



### Customer's Radiation Safety Check at First Beam Delivery: Shielded Room Installations

This check is primarily to ensure a safe environment for Varian personnel during LINAC installation. It is **not** a substitute for additional checks & surveys required by regulations &/or good practice.

Facility name: \_\_\_\_\_

Varian LINAC model: \_\_\_\_\_

LINAC serial number: \_\_\_\_\_

1.	<input type="checkbox"/> Yes <input type="checkbox"/> No, will use other controls (e.g. locks, signs, etc.) to assure safety. <i>If neither of the above applies, LINAC must not be beamed on until corrected.</i>	Interlocks & indicators for radiation safety are present & functional, including the following: <ul style="list-style-type: none"> <li>Interlock which prevents beaming on unless access door(s) fully closed; opening an access door causes beam termination (or alternate access control for maze without door), &amp;</li> <li>Visible indicators correctly identifying beam status at the access doors &amp; console.</li> </ul>		
2.	Ion chamber <b>photon</b> survey instrument  <i>A GM is <u>not</u> suitable for these quantitative measurements though it may be useful in finding shielding weaknesses; see Page 3 to locate rental instruments or assistance.</i>	Photon meter / probe model(s):  Date calibrated <i>(calibration required every 12 months in many countries):</i>	Meter / probe serial number(s):  Functional? Battery adequate?	
2a.	<input type="checkbox"/> Yes <input type="checkbox"/> No (if no, then Item 2b must be yes)	I confirm we have made measurements for LINAC installation operating conditions (see Items 1 & 2 on Page 3) & found no instantaneous <b>photon</b> dose rates above 25 µSv/h (2.5 mrem/h) within the area that will be occupied by Varian personnel.		
2b.	<input type="checkbox"/> Yes <input type="checkbox"/> N/A -- Item 2a applies	I confirm we have made measurements for LINAC installation operating conditions (see Items 1-3 on Page 3) & I estimate no <b>photon</b> doses that exceed 200 µSv (20 mrem) during the installation period within the area that will be occupied by Varian personnel.		
3.	Operating energy <input type="checkbox"/> Yes, we may operate above 8 MV <input type="checkbox"/> No operation @ energy above 8 MV	<i>If no, Items 4a-e on this page do not apply &amp; should be skipped. <b>Please complete Items 5 &amp; 6 below.</b></i>		
4a.	<input type="checkbox"/> We will complete a neutron survey (Please proceed to Item 4c). <input type="checkbox"/> No, we will NOT complete this survey.	<i>If no, please continue to Item 4b.</i>		
4b.	<input type="checkbox"/> In place of neutron survey, see signed copy of Page 2. <input type="checkbox"/> In place of neutron survey, see alternate signed statement on how worker radiation safety will be ensured (requires Varian RSO review).  <i>Please complete Items 5 &amp; 6 below.</i>	<i>If the LINAC is to be operated above 8 MV &amp; a neutron survey won't be done, then a statement explaining why this is acceptable must be provided. Page 2 provides a sample statement.</i> <i>If the statement on Page 2 is not used, Varian employees must delay beaming on unless / until a Varian Radiation Safety Officer (may be reached at <a href="mailto:radsafety@varian.com">radsafety@varian.com</a>) has:</i> <ul style="list-style-type: none"> <li>reviewed an alternative written statement provided by the customer, and</li> <li>made any special arrangements necessary to ensure Varian employees will not be exposed to unacceptable radiation levels.</li> </ul>		
4c.	<b>Neutron</b> survey instrument  <i>See Page 3 on locating rental instruments or assistance.</i>	Neutron meter model:  Date calibrated <i>(calibration required every 12 months in many countries):</i>	Serial number:  Functional? Battery adequate?	
4d.	<input type="checkbox"/> Yes <input type="checkbox"/> No (if no, then Item 4e must be yes)	I confirm we have made measurements for LINAC installation operating conditions (see Items 1 & 2 on Page 3) & found no instantaneous <b>neutron</b> dose rates above 25 µSv/h (2.5 mrem/h) within the area that will be occupied by Varian personnel.		
4e.	<input type="checkbox"/> Yes <input type="checkbox"/> N/A -- Item 4d applies	I confirm we have made measurements for LINAC installation operating conditions (see Items 1-3 on Page 3) & I estimate no <b>neutron</b> doses that exceed 200 µSv (20 mrem) during the installation period within the area that will be occupied by Varian personnel.		
5.	<input type="checkbox"/> <b>Yes</b> <input type="checkbox"/> <b>No (LINAC must not be beamed on until corrected.)</b>	<b>Considering operating conditions during LINAC installation (see Page 3), I confirm that beam-on operations will not cause non-compliant radiation (photon &amp;, where applicable, neutron) levels in any areas that will be occupied by individuals (including members of the public) during LINAC installation. I agree that beam-on operations may continue.</b>		
6.	Customer Physicist / Radiation Safety Officer:  <i>Signature confirms that the information provided is accurate.</i>	Signature  Printed name	Date  Title	
7.	Varian representative:  <i>Signature confirms that the information provided has been reviewed, found complete/acceptable, &amp; that beam-on work may continue.</i>	Signature  Printed name	Date  Title	

## Customer Statement on High-energy LINAC Room Shielding

Facility name: \_\_\_\_\_

Varian LINAC model: \_\_\_\_\_

LINAC serial number: \_\_\_\_\_

**Note: This statement is NOT required if a neutron survey has been done & noted on Page 1 of this document (Items 4c – 4e) OR if there will be no LINAC operation above 8 MV.**

By my signature below, I confirm that:

- for the shielded room housing the LINAC identified above, the materials that shield potentially-occupied areas from radiation are essentially 100% conventional concrete. The materials in the walls between the LINAC and potentially-occupied areas do NOT contain metal or other high atomic number radiation shielding elements (e.g. lead sheets, steel sheets, metal bricks or blocks, high atomic number additives [e.g. ores, metals, special minerals used to produce heavy concrete]),

AND

- the LINAC room access points (mazes, doors) and any other openings in the wall shielding were designed by a qualified individual to maintain doses from neutrons (as well as from photons) to acceptable levels when the LINAC is operated at its maximum energy and output,

AND

- areas adjacent to LINAC room access points (mazes, doors) and adjacent to any other openings in the wall shielding will not normally be occupied by Varian personnel when the LINAC is being operated above 8 MV.

Customer Physicist / Radiation Safety Officer – <i>signature confirms that the                  information provided is                  accurate.</i>	Signature	Date
	Printed name	Title

## Instructions for Measuring Radiation Dose Rates & Estimating Doses Delivered During Installation:

1. In the case of LINACs with rotational gantries/beams, radiation dose rate measurements -- in the area that will be occupied by Varian personnel -- are to be made at gantry/beam angles of 0°, 90°, 180°, & 270°; the LINAC will be operated at all gantry/beam angles during the installation process.
2. Dose rates must be measured under conditions that produce the most radiation, using the maximum LINAC beam energy & the maximum output corresponding to the maximum energy. The maximum field size is to be used; measurements with the beam towards the floor should have a water phantom in the beam.
3. A main purpose of this form is to assure the total dose received by Varian employees each year will be acceptable as these individuals install one LINAC after another. So instantaneous dose rates, even relatively high ones, are of concern only if they will persist & lead to photon or neutron doses above Varian limits during an installation. However, **as a convenience, Varian does not request dose calculations if instantaneous dose rates are consistently low**, that is if they don't exceed 25 µSv/h (2.5 mrem/h) at any gantry/beam angle in areas that will be occupied by Varian personnel.

Otherwise, we ask that the dose to the area that will be occupied by Varian [D(x)] be estimated for the installation period, using the applicable formula below. In these formulas, DR(x) is dose rate at location "x" in units of µSv/h or mrem/h & measured at gantry/beam angle indicated.

For Halcyon:  $Dose(x) = 3 \text{ h} \times [0.7 \times DR(x)_{\text{beam to floor}} + 0.1 \times DR(x)_{\text{beam}@90} + 0.1 \times DR(x)_{\text{beam to ceiling}} + 0.1 \times DR(x)_{\text{beam}@270}]$

For other LINACs:  $Dose(x) = 20 \text{ h} \times [0.7 \times DR(x)_{\text{beam to floor}} + 0.1 \times DR(x)_{\text{beam}@90} + 0.1 \times DR(x)_{\text{beam to ceiling}} + 0.1 \times DR(x)_{\text{beam}@270}]$

### Notes:

- In consideration of the rate of LINAC installations per employee, the Varian-specified photon & neutron dose limits per installation (Items 2s & 4b on Page1) are higher than the NCRP151-recommended limit on the average weekly dose to Radiation Workers in a Restricted Area from all types of radiation combined (100 µSv / 10 mrem).
- There may be installations where an alternate dose calculation is appropriate; please request a Varian representative to forward any proposed alternative to a Varian Radiation Safety Officer for review.

## Sources of Radiation Detection Instrumentation or Consultants:

If personnel &/or appropriate instruments are needed to conduct a radiation survey, resources are available on a temporary basis:

- For radiation detection instrument rentals (daily, weekly, etc.), do an internet search -- for example, search on "neutron meter rental".
- Some radiation control agencies maintain lists of radiation safety consultants. Some can be found online by searching on the location & "radiation safety consultant"; other lists can be obtained by contacting the agency. (Some regulatory agencies may require consultants to register with the agency before offering services -- it is recommended that you clarify the requirements that apply.)
- Listings on websites:
  - The Health Physics Society "Buyer's Guide" lists organizations that provide radiation safety consultants as well as firms that sell radiation detection instruments (see "Health Physics Consultation", "Health Physics Services", "Health Physics Instrumentation", or "Radiation Monitoring Instrumentation"). As of 2019 the website was at: <http://hps.org/aboutthesociety/affiliates/services.html>
  - The American Society for Radiation Oncology (ASTRO) lists a few shielding design firms. As of 2019 these were listed under "External Beam RT" & "Radiation Protection/Shielding" at: <https://astro.officialbuyersguide.net/>
  - Organizations in Brazil which may be able to assist with (or advise on) radiation surveys or instrument lease (websites valid as of 2019): <http://mra.com.br/>, <http://www.ird.gov.br/>, <http://www.ien.gov.br/>, <http://www.cnen.gov.br/servicos-tecnicos-especializados>, [https://www.ipen.br/portal\\_por/portal/default.php](https://www.ipen.br/portal_por/portal/default.php), <http://nuclear-powerplants.blogspot.com/2011/03/angra-nuclear-power-plant.html>