HDR 1000 PLUS WELL CHAMBER

The **HDR 1000 Plus Well Chamber**, precisely calibrates radioactive sources used for cancer treatment. The HDR 1000 Plus is the standard instrument for independently verifying prescribed patient dose. The verification helps protect the hospital from misadministration and liability. The HDR 1000 Plus is an air communicating chamber so there is no inaccuracy due to an undetected gas leak as in a pressurized chamber. Performance of the HRD 1000 Plus hads been **validated in over 30 publications.**

The HDR 1000 Plus is ideal for low dose rate and high dose rate brachytherapy. Source holders are available for most existing isotopes available on the market today. If we do not list a source holder for the isotope you wish to measure, contact us and we will develop one for you.

Advantages of the HDR 1000 Plus Ion Chamber

Easy to use: No complicated set-up or lengthy procedure.
Stable: Short term stability, within +/- 0.02% for ten insertions. One to two year re-calibrations average within 0.2% of original calibration.
Confidence: Corrections are built in, requiring only the application of the ADCL calibration factor.
A_{ion}: Ion collection efficiency is 1.000 with sources ranging from 0.1 mCi to greater than 20 Ci. If you have a different chamber with a lower collecting efficiency the response is not linear at activities other than the calibration point, and your accuracy may suffer.
Response: 0.1% over 1cm (+/-5mm about center)
Isotropic: No problems with inhomogeneities in sources.
Validated: Operation of the HDR 1000 Plus is described in nineteen publications clearly demonstrating the superior performance of the HDR 1000 Plus Well Chamber.
Versatile: Can be used with any standard electrometer.

Quality Assurance Tests

A new Quality Assurance Tool has been designed for the HDR 1000 Plus Well Chamber which performs the following crucial tests:

- Source positioning verification to 0.3mm
- Timer accuracy
- Consistency of source activity
- Fast, 10-15 minute procedure2
- No films and development procedures
- No multiple distance estimates

The Quality Assurance Tool tightly collimates the radiation received by the HDR 1000 Plus Well Chamber to a narrow plane. Three short measurments are taken as the 192Ir source is advanced to the 4mm opening. these measurements provide the information for (1) source positioning verification; (2) timer accuracy; (3) consistency of source activity.

A constant, K, is determined with formulas outlined in the instructions. If all the determinants of K remain within 1%, the user can be assured that the source position has remained constant to within 0.3mm, the source activity calibration has remained constant to within 0.01Ci, and the error in dwell time is less than 0.1 second.

SPECIFICATIONS

ADCL Calibrations:	HDR ^{192}Ir and/or LDR radionuclides as requested
Active Volume:	245 cm^3 (122mm x 4.6mm x 1.75mm)
Isotope Source Holder:	2.2mm I.D. (standard), Optional inserts available
Connector:	Two lug triax (standard), TNC, Type M, or BNC + Banana (optional)
Range:	0.1mCi to 20mCi

Cable	1 meter (3 feet)
Bias Voltage Applied:	+/-300 volts
Leakage:	Less than $5x10^{-14}$
Stability:	0.2% (Reproducibility)
Response:	+/-0.5% over 25mm at center of axis

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

A_{ion}	0.9996
Case:	Wooden carrying case
Dimensions:	
Height:	15.6 cm (6.1 inches)
Diameter:	10.2 cm (4 inches)
Insert Diameter:	3.5 cm (1.4 inches)
Insert Height:	12.1 cm (4.8 inches)
Weight:	2.7 kg (6.1 lbs)

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Long Term Stability of the HDR 1000 Ion Chamber

Results of re-calibrations show the long term stability is an excellent 0.16%.

SN	Initial Calibration	Second Calibration	Month Interval	Change	% Change
	Ci/nA	Ci/nA			
33	0.1250	0.1249	27	-0.0001	-0.08%
64	0.1250	0.1252	26	0.0002	0.16%
63	0.1256	0.1259	24	0.0003	0.24%
62	0.1250	0.1253	24	0.0003	0.24%
88	0.1253	0.1256	13	0.0003	0.24%
44	0.1278	0.1280	15	0.0002	0.16%
92	0.1251	0.1252	12	0.0001	0.08%
5	0.1266	0.1270	21	0.0004	0.32%
82	0.1294	0.1292	21	-0.0002	-0.15%
81	0.1273	0.1275	25	0.0002	0.16%
31	0.1268	0.1270	17	0.0002	0.16%
34	0.1267	0.1270	25	0.0003	0.24%
12	0.1298	0.1297	25	-0.0001	-0.08%
14	0.1299	0.1285	25	-0.0014	-1.08%
O33	0.1271	0.1271	35	0.0000	0.00%
O2B	0.125	0.1254	36	0.0004	0.32%
581	0.1289	0.1289	24	0.0000	0.00%
745	0.1279	0.1277	24	-0.0002	-0.16%
431	0.1279	0.1276	22	-0.0003	-0.23%
433	0.1272	0.1270	23	-0.0002	-0.16%
332	0.1268	0.1266	25	-0.0002	-0.16%
743	0.1279	0.1276	28	-0.0003	-0.23%
381	0.1286	0.1286	25	0.0000	0.00%
451	0.1278	0.1277	26	-0.0001	-0.08%
453	0.1269	0.1271	24	0.0002	0.12%
3044	0.1281	0.1280	24	-0.0001	-0.08%
450	0.1273	0.1272	24	-0.0001	-0.08%
335	0.1268	0.1260	26	0.0000	0.00%
3454	0.1260	0.1262	26	0.0002	0.16%
30263	0.1269	0.1270	25	0.0001	0.08%
30262	0.1268	0.1271	26	0.0003	0.24%
32044	0.1283	0.1282	24	-0.0001	-0.08%
32304	0.1265	0.1260	26	-0.0005	-0.04%
32041	0.1279	0.1279	26	0.0000	0.00%
30269	0.1269	0.1268	28	-0.0001	-0.08%
33093	0.1270	0.1267	26	-0.0003	-0.24%
31444	0.1281	0.1280	30	-0.0001	-0.08%

Average change 0.16%

Purchase Justification for a Well Chamber

Calibration Justification

HDR 1000 Plus Brachytherapy Well Chamber

What is it?

The HDR 1000 Plus Brachytherapy Well Chamber is a precise measuring instrument used for accurate calibration of radioactive sources in cancer treatment. The HDR 1000 Plus is the standard to independently verify the precision and accuracy of the prescribed dose patients receive from radioactive isotopes. This verification protects the hospital from liability and misadministration.

Why is it needed?

The former policy of relying on the manufacturer's calibration is no longer adequate. It is now recommended by various groups (AAPM, ABS, ACR, COMS) that each institution compare the manufacturer's stated value with accurate measurements using appropriately calibrated equipment.[1] Use of radionuclides without in-house verification of source strength is not advisable due to the accuracy required for maximizing tumor cell death and minimizing healthy tissue damage.[2,3]

" Well-type ionization chambers make it easy to establish source calibrations with NIST traceability. Thus, for sources for which NIST provides calibration it is no longer necessary and should no longer be a practice to rely on source strengths quoted by the manufacturer."[4]

ACR Standards for brachytherapy Physics requires a well chamber be used in order for an institution to be accredited.[5] Some NRC agreement states have ratified a mandate that a well chamber be used for independent calibration of interstitial brachytherapy applications.

Task Group 56 lists a calibrated well chamber and electrometer as instrumentation that is needed for any and all brachytherapy procedures.[4] It is clear that this equipment is no longer an option for all brachytherapy physics programs.

The well chamber is the recommended standard for HDR Ir calibrations as well. "Each HDR facility should acquire a suitable re-entrant chamber. The external beam ion chamber is an acceptable but not a recommended alternative."[4]

Dose calibrators typically used in nuclear medicine departments cannot be used for calibration of iodine or palladium seeds as the reading received will not be an accurate measurement. The problem is not the low activity, but low energy of iodine and palladium (28KeV, 22KeV) which do not adequately penetrate the thick walls of a dose calibrator. The nuclear medicine dose calibrator is optimized for reading Tc-99 which has an energy of 140 KeV and cannot adequately read energy levels as low as 28KeV.

Monitoring Source Activity

Brachytherapy sources are assigned a calibration by the manufacturer. For example, for LDR Iodine the manufacturers stated calibration accuracy is only +/-5% random uncertainty of the mean output with a 7% uncertainty spread in each range.[6] This means there could be a discrepancy in stated activity and the true value of your sources. Many manufacturers of brachytherapy seeds, including Amersham, recommend independent verification of their sources.[6] "Every institution practicing brachytherapy shall have a system for measuring source strength with secondary traceability for all source types used in its practice. Prior to using newly received sources for treatment, the vendor-supplied calibrations must be verified as per Task Group No. 40 recommendations. The institution should compare the manufacturer's stated value with the institutions standard."[4]

Task Group 40 of the AAPM Radiation Therapy Committee recommends a tolerance of 3% for agreement between the institutional assay and the vendor's statement of source strength. The common experience has increasingly been a significant number of shipments found outside the recommended 3% tolerance.[7] Without independent verification of your source strength this variance would not be discovered. These findings require that independent verification of the vendors stated value be performed.

References

1. Comprehensive QA for radiation oncology: Report of AAPM Radiation Therapy Committee Task Group 40. Med. Phys. 21(4):581-618, 1994. "However, it is the responsibility of the institution to verify that this (manufacturer's) calibration is correct. The institution should compare the manufacturer's stated value with the institution's standard."

2. A New Re-Entrant Ionization Chamber for the Calibration of... : Goetsch, Attix, DeWerd, Thomadsen. Int. Journal Radiation Oncology Biol. Phys. Vol. 24. pp. 167-170, 1991 " The manufacturer provides an activity calibration for each source with a stated accuracy of +/- 10%. No traceability of this calibration to any national standards laboratory has been demonstrated. Since the International Commission on Radiation Units and measurements has recommended an overall uncertainty of no more than +\-5% in absorbed dose delivered to the treatment volume, the manufacturer's calibration is not considered adequate by most institutions."

3. Physics: Calibration and Quality Assurance; Ezell, Hicks, and DeWerd, 7th International Brachytherapy Working Conference. 1992. "Calibration of all sources is necessary because some sources are delivered from the source manufacturer with ±10% specification, One facilities experience has shown a variation of 15% in delivered sources."

4. Code of practice for brachytherapy physics: Report of AAPM Radiation Therapy Committee Task Group No. 56. Med. Phys. 24(10), : 1568-1569, 1582, 1594-1595, Oct. 1997. " Well-type ionization chambers make it easy to establish source calibrations with NIST traceability. Thus, for sources for which NIST provides

calibration it is no longer necessary and should no longer be a practice to rely on source strengths quoted by the manufacturer."

5. ACR Standard for Brachytherapy Physics: Manually Loaded Sources. Res. 25, 1995. "Each facility should have instrumentation to independently verify the source strength provided by the manufacturer. This should be done with a well ionization chamber with a calibration directly traceable to NIST."

6. AMERSHAM product literature: 1997. "It is recommended that customers measure each source to validate the values stated on the (vendors) Test Report, prior to the sources being implanted into patients."

7. Experience with Assays of ^{125}I Seeds; Johnson, and Kline. Med. Phys. 24 (6): pg. 1019, June 1997. " A significant number of shipments have been outside the recommended 3% tolerance. Our supposition is that there has developed a systematic error in the calibration or "binning" system employed by the vendor. Also, based on our experience, the tolerance recommended by the RTC TG-40 must be considered unreasonable for ^{125}I seeds.

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