HDR 1000 PLUS WELL CHAMBER

REF 90008

U S E R   M A N U A L

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General Precautions

Warnings and Cautions alert users to dangerous conditions that can occur if instructions in the manual are not obeyed. Warnings are conditions that can cause injury to the operator, while Cautions can cause damage to the equipment.

⚠ WARNING: Electrical shock hazard when connected to 300 V bias supply. Do not remove cover.

⚠ WARNING: This device must only be used with specific source holders designed and manufactured by Standard Imaging. Use of any other source holders may result in chamber damage, calibration errors, or patient and/or user hazards.

⚠ CAUTION: Proper use of this device depends on careful reading of all instructions and labels.

⚠ CAUTION: This device should never be submerged to clean or scrubbed with an abrasive cleaner. Do not sterilize.

⚠ CAUTION: Do not drop, mishandle, or disassemble unit since it may result in change of calibration factor. Refer all servicing to qualified individuals.

⚠ CAUTION: Do not sharply bend triax cable. Damage to the cable may result in high leakage currents.

⚠ CAUTION: Ensure source freely moves within secured catheter. Proper location of source is necessary to assure proper calibration.

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1 Overview

The Standard Imaging HDR 1000 Plus Well Chamber is specifically designed for use with both the brachytherapy high-dose-rate (HDR) remote afterloading irradiators and low-dose-rate (LDR) brachytherapy sources, with the appropriate calibration. It is recommended that the chamber be calibrated every two years as is standard practice for other ion chambers. Initially, the calibration factor is given in the calibration report from the Accredited Dosimetry Calibration Laboratory (ADCL). The appendix provided with the calibration report discusses the calibration factors in greater detail. Calibration factors should be obtained from an ADCL for each brachytherapy source that is being measured. The ionization current expected from the HDR 1000 Plus is ap-proximately 8.7 nA/Ci for HDR brachytherapy sources. Thus, the measurement of all brachytherapy sources requires an electrometer with a calibrated scale for measuring currents in the appropriate range (see specifications section of this manual for typical sensitivities). Alternatively, a calibrated charge scale may be used with timed runs. If integral charge techniques are used with the time determined by the HDR irradiator timer, the contribution from the source transit-time should be taken into account.

For LDR sources, typical readings are 1 pA or less. An electrometer with a lower sensitivity of 1 fA is best for signal to noise considerations.

The HDR afterloading technique minimizes potential radiation exposure to medical personnel and permits brachytherapy treatments in a shorter time period. Calibration of all brachytherapy sources with well chambers is important. When a brachytherapy source with a high dose rate is used, it is imperative that there be an accurate and reliable calibration of the source strength by means of a suitable chamber, such as the HDR 1000 Plus. The initial activity of the ^{192}Ir sources for high dose rate brachytherapy applications is typically around 10 curies (Ci), or 370 gigabecquerels (GBq). The half-life of ^{192}Ir is 73.83 days. Therefore, frequent (usually quarterly) source replacements are required. These sources must be calibrated when placed in use and should be checked periodically during use. Suppliers of sources usually provide calibration certificates that can have an uncertainty of ±10%, necessitating an independent calibration for better accuracy. This point is ad-dressed in the article published in Int. J. Radiat. Oncol. Biol. Phys. <u>24:</u> 167-170 (1992) and Chapter 5 of High Dose Rate Brachytherapy: A Textbook, ed. S. Nag. Calibration methods for HDR sources using methods other than the HDR 1000 Plus well-type chamber can be complicated, time-consuming and prone to error. The HDR 1000 Plus is convenient for frequent use, since the time required for calibration is only a fraction of that required for thimble ion chamber techniques. A recommended calibration technique is given in Med. Phys. <u>18:</u> 462-467 (1991).

Please note that the factors that are used in the calibration of these chambers are the most current, and in some cases, may be different than those used in HDR treatment planning computers. This difference, if present, should be accounted for during your treatment planning activities. To avoid confusion, the American Association of Physicists in Medicine has recommended that air kerma calibrations be used for brachytherapy sources (AAPM Reports No. 41 and 21) instead of source activity.

2 Constancy Check

Regular constancy checks should be performed by using a procedure such as the following. The source holder may be removed to allow the stability of the HDR 1000 to be checked by means of a constancy check source, e.g. using a low dose rate brachytherapy check source. Alternatively, the stability can be monitored with the use of an external ^{60}Co beam. This value should be obtained upon receipt of the chamber and monitored for consistency there-after. Either place the chamber in the ^{60}Co beam at a known distance with a standard field, such as 10 cm x 10 cm, or place the check source in a reproducible position and take a current reading. A graph of the response corrected for decay should re-main within +/-0.5%.

Another acceptable method for these checks is a redundancy check or inter-comparison with one or two other chambers on the same source in the same time period. In particular, having two or three chambers that have been calibrated at an ADCL, which then would be used to measure the same source within a short time period is acceptable. If necessary, account should be made for decay. Either the same electrometer for each chamber or independent dosimetry systems can be used for this exercise applying the calibration factors for each. The chambers or the systems, whether at a given center or from a neighboring center, should be used at the same time and a ratio of results kept. This method is reliant upon the stability of the systems with respect to each other. We do not suggest comparison with a farmer chamber because set up problems can cause questionable results.

3 Calibration

As is standard practice for other ion chambers, it is recommended that the HDR 1000 Plus be calibrated every 2 years. This calibration should be performed by an Accredited Dosimetry Calibration Laboratory. Standard Imaging offers calibrations from the University of Wisconsin Accredited Dosimetry Calibration Laboratory. You need only one purchase order to cover calibrations, shipping and handling, and service. Standard Imaging hand carries all instruments to and from the ADCL.

4 Procedures for Well Chamber Measurements

The following procedures should be used any time that measurements are to be made with a well chamber and electrometer system. This applies only to the setup of the well chamber and electrometer, not to the setup of the ionization source.

1. With nothing connected to the input jack of the electrometer, turn the power on and wait at least 10 minutes for warm up.

2. Verify the leakage of the electrometer is within the manufacturer's stated acceptable limits.

3. Connect the well chamber to the electrometer and apply 100% voltage bias.

4. Allow the electrometer and the well chamber system at least 10 minutes to stabilize, making certain that all cabling is lying flat and unkinked.

5. Verify the leakage of the well chamber is within the manufacturer's stated acceptable limits.

6. Some electrometers, such as the Standard Imaging MAX 4000 Electrometer, allow the user to zero the device at any time. If desired, perform this system zeroing now.

7. Check the system leakage. Take a reading without exposing the chamber to radiation. This reading should be less than 0.1% of the final signal expected.

8. Measure the atmospheric temperature and pressure.

9. Turn on or insert the radiation source(s) and take at least 3 measurements. Generally, the measurements should not be moving in only one direction (i.e. three readings that continue to drop and hence may not yet be stabilized).

10. Analyze the data taking into account the average of the readings, system leakage, temperature/pressure corrections (see page 6), calibration factors and any other appropriate corrections to be made. The following equation can be used:

$$S_K = M_{raw} * C_{TP} * C_E * N_{SK}$$

4.1 Where:

S_K = the air kerma strength of the source in U

M_{raw} = the reading in A (if current scale) or in C/s (if charge scale measured for a set time in s)

C_{TP} = the temperature and pressure correction factor

C_E = the calibration factor for the electrometer scale

N_{SK} = the HDR 1000 Plus calibration coefficient (in this case the air kerma strength calibration factor)

NOTE: S_K can be divided by A_{ion} if desired to correct for recombination effects. Since the HDR 1000 Plus has an A_{ion} of 1.000, this is not necessary.

11. When all measurements are completed, set bias voltage to 0VDC, turn off the electrometer and disconnect the well chamber.

5 Well Chamber Response as a Function of Pressure

Calibration factors provided by an ADCL are corrected to standard temperature and pressure (STP: 22 °C and 760 Torr), and a correction for air density via a temperature/pressure correction must be applied to clinical measurements to obtain the correct air kerma strength for the source. As with many other products, including other ion chambers, Standard Imaging well chambers may be affected by significant changes in pressure. This effect is linked to their vented design, which was incorporated to eliminate the risk of leak-related response problems associated with pressurized well chambers. For some sources significant decreases in ambient pressure can predictably affect well chamber response.

- With low-energy photon emitting brachytherapy sources, such as Pd-103 and I-125, predictable and linear decreases in response are seen. This difference in response becomes more significant and exceeds the calibration uncertainty with pressure decreases as seen at higher altitudes.
- With high-energy photon emitting brachytherapy sources, such as Cs-137 and Ir-192, and beta emitting brachytherapy sources, such as Sr-90 and P-32, there is little to no effect with pressure decreases as seen at higher altitudes.

The response differences for low-energy photon emitters[1] may be corrected by the use of an additional correction factor, beyond that provided on the calibration certificate from the ADCL and after normal application of the C_{TP} correction factor. The equation incorporating this additional correction factor C_A related to pressure (altitude related air density) is provided below, as are the required constants. No additional correction factor is required for high-ene rgy photon emitters and beta emitters.

$$\boldsymbol{M_{corr} = M_{raw} * C_{TP} * C_A}$$

$$M_{corr} = M_{raw} \times \left[\frac{273.15 + T(^\circ C)}{295.15} \times \frac{760}{P(Torr)}\right] \times \left[k_1 \times [P(Torr)]^{k_2}\right]$$

Low-Energy Photon Emitting Brachytherapy Source	k_1	k_2
Pd-103	0.0241	0.562

I-125 (with silver)	0.0490	0.455
I-125 (no silver)	0.0573	0.431

The cause of this low energy pressure effect involves a combination of the range of the electrons being on the order of the size of the air cavity itself and the consequences of backscatter from the aluminum walls of the chamber. This is further explained in reference 2 on the following page. The chamber volumes for energies this low are medium sized cavities. For SI chambers, the distance across the inner and outer active region of the well chambers is on the order of the range of electrons generated by the low-energy photons emitted. Thus, a large fraction of the generated electrons will stop in the active region. The apparent over response of the well chamber is caused by these terminating electrons because the CTP correction should not be applied to electrons that stop in the active region. This is a simplified explanation for a complex phenomenon. For a more detailed explanation see the Medical Physics papers referenced on the following page.

Standard Imaging, therefore, recommends the following:

- Compare the rated or labeled activity of the source with the air kerma strength measurements obtained with the well chamber during recommended periodic checks after appropriate corrections.
- When using a Standard Imaging well chamber with low-energy photon emitting brachytherapy sources at pressures significantly below 760 Torr, incorporate the additional correction factor related to pressure response differences, after normal application of the C_{TP} correction factor.

References

1. "The effect of ambient pressure on well chamber response: Experimental results with empirical correction factors". Medical Physics. 32(3):700-709, 2005

2. "The effect of ambient pressure on well chamber response: Monte Carlo calculated results for the HDR 1000 Plus". Medical Physics. 32(4):1103-1114, 2005

6 General Operation

The HDR 1000 Plus Well Chamber has a vent hole to maintain the internal air at ambient atmospheric pressure. Thus, the readings obtained must be corrected for ambient temperature and pressure to the temperature and pressure of calibration (22° C and 760 mm Hg) at "normal" relative humidity (50% ± 25% non-condensing) in the usual accepted manner. The HDR 1000 Plus has available different inserts for HDR measurements, including a quality assurance (QA) insert. Note that the QA insert can provide information for source positioning verification, timer accuracy and consistency of source activity for HDR applications. This tool is described in Med. Phys. 22: April 1995 and in a separate instruction manual. Contact Standard Imaging for further information. The inserts are designed so that the center of all sources is located at the most sensitive spot of the chamber. Figure 1 shows a typical axial response curve for the HDR 1000 Plus. There is only a 0.1% decrease in sensitivity within ± 5 mm of center.

The HDR 1000 Plus utilizes a conventional triax connector and cable to be connected to a suitable electrometer. A bias of 300 volts must be applied to the electrometer low-impedance connection relative to chassis ground. The voltage polarity effect is less than 0.1%. If desired, a second bias level of 150 volts can also be used to determine the ionic recombination loss at 300 V. [1] The ionic recombination loss is less than 0.05% and thus can be considered negligible. The chamber calibration refers to the positive and negative voltage average.

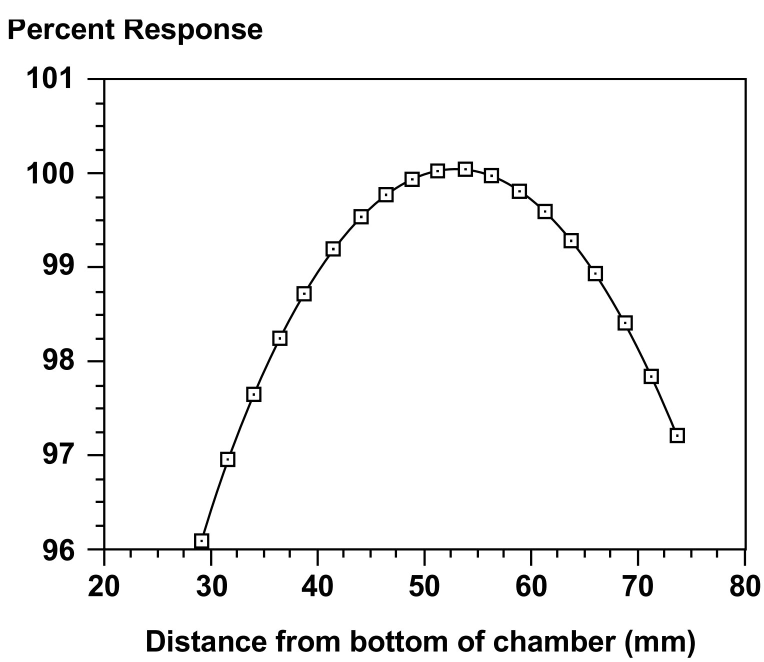


Figure 1: Typical axial response shown as a percent with distance from the bottom of the chamber.

The step by step procedure for measurement of HDR sources is given. The chamber should not be placed near a high scatter environment during measurements for the best accuracy; it should be located at least 25 cm from a wall or other high-scattering environment as

described in
Med. Phys. 19: 1311, 1992.

NOTE: Depending on altitude & seed type, the correction, C_A on page 7 may have to be applied. This note also affects the following source holders:

70016 Single LDR Seed Sources
70022 Seed Batch Assay Tool
70023 RAPID Strand® Iodine Seed Sources
70024 MICK® Cartridge Sources
70030 Nucletron selectSeed™ Sources
72307 Bard QuickLink®/Mick® Source Holder

[1] The equation used is $A_{ion} = 4/3 - (Q_1/3Q_2)$, where Q_1 is the charge or current measured at 300 V and Q_2 is the charge or current measured at 150 V. See Med. Phys. 11: 714 (1984).

7 Procedures for Specific Source Holders

7.1 70003 Cesium Remote Afterloading Sources

Insert the remote afterloading catheter into the source holder. Advance the cesium source to the bottom of the source holder. Retract the source to the most sensitive area of the well chamber to begin measurements following the steps outlined in *Procedures for Well Chamber Measurements*.

REF 7003

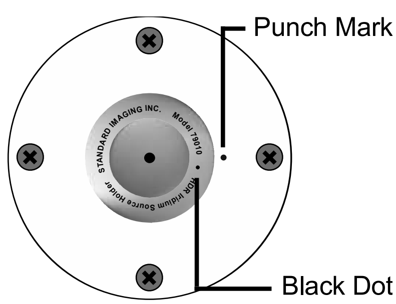
7.2 70010 HDR Iridium Sources

1. Place the HDR 1000 Plus chamber in the same room as the HDR unit for at least 30 minutes before the measurement to allow it to equilibrate to ambient temperature and pressure.

REF 70010

2. Connect the HDR 1000 Plus well chamber to a suitable electrometer, such as the MAX 4000 Plus or SuperMAX from Standard Imaging, and apply 300 V bias voltage, or the value and polarity indicated on your calibration certificate. Allow the system to stabilize for at least 10 min.

3. Connect a catheter, such as the endobronchial 6 French blue catheter, to the HDR irradiator.



4. Insert the Source Holder into the HDR 1000 Plus well chamber, and align the black dot on the Source Holder label with the punch mark on the body of the HDR 1000 Plus well chamber to ensure repeatable measurements. See image below.

5. Insert the catheter end to the bottom of Source Holder. The dead space at the catheter end must be known, so that the center of the ^{192}Ir source can be positioned at the most sensitive

position of the chamber. See Figure 1 for a typical axial response curve for the HDR 1000 Plus. Typically, the HDR 1000 Plus well chamber is calibrated about 50 mm up from the lowest point that a source can be driven into the Source Holder. This point is provided in the calibration report for each chamber. The chamber sensitivity decreases by approximately 0.1% when the source is moved up or down by 5 mm from that position.

6. Secure the catheter into the Source Holder by gently rotating the knurled catheter holding knob on the top of the Source Holder.

7. While observing all manufacturer-recommended safety procedures for the HDR irradiator, run the ^{192}Ir source to the calibration point of the well chamber for a minimum of 20 sec for current measurement or for a reproducible set time (1 min.) for charge measurement. If the charge mode is used and the charge is accumulated while the source is in transit, account for the transit time error of the source by making the standard timer end effect measurements as described in High Dose Rate Brachytherapy: A Text book, Nag, ed. Futura, 1994.

NOTE: This value will differ depending on the length of the catheter. The timer feature of the Standard Imaging MAX 4000 Plus (REF 90020) or SuperMAX (REF 90018) can be used to collect charge for set times and eliminate this effect.

8. Read and record the measured current or charge.

9. Use correction factors for temperature/pressure, electrometer correction factor (electrometer must be calibrated) and the ^{192}Ir HDR calibration factor given by the Accredited Dosimetry Calibration Laboratory for the HDR 1000 Plus to calculate the air kerma strength of the source.

7.3 70016 Single LDR Seed Sources

Insert an individual seed into the Teflon tube of the source holder. The source holder will place the seed at the most active area of the chamber. Take measurements following the steps outlined in *Procedures for Well Chamber Measurements*. A seed can be removed by taking the source holder out of the HDR 1000 Plus chamber and inverting. The Teflon tube will allow the seed to easily slide out. ADCL calibrations are available for LDR iridium, iodine and palladium seeds. ADCL calibrations are not available for gold.

REF 70016

7.4 70020 Cesium Sources

For ^{137}Cs calibrations, verify the plastic spacer inside the source holder insert is at the bottom of the source holder. Place the cesium source in the source holder for the measurement. Take measurements following the steps outlined in *Procedures for Well Chamber Measurements*.

7.5 70022 Seed Batch Assay Tool

The Source Holder for LDR Seed Batch Assay, REF 70022, is designed to hold up to 500 of low dose rate iodine or palladium seeds. The seeds to be measured are positioned at the most sensitive position on axis of the HDR 1000 Plus Well Chamber.

REF 70022

The purpose of this source holder is to enable physicists to sample a subset, typically 10%, of the large numbers of seeds often received for treatment of cancer. For example, if several treatments for prostate cancer are imminent, 50 to 200 seeds may be used per case.

To measure a number of seeds, place the desired number in the Source Holder for LDR Seed Batch Assay. Place the source holder in the HDR 1000 Plus Well Chamber. The seeds are centered at the most sensitive part of the chamber. A reading can be made with any standard electrometer. For consistency of measurements, and to save time, the Standard Imaging MAX 4000 Plus Electrometer can be set to collect charge for a user defined amount of time.

An explanation of how to perform sample measurements is explained very well in the reference "Verification of manufacturer-supplied ^{125}I and ^{103}Pd air-kerma strengths." Mellenberg and Kline; Medical Physics. 22(9):1495-1497, 1995. A thorough review of this article is recommended.

Correction factors for varying numbers of seeds need to be determined for either iodine or palladium, depending on which isotope is used. This is due to the self-absorption of the seeds in the source holder. Once determined these factors should remain constant. Thereafter a set number of seeds, i.e. 25, 50, 100, can be measured.

References

"Verification of manufacturer-supplied ^{125}I and ^{103}Pd air-kerma strengths". Mellenberg & Kline; Medical Physics. 22(9):1495-1497, 1995.

"Comprehensive QA for radiation oncology: Report of AAPM Radiation Therapy Committee Task Group 40". Medical Physics. 21(4):581-618, 1994.

7.6 70023 RAPID Strand® Iodine Seed Sources

The source holder for RAPID Strand Iodine Seeds is designed for QA measurements of the RAPID Strand 6711 Iodine Seeds prior to use. This insert works with the Standard Imaging HDR 1000 Plus Well Chamber only.

REF 70023

<u>NOTE</u>: To measure RAPID Strand seeds in the IVB 1000 Well Chamber, source holder REF 70048 is required.

The RAPID Strand Source Holder is constructed to simultaneously measure five seeds at one end of the RAPID Strand while the RAPID Strand remains in the spacing jig. The spacing jig is then inverted in the source holder and the five seeds at the other end are measured. This provides a QA check of the relative activity of the five seeds on each end of the RAPID Strand.

A RAPID Strand containing 10 iodine seeds was obtained and an extensive evaluation was performed with the HDR 1000 Plus and the RAPID Strand Source Holder 70023. Following the evaluation, individual seeds of the RAPID Strand were cut from the strand and individually calibrated. These measurements were compared to the initial, collective seed measurements of the intact RAPID Strand in Source Holder 70023 to obtain a correction factor.

The correction factor was found to be approximately 1.15 times the 6711 Iodine calibration factor from the University of Wisconsin Radiation Calibration Laboratory.

The RAPID Strand Source Holder, REF 70023, can be gas sterilized or steam sterilized (autoclaved).

To measure a RAPID Strand of iodine seeds, place the spacing jig, with the RAPID Strand in place, into the source holder. There is a plastic key on the bottom of the lead shielding to guide the spacing jig, so the seeds are in the center of the well chamber. There is no measurable rotational dependence. Record the measured activity. Invert the RAPID Strand

and take another measurement following the steps outlined in *Procedures for Well Chamber Measurements*.

A formula can be used to determine the average seed activity as a QA measurement of the sum of the activity of 5 seeds.

$$\text{Average Seed Activity} = \frac{(M_{raw} * N_{sk}' * C_{TP} * C_E)}{N}$$

Seed Activity = average seed activity as a QA measurement

M_{raw} = reading

N_{sk}'(correction factor) =

This combines both the calibration factor for one seed and a form factor (1.15) to account for the response curve of the HDR 1000 Plus Well Chamber. The correction factor is defined as 1.15 times the seed calibration factor for the seed in the HDR 1000 Plus. For example, for Iodine 6711 the N_{sk} = (1.15) x (2.6 x 10^{11} U/A) where the ADCL seed calibration factor is 2.6 x 10^{11} U/A.

N = number of seeds

C_{TP} = correction for temperature and pressure

C_E = electrometer calibration factor

Example:

If you receive a strand with a nominal or average activity of 0.3mGym^{2}h^{-1} per seed, the typical 5 seeds were measured, and the Iodine 6711 calibration factor of 2.6 x 10^{11} U/A is used.

Assume:

$$M_{raw} = 0.4957 \times 10^{-11} A \qquad C_{TP} = 1.014$$

$$N_{sk}' = (1.15)(2.6 \times 10^{11}) \qquad C_E = 0.998$$

$$N = 5$$

Seed Activity =

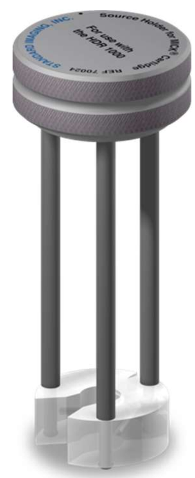
$$\frac{(0.4957 \times 10^{-11} A)(2.6 \times 10^{11})(1.15)(1.014)(0.998)}{5}$$

$$= 0.3 mGym^2h^{-1}$$

This average seed activity, as a QA measurement, can be compared to your expected RAPID Strand activity. Note, this is a QA measurement assuming the five seeds are the same activity.

7.7 70024 MICK® Cartridge Sources

This source holder provides a QA check of the activity of seeds loaded into a MICK® cartridge. It positions the cartridge for a quick, reproducible measurement. A spring-loaded clamp attachment easily grips the cartridge to minimize finger dose and allows quick insertion whether the Sterile Convenience Pack is used. It works with the traditional plastic cartridge, as well as the new shielded/disposable MICK® magazines.



REF 70024

As a service to our users, some brachytherapy seed correction factors have been determined with the help of the University of Wisconsin ADCL*.

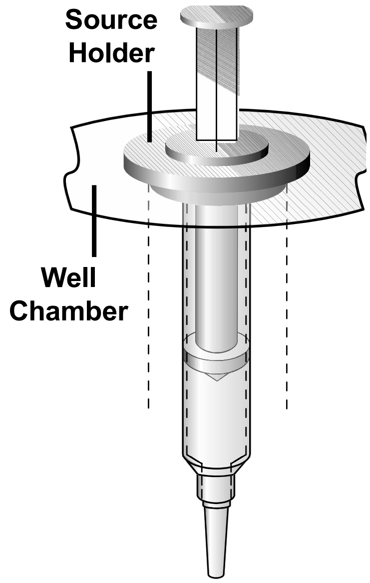
The collective seed measurements from this Source Holder were compared to the sum of the individual seeds measured in the Single Seed Source Holder, REF 70016, for Oncura 6711 and 6733 seeds in the sterile Convenience Pack. These measurements revealed the ratio or "correction factor" for either Oncura 6711 or 6733 seeds to be 1.59 in the traditional plastic cartridge (MICK catalog #7609-D), 1.69 in the brass shielded/disposable cartridge (MICK catalog #0216-DS, purchased before 3/23/06), or 1.75 in the newly designed brass shielded/disposable cartridge (MICK catalog #0216-DS, purchased after 3/23/06).

NOTE: These numbers differ from measurements taken with source holder 70047 for use with the IVB 1000 Well Chamber. Multiply this factor times the AAPM ADCL supplied single-seed air kerma strength calibration factor for that seed.

*Users should independently determine correction factors for each seed type used. See tech note 4638 "Multi-Seed MICK® Cartridge Assay Procedure."

7.8 70026 Syringe Holders

This source holder has been designed to provide a quick and convenient QA measurement of liquid sources in syringes. Simply place the appropriate source holder in the HDR 1000 Plus chamber for a measurement.



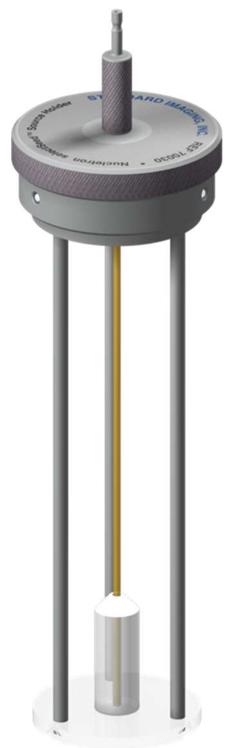
REF 70026

Source Holder 70026 for 5cc and 10cc Syringes, includes one set of two syringe holders, one for a 5cc syringe and one for a 10cc syringe.

Example:

For a Medastron source, a 4mCi dose in a 5cc syringe gives an approximate 3.3±0.1nC signal in 60 seconds. A 4mCi dose in a 10cc syringe gives an approximate 3.03 ±0.05nC signal in 60 seconds.

7.9 70030 Nucletron selectSeed™ Sources



REF 70030

1. The source holder for the Nucletron selectSeed™ I-125 source comes with two sterilizable adapters that interface easily with the Nucletron seedSelectron® push-fit connection. The seeds are delivered to the source holder in the horizontal position, with the stainless-steel finger shield in place.

2. After the seed is transferred, the adapter is disconnected from the source holder. The source holder is placed upright and the seed falls to the proper measuring position.

3. Remove the stainless-steel shield and insert the source holder into the well chamber. The source Holder is then placed in the well chamber for the measurement. For calibrated measurement, a calibration certificate for the Nucletron selectSeed™ I-125 source is required*. Follow the steps outlined in *Procedures for Well Chamber Measurements.*

* This document can be obtained from a primary or secondary standards laboratory that calibrates LDR iodine seeds. Standard Imaging uses the University of Wisconsin Accredited Dosimetry Calibration Laboratory for this service.

7.10 70031 Holder for Leipzig HDR Applicators

REF 70031

The Leipzig Applicator Source Holder is designed for use in the HDR 1000 Plus and IVB 1000 Well Chambers to perform output verification of Leipzig HDR applicators used with the microSelectron-HDR “classic” and the v2 afterloaders.

To commission the applicators, the user must follow the recommendations as presented in *Technique for routine output verification of Leipzig applicators with a well chamber*. See references on the following page for complete information.

To verify the output of the applicators with the well chamber and the insert, a physicist should use the following steps:

1. Find the source position inside the Leipzig applicator that maximizes the reading. This can be done by changing the source-indexer positioning in 1 mm increments for the classic machine and the v2 machine.

2. Perform the current measurements three times with remounting the setup in each measurement.

3. Calculate the CF using the following equation and procedure.

Procedure for Determining Correspondence Factor

The CF for each combination of well chamber and applicator are obtained as follows:

a. Place the applicator on the source holder at the well chamber entrance to determine the current reading *R* in nA, with the source in the position of maximum reading. Do not use the plastic cover when placing the applicator.

b. Multiply the reading *R* by the correction factor C_{TP} for the atmospheric conditions, relative to 22 °C and 760 Torr.

c. Divide *R* by the well chamber calibration factor *f* to account for the specific response of the well chamber.

d. Divide *R* by the air kerma strength, S_K, to account for the actual source strength.

$$\text{Correspondence Factor} = \frac{(R * C_{TP})}{(f * S_K)}$$

R = reading in nA

C_{TP} = correction for temperature and pressure

f = chamber calibration factor

S_K = Air Kerma Strength

4. Check if the CF value obtained for the applicator using the equation above agrees with its value in Table 1. If so, the output values from Table 1 can be used in clinical dosimetry. If not, further specific investigation is required. Taking into account the previously described uncertainty of the CF values and the uncertainty in the measurements by the users, it seems reasonable to recommend a tolerance of about ±5% in this comparison.

Well Chamber	Leipzig applicators H & V (Units in $nA^2 h^2 Gy^{-2} m^{-4}$)					
	H 3 cm	H 2 cm	H 1 cm	V 3 cm	V 2 cm	V 1 cm
HDR 1000[1]	1.28×10^6	9.50×10^5	4.92×10^5	N/A	N/A	N/A
HDR 1000[2]	1.285×10^6	9.570×10^5	5.011×10^5	1.125×10^6	8.284×10^5	4.547×10^5

Table 1: Typical Values for comparison

Typical values kindly provided by:

1 .J. Pérez-Calatayud, Hospital Universitario La Fe, Valencia, Spain

2. Zoubir Ouhib, Boca Raton Community Hospital, Boca Raton, FL, USA

V 3 cm Leipzig Applicator shown in well chamber

References

"Technique for routine output verification of Leipzig applicators with a well chamber". J. Pérez-Calatayud, et. al; Medical Physics. Vol 33 , No 1, pp. 16-20, January 2006.

"A dosimetric study of Leipzig applicators". José Pérez-Calatayud, Ph.D., et. al.; Int. J. Radiation Oncology Biol. Phys. Vol. 62, No. 2, pp. 579–584, 2005.

7.11 70088 Source Holder for Xoft® Electronic Brachytherapy System

REF 70088

This source holder has been designed to be used in conjunction with the HDR 1000 Plus Well Chamber to provide reproducible and convenient QA measurements of the Xoft® Electronic Brachytherapy System.

Insert the source holder into the chamber and align the mark on the label to the side vent hole or any other convenient, reproducible marking on the Chamber. Then insert the Xoft® X-ray source into the Source Holder until it bottoms. The marking on the Xoft® X-ray source should be centered at the top edge of the knob on the Source Holder. Finally, take measurements following the steps outlined in *Procedures for Well Chamber Measurements*.

Shipping Note: The Source Holder may be safely shipped with the Chamber in its carrying case if a few simple precautions are followed. First unscrew the long metal tube from the Source Holder and wrap it with bubble wrap or similar material. Then insert the lower portion of the Source Holder inside the Chamber. Carefully place the components in the carrying case and insert a suitably sized piece of stiff foam or similar material to prevent the source holder from sliding out of the chamber.

7.12 70095 Iridium Pin Source Holder

REF 70095

The Iridium Pin Source Holder is designed to accommodate three different sized iridium wire pins, such as models IRF-1, IRF-2, IREC-2, and IREL-2 manufactured by BEBIG gmbH, Berlin, Germany.

To use, take the U-shaped wire pin source and insert it, open end down, into the source holder tube pair of appropriate width (see Figure 2). Place the source holder into the HDR 1000 Plus Well Chamber to perform proper and repeatable QA measurement.

The Iridium Pin Source Holder can be gas sterilized.

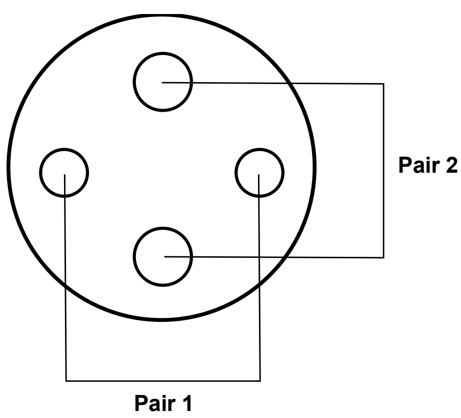


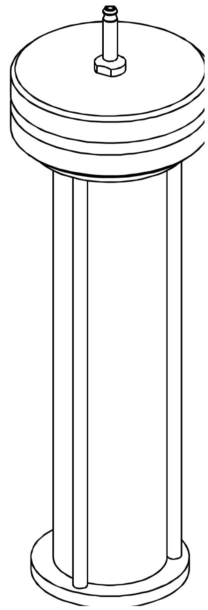
Figure 2: Looking down into the Iridium Pin Source Holder main cavity

7.13 70110 BEBIG Co-60 and Ir-192 Afterloader Source Holder

REF 70110

This source holder was designed for use with Co-60 Remote Afterloader sources manufactured by BEBIG GmbH, Germany. Insert the remote afterloader catheter into the source holder and follow measurement steps outlined in Procedures for Well Chamber Measurement. As a guide see also steps outlined for the use of the REF 70010 HDR Iridium Source Holder. Note that a calibration factor for the BEBIG Co-60 Source is not available from the Accredited Dosimetry Calibration Laboratory.

7.14 72280 Elekta microSelectron® and Flexitron HDR Source Holder



REF 72280

1. Place the HDR 1000 Plus well chamber in the same room as the Elekta microSelectron or Flexitron HDR unit for at least 30 minutes before the measurement to allow it to equilibrate to ambient temperature and pressure.

2. Connect the HDR 1000 Plus well chamber to a suitable electrometer, such as the MAX 4000 Plus or SuperMAX from Standard Imaging, and apply 300 V bias voltage, or the value and polarity indicated on your calibration certificate. Allow the system to stabilize for at least 10 minutes.

3. If necessary, thread the included coupler into the top of the Elekta microSelectron or Flexitron HDR Source Holder until it is finger tight. Attach an appropriate Elekta applicator to the coupler and to the Elekta microSelectron or Flexitron HDR Irradiator.

CAUTION: This coupler is designed to fit a Elekta gynecological applicator, and other applicators may not attach easily to the coupler.

4. Insert the Source Holder into the HDR 1000 Plus well chamber and align the black dot on the Source Holder label with the punch mark on the body of the HDR 1000 Plus well chamber to ensure repeatable measurements.

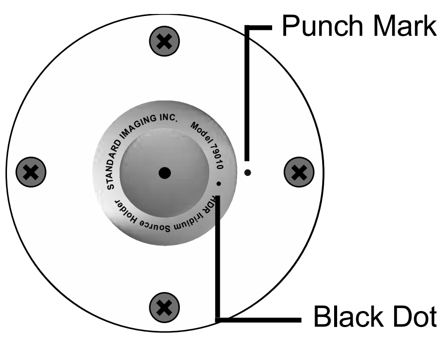
5. Determine the proper source position so the center of the 192Ir or 60Co source is at the most sensitive location along the well chamber central axis. See also Figure 1 for a typical axial response curve for the HDR 1000 Plus. Typically, the HDR 1000 Plus well chamber is calibrated about 50 mm up from the lowest point that a source can be driven into the Source Holder. The chamber sensitivity decreases by approximately 0.1% when the source is moved up or down by 5 mm from that position.

6. While observing all manufacturer-recommended safety procedures for the Elekta microSelectron or Flexitron HDR Source, run the 192Ir or 60Co source to the calibration point of the well chamber for a minimum of 20 sec for current measurement or for a reproducible set time (1 min.) for charge measurement. If the charge mode is used and the charge is accumulated while the source is in transit, account for the transit time error of the source by making the standard timer end effect measurements as described in High Dose Rate Brachytherapy: A Textbook, Nag, ed. Futura, 1994.

NOTE: This value will differ depending on the length of the catheter. The timer feature of the Standard Imaging MAX 4000 (REF 90015) or SuperMAX (REF 90018) can be used to collect charge for set times and eliminate this effect.

7. Read and record the measured current or charge.

8. Use correction factors for temperature/pressure, electrometer correction factor (electrometer must be calibrated) and 192Ir HDR calibration factor for the HDR 1000 Plus to calculate the air kerma strength of the source. For users who have an HDR 60Co source, please refer to the SI Technote 4813-00 for a calibration coefficient correction factor. Technote available at http://www.standardimaging.com/uploads/tech_notes/4813-00_60Co_Well_Chamber_Calibration_Tech_Note.pdf



7.15 72307 Bard QuickLink®/Mick® Source Holder

The Bard QuickLink/Mick Source Holder for the HDR 1000 Plus well chamber allows users to measure the source output strength of the seeds within the QuickLink or Mick cartridge pack, without first removing the cartridge from its sterile packaging.

For the Quick Link Cartridge:

1. With the green safety tab facing downward, roll the package into an approximate U-shape and slide it into the

Source Holder. Carefully bend the green tab in as needed so the package fits inside the Source Holder.

Note the package is rolled with the clear film to the inside, as shown at left. Once in place, the edges should line up with the two white dots on the top of the source holder.

2. Slide the cartridge down into the holder so the bottom of the cartridge (not the sterile packaging) is level with the black line on the bottom label, and the seed column is visible in the center of the holder, as shown below:

3. Place the Source Holder into the HDR 1000 Plus well chamber, and, following *Procedures for Well Chamber Measurements* on page 6 of this User Manual, take several measurements of the ionization currents.

A sterile-packaged QuickLink Cartridge containing 20 BARD STM1251 seeds was obtained by the University of Wisconsin Radiation Calibration Laboratory, and a collective average measurement value was obtained in the HDR 1000 Plus using the BARD QuickLink/Mick Source Holder and the method listed above. All single seeds were then removed from the cartridge and individually calibrated using the Single Seed Source Holder, REF 70016. These measurements were compared to the collective seed measurements of the intact cartridge to obtain a correction factor. This cartridge geometry correction factor (labeled C_{GEO} *below) was found to be approximately* 1.307 *times the STM1251 calibration factor. Note this factor will differ for different sources or manufacturers and should be verified by users before use.*

4. The following formula can now be used to determine the average seed activity as a QA measurement of the sum of the activity of N seeds.

Average Seed Activity = $(M_{raw} * N_{sk} * C_{GEO} * C_{TP} * C_A * C_E)/N$,

Where:

M_{raw} = Reading for electrometer well chamber system.

N_{sk} = The calibration factor obtained from an ADCL for a single seed measured with the Single Seed Source Holder, REF 70016

C_{GEO} = The cartridge geometry correction factor (1.307 for BARD QuickLink cartridge with STM1251 iodine seeds) to account for non-optimal loading and self-shielding seeds in the cartridge.

C_{TP} = Correction for temperature and pressure.

C_A = Correction for altitude related air density (see the section entitled, "Well Chamber Response as a Function of Pressure").

C_E = Electrometer calibration coefficient.

N = Number of seeds in cartridge.

Example:
A QuickLink cartridge loaded with twenty BARD STM1251 iodine seeds of intended activity of 0.82 U per seed is received. An HDR 1000 Plus well chamber previously calibrated by an ADCL for a single BARD STM1251 seed is used, which has an air kerma strength calibration coefficient (N_{sk}) of 2.048×10^{11} U/A. Following the above procedure as specified, the following values are measured or calculated:

M_{raw} = Average Charge collected of 907.25 pC in 15 sec exposure duration = 60.483 pA

N_{sk} = 2.048×10^{11} U/A

C_{GEO} = 1.307 (QuickLink cartridge with STM1251 iodine seeds)

C_{TP} = 1.0269 (at T=22.0 °C and P=98.67 kPa)

C_A = 0.9881

C_E = 0.999 C/Reading,

N = 20 seeds

Thus:
Average Seed Activity = $(M_{raw}*N_{sk}*C_{GEO}*C_{TP}*C_A*C_E)/N$

$= (60.483 \times 10^{-12}\ A * 2.048 \times 10^{11}\ U/A * 1.307 * 1.0269 * 0.9881 * 0.999)/20$

= 0.821 U/A

This average seed activity, as a QA measurement, can be compared to the expected BARD seed activity. Note this is a QA measurement assuming all 20 seeds are the same activity.

For the Mick Cartridge:
The same procedure outlined above for the Quick Link cartridge should be followed when using the Mick cartridge, with the only exception being the cartridge correction factor, C_{GEO}. This value was found through the work of the University of Wisconsin Radiation Calibration Laboratory to be 1.526 times the BARD STM1251 iodine seed calibration factor. Note that both factors are different for other seed isotopes such as ^{103}Pd. Similar work was completed for Theraseed. Please refer to the chart below:

Cartridge Geometry Correction Factor, C_{GEO}		
BARD Cartridge Type	Brachytherapy Seed/Isotope	
	STM 1251, ^{125}I, Iodine	Theraseed, ^{103}Pd, Palladium
QuickLink	1.307	1.412
MICK	1.526	1.818

7.16 70008 HDR 1000 QA Tool

Accurate delivery of doses using a HDR brachytherapy remote afterloading system depends on predicting the strength of the radioactive source at the time of treatment, the precision and consistency of the timer, and the ability of the unit to position the source at the proper dwell location along the catheter. Periodic quality assurance on HDR machines is a part of the standard protocol of the user. The HDR QA tool for an HDR 1000 Plus well chamber is designed to verify the consistency of source positioning, dwell time accuracy and source activity.

Wall Mount QA Measurements
A wall mount is available from Standard Imaging for convenient mounting and storage of

the HDR 1000 Plus. It is important that the chamber is in a consistent location for QA measurements. The QA tool can be placed in the open holder space in the wall mount that is next to the HDR 1000 chamber opening. The HDR 1000 chamber can be connected to a standard triax cable while mounted on the wall.

Note: The HDR 1000 can be used mounted on the wall for QA measurements, but should not be used any closer than 25 cm to any wall for calibration purposes. (See Medical Physics 19:

1311-1314 (1992)). Refer to the Instruction Manual received with the HDR 1000 for calibration procedures.

Figure 1 shows a schematic drawing of the lead lined HDR QA tool insert. This tool is inserted in the HDR 1000 Plus well chamber in place of the standard source holder insert.

The distance from the bottom of the tool to the center of the 4 mm spacer is 51 mm. The HDR QA tool insert tightly collimates the radiation received by the chamber to a narrow plane. When the source lies in that plane, the chamber responds with a large signal; when the source falls partially or completely out of the plane, the signal greatly diminishes.

This response curve is shown in Figure 2. For checking positional accuracy, the high slope regions of Figure 2, designated point A, are the most useful. For checking dwell time and activity, a plateau, designated point B in Figure 2, rather than a peak is desired. With this tool, the source position verification, timer accuracy and consistency of the source activity can be measured in a simpler manner by using the method described below.

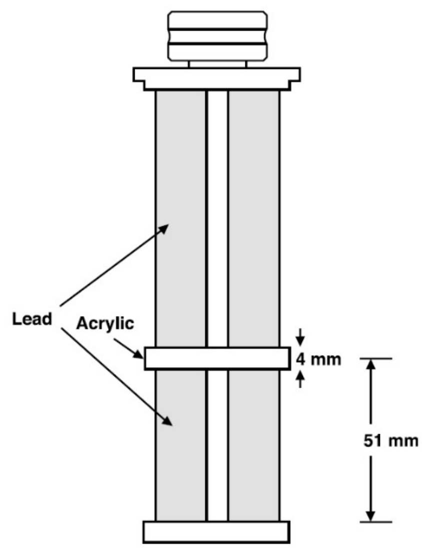


Figure 1: Schematic drawing of HDR QA Tool

This response curve is shown in Figure 2. For checking positional accuracy, the high slope regions of Figure 2, designated point A, are the most useful. For checking dwell time and activity, a plateau, designated point B in Figure 2, rather than a peak is desired. With this tool, the source position verification, timer accuracy and consistency of the source activity can be measured in a simpler manner by using the method described below.

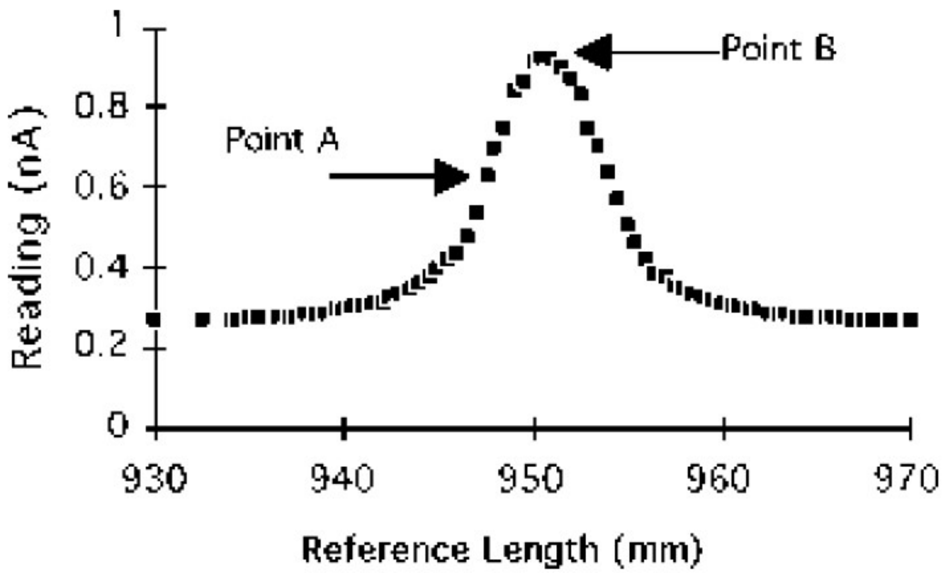


Figure 2: Representative response curve using HDR QA Tool insert of Fig. 1. The high slope region is designated A and the plateau region is designated B.

7.17 Operational Procedure

A. Initial Procedure

1. Insert the HDR QA tool into the well of the HDR 1000 Ion chamber.

2. Insert the catheter from the HDR afterloading machine through the opening in the top of the HDR QA tool. Push the catheter to the bottom of the chamber and lock the catheter in place with the provided holding device. Secure the catheter with the knurled catheter holding device.

Note: Take care not to kink the catheter and ensure that the catheter is secured and unable to move. If possible, dedicate a catheter to this purpose and once locked in place, let it remain in the QA tool. The catheter should have a gentle arc when connected to the HDR unit. Moving the HDR unit can result in differences in the recorded values; always keep the unit in the same position. For greater rigidity a needle catheter is recommended.

3. The first time the tool is used, take data to determine points A (slope) and B (plateau) as shown in Figure 2 to document the position on the HDR system. Point A should be where the reading equals about 0.5 of the difference between the maximum value and the trough value. Point B should lie in the middle of the maximum plateau. Program the HDR unit to begin 40 mm from the bottom of the well and move by the finest increments to 60 mm from the bottom, stopping for 10 seconds at each dwell position. Record the current reading at each position. If your HDR unit is unable to determine millimeter sized steps, reprogram the unit starting with different beginning locations to fill in the readings between the first set of dwell positions.

4. Correct the readings for temperature and pressure.

5. Determine the values of the constant, K (See section B. "Calculations for constant, K" below), for points A and B, corrected to a standard temperature and pressure. When the HDR QA tool is first used, a determination of the value of K for each of points A and B as measured above, must be made; thereafter, it will be a constant for your HDR unit. Thus, thereafter, only measurements of points A and B need to be made.

B. Calculations for constant, K

Constant, K, can be determined from measurements of the charge and current at Points A and B. The concepts behind these calculations are given in Med. Phys. 22: 435-440 (1995). The following expression for a constant, K, can be determined from the measurements for each point taken above:

1. $$K(x, t) = Q(x,t) * C_{tp} / A_o e^{(-\lambda\tau)} * t$$

OR

2. $$K(x) = I(x) * C_{tp} / A_o e^{(-\lambda\tau)}$$

Where:

K(x,t) is the function that relates the response of the system to x and time t; this function will be a constant for a given point of measurement.

Q(x,t) is the charge measured when the source is in position x for time t, where x is the position of the source in the QA insert and t is the exposure time, if using a gated measurement system, or otherwise the effective time, adjusted for transit time effects.

I(x) is the current measured when the source is at position x

C_{tp} is the correction for temperature and atmospheric pressure for the ionization chamber.

A_o is the source strength at the time of calibration of the ^{192}IR source

τ is the time since the calibration

λ is the decay constant of ^{192}IR

When an analysis is done for the uncertainties associated with the parameters of measurement, the total contribution is equivalent to 0.7% (See Table 1 for uncertainties for individual measurements). Therefore, any changes in the value of K greater than 1.5% may be considered significant. Therefore, a 1 mm error in position would become approximately a 20% change in the current-based K_A, or greater than 10 times the measurement uncertainty. The standard deviation of several trials without any changes has been shown to be within 1%.

Table 1: Showing uncertainty in test of K.

Test	Uncertainty in Test
Source Position	<0.1 mm
Dwell Time	<0.7%
Source Activity Consistency	<0.7%

Table 2 lists the ranges of error for positioning based on the difference in the value of K_A.

If the determinations of ΔK_A remain less than 10%, the error in positioning is < 0.5 mm.

Table 3 has listed ranges of error based on the difference in the value of K_B from the average value of K_B. The values given in Table 3 are based on two standard deviation limits and the uncertainty analysis given above.

For example, if all of the determinations of ΔK_B remain within 1%, the user can be assured that the source activity calibration has remained constant to within 0.1Ci, and the error in the dwell time is less than 0.1 second (See Table 3). Table 4 is based on the value of ΔK and can be used to determine which item, e.g. source positioning or dwell time, is in error depending which value or values of K are out of criterion.

Table 2: Deviation of K_A and limits of error for QA Measurements

QA Test	$\Delta K_A < 10\%$	$10\% < \Delta K_A < 20\%$	$\Delta K_A > 20\%$
Source Positioning	< 0.5 mm	0.5 < x < 1.0 mm	> 1.0 mm

Table 3: Deviation of K_B and limits of error for QA Measurements

QA Test	$\Delta K_B < 1\%$	$1\% < \Delta K_B < 2\%$	$\Delta K_B > 20\%$
Source Positioning	< 0.1 Ci	0.1 < A < 0.2 Ci	> 0.2 Ci
Dwell Time	< 0.1 s	0.1 < t < 0.2 s	> 0.2 s

Table 4: Table for determining item in error depending on difference in value(s) of K

Source of error appears as	Parameter			
	$\Delta K(x)_A$	$\Delta K(x)$	$\Delta K(x,t)$	$\Delta K(x)_A/\Delta K(x)_B$
Source Activity	off	off	off	on
Dwell Time	on	on	of	on
Source Positioning				
minor	off	on	on	off
major	off	off	off	off

Where:

$\Delta K(x)_A$, $\Delta K(x)_B$ are for current measurements and $\Delta K(x,t)_B$ is an integrated measurement. On means $\Delta K_B < 1\%$, and $\Delta K_A < 10\%$, Off means $\Delta K_B > 1\%$ and $\Delta K_A > 10\%$.

Note that the values of K are unique for your chamber and the electrometer used. Your chamber and electrometer should be calibrated to give calibration values, e.g. Nx, unique to your setup. The Nx value and the electrometer correction factors must be used as a multiplier for Q and I in the above equations 1 and 2 for activity calibrations. If the timer is suspected to be in error, the timer accuracy can be determined at a plateau position, Point B, by measuring the charge accumulated in the amount of dwell time set on the HDR control. The measured amount of time can be calculated from equations 1 and 2 as follows:

3) $Q\ (B, t_{set}) = Q\ (B) + Q(\text{transit})$

Where:

Q(transit) is the reading accumulated while the source moves into, and returns from, its dwell position.

Approaching this analogously to that typical of cobalt units, define an effective transit time, $t_{ef,tr}$ such that

4) $t_{meas} = t_{set} + t_{ef,tr}$

Where:

is a proportionality factor that should be equal to unity if the HDR timer is accurate $t_{ef,tr}$ is the equivalent time to account for that part of the reading produced with the source in transit going to and returning from its dwell position.

t_{meas} can be calculated by

5) $t_{meas} = Q(B, t_{set}) / I(B)$

To solve for the unknowns, b and $t_{transit}$, two different set times must be measured. (See Table 5).

An assumption could be made that for ease of use in daily performance of the timer check, the program should be stored on a program card or as a "standard" if the unit has these capabilities. Dwell times in such stored programs often increase exponentially over time to compensate for radioactive decay of the source. Thus, this procedure should not be done; see Med Phys 22: 435-440 (1995) for further explanations.

Table 5: Example determining of and $t_{transit}$ of Equations 4 and 5 for 8 separate measurements.

Date	I(B) (nA)	$Q(B,t_1)$ (nC)	$Q(924, t_2)$ (nC)	β	$t_{transit}$ (s)
24 May	11.780	62.85	121.90	1.003	0.32
1 June	11.170	59.70	115.70	1.003	0.33
2 June	11.030	59.45	114.10	0.991	0.44
3 June	10.890	58.15	112.20	0.993	0.38
8 June	10.260	54.95	105.80	0.991	0.40
9 June	10.080	54.65	104.45	0.988	0.48
10 June	10.180	54.75	104.95	0.986	0.45
11 June	10.160	54.05	104.50	0.993	0.35
		Average		0.994	0.39
		Std Dev		0.006	0.06

C. Standard QA Procedure

1. Set up catheter and QA Tool as described in steps A1 through A2.

2. Set the HDR unit to move the source to the selected points A and B from above. Take current measurements at these points. Then take a charge measurement each for times t_1 and t_2 (e.g. 10 seconds and 5 seconds) at point B. Record data and calculations on a chart as shown in Table 6.

3. Correct to a standard temperature and pressure.

4. Determine the day's values of the constant, K, at points A and B.

5. Compare the day's value for K to the initial value. Determine a percent difference for the present value of K versus this initial or average value for each measurement at points A, and B.

Documentation of Results

Sample QA charts are given in Tables 6 and 7 to retain a record of the QA measurements. In lieu of using these charts, columns can be added to the facility's regular QA form.

Table 6: QA Chart for HDR Source

Date	Initials	HDR UNIT DISTANCE INDICATION				
		Point A (current) KA (nA/Ci)	Point B (current) KB (nA/Ci)	-------------- KB (nC/Ci)	Point B (integrated) QB(t1) (nC)	-------------- QB(t2) (nC)

Table 7: QA Chart for HDR Source

Date	Initials	HDR UNIT DISTANCE INDICATION				
		Point A (current) KA (nA/Ci)	Point B (current) KB (nA/Ci)	-------------- KB (nC/Ci)	Point B (integrated) QB(t1) (nC)	-------------- QB(t2) (nC)
1/18	SCD	1.543	2.004	2.003	62.85	121.90
1/19	SCD	1.512	2.002	2.003	63.12	121.64
1/20	SCD	1.508	2.005	2.004	62.80	121.04
1/21	SCD	1.515	2.002	2.002	63.04	121.48
1/24	SCD	1.510	2.006	2.008	62.85	121.14
1/25	SCD	1.559	2.009	2.008	62.95	121.33
1/26	SCD	1.557	2.008	2.008	62.93	121.28

8 Bibliography

8.1 HDR Iridium Measurements

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9 Maintenance

Exterior cleaning of the device can be done with a soft brush and a cloth. Gently brush all surfaces to remove dirt and dust. Remove any remaining dirt with a cloth slightly dampened with a solution of mild detergent and water or a liquid disinfecting agent. Be especially careful that this is an external cleaning only and do not permit any liquid to seep into the HDR 1000 Plus in any manner during cleaning.

There are no serviceable parts on the HDR 1000 Plus. If the HDR 1000 Plus is dis-assembled, the calibration factor will become invalid and necessitate re-calibration. Also, the warranty will become void if the HDR 1000 Plus is disassembled. If the triax connector and external cable are modified, the value of the leakage may be affected.

Calibration of the HDR 1000 Plus Well Chamber is recommended every two years.

If assistance is desired in the proper disposal of this product (including accessories and components), after its useful life, please return to Standard Imaging.

10 Brachytherapy Measurement System/Parts Accessories

REF	Description
90008	HDR 1000 PLUS Well Chamber
50004	Carrying Case for any HDR 1000 Well Chamber
80026	Instruction Manual
70003	Source Holder for Cesium Remote Afterloading
70004	10 meter cable with triaxial BNC connectors and protective caps connected by chains. (Other lengths available upon request.)
70007	Wall mount for HDR 1000 Plus
70008	HDR ^{192}Ir Quality Assurance Tool
70010	Source Holder for HDR Iridium
70016	Source Holder for Single LDR Seeds
70020	Source Holder for Cesium
70022	Seed Batch Assay Tool
70023	Source Holder for RAPID Strand® Iodine Seeds
70024	Source Holder for MICK® Cartridges
70025	One Inch thick lead ring to surround HDR 1000 Plus
70026	Syringe Holder
70031	Holder for Leipzig HDR Applicators
70088	Source Holder for Xoft® Electronic Brachytherapy System
70095	Iridium Pin Source Holder
70110	BEBIG Co-60 and Ir-192 Afterloader Source Holder
72280	Elekta microSelectron® and Flexitron HDR Source Holder
72307	Bard QuickLink®/Mick® Source Holder
76004	Tube/Standoff Replacement Kit
10040	O-Ring, QA Tool

ADCL Calibrations are available through Standard Imaging. For details, please contact the Customer Service Team at 1-800-261-4446 or 1-608-831-0025.

11 Features and Specifications

Active Volume: 245 cm^3
ADCL Calibrations: HDR ^{192}Ir and/or LDR radionuclides as requested

Connector Two lug triax BNC (standard) TNC, Type M, or BNC + Banana (optional)

Range: 10 U to 80 MU   0.01 mCi to 20 Ci

Cable: 1 m (~3 ft)
Bias Voltage Applied: ±300 volts, typical
Leakage: Less than 50 fA
Stability: 0.2% (Reproducibility over 2 years)
Response: ± 0.5% over 25 mm at center of axis

Sensitivity:	Source	Current to Air Kerma Strength ($U=1uGym^2/h$)	Current to Apparent Activity
	HDR Iridium:	2.1 pA/U	8.6 nA/Ci
	Cesium:	2.0 pA/U	5.6 nA/Ci
	LDR Iridium:	2.3 pA/U	9.1 nA/Ci
	Iodine:	4.3 pA/U	5.4 nA/Ci
	Palladium:	2.1 pA/U	2.4 nA/Ci

A_{ion}: 0.9996, typical
Case: Wooden carrying case

Dimensions:
Height: 15.6 cm (6.1 in)
Diameter: 10.2 cm (4 in)
Insert Diameter: 3.5 cm (1.4 in)
Insert Height: 12.1 cm (4.8 in)

Weight: 2.7 kg (6.1 lbs)

Product Standards: IEC 60601-1[1], IEC 60601-1-2[1]

Operating Parameters
Temperature: 10 to 40 °C
Relative Humidity: 20 to 80% non-condensing
Pressure: 650 to 770 mmHg

Storage Parameters
Temperature: -15 to 50 °C
Relative Humidity: 10 to 95% non-condensing
Pressure: 600 to 800 mmHg

12 WARRANTY STATEMENT – 4424-18

Standard Imaging, Inc. sells this product under the warranty herein set forth. The warranty is extended only to the buyer purchasing the product directly from Standard Imaging, Inc. or as a new product from an authorized dealer or distributor of Standard Imaging, Inc.

For a period provided in the table below from the date of original delivery to the purchaser or a distributor, this Standard Imaging, Inc. product, provided in the table, is warranted against functional defects in design, materials and workmanship, provided it is properly operated under conditions of normal use, and that repairs and replacements are made in accordance herewith. The foregoing warranty shall not apply to normal wear and tear, or if the product has been altered, disassembled or repaired other than by Standard Imaging, Inc. or if the product has been subject to abuse, misuse, off-label use, negligence or accident.

Product	Warranty Period
Standard Imaging Ionization Chambers	5 years
Standard Imaging Detectors	1 year
Standard Imaging Well Chambers	2 years
Standard Imaging Electrometers	5 years
Standard Imaging BeamChecker Products	2 years
TomoScanner and TomoElectrometer	2 years
Standard Imaging Software Products	1 year
All Other Standard Imaging Products	1 year
Standard Imaging Custom Products	1 year
Standard Imaging Remanufactured Products	180 days
Standard Imaging Custom Select Products	90 days
Consumables	90 days
Serviced Product	90 days (for service performed)
Resale Products	As defined by the Original Equipment Manufacturer
ADCL Product Calibration (Standard Imaging uses the UW-ADCL for recalibrations required under warranty, unless otherwise requested)	0 - 90 days = 100% of ADCL Calibration Costs 91 - 182 days = 75% of ADCL Calibration Costs 183 – 365 days = 50% of ADCL Calibration Costs 366 – 639 days = 25% of ADCL Calibration Costs (days from date of shipment to customer)

Standard Imaging's sole and exclusive obligation and the purchaser's sole and exclusive remedy under the above warranties are, at Standard Imaging's option, limited to repairing, replacing free of charge or revising labeling and manual content on, a product: (1) which contains a defect covered by the above warranties; (2) which are reported to Standard Imaging, Inc. not later than seven (7) days after the expiration date of the warranty period in the table; (3) which are returned to Standard Imaging, Inc. promptly after discovery of the defect; and (4) which are found to be defective upon examination by Standard Imaging Inc. All transportation charges (including customs, tariffs, duties and brokerage fees) are the buyer's responsibility. This warranty extends to every part of the product excluding consumables (fuses, batteries, or glass breakage) or material reactions. Standard Imaging, Inc.

shall not be otherwise liable for any damages, including but not limited to, incidental damages, consequential damages, or special damages. Repaired or replaced products are warranted for the balance of the original warranty period, or at least 90 days.

This warranty is in lieu of all other warranties, express or implied, whether statutory or otherwise, including any implied warranty of fitness for a particular purpose. In no event shall Standard Imaging, Inc. be liable for any incidental or consequential damages resulting from the use, misuse or abuse of the product or caused by any defect, failure, malfunction or material reactions of the product, whether a claim of such damages is based upon the warranty, contract, negligence, or otherwise.

This warranty represents the current standard warranty of Standard Imaging, Inc. Please refer to the labeling or instruction manual of your Standard Imaging, Inc. product or the Standard Imaging, Inc. web page for any warranty conditions unique to the product.

13 Serialization Information

Standard Imaging products that are serialized contain coded logic in the serial number which indicates the product, day and year of manufacture, and a sequential unit number for identification:

A YY DDD X
A Unique product ID
YY Last two digits of the year
(e.g. 1999 = 99, 2000 = 00)
DDD Day of the year (1≤ DDD ≤ 365)
X Unique unit ID number (0 ≤ X ≤ 9)

14 Customer Care Policy Statement

Standard Imaging, at its discretion, may extend customer support only to the buyer purchasing the product directly from Standard Imaging, Inc. or as a new product from an authorized dealer or distributor of Standard Imaging, Inc. This customer care statement is in lieu of all other customer support statements, express or implied, whether statutory or otherwise, including any implied statements of fitness for a particular purpose.

Standard Imaging:

- Technical support is preferentially biased to those customers with valid and applicable Standard Imaging Certificate of Maintenance agreements.
- Technical support may range from providing detailed solutions to upgrade recommendations to the latest version of software for discontinued products.
- Will, at a minimum, provide technical support during its normal hours of operation.

- May, at its discretion, limit support of ancillary systems beyond its direct control, such as information technology systems, database management and 3rd party programs.
- Will provide technical support for the product for a minimum of 7 years from the date of delivery or discontinuance.
- Will not provide technical support for obsolete products, those products which are 7 years past the date of discontinuance.
- Will provide technical support for any and all involving issues with significant product risk, regardless of product age.

This customer care statement represents the current standard customer care statement of Standard Imaging, Inc. Please refer to the labeling or instruction manual of your Standard Imaging, Inc. product or the Standard Imaging, Inc. web page for any customer care statement conditions unique to the product. Specifications subject to change without notice.

15 Customer Responsibility

This product and its components will perform properly and reliably only when operated and maintained in accordance with the instructions contained in this manual and accompanying labels. A defective device should not be used. Parts which may be broken or missing or are clearly worn, distorted or contaminated should be replaced immediately with genuine replacement parts manufactured by or made available from Standard Imaging Inc.

⚠ CAUTION: Federal law in the U.S.A. and Canadian law restrict the sale, distribution, or use of this product to, by, or on the order of a licensed medical practitioner. The use of this product should be restricted to the supervision of a qualified medical physicist.

⚠ CAUTION: As desired by IAEA, English is the default language for labeling and manuals. If translated versions are available, resolve any differences in favor of the English versions.

⚠ WARNING: Measurement of high activity radioactive sources is potentially hazardous and should be performed by qualified personnel.

⚠ WARNING: Proper use of this device depends on careful reading of all instructions and labels.

⚠ WARNING: Where applicable, Standard Imaging products are designed to be used with the versions of common radiation delivery devices, treatment planning systems and other products or systems used in the delivery of ionizing radiation, available at the time the Standard Imaging product is released. Standard Imaging does not assume responsibility, liability and/or warrant against, problems with the use, reliability, safety or effectiveness that arise due to the evolution, updates or changes to these products or systems in the future. It is the responsibility of the customer or user to determine if the Standard Imaging product can be properly used with these products or systems.

Should repair or replacement of this product become necessary after the warranty period, the customer should seek advice from Standard Imaging Inc. prior to such repair or replacement. If this product is in need of repair, it should not be used until all repairs have been made and the product is functioning properly and ready for use. After repair, the product may need to be calibrated. The owner of this product has sole responsibility for any malfunction resulting from abuse, improper use or maintenance, or repair by anyone other than Standard Imaging Inc.

Standard Imaging will make numerous and reasonable attempts to contact a customer following completed manufacture or service of a product. Should a customer product remain at Standard Imaging for more than 1 year following its completed manufacture or service, Standard Imaging reserves the right to resell, restock, donate, discard or destroy the product.

If, in relation to the use of this product, a death or a serious deterioration of health has occurred, this should be reported to Standard Imaging, Inc. and the National Competent Authority of the country in which the incident occurred. When in doubt, please consult with an advisor or reach out to Standard Imaging, Inc. for further assistance.

The information in this manual is subject to change without notice. Please see www.standardimaging.com for the latest information. No part of this manual may be copied or reproduced in any form or by any means without prior written consent of Standard Imaging Inc.

16 Service Policy

If service, including recalibration, is required, please contact Standard Imaging's Customer Service department by phone or email prior to shipping the product. Standard Imaging's Customer Service and Technical Service staff will attempt to address the product issue via phone or email. If unable to address the issue, a return material authorization (RMA) number will be issued. With the RMA number, the product can be returned to Standard Imaging. It is the responsibility of the customer to properly package, insure and ship the product, with the RMA number clearly identified on the outside of the package. The customer must immediately file a claim with their carrier for any shipping damage or lost shipments. Return shipping and insurance is to be pre-paid or billed to the customer, and the customer may request a specific shipper. Items found to be out of warranty are subject to a minimum service fee of 1 hour labor (excluding recalibrations) for diagnostic efforts and require a purchase order (PO) before service is performed. With concurrence from customer, the product may be replaced if it is unserviceable or if the required service is cost prohibitive. Products incurring service charges may be held for payment. Standard Imaging does not provide loaner products. See the Standard Imaging Warranty and Customer Responsibility for additional information.

17 Return Policy

No merchandise will be accepted for credit without prior approval of return. Please contact Standard Imaging's Customer Service Department to receive a return authorization number before returning any merchandise for exchange or credit. Products manufactured by Standard Imaging must be returned within thirty days of receipt of order in 'like new' condition. No credit will be given for products returned after thirty days from receipt of order. A minimum twenty percent restocking fee will be charged on all returned merchandise. All materials returned must be shipped pre-paid. Credit for returned goods will be issued to customer's account for use against future purchases of merchandise only. Special orders, custom products, re-sale (not manufactured by Standard Imaging) products, and ADCL calibrations will not be accepted for return credit or exchange.

All products may not be registered, cleared, licensed or approved for sale in all countries or territories. Please contact Standard Imaging Customer Care for details.

CE 2862

EU	REP	Hoff & Lowendahl AB Högåsvägen 125 SE-741 41 Knivsta, Sweden

Authorized representative for the EU is Hoff & Lowendahl AB Högåsvägen 125, SE-741 41, Knivsta, Sweden (SRN: SE-AR-000001888). Contact information: info@lowendahl.eu.

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