Patient Dosimetry & Treatment Planning Policy (UK)

1. Introduction

This policy defines and describes the principles of patient treatment planning, including the prescription of dose by a Practitioner and the optimisation and delivery of doses within treatment planning.

2. Terms and Definitions

CAT -	Clinical Advisory Team
ClinOnc	Clinical Oncologist
CTV	Clinical target volume
Csign	Counter-signed; formal review of training case
DATIX	GenesisCare electronic system for reporting incidences and near misses
DIBH	Deep Inspiration Breath Hold
DMax	Point of maximum plan dose
D&I	Diagnosis and Interventions
eRPAC	Electronic Radiotherapy Plan Assessment and Check
FB	FreeBreathing
IGRT	Image Guided Radiotherapy
IR(ME)R Operator	Radiographer (rad), treatment planner (Dosimetrist & Physicist), plan checker (Physicist)
IR(ME)R Practitioner	Clinical Oncologist
Linac	Linear Accelerator
Local team	GenesisCare staff working in the treatment centre (PAOs, Centre Leader, Radiographers, Dosimetrist, and Lead Physicists)
MDT	Multi-disciplinary team
MSQ	MOSAIQ
MPE	Medical Physics Expert
MU	Monitor Units
eRPAC	electronic Radiotherapy Plan and Check (escribe document)
Opt_Structure	Volume ROI used for dose optimisation and reporting
OSC	On Screen Check
PAO	Patient Administration Officer
POI	Points of interest

PTV	Planning target volume
QCL	Quality Checklist
Rad Rx	Prescribed dose in MOSAIQ terms
ROI	Region of Interest
R&V	Record and verify
RT	Radiotherapy
PX	Prescription
pCT p	Planning Computed Tomography image dataset
SAT	SABR Advisory Team
SDM	Service Delivery Manager
SGRT	Surface Guided Radiotherapy
SOP	Standard operating procedure
SRM	Service Request Manager
TP	Treatment planning
TPS	Treatment Planning System
Tx	Treatment plan in MOSAIQ terms
TPS	Treatment Planning System
VMAT	Volumetric Modulated Arc Therapy
VSim	Virtual Simulation

3. Scope

This policy applies to all GenesisCare defined operators involved throughout the entire patient Radiotherapy treatment planning process.

It is a requirement under IR(ME)R 2017 that exposures to Target Volumes are individually planned and doses to non-target volumes are kept as low as reasonably practicable, as dictated in the IR(ME)R Employers Procedures – Radiotherapy UK RP-POL-001. This policy outlines the key tasks that must be completed to optimise radiotherapeutic dose and details who is responsible for completing each task. This document also details the training/competency framework that is in place to ensure that all dosimetry and treatment planning tasks are conducted safely and within best practice, as laid out in this policy and supporting documentation.

4. Responsibilities

It is the responsibility of all operators performing and documenting treatment planning tasks to abide by this policy and ensure that they are suitably entitled and competent before performing any QC task unsupervised.

Managers are responsible for implementing this policy and subsequent local policies and procedures.

PHY-TEM-001 records GenesisCare staff who are entitled as competent to carry out treatment planning and checking. For the purposes of IR(ME)R they are designated *Operators* of the TPS(s). PHY-TEM-001 also lists those staff designated MPE (Medical Physics Experts).

The Clinical Reference Management (CRM) electronic system is used to specify the Clinical Oncologists (ClinOncs) who have practicing privileges and for which treatment specialities. For the purposes of IR(ME)R, and limited to their specialties, the ClinOncs are designated as:

- *Referrers* for pre-treatment imaging, external beam radiotherapy treatment & concomitant imaging
- *Practitioners* for pre-treatment imaging, external beam radiotherapy treatment and concomitant imaging
- *Operators* of the treatment planning systems (TPS) for the purposes of defining treatment fields and delineating target volumes and organs at risk

5. Photon Patient Dosimetry

5.1. Operator Entitlement – Photon Dosimetry

PHY-TEM-001 records the operators who are competent and entitled to carry out Photon Patient Dosimetry and Treatment Planning and Plan Checking.

5.2. Electronic radiotherapy plan and check Escribe document (eRPAC)

An eRPAC must be completed for each patient. The eRPAC is a documentation tool for planning and checking that records the processes followed. The items on the eRPAC document are not an exhaustive list of all tasks and checks required on all plans, but all the tasks and checks on the document must be carried out unless they do not apply to the plan. All entries on the document must be completed to indicate the processes followed or the results of the checks or to indicate if they are not applicable. The use of the eRPAC is detailed in the Electronic Radiotherapy Plan Assessment and Check SOP, PHY-SOP-101.

eRPACs are specific to plan type (as per section 5.6), if an eRPAC does not exist for the type being planned use 'VMAT'.

5.3. Planning CT and other Imaging datasets

A planning CT scan (pCT) is carried out for all patients (excluding electron treatments) on a CT scanner that has been equipped for this purpose under guidance from GenesisCare and on which GenesisCare staff carry out regular radiotherapy appropriate QA testing. This includes CT scanners of the partner hospitals or GenesisCare's own scanners. Any queries regarding this must be addressed to the site Lead Physicist or Regional Physicist. It is the Lead Radiographer's responsibility to ensure consultation in this regard is sought and acted on.

The import of CT Planning scans and any other imaging datasets is described in PHY-WI-109

5.4. Intended Treatment

The intended treatment for the patient is stated in the Radiotherapy Booking Form stored in the electronic record for the patient within the Record and Verify system (R&V) and includes:

- proposed dose prescription, including prescription method:
  - single field (and prescription point)
  - MPD
  - prescription isodose

RT-WI-404 describes the processing of a radiotherapy booking form before it progresses to planning, including:

- checking the form is completed appropriately
- checking the proposed dose prescription is a standard dose (recorded on RT-PRO-051) and if not then it has been accepted by GenesisCare and is being recorded on the Non-Standard Dose Register (RT-PRO-037)
- ensuring that an appropriate *Clinical Dataset*, sufficient for planning purposes, has been received and is stored in the patient record in the record and verify system

5.5. Contouring

Contours/volumes are created in the pCT dataset as appropriate including any organs for which dose information is requested on the Radiotherapy Request form and any organs with constraints stated in RT-PRO-051.

Volumes are defined as per ICRU guidelines and recommendations from the RCR, IPEM, ScoR and ESTRO consensus guidelines:

Definitions			**GenesisCare Policy**
GTV	Gross Tumour Volume	GTV is the gross palpable or visible/demonstrable extent and location of the malignant growth	**Defined by ClinOnc** Created by ClinOnc or created by Planner and checked & finalised by ClinOnc.

CTV	Clinical Target Volume	CTV contains a demonstrable GTV and/or is considered to contain microscopic, subclinical extensions at a certain probability level	**Defined by ClinOnc,** defined directly or grown from GTV. If grown from GTV it may be appropriate to edit the CTV after growing to account for clinical factors (e.g. edit out of bone). Created by ClinOnc or created by Planner and checked & finalised by ClinOnc.

Definitions			**GenesisCare Policy**
PTV	Planning Target Volume	PTV is a geometric concept, used for treatment planning, to ensure the prescribed dose is actually delivered to the CTV. PTV includes an **internal margin** to account for daily physiological variations in position, shape and size of the CTV, and **setup margin** to account for uncertainties and variability in the reproducibility of patient positioning and geometric inaccuracies in treatment delivery. Thus, the PTV is 'locally determined' dependant on the equipment and methods in use. Note that the CTV + the internal margin is called the **Internal Target Volume (ITV).**	**Grown from CTV using standard margins** Standard geometric margins are applied (see below) based on body site and planning/treatment methods (e.g. IMRT, IGRT etc). It may be appropriate to use larger margins for specific clinical reasons for individual patients and if so, this must be noted in the record and verify system and referred to CAT as per RT-POL-136. The PTV is a geometric construct so it is never appropriate to edit the PTV after growing. <u>But</u> dose coverage of the PTV may be compromised if necessary, to reduce dose to OARs (section 5.7). '*Objective PTVs*' are often created during the optimisation/planning process, but dose statistics in the final plan are quoted to the actual PTVs. It may be appropriate to create '*Planning PTVs*' (section 5.6.4), in which case PTV statistics will be provided for '*Planning PTVs*' as well as actual PTVs. PTV statistics are described on the front sheet of the PDF treatment plan document, which is approved by the ClinOnc.

GenesisCare standard PTV margins	**Site**		**Margin**
	head & neck	immobilisation with mask, daily cone-beam imaging	5mm all round

	body	where CTV is well visualised on daily cone-beam imaging, e.g. Prostate	7mm all round
		where CTV is <u>not</u> well visualised on daily cone-beam imaging, e.g. prostate bed	1cm all round
	prostate & nodes	prostate well visualised on daily cone-beam imaging, nodes not well visualised & compromise with prostate position	7mm prostate, 1cm nodes
	prostate bed & nodes	CTV not well visualised on daily cone-beam imaging which will be matched on bony anatomy which is a good surrogate for nodes	1cm prostate bed 7-10mm nodes
	oesophagus	well visualised on daily cone-beam imaging, except sup & inf which is patient dependent (**note this is not the same as growing 7mm axially and 1 to 2cm sup & inf which increases the axial margin along whole length of the CTV not just at ends)	7mm all round, then extend sup & inf an extra 3 to 13mm** Or 7mm axially and 1 to 2cm sup & inf
	bladder	daily cone-beam imaging, but large daily variations, patient dependent	1 to 2cm all round
	Lung	daily cone-beam imaging, but large daily variations, patient dependent	1 to 2cm all round
Definitions			**GenesisCare Policy**

OAR	Organ At Risk	OARs are normal tissues whose radiation sensitivity may significantly influence treatment planning and/or prescribed dose (e.g. spinal cord). Dose–volume response of the normal tissues is a key concern and OARs are considered to be: **'serial'** (e.g. spinal cord) where dose above the tolerance limit to even a small volume may be deleterious, or **'parallel'** (e.g. lung) where the relative size of the volume irradiated above tolerance level is the most important parameter, or **'serial-parallel'** where dose response is both 'serial' & 'parallel' (e.g. heart with a serial response [coronary arteries] and parallel response [myocardium]	**Defined by ClinOnc.** Created by ClinOnc or created by Planner and checked & finalised by ClinOnc. If created by Planner they must follow the guidelines in PHY-MAN-102 where applicable. The ClinOnc may request specific OAR constraints and/or Planners will use the constraints described in RT-PRO-051. The ClinOnc may request specific OAR constraints that are specified in a referenced protocol. This will be sourced and referred to in advance of planning by the local team.
PRV	Planning Organ At Risk Volume	PRV is an OAR plus a margin to account for internal and setup uncertainties (as for PTV)	**Defined by ClinOnc** Created by ClinOnc or created by Planner and checked & finalised by ClinOnc. PRV is a relatively new concept/method in treatment planning, most important where high doses are 'wrapped around' serial OARs. PRVs will normally be used for any serial OARs close to high dose regions.

There are various methods whereby the consultant may approve planning volume rendering, the accepted methods are as follows:

- **CTV volume rendering**: The Doctor will log into the TPS using own login, locking the plan before exiting
- **CTV volume rendering with facilitated operator shadowing**: The Doctor will log into the TPS using dosimetrist's login, the dosimetrist must be either physically present or connected on remote screen share. Documentation must be made in Navigator by either Dr or the shadowing member of dosimetry team to confirm this
- VSIM document uploaded to the R&V – Dr approval via own login.
- Secure PDF password protected file emailed to Dr with passcode sent via alternative means (e.g. verbally or SMS)
    - ClinOnc needs to reply to the email which in turn is uploaded to the R&V as evidence of Dr review and approval. The email must contain relevant TPS lock time stamp information to allow plan traceability

5.6. Treatment Plan Optimisation

During the planning process the Planner completes the eRPAC as described in 5.2.

The Planner produces the treatment plan seeking to deliver the prescribed dose to the target, optimise the dose distribution and keep doses to Organs At Risk as low as achievable. "As low as achievable" and "optimised" within this policy is defined as: within the constraints either specifically requested by the ClinOnc or stated in RT-PRO-051 or defined within the nominated protocol used for planning.

The treatment planner is responsible for requesting a plan review by the ClinOnc if there are any issues.

Photon treatments for "conformal radiotherapy", making use of MLC and hard, physical wedges are not supported within GenesisCare planning practice. In cases where "conformal treatments" are requested, the default position of GenesisCare operators will be to apply inverse planned IMRT techniques to the supplied treatment volumes. Cases that do not optimally fit with this position will be discussed and reviewed by an MPE or Regional Physicist prior to planning.

Isodoses are displayed in absolute absorbed dose to water in gray (Gy). The Planner will always include the 100% isodose (in yellow), the 95% isodose (in green), and the 'ICRU hotspot' isodose (in red). They may include any other isodoses they deem necessary to inform the ClinOnc or Radiographer operators responsible for delivery of the treatment plan.

The following sections overview the optimisation approach for the differing treatment modalities. Specific instructions can be found in the GenesisCare Planning Notes, PHY-MAN-101.

5.6.1 Single fields

The ClinOnc positions or defines the field as required. The field may be made symmetric and the isocentre placed at Dmax or an appropriate point as prescribed by the ClinOnc. MLC is defined if required. The Planner may position the field and

define MLC if requested by the ClinOnc (who will approve DRRs at the plan approval stage).

In cases where the prescription point is at sufficient depth to be within bone, a 4cm sphere as per section 5.6.2 shall be used.

Plan Normalization: Plan normalised to 100% at Dmax at geometric centre of the field or another appropriate point as prescribed by the ClinOnc.

5.6.2 Parallel Pair – MPD prescription

The ClinOnc positions the fields as required. The fields may be made symmetric and the isocentre placed at mid-plane. MLC is defined if required. The Planner may position the fields and define an MLC port if requested by the ClinOnc (who will approve DRRs at the plan approval stage).

A 4cm diameter sphere is placed in the TPS at the dose prescription point (usually isocentre) and a density over-ride of 1.0g/cm^3 applied to the sphere to remove any effects of tissue heterogeneity on the dose prescription point. The aim of this approach is to simulate dose calculations equivalent to a conventional non-planned calculation, but still making account of heterogeneities further from the prescription point. In cases where metal artifact and or other fluence perturbing features exist in and around the prescription point, then an offset normalisation point will be considered and used. In all cases where the appropriateness of a prescription point is uncertain, then an appropriate MPE will be consulted.

The dose contribution from each field to the dose prescription point at mid-plane is made equal.

Plan Normalization: Plan normalised to 100% at mid-plane separation at the geometric centre of the field or another appropriate point at mid-plane as prescribed by the ClinOnc or optimised position, under MPE review, to be consistent with ClinOnc's prescribed position.

5.6.3 Parallel Pair – isodose prescription

In some cases, the ClinOnc may wish to plan a non-standard parallel pair, e.g.:

- different dose contributions from the two fields
- 'almost parallel pair' where the difference in gantry angle is slightly less than 180° (note if the difference is much less than 180° then the plan will be considered for a VMAT technique – if in doubt refer to Regional Physicist or MPE).

In these cases, the ClinOnc will prescribe to an isodose (instead of "MPD") and approve the isodose distribution.

The ClinOnc positions the fields as required. The fields may be made symmetric and the isocentre placed at mid-plane. MLC is defined if required. The Planner may

position the fields and define MLC if requested by the ClinOnc (who will approve DRRs at the plan approval stage).

If the plan is to be normalised in a similar as MPD prescription then the 4cm diameter sphere over-ride may be used, but it is not mandatory as the dose prescription/approval is to an isodose line rather than a point.

The dose contribution from each field to mid-plane may be made equal.

Plan Normalization: Plan normalised in discussion with ClinOnc, likely to be similar to MPD. Isodose distribution approved by ClinOnc.

5.6.4 Plan to 100%, defined fields

The ClinOnc positions the fields as required. The isocentre is placed at a sensible position to allow favourable beam shaping and subsequent IGRT. The Planner may position the fields if requested by the ClinOnc (who will approve the DRRs at the plan approval stage). Field and sIMRT segment weightings are adjusted to produce an optimised dose distribution.

Plan Normalization: 'ICRU Max' dose is required to be less than 108%. Plans are to be normalised to give a target **Mean Dose of 100%** (if this allows the 'ICRU Max' dose constraint). An Opt_Structure is created from the field and patient skin borders to allow this normalisation and dose reporting.
The Planner may normalise such that the mean dose is >100% & ≤101%, if they deem it necessary in order to produce an optimum distribution, provided the 'ICRU Max' dose constraint is met. If the 'ICRU Max' dose is greater than 107% or the Target Mean dose is below 100% the ClinOnc must be consulted to determine the most appropriate normalisation.

5.6.5 Inverse Planned IMRT

Volumes are defined as described in section 5.5. Dose objectives and constraints are defined in the TPS based on the target prescriptions and the OAR dose constraints (section 5.6) and the plan is optimised using processes described in the VMAT Planning work instruction PHY-WI-012.

Plan Normalization: Mus must be used to adjust plan normalisation and ensure the mean dose to the PTV matches the prescription.

5.6.6 SABR

Prior to pCT, SABR referrals are initially reviewed within a GenesisCare MDT for suitability. CTV volumes are defined or approved by a competent SABR consultant. PTV margins for the case/treatment site is defined by SABR consortium guidelines. Peer review of planning outlines created by competent SABR consultants are facilitated, on request, by the SABR Advisory Team (SAT).

SABR referrals can also come from the Primrose program, where referrals are accepted from non-competent consultants. These referrals, supported by competent consultants that are members of the SAT, can be from any referring ClinOnc within their practising privileges.

Plan Normalization: Dose maximum is defined as a minimum 110% and maximum 140% of the prescription. Normalisation of the plan is defined to a percentage of the plan reference POI dose, that is set to between 70 and 90%. OAR doses adhere to limits defined within UK Consensus on Normal Tissue Dose Constraints for Stereotactic Radiotherapy[1].

5.7 Compromising target coverage

For patients/sites where CTVs are defined, standard PTV margins (section 5.5) are used to ensure the entire CTV receives the prescribed dose each day treatment is delivered. These PTV margins are part of standard IMRT optimisations carried out during the planning process for all patients and are linked to GenesisCare IGRT equipment and methods.

In some cases, the ClinOnc and/or planning team may be concerned that planning with standard PTV margins may lead to high OAR doses, or compromised CTV coverage, in which case the following process applies:

a) Planner carries out initial planning optimisations based on the standard margins to generate an initial dose distribution, with options if appropriate for reducing OAR doses
b) ClinOnc reviews the dose distribution and decides if the high dose volumes can be reduced in order to reduce dose to the OARs, discusses with Planner how dose distribution can be altered to achieve this, defining OAR dose constraints as required
c) Planner carries out further optimisations to achieve dose distribution and/or OAR dose constraints defined by ClinOnc

The Planner will discuss with the ClinOnc that compromising the PTV dose coverage increases the risk of under-dosing the CTV on treatment and this will also be indicated on the front sheet of the plan where dose coverage of the CTV + standard margins is reported for all plans (section 5.11).

5.8 On-Screen Check (OSC)

On-screen checks (OSC) are mandatory for SABR cases and advisory for H&N, Brain and VMAT breast plans. A request for an OSC can be made to the SRM for all non-mandatory plan types at the planner's discretion.

This check is carried out at a time when it is still reasonable to further optimise or alter the plan, as described in PHY-SOP-101, It provides an opportunity to consult with an MPE before the plan has progressed to the final export and checking stages.

The purpose of the OSC is to ensure the plan has been well optimised, delivering the prescribed dose to the target(s) while reducing doses received by OARs as much as reasonably achievable. As described in; section 5.6, RT-MAN-101, PHY-WI-012.

The eRPAC indicates aspects that will be considered during an OSC, including appropriate contouring of targets and OARs and optimised dose distribution. Where possible communication between the planner and OSC should be verbal, i.e. the OSC'er will speak with the planner on the phone or via web-hosted screen share.

If a plan is challenging, the planner must discuss the planning approach with OSC'er during the initial planning process rather than waiting for post OSC feedback. For complex plans it is sensible for the OSC'er to discuss with the planner at the start of OSC to quickly gain a good understanding of the situation.
If the plan is acceptable, there is no need for comments/discussion, the OSC'er simply completes the OSC section on the eRPAC and the associated QCL.

When giving feedback to planner from OSC:

- the OSC'er will have a verbal conversation with planner (this will save time)
- if plan is being counter-signed OSC'er will discuss with counter-signer
- if OSC'er & planner can't agree then OSC'er will discuss with Regional Physicist
- if issues discussed and agreed by planner, then OSC'er will make a note as appropriate in the 'OSC comments' in eRPAC (for the record and for the benefit of the plan-checker)
- the OSC'er shall clarify with the planner and on the eRPAC if further OSC is required

5.9 Non-standard beam arrangements/plans

During planning or as soon as it becomes clear that a non-standard field arrangement is required, or some other aspect of the plan is non-standard, the planner will discuss the options with:

- the physicist whose site the patient is being treated at, and
- a Regional Physicist or suitable MPE

This discussion should occur as early as possible during the planning process (while there are still options to make changes) and must occur before plan export.

In most cases it will be necessary to have generated the 'standard' plan/field-arrangement to compare to the non-standard option.

Examples of non-standard field-arrangements include (but not limited to):

- any phase 1 breast treatment that isn't tangential fields only
- any phase 2 breast treatment that isn't applied electron field or standard mini-tangents

- any inverse-planned IMRT field that is abutting or adjacent to a static beam
- any requested conformal field arrangements
- beam arrangements with non-zero couch positions

Where the beam/planning arrangement impacts treatment delivery, i.e. involves non-standard patient setup, the Lead Radiographer of the site of delivery must be called during planning to form an MDT management call to discuss the case. The MDT should contain the Planner, Lead Radiographer, Local Physicist and a suitable MPE or Regional Physicist. The aim of the MDT is to put a safe, practical treatment plan in place for all stake holding operators. In the case where patients are transferred to another site, the Lead Radiographer is responsible to ensure suitable information or relevant local staff member are sent to support the delivery in another site, who's staff may not be fully aware of the setup particulars.

All plans will include a **Dose Reference Point**. This is a point in the target where the dose is calculated and recorded in the treatment plan. It must be representative of the plan and will usually be the isocentre but may not be if the isocentre is not representative (e.g. when the plan is very asymmetric or not contained within soft tissue).

The Plan will be locked before producing the Treatment Plan summary(5.11) and progressing the plan to the record and verify system.

5.10 Previous Radiotherapy Treatment

It is the responsibility of the local team to identify when patients have received previous radiotherapy and that this information is requested and made available prior to the start of the planning process and ideally before CT. An assessment must be made by the local team prior to CT to gauge whether any previous radiotherapy overlap might compromise the safe delivery of the intended treatment. Any concerns must be resolved prior to booking a start date to ensure time for resolution.

It is the responsibility of the Operator importing the CT to review this initial investigation by the local team alongside the booking form to assess whether any previous treatment information has been requested and received for consideration during the planning process.

During the planning or mark-up (electron) process it is the responsibility of the treatment Planner to ensure that any previous treatment has been considered, when evaluating and presenting dose distributions. In many cases previous treatment will be geographically distant from the intended treatment and must be stated on the treatment plan summary. Any previous treatment in close proximity (generally regarded as an overlap of the previous 50% isodose with intended 50% isodose) must be taken into account, either by way of clinical decision making with the Clinical Oncologist or by active optimisation in the TPS and confirmation of acceptable summed doses.

It is the responsibility of both the treatment planner and checker to ensure that any previous treatment has been adequately accounted for, considered by the Clinical Oncologist and documented on the treatment plan summary, see section 5.11.

5.11 Treatment Plan Summary

When the Planner has finalised the plan, a treatment plan summary document must be created and stored in the patient record within the R&V. The Planner, Checker and Consultant add their electronic "approval" to indicate their approval of the treatment plan and treatment. The patient cannot be treated until all the mandatory approvals have been applied.

The first page of the treatment plan summary is created using the GenesisCare Radiotherapy Treatment Plan document and the contents of the document is described in PHY-MAN-101.

Where appropriate, summary must encapsulate all dose modifying or delivery specific features of the therein reported plan, such as DIBH or bolus. It is the responsibility of the treatment planner to ensure that these aspects are reported adequately on the front sheet and are correct. It is the responsibility of the plan checker to verify that the plan notations mentioned here are complete (i.e. no relevant omissions), appropriate and correct.

Treatment plans with previous radiotherapy overlapping with the current plan must be documented in detail on the front sheet. It is the Planner's responsibility to make suitable estimates of the maximum dose in the overlap region. Where multiple treatments are planned on the same pCT then, where overlap exists, a cumulative plan of summed doses must be produced. This cumulative plan must present the dose distribution and the combined overlap maximum ICRU dose defined. Geographically distant previous treatments will be mentioned only. It is the Checker's responsibility to check the overlap estimates, ensuring completeness and correctness of the reported statistics.

5.12 Transfer of Plans to the record and verify system

The Planner must export the finalised plan from the TPS into the R&V prior to the independent plan checking process. The Planner checks the plan in the record and verify system, including but not limited to:

- all field setup details
- all doses and Mus
- DRRs

This approval is verification that they have carried out all Planner related procedures in this document and those contained within PHY-SOP-101.

5.13Plan Checking

The operator completing the plan checking task completes the checking section of the eRPAC document as described in section 5.2. The list of items is not an exhaustive list of all checks required on all plans, but all the checks listed on the document/sheet must be carried out unless they do not specifically apply to the plan being checked. All entries in the list must be completed to indicate the results of the checks or to indicate if they are not applicable. The Checker will carry out any other checks they think appropriate for the given case.

5.14 Dose Check

The prescription reference dose calculated in the treatment plan is second checked via an independent recalculation. See the RadCalc MU Checking manual, PHY-MAN-104.

If this does not produce a satisfactory result, it may be necessary to carry out dose check measurements on the treatment machine, the results of which must be documented in the patient record in the record and verify system. For **all fields** the dose to a point or the Mus must agree with the check calculation or measurement within:

Action Level: ±3% or ±3MU
Tolerance: ±5% or ±5MU

If a field is outside the Action Level but within Tolerance a comment must be made in the notes in the patient record in the record and verify system.

For the **whole plan** the dose to a single point (or the average of doses to points from each field) must agree with the check calculation or measurement within:

Action Level: ±3% for all plans
Tolerance: ±5% for single fields, parallel pairs and chest wall tangential field arrangements
±3% for all other field arrangements

If a field is outside the Action Level but within Tolerance a comment must be made in the planning notes in the patient record in the record and verify system.

5.15 Plan Corrections

If the Checker believes there is a problem with a plan and/or correction are needed they must discuss these with the Planner. If corrections are needed, they will be made by the Planner and checked by the Checker. If the corrections are simple the Checker can make them, and the Planner will check them. If the Planner who generated the plan is not available another Planner can make or check corrections and in this case a note will be made in the patient record. There is no need for the Checker to repeat comments made by the Planner.

5.16 Plan Check Sign-off

Once satisfied that the plan is safe and appropriate, the Checker must approve the plan, following the eRPAC Standard Operating Procedure, PHY-SOP-101.

5.17 Fluence Delivery Check

All complex IMRT/VMAT plans undergo a Patient Specific QA check on the Linac (e.g. using Mobius or ArcCheck) following the procedure outlined in PHY-SOP-200. It is the responsibly of a suitably appointed MPE to review any out of tolerance results and decide if the plan is suitable to proceed to treatment, in the event that the plan is deemed unsuitable for treatment a re-plan will be required.

5.18 Plan Approval

The final plan approval must be performed by the ClinOnc. By approving the plan, the ClinOnc:

- approves the prescription, which is stated on the treatment plan summary,
- accepts the plan dosimetry information stated on the treatment plan summary,
- approves the treatment field DRRs and field positions,
- accepts the dose information in the DVH,
- accepts the isodose distribution

6. Electron Patient Dosimetry

6.1 Operator Entitlement – Electron Dosimetry

PHY-TEM-001 records the staff who are competent to carry out:

1. electron patient dosimetry calculations
2. create electron treatment plans in the record and verify system
3. check calculations plans
4. electron output factor measurements
5. staff who are permitted to authorise output factors

6.2 Electron mark-up & Prescription

All Electron dosimetry and treatment planning is performed manually, there is no calculation in the TPS. The Electron Planning & Prescription form, PHY-TEM-002, and Dupuytren's electron Calc sheet, PHY-TEM-101, is used to prescribe and plan the treatment.

If the ClinOnc is present for the electron mark-up:

- the ClinOnc indicates the area to be treated and specifies the applicator and cut-out to be used or the shape to be used if non-standard, this is recorded on PHY-TEM-002 and a template made and photo(s) of the site taken

- the ClinOnc prescribes the electron energy and dose and prescription depth dose based on the depth of treatment required, this is recorded on PHY-TEM-002
- the ClinOnc physically signs PHY-TEM-002 to approve the prescription and treatment
- a plan summary document is created in the R&V containing the completed PHY-TEM-002 (physically signed by the ClinOnc) and the photo(s) of the electron setup
- the electron fields cannot be treated until the three mandatory approvals have been applied in the R&V, as described in section 6.6

If the ClinOnc is not present for electron mark-up:

- the electron treatment is virtually simulated in the TPS and is reviewed directly by the ClinOnc or a virtual simulation document is provided to them as per RT-MAN-081 (section Electron Virtual Simulation in TPS)
- the ClinOnc verifies the applicator and cut-out to be used or the shape to be used if it is non-standard, and the electron energy and dose and prescription depth dose based on the depth of treatment required, and this is transcribed onto PHY-TEM-002 by the Plannermark-up is carried out by Radiographers as described in RT-MAN-081 (section Electron V-Sim Mark-up Preparation) and a template is made and photo(s) of the site are taken
- a plan summary is created in the R&V containing the completed PHY-TEM-002, the photo(s) of the electron setup and a rendered TPS image of the electron field
- the electron fields cannot be treated until the three mandatory approvals have been applied

6.3 Output factor

PHY-TEM-107 & PHY-TEM-108 include a table of Output Factors which have been authorised for electron dose calculations. There are two live controlled versions, one for all Synergy Linacs and one for all Versa Linacs. Commissioning and subsequent measurements show that, for beam energy matched machines, one set of output factors can be used for all Synergy Linacs, and another set of output factors can be used for all Versa Linacs.

If a cut-out is to be used where the factor is not yet authorised for that Linac type (i.e. not yet recorded in the table) then measurements will be made to determine the factor. These measurements can be made on any GenesisCare Linac of that type. The measurements are recorded in RT-TEM-035.

If the factor is within 5%, i.e. $0.95 \leq \text{factor} \leq 1.05$ then only one set of measurements is required.

If the factor is greater than 5%, i.e. factor < 0.95 or factor > 1.05 then independent measurements (made by another authorised person) are required to verify the factor.

The measurements are reviewed by a member of staff who is permitted to authorise output factors , they will check the calculations and compare to previously measured factors and then add the new factor to the table of authorised factors if they are satisfied. The table in the RT-TEM-035 spreadsheets are password protected and the password known only to those who are permitted to authorise new factors.

6.4 Dose Calculation

The Planner calculates the electron Mus using:

- the prescribed dose per fraction, D#
- the prescription depth dose, PDDe
- the output factor (OF) for the applicator and cut-out

$$\mathrm{OF}= \frac{\text{Output (Cut-out)}}{\text{Output (Applicator}}$$

The Planner calculates the Mus, using the prescription details in the Electron Prescription & Planning form, stored in the patient record in the record and verify system, and the Electron Output Factor data sheets, using the formula:

$$MU = D\#\ (Gy)\ x\ 100\ x\ \frac{1}{OF}\ x\ \frac{100}{PDDe}$$

The Planner records the electron calculation on the electron Prescription & Planning form, and enters and applies approvals within the R&V.

For remote electron planning (when the ClinOnc has not been present for electron mark-up) the virtual simulation documents and associated correspondence will be attached to the patient's electronic file in the R&V and approved by the Planner.

The Planner applies their electronic approval, which is verification that they have followed all procedures described above and they are fully satisfied with the electron calculation and plan/treatment in the R&V.

6.5 Dose Calculation & Plan Check

The Checker follows procedure PHY-SOP-101 to check the electron calculation and all details on the electron Prescription & Planning form.

The Checker applies their electronic approval, which is verification that they have followed all procedures described above and they are fully satisfied with the electron calculation and plan/treatment in the record and verify system.

6.6 Electronic Plan Approval

Three approvals need to be applied to the Electron Plan before the treatment is delivered, which are "Planner", "Checker" and "Consultant".

The "Consultant" approval is applied as follows:
If the ClinOnc <u>is not</u> present for electron mark-up they may or may not physically sign the paper Electron Planning & Prescription form, PHY-TEM-002, in either case they must apply their electronic approval directly in the R&V prior to the commencement of the treatment (because they do not see the mark-up on the patient).

If the ClinOnc <u>is present</u> for the electron mark-up and has physically signed the paper Electron Planning & Prescription form, PHY-TEM-002, the Checker will add the "Consultant" approval to the document in recognition that the treatment has been approved by the Consultant physically signing the form and reviewing the patient in person.

7. Training – Patient Dosimetry

PHY-TEM-001 records the staff who are authorised and entitled as competent to carry out Patient Dosimetry and Treatment Planning and Plan Checking.

a. Training – Planning Photon Dosimetry

Before being signed-off as competent in each planning category staff undergo a 4-part training schedule:

1. The 'Trainee' is supplied with a list of documents relevant to the plan type. The trainee is required to read this documentation and complete a formal, open book, quantitative assessment of the key policy features of that plan type.
2. The 'Trainee' carries out planning practice on training-set data in the TPS. These are anonymised patients who have already been planned clinically. This will involve planning on the TPS and will involve R&V export etc. To progress to the next stage, the trainee must have their training cases formally assessed by a competent operator. This formalised section review is performed live, by a 'Trainer' who acts as the section assessor shadowing the trainee (Csign). Responses of observations recorded in the trainee's training record, PHY-TEM-117.
3. The Trainee produces clinical plans which are then counter-signed by a 'Trainer' who themselves is a planner, authorised as competent in that plan category. This process is performed live in a shadowing session, the process is:
    - the Trainee creates the plan in the TPS under observation, which is then guided by the counter-signer and adapted if necessary to produce a clinically optimal plan
    - the Trainee will create the treatment plan but not approve
    - the Trainee will create in the R&V, but **<u>not</u>** approve, the treatment plan summary

- the Trainer will check and approve the treatment plan in the R&V, which verifies they have fully reviewed the clinical plan, ensuring it is clinically optimal, and that they take clinical responsibility for the plan as per this policy
- the plan will then undergo the standard plan check process (Note: the Trainer/Counter-Signer **shall not** also be the Checker)

4. Following documented evidence of good clinical practice in at least 3 clear and fault free observations, a final competency assessment is performed. This entails a live run through of a clinical case, under direct observation from the SRM, SDM or Regional Principal Physicists. During this session, the SDM/SRM will complete a Competency Proforma (PHY-TEM-116). The opportunity is arranged during this session for the Trainee to demonstrate competence. Following the site specific proforma questions and defined model answers, situational steers and questions are posed to the Trainee with the answers graded. The competency assessment, recorded and graded on the proforma, is saved and used as evidence of Trainee competency.

   Newly competent Operators will be re-assessed within the first 6 months of being signed off. And Competency will be reviewed annually.

b. Training – Checking Photon Patient Dosimetry

Before being signed-off as competent in checking plans, staff under-go a period of evidenced training in each planning category. The plan will be checked where they carry out the plan-check process on clinical plans whilst being accompanied and counter-signed by a Trainer who is authorised to carry out Plan Checks in that plan category:

The Trainee carries out the plan-check process, as described in this doc and, whilst being accompanied by the Trainer. The Trainee discusses with the Trainer what they are checking and:

1. The 'Trainee' is supplied with a list of all relevant to the plan type GenesisCare documentation. The trainee is required to read this documentation and complete a formal, open book, quantitative assessment of the key policy features of that plan type.
2. The Checker then completes observed Csigns:
   - the Trainee approves in MOSAIQ: Rad Rx, Site Setup, Fields, Dosimetry etc
   - (the Trainee will **not** approve the Tx PDF plan)
   - the Trainer will check and re-approve in MOSAIQ: Rad Rx, Site Setup, Fields, Dosimetry etc
   - the Trainer will approve the Tx PDF plan which verifies they have fully checked the clinical plan, ensuring it is clinically optimal, and that they take clinical responsibility for checking the plan

7.3 Planning electron treatments

Before being signed-off as competent in the electron planning category staff under-go a two-part training:

1. The 'Trainee' is supplied with a list of all relevant to the plan type GenesisCare documentation. The trainee is required to read this documentation and complete a formal, open book, quantitative assessment of the key policy features of that plan type.
2. The Trainee carries out electron planning practice on patient data for patients who have already been planned clinically. This will involve dosimetry calculations and may involve export to MOSAIQ etc.
3. The Trainee produces clinical 'plans' (dosimetry calculations and plan/treatment data in MOSAIQ) which are then counter-signed by a Trainer who is a planner who is authorised as competent in electron planning. In this case the process is:
    - the Trainee carries out the dosimetry calculation and completes the electron Prescription & Planning form
    - the Trainee will create & approve in MOSAIQ: Rad Rx, Site Setup, Fields, Dosimetry etc
    - the Trainee will create in MOSAIQ (but **not** approve) the Tx PDF plan as described in section 3.4
    - the Trainer checks the electron calculation and all details on the electron Prescription & Planning form, and checks and re-approves all the treatment details in MOSAIQ including Rad Rx & Prescription, Field details, Dosimetry, and Site Setup (patient verification purposes only)
    - the Trainer shall approve the Tx plan PDF in MOSAIQ which verifies they have fully reviewed and checked the dosimetry calculation and the clinical plan/treatment data in MOSAIQ, and that they take clinical responsibility for the plan/treatment data
    - the Checker (who is **not the same** person as the Trainer/Counter-Signer) carries out the checking process as described in section 3.5 above, including approving the Tx plan PDF when satisfied

7.4 Checking electron calculations & plan/treatment data

Before being signed-off as competent in checking electron plans/treatment data staff under-go a period of training where they carry out the plan-check process on clinical plans whilst being accompanied and counter-signed by a Trainer who is authorised to carry out Plan Checks in that plan category:

The Trainee carries out the plan-check process, as described in this document, whilst being accompanied by the Trainer. The Trainee discusses with the Trainer what they are checking and:

1. The 'Trainee' is supplied with a list of all relevant to the plan type GenesisCare documentation. The trainee is required to read this documentation and complete a formal, open book, quantitative assessment of the key policy features of that plan type.

2. The Checker then completes observed Csigns:
    - the Trainee approves in MOSAIQ: Rad Rx, Site Setup, Fields, Dosimetry etc
    - (the Trainee will **not** approve the Tx PDF plan)
    - the Trainer will check and re-approve in MOSAIQ: Rad Rx, Site Setup, Fields, Dosimetry etc
    - the Trainer will approve the Tx PDF plan which verifies they have fully checked the clinical plan, ensuring it is clinically optimal, and that they take clinical responsibility for checking the plan

8. Evaluation

TThis is a controlled document that will be monitored by the Radiation Oncology Committee and updated periodically by the Medical physics team. This document will be subject to routine audits as per IR(ME)R National Audit Programme – GenesisCare UK Radiotherapy (RT-SOP-228).

9. References

- 1 G.G. Hanna, et al (2018). UK Consensus on Normal Tissue Dose Constraints for Stereotactic Radiotherapy. Clinical Oncology Vol 30, Issue 1, P5-14.

10. Appendix

- No Appendices applicable for this document

Revision History

Version	Revision Date	Revised By (Position Title)	Description of change
12.1	April 2017	Head of Governance	Transferred to new document template
13.0	December	Head of Quality	Updated policy that state all of the variations and accepted methods
13.1	April 2019	Compliance Manager	Transferred to new document template
14.0	June 2020	Service Delivery Manager UK – Stuart Williams	Material update to current practice.

14.1	November 2021	Hussein El-Shaer	Reviewed & updated document with current standardised format.