TomoTherapy® Treatment System

Site Planning Guide

T-SPG-0000 C

TomoHD™

TomoTherapy® Treatment System

Site Planning Guide

Privacy Statement

TomoTherapy Incorporated is committed to providing medical equipment that helps customers to be compliant with the Health Insurance Portability and Accountability Act of 1996 (HIPAA). The following specific features and design measures have been incorporated into the TomoTherapy® Hi·Art® treatment system to facilitate this:

- The TomoTherapy® network is physically distinct and has a single point of connection to the rest of the institution's network.
- The point of connection between the facility and the TomoTherapy® networks is protected by a firewall device, typically configured to allow

only specific, controlled forms of network traffic (for example, DICOM import).

- The Planning Station and Operator Station are protected by Windows® system passwords, and TomoTherapy® applications are protected by user-specific passwords.
- A user-level screen lock capability is provided on TomoTherapy® workstations.

Warranty Information

If the Planning Station or Operator Station software, planning system, optimizer cluster, or treatment system hardware is modified in any manner all warranties associated with the software and equipment shall become null and void. TomoTherapy Incorporated does not assume any responsibility or liability with respect to unauthorized modification or substitution of subsystems or components.

The TomoTherapy® treatment system, including each computer workstation and associated system software, has been extensively validated to demonstrate that the system will perform as expected. The installation of additional software not released by TomoTherapy Incorporated (e.g. third party, off-the-shelf, etc.) on these computer workstations is not permitted. This includes any Microsoft®Windows® updates. Any effect on the safe and intended operation of the TomoTherapy® treatment system caused by the introduction of additional software is unknown and TomoTherapy cannot be responsible for any impact caused by adding such software.

TomoTherapy® Hardware and Software Maintenance

Only qualified service personnel should service or maintain system hardware components. If you determine that the TomoTherapy® treatment system requires service, always contact the TomoTherapy Customer Interaction Center.

If you feel that any TomoTherapy® treatment system software application does not perform as expected, or provides results that are not consistent with your established clinical and research protocols, call TomoTherapy Incorporated.

Use of Third-Party Software

Automatic image registration is based on routines in Numerical Recipes: The Art of Scientific Computing, published by Cambridge University Press, which are used by permission.

Instructions for Use of the TomoTherapy® Treatment System

TomoTherapy user documentation applies to safe and effective use of the TomoTherapy® treatment system by educated dosimetrists, therapists, and physicists. Personnel must be trained by TomoTherapy Incorporated before the TomoTherapy® treatment system is used for research or clinical purposes. TomoTherapy® treatment system documentation was originally drafted, approved, and supplied in English (US).

The following statements are intended to alert the user to potential conditions that could result in injury to the patient (warning) or conditions that could affect system components (caution).

Warning Warning statements describe possible conditions that can result in serious or fatal injury to the patient or facility personnel. Each warning gives the possible condition and how to avoid it.

Caution Caution statements describe possible conditions that can affect system performance or cause damage to system components. Each caution gives the possible condition and how to avoid it.

TomoTherapy Incorporated

TomoTherapy Incorporated
1240 Deming Way
Madison, WI 53717 USA

For more information, to request documentation, or if you have a service issue, please contact the Technical Solutions Center: Telephone support is available 24 hours a day, 7 days a week. Support is also available through email at: support@tomotherapy.com.

NOTE: If your facility works with a third-party service provider, please contact them directly for your service-related issues.

Technical Solutions Center

Country/Region	Toll-Free Number
North America	1 866 368 4807
Belgium	0800 38783
France	0805 631 565
Germany	0800 000 7541

Italy	800 986 399
Netherlands	0800 0201364

Country/Region	Toll-Free Number
Switzerland	0800 001927
United Kingdom	0808 238 6035
China/CNC (Northern)	10 800 712 1701
China (Southern)	10 800 120 1701
Hong Kong	800 967912
Japan	0044 22 132374
Singapore	800 1204 683
South Korea	0079 81 4800 7204
All other locations	1 608 824 2900 or 32 2 400 44 44

Contact information and other resources may also be found online at www.tomotherapy.com.

Contents

Chapter 1

Site Planning

Site Planning Service

Overview

This guide details the construction and equipment requirements that the clinical facility must meet before we deliver and install the TomoTherapy® treatment system.

To help the facility meet those requirements, we provide a site-planning service that includes guidance from a TomoTherapy Project Manager. The Project Manager will:

1. Review the site plan to ensure that it complies with the specifications in this guide.
2. Visit the facility:
    - For a construction kick-off meeting.
    - To inspect the site before the facility pours concrete to seal in the floor conduits.
    - To inspect the site shortly before construction is complete to ensure that it will be ready for system delivery.
3. Offer telephone and e-mail support to answer questions from project team members every step of the way.

The Site Planning Guide

IMPORTANT: The clinical facility is responsible for ensuring that site construction meets all of the requirements in this guide and those of all government regulatory agencies. If you have questions about any of the requirements detailed in this guide, contact a TomoTherapy Project Manager. Failure to meet the specifications outlined in this guide may affect the *TomoTherapy* treatment system warranty.

The drawings at the back of this guide illustrate a typical layout for the Treatment Vault and other rooms needed for the *TomoTherapy* treatment system, construction requirements, and component specifications.

IMPORTANT: These drawings are for reference only! TomoTherapy Incorporated is not liable for any direct, indirect, special, incidental, or consequential damages resulting from the use of these drawings or the *Site Planning Guide*.

Wireless System Compliance

This device includes a secure wireless connection operating in the 5GHz frequency range for service troubleshooting use, and is in compliance with IEEE standard 802.11a and 802.11n. The wireless system utilizes radios that operate at 50mW or less.

For further information contact the TomoTherapy Project Manager.

How to Contact a TomoTherapy Project Manager

The TomoTherapy Project Manager will contact the facility to begin the planning process. If you have questions during planning and construction, use the information below to contact TomoTherapy:

TomoTherapy, Inc.

1240 Deming Way

Madison, WI 53717-1954 USA

Site Planning Department

Telephone: 608.824.2800

Toll Free: 866.368.4807 (North America only)

FAX: 608.824.3096

Email: siteplanning@tomotherapy.com

Customer Support

Telephone: 608.824.2900

Email: support@tomotherapy.com

The TomoTherapy Treatment System

Site Selection

The *TomoTherapy* treatment system components and support equipment are distributed among five different areas of the site:

1. Treatment Vault
2. Operator Station
3. Planning Station
4. Cluster Rack Room
5. Mechanical Room

As an example, Drawing 1.0 Key Plan at the back of this guide shows a typical room layout for a *TomoTherapy* treatment system. Your site layout may look different, but should include each of these primary areas.

In the next chapter, we list the *TomoTherapy* treatment system components and support equipment supplied by TomoTherapy and provide dimensions for each. Use this information to help plan the best layout to accommodate the *TomoTherapy* treatment system at the facility.

When analyzing the best potential location for the *TomoTherapy* treatment system, the facility is responsible for involving electricians, physicists, ventilation specialists, information technology staff, and facility managers. The TomoTherapy Project Manager will also help during this process by answering questions and assessing options with facility staff and contractors.

Special Considerations When Planning Layout

As you plan where to locate the various rooms for the *TomoTherapy* treatment system, consider the special requirements listed below.

Cluster Rack Room Location

Due to the heat and noise generated by the Data Server equipment, we recommend that you locate it in a room that is separate from the Planning and Operator Stations or other work area. It is also important that you do not place the Data Server equipment in the Treatment Vault or in a room where it will be exposed to electromagnetic interference.

Fiber optic connections are required between the Data Server and Operator Station switches. See "Network Specifications" (Chapter 7) for details.

See "Mechanical Specifications" (Chapter 6) for heat output information.

Operator Station Location

Select an Operator Station location that allows a clear path to the Treatment Vault. The Operator Station and the Data Server must be connected via fiber-optic cable and the distance should not exceed a maximum cable length of 1640 ft (500 m).

See "Network Specifications" (Chapter 7) for more details.

Planning Station Location

The treatment planning station is typically located in the dosimetry area of the facility. If using copper cable connection between the Planning Station and the Data Server, the distance must not exceed a maximum cable length of 300 ft (91.44 m). If using fiber-optic cable, do not exceed 1,640 ft (500 m).

See "Network Specifications" (Chapter 7) for more details.

Frequency Converter

For sites that require it, TomoTherapy supplies a frequency converter that converts the input power to the Power Distribution Unit from 50 to 60 Hz.

To ensure adequate cooling capability for the frequency converter, establish a Mechanical Room that is separate from other areas of the *TomoTherapy* treatment system.

See "Electrical Specifications" (Chapter 5) for converter input power requirements.

See "Mechanical Specifications" (Chapter 6) for converter heat output information.

Architectural Responsibilities

TomoTherapy recommends that the facility use the services of a licensed architect to prepare drawings for the site. Careful preparation of site drawings is critical to the success of the project and will reduce delays. We've outlined a general list of the architect's responsibilities below.

During Planning

1. Supply the TomoTherapy Project Manager with initial drawings of the proposed site as soon as they are available.
2. Prepare a site plan that includes architectural, engineering, and construction documents that comply with the requirements in this guide. Submit the drawing set to TomoTherapy for approval before you release the set to potential contractors for bidding.
3. Work with the TomoTherapy Project Manager to coordinate site inspections and determine the system installation date.
4. Provide a copy of the final construction documents to the TomoTherapy Project Manager as soon as they are available.
5. Submit architectural, construction, electrical, and mechanical documents to regulatory agencies for approval as needed.
6. Continue to communicate with the TomoTherapy Project Manager to ensure that work progresses as specified by TomoTherapy. Site requirements are subject to change without notice, so frequent communication with the TomoTherapy Project Manager is essential. Failure to meet the specifications outlined in this guide may affect the *TomoTherapy* treatment system warranty.

During Construction

1. During construction, ensure that structural, electrical, and mechanical work is performed according to requirements. Notify the TomoTherapy Project Manager of any changes during construction, including changes to the construction completion date.

2. Participate in these TomoTherapy site inspections:

    - **Floor Conduit Inspection**: After all conduit is routed within the floor, but before concrete is poured, the TomoTherapy Project Manager will inspect the conduit diameter, length, and termination points and ensure that there is proper clearance around anchor bolt locations.
    - **Final Site Inspection**: Shortly before construction is complete, the TomoTherapy Project Manager will inspect the site to ensure that construction meets all of the specifications outlined in this guide and to determine whether the site is ready for installation. The Project Manager will complete a checklist and note any work that must be completed by the facility before installation begins. Failure to meet the specifications outlined in this guide may affect the *TomoTherapy* treatment system warranty.

IMPORTANT: If the TomoTherapy Project Manager determines that the site will not be ready for installation by the scheduled date, shipment will be rescheduled based on site readiness and TomoTherapy installation staff availability.

Power Monitoring Program

TomoTherapy requires all facilities to participate in the Power Monitoring Program before a *TomoTherapy* treatment system is installed. Through this program, TomoTherapy verifies that the facility meets minimum power requirements before installation begins. For program details, see “Electrical Specifications” (Chapter 5).

Planning for Delivery and Installation

Even before construction begins, it is important that the facility plans where the system components will be unloaded at delivery and which route the gantry will take from the building entrance to the Treatment Vault. Be sure to indicate the proposed route on the architectural drawings that you submit to TomoTherapy.

During the on-site inspections, the TomoTherapy Project Manager will examine the unloading area and the rigging path and indicate if there are any further steps needed to prepare the route for delivery day.

IMPORTANT: It is the facility's responsibility to ensure that the site complies with all TomoTherapy requirements before delivery and installation. Failure to meet the specifications outlined in this guide may affect the *TomoTherapy* treatment system warranty.

Planning a Delivery Route

As you plan for delivery, consider these questions:

1. Are the facility hallways and doorways large enough for the gantry and clear of obstructions? Is the proposed entrance maze to the Treatment Vault wide enough to accommodate the gantry?

   See Drawing 7.0 Rigging Clearance Plan and 7.3 Rigging Clearance Details.

2. Can the hallway floors tolerate the 8,500-lb (3,856-kg) delivery weight of the gantry? Does the delivery path require additional shoring to protect the facility structure from damage due to the gantry weight?

3. Will any windows, skylights, or doors need to be temporarily removed?

   See Drawing 7.0 Rigging Clearance Plan and 7.3 Rigging Clearance Details.

4. Is the Treatment Vault located on a ground-level floor? If not, how will the gantry be transported to another floor?

5. Does the unloading area include ample parking space for the delivery truck? Is the area between the truck and the facility free from obstructions? If necessary, be prepared to close an adjacent street and obtain any required permits.
6. Are there any unique site-specific rigging or delivery issues? If so, alert the TomoTherapy Project Manager.

Delivery Day

On delivery day, TomoTherapy Installation Technicians will arrive along with a professional rigging crew to unload the truck, move the system to the Treatment Vault, and unpack the system.

The unloading area must be large enough to allow the rigging crew to unload components and to maneuver rigging gear.

For installations in the United States, TomoTherapy transports the treatment system to the site in a 45-ft (13.7-m) truck. All items are on wheels, so everything can be rolled into the facility. (The cluster is delivered in a pallet, but the cluster cabinet has wheels.) The dimensions of the crates that TomoTherapy uses for shipments within the United States are shown in Table 1-1.

Table 1-1: Crate dimensions for shipments within the United States.

Crate Size for Shipments Within the U.S.	Crate Weight for Shipments Within the U.S.
115 x 57 x 93 inches	9562 lb
117 x 30 x 37 inches	1380 lb
32 x 27 x 75 inches	1090 lb
38 x 24 x 62 inches	336 lb
20 x 74 x 78 inches	656 lb
92 x 45 x 87 inches	610 lb
92 x 58 x 61 inches	600 lb
59 x 55 x 45 inches	430 lb
92 x 55 x 61 inches	600 lb

Table 1-1: Crate dimensions for shipments within the United States.

Crate Size for Shipments Within the U.S.	Crate Weight for Shipments Within the U.S.
40 x 48 x 36 inches	462 lb
40 x 48 x 36 inches	444 lb
40 x 48 x 36 inches	494 lb
40 x 48 x 36 inches	426 lb
40 x 48 x 36 inches	520 lb
40 x 48 x 36 inches	400 lb
40 x 48 x 36 inches	878 lb
50 x 50 x 88 inches	1595 lb
36 x 54 x 81 inches	1434 lb
	Total Weight = 21,917 lb

For locations outside of the United States, transportation methods may vary. All items are in wooden crates on skids and the contents are in the original tri-corrugated tri-wall crates. These crages can be moved onto a wheeled skid (procurred locally). The dimensions of the crates that TomoTherapy uses for international shipments are shown in Table 1-2. International sites can use this information to determine the size of vehicle needed to transport the components to the facility.

Table 1-2: Crate dimensions for shipments outside the United States

Crate Size for Shipments Outside the U.S.	Crate Weight for Shipments Outside the U.S.
292 x 145 x 238 cm	4338 kg
297 x 76 x 94 cm	626 kg
82 x 69 x 191 cm	495 kg
97 x 62 x 159 cm	152 kg
51 x 188 x 198 cm	298 kg

Table 1-2: Crate dimensions for shipments outside the United States

Crate Size for Shipments Outside the U.S.	Crate Weight for Shipments Outside the U.S.
234 x 114 x 221 cm	277 kg
234 x 147 x 155 cm	272 kg
150 x 140 x 114 cm	195 kg
234 x 140 x 155 cm	272 kg
102 x 122 x 92 cm	210 kg
102 x 122 x 92 cm	202 kg
102 x 122 x 92 cm	224 kg
102 x 122 x 92 cm	193 kg
102 x 122 x 92 cm	236 kg
102 x 122 x 92 cm	181 kg
102 x 122 x 92 cm	398 kg
127 x 127 x 224 cm	724 kg
92 x 137 x 221 cm	650 kg
	Total Weight = 9942 kg

Unloading the Truck

If the facility has a loading dock (Figure 1-1) and the delivery path is at ground-level, the rigging crew can roll components off the truck and directly into the facility (Figure 1-2).

Figure 1-1: Facility loading dock.

Figure 1-2: Gantry rolled through the facility hallway.

If no loading dock is available and the delivery path is at ground level, the rigging crew can use a forklift to move the components from the truck to the door. To use a forklift, ensure that a parking area that is at least 30 x 50 ft (9 x 15 m) is available and clear from obstructions.

If the Treatment Vault is not at ground level, consider how to transport the gantry to another floor. The gantry might be hoisted through:

- An elevator shaft. Inform the TomoTherapy Project Manager of the elevator's delivery capacity and ensure that an elevator technician is on site when the system is transported through the facility. Ensure that appropriate facility personnel review and approve any delivery plan that involves using an elevator shaft.
- A window or wall opening above ground level.
- A roof opening (Figure 1-3).

Figure 1-3: Gantry lowered by crane through a roof opening.

Be sure to notify your TomoTherapy Project Manager if you plan to use special equipment or otherwise modify the typical delivery process. The TomoTherapy Project Manager will arrange for the special crew and equipment, but the facility is responsible for the cost.

Chapter 2

Equipment

In this chapter, we provide general lists of TomoTherapy- and facility-supplied equipment to help the facility plan for construction and installation. The lists are not exhaustive and are not intended to be comprehensive.

Failure to meet the specifications outlined in this guide may affect the *TomoTherapy* treatment system warranty.

Required Equipment

To help you plan for equipment purchase and installation, review the following two tables. They list TomoTherapy-supplied equipment and the most common facility-supplied equipment. We'll describe many of these components in more detail in the rest of this chapter

Table 2-1: TomoTherapy-supplied equipment

Equipment	Installed by
Gantry and Enclosures	TomoTherapy
Patient Table	TomoTherapy
Power Distribution Unit	TomoTherapy
Operator Station Computer Components	TomoTherapy
Operator Station Network Switch	TomoTherapy
Operator Station Status Console	TomoTherapy
Operator Station Step-Down Transformer	TomoTherapy
Planning Station Computer Components	TomoTherapy
Database Server and Optimizer	TomoTherapy
Lasers	TomoTherapy
Compressed Air Regulator	Facility
Frequency Converter for 50-Hz sites	Facility

NOTE: Table 2-1 and Table 2-2, and similar tables throughout this guide, are intended to provide a general list of TomoTherapy-supplied and facility-supplied equipment. These lists are not intended to be exhaustive.

Table 2-2: Facility-supplied equipment

Equipment	Installed by
Shielding Material	Facility

Table 2-2: Facility-supplied equipment

Equipment	Installed by
Main Disconnect Panel for incoming power	Facility
Emergency Off and Emergency Stop Buttons	Facility
Door Switch and Reset	Facility
System Status Indicators (Power On, Room Ready, Radiation On)	Facility
HVAC Equipment including Thermostats	Facility
Remote Temperature-Monitoring System or Temperature Alarm in the Cluster Rack Room	Facility
Laser Mounting Plates	Facility
Power and Signal Conduits and Trenches	Facility
Junction boxes and Receptacles	Facility
Lighting	Facility
Air Compressor and components for air quality	Facility
Fire Safety Equipment	Facility
Flooring	Facility
Emergency Power System (not required)	Facility
Recommended: Power Conditioner	Facility
Recommended: Gantry Pit Floor Drain or Moisture Sensor	Facility
Recommended: Physics Conduit	Facility
Recommended: Closed-Circuit TV Cameras	Facility
Recommended: Intercom System	Facility
Recommended: Cabinets and Shelving	Facility

The Treatment Vault

The Treatment Vault

The Treatment Vault houses the *TomoTherapy* treatment system, positioning components, and Power Distribution Unit (PDU) (Figure 2-1).

The components in the vault include:

- Rotating gantry assembly and enclosures.
- Patient table.
- Laser positioning system including seven lasers.
- Power Distribution Unit, if no separate equipment room is available.

Figure 2-1: *TomoTherapy* treatment system components in the Treatment Vault (PDU not shown).

For Treatment Vault construction requirements, see “Architectural Specifications” (Chapter 4).

For Treatment Vault electrical requirements, see “Electrical Specifications” (Chapter 5).

For Treatment Vault environmental requirements, see “Mechanical Specifications” (Chapter 6).

Gantry and Enclosures

The rotating gantry assembly generates and delivers radiation to patients. The enclosures cover the gantry.

NOTE: The front gantry covers are designed to detach and roll forward to allow TomoTherapy service personnel to service the gantry. Ensure that there is ample space without obstruction to allow service personnel to move the covers away from the gantry. See Drawing 7.2 Service Clearance.

Table 2-3: Dimensions for gantry with enclosures

Gantry With Enclosures	Dimension
Weight	10,000 lb (4536 kg)
Height	99.3 inches (252.1 cm)
Width	110 inches (279.5 cm)
Depth	68.3 inches (173.6 cm)

Patient Table

The patient table supports and moves the patient through the gantry bore during TomoImage scans and treatment procedures.

Table 2-4: Patient table dimensions

	Dimension
Weight	900 lb (408 kg)
Weight load	440 lb (200 kg)
Height	44.5 inches (113 cm)

Table 2-4: Patient table dimensions

	Dimension
Width	25.5 inches (64.7 cm)
Length	114.2 inches (290 cm) to 182.2 inches (462.7cm)

For patient table power requirements, see “Electrical Specifications” (Chapter 5).

Laser Positioning System

A laser positioning system is mounted in the Treatment Vault to accurately position patients on the table. The five Dorado lasers (Figure 2-2) and two Apollo lasers (Figure 2-3) are mounted on the Treatment Vault walls and ceiling.

Figure 2-2: Dorado lasers.

Figure 2-3: Apollo lasers

For laser mounting information, see "Architectural Specifications" (Chapter 4).

For laser power requirements, see "Electrical Specifications" (Chapter 5).

Operator Station

The Operator Station is the computer workstation (Figure 2-4) that the technologist uses for calibration, patient positioning, registration, imaging, and treatment.

For Operator Station component layout and connectivity, please refer to T-SCH-00018.

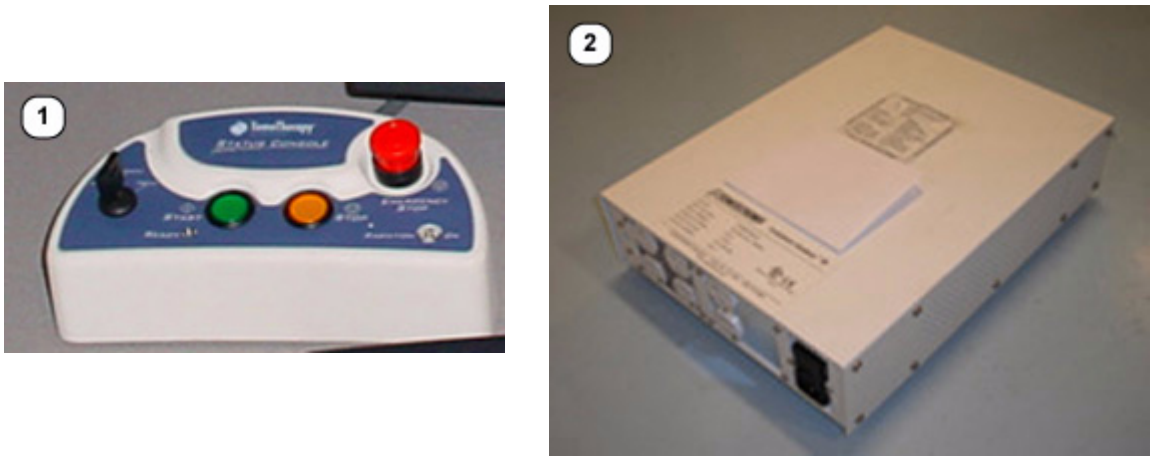


Figure 2-4: Operator Station components

Item	Description
1	Status Console
2	Step-down Transformer

Table 2-5: Operator Station component dimensions

Component	Dimensions
Computer, flat-screen monitor, and keyboard	Standard
Printer	16.5 x 21.5 x 15.6 inches (41.9 cm x 54.6 cm x 39.5 cm)

Table 2-5: Operator Station component dimensions

Component	Dimensions
Status Console	8.5 x 4.5 x 3.0 inches (21.6 cm x 11.4 cm x 7.6 cm)
Step-Down Transformer [Supported on a 18 x 12 x 7 inches (45 x 31 x 18 cm) shelf mounted under the workstation surface]	15.75 x 11.75 x 4 inches (40 cm x 30 cm x 10 cm) Weight = 34 lb (15.5 kg)

Planning Station

The Planning Station is the computer workstation where the clinician analyzes the patient's computed tomography (CT) data and uses it to create an optimized treatment plan. The facility must have on-site a CT device that generates DICOM images.

In addition to standard computer components, the Planning Station may include a Vidar scanner and a film analyzer work station (Figure 2-5), which the facility may purchase separately from TomoTherapy

Figure 2-5: Vidar Scanner.

For Planning Station component layout and connectivity, please refer to T-SCH-00018. For facilities that purchase multiple Planning Stations, the requirements outlined here apply to each station.

Table 2-6: Planning Station component dimensions

Component	Dimension
Computer, flat-screen monitor, and keyboard	Standard
Printer	16.5 x 21.5 x 15.6 inches (41.9 cm x 54.6 cm x 39.5 cm)
Film-analysis equipment	19 x 30 x 24.5 inches (48.3 cm x 76.2 cm x 62.2 cm)

SharePlan Workstation (Optional)

IMPORTANT: It is the customer's responsibility to maintain the system. This includes administering users, adding and maintaining virus-scanning software, and maintaining Windows security updates.

SharePlan is a stand-alone workstation that the customer can purchase as an option. It is used to create a SharePlan treatment plan that can be delivered on an IMRT system other than the *TomoTherapy Treatment System*.

The customer exports a TomoTherapy treatment plan into SharePlan, and then uses SharePlan to do the following:

- Create and optimize individual plans based on the planned dose distribution from the TomoTherapy Treatment plan.
- Evaluate dose distributions, DVH, and dose characteristics for the SharePlan treatment plan.
- Export, via DICOM, the clinically approved SharePlan treatment to a third-party Treatment Delivery System (TDS).

Information Needed prior to SharePlan Installation

Obtain the most current version of 104155, *SharePlan Workstation Pre-Install Checklist*. It details the information that must be collected as you plan for SharePlan installation.

SharePlan Components and Network Topology

See Table 2-7 for SharePlan components and power requirements:

- The SharePlan Workstation computer is shipped standard with a NEMA power cable.
- A 10-ft (305 cm) CAT 5e cable is shipped standard for facility network connection to the SharePlan workstation.

Table 2-7: SharePlan Components and Power

Component	Dimensions	Power (supplied by facility)
Computer (keyboard is standard)	8" W x 17" H x 19" D (20.3 cm x 43.2 cm x 48.3cm)	**North America**: 100-120 VAC, 10 A, 60 Hz **International**: 220-240 VAC, 5 A, 50/60 Hz **Japan**: 100 VAC, 10 A, 50/60 Hz
Flat screen monitor	24” (61 cm)	**North America**: 100-120 VAC, 1.25 A, 60 Hz **International**: 220-240 VAC, 0.65 A, 50/60 Hz **Japan**: 100 VAC, 1.25 A, 50/60 Hz

The Cluster Rack Room

The Cluster Rack Room houses the database server where patient data is imported and stored, and the Optimization Engine where dose optimization and dose calculations are performed. See “Network Specifications” (Chapter 7) for maximum cable length between the Data Server and the Operator Station and Planning Station.

Table 2-8: Data Server dimensions

	Dimension
Weight	900 lb (408 kg)
Height	59 inches (149.8 cm)
Width	26 inches (66.0 cm)
Depth	38 inches (97.0 cm)

For power requirements, see “Electrical Specifications” (Chapter 5).

For heat output specifications, see “Mechanical Specifications” (Chapter 6).

For network requirements, see “Network Specifications” (Chapter 7).

Equipment Room (optional)

Construct an area within the Treatment Vault for the Power Distribution Unit (PDU). The PDU isolates the power source for critical TomoTherapy components in the Treatment Vault and Operator Station.

If you construct a separate Equipment Room, ensure that it is adjacent to the Treatment Vault so that the maximum cable length between the PDU and the gantry does not exceed 35 ft (10.6 m).

IMPORTANT: Do not connect any other components to this power source.

Figure 2-6: PDU in the Equipment Room.

Table 2-9: Power Distribution Unit dimensions

	Dimension
Weight	900 lb (408 kg)
Height	60 inches (152.4 cm)
Width	22 inches (55.9 cm)
Depth	21 inches (53.3 cm)

For configuration and input power information, see “Electrical Specifications” (Chapter 5).

For heat output specifications, see “Mechanical Specifications” (Chapter 6).

Mechanical Room

The Mechanical Room houses the facility-supplied air compressor (Figure 2-7), air tank (Figure 2-8), dryer (Figure 2-9), and filter. For 50-Hz sites, it also holds the TomoTherapy-supplied frequency converter (Figure 2-10).

Figure 2-7: Example of an air compressor in the Mechanical Room.

For power requirements and information about a power conditioner, see "Electrical Specifications" (Chapter 5).

For heat output specifications, see "Mechanical Specifications" (Chapter 6).

Figure 2-8: Air tank suspended from the ceiling in the Mechanical Room.

Figure 2-9: Two examples of an air dryer mounted in the Mechanical Room.

Figure 2-10: Frequency converter (50-Hz sites only).

Table 2-10: Frequency converter dimensions.

	Dimension
Weight	1502 lb (680 kg)
Height	58 inches (145.0 cm)
Width	22 inches (55.9 cm)
Depth	40 inches (100.0 cm)

System Status Indicators

Local regulations often require light or auditory indicators to alert people when the system power is on, the room is ready for radiation, and when radiation is on.

Place system status indicators at the Treatment Vault door or barrier. Provide the TomoTherapy Project Manager with the status-indicator configuration for your site.

Storage Areas

Storage During Installation

The facility must establish a locked storage area where TomoTherapy Installation Technicians can store tools and testing equipment for approximately one month during installation. Choose a location that is near the installation site and that is accessible 24 hours per day.

Also, supply a clean 12 ft x 12 ft (365 cm x 365 cm) low-traffic, indoor storage area where TomoTherapy Installation Technicians can place the gantry enclosures during installation. The enclosures are delivered in sections, so you may establish multiple storage areas if one area cannot accommodate all of the enclosures.

Optional Equipment

Although optional equipment is not required by TomoTherapy, it may be required by local governments; for example, some facilities are required to place a sink in the Treatment Vault. Here are just a few additional examples of features that you might consider including, but that are not required by TomoTherapy:

- Patient dressing room
- Storage cabinets in the Treatment Vault
- Storage for physicist's equipment
- Additional printers, computers, or camera monitors
- Critical-care medical equipment

If the facility plans to install optional equipment, include details in the site plan so the TomoTherapy Project Manager can approve the plan for clearance and serviceability.

Chapter 3

Shielding Considerations

IMPORTANT: The clinical facility is responsible for ensuring that a qualified radiation physicist determines shielding needs and government-regulation compliance before construction begins.

Determine Shielding Needs

Determine Shielding Needs

Each site must comply with government regulations for shielding requirements. It is the facility's responsibility to ensure that a qualified radiation physicist determine the appropriate shielding needs for the site. Before construction begins, the physicist also must submit:

- A shielding analysis report to the government regulatory agency.
- A TomoTherapy Shielding and Leakage Checklist to the TomoTherapy Project Manager.

TomoTherapy will answer any questions you have about the shielding information in this guide, but will not determine shielding needs for the facility. In addition, TomoTherapy cannot be held liable if shielding is inappropriate or inadequate, or if shielding is improperly constructed.

IMPORTANT: The shielding information in this guide is provided for reference only! A qualified radiation physicist must determine shielding requirements based on site considerations and government regulations.

Shielding Considerations

When determining shielding needs, the facility's radiation physicist should consider many factors, among them:

1. The type and amount of any shielding material used to construct existing walls, floor, ceiling, and doors.
2. The current and future expected workload of the Treatment Vault. Consider the number and type of treatments typically made now to determine weekly or yearly monitor units (MU) that the department is likely to require based on the intended clinical case load.
3. Allowable exposure levels.
4. The current and future expected use of the space adjacent to the Treatment Vault.

5. Example scatter data from a *TomoTherapy* treatment system.[1]

Shielding for Renovated Sites

IMPORTANT: If you are renovating an existing site, do not assume that existing shielding is adequate. The unique features of the TomoTherapy treatment system require that a qualified radiation physicist determine shielding needs based on the specifications of this device, the site, and the expected workload. When renovating, consider these factors:

- The *TomoTherapy* treatment system uses intensity modulated radiation therapy (IMRT) that creates a greater accelerator workload than conventional (non-IMRT) devices that might have occupied the site previously.
- Leakage radiation and room shielding considerations increase significantly for IMRT treatments due to the increased beam-on time.
- An existing vault that accommodated a device that is rated at 6 MV accelerator workloads (5 x 106 MU/yr) still may not provide adequate shielding due to different isocenter locations and scatter radiation between the previous device and the *TomoTherapy* treatment system.

IMPORTANT: Do not assume that the beam stop on the *TomoTherapy* treatment system provides adequate shielding for the site or that the existing bunker shielding, in addition to the beam stop, is adequate.

Radiation Levels

The System

The *TomoTherapy* treatment system uses helical and topographic mode (TomoDirect™) to deliver IMRT.

- Helical tomotherapy generates a 6 MV slit beam of radiation that continuously rotates on a slip-ring gantry while the patient moves through the beam.
- TomoDirect generates a 6 MV slit static beam of radiation for different angles, while the patient moves through the beam.

Note that all field widths provided reflect values at isocenter.

The radiation beam is 40 cm wide in the transverse direction at the isocenter level. A primary set of moveable tungsten jaws (23 cm thick) define the delivery slice width, which can be adjusted from 4 mm at MVCT to 5 cm in the inferior-superior direction of the patient. Thus, the maximum size of the primary beam for treatment is limited to 5 cm in the longitudinal direction (slice width) by 40 cm wide in the transverse direction (multi-leaf collimator direction) projected at the isocenter, which is located at 85 cm from the source.

The primary beam is further collimated by sixty-four interleaved, adjustable leaves that each project 6.25-mm at isocenter. By either blocking the radiation or allowing it to pass through, this multi-leaf collimator (MLC) enables the *TomoTherapy* treatment system to provide a range of low to high levels of intensity modulation.

The *TomoTherapy* treatment system includes an on-board primary beam block. The lead-slab beam block is located on the rotating gantry opposite the beam source.

Radiation Testing

At TomoTherapy, we tested levels of leakage, scatter, and primary radiation of a *TomoTherapy* treatment system under these conditions:

- Within a vault that meets the construction requirements listed in this guide. The vault was large (greater than 100 m^2) to minimize secondary scattering from the walls. In addition, a portable cylindrical lead collimator was used to prevent the ion chamber from measuring collected scatter radiation from the walls.
- Using continuous gantry rotation to simulate actual helical treatments.

The results are shown in the rest of this chapter. Tenth-Value Layers (TVL) in concrete (ρ=2.3 g/cm^3) are also provided for both the leakage and the primary beam radiation. This guide includes data for both continuous gantry rotation and static delivery. A qualified radiation physicist should use these results to calculate the shielding requirements for the site.

Leakage Radiation with Continuous Rotation

The effective leakage was measured as a function of angle and distance away from the isocenter. We define zero degrees as the direction from the isocenter to the treatment couch (Figure 3-1). Leakage measurements were performed with the jaws closed and all MLC leaves closed with the gantry rotating at a 20-second rotation period. Data were collected and recorded using a large-volume ion chamber with a collection volume of 800 cc (A6 model, Standard Imaging, Madison, Wisconsin, US).[2] It was placed at angular increments of 15º. The radial distances varied from 100 cm to 350 cm. See Figure 3-2 for an illustration of the rotating gantry and room angles.

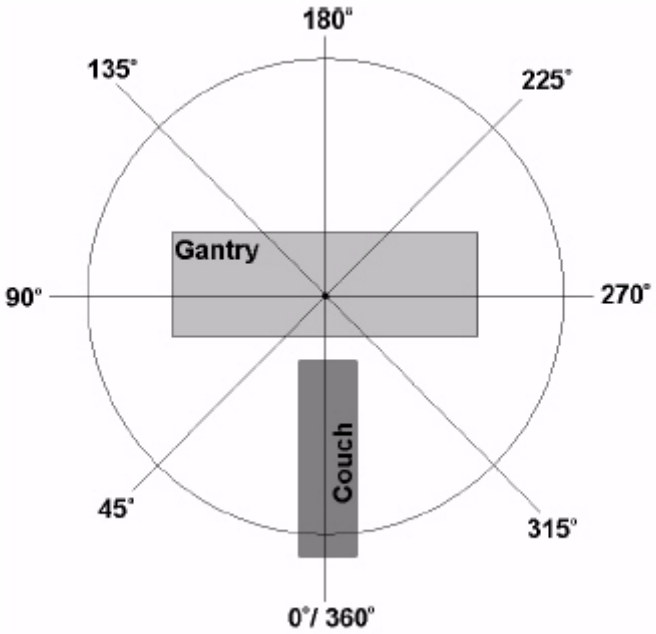


Figure 3-1: Top view of the room angles defined for the room leakage measurements.

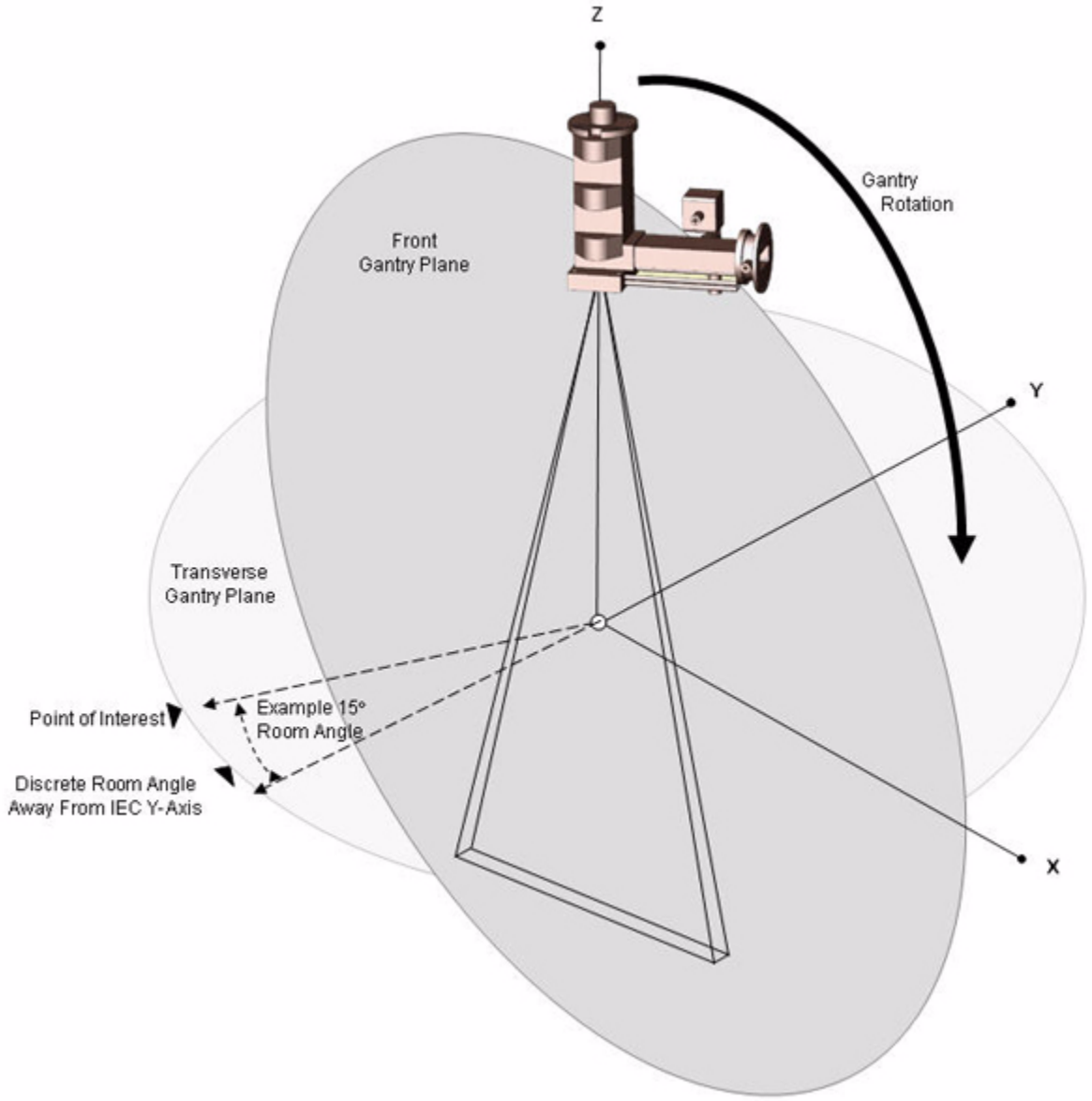


Figure 3-2: Single room leakage measurement location recorded while the gantry rotated continuously.

Leakage radiation levels vs. radial distance away from the isocenter are shown for various room angles in Figure 3-3 and Figure 3-4. The leakage values given are measured leakage relative to the calibration-field output, which is defined as a 5-cm x 40-cm field at isocenter. A power fit was superimposed on the data for angles ranging between 0º and 150º, and extrapolated to all distances between 1 m and 4 m. The extrapolation is

shown graphically in Figure 3-4, both extrapolated and measured data points are shown in Table 3-1, and the power fit results are shown in Table 3-2.

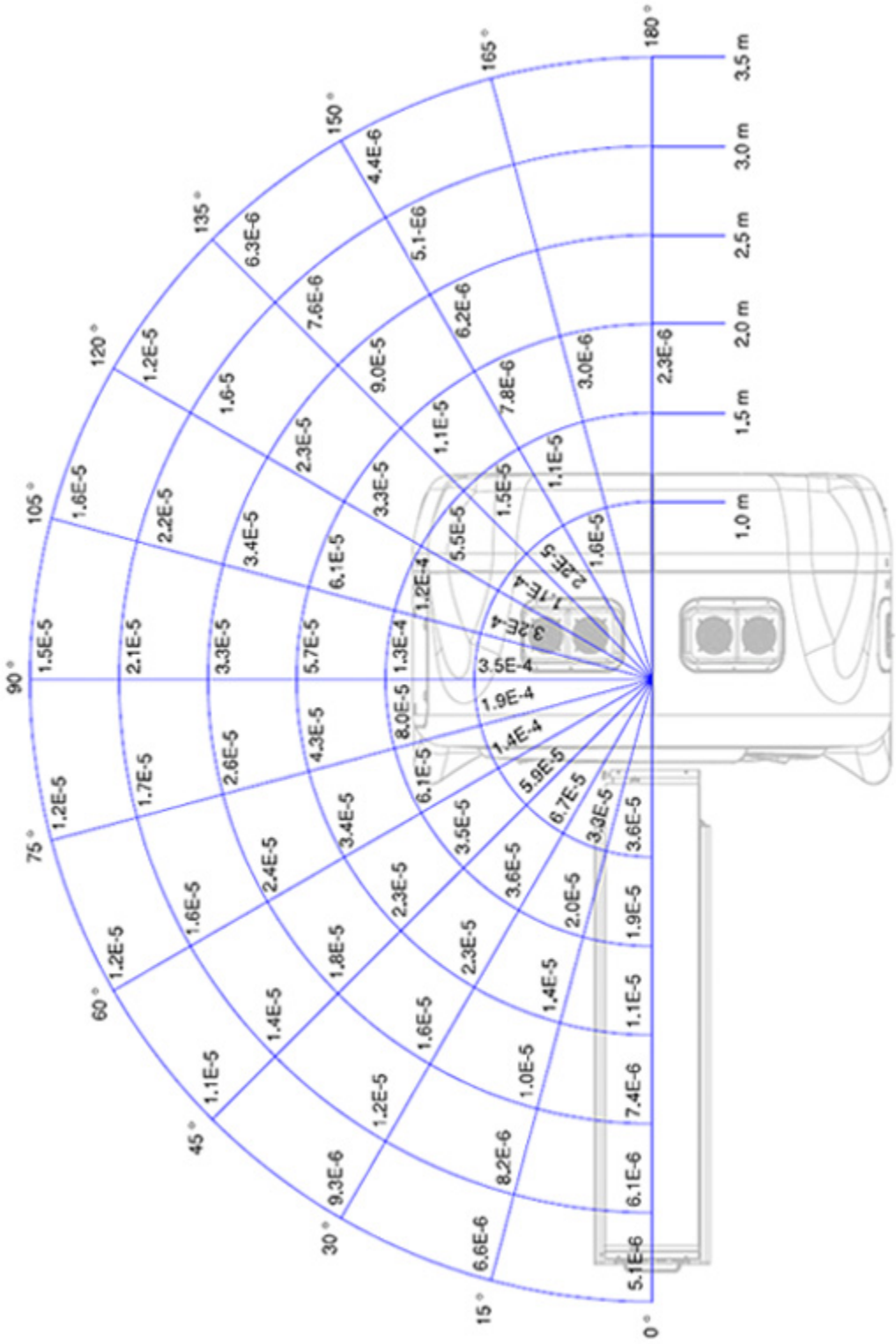


Figure 3-3: Leakage radiation relative to calibration output as a function of angle and distance away from isocenter. Note: Some values are extrapolated from a power fit (see Table 3-1).

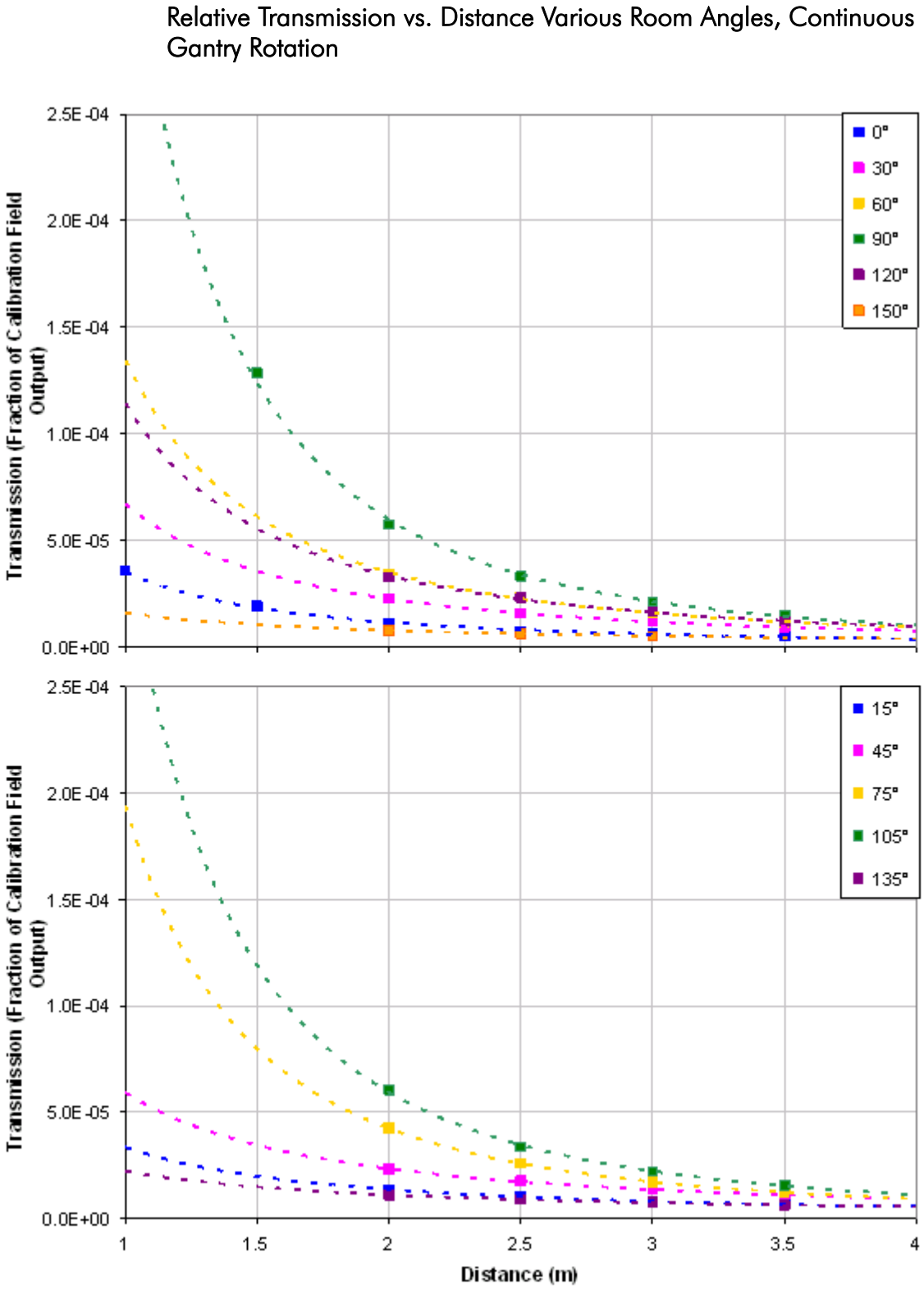


Figure 3-4: Leakage radiation vs. radial distance from the isocenter. Results for all room angles are shown on two graphs for clarity; room angles are as labeled. Note: Values for 165° and 180° are not shown; there were not enough data for a power fit.

Table 3-1: Fraction of the leakage radiation relative to the isocenter output vs. radial distance from the isocenter for various room angle with continuous rotation of the gantry.

Degrees from IEC-Y	Distance From Isocenter (m)					
	1	1.5	2	2.5	3	3.5
0	3.59×10^{-5}	1.91×10^{-5}	1.09×10^{-5}	7.35×10^{-6}	6.11×10^{-6}	5.08×10^{-6}
15	3.35×10^{-5}	1.99×10^{-5}	1.36×10^{-5}	1.04×10^{-5}	8.23×10^{-6}	6.62×10^{-6}
30	6.72×10^{-5}	3.55×10^{-5}	2.27×10^{-5}	1.57×10^{-5}	1.21×10^{-5}	9.32×10^{-6}
45	5.93×10^{-5}	3.45×10^{-5}	2.33×10^{-5}	1.76×10^{-5}	1.37×10^{-5}	1.10×10^{-5}
60	1.35×10^{-4}	6.14×10^{-5}	3.42×10^{-5}	2.36×10^{-5}	1.61×10^{-5}	1.16×10^{-5}
75	1.94×10^{-4}	7.96×10^{-5}	4.25×10^{-5}	2.59×10^{-5}	1.73×10^{-5}	1.24×10^{-5}
90	3.47×10^{-4}	1.29×10^{-4}	5.74×10^{-5}	3.31×10^{-5}	2.13×10^{-5}	1.49×10^{-5}
105	3.17×10^{-4}	1.19×10^{-4}	6.05×10^{-5}	3.38×10^{-5}	2.20×10^{-5}	1.57×10^{-5}
120	1.14×10^{-4}	5.54×10^{-5}	3.26×10^{-5}	2.30×10^{-5}	1.65×10^{-5}	1.20×10^{-5}
135	2.24×10^{-5}	1.49×10^{-5}	1.11×10^{-5}	9.05×10^{-6}	7.61×10^{-6}	6.28×10^{-6}
150	1.60×10^{-5}	1.05×10^{-5}	7.80×10^{-6}	6.23×10^{-6}	5.13×10^{-6}	4.38×10^{-6}
165	--	--	2.98×10^{-6}	--	--	--
180	--	--	2.30×10^{-6}	--	--	--

NOTE: Italicized values are extrapolated from the power fit shown in Figure 3-4 and Table 3-2.

Table 3-2: Power-curve fit for leakage vs measurement radius plots in Figure 3-4. Note: The variable y represents the fraction of leakage related to the output at isocenter as a function of the distance to isocenter.

Room Angle (degrees)	Transmission (Power-Curve Fit; distance in m)
0º	$y = (3.52 \times 10^{-5}) \times distance^{-1.6058}$
15º	$y = (3.35 \times 10^{-5}) \times distance^{-1.2863}$
30º	$y = (6.72 \times 10^{-5}) \times distance^{-1.5736}$
45º	$y = (5.93 \times 10^{-5}) \times distance^{-1.3392}$
60º	$y = (1.35 \times 10^{-4}) \times distance^{-1.9428}$
75º	$y = (1.94 \times 10^{-4}) \times distance^{-2.1981}$
90º	$y = (3.47 \times 10^{-4}) \times distance^{-2.5360}$
105º	$y = (3.17 \times 10^{-4}) \times distance^{-2.4154}$
120º	$y = (1.14 \times 10^{-4}) \times distance^{-1.7800}$
135º	$y = (2.24 \times 10^{-5}) \times distance^{-1.0010}$
150º	$y = (1.60 \times 10^{-5}) \times distance^{-1.3007}$

Scatter Radiation with Continuous Gantry Rotation

To provide full scattering conditions, we used the maximum field size of 5 cm x 40 cm with all multi-leaf collimator leaves open, placed a cylindrical phantom at isocenter, and rotated the gantry for three 20-second rotations. We then measured radiation due to scatter off of the phantom patient. We recorded measurements at angular increments from 0º to 180º at a single radial distance of 2.0 m. Table 3-3 shows the these (leakage + scatter) measurements, as well as the original leakage values from Table 3-1 for comparison purposes.

The table below shows the worst-case patient scatter; clinically relevant patients will exhibit smaller scatter increases. For example, at 90º, the increase in measured radiation due to scatter from the patient is 47% ($8.44 \times 10^{-5}/5.74 \times 10^{-5} = 1.47$). However, this was measured at maximum

aperture (5.0 cm) with all 64 leaves open and no modulation. For a clinical case that uses the 2.5-cm beam, on average 16 leaves per projection, and on average 50% leaf open time (modulation factor 2.0), this additional scatter would be reduced by a factor of 16, bringing the scatter increase down to 2.9%. See Table 3-5 for a few clinical examples.

Table 3-3: Total (leakage + patient scatter) radiation at 200 cm from isocenter, relative to calibration output.

Room Angle (degrees)	Leakage Radiation Jaws and Leaves Closed	Leakage and Scatter Radiation Jaws and Leaves Open
0°	1.09×10^{-5}	7.81×10^{-5}
15°	1.36×10^{-5}	8.21×10^{-5}
30°	2.27×10^{-5}	1.01×10^{-4}
45°	2.33×10^{-5}	1.14×10^{-4}
60°	3.42×10^{-5}	1.22×10^{-4}
75°	4.25×10^{-5}	1.31×10^{-4}
90°	5.74×10^{-5}	8.44×10^{-5}
105°	6.05×10^{-5}	8.43×10^{-5}
120°	3.26×10^{-5}	3.92×10^{-5}
135°	1.11×10^{-6}	2.68×10^{-5}
150°	7.80×10^{-6}	5.73×10^{-5}
165°	2.98×10^{-6}	7.59×10^{-5}
180°	2.30×10^{-5}	5.79×10^{-5}

Primary Radiation with Continuous Gantry Rotation

Measurements taken 1.36 m below isocenter using a large-volume ionization chamber indicate that the lead beam stop reduces the transmission of primary radiation to 0.4% of the calibrated output at isocenter. The effect of this attenuation on shielding requirements must be fully evaluated.

The primary radiation contribution was 6.3% of the overall radiation level at 250 cm from isocenter as measured within the plane of gantry rotation (room angle = 90º). This was measured with maximum aperture (5 cm x 40 cm). For clinical cases, the effective contribution of the primary beam could conservatively be reduced by a factor of 16, as was the scatter radiation, by assuming, on average, a field width of 2.5 cm, 16 open leaves and a modulation factor of 2.0.

Leakage Radiation with a Static Gantry

Leakage was measured relative to the output at isocenter at the plane of the patient with the gantry at 0º, as shown in Figure 3-1 and in Table 3-4. All measurement values are expressed as a percentage of the calibrated output at isocenter. In the plane of measurements, the highest leakage happens between 75 and 90º. At 2 m and 90º, leakage is approximately 0.001%.

In addition, the leakage 100 cm from the electron path between the gun and target, including a 100 cm hemisphere radiused from the gun, has been measured in the isocenter plane, with the gantry at 270º. The maximum leakage value for a horizontal scan of 180º around the machine head is 0.02%. For the same position of the gantry, but in the vertical scan plane, the maximum leakage has been calculated to also be at 0.02%.

Leakage measured at 100cm from the electron gun, on axis from the top of the accelerator, is less than 0.1% of the reference value (treatment beam at machine isocenter).

Table 3-4: Leakage radiation for a static gantry located at 0º vs. radial distance from the isocenter.

Degrees	Distance From Isocenter (m)					
from IEC-Y	1	1.5	2	2.5	3	3.5
0	2.68×10^{-5}	1.82×10^{-5}	1.12×10^{-5}	6.80×10^{-6}	6.11×10^{-6}	5.82×10^{-6}
15	2.73×10^{-5}	1.63×10^{-5}	9.52×10^{-6}	6.71×10^{-6}	5.62×10^{-6}	4.87×10^{-6}

Table 3-4: Leakage radiation for a static gantry located at 0° vs. radial distance from the isocenter.

Degrees from IEC-Y	Distance From Isocenter (m)					
	1	1.5	2	2.5	3	3.5
30	3.49×10^{-5}	1.55×10^{-5}	1.05×10^{-5}	6.09×10^{-6}	5.22×10^{-6}	4.70×10^{-6}
45	2.73×10^{-5}	1.63×10^{-5}	9.52×10^{-6}	6.71×10^{-6}	5.62×10^{-6}	4.87×10^{-6}
60	1.07×10^{-5}	7.18×10^{-6}	4.99×10^{-6}	4.27×10^{-6}	3.72×10^{-6}	3.36×10^{-6}
75	--	8.22×10^{-6}	5.21×10^{-6}	4.40×10^{-6}	3.72×10^{-6}	3.36×10^{-6}
90	--	7.78×10^{-6}	5.76×10^{-6}	4.87×10^{-6}	4.13×10^{-6}	3.48×10^{-6}
105	--	3.75×10^{-6}	2.96×10^{-6}	2.49×10^{-6}	2.33×10^{-6}	2.16×10^{-6}
120	--	1.52×10^{-6}	1.89×10^{-6}	1.99×10^{-6}	1.89×10^{-6}	1.71×10^{-6}
135	--	--	2.09×10^{-6}	2.01×10^{-6}	$1.82x\ 10^{-6}$	1.67×10^{-6}
150	--	2.33×10^{-6}	2.38×10^{-6}	2.28×10^{-6}	2.23×10^{-6}	2.06×10^{-6}
165	--	2.44×10^{-6}	2.48×10^{-6}	2.34×10^{-6}	--	--
180	4.03×10^{-6}	2.88×10^{-6}	2.64×10^{-6}	2.41×10^{-6}	--	--

Tenth-Value Layer (TVL) for Leakage Radiation

The TVL for the leakage radiation was measured using a standard measurement setup as described by Nelson and LaRiviere.[3] As with the leakage measurements described earlier, a cylindrical lead shield was used to prevent room scatter from contaminating the measurements. The measured TVL in concrete (ρ=2.3 g/cm^3) for the leakage radiation was 29 cm.[3,4,5]

Tenth-Value Layer (TVL) for Primary Radiation

The TVL for primary radiation was measured with the same equipment, but with the ion chamber positioned beyond the beam stop. The measured TVL in concrete (ρ=2.3 g/cm^3) for the primary radiation was 34 cm.[4,5]

Treatment Characteristics

Clinical use of the *TomoTherapy* treatment system can vary considerably from facility to facility. Qualified radiation physicists can estimate the weekly or yearly MU that their department is likely to require based on their intended clinical case load and the proportion of the techniques provided by TomoTherapy. They can then use that information, along with the applicable allowable exposure levels to determine or analyze their room and shielding design. Qualified radiation physicists also can determine if scatter radiation should be considered in their shielding design.

This guide provides some basic information about typical TomoHelical and TomoDirect treatments to aid the physicist in making these estimates. The output rate assumed in this section is 880 cGy/min (1.5 cm depth, SAD setup), which is typical for current-production *TomoTherapy* treatment systems.

In TomoHelical mode, some typical treatment parameters are shown in Table 3-5 for three sample cases. Given these typical cases, a radiotherapy department that treats only prostates could probably treat as many as four patients per hour, for a total beam-on time of 16 minutes per hour. Other treatment sites might require more beam-on time, as shown in Table 3-5.

Table 3-5: *TomoTherapy* treatment system example treatment parameters in TomoHelical mode.

Treatment Site	Prescription Dose (Gy)	Fraction Dose (Gy)	Beam-on Time (min)	Field Width (cm)	Number of Open Leaves	Leaf Open Time (%)
Prostate	78.0	2.0	4.0	2.5	12	41
Whole Brain	30.0	3.0	3.5	2.5	9	60
Nasopharynx	72.0	2.1	6.3	2.5	10	54

In TomoDirect mode, typical beam-on times are 4 minutes. A radiotherapy department using TomoDirect could probably treat as many as five patients per hour, for a total beam-on time of 20 minutes. As with TomoHelical plans, only a subset of the 64 leaves will normally be used for clinical cases, and the leaf-open times will be less than 100%.

References

1. J. Blalog, D. Lucas, C. DeSouza, and R. Crilly, 2005. Helicla TomoTherapy radiation leakage and shielding considerations. Medical Physics. 32(3):710-819.
2. Minniti, R. and S.M. Seltzer, 2007. Calibration of a 137Cs γ-ray beam irradiator using large size chambers. Applied Radiation and Isotopes 65, 401-403.
3. Nelson, W.R. and P.D. LaRiviere, 1984. Primary and leakage radiation calculations at 6, 10, and 25 MeV. Health Phys. 47, 811-18.
4. National Council on Radiation Protection and Measurements, 2005. NCRP 151: Structural shielding design and evaluation for megavoltage x- and gamma-ray radiotherapy facilities (Bethesda, MD: National Council on Radiation Protection and Measurements).
5. International Atomic Energy Agency, 2006. Radiation Protection in the Design of Radiotherapy Facilities. Safety Reports Series no. 47 (Vienna: International Atomic Energy Agency).

Chapter 4

Architectural Specifications

IMPORTANT: The clinical facility is responsible for ensuring that site construction meets all of the requirements specified in this guide and by all government regulatory agencies. If you have questions about any of the requirements detailed in this guide, contact a TomoTherapy Project Manager.

Failure to meet the specifications outlined in this guide may affect the *TomoTherapy* treatment system warranty.

Facility-Supplied Equipment for Construction

The table below lists equipment and materials for construction that the facility must supply.

Table 4-1: Facility-supplied equipment and materials

Equipment and Materials	Specifications	Installed by
Shielding Material	Comply with government regulations and facility requirements determined by a qualified radiation physicist.	Facility
Laser Mounting Plates	See (page 4-13).	Facility
Electrical Trenches with dividers	Comply with local regulations/ facility requirements	Facility
Flooring	See (page 4-11).	Facility
Standard construction materials including concrete, rebar, studs, drywall, etc.	Comply with local regulations/ facility requirements	Facility
Recommended: Gantry Pit Floor Drain or Moisture Sensor	Drain: Accommodate a water drainage flow rate of 1 gpm (3.81 lpm). Sensor: Comply with local regulations/facility requirements	Facility
Optional: Treatment Vault Cabinets and Shelving	Comply with local regulations/ facility requirements	Facility

Treatment Vault Dimensions

Treatment Vault Dimensions

Construct the Treatment Vault to the dimensions listed in Table 4-2 and Table 4-3. Refer to these drawings for all Treatment Vault specifications:

- Drawing 2.0 Isocenter and Sub-Base Location Plan
- Drawing 2.1 Sub-Base Layout
- Drawing 2.2 Sub-Base Details

Table 4-2: Treatment Vault dimensions

	Dimensions
Height	9 ft (274.3 cm)
Width	17 ft (518 cm)
Length with Equipment Area	28.2 ft (860 cm)
Length without Equipment Area	23 ft (701 cm)

Table 4-3: Treatment Vault entrance maze dimensions

	Dimension
Height	Gantry delivered on wheels: 6 ft 10 inches (208.3 cm) Gantry delivered on skates: 7 ft (213.4 cm)
Width	4 ft (122 cm)

Clearances

When planning for vault construction, ensure that any storage cabinets or shelving are placed outside of the required clearances specified in Drawing 7.2 Service Clearance. Construct shelving or cabinets outside of the service area.

Gantry Sub-base

Gantry Sub-base

Construct the sub-base according to structural documents prepared by a licensed structural engineer.

The gantry sub-base must meet local code requirements and support the 10,000-lb (4536-kg) weight of the gantry. Allow for a minimum sub-base depth of at least 10 inches (25.4 cm) for gantry anchor bolt placement.

NOTE: TomoTherapy is responsible for installing the anchor bolts.

Route all conduit, drain lines, and rebar clear of the gantry and patient-table anchor locations (Figure 4-1). See Drawing 2.1 Sub-Base Layout for sub-base components and locations.

Floor Levelness

The floor must be level enough to meet a required flatness tolerance of ± 0.25 inches (0.635 cm) over 10 ft (305 cm).

See Drawing 7.1 Floor Tolerance.

Figure 4-1: Gantry pit construction and utility routing before concrete pour.

Seismic Regulations

If the facility is required to meet local or regional seismic regulations, provide the TomoTherapy Project Manager with the specifics of those regulations in writing. Add time to the site-preparation schedule so a TomoTherapy Installation Technician can visit the site prior to system delivery to install anchors for the Gantry, Patient Table, PDU, and Data Server Unit. Anchors must be specified by a facility-contracted structural engineer. TomoTherapy will supply and install the specified anchors.(Figure 4-2).

If local or regional seismic regulations require support angles for the PDU and DSU, TomoTherapy will supply a Seismic Cluster Mounting Kit (PN 101033).

Successful regulatory inspections of anchors must occur before the system is installed. It is the facility's responsibility to contact the regulatory agencies and arrange for any required inspections prior to system installation.

Figure 4-2: Treatment Vault showing gantry pit.

Gantry Pit Dimensions

Construct a floor pit to the dimensions listed in Table 4-4. TomoTherapy will install the gantry over this pit (Figure 4-3). Slope the floor of the pit to allow for drainage. The depth of the pit must measure at least 10 inches (25.4 cm), but may be deeper. Construct the pit topography to be as square as possible.

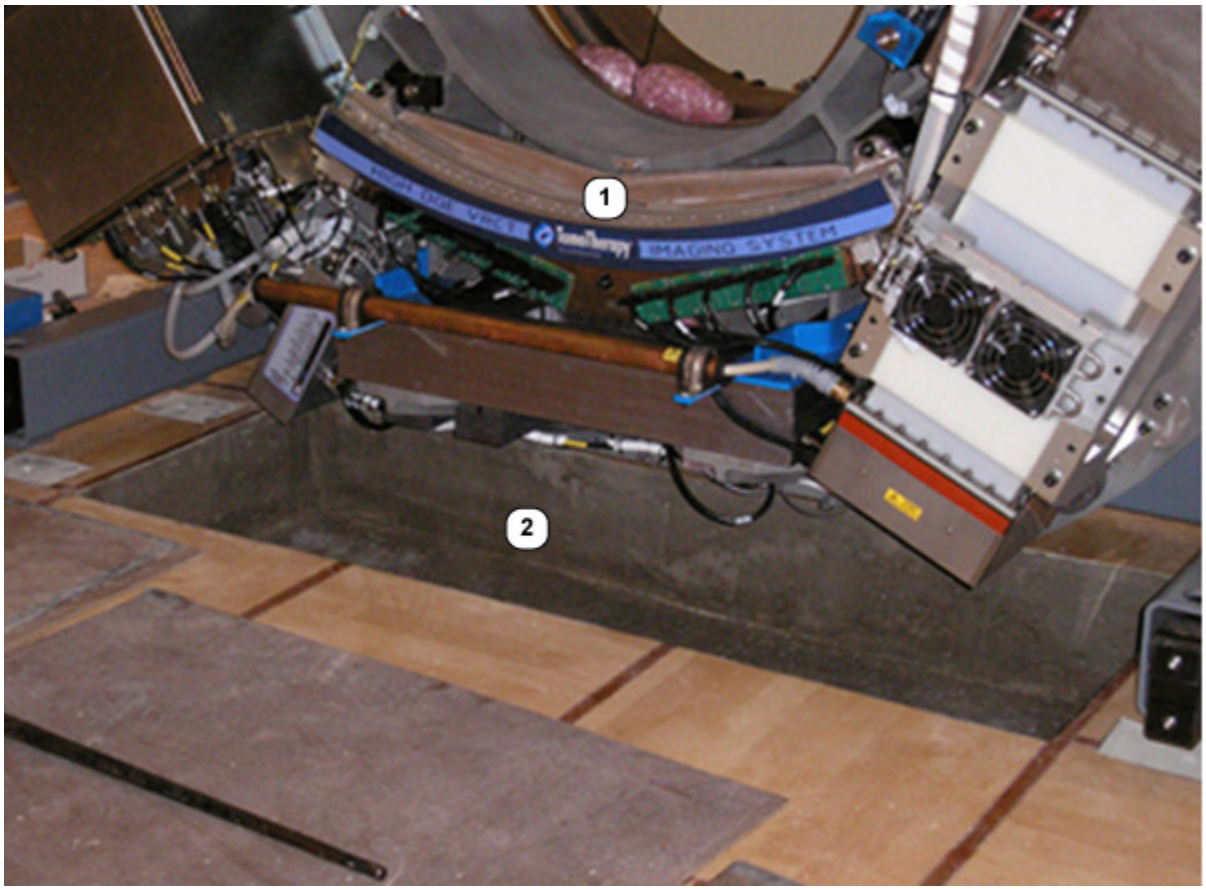


Figure 4-3: The gantry is positioned over the pit.

Item	Description
1	Gantry
2	Pit

Table 4-4: Gantry pit dimensions

	Dimensions
Length	6 ft 2.5 inches (189.2 cm)
Width	2 ft 3.5 inches (69.9 cm)
Depth	10 inches (25.4 cm)

Gantry Pit Floor Drain

TomoTherapy recommends that you install an unobstructed floor drain in the gantry pit floor for emergency water evacuation. Install the drain in the front right or front left corner of the gantry pit to accommodate a water drainage flow rate of 1 gpm (3.8 lpm) (Figure 4-4). Install the drain at the lowest point in the pit to ensure good drainage.

IMPORTANT: If you install a drain in the gantry pit, include all drain features that are required by local code; for example, a water trap, backflow preventer, etc.

If the site will not accommodate a floor drain in the pit, we require that you use a moisture sensor connected to an alarm to alert you if water enters the pit. Do not wire the moisture sensor to the shunt trip.

Figure 4-4: Gantry pit with floor drain.

Trenches

Main

Construct a main trench measuring at least 12 inches wide x 4 inches deep (30.5 cm wide x 10.2 cm deep) from the PDU toward the back of the gantry. Install dividers as specified in Drawing 4.0 Conduit and Trench Plan.

Signal and Power

Construct separate signal and power cable trenches from the main trench to the back of the gantry following these guidelines (also see Figure 4-5 and Drawing 4.0 Conduit and Trench Plan):

- Outside edges must be within 18 inches (46 cm) of either side of the machine centerline.
- Minimum of 8 inches wide x 4 inches deep. (20.3 cm x 10.2 cm).
- Terminate 2 ft 5 inches (73.7 cm) from isocenter.
- Install dividers as specified in Drawing 4.0 Conduit and Trench Plan.

Electrical trenches must be grounded according to regulatory agency requirements.

See Drawing 2.1 Sub-base Layout.

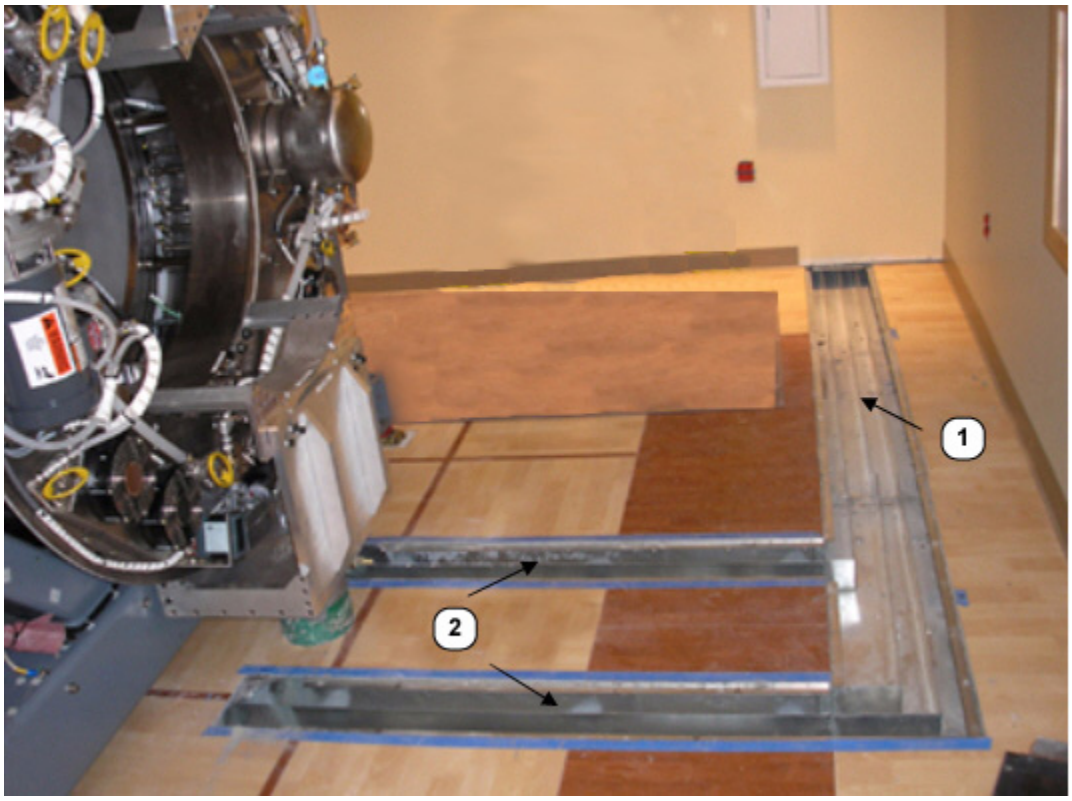


Figure 4-5: Power and signal trenches branching from the main trench to the back of the gantry.

Item	Description
1	Main Trench
2	Power and Signal Trenches

Floor Covering

Install finished flooring before the *TomoTherapy* treatment system is delivered and installed.

In the Treatment Vault and at the Operator Station, we recommend that you use static-dissipative sheet vinyl or similar floor covering.

CAUTION: Static discharges from carpeting can cause the following:

- Patient discomfort
- Component failure while gantry enclosures are removed for service or maintenance activities

Do not use floor covering that produces static electricity to cover the floors in the Treatment Vault. If you install carpeting, select an ion-resistant, anti-static carpet or a carpet treated with an anti-static solution.

The TomoTherapy Installation Technicians may need to remove portions of the floor covering around the gantry and patient table to ensure that those components rest on the concrete floor, but these areas will not be visible when the gantry enclosures and patient-table base cover are in place.

If you install flooring after the *TomoTherapy* treatment system is installed, stop a minimum of 2 inches (50.8 mm) from each side of the aluminum patient table base to allow TomoTherapy service staff to adjust the table position. The table base measures 20 x 50 inches (50.8 cm x 127 cm).

Treatment Vault Entrance

To secure the entrance to the Treatment Vault, install either a shielded door or a door-less maze with a door/entrance interlock device.

IMPORTANT: A radiation physicist must determine the appropriate door thickness and material based on the shielding requirements of the site.

Figure 4-6: Standard Treatment Vault door.

Figure 4-7: Sliding Treatment Vault door.

Laser Mounting Plates

Laser Mounting Plates

NOTE: Laser mounting plates must be spaced 1/2 inch off any concrete surface.

Five Dorado lasers and two Apollo lasers will be mounted to the walls and ceiling of the Treatment Vault by the laser manufacturer. To prepare for laser installation, provide and install 3/8-inch (0.95 cm) aluminum laser mounting plates either directly on the wall and ceiling surface or in recessed openings.

Lasers are used to help accurately position the patient, so it is important that you install the laser mounting plates precisely in the positions listed in this guide.

See Drawing 3.2 Laser Equipment Details for clearance and mounting information, and laser cabinet and laser guard specifications. Cut openings in the doors only after the lasers are installed. If you protect the lasers with cabinets or doors, keep the openings free from obstructions. Do not insert windows into the cabinet or door openings.

Figure 4-8: Recessed lasers covered by doors.

As you plan for construction or renovation, consider which of the three mounting options described below will work best for the site.

Fully Recessed Openings

If the furred out wall of the Treatment Vault has sufficient thickness of 8 to 10 inches (20.32 to 25.4 cm), we recommend that you construct recessed openings for the lasers. Consider providing additional protection by installing doors over the lasers (Figure 4-8).

NOTE: If you plan to install doors over the lasers, a facility physcist must mark the position of the openings in the cabinet doors, with help from a TomoTherapy Installation Technician, and a facility contractor must cut the door openings.

Partially Recessed Openings

If the Treatment Vault lacks enough available space for a fully recessed opening, consider constructing a partially recessed opening (Figure 4-9). You can provide additional protection for the lasers by constructing cabinets around them.

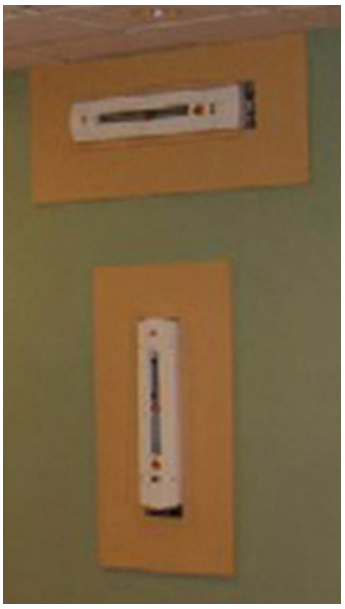


Figure 4-9: Partially recessed Dorado lasers without cabinets.

NOTE: If you plan to install doors over the lasers, a facility physcist must mark the position of the openings in the cabinet doors, with help from a TomoTherapy Installation Technician, and a facility contractor must cut the door openings.

Surface

When a recessed opening is not feasible, you must mount the laser plates to the wall and ceiling surfaces. Construct cabinets around the lasers or install laser guards to ensure their protection (Figure 4-10).

Figure 4-10: Surface-mounted lasers covered with cabinets.

NOTE: If you plan to install doors over the lasers, a facility physcist must mark the position of the openings in the cabinet doors, with help from a TomoTherapy Installation Technician, and a facility contractor must cut the door openings.

Surface-Mounted Lasers

Construct the mounting surface with unistrut or concrete. See Drawing 3.0 Treatment Vault Equipment Plan and Table 4-5 for laser locations. Mount the plates so that they rest at least 0.5 inches (1.3 cm) off the concrete.

Install steel bars or a plastic laminate enclosure on either side of wall-surface-mounted lasers to protect them. An 8-inches (20.3 cm) minimum recessed laser guard is required. See Drawing 3.2 Laser Equipment Details.

See Figure 4-11 and Figure 4-12 for examples of surface-mounted plates

Table 4-5: Surface-mounted laser plate locations

Drawing 3.0 Number	Laser	Vault Location	Plate/Surface	Placement
1A	Apollo Overhead	Ceiling	18 x 12 x 0.25 inches (45.7 cm x 30.5 cm x 0.6 cm)	Centered on the ceiling at virtual isocenter 2 ft 3.5 inches (70 cm) from the machine isocenter.
1B	Apollo Gantry Rear	Wall behind the gantry	18 x 12 x 0.25 inches (45.7 cm x 30.5 cm x 0.6 cm)	Vertical, centered at isocenter height 3 ft 8.25 inches (112.4 cm) above the finished floor.
2A	Dorado Overhead	Ceiling	42 x 16 x 0.25 inches (106.7 cm x 40.6 cm x 0.6 cm)	Centered on the ceiling, 5 ft (152.4 cm) in front of the machine isocenter.
2B	Dorado Vertical Side (2)	Each wall to the left and right side of the gantry	42 x 16 x 0.25 inches (106.7 cm x 40.6 cm 0.6 cm)	Vertical, centered at virtual isocenter 2 ft 3.5 inches (70 cm) from the machine isocenter. Install so that the center of the plate is 3 ft 8.25 inches (112.4 cm.) above the finished floor.
2C	Dorado Horizontal Side (2)	Each wall to the left and right side of the gantry	42 x 16 x 0.25 inches (106.7 cm x 40.6 cm x 0.6 cm)	Horizontal, centered at virtual isocenter 2 ft 3.5 inches (70 cm) from the machine isocenter. Install so that the center of the plate is 12 inches (30.5 cm) minimum below the ceiling.

See Drawing 4.1 Laser Conduit Plan and 4.2 Laser Conduit Elevation.

Figure 4-11: Dorado side laser plates mounted on the wall surface.

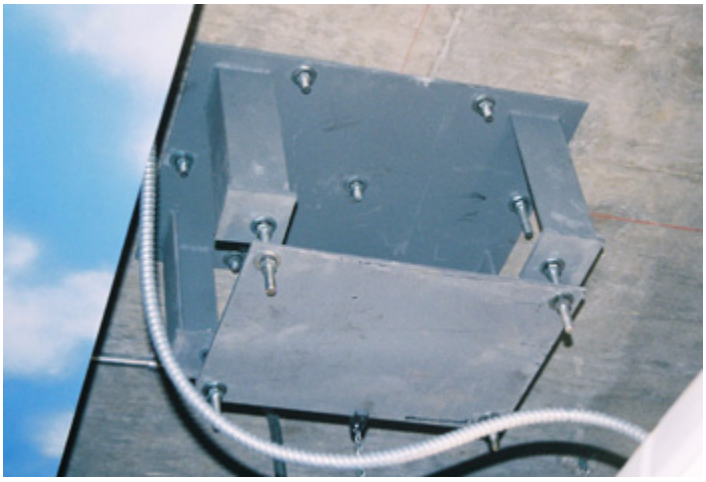


Figure 4-12: Apollo mounting plate on the Treatment Vault ceiling.

Recessed-Opening-Mounted Lasers

If the facility plans to install the lasers in recessed openings, follow the guidelines listed in Table 4-6 to determine the size of the openings.

The finished wall must not overlap the mounting plate. The plate must remain independent of the furred out wall.

See Drawing 3.2 Equipment Details for recessed laser plate specifications

Table 4-6: Treatment Vault laser opening dimensions

Drawing 3.0 Number	Laser	Vault Location	Clear Opening Size	Clear Recess Depth
1A	Apollo Overhead	Ceiling	18 x 12 inches (45.7 x 30.5 cm)	At least 10 inches (25.4 cm.) from the steel mounting plate to the ceiling plane.
1B	Apollo Gantry Rear	Wall behind the gantry	18 x 12 inches (45.7 x 30.5 cm)	At least 8 inches (20.32 cm) from the mounting plate to the recess opening on the wall plane or laser-box door.
2A	Dorado Overhead	Ceiling	42 x 16 inches (106.7 x 40.6 cm)	At least 10 inches (25.4 cm) from the mounting plate to the ceiling plane.
2B	Dorado Vertical Side (2)	Each wall to the left and right side of the gantry	42 x 16 inches (106.7 x 40.6 cm)	At least 8 inches (20.32 cm) from the mounting plate to the recessed opening on the wall plane.
2C	Dorado Horizontal Side (2)	Each wall to the left and right side of the gantry	42. x 16 inches (106.7 x 40.6 cm)	At least 8 inches (20.32 cm) from the mounting plate to the recessed opening on the wall plane.

Figure 4-13: Recessed laser openings.

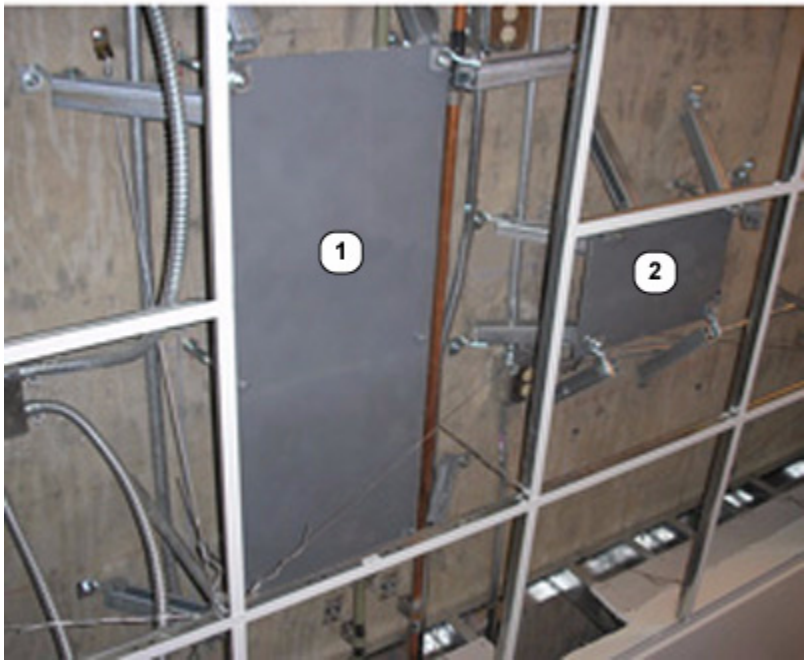


Figure 4-14: Apollo and Dorado mounting plates on Treatment Vault ceiling.

Item	Description
1	Dorado Laser Mounting Plate
2	Apollo Laser Mounting Plate

Equipment Room Dimensions

If there is not room in the Treatment Vault for an equipment area to place the PDU, construct a separate Equipment Room within 35 ft (1066.8 cm) of the gantry to the minimum dimensions listed in Table 4-7. If you plan to also place the Service Tool Kit and other equipment in this room, expand the room size accordingly.

Table 4-7: Equipment room dimensions

	Minimum Dimensions
Height	9 ft (275 cm)
Width	4 ft 9.5 inches (146 cm)
Depth	4 ft 9.5 inches (146 cm)

Operator and Planning Stations

Construct workspace to accommodate the Operator Station computer, status console, and printer. For equipment dimensions, see “Equipment” (Chapter 2).

Construct a 18 x 12 x 7 inches (45 x 31 x 18 cm) shelf under the Operator Station workstation surface for the step-down transformer.

Construct workspace to accommodate the Planning Station computer, printer, and film analyzer. For equipment dimensions, see “Equipment” (Chapter 2).

Chapter 5

Electrical Specifications

IMPORTANT: The clinical facility is responsible for ensuring that site construction meets all of the requirements specified in this guide and by all government regulatory agencies. If you have questions about any of the requirements detailed in this guide, contact a TomoTherapy Project Manager immediately.

Failure to meet the specifications outlined in this guide may affect the *TomoTherapy* treatment system warranty.

Facility-Supplied Equipment

The table below lists the electrical equipment that the facility must supply. See Table 2-1 in "Equipment" (Chapter 2) for TomoTherapy-supplied electrical equipment.

Table 5-1: Facility-supplied equipment

Equipment	Specifications	Installed by
Main Disconnect Panel for incoming power	Rated for supply voltage, 70 A, shunt trip recommended.	Facility
Emergency Off and Emergency Stop Buttons	Push to operate, twist to reset.	Facility
Door/Entrance Switch and Reset	Local regulations/facility requirements.	Facility
System Status Indicators (Power On, Room Ready, Radiation On).	Incandescent bulbs, 40 to 200 W fluorescent bulbs, fluorescent lamp with electronic or inductive ballast, or auditory indicators.	Facility
Thermostats	2°F /1°C response	Facility
Temperature Sensors	Alarm activated if Cluster Rack Room temperature exceeds 68°F (20°C).	Facility
Junction Boxes and Receptacles	Local regulations/facility requirements.	Facility
Power and Signal Conduits	Local regulations/facility requirements.	Facility
Electrical Trenches	Local regulations/facility requirements.	Facility
Lighting	Local regulations/facility requirements.	Facility
Fire Safety Equipment	Local regulations/facility requirements.	Facility
Emergency Power System (not required)	Configured to meet system power requirements.	Facility
Recommended: Power Conditioner (double conversion)	Configured to meet system power requirements.	Facility
Recommended: Physics Conduit	Local regulations/facility requirements.	Facility
Recommended: Closed-Circuit TV Cameras	Local regulations/facility requirements.	Facility
Recommended: Intercom System	Local regulations/facility requirements.	Facility

Incoming Electrical

The TomoTherapy-supplied Power Distribution Unit (PDU) supplies power to components in the Treatment Vault and the Operator Station. Power must be derived directly from a main distribution panel and be dedicated to the *TomoTherapy* treatment system. See Drawing 3.4 Incoming Electrical Schematic.

Any peripheral devices must be powered directly by facility power and not through the PDU; for example:

- TomoTherapy-supplied printers
- Apollo lasers
- The Planning Station computer
- Any facility-supplied devices such as cameras, intercoms, viewing monitors, and System-Status Indicators.

IMPORTANT: This rack system* is intended to be used in a location having equi-potential bonding (such as a telecommunication center, a dedicated computer room or a Restricted Access Location). The building installation shall provide a means of connection to protective earth and the equipment shall be connected to that means. A facility service person shall check whether the socket outlet providing power also provides a connection to protective building earth. If not, a facility service person shall arrange for the installation of a protective earthing conductor from the separate protective earthing terminal to the protective earth wire in the building.

Table 5-2: Power source for *TomoTherapy* treatment system and facility-supplied components

Component	PDU Power	Facility Power
Power Distribution Unit (PDU)		X
Gantry and Patient Table	X	
Operator Station computer components (except printer)	X	
Planning Station computer components		X
Apollo Lasers (2)		X
*Database Server and Optimizer (rack system)		X
Dorado Lasers (5)	X	

Table 5-2: Power source for *TomoTherapy* treatment system and facility-supplied components

Component	PDU Power	Facility Power
TomoTherapy-supplied printers		X
Facility-supplied Door Interlock and Reset Switch	n/a Low-voltage signal	n/a
Facility-supplied System Status Indicators		X
Facility-supplied Camera		X
Facility-supplied Intercom		X
Facility-supplied Viewing Monitors		X

Input Power to the PDU

Table 5-3: System power requirements

	Requirements
Power Factor	0.85 at maximum load
Power Rating	58 kVA maximum
Grounding conductor	For all routings, dedicated earth ground (conductor) should be at least the same size as the power wires. Do not use electrical conduits or electrical raceways as the sole grounding conductors. Add a ground electrode to the PDU.
Transformers	Locate power conditioners, step-down transformers (at the Operator Station), or isolation transformers close to the Treatment Vault.
Conduit	Do not locate electrical conduit or junction boxes under the gantry or patient table anchor locations. Install all conduits and junction boxes as illustrated in Drawing 4.0 Conduit and Trench Plan.
Lighting	Ensure that all lighting fixtures remain outside of the equipment service areas. See Drawing 7.2 Service Clearance.
Emergency Power	Emergency power supply is not required for the *TomoTherapy* treatment system. If you do establish an emergency power supply, use the same power requirements that are specified for the PDU. Also, provide emergency power for all HVAC systems that support the *TomoTherapy* treatment system. It is critical that room temperature be maintained when operating the *TomoTherapy* treatment system. If facility power is lost, there will be an interruption in voltage during transfer to emergency power and, therefore, an interruption in treatment.

Table 5-4: PDU power requirements

	Power
Input Frequency	60 ± 2 Hz
Nominal Input Voltage	480 VAC line voltage, 3 Phase Delta Configuration Other voltages allowed with approval: 380, 400, 415, 440, 460 VAC. All voltages utilize a circuit breaker set to a current limit of 90A per phase by input circuit breaker on the PDU. **Unloaded Voltage Range**: ±5% nominal voltage with no load **Loaded Voltage Range:** +5% to -10% nominal voltage at full load
Input Power Cable	4 AWG (21.14 mm^2) wire per phase and 4 AWG (21.14 mm^2) wire for ground, minimum. Use the same size as the phase conductors. Rated for 194°F (90°C). The PDU accepts up to #2/0 AWG 67.40 mm^2 conductors) Encase incoming power in a 2-inch diameter (5.0 cm) connector to the face of the PDU. The facility-contracted electrician must provide separation by means of flexible conduit within the PDU junction box for exposed wire. See Drawing 3.3 Equipment Profiles.
Phase Balance	Phase voltages balanced within 2%
Main Circuit Breaker or Disconnect	70 A (all voltages) Wired to the PDU. If you cannot place the main disconnect at the Operator Station, ask the TomoTherapy Project Manager to approve an alternate location.
Grounding Input Conductors	The local ground should have an earth ground conducted impedance of 25 Ohms or less. Use dedicated safety grounds that are not used for grounding any functional currents from other equipment. Wiring must comply with local and national codes for safety ground conductors. The PDU requires a local grounding electrode for optimal equipment performance. Use building steel, metal water pipe, or grounding rod. If water pipe is used, it must have ground exposure for a minimum of 10 ft (3.05 m). **Important:** Do not use any pipe related to gas supplies as a grounding electrode.

Component Power Recommendations

Domestic and international power recommendations are specified in Table 5-5 to Table 5-10 and in Figure 5-1 to Figure 5-3.

Treatment Vault Component Power

Table 5-5: Treatment Vault component minimum power recommendations

Component	Power	Power Supplied by
Gantry	400 VAC, 3 phase	TomoTherapy PDU
Patient Table	230 VAC, 3 phase	TomoTherapy PDU
Power Distribution Unit (PDU)	480 VAC line voltage (recommended), 3 Phase Delta Configuration (tolerance ± 5%). Other voltages supported with approval from the TomoTherapy Project Manager. See Chapter 1 for contact information.	Facility
Apollo Lasers	**North America:** 120 VAC, 1 phase **International:** 240 VAC, 1 phase	Facility
Dorado Lasers	230 VAC, 1 phase	TomoTherapy PDU
System Status Indicators (System Power On, Room Ready, Radiation On)	8A maximum 50/60 Hz, 48-240 VAC Minimum ON load current: 50 mA Minimum OFF load current: 10 mA Facility must provide over-current protection to the high-voltage side of the SSI assembly for all three indicator outputs.	Facility

Cluster Rack Room Component Power

Table 5-6: Cluster Rack Room component minimum power recommendations

Component	Recommended Facility-Supplied Power	Rated Component Power	Power Supplied by
Optimizer circuit 1	200-240 VAC, 15 A, 50/60 Hz	200-240 VAC, 15 A, 50/60 Hz	Facility
Optimizer circuit 2	200-240 VAC, 15 A, 50/60 Hz	200-240 VAC, 15 A, 50/60 Hz	Facility

Operator Station Component Power

Table 5-7: Operator Station component minimum power recommendations

Component	Recommended Facility-Supplied Power	Rated Component Power	Power Supplied by
Printer	**North America:** 120 VAC, 15 A, 60 Hz **International:** 220-240 VAC, 8 A, 50/60 Hz **Japan:** 100 VAC, 15 A, 50/60Hz	**North America:** 120 VAC, 11 A, 60 Hz **International:** 240 VAC, 6 A, 50/60 Hz **Japan:** 100 VAC, 12 A, 50/60 Hz	Facility
Step-Down Transformer (supplies power to computer & peripherals)	Not Applicable -- Power supplied by the TomoTherapy Power Distribution Unit	Not Applicable -- Power supplied by the TomoTherapy Power Distribution Unit	TomoTherapy PDU

Planning Station Component Power

Table 5-8: Planning Station component minimum power recommendations

Component	Recommended Facility-Supplied Power	Rated Component Power	Power Supplied by
UPS (supplies power to computer & peripherals)	**North America**: 120 VAC, 15 A, 60 Hz **International**: 220-240 VAC, 8 A, 50/60 Hz **Japan**: 100 VAC, 7 A, 50/60 Hz	**North America**: 120 VAC, 15 A, 60 Hz **International**: 220-240 VAC, 8 A, 50/60 Hz **Japan**: 100 VAC, 7 A, 50/60 Hz	Facility
Printer	**North America**: 120 VAC, 15 A, 60 Hz **International**: 220-240 VAC, 8 A, 50/60 Hz **Japan**: 100 VAC, 15 A, 50/60 Hz	**North America**: 120 VAC, 11 A, 60 Hz **International**: 240 VAC, 6 A, 50/60 Hz **Japan**: 100 VAC, 12 A, 50/60 Hz	Facility

Mechanical Room Component Power

Table 5-9: Mechanical Room component minimum power recommendations

Component	Recommended Facility-Supplied Power	Rated Component Power	Power Supplied by
Frequency Converter (if required)	208, 380, 400, 415 VAC Y 220, 380, 460 VAC Delta	400 VAC, 100 A, 50 Hz Other voltages supported with approval from the TomoTherapy Project Manager. See “Site Planning” (Chapter 1) for contact information.	Facility
Air Compressor, Tank, Dryer, and Filter	Refer to manufacturer.	Refer to manufacturer.	Facility
Power Conditioner (double conversion)	Refer to manufacturer.	Refer to manufacturer.	Facility

Power Recommendations for Optional Components

Table 5-10: Optional component minimum power recommendations

Component	Recommended Facility-Supplied Power	Rated Component Power	Power Supplied by
Film-analysis equipment (if purchased from TomoTherapy)	**North America**: 120 VAC, 15 A, 60 Hz **International**: 220-240 VAC, 8 A, 50/60 Hz **Japan**: 100 VAC, 15 A, 50/60 Hz	**North America**: 120 VAC, 8 A, 60 Hz **International**: 240 VAC, 4 A, 47/63 Hz **Japan**: 100 VAC, 8 A, 47/63 Hz	Facility
Dosimetry Workstation	**North America**: 120 VAC, 15 A, 60 Hz **International** 220-240 VAC, 8 A, 50/60 Hz **Japan**: 100 VAC, 15 A, 50/60 Hz	**North America**: 120 VAC, 6 A, 60 Hz **International**: 240 VAC, 3 A, 47/63 Hz **Japan**: 100 VAC, 6 A, 47/63 Hz	Facility
Dosimetry Monitor	**North America**: 120 VAC, 15 A, 60 Hz **International**: 220-240 VAC, 8 A, 50/60 Hz **Japan**: 100 VAC, 15 A, 50/60 Hz	**North America**: 120 VAC, 0.75 A, 60 Hz **International**: 220-240 VAC, 0.4 A, 50/60 Hz **Japan**: 100 VAC, 0.75 A, 50/60 Hz	Facility
Electrometer	**North America**: 120 VAC, 15 A, 60 Hz **International** 220-240 VAC, 8 A, 50/60 Hz **Japan**: 100 VAC, 15 A, 50/60 Hz	**North America**: 100 VAC, 2 A, 60 Hz **International**: 240 VAC, 1 A, 50/60 Hz **Japan**: 100 VAC, 2 A, 50/60 Hz	Facility
Water Tank Control Box	**North America**: 120 VAC, 15 A, 60 Hz **International**: 220-240 VAC, 8 A, 50/60 Hz **Japan**: 100 VAC, 15 A, 50/60 Hz	**North America**: 120 VAC, 0.3 A, 60 Hz **International**: 220-240 VAC, 0.3 A, 50/60 Hz **Japan**: 100 VAC, 0.3 A, 50/60 Hz	Facility

Table 5-10: Optional component minimum power recommendations

Component	Recommended Facility-Supplied Power	Rated Component Power	Power Supplied by
Dosimetry Analysis Workstation	**North America**: 120 VAC, 15 A, 60 Hz **International**: 220-240 VAC, 8 A, 50/60 Hz **Japan**: 100 VAC, 15 A, 50/60 Hz	**North America**: 120 VAC, 6 A, 60 Hz **International**: 200-240 VAC, 3 A, 47/63 Hz **Japan**: 100 VAC, 6 A, 47/63 Hz	Facility
Dosimetry Analysis Monitor	**North America**: 120 VAC, 15 A, 60 Hz **International**: 220-240 VAC, 8 A, 50/60 Hz **Japan**: 100 VAC, 15 A, 50/60 Hz	**North America**: 120 VAC, 0.75 A, 60 Hz **International**: 220-240 VAC, 0.4 A, 50/60 Hz **Japan**: 100 VAC, 0.75 A, 50/60 Hz	Facility

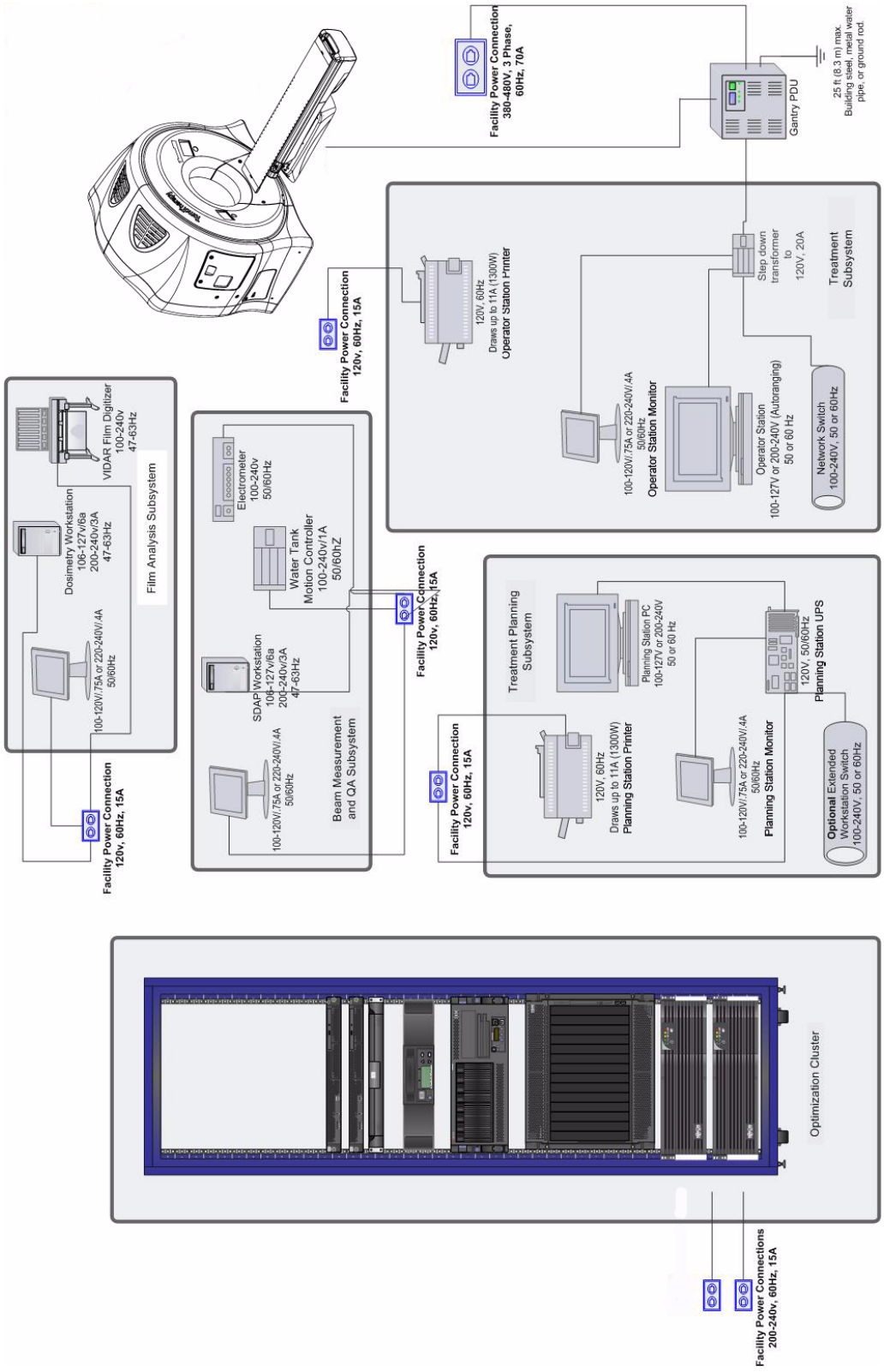


Figure 5-1: Power requirements for facilities in North America.

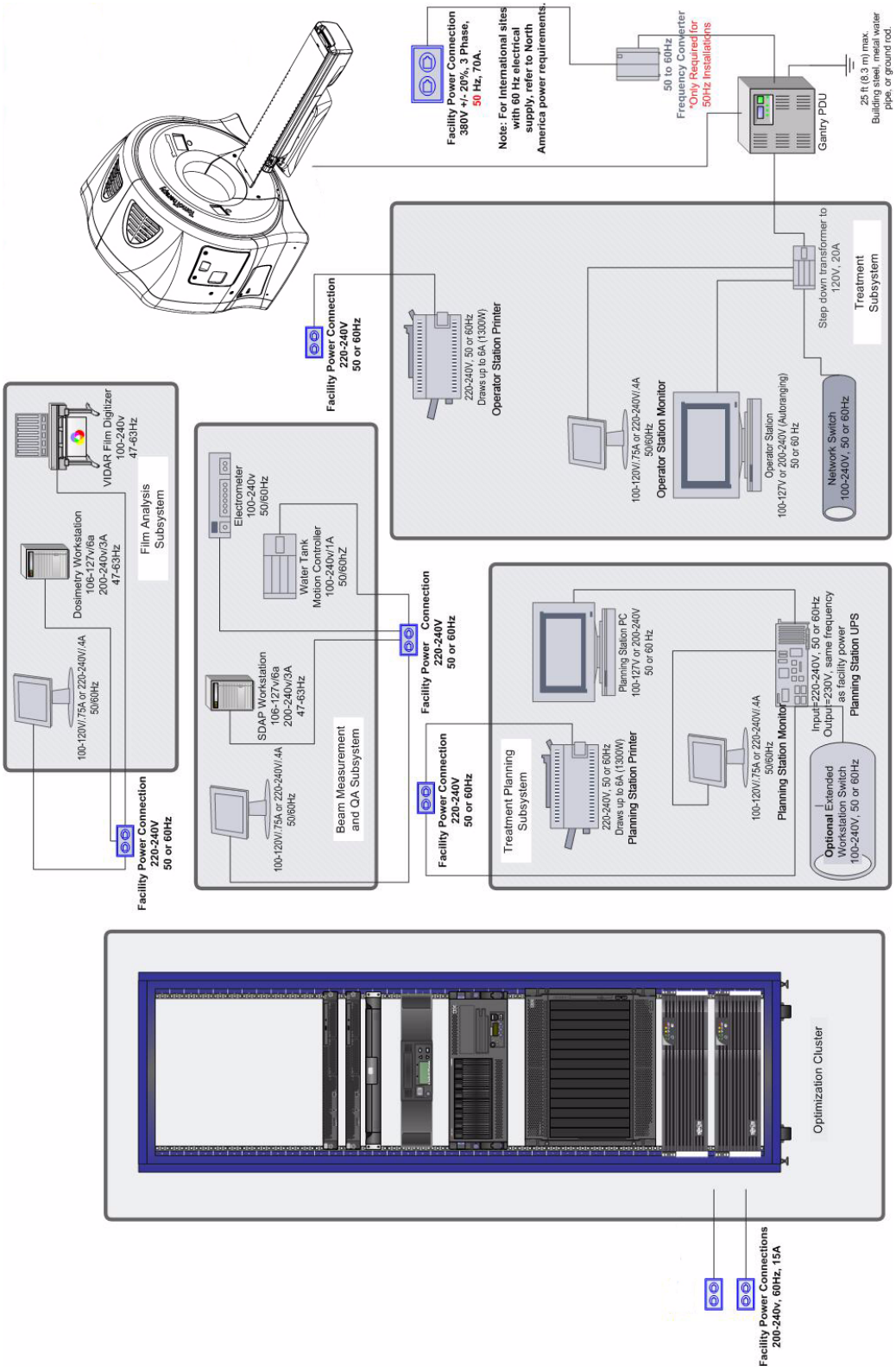


Figure 5-2: Power requirements for international facilities.

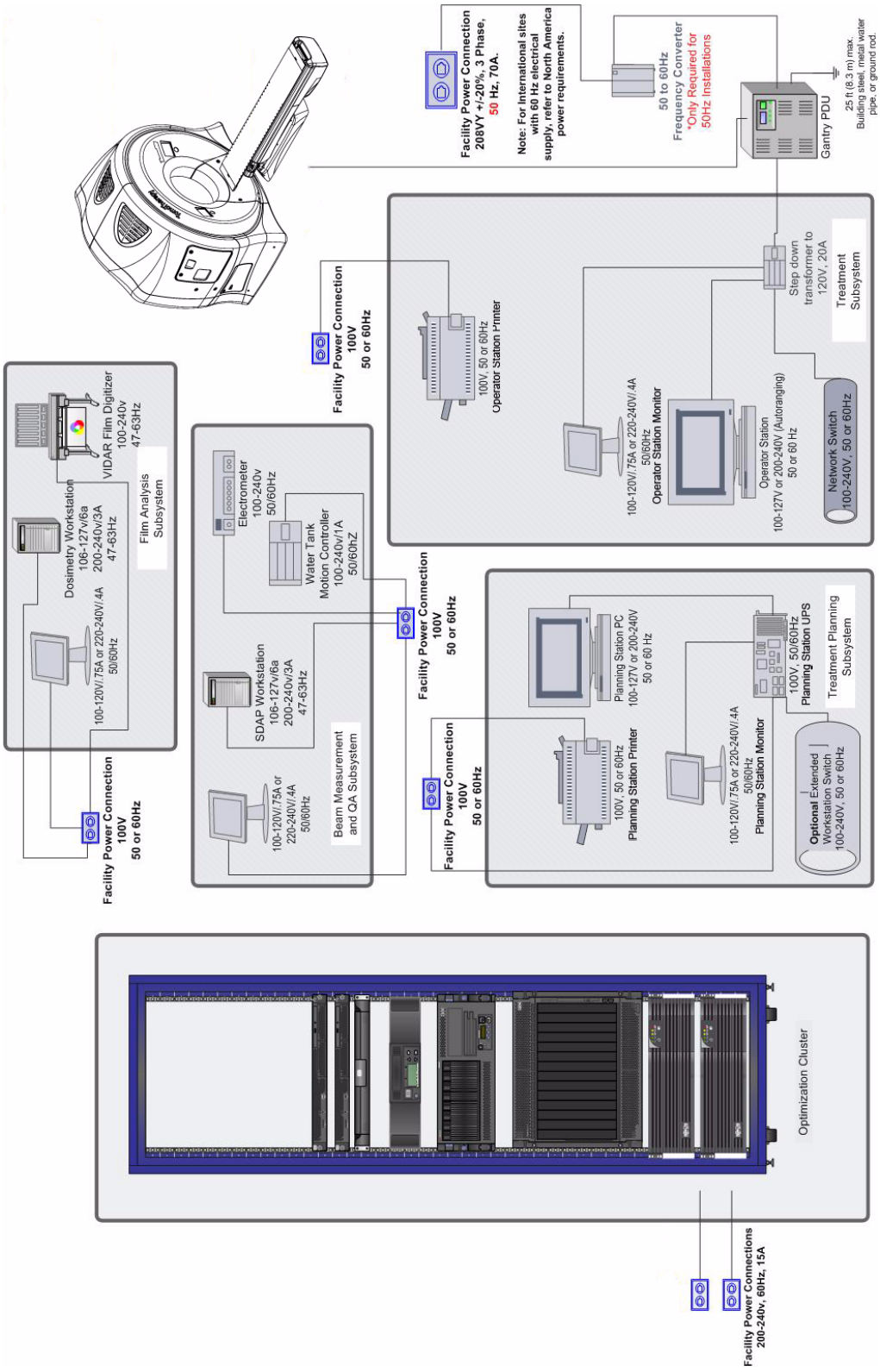


Figure 5-3: Power requirements for facilities in Japan.

Conduits

Power cables must be separated from signal cable. Build dedicated trenches from the PDU to the *TomoTherapy* treatment system components as described in "Architectural Specifications" (Chapter 4).

Due to the complexity and variety of requirements of local, state, and country electrical codes, facility-employed electrical contractors must determine the size of input conduit and the actual layout of embedded electrical conduits that meet both code requirements and TomoTherapy specifications.

Figure 5-4: Signal cables routed through conduit to the PDU junction box.

See Table 5-11 for locations of conduit with wiring. To avoid damaging conduits, ensure that existing or new conduits and any reinforcement are clear of the gantry and patient-table anchor locations (see Drawing 2.1 Sub-base Layout).

See Table 5-12 for locations of conduits without wiring, but with pull strings. TomoTherapy will wire those conduits.

Also see these drawings:

- Drawing 4.0 Conduit and Trench Plan
- Drawing 4.1 Laser Conduit Plan
- Drawing 4.2 Laser Conduit Elevation
- Drawing 4.3 Legend

Table 5-11: Conduit and wire installations (all values are inside diameter).

Drawing 4.0 Number	Conduit	Conduit From	Conduit To	Size
1	Power	Operator Station Emergency-Off	Main Disconnect	0.5 inch (1.2 cm)
2	Power	Main Disconnect	PDU	Facility-supplied
3	Power	Emergency-Stops in Treatment Vault	PDU Junction Box	0.5 inch (1.2 cm)
4	Power	Facility-supplied System Status Indicators	Back of Gantry	0.75 inch (1.9 cm) minimum
5	Power	Door Interlock Switch	PDU Junction Box	0.5 inch (1.2 cm)
6	Power	Each Dorado Laser Receptacle in series	PDU Junction Box via the ceiling junction box	1.0 inch (2.5 cm)
7	Power	Ground Electrode	PDU	Facility-supplied. Use same size conductor as incoming power.

Table 5-12: Conduit (non-wire) installations

Drawing 4.0 Letter	Conduit	Conduit From	Conduit To	Size	Max. Length
A	Signal	Operator Station Junction Box	Back of Gantry via the PDU signal trough	2 inches (5.0 cm)	80 ft (24.38 m)
B	Power	Operator Station Junction Box	PDU Junction Box	2 inches (5.0 cm)	80 ft (24.38 m)
C	Signal	Patient Table Junction Box	Back of Gantry	3 inches (7.6 cm)	20 ft (6.09 m)
D	Power	Patient Table Junction Box	PDU via electrical trench	3 inches (7.6 cm)	55 ft (16.76 m)
E	Signal	Each Dorado Laser (5)	6 inches above accessible ceiling	1.5 inches (3.8 cm)	55 ft (16.76 m)

Table 5-12: Conduit (non-wire) installations

Drawing 4.0 Letter	Conduit	Conduit From	Conduit To	Size	Max. Length
G	Signal	TomoTherapy Communications Trench	Back wall NEIS intercom location	0.5 inch (1.27 cm)	N/A
F	Signal	Operator Station	Treatment Vault	4.0 inches (10 cm)	N/A

Junction Boxes

Install junction boxes in the locations listed in Table 5-13.

Table 5-13: Junction boxes

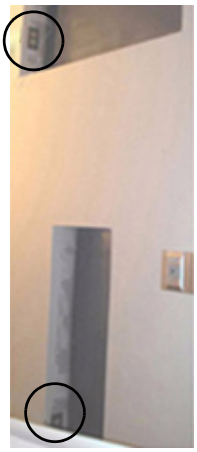
Room	Location	Description
Treatment Vault	PDU	2 ft x 1 ft 6 in. x 1 ft (61.0 cm x 45.7 cm x 30.5 cm) Provide a floor box cover plate, but leave 6 inches (15.2 cm) of the junction box uncovered in front of the PDU for wire connection (Figure 5-5).
Treatment Vault	Patient Table	8 x 8 x 6 inches (20.4 cm x 20.4 cm x 15.2 cm) Position the center of the patient-table floor junction box 2 ft 8 in. (81 cm) from the equipment isocenter (see Drawing 2.2 Sub-Base Details). Terminate the top edges of the junction box flush with the finished concrete floor. Drill the cable access holes in the cover plate or leave part of the junction box uncovered for wire connection.
Treatment Vault	Ceiling	Connect power for Dorado lasers through this box to the PDU.
Operator Station	Under the counter-top	Incoming 2-inch (5 cm) power and 2-inch (5 cm) signal conduits. Provide 2-inch (5 cm) grommeted opening in the cover plate for each conduit.

Figure 5-5: PDU with floor box cover plate.

Receptacles

In addition to code-required receptacles, install the receptacles listed in Table 5-14 for TomoTherapy equipment.

Table 5-14: System receptacles

Room	Location	Size	Details
Treatment Vault	Each Apollo Laser (2)	**North America**: 120 VAC **International**: 240 VAC **Japan**: 100 VAC	Facility-supplied with wall switch.
Treatment Vault	Each Dorado Laser (5)	230 VAC outlet NEMA 6-20R or international equivalent	Interconnect the lasers in one circuit using the power cable housed in the power conduit. Connect to the PDU. See Drawing 3.2 Laser Equipment Details. 
Cluster Rack Room	Wall outlets	Two (2) 200-240 VAC, 20A receptacles. Verify the receptacle style with the TomoTherapy Project Manager.	Connect to facility-supplied power. International sites must provide power cords and receptacles that are equivalent to this specification or provide plug ends.
Operator Station	Above the countertop	**North America**: 120 VAC **International**: 240 VAC **Japan**: 100 VAC	For printer connection to facility-supplied power.

Wiring

Install required wiring in the locations listed in Table 5-15.

When routing cable, follow these guidelines:

1. Route interconnection cables through conduits and/or wiring troughs as specified.
2. Do not allow exposed cables on the floor, wall, or other area outside of the equipment. Ensure that any cables that lie outside of conduits or wiring troughs are protected with guards or sheathing.
3. When possible, terminate cables to length, leaving enough slack so that the cable is not pulled tight when connected or when equipment is moved.
4. Do not use excessive cable length or coil excess cable to avoid introducing noise that could interfere with system operation.
5. Secure all ground wires with lock washers and nuts.

Table 5-15. System wiring

Wiring From	Wiring To	Details
Power and Signal Troughs	Main Bunker Ground	--
Facility-supplied System Status Indicators (System Power On, Room Ready, and Radiation On)	Back of the Gantry (SSI box)	Must meet local regulations. 24-10 AWG TomoTherapy recommends that facility wires be comprised of insulated conductors with an overall cable jacket. Do not use or coil excessive cable length to avoid introducing noise that could interfere with the SSI signals. Label the wire ends accordingly: System Power On, Room Ready, and Radiation On. Pull the wires back to the back of the gantry via the electrical trench. TomoTherapy will make the connection to the System Status Interface assembly. Refer to Table 5-1 for System Status Indicator equipment specifications. Refer to Table 5-5 for System Status Indicator power specifications.

Table 5-15. System wiring

Wiring From	Wiring To	Details
Door/Entrance Interlock	PDU	24 VAC, 3 A For safe machine operation and compliance with local regulations, install a normally open switch. Use minimum 20 AWG (0.52 mm^2) shielded, twisted-pair wire or wire specified by local regulations. Pull the wire back to the PDU junction box. TomoTherapy wll make the final connection.
Power for Dorado Lasers	PDU	230 VAC, 20 A Use 14 AWG (2.08 mm^2) wire in a line / neutral / ground configuration. Lasers wired in parallel to the JB3 ceiling junction box, then wired in series from this box to the PDU. This is a series parallel circuit. Power is supplied by the PDU.
Emergency Stop Buttons	PDU	Set the switch in the normally closed position. Use twist-to-reset style, wired in series. Use minimum 20 AWG (0.52 mm^2) shielded, twisted-pair wire or gauge specified by local regulations. Pull the end wire back to the PDU junction box. TomoTherapy will make the final connection.
Emergency Off Button	Shunt trip breaker in Main Disconnect	--

Lighting

Install lighting outside the service clearance areas. TomoTherapy recommends:

- Fixtures that are flush with the finished ceiling.
- A combination of incandescent and fluorescent lighting.
- Dimmers to control light levels at the Operator Station and in the Treatment Vault.

Ensure that lighting is operational before the TomoTherapy system is installed.

Optional Electrical

IMPORTANT: Optional electrical equipment such as video or intercom systems, must not be powered by the *TomoTherapy* treatment system.

◆ Video

The facility may supply and install a video system. TomoTherapy recommends these closed-circuit television camera locations:

- One stationary camera 5 ft (153 cm) above the finished floor behind the gantry on the machine centerline.
- One pan, tilt, and zoom camera on the wall or ceiling at the foot of the patient table.

Power Conditioning

The Power Monitoring Program

TomoTherapy requires all facilities to participate in the Power Monitoring Program before a *TomoTherapy* treatment system is installed. Through this program, TomoTherapy verifies that the facility meets minimum power requirements before installation begins.

The Project Manager will initiate the Power Monitoring Program at the construction kick-off meeting. The service is provided by a third-party contractor and materials and analysis are offered at no cost to the customer.

It is important that the facility install the power monitor within 24 hours of receipt and allow it to run for five to seven days. After this period, the facility must send the monitor to the third-party contractor via mail within 24 hours. TomoTherapy will notify the facility of the results. TomoTherapy is not responsible for costs associated with installing or removing the testing device, or for late fees if the facility does not return the device in the expected time.

If the results indicate that additional power conditioning equipment is required, the facility is responsible for purchasing the equipment and conducting another power-monitoring test at the facility's expense.

Power Conditioners

The *TomoTherapy* treatment system relies on consistent power quality. Due to the irregular quality of the power supplied by local power-utility suppliers, TomoTherapy strongly recommends that the facility purchase and install a power conditioner (double conversion). Do not install a power conditioner in the Treatment Room.

A power conditioner is available for purchase from TomoTherapy. If you choose to purchase from another vendor, consult your TomoTherapy Project Manager to receive more information and specifications. The power conditioner must be approved by TomoTherapy before purchase.

Chapter 6

Mechanical Specifications

IMPORTANT: The clinical facility is responsible for ensuring that site construction meets all of the requirements specified in this guide and by all government regulatory agencies. If you have questions about any of the requirements detailed in this guide, contact a TomoTherapy Project Manager.

Failure to meet the specifications outlined in this guide may affect the *TomoTherapy* treatment system warranty.

Facility-Supplied Equipment

The table below lists the mechanical equipment that the facility must supply.

Table 6-1: Facility-supplied equipment

Equipment	Specifications	Installed by
Treatment Vault HVAC equipment	Capable of cooling to 68-75°F (20-24°C).	Facility
Cluster Rack Room HVAC equipment	Capable of cooling to 68°F (20°C).	Facility
Remote temperature-monitoring system or temperature alarm	Alarm activated if Cluster Rack Room temperature exceeds 68°F (20°C).	Facility
Air Compressor, tank, and dryer	See page 6-8 to 6-10.	Facility
Fire Safety Equipment	Local regulations/facility requirements.	Facility
Recommended: Floor Drain or Moisture Sensor	Drain: Accommodate a water drainage flow rate of 1 gpm (3.81 lpm). Sensor: Comply with local regulations/facility requirements.	Facility

Treatment Vault Mechanical Equipment

Treatment Vault Mechanical Equipment

To accommodate the expected heat output generated by the TomoTherapy system components in the Treatment Vault, install a dedicated Heating Ventilation and Air Conditioning (HVAC) system or dedicate a separate zone on a system operating continuously with power from a source with generator backup. Consider these factors when selecting an HVAC system:

- Heat output
- Room size and layout
- Room components
- Room location
- Climate ambient temperature
- Climate relative humidity
- Room air flow
- Room air volume
- Air duct length to the Treatment Vault and number of bends

Include specifications for the HVAC system type, equipment selections, and operating parameters in the site plan that you submit to TomoTherapy.

For minimum environmental air requirements, see Table 6-2.

Table 6-2: Treatment Vault environmental requirements

	Environmental Requirements
Heat output	40,000 BTU/h (11.7 kW)
Room Temperature	68-75°F (20-24°C)

Table 6-2: Treatment Vault environmental requirements

	Environmental Requirements
Relative Humidity	30-60%, non-condensing
Supply Air Temperature (maximum)	55°F (12.8°C)

NOTE: Of the 40,000 BTU/h (11.7 kW) heat output in the Treatment Vault, the gantry generates 38,000 BTU/h (11.14 kW) and the PDU generates 2,000 BTU/h (0.59 kW). If you place the PDU in an equipment room that is separate from the Treatment Vault, consider the heat output of all components in that room, including the added heat output of the PDU, when determining cooling needs.

Calculate Treatment Vault Heat Load and Air Flow

Use the minimum environmental requirements from Table 6-2 and the calculations shown below to determine the combined heat output and minimum air flow for the Treatment Vault.

NOTE: These numbers only represent the sensible heat load, and additional margins must be accommodated in the calculations to satisfy additional latent heat loads that are largely dependent on HVAC system losses and the ambient humidity for that geographic location.

Example (English units):

- Vault Lighting Gain (BTU/h) = (Room Lighting in Watts x 3.412 BTU/Watt-hour)
- Total Heat Gain (BTU/h) = 38,000 BTU/h + Lighting Gain + PDU heat load (if in the Treatment Vault) + Frequency Converter heat load (if applicable)
- Minimum Air Flow (cfm) = Total Heat Gain (BTU/h) / (1.08 x (T_{Room} - T_{Supply}))

Example (Metric units):

- Vault Lighting Gain (kW) = (Room Lighting in Watts / 1000)

- Total Heat Gain (kW) = 11.723 kW + Lighting Gain + PDU heat load (if in the Treatment Vault) + Frequency Converter heat load (if applicable)
- Minimum Air Flow (L/s) = (Total Heat Gain (kW) / (1.2 x (T_{Room} - T_{Supply}))) x 1000

Thermostat

Install a dedicated thermostat 4 ft (122 cm) in front of the machine isocenter on the wall and 5 ft (153 cm) above the finished floor. The thermostat should have a 2°F /1°C response range.

Frequency Converter (50 Hz only)

For 50 Hz sites, TomoTherapy supplies a frequency converter. We recommend that you place the frequency converter in the Mechanical Room. If the site does not have a Mechanical Room, you may place the converter in the Treatment Vault, but you must consider the additional heat load. See details for the frequency converter on page 6-11.

Return Air Duct

Install two return-air vents above the patient table. Air vents should be placed approximately 4–5 ft. from the machine isocenter.

See Drawing 5.0 Heating Ventilation and Air Conditioning.

Supplemental Air

To provide 12.8°C (55°F) supplemental air flow of 70–140 cfm (33–66 lps), install an underslab 8 x 4 in. (20 x 10 cm) air duct or 6-in. (15-cm) round (or equivalent minimum cross-sectional area) PVC duct to the underside of the gantry covers.

Route the duct under the slab and terminate 2 in. (5 cm) above the finished floor 2 ft., 5 in. (73.6 cm) from isocenter (Figure 6-1). Connect the air duct to the room-supply air and include an accessible manual damper within the Treatment Vault.

Leave open the exposed portion of the air duct under the gantry covers and include a debris screen.

See Drawing 5.0 Heating Ventilation and Air Conditioning.

Figure 6-1: Supplemental air duct in back of the gantry pit.

Compressed Air Line

The facility must supply a dedicated air compressor, detailed on page 6-8.

In the floor of the Treatment Vault, embed a copper compressed air line from the facility-supplied air. Add a quick-disconnect fitting to the compressed air line before adding the barbed fitting so that a hose may be attached for system cleaning during planned maintenance procedures. See Drawing 2.2 Sub-base Details for location and termination specifications.

See Drawing 2.2 Sub-base Details.

Use thick-body or wide-body copper pipe. Use 0.75 in. (2 cm) inside diameter for up to a maximum of 300 ft (91.44 m) or 1.0 in. (2.54 cm) for up to 500 ft (152.4 m). Install tubing within 8 in. (20.3 cm) on either side of the machine isocenter.

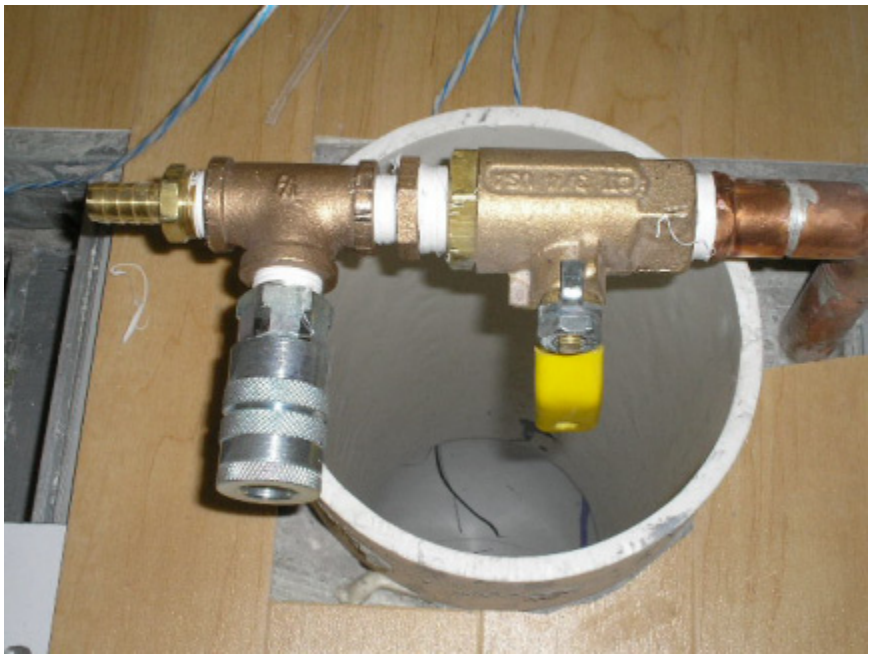


Figure 6-2: Terminated compressed air line with quick-disconnect fitting.

Mechanical Room

The Mechanical Room houses the air compressor, air tank, dryer, and filter. For 50-Hz sites, it also holds the frequency converter. The Mechanical Room should include an acoustical barrier due to noise generated by the equipment.

Air Compressor

Install a dedicated, facility-supplied air compressor to meet the flow-rate and quality requirements listed in Table 6-3.

IMPORTANT: The TomoTherapy Project Manager must approve the air compressor specifications before the facility purchases the equipment and before construction.

Table 6-3: Air flow rate and quality requirements

	Environmental Requirements
Flow Rate	15 scfm at 90 psig (measured at sea level) 7.1 lps at 6.2 bar
Water Content	Free of condensed water. Dew point = 34 to 40°F (1 to 4°C)
Oil Content	Zero oil content allowed. Compressed air must be completely free of oil droplets and vapor. (Oil filters to reduce oil content are not adequate for this requirement.)
Filtration	Filtered to allow no particulate matter larger than 0.5 microns

The standard cubic feet per minute (SCFM) in Table 6-3 reflects the value at sea level. To correct for altitude, multiply the listed SCFM for the compressor by the SCFM correction factor listed in Table 6-3.

Table 6-3 SCFM corrected for elevation above sea level

Elevation of Compressor Above Sea Level	SCFM Correction Factor
Sea level	1.0
1000 ft (304 m)	0.9718
2000 ft (610 m)	0.9438
3000 ft (914 m)	0.9164
4000 ft (1219 m)	0.8899
5000 ft (1524 m)	0.8636
6000 ft (1829 m)	0.8383
7000 ft (2134 m)	0.8133
8000 ft (2438 m)	0.7878
9000 ft (2743 m)	0.7638
10000 ft (3048 m)	0.7408

Figure 6-4: Example of an air compressor in the Mechanical Room.

Air Tank

The facility must supply a 60-gallon (227-liter) air tank and install it in the Mechanical Room near the air compressor. Set the air tank to automatically purge for 4 to 5 seconds every 30 minutes.

Figure 6-5: Air tank suspended from the ceiling in the Mechanical Room.

Dryer

The facility must supply a dryer to maintain a dew point of 34 to 40°F (1 to 4°C).

Figure 6-6: Air dryer in the Mechanical Room

Inline Air Regulator

Install the inline regulator supplied by TomoTherapy in an unobstructed, accessible location in the Treatment Vault. If unable to place it in the Treatment Vault, install it in the Mechanical Room with the air compressor. Install an inline shut-off valve between the air compressor and the air regulator.

Figure 6-7: Air regulator in the Mechanical Room.

Frequency Converter (50-Hz sites only)

For 50-Hz sites, TomoTherapy supplies a frequency converter to convert the power to the PDU to 60 Hz.

Install the TomoTherapy-supplied frequency converter no closer than 6 inches (15.2 cm) to any adjacent wall surface.

Table 6-4 lists the required clearances around the frequency converter.

Table 6-4: Frequency converter location requirements

	Minimum Distance
Clearance above the unit for heat dissipation	3 ft (1 m)
Clearance in front of the unit to open the access panel	3 ft (1 m)
Distance from any wall	6 in. (15 cm)

The frequency converter is capable of continuous normal operation when the environmental requirements listed in Table 6-5 are maintained.

Table 6-5: Frequency converter environmental requirements

	Environmental Requirements
Heat output	12,000 BTU/h (3.52 kW)
Temperature range	0 to 40°C (32 to 104°F) For optimal performance and reliability, maintain the room temperature below 25°C (77°F).
Relative humidity	Below 60%, non-condensing

NOTE: These numbers only represent the sensible heat load, and additional margins must be accommodated in the calculations to satisfy additional latent heat loads that are largely dependent on HVAC system losses and the ambient humidity for that geographic location.

Ensure that the room that contains the frequency converter meets all local fire and safety codes.

Do not locate the converter near any heat source or machinery that produces metallic shavings, dust, or powder, or any facility that produces corrosive substances or vapor.

Ensure that the room provides adequate ventilation according to the manufacturer's documentation.

Cluster Rack Room Mechanical Equipment

The Data Server components generate an average combined heat output of 18,000 BTU/h (5.28 kW). Place these components in a dedicated Cluster Rack Room that can be independently temperature-controlled. The minimum environmental requirements are listed in Table 6-6.

HVAC

Install a dedicated HVAC system on 24-hour operation with emergency power backup. Install a thermostat with 2°F /1°C response range within 4 ft (122 cm) of the cluster rack.

Remote Monitoring

Install a remote temperature-monitoring system or temperature-activated alarm. If the Cluster Rack Room becomes overheated, you will have less than two hours to perform a controlled shut down of the *TomoTherapy* treatment system. A temperature-monitoring system will alert you and allow you to respond quickly to overheating.

Table 6-6: Server Room environmental requirements

	Environmental Requirements
Heat output	18,000 BTU/hr (5.3 kW)
Temperature	68°F (20°C) or cooler
Relative Humidity	30-60%, non-condensing
Supply Air Temperature (maximum)	53°F (12°C)

NOTE: These numbers only represent the sensible heat load, and additional margins must be accommodated in the calculations to satisfy additional latent heat loads that are largely dependent on HVAC system losses and the ambient humidity for that geographic location.

Calculate Cluster Rack Room Heat Load and Air Flow

Use the minimum environmental requirements from Table 6-6 and the calculations shown below to determine the combined heat load and minimum air flow for the Cluster Rack Room:

Example (English units):

- Insulation Gain (BTU/h) = ((Area / Insulation R-Value) x ($T_{Surround}$ - T_{Room}))
- Lighting Gain (BTU/h) = (Room Lighting in Watts x 3.412 BTU/Watt-hour)
- Total Heat Gain (BTU/h) = 18,000 BTU/h + Insulation Gain + Lighting Gain
- Minimum Air Flow (cfm) = Total Heat Gain (BTU/h)/ (1.08 x (T_{Room} - T_{Supply}))

Example (metric units):

- Insulation Gain (kW) = ((Area / Insulation R-Value) x ($T_{Surround}$ - T_{Room}))
- Lighting Gain (kW) = (Room Lighting in Watts / 1000)
- Total Heat Gain (kW) = 5.275 kW + Insulation Gain + Lighting Gain
- Minimum Air Flow (L/s) = (Total Heat Gain (kW)/ (1.2 x (T_{Room} - T_{Supply}))) x 1000

Chapter 7

Network Specifications

IMPORTANT: The clinical facility is responsible for ensuring that site construction meets all of the requirements specified in this chapter and by all government regulatory agencies. If you have questions about any of the requirements detailed in this guide, contact a TomoTherapy Project Manager.

Network Requirements

The TomoTherapy treatment system network is designed as a private local area network protected by a firewall. The firewall is designed to perform PAT (Port Address Translation) to forward ports from the outside interface to services located on the TomoTherapy treatment system network. To ensure that the TomoTherapy treatment system can receive DICOM CT images and RT Structure sets from other TPS system(s) or CT Scanners/Simulators, the facility must provide TomoTherapy with information about the facility network, including IP addresses.

To help the facility prepare for system installation, TomoTherapy has outlined the system requirements for wiring, power, and network communication in separate documents, listed below, that you will receive from the TomoTherapy Project Manager.

- *Network System Requirements* (T-COD-HB0003)
- Remote Software Solutions pre-install checklist
- OIS Connect pre-install checklist

In addition, you can find network connectivity information in T-SCH-00018 and T-SCH-00019 (Figure 7-7, Figure 7-8, and Figure 7-9 in this chapter).

The facility Information Technology staff can use T-COD-HB0003 to plan for network wiring. In addition, we ask that they complete the forms at the front of the document to provide TomoTherapy with the following information.

1. Facility-assigned IP addresses for the outside interface of the firewall.
2. Details about the treatment planning systems from which the facility imports CT images and RT structure sets.

Remote Software Solutions (RSS)

Remote Software Solutions uses a virtual Remote Planning Station. Configuration of the virtual Remote Planning Station requires specific configuration of the firewall allowing a network connection into the TomoTherapy Treatment System via the hospital network.

Information Needed Prior to RSS Installation

Obtain the most current Remote Software Solutions preinstall checklist (for example, 106210, *Remote Software Solutions Preinstall 1.1.0*). It details the information that must be collected as you plan for RSS installation.

OIS Connect

OIS Connect affects changes to the DICOM Destination configuration(s), the TomoTherapy Treatment System firewall, and network connectivity between the Oncology Information System (OIS) system and the TomoTherapy Treatment System firewall.

Information Needed prior to OIS Connect Installation

Obtain the most current version of T-SVC-00357, *OIS Connect Pre-Install Checklist*. It details the information that must be collected as you plan for OIS Connect installation.

Power Requirements

For power requirements, see “Electrical Specifications” (Chapter 5).

Wiring Requirements

LAN Cabling

Install dedicated point-to-point cable runs to connect the Data Server to the Planning Station(s) and the Operator Station. The facility supplies, installs, and terminates all cables. See Drawing 6.0 Networking Drops Diagram.

Table 7-1: Local Area Network (LAN) drops

LAN Drop From	LAN Drop To
Cluster Rack Room	Facility network (DICOM connection) from which TomoTherapy receives patient data through DICOM imports.
Cluster Rack Room	Operator Station
Cluster Rack Room	Backup LAN drop to the Operator Station
Cluster Rack Room	Planning Station
Cluster Rack Room	Planning Station color printer
TomoTherapy service personnel work area	Facility network to provide high-speed access to the internet.

Network cabling must be on a separate physical network from the facility network and must not carry non-TomoTherapy traffic.

Cluster to the Operator Station

Install fiber-optic cable between the Operator Station and Cluster switch. See “Fiber-Optic Cable” (page 7-5) for fiber-optic installation details.

Cluster to the Planning Station

Network cabling must be on a separate physical network from the facility network and must not carry non-TomoTherapy traffic.

If the distance between the Planning Station and the Cluster switch is greater than 300 ft (91.44 m), use a fiber-optic connection. If the distance is less than 300 ft (91.44 m), you may use CAT 5e or CAT 6 copper cable.

If you use fiber-optic cable between the Planning Station and Data Server, you must purchase a TomoTherapy Extended Workstation Connectivity Package. The package includes a switch, transceivers, and Multi-Mode patch cables.

If you plan to install multiple Planning Stations in the future, we recommend that you install fiber-optic cable between the Planning Station and Cluster switch. Multiple Planning Stations not located in the same room will require additional extended workstation connectivity packages.

Cluster Rack Room Jacks

In addition to the multi-media data jacks, install an RJ-45 data jack in the Cluster Rack Room for facility network connections.

Internet Connection

Install a network connection with high-speed access to the Internet in an area that can be used by TomoTherapy service personnel.

Telephone

Ensure that a telephone is available for TomoTherapy Installation Technicians to use during delivery and installation. The telephone should be as close to the Treatment Vault or Operator Station as possible.

Fiber-Optic Cable

Standards

When installing fiber-optic cable, adhere to the following codes and standards. All local, state, and national codes take precedence over these standards.

Locally accepted latest edition of NFPA Article 70, the NEC Code TIA/EIA 568 B.1 Commercial Building Telecommunications Cabling Standard Part 1: General Requirements.

TIA/EIA 568 B.2	Commercial Building Telecommunications Cabling Standard Part 2: Balanced Twisted Pair Cabling Components
TIA/EIA 568 B.3	Commercial Building Telecommunications Cabling Standard Part 3: Optical Fiber Cabling Components
TIA/EIA 569	Commercial Building Standard for Telecommunications Pathways and Spaces
TIA/EIA 606	The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
TIA/EIA 607	Commercial Building Grounding and Bonding Requirements for Telecommunications
TIA/EIA 526-14	Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
TIA/EIA 598	Optical Fiber Cable Color Coding BICSI (Building Industry Consulting Services International) TDMMs Telecommunications Distribution Methods Manual) Latest Edition (Volume 11)

Fiber Optic Conduit

Use innerduct conduit that includes an installed pull rope. Innerduct must be UL listed and meet the requirements of the NEC for installation in plenum and non-plenum rated ceiling spaces.

Install innerduct using gradual, rather than sharp, bends (Figure 7-1). Bend radii should not be less than 10 times the diameter of the innerduct.

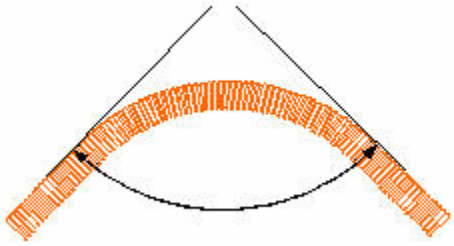


Figure 7-1: Install innerduct using gradual bends.

Support any bends in the innerduct to avoid flexing, compressing, or twisting of the fiber-optic cable during the installation.

Install the innerduct using connector clamps mounted to the building structure. Place the clamps every 3 ft (0.9 m) and within 12 inches (30.5 cm) of pull boxes (Figure 7-2). Do not use bridle rings and J-hooks to support the innerduct.

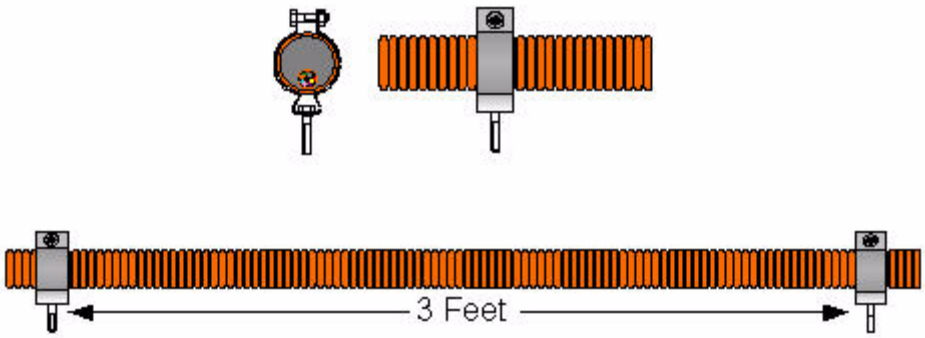


Figure 7-2: Support the innerduct with clamps applied every 3 ft (0.9 m)

Install a galvanized metal pull box at every 100 ft (30.5 m) of linear length (Figure 7-3) and/or at 180° of bends (Figure 7-4). Use a 12 x 12 x 4-inch (30.5 x 30.5 x 10- cm) pull box with 1-inch (2.54 cm) knock outs and a removable cover. Securely fasten the pull box to the ceiling structure. Terminate the installed innerduct into the pull boxes.

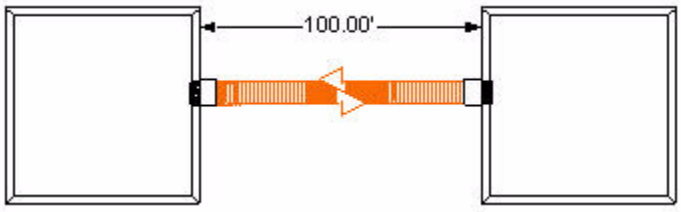


Figure 7-3: Install pull boxes every 100 ft (30.5 m) of linear length of conduit.

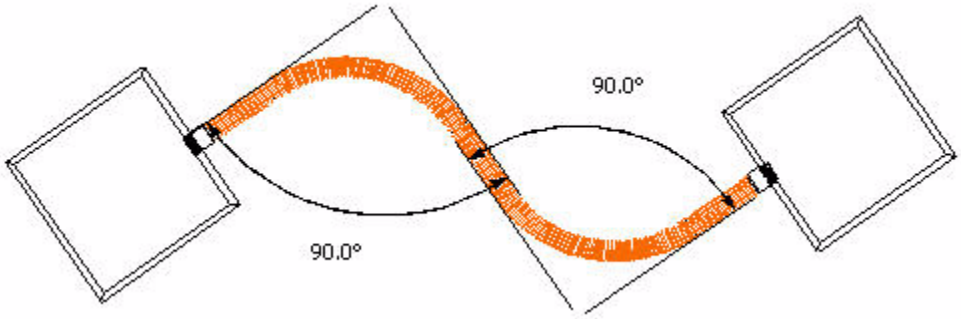


Figure 7-4: Install a pull box after 180º of bend in the conduit.

Route Innerduct parallel to outside walls and in corridors. Avoid routing main conduit across structural walls and over modular workstation walls.Avoid excessive transitions (up, down, and to the left and right) when routing the innerduct. Ensure that the run is as straight as possible.

Optical Fiber

Use the same manufacturer for all fiber-optic, cable-related components: for example, cable, connectors, couplers, patch panels, and patch cords.

The Operator Station connection requires 6-strand multi-mode cable. Use multi-mode 50/125 laser-optimized fiber-optic cable. Do not exceed 1,640 ft (500 m). Use LC Connectors for terminations.

Although Multi-Mode cable is preferable, Single-Mode cable is acceptable. Contact your TomoTherapy Project Manager to discuss the Single-Mode option.

The cable must be an all-dielectric cable; however, you may use armored cable if Operator Station and the Cluster are physically located in separate buildings and local codes require armored cable for connections between buildings. If you are installing optical fiber between buildings or in an adverse environment that requires armoring, the armor must be properly grounded according to TIA/EIA 607 and the NEC code. Ensure that all grounds are made as close as practical to the entrance of the building.

The transceivers supplied by TomoTherapy operate at a wavelength of 1300-nm.

If the facility is installing only one *TomoTherapy* treatment system, use a Multi-Media data jack at the cluster. If multiple systems might be installed, consider using a small wall-mounted or rack-mounted distribution center at the cluster.

If applicable, all installed innerduct and cable runs must meet the requirements for plenum-rated environments.

Network Wiring Variations

In T-COD-HB0003, the connections and cables for various configurations are summarized:

- Standard Network, Fiber to the Operator Station Only
- Extended Network, Fiber to the Operator Station and a Single Planning Station Area
- Extended Network, Fiber to the Operator Station and Multiple Planning Station Areas

Installation

Leave a 15 ft (4.57 m) slack loop at the Cluster End and the Operator Station end of the fiber cable runs. Coil extra slack into a 12 x 12 x 4-inch (30.5 x 30.5 x 10-cm) box.

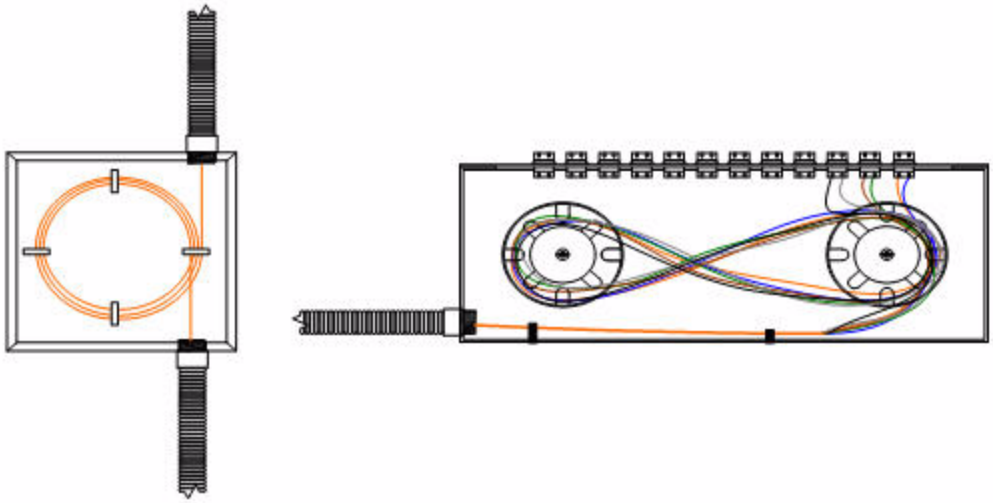


Figure 7-5: Coil extra fiber as shown.

When stripping fiber cable jackets, strip only enough jacket to effectively and accurately terminate the individual strands. Coil unjacketed slack in the distribution point Figure 7-5.

At the workstation end of the run, install terminated strands straight through following standard color coding schemes (Figure 7-6). At the Cluster end, insert a “flip” (crossover) in the strand run.

IMPORTANT: The flip is critical to the operation of the fiber network connections.

Do not use a bend radius for fiber cables that is smaller than 1 inch (2.5 cm).

Do not exert excessive force on fiber cables when installing. Use Kellums grips where possible. Use the cable Kevlar yarn with the pulling apparatus so that you distribute force across the whole fiber cable when pulling cable through conduit.

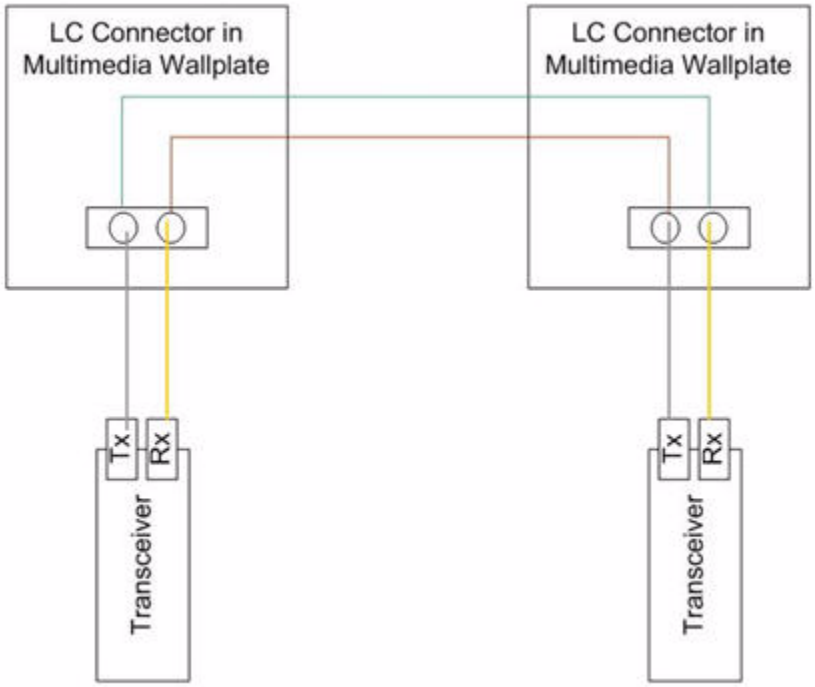


Figure 7-6: Install terminated strands straight through.

Labeling and Identification

Apply computer-generated marking labels on each end of the fiber cables. At the Operator Station end, apply a wire wrap label with the fiber cable identifier within 6 inches (15.2 cm) of the fiber cable end.

Label each faceplate port with the designated strand identifier.

Label all Optical Fiber Distribution Points (LIUS, patch panels, or Multi-Media Outlets acting as a distribution point) with the designated strand identifier and cable identifier.

Testing

Test all terminated strands of Optical Fiber with an Optical Power and Lightsource test set. Refer to standard TIA/EIA 526-14A Method B.

End-to-end loss should not exceed 8.5 dB including patch connections. Any strand test that results in a value exceeding the calculated loss value must be corrected and retested. All tests results must achieve passing status before TomoTherapy will install the *TomoTherapy* treatment system.

Provide test results in electronic format to TomoTherapy. Supply as-built drawings with fiber cable routes and deviations or changes to TomoTherapy at the end of the project.

Provide one copy of the drawing and test results to the facility and one copy to TomoTherapy. Also leave one copy in the Cluster Rack room. Protect this copy with a plastic sleeve or envelope, and attach it to the wall adjacent to the Cluster.

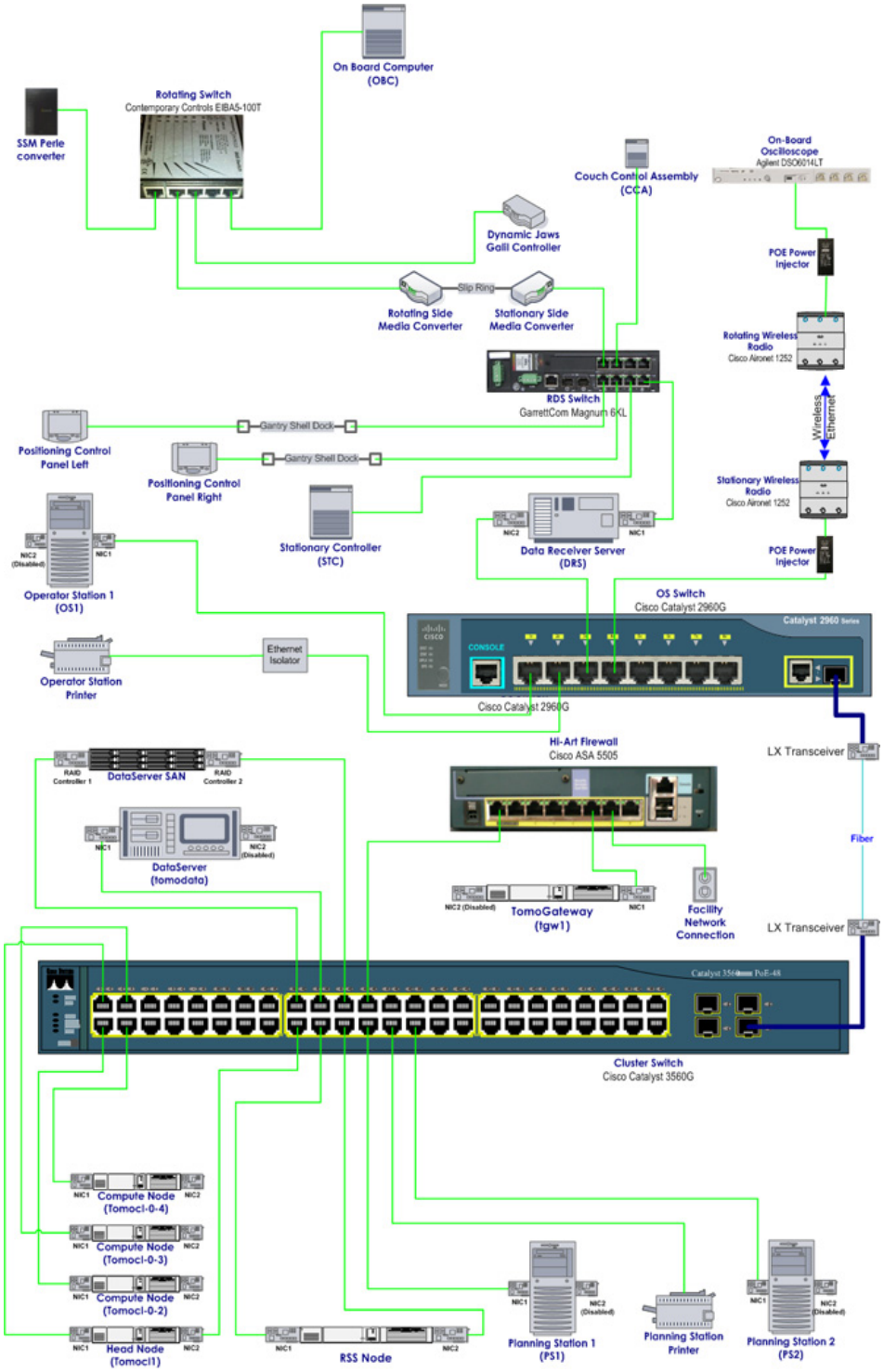


Figure 7-7: Example* Physical Network Diagram (Base)

**For planning purposes, refer to the latest version of T-SCH-00018, the released diagram.*

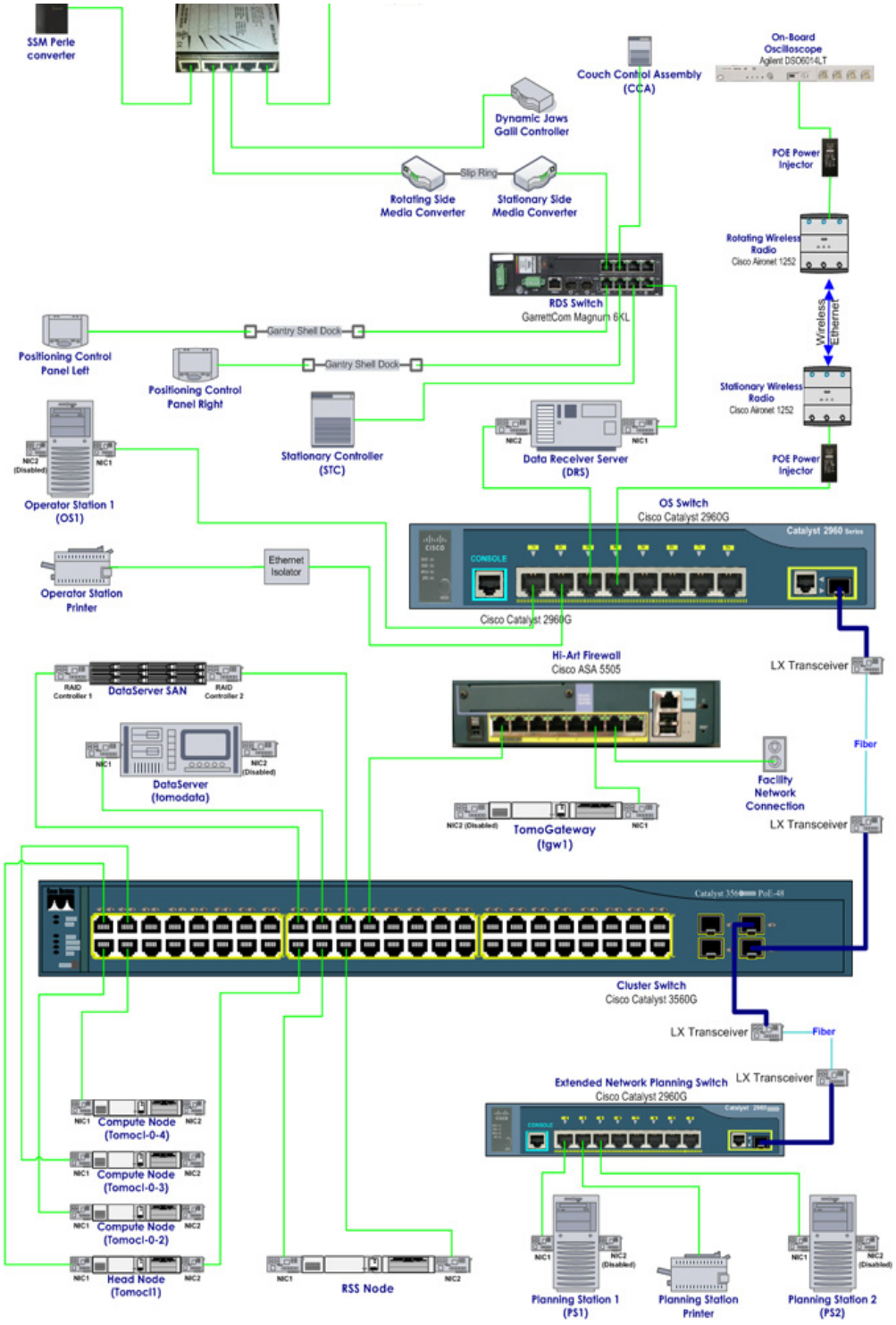


Figure 7-8: Example* Physical Network Diagram (Extended)

**For planning purposes, refer to the latest version of T-SCH-00018, the released diagram.*

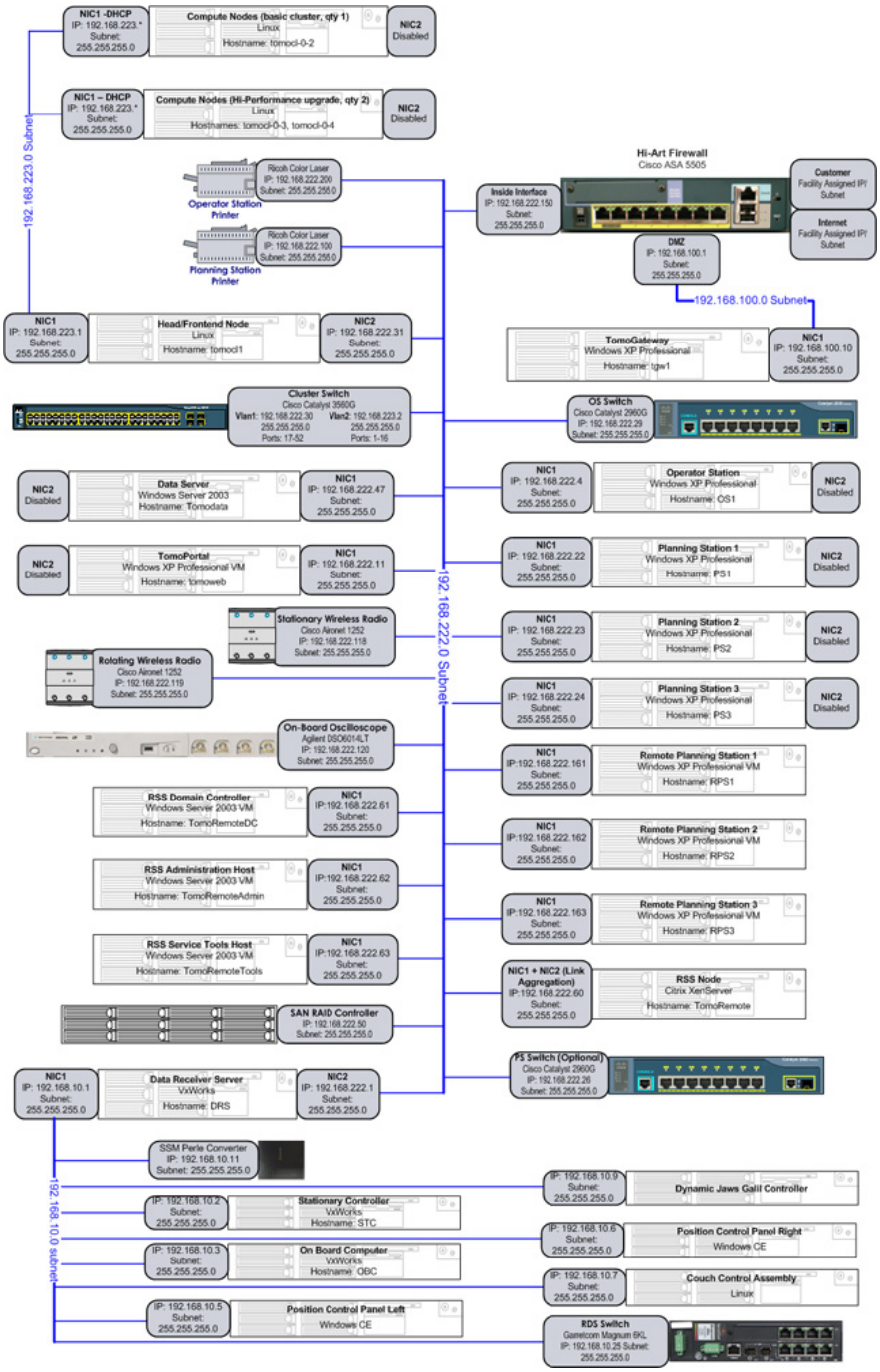


Figure 7-9: Example* Logical Network Diagram

**For planning purposes, refer to the latest version of T-SCH-00019, the released diagram.*

Chapter 8

On-Site Inspection

This chapter lists the items that the TomoTherapy Project Manager will inspect just before construction is complete to ensure that the site will be ready for installation.

IMPORTANT: The facility must meet the requirements outlined in this list before TomoTherapy delivers the treatment system.

On-Site Inspection Checklist

TomoTherapy Project Managers use a checklist to ensure that site construction is complete and that it meets the requirements stated in this guide. The Project Manager will note any outstanding issues on the checklist and supply a copy to the facility at the end of the inspection. It is the facility's responsibility to address those issues and ensure that the site is ready for delivery and installation.

To help you prepare for the inspection, we've listed the items from the checklist below and on the following pages. Review these items to ensure that the site will meet inspection requirements.

Treatment Vault

Delivery

1. Rigging path is defined and cleared.
2. There is a clear opening through the maze and, if needed, the door is removed to accommodate delivery.

Construction

1. Walls are finished, including baseboards.
2. Ceiling is finished and height is appropriate for rigging equipment.
3. Wall-to-gantry pit clearances meet requirements.
4. Treatment Vault door and hardware are on-site.
5. Pit size and location meet architectural drawing specifications.
6. Floor flatness meets tolerances.
7. Cabinets, shelving, and storage are finished.
8. Floor covering is installed.

Electrical

1. Conduits, troughs, and junction boxes are installed in the correct number, size, and location.
2. Conduits, troughs, and junction boxes are clean and dry. Pull strings are included.
3. Main power is installed and awaiting termination to PDU.
4. Main room lights and set-up lights are operational.
5. If door-less maze, then interlock device is installed, wires are pulled to the PDU.
6. Emergency-Off and Emergency-Stop buttons are installed and wired in a loop. Wires are pulled to the PDU with enough wire to reach the back of the gantry.
7. System Status Indicators are installed and wiring is pulled to the back of the gantry. Powered by facility.
8. All laser conduits are run, receptacles wired, and mounting plates installed. Laser conduit location, height, and recess size meet requirements.
9. Receptacles for Dorado lasers are installed.
10. Receptacles for Apollo lasers are installed.
11. System Status Indicators are installed and wiring is pulled to the back of the gantry.

Mechanical

1. Facility air is installed according to approved drawings and is operational and balanced according to the HVAC contractor.
2. Compressed air specifications meet requirements, as verified by the HVAC contractor and the TomoTherapy Project Manager.
3. Thermostat is installed and operational.
4. Receptacles for Apollo lasers are installed.
5. In-line air regulator is installed and accessible.

Operator Station

1. Walls are finished, including baseboards.
2. Ceiling is finished.
3. Floor covering is installed.
4. Cabinets, shelving, and mill work is finished.
5. 70 amp main disconnect is installed and wired to the PDU.
6. Emergency-Off button is installed and operational.
7. If door-less maze, the switch is operational and in the normally open position.
8. Conduits, troughs, and junction boxes are installed in correct number, size, and location.
9. Lighting is operational.
10. Telephone is available for use.
11. The shelf for the step-down transformer under the Operator Station counter is installed.
12. Data connections are installed.
13. LC fiber connections are installed.

Planning Station

1. Walls are finished, including baseboards.
2. Ceiling is finished.
3. Floor covering is installed.
4. Cabinets, shelving, and mill work is finished.
5. Lighting is installed and operational.
6. Power outlets are installed as specified.
7. Data connections are installed (RJ45 or LC, depending on distance to the Cluster).

Cluster Rack Room

1. Walls are finished and painted.
2. Ceiling is finished.
3. Floor covering is installed.
4. Lighting is operational.
5. Two (2) power outlets are installed.
6. Dedicated HVAC is operational and balanced to address expected heat load, as verified by the HVAC contractor.
7. Thermostat is installed and operational.
8. Two or four RJ45 jacks, and three or five LC fiber connections for LAN connections are installed.
9. Results of fiber strand testing.
10. Temperature-sensor alarm is installed and set to 68°F (20°C).

General

1. Rooms are clear of dirt, dust, and construction materials.
2. Optional film processor is operational and ready for set up and acceptance test procedures.
3. Dust from other construction projects cannot enter Operator Station or Treatment Room.
4. Final arrangements for rigging and delivery have been made.
5. Storage area dedicated for gantry enclosures.

Chapter 9

Appendix

IMPORTANT: The clinical facility is responsible for ensuring that site construction meets all of the requirements specified in this chapter and by all government regulatory agencies. If you have questions about any of the requirements detailed in this guide, contact a TomoTherapy Project Manager.

Noise Eliminating Intercom System (NEIS) Positioning

NOTE: The NEIS is standard on TomoHD systems. The only item that needs locating in the treatment room is the Intercom Speaker.

The following diagram (Figure 9-1) shows the location of the NEIS Intercom Speaker when used with the *TomoTherapy* treatment system. Note that the facility must supply all conduits and power receptacles.

Intercom Speaker Location

Mounted on the vault wall behind the gantry approximately 1 ft (30.48 cm) below the top of the gantry, no more than 3.28 ft (1 m) from the back of the gantry and no closer than the service clearance of 3 ft (0.914 m).

Cabling runs from the NEIS intercom speaker through the *TomoTherapy* Communications Trench to the Operator Station outside the treatment vault.

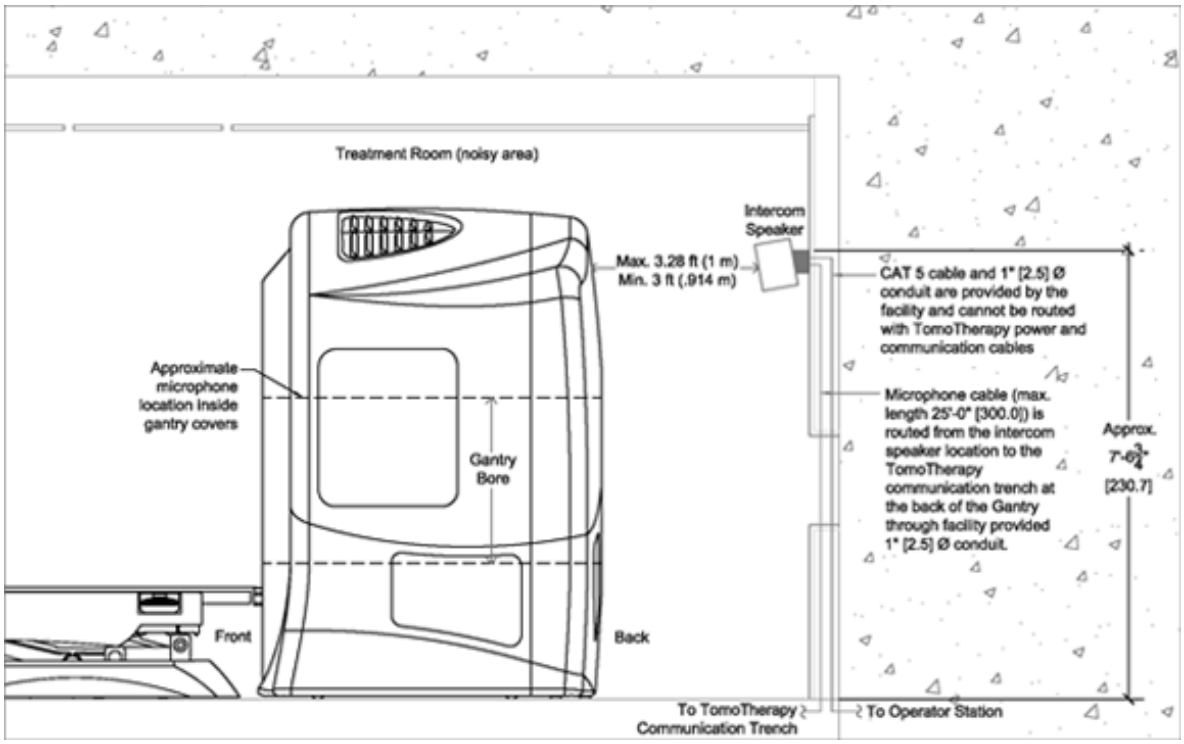


Figure 9-1: NEIS Positioning Diagram