

What is the Radiotherapy Quality Control Program (PQRT) of the National Cancer Institute – Rio de Janeiro/Brazil?

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Abstract

The National Cancer Institute (*INCA*) Quality Program in Radiotherapy (*PQRT*) started in 1999 as a 3 years pilot program with only 33 participant institutions. Due to its positive results, it has been integrated to the permanent *INCA* programs and its activities extended to all the radiotherapy services where patients from the National Health System (*SUS*) are treated. They are about 150 services (90% of all the available Brazilian radiotherapy services). The *PQRT* activities objective is to allow that radiotherapeutic treatments can be carried out just like planned, according to international quality and safety standards. The *PQRT* main activities are: on-site quality control audits, postal TLD audits in reference and non-reference conditions, training and development of research projects. The on-site quality control audits have already evaluated 75 teletherapy units (37 Co-60 and 38 linear accelerators), performing dosimetric, electrical, mechanical and safety tests. The Postal TLD audits used, till 2002, for the 33 participants, the International Atomic Energy Agency (IAEA) system for reference conditions. Five audits have been performed with this simple system. Since 2003, the *PQRT* postal TLD audit program is using its own system, developed for reference and non-reference conditions. This new system has been already applied to 58 beams (18 Co-60 and 40 linacs). In total, in reference conditions, *PQRT* has performed 400 audits in reference conditions (190 Co-60 and 210 linacs). Eighteen courses attended to the participants, covering their main practical problems. In parallel, some research studies have been carried out.

1. INTRODUCTION

It's a national program, free cost for the participants, to stimulate and to promote actions and conditions for the application of radiotherapy with quality and efficiency. It started in 1999 as a 3 years pilot program, covering 33 philanthropic institutions distributed over 19 Brazilian states. Since 2002, due to its positive results, it has been integrated to the permanent programs of the National Cancer Institute and its activities extended to all the radiotherapy centers that attend to patients of the National Health System (*SUS*). They are about 150 centers (90% of all the available services) over all the Brazilian states.

All the activities and measurements developed by the PQRT have main objective to allow that the radiotherapeutic treatments can be carried out just as they have been planned, according to the international quality and safety standards. It's important to be sure that the prescribed dose has been actually delivered to the target tumor volume with a minimum dose to the healthy neighbor tissues.

The main activities of the PQRT are: **on-site quality control audits, postal TLD audit in reference and non-reference conditions, training and development of research projects.**

2. ON-SITE QUALITY CONTROL

The **on-site quality control** evaluated 75 beams from teletherapy treatment units (37 Co-60 and 38 linear accelerators). We performed dosimetrical [1], electrical, mechanical and safety tests [2]. As supposed, we found more problems among the old Co-60 machines than among the linear accelerators. As shown in figures 1, 2, and 3, the main problems found in the **Co-60** units were related to: **field flatness (80%), filter factors (48%), lasers (35%)** and **collimator axis rotation (33%)**. In regard to the linear accelerators, we found problems related to: **field flatness (28%)** and **lasers alignment (27%)**. When possible, the problems are corrected during our visit. Those that need the maintenance group action should be corrected as soon as possible and communicated to us.

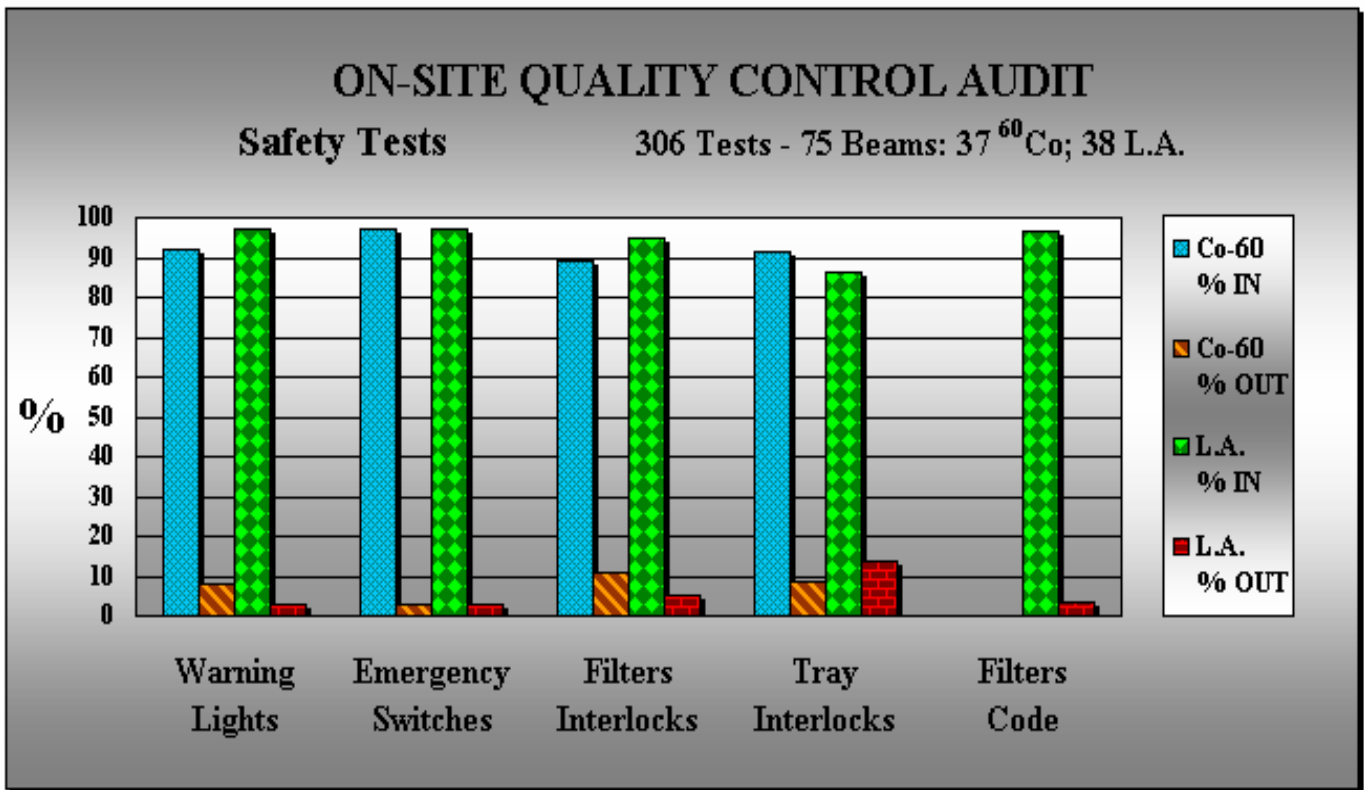


Figure 1: On-Site Quality Control - Safety Tests.

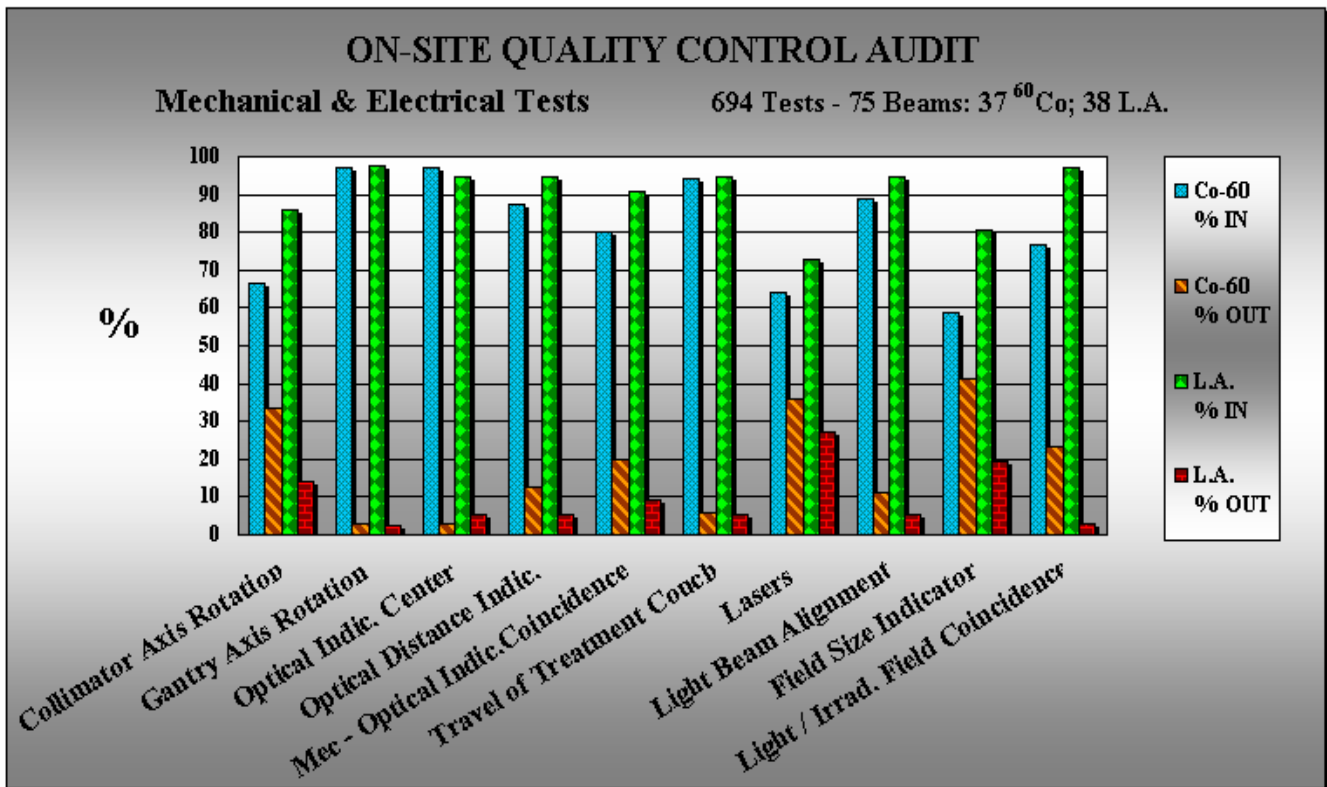


Figure 2: On-Site Quality Control - Mechanical and Electrical Tests.

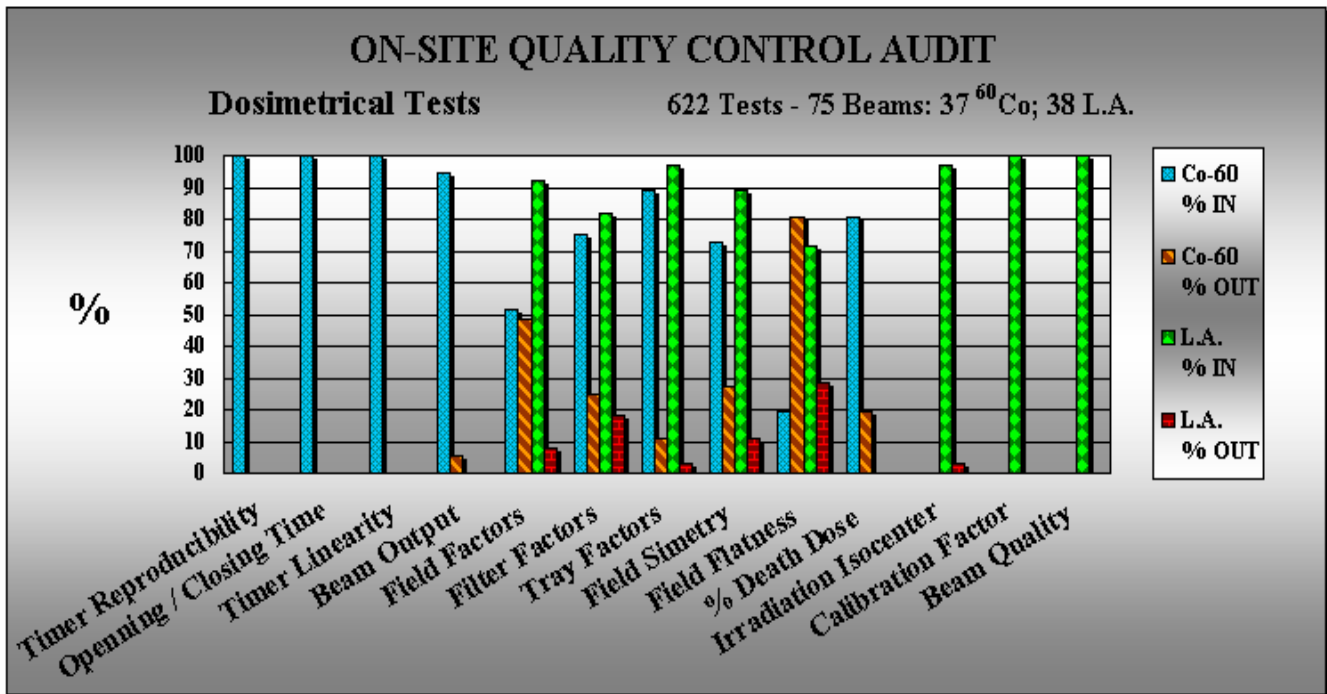


Figure 3: On-Site Quality Control - Dosimetical Tests.

3. POSTAL TLD AUDIT PROGRAM

The **postal TLD audit program** used till 2002, for the 33 participants institutions, has been the International Atomic Energy Agency system **for reference conditions** – Figure 4 – which evaluates only the dose at the reference point. The dose delivered to each TLD has been defined as 2 Gy.



Figure 4: IAEA TLD Postal System.



Figure 5: New PQRT TLD Postal System.

Our **postal TLD audit in non-reference conditions** [3] has been developed by ourselves – Figure 5 – and used since 2003, after its approval through many different tests. The new kit should be irradiated in a standard water phantom at SSD, according to our irradiation TLD protocol. The dose delivered to each TLD should be the same, that is, 2 Gy.

The new TLD postal system evaluates: **reference beam output, depth dose data, beam quality (for linacs only), beam output variations with field size, wedge and tray transmission factors, field flatness and symmetry.**

After five times with IAEA system and the first time with our system, we've already performed audits in 400 beams in reference conditions (190 Co-60 and 210 linacs). The results are shown in Figure 6. All the beams with deviations inside the investigation and emergency ranges have been reevaluated. A strong decrease in deviations can be seen from the 1st to the 2nd audit. The results of the following evaluations have shown that the problems regarding to the dose at the reference point have been solved and they stayed in between the acceptable limits.

In Figure 7 we can see the first results of the new system, applied to 58 beams (18 Co-60 and 40 linacs). The main problems found in the **Co-60** units were related to **field flatness (25%)** and, for linacs, **depth dose (18%)** and **field flatness (15%)**.

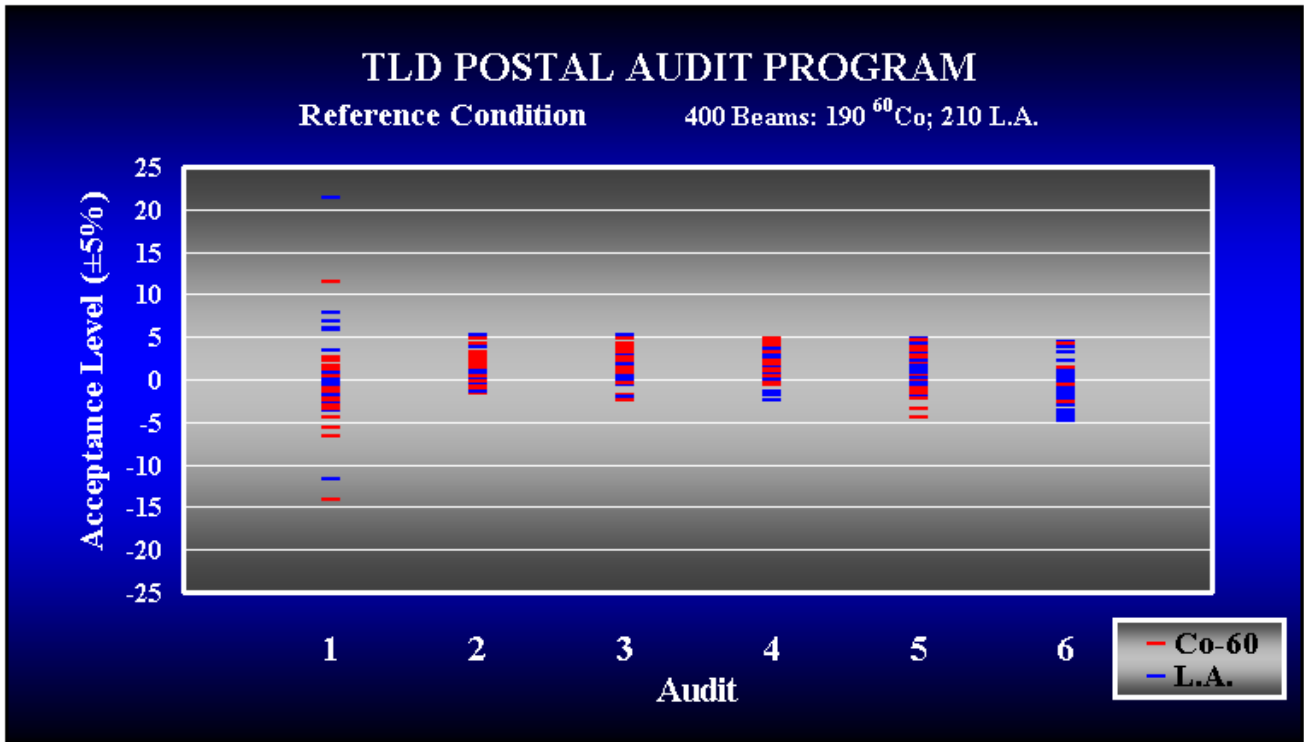


Figure 6 – TLD Postal Audits in Reference Conditions.

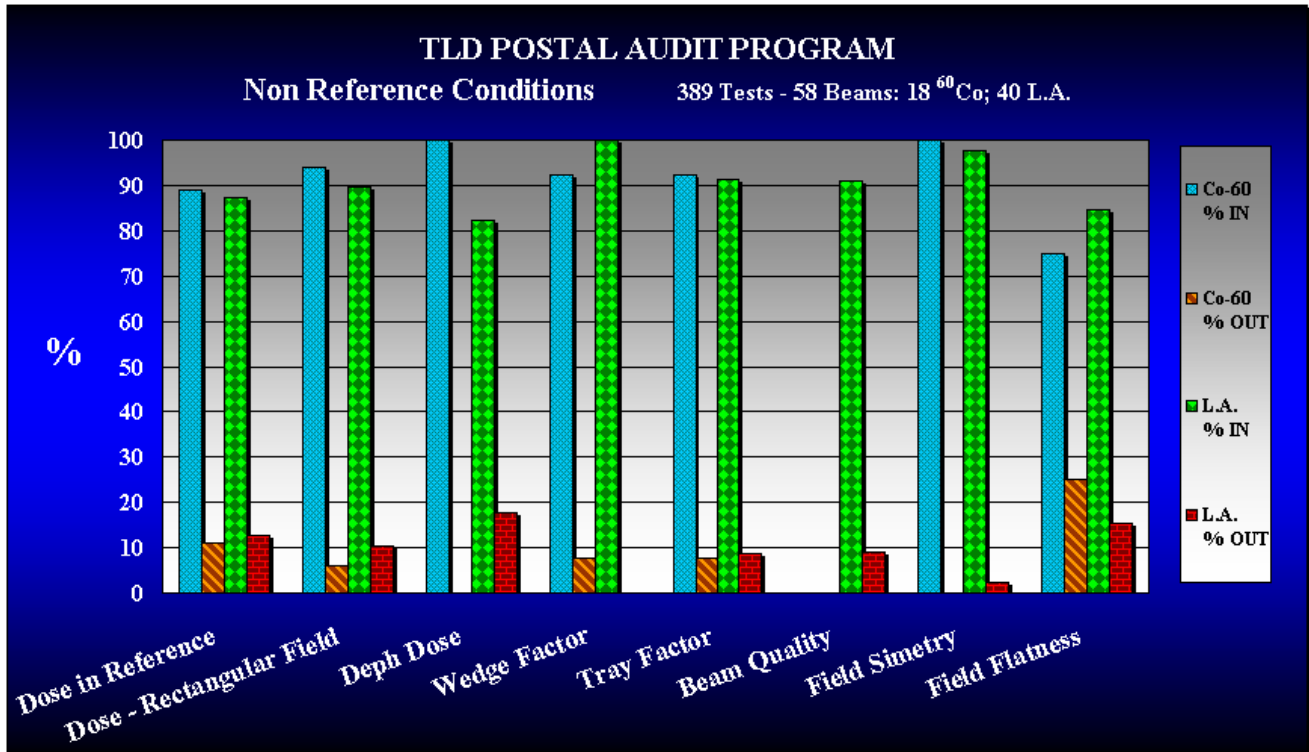


Figure 7 – TLD Postal Audits in Non Reference Conditions

4. TRAINING ACTIVITIES

Our training activities started on 2000 with a large spectrum courses for physicists, physicians and technicians. According to their necessities, the courses became more and more specialized covering specific subjects. The main courses have been:

- I Workshop on Radiotherapy
- II Workshop on Radiotherapy
- I Shielding in Radiotherapy – techniques and rules
- II Shielding in Radiotherapy – techniques and rules
- Recommendations on High Dose Rate Ir-192 Sources Calibration for Use in Brachytherapy
- 3 Refreshment Courses for Physicists in Radiotherapy
- 3 Refreshment Courses for Physicians in Radiotherapy
- 3 Refreshment Courses for Technicians in Radiotherapy
- Electron Beam Dosimetry
- Acceptance, Commissioning and Quality Control on Clinac 2100C Accelerators
- Practical Use of CadPlan and SomaVision Varian Treatment Planning Systems
- Refreshment Courses for Physicists Siemens Linear Accelerators Users

5. DEVELOPMENT OF RESEARCH PROJECTS

Besides the routine and training activities we have been advised some graduation and post graduation students and already produced:

- *Aplicação dos Detectores Semicondutores na Dosimetria in Vivo em Tratamento de Irradiação de Corpo Inteiro;*
- *Dosimetria in Vivo com Uso de Detectores Semicondutores e Termoluminescentes no Tratamento de Câncer de Cabeça e Pescoço;*
- *Desenvolvimento de um Sistema Dosimétrico Postal para Uso em Programas de Qualidade em Radioterapia Com Feixes de Fótons em Condições de Não-Referência;*

The following projects are in development:

- *Estudo das Propriedades Físicas do Filtro Dinâmico – Modulação Unidimensional*
- *Desenvolvimento de um Sistema Dosimétrico Postal para Feixes de Elétrons*
- Patient Dose Assessment for Quality Control in Radiotherapy in Brazil (together with IRD and supported by IAEA)

6. CONCLUSIONS

Through the on-site quality control evaluations, we could see that is not usual nowadays to find a Co-60 unit without any operational problem, since they are already old. They have been replaced by linear accelerators in all the radiotherapeutic centers in Brazil. But also for these linear accelerators, our on-site audit program has proved to be very useful, has shown in the results. Many conceptual errors have been found, explained and corrected during these visits. They give

to the local staff the chance to clear doubts, discuss results and intercompare dosimetric equipments. If possible, they should be done once a year, but no less than each two years. The TLD postal audit program is an important complement of the on-site audits. Through it we can keep control on the main operational parameters when we have a large number of equipments and/or large distances to be covered, like in Brazil. The results of the TLD postal system developed by us have shown a very good agreement with the results of the on-site evaluations. Considering also its low costs, it is very useful to cover the interval in between the on-site evaluations.

REFERENCES

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2. International Atomic Energy Agency, *Aspectos Físicos de la Garantía de Calidad en Radioterapia: Protocolo de Control de Calidad*, IAEA, Viena, Austria (1999).
3. Viamonte M., Alfredo, *Desenvolvimento de um Sistema Dosimétrico Postal para Uso em Programas de Qualidade em Radioterapia Com Feixes de Fótons em Condições de Não-Referência*, Instituto de Radioproteção e Dosimetria - IRD, Rio de Janeiro, Brasil (2003).