are used units, it's hard to predict the price and the possibility for repairing. Especially problematical are the cases when the x-ray tube or HV transformer, are broken. The other type is the panoramic unit. There are much more often cases of purchasing used units, which are financially more advantageous. What should be known especially is that the focusing of the older units cannot be performed precisely. It results in this that the front or the rear teeth are not well focused e.g. are smeared in the picture.

With the dental equipment, the practical entering of the digitalization is going faster. The reason is the lower price and the quick pay off, due to big exploitation. It's very important on purchasing a sector unit, to ensure the timer has the short timings (app. 1 sec.), so that a digitalization can be used.

There is equipment for **imaging diagnostics of a non X-ray type** that is widely used in this field, along with the X-ray equipment. We'll try and add a very short analysis for them.

Magnetic resonance MRI - these equipment**,** although cautiously, enters in the health structure as an inseparable part of the imaging diagnostics. Very often the owners of the medical institutions try to solve the dilemma (of course, due to financial problems) weather to purchase a CT or MRI. We should note, these are two units complementing and not contradicting one to another. Of course, the best solution is to have both systems, but solving the dilemma, when such a purchase is impossible, should be based on the real medical requirements, concerning the specifics of the medical institution. There are two major MRI groups on the market, in respect to their medical application. One is MRI for the whole body, and the other one is for extremities. Another separation of MRI is in respect of the unit's construction. One group is with permanent (restrictive) magnets. The other one is using gas filling. The second group can be found more often, although the maintenance expenses are considerably bigger. It's very important to precisely define what is the real necessity of the medical institution, of coarse, taking into consideration its' financial potential. MRI for the whole body should have a faraday's cage and this is also big expense. MRI for extremities is without faraday's cage. The power of the MRI should be précised also very carefully. This is because with the raise of the power of the unit the price raises faster.

The above made analysis claims neither for completeness nor for pedantic precision. It aims to give certain directions for the method one should adopt on choosing and purchasing X-ray equipment. Also one should take into consideration the new Health law that will start working and the Regulation for the radiation protection of persons undergoing medical examination or treatment. The originated problems can be solved with close cooperation between radiologists, medical physicists and x-ray engineers.