Human Factors Evaluation of Teletherapy

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Function and Task Analysis

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Prepared for
U.S. Nuclear Regulatory Commission

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ABSTRACT

As a treatment methodology, teletherapy selectively destroys cancerous and other tissue by exposure to an external beam of ionizing radiation. Sources of radiation are either a radioactive isotope, typically Cobalt-60 (Co-60), or a linear accelerator. Records maintained by the NRC have identified instances of teletherapy misadministration where the delivered radiation dose has differed from the radiation prescription (e.g., instances where fractions were delivered to the wrong patient, to the wrong body part, or were too great or too little with respect to the defined treatment volume). Both human error and machine malfunction have led to misadministrations. Effective and safe treatment requires a concern for precision and consistency of human-human and human-machine interactions throughout the course of therapy. The present study is the first part of a series of human factors evaluations for identifying the root causes that lead to human error in the teletherapy environment. The human factors evaluations included: 1) a function and task analysis of teletherapy activities, 2) an evaluation of the human-system interfaces, 3) an evaluation of procedures used by teletherapy staff, 4) an evaluation of the training and qualifications of treatment staff (excluding the oncologists), 5) an evaluation of organizational practices and policies, and 6) an identification of problems and alternative approaches for NRC and industry attention. The present report addresses the function and task analysis of teletherapy activities and provides the foundation for the conduct of the subsequent evaluations. The report includes sections on background, methodology, a description of the function and task analysis, and use of the task analysis findings for the subsequent tasks. The function and task analysis data base also is included.

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EXECUTIVE SUMMARY

Background

Teletherapy is a multidisciplinary, multiphased treatment methodology for treating cancerous and other tissue through selective exposure to an external beam of ionizing radiation. A radioactive isotope, typically Cobalt-60 (Co-60), or a linear accelerator capable of producing very high energy x-ray and electron beams are the principal sources of the radiation. Treatment typically takes place on a daily basis over a period of weeks and is planned and administered by a team of specialists including a radiation oncologist, a radiation physicist, a therapist, and possibly a dosimetrist. Effective treatment depends upon successful performance of functions and tasks involving people, machines, and procedures. Records maintained by the Nuclear Regulatory Commission (NRC) have identified cases of teletherapy misadministration—where the delivered radiation dose has differed from the radiation prescription (e.g., instances where the treatment was to the wrong patient, the wrong body part, or the dose was too great or too little). Both human error and machine malfunction have led to misadministrations. Those involving the wrong patient or body part are clearly of no value and may increase medical risk to the patient. Misadministration above the prescribed dose may destroy healthy tissue and organs; misadministration below the prescribed level may result in ineffectively treating the disease. With either deviation, the consequence can be life threatening.

Objective

The present effort, the function and task analysis, was sponsored by the NRC as the first part of a series of human factors evaluations designed to identify the root causes of human error in teletherapy. The six phases to the study included: 1) a function and task analysis of teletherapy activities, 2) an evaluation of the human-system interfaces, 3) an evaluation of procedures used in teletherapy departments, 4) an examination of the training and qualifications of treatment staff (excluding the oncologists), 5) an evaluation of organizational practices and policies, and 6) an identification of problems and alternative approaches for NRC and industry attention. To further acquire an in-depth and up-to-date understanding of the practice of teletherapy in support of these evaluations, a systematic literature review also was conducted. The present report, however, focuses solely on the function and task analysis.

Methodology

Conduct of the function and task analysis involved four major activities: 1) developing the site sampling strategy, 2) conducting data collection, 3) developing the function/task descriptions and the database, and 4) verifying the technical accuracy of the function/task descriptions and database.

Three factors were considered in selecting visit sites: geographical dispersion, type of teletherapy organization, and use of Co-60 treatment units, where possible. To avoid any disproportionate influence of treatment philosophies or practices associated with a given region

or center, individual radiation oncology facilities were selected from the West Coast, Midwest, Southeast, and East Coast. With respect to teletherapy organizations, three types were identified and sampled: university-based departments, community-based hospitals/centers, and free-standing facilities. A final consideration for selecting a visit site was the presence of a Co-60 treatment unit. A few sites visited used only linear accelerators, although the majority included at least one Co-60 unit. Altogether, 14 different radiation oncology facilities selected from the four geographical regions and from among the three types of organization were visited.

Site visits involved interviews with teletherapy staff and direct observation of teletherapy treatments. Interviews were held with chief therapists, staff therapists, radiation physicists, dosimetrists, department directors, and radiation oncologists. Interview priority was given to the first four positions. Direct observation of teletherapy treatments supplemented the interviews. Functions and tasks related to the treatment of patients with Co-60 machines and with linear accelerators were observed during various phases of their treatment regime.

Function and task descriptions were prepared upon completion of data collection activities. Tasks were defined as discrete units of operator behavioral or cognitive activity having a discernable starting point, duration, and end point. Those tasks that were related in terms of their contribution to an output goal of the teletherapy system were aggregated, and the aggregated entities were treated as system functions or subfunctions. A dBASE IV file of functions, subfunctions, tasks, and associated information was developed for use during performance of subsequent parts of the project. Finally, all function/task descriptions and associated data entered into the database were reviewed for technical accuracy by subject matter experts (SME consultants).

Description of the Function and Task Analysis

Altogether, 176 discrete tasks were identified as integral components of the teletherapy process. Each record in the data base corresponds to an individual task statement. Each record also includes fields which contain the following type of information: position of individual performing the task, equipment used during task performance, cues, conditions, standards for task performance, interactions with other staff members, communications required and communication mode, task difficulty, frequency of performance, time required to perform, likelihood of error, consequences of error, pervasiveness of error, and qualifying comments.

Potential errors were defined as a deviation in intended dose to a patient during an administration. Errors were then specified in terms of their category and pervasiveness. Error category refers to how the unintended deviation from radiation dose to the patient is manifested (e.g., dose to intended volume higher than desired, portion of intended target volume not irradiated). Error pervasiveness refers to whether the error 1) would typically be limited to a singular daily treatment (labelled as episodic), 2) would be likely to affect a prolonged portion of an individual patient's course of treatment (labelled programmatic), or 3) would affect all patients treated on or affected by the specific piece of equipment (labelled systematic). For example, a shielding block that was omitted from a patient's daily treatment would receive a

category-pervasiveness code designation of 3A—a combination of error category number 3 (radiation dose to normal tissue outside intended transit volume) and error pervasiveness category A (episodic - affecting single daily treatment).

The 176 tasks were grouped into ten discrete functions as shown in Figure ES.1. Some functions were divided into subfunctions in order to adequately organize the range of tasks performed. Some tasks were divided into subtasks. The structure of and the data contained in the task analysis data base provide a foundation for the analyses to be performed in the subsequent phases of the project. The data base provides an inventory of tasks and detailed information pertaining to how these tasks are performed, allowing for in-depth evaluation of factors that impact task performance and outcome.

It was found that significant variations exist between and within teletherapy facilities in how tasks are performed, which tasks are performed and in order in which they are performed. The factors causing these variations include facility-specific issues such as unique practices and policies, use of different equipment, and differences in preferred practice between oncologists and staff members. These differences are further complicated by the finding that specific functions and tasks are only rarely described in written procedures.

The organization of the task data contained in the data base is as close as possible to the most likely flow of functions and tasks in a teletherapy facility. The function and task analysis data base offers an inventory of tasks performed, an analysis of these tasks in terms of how they are performed, and the errors that are likely to occur. The function and task analysis also provides a point of departure or foundation for the subsequent phases of the study.

LEGEND

- Arrow: Signifies the sequence of function performance
- Block: Contains the function title and function identification number
- “OR” gate: Indicates that a choice may be made between two or more of the functions following or preceding the gate as to which is to be performed (or has been performed)

Figure ES.1 Top level of teletherapy process functions.

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The authors wish to express their gratitude to the administrative and professional personnel in the various radiation oncology departments visited during data collection activities. Their voluntary willingness to participate, interrupt their own busy schedules, and provide useful information is, indeed, appreciated. The authors also would like to acknowledge the contribution of subject matter experts—a group of highly knowledgeable radiation oncologists, radiation physicists, and therapists who served as consultants to the project and were able to enhance its technical accuracy.

FOREWORD

This report is prepared for the Office of Nuclear Regulatory Research of the U.S. Nuclear Regulatory Commission as part of the work performed under NRC-04-90-053, Human Factors Evaluation of Teletherapy. Teletherapy is a treatment methodology in which cancerous tissue is selectively destroyed by exposure to an external beam of ionizing radiation. The source of radiation may originate from a radioactive isotope, typically Co-60, or a linear accelerator device for producing very high energy x-ray and electron beams. As practiced in departments of radiation oncology, teletherapy (or radiation therapy) is a complex, multiphased, multidisciplinary process involving the teamwork of radiation oncologists, radiation physicists, dosimetrists, and therapists.

The present report is Volume II of a series of human factors evaluations for identifying the diverse array of factors that contribute to human error in the teletherapy setting. There are five major reports to this overall series, *Human Factors Evaluation of Teletherapy*:

<i>Volume I</i>	<i>Identification of Problems and Alternative Approaches</i>
<i>Volume II</i>	<i>Function and Task Analysis</i>
<i>Volume III</i>	<i>Human-System Interfaces and Procedures</i>
<i>Volume IV</i>	<i>Training and Organizational Analysis</i>
<i>Volume V</i>	<i>Literature Review</i>

1.0 INTRODUCTION

Teletherapy is a treatment methodology in which cancerous or other tissue is selectively destroyed by exposure to an external beam of ionizing radiation. The source of radiation may be a radioactive isotope, typically cobalt-60 (Co-60), or a linear accelerator device that produces very high energy x-ray and electron beams. As practiced in departments of radiation oncology, teletherapy (or radiation therapy) is a complex, multiphased, multidisciplinary process incorporating the functions of diagnosis and tumor localization, pre-treatment planning, equipment checks, simulation, treatment planning, treatment set-up, treatment, and periodic follow-up evaluation. Key staff members of the treatment team include the radiation oncologist, radiation physicist, dosimetrist, and therapist.

Records maintained by the NRC have implicated human error in cases where the delivered teletherapy treatment has differed from the radiation prescription (Federal Register, July 30, 1990). Misadministration of prescribed radiation dose, whether by machine malfunction or human error, can have deleterious consequences (e.g., instances where the treatment was to the wrong patient, the wrong body part, or the dose was too great or too little). Delivered below the prescribed level, misadministration can lead to ineffective treatment; delivered above the prescribed level, it can lead to damage to healthy tissue and critical structures.

The overall study, sponsored by the NRC's Office of Nuclear Regulatory Research, involved conduct of a series of human factors evaluations to identify the root causes of human error in teletherapy. There were six major phases to the study: 1) performance of a function and task analysis of teletherapy activities, 2) conduct of an evaluation of human-system interfaces, 3) evaluation of the procedures used by teletherapy staff, 4) evaluation of the training and qualifications of teletherapy staff, 5) evaluation of organizational practices and policies, and 6) identification of human factors problems and alternative approaches for resolving these problems.

It was important to arrive at a sound understanding of the functions and tasks that make up the teletherapy process in order to support the subsequent tasks. The present report addresses only the function and task analysis of teletherapy activities. The report is divided into five sections. Section 2.0 reviews relevant background and issues upon which the study is based. Section 3.0 describes the study's methodology, including the site sampling strategy, the data collection activities, the development of the function/task analysis descriptions and data base, and the verification process for technical accuracy. Section 4.0 provides a detailed description of the ten function areas and the intended use of the task analysis data. It also describes the management function analysis which was supported by a separate database. Section 5.0 is the conclusion and summarizes the salient aspects of the function and task analysis. The function and task analysis database of treatment-related tasks appears in Appendix A. The management functions and tasks appear in Appendix B.

2.0 BACKGROUND

Effective application of ionizing radiation depends upon many complex and dynamic interactions among equipment, procedures, and people. In the interest of gaining a sense of the complexity involved, this section provides a brief overview of the teletherapy process as well as a look at some of the differences between Co-60 and linear accelerator units.

2.1 Overview of the Teletherapy Process

The radiation oncologist first conducts a clinical evaluation of the patient to determine initial treatment concerns, usually after the diagnosis of malignancy has been confirmed. The extent or stage of the disease is determined and provides the basis for arriving at a therapeutic decision. The therapeutic decision will have either a curative intent (i.e., total eradication of the tumor) or a palliative intent (i.e., to relieve suffering and extend life). Upon selection of radiation therapy as the treatment approach, the radiation oncologist provides a treatment prescription. Taking into account suspected tumor volume and dose tolerances of critical anatomical structures in the vicinity of the tumor, the prescription defines the treatment volume, total dose, number of treatments, dose per treatment, and frequency of treatment (Bentel, Nelson, & Noell, 1989).

Given an initial prescription, the combined efforts of the oncologist, physicist and simulator technologist are applied to the planning of the treatment program. To achieve maximum accuracy, the treatment set-up is first simulated to enable precise and accurate location of the treatment fields as well as to mark the patient externally to aid in the set-up of the patient when treated. Simulation serves as a focal planning point for the patient's treatment, bringing together the treatment team with all the data pertaining to a particular patient. It allows questions of set-up and planning to be resolved without actually using the treatment machines (Mizer, Scheller, & Deye, 1986). It allows the precise location of the radiation treatment to be determined and involves the professional judgments of the oncologist, medical physicist and simulation therapist working together.

During simulation, the physical relationship of the treatment area with respect to anatomical features of the patient and equipment position are recorded for later duplication on the treatment machine. The output of the simulation includes simulation films, treatment equipment position, the patient's position while being treated, sketches of anatomical features of the patient, treatment field marks (tattoos), and identification of treatment ports (the area at which the radiation beam enters the patient's body). This information is transferred to the patient's chart before treatments begin. Simulation data must be complete, accurate, and readily understandable by the therapist who will set-up the patient and treatment machine for daily treatments. The data must then be accurately transcribed to the treatment chart.

Simulation is performed on a treatment simulator. The treatment simulator includes the major features of a typical treatment machine. The striking difference between the simulator and treatment machines is that the simulator does not produce radiation of sufficient intensity to be used for treatment. The simulator does, however, have the capability to make X-ray exposures

(simulation films) and many have fluoroscopy. Properly prepared simulation films show the correct location of the treatment area with respect to the internal anatomy of the patient. They also include marked areas that the oncologist believes should be blocked from radiation exposure during treatment. These marked simulation films will be used directly in the process of creating customized blocks or using standard blocks during treatment. It is the role of the oncologist to approve the simulation films.

During treatment planning, the physicist and dosimetrist direct their attention to those factors having a direct impact on accuracy of dose delivery (e.g., machine output measurements, precision of beam alignment, determination of tumor depth, calculation of dose, use of treatment planning computers and data tables, and independent verification of dose calculations). Other personnel (e.g., mold room technician or staff therapist) are likely to be involved in the fabrication of custom shielding blocks, compensators, and immobilization devices. Information pertaining to the details of how the patient is to be set-up and treated must be accurately transferred to the therapist in the patient's treatment chart. It is important that the patient be set-up in the exact way that was determined during the simulation of the treatment. In those situations involving an adjacent anatomical structure that is particularly sensitive to radiation, precise set-up, positioning, and immobilization of the patient is very important (Bentel et al., 1989).

After all the details of treatment planning have been resolved, the patient proceeds to treatment. The therapists now have the greatest degree of contact with the patient as they deliver treatment on a fractionated daily basis (i.e., the total dose divided by the number of treatment days). Of primary concern is the avoidance of any deviation from the treatment plan since the possibility of human error—treating the wrong patient, leaving out a wedge filter, entering a wrong machine parameter, imprecise patient positioning—is always present. Some radiation oncology departments have computerized record-and-verify systems that automatically check the correct machine parameters before the treatment is delivered (Mohan, Podmaniczky, Caly, Lapidus & Laughlin, 1984). Other departments have initiated quality assurance programs that typically include components of the treatment process such as reporting of treatment errors, monitoring the frequency of errors by error type (e.g., machine malfunction, calculation errors, treatment delivery errors, and block fabrication errors), and implementing quality control measures for avoiding recurrence of such incidents (Swann-D'Emila, Chu, & Daywalt, 1990).

Once treatment begins, the patient's progress is monitored throughout the treatment process. Patients are treated and observed on a daily basis by therapists. Treatments are charted on a daily basis, the charts are checked weekly by the dosimetrist or physicist, and weekly chart rounds are conducted by the oncologist and team members to assess the adequacy of treatment. Post-treatment follow-up of the results and any complications of radiation therapy are within the purview of the radiation oncologist.

2.2 Differences between Linear Accelerator and Co-60 Units

During the course of treatment, a linear accelerator unit is capable of accommodating four or five patients per hour (depending on the complexity of the set-up), hour after hour, five days per week. Treatment sessions with Co-60 units take somewhat longer on the average because the beam is less powerful. Also, the age of the radioactive source needs to be considered. In departments having both types of machine, therapists typically are expected to rotate between the two.

The versatility of Co-60 units for differing treatment regimes is considered limited by many oncologists because of lower maximum power, and the ability to produce only gamma radiation. Linear accelerators, on the other hand, produce varying intensities of X-ray and electron beams. Advantages of the Co-60 units are considerably lower initial cost, reduced space requirements, fewer maintenance requirements, and greater reliability (in terms of the relatively simple operation of peripheral components). Co-60 units, however, must be periodically calibrated, and the sources replaced and leak-tested.

There are also significant differences in the operator interfaces and tasks required for the operation of Co-60 and linear accelerator units. Co-60 units must continuously house radioactive source material; linear accelerator units create a variety of radiation beams electronically. As a consequence, the operator interface and tasks required by the equipment reflect this fundamental difference in the nature of the source of radiation. Visits to facilities, interviews with professional staff members, and review of relevant texts revealed that Co-60 units are frequently the oldest units in a teletherapy facility since fewer and fewer manufacturers are making them. In the United States, Co-60 units are increasingly being replaced with linear accelerators units. As a result of this trend, Co-60 control consoles and associated equipment are usually older and different from the newer linear accelerator technology, much of which consists of computer- and software-based displays and controls. The extent to which these operator interface differences relate to human error is addressed in the second phase of the study on user-system interfaces.

Given that therapists treat as many as 35-40 patients a day on a given machine (with each patient having a unique prescription, set-up procedure, and dose delivery schedule), it is not surprising that intricate interactions among equipment, procedures, and people may, over time, result in conditions susceptible to human error. In order to arrive at a determination of the diverse factors that lead to human error in the teletherapy environment, an in-depth understanding of the functions and tasks that make up the process was an essential first step.

3.0 METHODOLOGY

A comprehensive function and task analysis of the teletherapy process constituted the principal objective of the first Phase of the study. While the analysis focused on the functions and tasks required to administer teletherapy, additional data and information were collected that facilitated performance of subsequent phases. The overall approach to the function and task analysis is shown in Figure 3.1.

Figure 3.1 Function and task analysis methodology

3.1 Site Sampling Strategy

Figure 3.1 shows that the first major block of activity is the development of a site sampling strategy. The foremost consideration to the sampling plan was to obtain as representative a sample of teletherapy organizations as practically possible. Three major factors had an impact on the sampling strategy: a) geographical dispersion, b) type of teletherapy organization, and c) inclusion of Co-60 treatment units, where possible. Selecting sites from different geographical areas was considered important to avoid any disproportionate influence (in terms of treatment philosophies or practices) that may be associated with a given region or center. Individual sites were selected from the San Francisco, CA, Chicago, IL, Houston, TX and Washington, DC regions.

In terms of type of organization, three types of teletherapy organizations were identified and sampled: university-based departments, community-based hospitals/centers, and free-standing facilities. Management styles, organizational factors, policies, patient load, and equipment types were expected to vary among the three major types of organization. Finally, an effort was made to select facilities that used Co-60 units as the sole treatment machine or in conjunction with linear accelerator units.

In accordance with the above sampling plan, candidate radiation oncology departments were selected from the American College of Radiology Membership Directory for initial contact. The candidate list was shared with SME consultants for their review and suggestions. A letter was sent to the directors of the candidate departments (in conjunction with a phone call) describing the purpose of the study and requesting their participation. Important aspects of the letter were contractor-stated assurances with respect to anonymity of information sources and the NRC Project Manager's phone number in the event further assurances or questions needed to be addressed. The level of cooperation of the candidate departments was favorable; fewer than 15% of those contacted chose not to participate. No differences were discerned between participating and non-participating departments. It also should be noted that site visits were made prior to publication of NRC's *Regulatory Guide 8.33 Quality Management Program*.

3.2 Data Collection Activities

The first step of the data collection activities was to prepare for the site visits. Data collection personnel familiarized themselves with the teletherapy process through a review of relevant documents and initial meetings with SME consultants. Data collection sheets were developed for recording the relevant task performance information. Table 3.1 lists the relevant elements from the data collection sheet.

Table 3.1 Task-Related Data Collection Elements

Functions	Communications
Sub-functions	Communication mode
Task statements	Task difficulty
Position	Task frequency
Equipment	Time required
Cues	Likelihood of error
Standards	Task-error linkage
Staff interactions	Consequences of error
	Error Pervasiveness

At the same time, data collection sheets were developed for collecting departmental as well as training information (to be utilized for subsequent tasks) as shown in Table 3.2.

Table 3.2 Departmental/Training Data Collection Elements

<u>Departmental</u>	
Identification of treatment units	Turnover rate
Kind of simulator	Performance evaluation
Treatment planning equipment	Staffing by equipment
Treatment planning software	Shift length\schedules
Patients treated per day	Policy information sources
Patients simulated per day	Sick\vacation leave
Number of therapists	Coverage for absences
Number of physicists	Work alone percentage
Number of dosimetrists	Self report of errors policy
Reporting chain	Unions
Hiring authority	Quality control procedures
	Quality assurance program
<u>Training</u>	
Formal training on site	Certification required
On-the-job training	Orientation program
Staff responsible for training	Performance assessment
Qualifications for new hire	Continuing education
Type of program completed	

During the site visit, two data collection methods were employed: interviews with teletherapy staff and direct observation of teletherapy treatments. Depending upon the particular facility, interviews were conducted with the chief therapists, staff therapists, radiation physicists, dosimetrists, department directors, and radiation oncologists, when available. Interview priority was given to the first four positions. Because of the nature of their work schedules, the chief therapists, physicists, and department directors were able to furnish much of the above information. Staff therapists who were treating patients had less time available; therefore, their interviews were more compressed, yet very valuable.

Direct observation of the treatment process served as an informative supplement to the interviews. Patients with diverse pathologies were observed being treated by teletherapy staff at various phases (e.g., simulation, set-up and positioning, dose delivery) throughout their treatment regimes on both Co-60 and linear accelerator units. Additionally, photographs were taken of the various components, controls, and displays of the teletherapy equipment.

3.3 Develop Function/Task Descriptions and Database

Upon completion of data collection activities, task and function descriptions were prepared. Tasks, for the purpose of the study, are defined as discrete units of operator behavioral or cognitive activity having a discernable starting point (i.e., initiating cue or stimulus), duration, and end point. When aggregated, a group of tasks contributes to a specific functional objective and ultimately to an output goal of the system. Task statements in the present study include an action verb for defining the activity, followed by a brief description of the action.

Preparation and examination of the task statements led to the identification of specific functional areas related to teletherapy system outputs. Tasks that were found to be functionally related were thus aggregated and the aggregated entity was entered into the ensuing data base as a system function. Analysis of the functions, in turn, led to the development of function flow diagrams for graphically depicting the sequence and hierarchy of functions performed in teletherapy.

To facilitate access to the task statements and supporting data, a DBASE IV file was created into which all the task-relevant data was entered. The DBASE IV file was created as a working data base to be easily expanded, modified and flexibly used during performance of subsequent phases of the project.

3.4 Verify Technical Accuracy

The last block of activity focused on assuring the technical accuracy of the function and task descriptions and the associated data entered into the database. Relevant sections of the data base printout were sent to the SME consultants with the request to identify and correct any omissions, technical inaccuracies, or other misrepresentations falling within their domain of expertise. Comments of the SME consultants were then incorporated into the working data base.

4.0 DESCRIPTION OF THE FUNCTION AND TASK ANALYSIS

This section describes the results of the function and task analysis of teletherapy activities. The analysis includes both treatment-related tasks and management tasks in two separate data bases. A description of all functions contained in the data bases is provided in this section. A copy of the entire treatment-related function and task analysis data base is in Appendix A. The management function and task analysis database, consisting of an inventory of function and task statements, is provided in Appendix B.

4.1 Treatment-related Function and Task Analysis Data

An overview of the teletherapy function and task analysis data elements that make up the treatment-related task analysis to be described in this section are in Table 3.1 above. As the task analysis data corresponding to these data elements were collected, they were transcribed into a DBASE IV data file to facilitate the refinements required during the development of the function and task analysis, and to provide the ability to sort task statements by specific attributes for analyses performed in subsequent phases of the project.

A summary of the functions to be discussed in the sections that follow is presented in Table 4.1. Also shown are the treatment staff positions typically responsible for executing these functions.

4.1.1 Error Category and Pervasiveness Assignment

The methodology used to specify the category and pervasiveness of error possible for each task is provided in Table 4.2. Eight categories of error were defined. The first six error categories describe how unintended deviations in radiation dose to the patient may be manifested. Category 7 errors are non-radiation related injuries. They were included in the database because this information was readily provided during interviews and often mentioned in reviews of teletherapy incidents and discussions with teletherapy SMEs. The Category 8 error classification corresponds to incorrect treatment resulting from decisions made by the oncologist. Clinical errors made by the oncologist were considered beyond the scope of the present analysis. They were, however, a necessary element in this analysis because they help to provide an understanding of the division between the responsibility of the oncologist and the responsibility of the rest of the teletherapy staff with respect to error consequences within the context of the overall teletherapy process.

With respect to error pervasiveness, three levels were defined. Error pervasiveness is defined in terms of the extent to which the error is likely to affect individual treatments, individual patients, or all patients treated on a given machine. As shown in Table 4.2, an episodic error affects a single daily treatment; a programmatic error impacts a larger portion of the patient's treatment; and a systematic error affects all patients treated on a specific treatment machine or treatment planning machine. Episodic errors occur on a random or unpredictable basis during a

Table 4.1 Treatment-related functions identified
and staff typically responsible for performing them

Function No.	Function	Position
1.0	Diagnosis, Tumor Localization, and Identification of Initial Treatment Concerns	Oncologist
2.0	Pre-treatment Planning Session	Oncologist, Dosimetrist/ Physicist, Therapist
3.0	Treatment and Safety Equipment Checks, Adjustments and Maintenance	Physicist, Biomedical Engineer, Equipment manufacturer engineer
4.0	Simulation	Oncologist, Physicist, Therapist (simulation technologist)
5.0	Treatment Computer Data File Set-up	Physicist
6.0	Treatment Planning	Physicist, Dosimetrist, Therapist
7.0	Custom Blocks	Therapist, Therapist-intern, Dosimetrist, Block maker (technician)
8.0	Treatment Set-up	Therapist, (Dosimetrist/ Physicist may assist occasionally)
9.0	Treatment Administration from Control Console	Therapist
10.0	Monitor Patient Progress and Treatment Adequacy	Therapist

single treatment (e.g., incorrect exposure time set); programmatic errors (e.g., custom block incorrectly fabricated) can be propagated across all the treatments for a given patient; and systematic errors (e.g., beam calibrated incorrectly) can pervade all the patients treated by a given treatment machine. While episodic errors are not to be excused or tolerated, quality assurance efforts will realize their greatest impact when targeted at the more pervasive errors.

Table 4.2 Specification of Treatment Errors

<u>Error Category</u>
1. Dose to intended volume higher than desired.
2. Dose to intended volume lower than desired.
3. Radiation dose to normal tissue outside intended treatment volume (includes the wrong patient or body part).
4. Portion of intended target volume not irradiated.
5. Inhomogeneous dose to intended target volume (i.e. dose intensity across treatment area can vary in an unacceptable manner due to lack of appropriate beam modification which accounts for anatomical variation in tissue thickness or variations in tissue density).
6. Premature, uncontrolled or unplanned exposure to patient and/or treatment staff.
7. Non-radiation-related injury.
8. Prescription not appropriate or not reflective of true disease condition due to error(s) in the process of tumor localization, identification of critical structures or treatment volume specification.
<u>Error Pervasiveness</u>
A. Episodic - affects single daily treatment.
B. Programmatic - affects entire or large portion of patient treatment course.
C. Systematic - affects all patients treated on a specific treatment machine or treatment planning machine.

Table 4.3 provides examples of errors that occur when performing teletherapy tasks. By combining the different designations for error category (e.g. 1-8) and error pervasiveness (e.g., A, B, or C) into a singular error code, the reader has a short-hand and immediate reference to the type of error that is associated with a task and to its pervasiveness or consequences. It also is noted that a task may have more than one error code associated with it; the data base structure allows for each task to be associated with up to five error category-pervasiveness codes.

**Table 4.3 Examples of Error Category
and Error Pervasiveness Combinations**

<u>Code</u>	<u>Sample Error</u>	<u>Category-Pervasiveness</u>
1.	Beam calibrated incorrectly	1C, 2C
2.	Block fabricated incorrectly	3B, 4B
3.	Wedge filter omitted incorrectly	1A, 5A
4.	Incorrect monitor units (MU) or exposure time set	1A, 2A
5.	Block omitted	3A
6.	Door interlock is not functional, allowing the "beam on" button to be pressed prematurely	6A
7.	Block dropped on patient	7A
8.	Incorrect diagnosis, tumor localization, or improper prescription for condition	8A

4.1.2 How Function and Task Analysis Data were Developed

Most of the task statements were developed through observation during on-site visits, and were clarified through discussions with staff members, or were derived from source texts on teletherapy. SME consultants later reviewed and expanded the list of task statements. Some of the detailed data were provided directly by individuals on-site, and other data were derived by the research team and later reviewed and modified, as required, by SME consultants and other individuals at teletherapy facilities. Much of the data was provided directly by the SME consultants. With the exception of the task statements themselves, all of the function and task analysis data were obtained verbally or in written form from on-site teletherapy staff or from SME consultants.

4.1.2.1 Task Analysis Data Collection Environment

Teletherapy tasks were performed differently at the sites visited for a number of reasons: 1) individual preferences of teletherapy staff, 2) differences in the kinds of cases treated, 3) differences in approach by attending oncologists, 4) differences between treatment centers, and 5) differences in the treatment planning equipment and treatment machines. Individual preferences also were evident when the SME consultants reviewed and assisted with the function and task analysis. During the site visits, task data were obtained from staff members during their frequently busy work schedules. The data collection effort resulted in many issues that required further clarification with SME consultants.

Overall, the level of complexity and the extent of the function and task analysis as it now exists reflects a selective process of obtaining that information deemed absolutely essential within the practical constraints of the data gathering process. Some task-relevant data sought in the early stages of the analysis proved to be inappropriate to qualify or quantify on a per-task basis. Specifically, these data included task criticality and workload. Although function and task analysis data were gathered that would provide an estimate of these phenomena, attempts to measure them directly in interviews caused confusion and was deemed impractical. Task workload and criticality, it seems, are context specific rather than task specific.

4.1.2.2 Inter-Task Dependencies and Criticality

The focus of the function and task analysis was on tasks leading up to and including the treatment of patients, and monitoring of the treatment process. Due to this focus, all of the tasks in the treatment-related function and task analysis are critical either to the delivery of treatment or to the patient's well-being while being treated. Although some tasks are subject to omission through memory lapses, most tasks are required for the performance of subsequent tasks and dependent on previous tasks. In the majority of cases, omission of a task would halt the process until it was performed allowing subsequent tasks to be performed. On the other hand, incorrect task performance, if not noticed, would likely cause a treatment error. Tasks that involve recording of treatment data, though not immediately sequentially dependent, were also found to be critical for ensuring that the treatment dosages delivered were consistent with the prescription. The notable exception to task interdependence is the management tasks found in Appendix B. Management tasks are not generally considered interdependent because failure to perform them, or performing them incorrectly, would not affect immediate performance of treatment-related tasks; however, such failures would gradually affect performance of treatment-related tasks over time if not detected. Other tasks subject to omission such as omitting a beam modification device (e.g., a wedge filter) deserve careful consideration in evaluation of their contribution to the possibility of treatment errors.

Within the current function and task analysis data base, initial estimations of variations in task criticality between treatment-related tasks can be made from three of the function and task analysis data fields; the errors associated with each task (ERROR_CONS), the subjectively-rated likelihood of human error field (LIKLI_H_E), and the subjectively rated likelihood that human error will remain undetected field (LIK_UNDET). It seems premature at this point in the analysis to assume that values in these fields could lead to a precise comparison of task criticality. It is difficult to say which type of error is more serious: a mistake in the calibration of a treatment machine that results in undetected underdoses by 5% to hundreds of patients, or a crippling dose of radiation to the spinal cord of a single patient during the course of treatment of that patient. The task or tasks involved with the treatment machine calibration error may have a higher probability of resulting in the 5% error described and a higher likelihood of going undetected than the tasks directly involved in the overdose to the spinal cord (with their respective errors and likelihood of not being detected). In addition, the tasks involved with each of these errors may be associated with other potential errors of varying degrees of likelihood resulting in more or less severe consequences.

4.1.2.3 Task Workload

The function and task analysis was originally designed to determine the workload associated with each teletherapy task so that error likelihood could be compared to workload. Workload, in the context of this study, was defined as the difficulty of performing a task. No distinction was made between physical and mental workload in the difficulty rating of each task. While the difficulty field in the data base provides subjective SME estimates of relative workload on a per-task basis, a caveat is in order. In brief, SMEs reported difficulty in making the ratings since it was difficult to conceive workload as a property of a given task. Instead of workload being associated directly with each task, subsequent examination and discussion found workload to be more closely associated with the environment and prevailing context in which tasks were performed. For example, therapists would describe their work environment as having a heavy workload, meaning they had to treat four or five patients an hour. They would not describe the workload associated with a particular task (e.g., rotating the gantry) as heavy, moderate, or light. Moreover, it was realized that managerial factors (e.g., staffing, patient scheduling system, performance expectations or norms) play an important role in shaping the work conditions in the teletherapy setting.

With respect to workload *per se*, the time required to perform a task and the time available were considered the chief variables in determining workload. Analysis of data gathered during interviews, observations, and literature review indicated that workload on a facility level was influenced by four major factors:

1. The number of patients that must be treated in a given amount of time
2. The capabilities of the staff available to treat patients,
3. Slippage in the daily schedule for treatments and/or simulations, and
4. The typical difficulty level of the cases treated.

In a very busy facility or during an unusually busy day in a facility, all tasks have a high degree of mental stress associated with them, as reported by therapists. At facilities that are not so busy, or on slow days, the workload associated with tasks does not seem to be a serious issue. This phenomenon brings about an interesting consideration for future evaluation of task performance. Individuals report that they feel that error likelihood increases due to the hectic work environment when working during busy conditions. That errors are more likely to occur during periods when unusually high numbers of patients are treated has been demonstrated by Swann-D'Emilla, Chu, and Daywalt (1990). These investigators found that as the number of patients treated on a machine increases, the probability of error also increases.

Unscheduled interruptions that are time-consuming frequently result in a backlog of patients waiting to be treated or simulated. Treatment personnel report that these interruptions add to their workload. Interviews with teletherapy staff indicate that slippage of the daily schedule, which may or may not be exacerbated by an already demanding treatment schedule, increases the subjective workload of treatment-related tasks and increases the likelihood of errors of both commission and omission. This effect is frequently compounded by unplanned events such as absenteeism, equipment breakdown, emergency treatments, failure to locate personnel when needed for treatment functions, competing tasks, and requests for information from other departments. For this reason, interruptions and slippage of the schedule are viewed as a contributing factor to workload, and as a contributing factor to an increased likelihood of error for a wide array of treatment-related tasks.

Teletherapy staff also reported a tendency to commit errors during treatment due to monotony. This monotony may be inevitable for some therapists, but was increased in departments with a characteristically slow pace or during slow times. The impact of monotony, although well documented for other professions (i.e., extended monitoring of CRTs in military settings) does not seem to be well documented in formal investigations of error commission in the teletherapy field. Teletherapy departments usually, but not always, rotate their therapists between different treatment machines and the simulator within the department in an attempt to reduce the effects of monotony.

Some teletherapy facilities are noteworthy in that they choose to treat more challenging cases compared to other facilities. This is typical of teletherapy facilities associated with universities that have research-oriented oncology departments. Such facilities typically have advanced treatment equipment and highly trained staff. Difficult cases come to or are referred to these facilities because of their reputation. In addition to the more challenging cases, these facilities also maintain rapid-paced patient treatment schedules. Teletherapy staff at these facilities report high levels of subjective workload virtually all of the time. In fact, treatment personnel were difficult to interview at these facilities because of the pressures of the work environment. When asked if the pressure of the daily schedule contributes to increased error commission, individuals working at this kind of facility, or individuals who had previously worked at such a facility, frequently stated that it did.

4.2 Management Tasks

Although qualitatively different from the treatment-related tasks, management tasks (e.g., hiring qualified personnel, establishing policies and procedures for the department, implementing a quality assurance plan) also are part of the function and task analysis. Because management tasks are qualitatively different and are performed further upstream from the front-line activities of treatment personnel, the function and task analysis data fields in the data base of treatment-related tasks are not appropriate for evaluating management tasks. As noted by Reason (1990), errors associated with management tasks are termed latent errors. Latent errors "may lie dormant within the system for a long time, only becoming evident when they combine with other factors to breach the system's defenses" and are most likely "spawned by those whose activities are removed in both time and space from the direct control interface: designers, high-level decision makers, construction workers, managers and maintenance personnel" (p. 173). Reason attributes the active errors that front-line workers make, in large measure, to the cumulative effects of latent errors that system designers and managers make further upstream.

The management function has been broken down into the inventory of subfunctions and tasks listed in Appendix B. The management tasks are typically shared between management positions. Teletherapy facilities have a medical director, an administrative director and, depending on the extent of the physics component, a physics director. The impact of specific management tasks on patient treatment in terms of an increase or decrease in likelihood of unintended deviation of intended dose is the subject of further analysis as reported in *Volume IV, Training and Organizational Analysis*, NUREG/CR-6277 (1995).

4.3 Description of the Function Areas

This section is provided as a guide to the reader in understanding the function and task analysis data in Appendix A. An overview of the flow of functions is provided in Figure 4.1. The sections that follow provide an overview of each of the ten treatment-related functions, followed by a discussion of how the function and task analysis data were used in the subsequent phases of the study. It is noted that some functions were divided into subfunctions before being broken down into tasks, while other functions were divided directly into tasks.

LEGEND

Arrow: Signifies the sequence of function performance

Block: Contains the function title and function identification number

“OR” gate: Indicates that a choice may be made between two or more of the functions following or preceding the gate as to which is to be performed (or has been performed)

Figure 4.1 Function flow of teletherapy process

To the extent possible, the order in which these functions and subfunctions are presented in the data base correspond to the order in which they are typically performed. Variability in the sequence of actual performance of teletherapy activities between facilities and/or individuals increases as the level of task analysis categories becomes more specific (i.e., more for subtasks than for tasks, and more for subfunctions than functions). Thus, the order in which the tasks and subtasks occur within the data base may not always reflect the order of actual performance. In addition, for ease of understanding and analysis, it was sometimes necessary to separate tasks or subtasks into discrete groups by subject area rather than by normal order of performance. Subtasks and tasks within such groups give the appearance of being performed in the order in which they are listed in the data base, although this is not true in actual practice. For example, the function "Treatment Set-up" subsumes subfunctions "Patient Set-up", and "Treatment Machine Set-up". All "Patient Set-up" tasks are listed before the "Treatment Machine Set-up" tasks. In actual practice, the tasks in these two subfunctions are performed concurrently; the exact order in which these tasks are performed is variable between and within facilities. This variability is due to factors such as the specific requirements of the case being treated, preferences of the supervisory staff, individual therapists, the number of therapists involved, departmental workload, the treatment and treatment planning equipment present in the department, and generally accepted rules of performance followed by the facility.

To clarify this situation, function flow diagrams are provided. Each function flow diagram breaks the function down to the next lower level of analysis; if a function contains subfunctions, the breakdown is to subfunction. If the function contains only tasks, the breakdown is by task. The function flow breakdown diagrams of each function are presented before the discussion of each function in the sections that follow.

4.3.1 Function 1: Diagnosis, Tumor Localization, and Identification of Initial Treatment Concerns

Function 1.00 as depicted in Figure 4.2 is the sole responsibility of the oncologist. It is included in the analysis to provide context for other functions performed by the various members of the teletherapy staff, to demonstrate how the treatment process is initiated, and to ensure that the function and task analysis is complete to the extent possible. This function demonstrates the important division of responsibility for treatment quality that exists between the oncologist and the rest of the teletherapy treatment staff.

The tasks in Function 1.00 played a minimal role in the later analyses because they are performed by the oncologist, and the goal of this analysis is to investigate causes of error in carrying out the treatment specified by the oncologist. The communication required in the performance of these tasks, and the manner in which the conclusions reached by the oncologist are communicated to other staff members in the functions that follow, are assessed in *Volume I, Identification of Problems and Alternative Approaches*, NUREG/CR-6277 (1995).

Figure 4.2 Function 1: Diagnosis, tumor localization, and identification of initial treatment concerns

4.3.2 Function 2: Pre-treatment Planning Session

The pre-treatment planning function in Figure 4.3 involves discussion of aspects of the case to be treated that must be considered during the simulation and treatment of the patient. The oncologist is the central figure and communicates pertinent case information to the rest of the treatment staff. The manner in which this function is represented in the data base gives the impression that it is always performed, and that the occurrence of the planning session

Figure 4.3 Function 2: Pre-treatment planning session

is carried out with some degree of formality. In actual practice, pre-treatment planning sessions were found to vary widely in the degree of formality with which they are undertaken. They were found to frequently take place within a few minutes in an impromptu fashion when members of the treatment staff encountered one another in the work area. At other times, the pre-treatment planning session was found to be formal and was conducted in a predesignated meeting room at a predesignated time. Frequently, this function was altogether omitted from the progression of functions leading to treatment.

When the pre-treatment planning session was not performed, it was reportedly because the case to be treated was a type frequently encountered by the teletherapy staff, and the treatment methodologies involved were well understood. The extent to which the pre-treatment planning session was actually performed in teletherapy facilities compared to the extent to which it should have been performed was a matter for further evaluation through interviews of teletherapy department staff. In addition, the efficiency of communications and modes of communications while this function is being performed is further examined in *Volume I, Identification of Problems and Alternative Approaches*, NUREG/CR-6277 (1995).

4.3.3 Function 3.00: Treatment and Safety Equipment Checks, Adjustments and Maintenance

The equipment checks, adjustments and maintenance tasks of Function 3.00 shown in Figure 4.4 were found to be performed in accordance with NRC requirements in 10 CFR 35, state requirements, the requirements of the accrediting organization JCAHO (Joint Committee on Accreditation of Healthcare Organizations) as well as professional societies including the ACR (American College of Radiology), ICRU (International Commission on Radiation Units and Measurements), and the AAPM (American Association of Physicists in Medicine). Initial indications were that the JCAHO takes its criteria directly from the professional organizations. Significant variability was found between the NRC requirements involving maintenance of Co-60 treatment equipment and state requirements involving maintenance of Linear Accelerators.

Some of the Function 3.00 tasks are performed by therapists. They include daily equipment warmup, and conducting and recording of the results of output tests. The more technical components of this function are performed by the physicist, and/or the resident engineer. As indicated in the task analysis data base, most departments use manufacturer representatives or third party contractors to perform maintenance on their linear accelerators. Some departments (approximately 10%) employ a factory trained engineer who can perform this work without outside assistance. There are also some hospital maintenance personnel (bio-medical engineers) that perform intermediate level maintenance on linear accelerators with assistance over the phone from a manufacturer representative. NRC requirements limit access to Co-60 equipment maintenance to licensed manufacturer representatives. Testing of some types of Co-60 machines is done by the licensee as required by NRC.

Figure 4.4 Function 3: Treatment and safety equipment checks, adjustments and maintenance

The degree to which maintenance requirements are adopted and implemented by teletherapy facilities was found to vary. Initial findings indicate that this variability concerning implementation of maintenance requirements is more of an issue for the use of linear accelerator equipment than for Co-60 equipment. This is because the Co-60 equipment is regulated by the NRC, and this regulation is typically less variable between states, and typically more specific than the regulation of linear accelerator equipment by the states. Also, due to the manner in which the radiation is produced in Co-60 machines (i.e., from radioactive material rather than electrically induced radiation), these machines have fewer total components, particularly electrical components, that require maintenance. However, errors associated with Function 3.00 calibration tasks tend to be systematic, meaning they affect all patients treated on the equipment, regardless of whether the equipment is a Co-60 device or linear accelerator.

4.3.4 Function 4.00: Simulation

As portrayed in Figure 4.5, simulation was found to be a complex and crucial aspect of the teletherapy process. Its performance was found to have the potential to dramatically affect the accuracy of radiation therapy. A variety of errors also can occur that reduce that accuracy. The output of the simulation function includes specific equipment position data, and data describing the patient's treatment position, anatomical features, and the location of treatment ports (the area at which the radiation beam enters the patient's body). This information, derived from simulation films, must be transferred to the patient's chart in a form that is complete, accurate, and readily understandable by the therapist who sets up the patient and treatment machine for daily treatments.

The overall adequacy of the simulation was found to be the responsibility of the attending oncologist. It was the role of the oncologist to approve the simulation films. Performing the simulation itself required the combined efforts of the oncologist and a simulation technologist. The individuals performing the tasks of simulation technologist were found to vary. For example, it was often a radiation therapist who rotated through the position of simulation technologist, but was sometimes a therapist permanently assigned as a simulation technologist, or a dosimetrist. The oncologist typically directed the process and evaluated the position of each of the treatment fields as they were adjusted to the oncologist's treatment goals. The simulation technologist controlled the position of the treatment table, the gantry, and the collimator, and then exposed and developed the simulation films, and placed them on a viewing light box for review by the oncologist.

At times, the simulation technologist was found to perform the simulation independent of the oncologist, with the oncologist only approving the simulation films. At other times, the oncologist was found to work side-by-side with the simulation technologist throughout the simulation. Variations in the degree to which the oncologist was present during the entire simulation was a result of one or more of the following considerations: 1) the style preferred by the oncologist, 2) the skill of the simulation technologist, 3) the complexity of the case, and 4) the accepted procedure of the facility.

LEGEND

- Arrow:** Signifies the sequence of function performance
- Block:** Initial block contains the function; subsequent blocks contain sub-functions or tasks.
- “AND” gate:** Indicates that all of the functions following or preceding the gate must be performed
- “AND/OR” gate:** Can act as either “AND” or “OR” gates

Figure 4.5 Function 4.00: Simulation

As recognized by Mizer, Scheller and Deye (1986), there are three major reasons for the use of simulators in teletherapy. First, simulators enhance the accuracy of radiation therapy through their ability to image and produce films of the location and extent of the tumor and surrounding normal tissue relative to the treatment fields, as well as the ability to mark the patient externally. High quality simulation films are one of the goals of the simulation process and are crucial for the accuracy of subsequent treatments. Second, simulation serves as a focal point for planning the patient's treatment by bringing together at one place the oncologist and treatment staff with all the pertinent data. And third, the simulator enhances the efficiency of teletherapy operations since it allows questions of set-up and planning to be resolved without actually using the treatment machines.

Due to the physical properties of radiographic film, treatment machines are too powerful to make a high quality image of the anatomy within and surrounding a treatment port. The powerful x-ray or gamma beams from treatment machines tend to bleach out crucial anatomical details

such as bony landmarks, internal organs, and the tumor itself. These details are essential to the oncologist to allow an understanding of the location of the treatment port with respect to the desired target area. The proximity of critical structures within the patient's body that are more sensitive to the effects of radiation than other tissues (i.e., the eyes, spinal cord, kidneys, rectum and lungs) must be taken into account. Simulators are equipped with standard x-ray capabilities that provide the high quality films required to view crucial surrounding anatomical structures.

Simulation rooms are sometimes equipped with fluoroscopy equipment that allows the simulation technologist and oncologist to obtain a real-time view (from a shielded viewing area) of the position of the treatment field (the borders of which are marked by radio-opaque markers). Fluoroscopy allows rapid review and iterations of the treatment area position with respect to internal target and non-target structures. Fluoroscopy may be used repeatedly during a simulation while the treatment field location is adjusted without the requirement of waiting for radiographs to be developed.

Simulators exhibit an overall structure that corresponds closely to treatment machines. A typical Co-60 treatment machine and a typical linear accelerator are shown in Figures 4.6 and 4.7 respectively. As is the case for treatment machines, simulators also have an adjustable treatment table, a gantry which rotates through an arc of 360 degrees, and a treatment head (from which the radiation is emitted on treatment machines, and from which x-rays are taken on simulators). Both simulators and treatment machines are capable of projecting a field light through the treatment head collimator (the device that shapes the field size in the X- and Y-axes). The shape of the field light is modified in the same manner in which the radiation beam is modified; that is, by the collimator, although for Co-60 machines there is some dispersion of radiation outside the edges of the actual field position. The field light allows field size to be inspected visually on the patient; field size is controlled by the collimator which Figures 4.6 and 4.7 show affixed to the treatment head. The collimator setting may be an analog scale on the collimator only, and can also include a digital readout at the control console and/or in the simulation or treatment room. In addition to the field size, the orientation of the treatment field is measured and indicated as the collimator angle. This is the degree of rotation of the collimator that causes a rectangular treatment field to pivot clockwise or counterclockwise.

A measurement of central importance in simulating treatment is the distance between the source and the isocenter¹ of the treatment machine. This distance is the source to axis distance (SAD). Cobalt-60 treatment machines frequently have an SAD of 80 cm, while linear accelerators almost always have an SAD of 100 cm. During the simulation, it is important for the simulation technologist to be aware of and to record the SAD of the treatment machine on which the simulated patient will be treated. If the wrong SAD is used in simulation, the beam during treatment will be either closer or further away than the distance that was used in the

¹ The isocenter is the point in space around which the gantry (and therefore the treatment head) rotate. The radiation source is always at the same distance from the isocenter regardless of the position of the gantry.

• FIELD POSITION LIGHT FOLLOWS THE SAME DIVERGENCE AS THE TREATMENT BEAM

Figure 4.6 Drawing of typical Co-60 isocentric treatment machine (Note: There are still some older, simpler Co-60 machines, although infrequently used, that do not have a rotating gantry. They allow vertical movement of the treatment head and rotation of the treatment head.)

simulation. Due to the divergence of the radiation beam as it travels through space, the field treated becomes larger or smaller than intended. In addition, due to the decrease in strength of radiation in accordance with the inverse square law², the impact of the beam on the patient will also be either more or less intense than intended.

² The inverse square law holds that the intensity of a field of radiation is inversely proportional to the square of the distance to the source.

Figure 4.7 Drawing of a linear accelerator

It is clear that the characteristics of the treatment machine to be used must be considered during the simulation. The data corresponding to the position of the patient relative to the simulator head (simulating the position of the source) is equally critical and must be accurately recorded at the time of the simulation. Table 4.4 presents important data pertaining to the physical characteristics of the simulator and treatment field that must be recorded during simulation.

Table 4.4 Essential Equipment-Related Data Recorded During Simulation

SAD:	Source-to-axis (or isocenter) distance, where source refers to the x-ray tube focal spot or the Co-60 source.
TSD:	Target-to-surface distance, where target refers to the x-ray tube focal spot and surface refers to the body surface of the patient at the central axis (unless otherwise stated).
FFD:	Focus-to-film distance where focus is the location of the simulator x-ray tube focal spot.
IFD:	Intrafield distance, or the measurement of the thickness of the patient along the central axis of the beam (or along a line parallel to the central axis) from the entrance point to the exit point. Also referred to as "separation."
Field Size:	The size (L x W) of the rectangular treatment field used in the simulation.
Gantry Angle:	The angle of the isocentrically mounted gantry relative to its vertical downward position.
Collimator Angle:	The angle at which the collimator is turned with respect to the plane of gantry rotation.

Adapted from Mizer, Scheller, and Deye (1986).

Typical teletherapy departments have only one simulator which resides in a room dedicated to the use of this device. The vast majority of treatment plans are simulated on one simulator whether or not the department has both linear accelerators and Co-60 equipment. Very large departments may have two simulators although this is uncommon.

In addition to the physical characteristics of the simulation equipment, it is also necessary to obtain and record measurements of the patient's anatomy surrounding the treatment area. The distance from the surface of the patient's body to the location of the treatment volume on the side of the patient's body facing the treatment beam is one important measurement. The distance from the treatment volume to the other side of the body is another. Irregularities in the patient's external anatomy over the treatment area must be determined and retained in a reproducible form. This typically involves pressing a bendable contour wire across the anatomy of interest (contours also can be taken with plaster cast material, CT imaging, and other measurement devices) and then tracing the outline of this contour onto paper. This contour and other data pertaining to the patient's physical dimensions will be used in the treatment planning process (Function 6.00) where calculations for radiation dose to the treatment volume and varying depths surrounding the treatment volume are made.

Treatment simulation is a very important component of the teletherapy process. It requires the knowledge and skills of the oncologist as well as the simulator technologist in positioning the patient and manipulating the simulation equipment, in recording essential treatment-related data, and in transferring and communicating the data to other staff members for implementing subsequent phases of the teletherapy process. It is critical that there is consistency between simulator equipment parameters and corresponding parameters on the treatment machines, and that the procedures and forms used for recording and transferring simulation data to the treatment planning and treatment set-up phases of therapy be well conceived and as clear as possible. Reports of misadministrations have implicated failure to correctly convey critical information and incorrectly held assumptions about the intended approach as causal factors.

4.3.5 Function 5.00: Treatment Computer Data File Set-Up

Treatment planning computers are a great aid in performing treatment planning (Function 6.00) for teletherapy treatment, particularly for complex cases using multiple beams to intersect a treatment volume from various positions. To apply the beam intensity calculation algorithms appropriately, the software-based calculations must be based on specific characteristics of the beam of the treatment unit. These characteristics include the maximum rated power of the linear accelerator, the various beam energies available, and the type of beams (i.e., electron or photon) available. In addition, treatment planning for both linear accelerator and Co-60 equipment require beam intensity, beam profile, and depth dose data. Beam profile data correspond to the characteristic variations in beam intensity in the X- and Y-axes of a treatment field brought about by the specific mechanics by which each teletherapy machine broadens the treatment beam to increase the field size, and in the case of linear accelerators, reduce irregularities in the pattern of radiation. Depth dose is the pattern of beam attenuation as it passes through a known medium (water is typically used as the medium). Accurate representation of these treatment machine parameters in treatment planning is clearly important for accurate dose calculation.

In addition to treatment beam characteristics, wedge filter characteristics are also required for the treatment planning computer files. Wedge filters are used to compensate for instances in which the beam impacts a curved surface of the patient's body. A wedge filter is a tapered piece of metal that is placed under the treatment head. It modifies the pattern of beam attenuation in either the X- or Y- axis. The wedge filter progressively decreases the intensity of the radiation across the beam, more at the thicker part and less at the thinner part as shown in Figure 4.8. Note that the beam on the right is unmodified.

In the patient, the radiation beam would travel through more tissue at the closest portions of curved anatomy and less at portions which are further from the source before striking the target

Figure 4.8 Effect of wedge filter on percent depth dose of radiation beam in a tissue-equivalent medium

area. Left unmodified, the beam would be differentially attenuated by the patient's body as a function of the depth of the target volume. The portion of the beam that travelled through the least amount of tissue would be stronger than the portion of the beam that travelled through more tissue. This would result in uneven (inhomogeneous) distribution of dose over the treatment area. To correct this situation, a wedge filter is used to progressively attenuate the beam as it passes through less tissue before reaching the target area. The treatment planning computer must have accurate information in its files to provide accurate beam characteristics for the wedge filters employed in the treatment plan so that dose intensity calculations over the treatment area are accurate. If the actual wedge filters used are different from the attenuation factor for these wedge filters as it exists in the treatment computer, the treatment plan would be in error.

Treatment machine beam characteristics are contained in a file or files that are resident on the treatment planning computer. When it is necessary to update these files, the update is performed by the physicist. These data files are not modified often; however, periodic investigations of software and data file adequacy by the physicist are part of the typical role of the physicist. Files corresponding to Co-60 machines must be updated each time the source is changed. The linear accelerator beam-related data files must be updated after each calibration of the linear accelerator to ensure that small deviations in beam intensity from the previous calibration are accounted for by the treatment planning computer. The wedge filter-related data must be updated when new or additional wedge filters are used in treatments. The steps taken in setting up these files vary with the design characteristics of the treatment planning computer software used.

Treatment machine parameters and wedge filter factors are not necessarily set-up or manipulated simultaneously as Figure 4.9 shows. A department may purchase a new wedge filter

or set of wedge filters, requiring the modification of only the wedge filter identification and attenuation property file. On the other hand, a Co-60 machine may be recalibrated while the existing wedge filters are retained, thus requiring that only the treatment machine identification and beam parameter files be updated.

Activities involving the use of treatment planning computers are one of several functional areas in teletherapy in which the use of and the complexity of software is rapidly increasing. Initial information from SME consultants and known misadministrations of dose incidents indicate that the process of modifying and using these files represents a source of possible error. These errors result in systematic erroneous dose calculations in treatment plans for all patients treated after the use of an outdated (or incorrect) treatment machine or wedge filter data file by a dosimetrist or physicist. It may be necessary for a department to retain outdated beam parameter files in their treatment planning computer data files to enable detailed evaluations of the treatment plans used for old cases treated at the time the file was current. Some versions of treatment planning computer software and user interface that do not allow for these outdated data files to be labeled or closed off from current dose calculations may be unsatisfactory. Additionally, facility supervisory regulations pertaining to the handling of these outdated treatment machine data files may also be unsatisfactory.

Figure 4.9 Function 5.00: Treatment computer data file set-up

Because the file set-up task is performed infrequently in any given department, to date it has been evaluated only through discussions with SME consultants. They indicated that there is a possibility of data file mix-ups due to the use of centralized treatment planning computers interfaced with multiple remote teletherapy user facilities. This type of interface can result in

treatment plans that are created from inappropriate treatment machine data or wedge filter data due to faulty data communication.

4.3.6 Function 6.00: Treatment Planning

The sub-functions to treatment planning are shown in Figure 4.10. Perez and Brady (1992) describe good treatment planning as exploiting the maximum therapeutic ratio of beam arrangement such that the target volume receives a homogenous dose while as little dose as possible is delivered to the surrounding normal tissue. Perez and Brady also state that the

Figure 4.10 Function 6.00: Treatment planning

predicted consequences of treatment are based on the precision with which the dose and the irradiated volume are defined. As discussed above, treatment planning frequently involves the use of dedicated treatment planning computers and software. The resulting treatment plans include a graphic representation of isodose curves as they would exist in the patient's body. Isodose

curves are a group of lines that follow the contour of a constant percent dose level³ as it exists within the entire volume through which the treatment beam must pass including the treatment area. The actual percent dose lines are affected by irregularities of the patient's external anatomy (contour), by differing radiation attenuation properties of body tissues (i.e., bone attenuates a radiation beam much more per unit measure than lung tissue), by wedge filters, blocks, and the additive effects of intersecting beams. The percent dose lines depicted on the treatment plan are a direct result of the software capabilities of the treatment planning computer system, the data files that have been entered into the computer, and how the data were entered by the treatment.

It is of interest to note that accounting for different densities of body structure in treatment plans requires additional effort, expertise, and more sophisticated software than that which is typical. For this reason, treatment plans at most facilities do not account for differing densities of body materials; a water equivalent is used for each unit measure of body tissue. Water is more dense than lung and less dense than bone. Therefore, accounting for differences in body tissue density yields a more accurate application of dose to the target and surrounding area. However, historical treatment data for particular types of treatment have used water-equivalent-based plans. The question then arises as to whether or not it is better to adjust the treatment administered according to a treatment plan that takes variations in tissue densities into account or to attempt to keep the treatment as close as possible to that which has historically proven the most effective.

As previously discussed, treatment plans are graphic displays that depict isodose curves, beam positions, target volume and anatomical reference locations. Depending on the sophistication of the equipment used at the teletherapy facility, the treatment plan may be superimposed on a computed tomography (CT) image. For simple treatment fields (typically single field on a relatively flat contour), treatment plans may be produced with a hand calculator, and the graphic isodose curve may consist of a free-hand sketch, or may not be included.

An example of isodose curves and the additive effects of intersecting beams are depicted in Figure 4.11. The isodose curves in this figure are similar to those that are produced on treatment planning computers; however, in this case the beams are proceeding through a water phantom⁴, and therefore, the shape of the isodose curves is not altered by irregularities in patient contour or internal structures. Note that the additive effect on the total dose from the intersecting beams is highest (see arrow) where the beams proceed through the shortest distance of the water

³According to Kahn (1984), percent depth dose is defined as the quotient, expressed as a percentage, of the absorbed dose at any depth d to the absorbed dose d at a fixed reference depth along the central axis of the beam. For Co-60 and linear accelerators, the reference depth is taken at the position of the peak absorbed dose. Isodose curves associated with percentages indicate the percentage of dose relative to the peak absorbed dose at this location.

⁴ The term *phantom* refers to a device made of a material through which a radiation beam is transmitted, and in which a radiation detector or detectors are placed to measure radiation intensity at a given point or points within that material. The characteristics of absorption of radiation by water are frequently used as references even if other material such as plastic is used as the medium in the phantom. Water is used as the standard because its properties for radiation absorption are very similar to human flesh.

phantom. This is because the beam intensity is increasingly attenuated as it passes through the water. The same phenomenon occurs in planning treatments with intersecting beams in patients.

Figure 4.11 Isodose curves of intersecting beams in water phantom

When a treatment plan is generated it shows the position of the treatment beam or beams as they travel through the patient. Changes in dose as beams travel through tissue and intersect (if multiple beams are used) are indicated by isodose curves. These isodose curves are presented in proximity to the patient's external and internal anatomy and the target area. Data corresponding to the external anatomy (or contour) is entered into the treatment planning computer as previously described. Internal bony landmarks and the outline of the treatment area are also entered in a similar fashion. This data may be supported by simulation films and descriptions of the tumor location by the oncologist. It is, of course, of the utmost importance that data corresponding to internal and external anatomy, treatment area position, and treatment beam position be combined in a manner that accurately represents the patient. Some facilities use CT scans to provide external and internal anatomy. A copy of a "slice" of the CT scan may be generated and then placed on a lighted viewing box. The data are then entered using the treatment planning computer's stylus to indicate points along outlines of internal and external anatomy. As these data are incorporated, the treatment planning computer displays the data in graphical form on its monitor. After the data points have been incorporated, the position of the beam or beams is superimposed over this image.

For more complex, multiple-beam treatments, the treatment planner varies the dose levels and beam position until an acceptable treatment plan is developed. The treatment planner then usually makes one or two more alternate treatment plans, each representing a form of tradeoff between maximizing some desirable aspects of treatment while minimizing others. The oncologist inspects these candidate plans and either selects one plan or requests additional plans incorporating other combinations of beam position and/or dose. The oncologist approves the most acceptable treatment plan, that is, the plan that delivers the desired dose to the target volume, and simultaneously delivers the least possible dose to surrounding healthy tissue and critical structures.

In departments with both dosimetrists and physicists, routine treatment planning is typically performed by the dosimetrist, while more complex cases are typically handled by the physicist. If a department lacks a physicist, then a dosimetrist may do the treatment planning. Likewise the physicist may do the treatment planning when a department does not have a dosimetrist. Some departments have neither a resident physicist nor a dosimetrist. These departments may send their treatment planning requirements out to a consulting firm specializing in this service. Others may have a physicist that rotates through the department on certain days during the week.

The treatment planning function of the teletherapy process is a vital link between the simulation of treatment and the treatments performed. Successful treatment planning requires good communication between the oncologist and the dosimetrist and between the simulation technologist and the dosimetrist. Some aspects of this communication are verbal and other aspects are paper-based. The required information flow is provided in the function and task analysis. The interface characteristics of the treatment planning computers as they relate to treatment planning tasks is quite variable. Aspects of this interface, in addition to those discussed for Function 5.00, were evaluated with respect to human factors standards for medical instrumentation as reported in *Volume III Human-System Interfaces and Procedures*, NUREG/CR-6277 (1995).

4.3.7 Function 7.00: Custom Blocks

When it is necessary to alter the shape of the treatment field by means other than the collimator on Co-60 or linear accelerator treatment machines, blocks are required. The unblocked field modified by collimator only is a rectangle (or square) which is adjustable in size, but only in the X- and Y-axes. If the treatment volume is close to a critical structure, and requires a treatment field of a size that overlaps a critical structure, blocks are required to modify the shape of the rectangular field, and protect the critical structure from damaging levels of radiation exposure. Teletherapy departments use both custom and standard blocks.

Standard blocks are pieces of lead approximately 3-4" thick in various sizes and shapes. These standard blocks are simply set on a transparent block tray under the treatment head to shield an anatomical area. The intended shielding pattern of the blocks is indicated by the shadow cast by the treatment field light passing through the block tray onto the patient's body. There is frequently some inaccuracy involved in the use of standard blocks because the border of the area to be shielded is frequently curved and most standard blocks have straight edges. Because the

areas to be shielded are typically irregular in size and shape and variable between patients, it is sometimes impossible to obtain accurate shielding with standard blocks. When standard blocks are used, some deviation from the border of the area to be shielded is allowed to remain. Decisions on when the accuracy of standard blocks is acceptable or not depends on the judgments of the oncologist and the specifics of the treatment. Some departments use standard blocks in a significant number of treatments in which blocks are required. Others never use standard blocks.

Custom blocks (Figure 4.12) are usually made at the teletherapy facility for each patient that requires them. Occasionally blocks are made outside the facility. Some teletherapy departments have an individual dedicated to making blocks. Other facilities require the dosimetrist to make custom blocks, while still others rotate therapist trainees through the block making position.

Figure 4.12 Function 7.00: Custom blocks

To begin the process of making custom blocks, the oncologist marks the areas to be blocked on the approved simulation films. The marked simulation films are then sent to the block maker. The simulation films may include a block making request with the patient's name, the name of the oncologist, and treatment machine identification, if required. To make the block, the block maker first places the simulation film on the base of the block mold cutting machine as shown in Figure 4.13. A styrofoam block mold is then placed in the appropriate position on the cutting machine. The outline of the blocked areas are traced on the simulation film with the block cutting machine stylus. This simultaneously pulls a hot wire through the styrofoam mold in the shape of the block to be made. The completed block molds are filled with a molten lead alloy and allowed to solidify. The solidified blocks, removed from the mold, are placed on a block template (tray) that is positioned on the block cutting machine. A light similar in effect to a treatment field light is projected from above the block, projecting the shadow cast by the block onto the simulation film at the base of the block making machine. The block is adjusted on the tray until the shadow falls exactly on the area marked for the block on the simulation film. The template is marked and the block is attached to the template with screws. Finally, the block assembly is labeled with the patient's name.

Figure 4.13 Block mold cutting machine

Individuals at teletherapy sites have reported that block making errors do result in treatment errors. One way in which this can occur is that the blocks are created in a manner that is appropriate for one treatment machine but not for another. For example, blocks are cut in such a way that when placed in a beam, the sides of the blocks match the angle of divergence of the beam as it exits from the treatment head in an inverted "V" shape. Some machines require the block template to be inserted so that the blocks face up, while others (though infrequently), require the blocks to face down. Figure 4.14 shows blocks being inserted into the treatment head block holder in the blocks down position. If the blocks are cut for the wrong orientation, the angle of the block will be opposite to the beam divergence. This causes the blocking effect to be significantly reduced at the edge of the field, accounting for a significant portion of the block's diameter. Other errors include sloppy placement of blocks, an excessive number of air bubbles in the block material, making the blocks the wrong thickness for the beam intensity, and mislabeling the intended orientation of the block or the patient's name on the block tray.

Figure 4.14 Insertion of custom blocks (blocks down)

4.3.8 Function 8.00: Treatment Set-Up

As depicted in Figure 4.15, the treatment set-up process includes the activities required to bring the patient to the treatment room, and to position the patient and the treatment machine for treatment. The treatment set-up must result in the exact configuration of treatment equipment and beam position with respect to the position of the patient as it was specified at the conclusion of simulation. The process of setting up the treatment equipment and positioning the patient is performed by the therapist. It was found that a dosimetrist or physicist may assist with set-ups that were unusually difficult, usually on the first treatment.

At the start of treatment set-up, the therapist must identify the patient, and ensure that the treatment chart is complete and that the set-up and dose data contained in the chart are reasonable for the prescription. Checking patient identity and the treatment chart is of most importance immediately before the first treatment of the patient's treatment program. It is also important that charts are checked for changes throughout the course of treatment. The therapist uses set-up instructions and anatomical drawings contained in the treatment chart, field position marks and/or tattoos (applied during simulation) on the patient as guides for the set-up process. The treatment chart will also state requirements for blocks or wedge filters which must be installed at this time.

The therapist manipulates the treatment equipment with both manual and electronic controls. Important features of the equipment interface include patient positioning lasers, and the controls required to rotate the gantry, position the treatment table, and adjust the collimator. The collimator controls are usually electronic but may be manual, particularly on the older Co-60 machines. The gantry controls are always electronic. The treatment table controls always have a manual control capability in the X and Y directions, and usually an additional electronic capability. The gantry and collimator controls are usually located on a control pendant that hangs

from the ceiling of the treatment room. This control pendant may also control the treatment table depending on the equipment model. The positioning laser lights typically are projected from the wall of the treatment room on either side of the patient, from the ceiling, and from the wall facing the treatment machine along the gantry axis. As shown earlier in Figure 4.7, the positioning laser lights intersect at the isocenter of the treatment machine (assuming proper adjustment); they are very important in positioning the patient with respect to the isocenter.

Figure 4.15 Function 8.00: Treatment set-up

Depending on the sophistication of the equipment, control functions will be associated with either analog displays or will be augmented by digital readouts indicating the position and settings of the equipment. Some treatment rooms are equipped with CRT monitors that provide readouts of equipment position parameters and may also display the parameters required for the set-up. The most advanced systems not only display the treatment equipment position parameters, but can also move the equipment to the required position automatically. The sophistication of the treatment equipment interface for treatment set-up and treatment administration (Function 9.00) is primarily dependent on the age of the equipment. Clearly, the newer equipment tends to be the more sophisticated in this respect. Because the trend in teletherapy facilities in the United States has been toward increased use of linear accelerators, and because many of the existing Co-60 treatment machines have been in use for 20 years or more, the Co-60 treatment equipment typically involves the older analog-based interface components. Significant differences between Co-60 machines and linear accelerators are discussed further in *Volume III, Human-System Interfaces and Procedures*, NUREG/CR-6277 (1995).

4.3.9 Function 9.00: Treatment Administration from Control Console

Figure 4.16 shows the tasks directly involved with the administration of radiation that require interaction with the treatment machine control console. Treatment administration involves the selection of beam types and beam energies (linear accelerator only), setting the monitor units (linear accelerator) or exposure time (Co-60), activating the beam, and monitoring the patient during the treatment process on visual and audio monitors. As stated above, a typical error committed within this function area is entering the incorrect treatment dose. Site visits have shown that configurations of the interface portions of control consoles are quite variable depending on manufacturers, model, and age of the equipment. Some treatment doses are entered by pressing numbers on a keypad accompanied by simultaneous digital displays, while others require manually setting minutes and seconds on a circular timer with no digital display.

LEGEND

Arrow: Signifies the sequence of function performance

Block: Initial block contains the function; subsequent blocks contain sub-functions or tasks.

"OR" gate: Indicates that a choice may be made between two or more of the functions following or preceding the gate as to which is to be performed (or has been performed)

"AND/OR" gate: Can act as either "AND" or "OR" gates

Figure 4.16 Function 9.00: Treatment administration from control console

An inspection of Function 8.00 (Treatment Set-Up) and Function 9.00 (Treatment Administration from Control Console) task error consequence data in the function and task analysis data base indicates a clear trend in the degree of error pervasiveness for these tasks. All of the treatment set-up and treatment administration tasks can lead to deviation in the intended treatment; however, the majority of these errors are associated with single treatments as opposed to errors in other function areas that cause deviation in treatment over the course of treatment (i.e., treatment planning), or to all patients treated (i.e., equipment calibration).

A brief review of treatment administration errors in conjunction with discussions with teletherapy staff members, management personnel, and SME consultants indicate that the majority of treatment set-up and treatment administration errors that occur in Functions 8.00 and 9.00 tasks are relatively inconsequential to the patient; however, these errors are not uncommon and their consequences are frequently subject to clinical interpretation and uncertainty. The relatively high number of treatment errors reported for these functions is not surprising due to the sheer number of tasks that the therapist must perform. These errors are episodic as discussed earlier. They are unpredictable and random in occurrence, of a routine and skill-based nature (Rasmussen, 1986), and typically affect a single treatment. Examples of these errors include leaving out a block or wedge filter, entering the wrong monitor units or exposure time (radiation dose), or failure to record treatment data. Further discussion of these errors and the tasks on which they have an impact can be found in *Volume I Identification of Problems and Alternative Approaches* and *Volume IV Training and Organizational Analysis*, NUREG/CR-6277 (1995).

Teletherapy facility staff, SME consultants, and relevant literature stated that the impact to the patient resulting from the majority of treatment set-up or administration errors could be reduced or virtually eliminated if the therapist brings the error to the attention of the oncologist. The oncologist would review the specifics of the deviation in intended dose and then adjust the prescribed dose to the patient for the remainder of the course of treatment. This phenomenon, self-reporting of errors, is important in the evaluation of the human factors involved with deviations in treatment. An error in treatment administration (if recognized) is frequently known only to the therapist who committed the error. It can be expected that these errors will be self-reported to the extent that the work environment of the teletherapy facility is supportive of the therapist. Clearly, self-reporting of errors is less likely to occur if disciplinary action, embarrassment, or an unfavorable performance appraisal results. Although there is likely to be variation across facilities in terms of organizational climates that permit candid self-reporting of errors, at the sites visited, therapists reported that the climate in their current departments was conducive to self-reporting of errors. They sometimes referred to other places where they worked where this was not the case.

The human-machine interface issues involved with treatment set-up and treatment administration are extensive. The variability of the equipment interface designs represents potential sources of confusion when therapists are rotated from one treatment machine to another, which is a common practice within a teletherapy facility. Within this variation of equipment design, there exist physical aspects of the individual components of the interface designs that vary in the degree to which they conform to human-machine interface standards. The tasks contained

in the function and task analysis were used as a guide in questioning additional teletherapy staff as to aspects of the interface that present problems. Furthermore, the controls and displays associated with these tasks were evaluated against human-machine interface standards where appropriate. In addition to the human-machine interfaces, the procedures and forms used for recording treatment-related data (e.g., the patient's chart) were also evaluated and reported in *Volume III, Human-System Interfaces and Procedures*, NUREG/CR-6277 (1995).

4.3.10 Function 10.00: Monitor Patient Progress and Treatment Adequacy

Monitoring patient progress and the adequacy of the treatment is an on-going process occurring throughout the course of treatment. This process incorporates regular blood analysis and physical examinations by the oncologist, the discussion of treatment cases at chart round meetings, and the evaluation by the oncologist of treatment port verification films. One facility required the therapists to perform blood analysis on a weekly basis. It is more typical for this function to be performed by the nursing staff. All therapists are required to monitor patients for visible signs of degeneration of health as a result of their disease or treatment side-effects. Continued treatment of a patient with blood or other health problems can, of course, pose a serious risk to the patient.

The tasks that are most likely to result in deviation of intended treatment by the teletherapy staff include the communications from the oncologist to the staff to adjust the treatment prescription. If the oncologist does not communicate changes effectively, or write them clearly, then it is possible that they will not be incorporated into the treatment process. Individuals interviewed indicate that this kind of error does occur. For example, in some facilities such changes are written on the front cover of the patient's chart. The technologist typically uses the information on the inside of the chart, and may pick up the chart, open it and begin treatment without seeing the change. Other facilities take additional precautions with changes including notes inside the charts or highlighting the changed treatment parameters.

The Function 10.00 inventory, as shown in Figure 4.17, provided useful information and guidance for systematically evaluating the communications and process of changing treatment parameters during the course of treatment. The inventory of the functions and tasks involved provides the necessary foundation for identifying those aspects of the patient monitoring process that are vulnerable to less than effective procedures for evaluating patient progress and unexpected side effects. As was true of tasks in other functional areas, there was found to be considerable variation among teletherapy facilities in the manner by which the monitoring of patient progress and treatment adequacy was carried out.

4.4 Use of the Function and Task Analysis Data for Subsequent Phases

As discussed earlier, the subsequent phases of the study included an evaluation of the human-system interfaces, procedures, training, and organizational factors as well as a summary phase for identifying the major human factors problems that can adversely affect task performance. Alternative approaches for alleviating these problems also were addressed in the final phase.

Figure 4.17 Function 10.00: Monitor patient progress and treatment adequacy

The function and task analysis was found to be useful and of considerable value to the subsequent phases in several ways. First, the effort expended in conducting the analysis provided the principal investigators with a substantive mental model of the teletherapy system as it is operationalized in large community hospitals, university-based centers, and smaller free-standing or satellite facilities. By having a good understanding of the teletherapy processes and their relationships at the outset of the remaining phases, potential problems could be anticipated and appropriate inquiries made during data collection activities. The quality of the information obtained and the efficiency of obtaining it were welcomed outcomes, attributed in large measure to the comprehensive foundation that the function and task analysis provided. Second, the function and task analysis found direct use in the construction of data collection instruments for

the remaining phases. The function and task analysis served to identify the relevant interfaces of the treatment machines, control consoles, simulator units, treatment planning computers, and patient positioning devices with which treatment personnel interacted. By examining task sequences and the necessary coordination of teletherapy events across time, the collection of information on procedures and practices was facilitated. The function and task analysis also provided cursory information on training practices and organizational factors affecting teletherapy performance that was followed up. Third, the function and task analysis helped to identify potential choke points (i.e., where the system appeared too tightly coupled) and places in the task flow where the workload seemed excessive. And fourth, the potential choke points proved to be fertile ground for the occurrence of skill-based and rule-based errors. It was here that mismatches typically occurred between what personnel were required to do and what they reasonably could be expected to do. The identification and subsequent verification of errors, mismatches and sub-optimal strategies, in turn, eventually led to the formulation of alternative approaches for facilitating the human performance that is required by the teletherapy system (Henriksen, Kaye, Jones, Morisseau & Persensky, 1994).

The function and task analysis also was used in the final phase of the study for identifying major human factors problems and alternative approaches. As described in *Volume I Identification of Problems and Alternative Approaches*, NUREG/CR-6277 (1995), the function and task analysis provided the human performance baseline against which potential problems uncovered in phases 2 (human-system interfaces, 3 (procedures), 4 (training), and 5 (organizational factors) were evaluated. In other words, the impact of the potential problems identified in these phases on the performance of teletherapy tasks, sub-functions, and functions was directly evaluated. Each of the task areas that received high impact ratings was evaluated in terms of detectability and consequences of the associated human error. In this manner, the most serious human factors problems were identified and alternative approaches formulated for their resolution.

5.0 CONCLUSION

The present report provided an overview of the teletherapy process, outlined the methodology for conducting the function and task analysis, described the function areas, and listed the functions, sub-functions, and tasks for treatment-related and management activities in separate data bases (Appendices A and B). Teletherapy sites showed considerable variation in how tasks were performed, which tasks were performed, and in what order. It was noted that site visits were made before publication of NRC's (1991) *Regulatory Guide 8.33 Quality Management Program*. The factors driving such variation included differing practices, various equipment used, and individual differences among oncologists and staff members both between and within facilities. These practices were further complicated by the finding that function and task performance processes were not specifically documented. Performance processes were typically explained verbally to new employees during periods of on-the-job training. The processes were accepted and followed, but not documented in any degree of detail.

The function and task analysis was found to be useful and of value to subsequent phases of the study in several ways: 1) by providing the principal investigators with a substantive mental model of the teletherapy process, 2) by providing an organization and structure for the construction of data collection instruments used in the subsequent phases, 3) by identifying potential choke points in the task flow where performance expectations appeared unreasonable in terms of capabilities of personnel, and 4) by providing an early indication of the most vulnerable task areas subject to error that subsequent phases were able to confirm. The identification and subsequent verification of errors, in turn, led to the formulation of alternative approaches for alleviating the errors, as reported in *Volume I Identification of Problems and Alternative Approaches*, NUREG/CR-6277 (1995).

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7.0 GLOSSARY

Beam	Directed radiant energy, such as an x-ray or electron beam, normally limited in cross section by the mechanism of generation or by collimating apertures or other beam-shaping devices.
Block tray	A square flat piece of plastic on which blocks are attached (custom blocks) or positioned (standard blocks).
Block	A piece of metal (lead or lead alloy) that is positioned under the beam to prevent radiation from reaching specific anatomy. These can be standard blocks which come in a variety of shapes and are positioned on the block tray during each treatment, or custom blocks which are specially made for a specific patient's treatment, are attached to a block tray, and are most often used to define an irregular field.
Bolus	A material similar to gelatin that is placed on portions of a treatment location on a patient's body that absorbs radiation equivalently to human flesh. It is usually used to even out the irregular contours of the patient to present a plane incident surface normal to the beam, or to increase surface dose.
Calibration	Determination, for a radiation beam, of the exposure rate or absorbed dose rate at a calibration point in the beam under a closely specified set of conditions.
Collimator	An arrangement of shielding material designed to define the dimensions of a beam of radiation.
Divergence	The geometric spreading of a beam's field size with increasing distance from the source.
D_{max} Dose	The depth of maximum dose for a single ionizing radiation field.
Dosimetrist	An individual who has received specific training in the aspects of dosage measurement and calculation as related to radiation therapy.
Field Size	The dimensions of the treatment field (<i>width x length</i>) as indicated by the collimator setting.
Fluoroscopy	Examination by means of an instrument (the fluoroscope) that projects x-ray shadows on a fluorescent screen, used to visualize the form and motion of deep structures of the body.
Gamma ray	A type of photon that arises from the nucleus of a radioactive atom. X-ray and gamma-ray photons of the same energy have identical properties.
Gantry	The portion of the treatment machine that supports the treatment head and rotates about the isocenter on a horizontal axis.
Gantry angle	The angle of the isocentrically mounted gantry relative to its vertical downward position.

***Inverse Square
Law***

A law relating radiant flux density to the distance from the source of radiation. The radiant flux density is inversely proportional to the square of the distance between the point at which the flux density is measured and the point at which the radiation source is located.

Isocenter

The imaginary point in space around which the treatment head (more precisely, the center of the collimator on the treatment head) rotates. This point is used as a reference for isocentric treatments.

Isodose Chart

A family of isodose curves usually drawn for equal increments of percentage depth dose, representing the distribution of absorbed dose in a specified plane for a specified beam.

Isodose Curve

A line typically depicted in a plane along which the absorbed dose is constant.

Light Field

An area projected on the patient's body surface that is illuminated by a light system, which, geometrically (as nearly as is practical) mimics the surface area of the treatment beam. Therefore, the illuminated area can be used to identify the area of treatment beam entry when setting up the patient for treatment.

Linear Accelerator

A device for accelerating particles using electricity resulting in x-rays suitable for radiation therapy. Many linear accelerators produce x-rays at different energies for different kinds of treatments.

***Optical Distance
Indicator***

A light device used to indicate the distance of the patient from the treatment source.

***Percentage Depth
Dose***

The ratio, expressed as a percentage of the absorbed dose rate at a point, at some depth along the beam axis, to the absorbed dose rate, at a fixed reference point on the beam axis.

Phantom

A volume of tissue-equivalent material, usually used to measure the characteristics of radiation beams as they pass through the material.

Port Film

An x-ray image taken under actual treatment conditions using a short exposure from the treatment machine through the patient onto an x-ray film. The film is used to determine if the treatment being applied is correctly positioned on the intended target area.

Positioning Laser

Small laser beams located in the treatment room that converge on the isocenter. They are used to position the patient. Tattoos frequently are used to mark the position at which positioning lasers shine on the patient when the patient is in the proper position.

Rad

Unit of absorbed dose, equivalent to 100 ergs/g (0.01 J/kg) of absorber. 1 rad = 1 cGy (1Gy = 100 rad).

Radiation Field

Surface area on the patient defined by the passage of the treatment beam through the skin surface.

Rotation Therapy

External beam teletherapy in which the source of radiation moves circumferentially relative to the patient (while centered in the volume of interest).

<i>Simulation</i>	The use of a simulator (diagnostic-quality x-ray beam on a therapy mounting) to determine the various treatment field outlines and orientations to be used in a course of radiation therapy.
<i>Simulator</i>	A radiation generator operating with a diagnostic x-ray beam that has the mechanical capability to orient this beam toward a patient using parameters that imitate those proposed for therapy. It often provides direct x-ray fluoroscopic visualization of the area in question.
<i>Simulation Film</i>	An x-ray taken on the treatment simulator that shows the position of the treatment field with respect to bony landmarks.
<i>SSD</i>	Source-to-surface distance, or the distance measured along the beam axis from the front surface of the source to the surface of the irradiated object.
<i>Tattoos</i>	Small indelible marks made on the patient's skin to indicate field centers and edges. Often, these marks are also indicated on the setup diagram in the patient chart, photographs of the patient, and the x-ray films taken on the simulator.
<i>Teletherapy</i>	The delivery of radiation treatments to the patient from a machine located remote from the body.
<i>Treatment Port or Treatment Field</i>	The area on the patient's body at which the treatment beam penetrates. Generally, the location of a treatment field on a patient.
<i>Treatment Head</i>	The housing for the radioactive source (typically Co-60) constructed of high density shielding material. The treatment head most often attached to the treatment machine via the gantry.
<i>Wedge (or Wedge Filter)</i>	A metal wedge-shaped accessory placed beneath the treatment beam which causes a progressive decrease in the dose rate across the whole or part of a beam.

APPENDIX A

FUNCTION AND TASK ANALYSIS DATABASE

A.1 Description of Treatment-Related Function and Task Analysis Data Fields

The function and task analysis data elements reside in *data fields* within a dBASE IV file. These data are collectively referred to as the function task analysis database. Each dBASE IV data record presented here corresponds to an individual task statement. The data fields under each task statement contain information corresponding to the context within which the stated task is performed. Due to space limitations for the names that can be applied to data fields in dBASE IV, the fields names are somewhat cryptic abbreviations of the function and task analysis data element involved.

The largest unit of analysis used in the function and task analysis is the *function* that corresponds to a broad but discrete component of teletherapy, and subsumes multiple task statements. Some functions are subdivided into *subfunctions* for the sake of clarity in evaluating the task statements in meaningful groups. Subfunctions correspond to broad but discrete components of teletherapy functions of a finer level of analysis than functions. Where used, subfunctions are further subdivided into *task statements*. Where no subfunctions are used, the functions themselves are subdivided into task statements.

When necessary, task statements may be further divided into *subtask statements*. Subtask statements were not given a separate field name within the database structure. Instead, they are indicated by a numbering system. For example, a task may be numbered "1.00". If this task is composed of subtasks, they will be numbered "1.01", "1.02", and so on.

Table A.1 lists the data fields as they exist in the function and task analysis database and describes the information included in each field. Because the analysis performed is an analysis of the tasks identified, the information contained in each of the fields corresponds to the *task statement*. Some of the fields require that a subjective rating be made on a 1-4 scale. This rating corresponds to a combined average of responses received by subject matter experts at facilities visited and subject matter expert consultants for this project. Note that even if the task analysis field does not contain a rating, the content was obtained from these same sources.

Following Table A.1, a print-out of the dBASE IV file is provided. This print-out contains all of the function and task analysis data collected in Phase 1.

Table A.1 dBASE IV Function and Task Analysis Data Fields and Descriptions

<u>dBASE IV Field Name</u>	<u>Field Description</u>
FUNCT_NO:	This contains a unique number identifying each teletherapy function.
FUNCTION:	This contains a statement describing what is undertaken in the function area.
SUBFUN_NO:	This contains a unique number for subfunction within a function (if present).
SUBFUN_STA:	This contains a statement describing what is undertaken in the subfunction area.
TASK_NO:	This contains a unique number for identifying each task.
NUMBER:	This is a unique number assigned to each task statement that incorporates function, subfunction and task numbers.
TASK_STATE:	This contains a statement corresponding to a specific teletherapy activity.
POSITION:	This contains the position of the individual (i.e., technologist, physicist) who typically performs the task, and typical alternative positions if appropriate.
EQUIPMENT:	This field describes the equipment used by the individual performing the task, or the individual controls involved.
CBLT_LINAC:	This field states whether a task is performed only on a Co-60 machine or only on a linear accelerator or is common to both (i.e., Generic).
CUES:	This field describes the aspects of the work environment that prompt the individual to perform a task.
CONDITIONS:	This field describes the immediate conditions under which the task is performed.
STANDARD:	This field describes the standard that the quality of the task output is generally expected to meet.
INTERACT:	This field describes the other teletherapy staff that the primary individual involved in task performance must interact with in performing the task.

Table A.1 dBASE IV Function and Task Analysis Data Fields and Descriptions (*continued*)

<u>dBASE IV Field Name</u>	<u>Field Description</u>
COMM_SUBJ:	This describes the most typical kind of subject matter communicated in the interaction while or just prior to performing the task (e.g., "technologist provides instructions to the patient", or "oncologist marks change of treatment units in patient's chart").
COMM_MODE:	This indicates the mode of communication that occurs in the interactions involved with the task (i.e., verbal, written).
DIFFICULTY:	This contains a rating of the difficulty of the task (on a 1-4 scale). The scale is a subjective measurement of the difficulty concept. A "1" indicates that the task is one of the easiest tasks performed by the teletherapy staff individual, and a "4" indicates that the task is one of the tasks most difficult to perform.
TIME_REQ:	This contains an estimation of the approximate amount of time or typical range of time required to perform a task.
FREQUENCY:	How often the task is performed (i.e., once a day, or for each patient).
LIKLI_H_E:	This contains a rating of the likelihood (on a 1-4 scale) that an error will occur during the execution of this task. The scale is a subjective measurement of the error likelihood concept. Errors will involve deviation in intended dose to the patient.
ERRORS_POS:	This contains a description of the errors possible for the task if required over and above the five ERRCONS fields.
ERROR_CONS:	This contains a description of the consequences of the errors described.
ERRCONS#:	Each of these five fields (ERRCONS1 through ERRCONS5) contain a code describing the consequences and severity of errors possible for each task (see Table 4.1).
COMMENTS:	This field includes additional qualifying information relevant to the task, a continuation of any of the above fields marked by an "*", or additional information of interest pertinent to the task.

Page No. 1

FUNCT_NO 1.00
FUNCTION Diagnosis, Tumor Localization, and Identification of Initial
Treatment Concerns
SUBFUN_NO 0.00
SUBFUN_STA None
TASK_NO 1.00
NUMBER 0100010
TASK_STATE Review patient information, examine patient, and order additional
tests as required.
POSITION Oncologist
EQUIPMENT Imaging studies and laboratory reports
CBLT_LINAC Cobalt or Linear Accelerator
CUES Consultation Request
CONDITIONS Pathologic diagnosis of malignancy or (rarely) benign condition
for which radiation therapy is accepted treatment.
STANDARD Professional judgment
INTERACT Patient, referring physician
COMM_SUBJ Symptoms. Oncologist makes treatment recommendations to referring
physician.
COM_MODE Verbal, Treatment recommendations are written in consultation
report, history and physical exam.
DIFFICULTY n
TIME_REQ variable
FREQUENCY variable
LIKLI_H_E n
LIK_UNDET n
ERRORS_POS Not applicable to this study.
EROR_COMNT Not applicable to this study.
ERRCONS1 8A
ERRCONS2
ERRCONS3
ERRCONS4
ERRCONS5
COMMENTS1 These tasks performed by the Oncologist are included to provide
contextual information.
COMMENTS2

FUNCT_NO	1.00
FUNCTION	Diagnosis, Tumor Localization, and Identification of Initial Treatment Concerns
SUBFUN_NO	0.00
SUBFUN_STA	None
TASK_NO	2.00
NUMBER	0100020
TASK_STATE	Determine appropriateness of teletherapy as treatment of choice.
POSITION	Oncologist
EQUIPMENT	None
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	New patient
CONDITIONS	Initial evaluation of new patient.
STANDARD	Professional judgment, accepted radiation therapy practice
INTERACT	None
COMM_SUBJ	None
COM_MODE	None
DIFFICULTY	n
TIME_REQ	Variable
FREQUENCY	One time for each new patient
LIKLI_H_E	?
LIK_UNDET	?
ERRORS_POS	Prescribing teletherapy when another treatment would be more beneficial.
EROR_COMNT	Disease is not treated effectively, and/or patient suffers unnecessary adverse effects from radiation treatment.
ERRCONS1	n
ERRCONS2	
ERRCONS3	
ERRCONS4	
ERRCONS5	
COMMENTS1	
COMMENTS2	

FUNCT_NO 1.00
FUNCTION Diagnosis, Tumor Localization, and Identification of Initial Treatment Concerns
SUBFUN_NO 0.00
SUBFUN_STA None
TASK_NO 3.00
NUMBER 0100030
TASK_STATE Localize tumor and proximity of critical structures.
POSITION Oncologist
EQUIPMENT Imaging studies or test results, pathology reports as required.
CBLT_LINAC Cobalt or Linear Accelerator
CUES New patient
CONDITIONS Decision made to proceed with teletherapy. Patient consent obtained.
STANDARD Professional judgment
INTERACT None
COMM_SUBJ None
COM_MODE None
DIFFICULTY n
TIME_REQ Variable
FREQUENCY One time for each new patient
LIKLI_H_E 2
LIK_UNDET 4
ERRORS_POS Inaccuracies in localizing tumor, or failure to consider factors impacting the treatment of the treatment volume containing the tumor.
EROR_COMNT Disease is not treated effectively, and/or patient suffers unnecessary adverse effects from radiation treatment.
ERRCONS1 8B
ERRCONS2
ERRCONS3
ERRCONS4
ERRCONS5
COMMENTS1
COMMENTS2

FUNCT_NO 2.00
 FUNCTION Pre-treatment Planning Session
 SUBFUN_NO 0.00
 SUBFUN_STA None
 TASK_NO 1.00
 NUMBER 0200010
 TASK_STATE Outline initial treatment plan parameters and any important patient-related factors.
 POSITION Oncologist
 EQUIPMENT None
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES Patient scheduled for simulation
 CONDITIONS Meeting room, or casual discussion in work area.
 STANDARD Understanding or acquaintance with important factors involved with case.
 INTERACT Physicist and/or Dosimetrist, Sim. Technologist
 COMM_SUBJ Important factors involved with case.
 COM_MODE Verbal. Written if prescription is prepared at this time.
 DIFFICULTY 1
 TIME_REQ Variable
 FREQUENCY One time for each new patient
 LIKLI_H_E 3
 LIK_UNDET 2
 ERRORS_POS Miscommunication of aspects of case critical to treatment.
 EROR_COMNT Additionally, critical structures and tumor volume may be inaccurately identified and/or located. Being the responsibility of the Oncologist, these errors are not part of this study.
 ERRCONS1 1B
 ERRCONS2 2B
 ERRCONS3 3B
 ERRCONS4 4B
 ERRCONS5
 COMMENTS1 This process is undertaken formally for roughly 20% of all patients treated. Formal pre-planning is not deemed necessary in the other 80% of cases, because they are typical case types requiring a standard and well-understood methodology.
 COMMENTS2

FUNCT_NO 2.00
FUNCTION Pre-treatment Planning Session
SUBFUN_NO 0.00
SUBFUN_STA None
TASK_NO 1.01
NUMBER 0200011
TASK_STATE Discuss critical structures and their dose limits for course of treatment.
POSITION Oncologist
EQUIPMENT None
CBLT_LINAC Cobalt or Linear Accelerator
CUES Patient scheduled for simulation
CONDITIONS Meeting room, or casual discussion in work area.
STANDARD Understanding of the critical structures and their dose limits for the course of treatment.
INTERACT Physicist and/or Dosimetrist, Sim. Technologist
COMM_SUBJ Critical structures within and outside the target volume, their dose limits, and the location of the target area.
COM_MODE Verbal
DIFFICULTY 2
TIME_REQ 0-40 min
FREQUENCY One time per course of treatment
LIKLI_H_E 1
LIK_UNDET 1
ERRORS_POS Critical structures and their dose limits are not understood by simulation and treatment planning staff.
EROR_COMNT Deviation from intended dose, or other planned treatment parameters. Unnecessary damage to normal tissue or critical structures, or undertreatment of target volume.
ERRCONS1 1B
ERRCONS2 2B
ERRCONS3 3B
ERRCONS4 4B
ERRCONS5
COMMENTS1
COMMENTS2

FUNCT_NO 2.00
FUNCTION Pre-treatment Planning Session
SUBFUN_NO 0.00
SUBFUN_STA None
TASK_NO 1.02
NUMBER 0200012
TASK_STATE Discuss total dose, dose fractionation, and dose distribution for target volume required for case.
POSITION Oncologist
EQUIPMENT None
CBLT_LINAC Cobalt or Linear Accelerator
CUES Standard practice for pre-treatment planning session
CONDITIONS
STANDARD Understanding of the case "boundary conditions" reached among the team that will be involved in the simulation and treatment planning of the case.
INTERACT Physicist and/or Dosimetrist, Sim. Technologist
COMM_SUBJ Dose characteristics of case
COM_MODE Verbal*
DIFFICULTY 2
TIME_REQ 0-10 min
FREQUENCY One time per course of treatment
LIKLI_H_E 1
LIK_UNDET 1
ERRORS_POS Total dose or dose distribution for target not adequately communicated or understood by simulation and treatment planning staff.
ERROR_COMNT Deviation from intended total dose, dose fractionation or dose distribution possibly resulting in overexposure to critical structures, or underdose to target volume (insufficient for tumor control).
ERRCONS1 1B
ERRCONS2 2B
ERRCONS3 3B
ERRCONS4 4B
ERRCONS5
COMMENTS1
COMMENTS2

FUNCT_NO 2.00
 FUNCTION Pre-treatment Planning Session
 SUBFUN_NO 0.00
 SUBFUN_STA None
 TASK_NO 1.03
 NUMBER 0200013
 TASK_STATE Discuss patient-specific problems such as mobility limitations,
 and anxiety.
 POSITION Oncologist
 EQUIPMENT None
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES Case is preceived to require special attention.
 CONDITIONS Meeting room, or casual discussion in work area.
 STANDARD Understanding of the patient specific issues that may impact
 treatment.
 INTERACT Physicist and/or Dosimetrist, Sim. Technologist
 COMM_SUBJ Dose characteristics of case
 COM_MODE Verbal
 DIFFICULTY 2
 TIME_REQ 0-10 min
 FREQUENCY One time per course of treatment
 LIKLI_H_E 1
 LIK_UNDET 1
 ERRORS_POS Not considering patient specific problems, i.e. over anxious
 patient could be more likely to move during treatment, or patient
 may not be able to hold certain treatment positions because of
 mobility limitations.
 EROR_COMNT See error effects below
 ERRCONS1 3A
 ERRCONS2 4A
 ERRCONS3 5A
 ERRCONS4
 ERRCONS5
 COMMENTS1 A good example of this issue is in breast treatment, in which the
 patient is required to hold the arm up and above the head. This
 is often difficult due to the mobility limiting effects of recent
 surgery.
 COMMENTS2

FUNCT_NO 2.00
FUNCTION Pre-treatment Planning Session
SUBFUN_NO 0.00
SUBFUN_STA None
TASK_NO 2.00
NUMBER 0200020
TASK_STATE Review the use of department equipment for unusual situations
impacting plan for patient treatment such as the use of
specialized shielding
POSITION Oncologist
EQUIPMENT None
CBLT_LINAC Cobalt or Linear Accelerator
CUES Case is somewhat unusual in beam blocking or other requirements.
CONDITIONS Meeting room, or casual discussion in work area.
STANDARD Understanding of the use of department equipment for unusual
treatment circumstances that may impact treatment.
INTERACT Physicist, Dosimetrist, Sim. Technologist, Technologist
COMM_SUBJ Use of equipment for unusual treatment cases.
COM_MODE Verbal
DIFFICULTY 2
TIME_REQ 1-10 min
FREQUENCY As necessary
LIKLI_H_E 1
LIK_UNDET 1
ERRORS_POS Not noticing, considering, or requesting information from other
specialties on treatment aspects of unusual cases.
ERROR_COMNT
ERRCONS1 8B
ERRCONS2
ERRCONS3
ERRCONS4
ERRCONS5
COMMENTS1
COMMENTS2

FUNCT_NO 3.00
 FUNCTION Treatment and Safety Equipment Checks, Adjustments and Maintenance
 SUBFUN_NO 1.00
 SUBFUN_STA Daily Beam Output Data Collection and Warmup
 TASK_NO 1.00
 NUMBER 0301010
 TASK_STATE Turn on accelerator, simulator, Cobalt-60 units. Perform warm up procedures and document obvious abnormalities in equipment function.
 POSITION Technologist (therapist)
 EQUIPMENT Linear Accelerator, Simulator, or Cobalt-60
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES As per standard daily routine
 CONDITIONS Treatment equipment off, beginning of day
 STANDARD Equipment checked out before first treatment. *Linear accelerator and simulator must be allowed to warm up adequately before output measurements.*
 INTERACT None if equipment operates within specs. If not, Physicist, engineer or supervisor.
 COMM_SUBJ Data that seems or is out of tolerance
 COM_MODE Verbal if physicist or engineer is present, otherwise written on beam quality measurement forms.
 DIFFICULTY 1
 TIME_REQ 10-30 min
 FREQUENCY 1 time per day per machine or after interruption of power
 LIKLI_H_E 1
 LIK_UNDET 2
 ERRORS_POS Failure to follow warm up procedures properly before output data is taken, or treatment is performed. Failure to document problems evidenced by operator messages, and equipment abnormalities, (i.e. sounds, smells) occur.
 EROR_COMNT If not noticed, improper treatment is likely.
 ERRCONS1 1C
 ERRCONS2 2C
 ERRCONS3 3C
 ERRCONS4 5C
 ERRCONS5 7A
 COMMENTS1 * The standard procedure may be written by equipment manufacturer or physicist.
 COMMENTS2

FUNCT_NO 3.00
FUNCTION Treatment and Safety Equipment Checks, Adjustments and Maintenance
SUBFUN_NO 1.00
SUBFUN_STA Daily Beam Output Data Collection and Warmup
TASK_NO 2.00
NUMBER 0301020
TASK_STATE Collect output data from treatment machine(s) and simulator(s).
POSITION Technologist (therapist)
EQUIPMENT Linear Accelerator, Simulator, Cobalt Unit
CBLT_LINAC Cobalt or Linear Accelerator
CUES Standard procedure for start of day
CONDITIONS Treatment equipment warming up or warmed up
STANDARD All data required to support daily treatment beam quality evaluationis collected
INTERACT Physicist or Supervisor to report significant problems
COMM_SUBJ Assistance required for daily data collection process, or report significant findings
COM_MODE Written in daily log
DIFFICULTY 2
TIME_REQ 15-30 min
FREQUENCY Daily
LIKLI_H_E 2
LIK_UNDET 2
ERRORS_POS Equipment set up incorrectly for output test.
EROR_COMNT Could result in incorrect dose (over- or underexposure of target tissue, or overexposure of non-target tissue).
ERRCONS1 1C
ERRCONS2 2C
ERRCONS3 3C
ERRCONS4 5C
ERRCONS5
COMMENTS1
COMMENTS2

FUNCT NO	3.00
FUNCTION	Treatment and Safety Equipment Checks, Adjustments and Maintenance
SUBFUN_NO	1.00
SUBFUN_STA	Daily Beam Output Data Collection and Warmup
TASK NO	2.01
NUMBER	0301021
TASK_STATE	Place treatment table, gantry, and collimator angle to pre-established standard position for isocentricity and output checks.
POSITION	Technologist (therapist)
EQUIPMENT	Linear Accelerator, Simulator, Cobalt Unit, treatment table, gantry and collimator angle and light field controls, position lasers
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Standard procedure for start of day
CONDITIONS	Treatment equipment warming up or warmed up
STANDARD	Positions should be exact +/- 1 deg. or 1 mm.
INTERACT	None
COMM_SUBJ	None
COM MODE	None
DIFFICULTY	1
TIME REQ	2-4 min
FREQUENCY	Daily
LIKLI H E	1
LIK UNDET	2
ERRORS_POS	Equipment set up incorrectly for output test.
EROR_COMNT	Could result in incorrect dose (over- or underexposure of target tissue, or overexposure of non-target tissue).
ERRCONS1	1C
ERRCONS2	2C
ERRCONS3	
ERRCONS4	
ERRCONS5	
COMMENTS1	
COMMENTS2	

FUNCT_NO
FUNCTION

3.00

Treatment and Safety Equipment Checks, Adjustments and Maintenance

SUBFUN_NO
SUBFUN_STA

1.00

TASK_NO

Daily Beam Output Data Collection and Warmup

NUMBER

2.02

TASK_STATE

0301022

Position dosimetry constancy phantom (rectangular object that may enclose a dosimeter) in standard position on treatment table.

POSITION

Technologist (therapist)
Phantom, laser positioning lights
Cobalt or Linear Accelerator

EQUIPMENT

Standard procedure for start of day
Treatment equipment warming up or warmed up

CBLT_LINAC

Phantom is marked at the points where the laser lights should strike if the phantom is positioned correctly. Accuracy should be

CUES

≤ 2 mm.

CONDITIONS

None

STANDARD

None

INTERACT

None

COMM_SUBJ

1

COM_MODE

1-2 min

DIFFICULTY

Daily

TIME_REQ

1

FREQUENCY

1

LIKLI_H_E

1

LIK_UNDET

1

ERRORS_POS

1C

EROR_COMNT

2C

Position phantom in incorrect position.
Delay of procedure, and repositioning necessary. Incorrect readings if not corrected.

ERRCONS1

ERRCONS2

ERRCONS3

ERRCONS4

ERRCONS5

COMMENTS1

COMMENTS2

FUNCT_NO 3.00
FUNCTION Treatment and Safety Equipment Checks, Adjustments and Maintenance
SUBFUN_NO 1.00
SUBFUN_STA Daily Beam Output Data Collection and Warmup
TASK_NO 2.03
NUMBER 0301023
TASK_STATE Line up phantom with laser position lights to pre-established points on phantom.
POSITION Technologist (therapist)
EQUIPMENT Phantom, collimator controls, laser positioning lights
CBLT LINAC Cobalt or Linear Accelerator
CUES Standard procedure for start of day
CONDITIONS Treatment equipment warming up or warmed up
STANDARD Position must be exact to within 2 mm.
INTERACT None
COMM_SUBJ None
COM_MODE If the laser lights do not align, this is recorded in the daily log.
DIFFICULTY 1
TIME_REQ 1-2 min
FREQUENCY Daily
LIKLI_H_E 1
LIK_UNDET 3
ERRORS_POS Light field positioned inaccurately.
EROR_COMNT Could result in incorrect dose (over- or underexposure of target tissue, or overexposure of non-target tissue).
ERRCONS1 1C
ERRCONS2 2C
ERRCONS3 5C
ERRCONS4
ERRCONS5
COMMENTS1
COMMENTS2

FUNCT_NO 3.00
FUNCTION Treatment and Safety Equipment Checks, Adjustments and Maintenance
SUBFUN_NO 1.00
SUBFUN_STA Daily Beam Output Data Collection and Warmup
TASK_NO 2.04
NUMBER 0301024
TASK_STATE Observe correspondence between beam center of field light, and laser positioning lights on marked phantom.
POSITION Technologist (therapist)
EQUIPMENT Phantom, gantry rotation controls
CBLT_LINAC Cobalt or Linear Accelerator
CUES Standard procedure for start of day
CONDITIONS Treatment equipment warming up or warmed up
STANDARD Position must be exact to within 2 mm. Checks should be made with gantry at 0 deg., at 90 deg., and at 270 deg.
INTERACT Significant deviations reported to supervisor, engineer, or physicist.
COMM_SUBJ Recorded daily results.
COM_MODE Daily data is written; problems documented and reported verbally.
DIFFICULTY 1
TIME_REQ 2-4 min
FREQUENCY Daily
LIKLI_H_E 1
LIK_UNDET 3
ERRORS_POS Discrepancies between laser indicator lights and field center indicator not noticed or reported.
EROR_COMNT Could result in incorrect dose (over- or underexposure of target tissue, or overexposure of non-target tissue).
ERRCONS1 1C
ERRCONS2 2C
ERRCONS3 3C
ERRCONS4 4C
ERRCONS5 5C
COMMENTS1
COMMENTS2

FUNCT_NO 3.00
FUNCTION Treatment and Safety Equipment Checks, Adjustments and Maintenance
SUBFUN_NO 1.00
SUBFUN_STA Daily Beam Output Data Collection and Warmup
TASK_NO 2.05
NUMBER 0301025
TASK_STATE Set up light field on 10 x 10 cm square target on phantom surface.
POSITION Technologist (therapist)
EQUIPMENT Phantom, collimator controls
CBLT_LINAC Cobalt or Linear Accelerator
CUES Standard procedure for start of day
CONDITIONS Treatment equipment warming up or warmed up
STANDARD Position must be exact to within 2 mm.
INTERACT None
COMM_SUBJ None
COM_MODE None
DIFFICULTY 1
TIME_REQ 1-2 min
FREQUENCY Daily
LIKLI_H_E 1
LIK_UNDET 3
ERRORS_POS Light field positioned inaccurately.
ERROR_COMNT Could result in incorrect dose (over- or underexposure of target tissue, or overexposure of non-target tissue).
ERRCONS1 1C
ERRCONS2 2C
ERRCONS3 3C
ERRCONS4 4C
ERRCONS5 5C
COMMENTS1
COMMENTS2

FUNCT_NO 3.00
FUNCTION Treatment and Safety Equipment Checks, Adjustments and Maintenance
SUBFUN_NO 1.00
SUBFUN_STA Daily Beam Output Data Collection and Warmup
TASK_NO 2.06
NUMBER 0301026
TASK_STATE Expose phantom to pre-determined standard dose of radiation.
POSITION Technologist (therapist)
EQUIPMENT Phantom with dosimeter, accelerator console
CBLT_LINAC Cobalt or Linear Accelerator
CUES Standard procedure for start of day
CONDITIONS Treatment equipment warmed up
STANDARD Exposure made to pre-established values
INTERACT None
COMM_SUBJ None
COM_MODE None
DIFFICULTY 1
TIME_REQ 1-2 min per beam
FREQUENCY Daily
LIKLI_H_E 1
LIK_UNDET 3
ERRORS_POS Incorrect energy or exposure time set.
EROR_COMNT Could result in incorrect dose (over- or underexposure of target tissue).
ERRCONS1 1C
ERRCONS2 2C
ERRCONS3
ERRCONS4
ERRCONS5
COMMENTS1
COMMENTS2

FUNCT_NO 3.00
 FUNCTION Treatment and Safety Equipment Checks, Adjustments and Maintenance
 SUBFUN_NO 1.00
 SUBFUN_STA Daily Beam Output Data Collection and Warmup
 TASK_NO 2.07
 NUMBER 0301027
 TASK_STATE Record results from exposed dosimeter and compare to expected energy/output range developed by Physicist during the calibration of the equipment.
 POSITION Technologist (therapist)
 EQUIPMENT Dosimeter, treatment machine expected energy/output file
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES Standard procedure for start of day, NRC regs from 10 CFR 35, JCAHO requirements
 CONDITIONS Exposure for output check made
 STANDARD Machine output must be within +/- 3% of the range described by the energy output standard.
 INTERACT Significant deviation reported to supervisor, engineer, or physicist.
 COMM_SUBJ Significant deviations of any values taken.
 COM_MODE Documentation of data (significant deviations are typically reported verbally)
 DIFFICULTY 1
 TIME_REQ 15 sec/beam 10 min tot
 FREQUENCY Daily
 LIKLI_H_E 1
 LIK_UNDET 3
 ERRORS_POS Significant deviation in beam energy from dose readings not noticed or not reported accurately.
 EROR_COMNT Could result in incorrect dose (over- or underexposure of target tissue, or overexposure of non-target tissue).
 ERRCONS1 1C
 ERRCONS2 2C
 ERRCONS3 3C
 ERRCONS4 5C
 ERRCONS5
 COMMENTS1 The likelihood that this error would go undetected is about 90% for a given day, but about 20% to exceed one week on the average.
 COMMENTS2

FUNCT_NO 3.00
 FUNCTION Treatment and Safety Equipment Checks, Adjustments and Maintenance
 SUBFUN_NO 1.00
 SUBFUN_STA Daily Beam Output Data Collection and Warmup
 TASK_NO 3.00
 NUMBER 0301030
 TASK_STATE Check "radiation on" indicator lights.
 POSITION Technologist (therapist)
 EQUIPMENT "Radiation on" lights, treatment machine control console, treatment room door
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES Daily equipment checks, NRC regs (10 CFR-35)
 CONDITIONS Should be checked when making exposure for output check
 STANDARD All "radiation on" lights should come on when beam is activated.
 INTERACT Supervisor, engineer, supervisor or physicist as reqd.
 COMM_SUBJ Whether or not radiation indicator lights activate.
 COM_MODE Written in daily log.
 DIFFICULTY 1
 TIME_REQ Part of output test
 FREQUENCY Daily
 LIKLI_H_E 1
 LIK_UNDET 4
 ERRORS_POS Not noticing that "Radiation On" indicator light does not come on when beam is on or source is exposed.
 ERROR_COMNT Treatment error would probably not occur, however the technologist(s) could be exposed.
 ERRCONS1 6C
 ERRCONS2
 ERRCONS3
 ERRCONS4
 ERRCONS5
 COMMENTS1
 COMMENTS2

FUNCT_NO 3.00
FUNCTION Treatment and Safety Equipment Checks, Adjustments and Maintenance
SUBFUN_NO 1.00
SUBFUN_STA Daily Beam Output Data Collection and Warmup
TASK_NO 4.00
NUMBER 0301040
TASK_STATE Verify patient audio communication system and video monitor system is operational.
POSITION Technologist (therapist)
EQUIPMENT Patient audio communication devices, patient monitor and camera system
CBLT_LINAC Cobalt or Linear Accelerator
CUES Daily device checks
CONDITIONS One technologist in treatment room, another at treatment console area
STANDARD Audio and visual monitoring systems should be demonstrated to be functional.
INTERACT Other technologist as available
COMM_SUBJ The function of the audio and visual monitoring systems
COM_MODE Verbal
DIFFICULTY 1
TIME_REQ 1-2 min
FREQUENCY Daily
LIKLI_H_E 1
LIK_UNDET 1
ERRORS_POS Not noticing a failure in the audio or visual monitoring systems are functional.
EROR_COMNT Undetected pt. movement resulting deviation in treatment delivered. Patient could have a medical emergency or fall off of the treatment table.
ERRCONS1 2A
ERRCONS2 3A
ERRCONS3 4A
ERRCONS4 5A
ERRCONS5 7A
COMMENTS1
COMMENTS2

FUNCT_NO	3.00
FUNCTION	Treatment and Safety Equipment Checks, Adjustments and Maintenance
SUBFUN_NO	2.00
SUBFUN_STA	Safety Device Check
TASK_NO	1.00
NUMBER	0302010
TASK_STATE	Check that door interlock is in working order.
POSITION	Technologist (therapist)
EQUIPMENT	Door to treatment room, treatment machine control console
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Daily equipment checks
CONDITIONS	During morning warmup and output checks.
STANDARD	Should be impossible to activate beam with door open or ajar. Beam should shut off automatically if door is opened. NRC regulations in 10 CFR 35.
INTERACT	Other technologist as available
COMM_SUBJ	Is door open/shut? Report of interlock not functioning.
COM_MODE	Verbal. Written in daily log
DIFFICULTY	1
TIME_REQ	1 min
FREQUENCY	Daily
LIKLI_H_E	1
LIK_UNDET	3
ERRORS_POS	Not noticing that door interlock is not functioning.
EROR_COMNT	The door interlock prevents the treatment beam from being activated when the door to the treatment room is open. Undetected failure of this device could cause unnecessary exposure to technologist(s)/aide(s) or patient before *
ERRCONS1	6A
ERRCONS2	
ERRCONS3	
ERRCONS4	
ERRCONS5	
COMMENTS1	
COMMENTS2	

FUNCT_NO	3.00
FUNCTION	Treatment and Safety Equipment Checks, Adjustments and Maintenance
SUBFUN_NO	2.00
SUBFUN_STA	Safety Device Check
TASK_NO	2.00
NUMBER	0302020
TASK_STATE	Check function of all emergency off switches.
POSITION	Technologist or Physicist
EQUIPMENT	Emergency off switches, treatment machine control console
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Weekly equipment checks
CONDITIONS	During morning warmup and output checks. Linear acc. requires warmup before check.
STANDARD	Emergency off switches should switch off all power to treatment machine
INTERACT	None
COMM_SUBJ	None
COM_MODE	Written in daily log
DIFFICULTY	1
TIME_REQ	5 min
FREQUENCY	Weekly
LIKLI_H_E	1
LIK_UNDET	4
ERRORS_POS	Not checking for or not finding non-functional emergency off switches.
EROR_COMNT	If a treatment unit malfunctions, or a patient is in need of immediate attention, and treatment must be stopped. If the emergency stop equipment does not operate,*
ERRCONS1	1A
ERRCONS2	3A
ERRCONS3	7A
ERRCONS4	
ERRCONS5	
COMMENTS1	the patient and the techs removing the patient from the treatment room will receive unnecessary radiation exposure. There are typically about 4 E.O.S.s per treatment room. One on the console, one on the pendant and one on either side of the gantry.
COMMENTS2	

FUNCT_NO 3.00
FUNCTION Treatment and Safety Equipment Checks, Adjustments and Maintenance
SUBFUN_NO 2.00
SUBFUN_STA Safety Device Check
TASK_NO 3.00
NUMBER 0302030
TASK_STATE Check treatment machine collision avoidance safety interlocks.
POSITION Technologist (therapist)
EQUIPMENT Treatment table controls, gantry controls, electron beam cones
CBLT_LINAC Cobalt or Linear Accelerator
CUES Weekly equipment checks
CONDITIONS Treatment machine made available for maintenance
STANDARD All interlocks should shut down gantry rotation, or treatment table movement before forceful collision occurs.
INTERACT None
COMM_SUBJ Written in daily log
COM_MODE None
DIFFICULTY 1
TIME_REQ 15 min.
FREQUENCY Weekly
LIKLI_H_E 1
LIK_UNDET 4
ERRORS_POS Not evaluating function of collision avoidance safety interlocks or
EROR_COMNT Physical injury to patient or technologist, and/or damage to treatment equipment. If error is made, would go undetected until next time it is checked.
ERRCONS1 7A
ERRCONS2
ERRCONS3
ERRCONS4
ERRCONS5
COMMENTS1 Many treatment systems, particularly the older systems, do not have collision avoidance interlocks.
COMMENTS2

FUNCT_NO 3.00
 FUNCTION Treatment and Safety Equipment Checks, Adjustments and Maintenance
 SUBFUN_NO 3.00
 SUBFUN_STA Weekly Output and Constancy Checks, Calibrations and Adjustments
 TASK_NO 1.00
 NUMBER 0303010
 TASK_STATE Review daily data collected by technologist to check constancy of dose per monitor unit along the central axis for all beam types and beam energies used.
 POSITION Physicist
 EQUIPMENT Dosimetric output data collected by technologist at beginning of day
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES Weekly reviews of daily measurements as recommended by AAPM, NRC regs (10 CFR-35), JCAHO
 CONDITIONS All daily output checks have been performed
 STANDARD Within 3% of values determined at calibration
 INTERACT None
 COMM_SUBJ Acceptance of data, or need for followup
 COM_MODE Sign off for acceptance, or explain (in writing) need for followup. Document anything unusual.
 DIFFICULTY 2
 TIME_REQ 10 min per beam
 FREQUENCY Weekly, unless significant problem reported
 LIKLI_H_E 2
 LIK_UNDET 4
 ERRORS_POS Incomplete or inaccurate documentation. Mismeasurement of dose rate constancy. Data not evaluated. Trends (intensity increasing or decreasing at unexpected rate) not noticed.
 EROR_COMNT Undetected deviation in beam intensity.
 ERRCONS1 1C
 ERRCONS2 2C
 ERRCONS3 3C
 ERRCONS4 5C
 ERRCONS5
 COMMENTS1
 COMMENTS2

FUNCT_NO 3.00
FUNCTION Treatment and Safety Equipment Checks, Adjustments and Maintenance
SUBFUN_NO 3.00
SUBFUN_STA Weekly Output and Constancy Checks, Calibrations and Adjustments
TASK_NO 2.00
NUMBER 0303020
TASK_STATE Check flatness and symmetry of x-ray beam (beam uniformity) for linear accelerator, and Co-60 Machine.
POSITION Physicist
EQUIPMENT Linear Accelerator, Co-60 Machine, X-ray film
CBLT_LINAC Cobalt or Linear Accelerator
CUES Weekly equipment checks
CONDITIONS During morning warmup and output checks after machine is warmed up.
STANDARD Dose uniformity should be within +/- 3% over the central 80% of the field at a depth of 10 cm. (As per NCRP report no. 69, 1981).
INTERACT None
COMM_SUBJ Record data in physics log
COM_MODE None
DIFFICULTY 3
TIME_REQ 20 min per beam
FREQUENCY Weekly (recommended)
LIKLI_H_E 2
LIK_UNDET 4
ERRORS_POS Symmetry or flatness of beam out of specification, not noticed or properly recorded.
EROR_COMNT Non-uniform dose distribution to treatment volume leading to over or under doses.
ERRCONS1 1C
ERRCONS2 2C
ERRCONS3 4C
ERRCONS4 5C
ERRCONS5
COMMENTS1 The standard against which the beam uniformity is evaluated is a predictable beam intensity profile which is used to calculate the doses to the treatment volume.
COMMENTS2

FUNCT_NO 3.00
FUNCTION Treatment and Safety Equipment Checks, Adjustments and Maintenance
SUBFUN_NO 3.00
SUBFUN_STA Weekly Output and Constancy Checks, Calibrations and Adjustments
TASK_NO 3.00
NUMBER 0303030
TASK_STATE Measure and evaluate depth dose constancy.
POSITION Physicist
EQUIPMENT Linear accelerator, Co-60 machine, water or equivalent phantom, and radiation measurement instrumentation
CBLT_LINAC Cobalt or Linear Accelerator
CUES Weekly measurement as recommended by the AAPM, JCAHO. (NRC in 10 CFR-35 specifies monthly for CO-60).
CONDITIONS During morning warmup and output checks, after machine is warmed up.
STANDARD Within 2% of value determined at calibration
INTERACT None
COMM_SUBJ None
COM_MODE Results written in physics data log
DIFFICULTY 3
TIME_REQ 45 min per beam
FREQUENCY Weekly
LIKLI_H_E 2
LIK_UNDET 4
ERRORS_POS Mismeasurement of depth dose beam data.
EROR_COMNT Occult deviation in beam energy, and subsequent over- or underexposure of target area.
ERRCONS1 1C
ERRCONS2 2C
ERRCONS3 3C
ERRCONS4 5C
ERRCONS5
COMMENTS1
COMMENTS2

FUNCT_NO 3.00
 FUNCTION Treatment and Safety Equipment Checks, Adjustments and Maintenance
 SUBFUN_NO 3.00
 SUBFUN_STA Weekly Output and Constancy Checks, Calibrations and Adjustments
 TASK_NO 4.00
 NUMBER 0303040
 TASK_STATE Compare light field size and position and cross hairs with treatment beam field and also with console digital or mechanical displays of field size.
 POSITION Physicist
 EQUIPMENT Cobalt-60 machine, linear accelerator, simulator, x-ray film and processor
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES Weekly equipment checks recommended by AAPM, JCAHO (NRC in 10 CFR-35 requires monthly check for CO-60.)
 CONDITIONS During morning warmup and output checks.
 STANDARD Correspondence in field size should be within 2 mm.
 INTERACT None
 COMM_SUBJ None
 COM_MODE Results written in physics data log
 DIFFICULTY 1
 TIME_REQ 30 min per machine
 FREQUENCY Weekly (recommended)
 LIKLI_H_E 1
 LIK_UNDET 4
 ERRORS_POS Not comparing/noticing/recording that field size indicated is different from actual field size or location, or non-coincidence between light/radiation beam.
 EROR_COMNT Undertreatment of tumor and overtreatment of normal tissues.
 ERRCONS1 3C
 ERRCONS2 4C
 ERRCONS3
 ERRCONS4
 ERRCONS5
 COMMENTS1 Typically checked at 100 cm SSD for linear accelerator, and 80 cm. for Cobalt.
 COMMENTS2

FUNCT_NO	3.00
FUNCTION	Treatment and Safety Equipment Checks, Adjustments and Maintenance
SUBFUN_NO	3.00
SUBFUN_STA	Weekly Output and Constancy Checks, Calibrations and Adjustments
TASK_NO	5.00
NUMBER	0303050
TASK_STATE	Measure and evaluate dose rate constancy for Co-60 or linear accelerator treatment machines.
POSITION	Physicist
EQUIPMENT	Cobalt machine, linear accelerator, dose measurement instruments
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Weekly measurement as recommended by the AAPM, and the ACMP.
CONDITIONS	During morning warmup and output checks, machine must be sufficiently warmed up.
STANDARD	Within 3% of expected value
INTERACT	None
COMM_SUBJ	None
COM_MODE	Results written in physics data log
DIFFICULTY	2
TIME_REQ	30 min per beam energy
FREQUENCY	Weekly
LIKLI_H_E	2
LIK_UNDET	4
ERRORS_POS	Mismeasurement of dose rate constancy.
EROR_COMNT	Undetected deviation in beam intensity across beam
ERRCONS1	1C
ERRCONS2	2C
ERRCONS3	5C
ERRCONS4	
ERRCONS5	
COMMENTS1	n/a
COMMENTS2	

FUNCT_NO 3.00
 FUNCTION Treatment and Safety Equipment Checks, Adjustments and Maintenance
 SUBFUN_NO 3.00
 SUBFUN_STA Weekly Output and Constancy Checks, Calibrations and Adjustments
 TASK_NO 6.00
 NUMBER 0303060
 TASK_STATE Check treatment machine gantry rotation characteristics.
 POSITION Technologist (therapist)
 EQUIPMENT Treatment machine gantry control, treatment machine control console, stop watch.
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES Weekly equipment checks
 CONDITIONS During morning warmup and output checks.
 STANDARD Gantry clearance, direction and speed of rotation adequacy, setting limit switches, console rotation controls, and monitor units delivered per degree*
 INTERACT Technologist as available
 COMM_SUBJ Results. Aspects of gantry performance test.
 COM_MODE Documented in daily log. Verbal during test.
 DIFFICULTY 1
 TIME_REQ 5-10 min
 FREQUENCY Weekly
 LIKLI_H_E 2
 LIK_UNDET 3
 ERRORS_POS Not evaluating, finding and/or recording abnormalities in gantry rotation characteristics, rotation limit setting switch function or dose delivered per degree of rotation.
 EROR_COMNT Dose per degree of rotation corresponds to treatments in which the gantry rotates during the treatment.
 ERRCONS1 1C
 ERRCONS2 2C
 ERRCONS3 3C
 ERRCONS4 4C
 ERRCONS5
 COMMENTS1 * and setting limit switches interlocks (if present) should be operational, or conform to the values expected or to manufactures specifications.
 COMMENTS2

FUNCT_NO 3.00
FUNCTION Treatment and Safety Equipment Checks, Adjustments and Maintenance
SUBFUN_NO 3.00
SUBFUN_STA Weekly Output and Constancy Checks, Calibrations and Adjustments
TASK_NO 7.00
NUMBER 0303070
TASK_STATE Check source transport mechanism; transit time from key on to source on; and from timer off to source safe.
POSITION Physicist
EQUIPMENT Cobalt treatment machine control console, stop watch or clock that displays time in seconds.
CBLT_LINAC Cobalt only
CUES Weekly equipment checks
CONDITIONS During morning warmup and output checks, or other time machine not in use.
STANDARD NRC regs. (10 CFR 35)
INTERACT None
COMM_SUBJ None
COM_MODE Results written in physics data log
DIFFICULTY 2
TIME_REQ 30 min per machine
FREQUENCY Weekly (recommended)
LIKLI_H_E 2
LIK_UNDET 4
ERRORS_POS Improper measurement of transit time.
EROR_COMNT Miss important changes in source drive mechanism leading to sticking source and/or inaccurate patient treatment times.
ERRCONS1 1C
ERRCONS2 2C
ERRCONS3 6A
ERRCONS4
ERRCONS5
COMMENTS1
COMMENTS2

FUNCT_NO 3.00
 FUNCTION Treatment and Safety Equipment Checks, Adjustments and Maintenance
 SUBFUN_NO 4.00
 SUBFUN_STA Monthly Output and Constancy Checks, Calibrations and Adjustments
 TASK_NO 1.00
 NUMBER 0304010
 TASK_STATE Check/adjust collimator, collimator rotation, gantry, and treatment table rotation scale readouts.
 POSITION Physicist
 EQUIPMENT Linear Accelerator, Co-60 machine, and Simulator, control consoles
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES Monthly check as recommended by the AAPM and ACMP
 CONDITIONS During morning warmup and output checks, or other time machine not in use.
 STANDARD Within 2 mm and/or 1 deg.
 INTERACT None
 COMM_SUBJ None
 COM_MODE Results written in physics data log
 DIFFICULTY 2
 TIME_REQ 1 hr per machine
 FREQUENCY Monthly
 LIKLI_H_E 2
 LIK_UNDET 2
 ERRORS_POS Failure to detect inaccuracies in treatment table, gantry, and collimator positioning scale readouts.
 EROR_COMNT Under- or overexposure to target area, or overexposure to non-target area.
 ERRCONS1 1C
 ERRCONS2 2C
 ERRCONS3 3C
 ERRCONS4 4C
 ERRCONS5 5C
 COMMENTS1
 COMMENTS2

FUNCT_NO 3.00
FUNCTION Treatment and Safety Equipment Checks, Adjustments and Maintenance
SUBFUN_NO 4.00
SUBFUN_STA Monthly Output and Constancy Checks, Calibrations and Adjustments
TASK_NO 2.00
NUMBER 0304020
TASK_STATE Check/adjust mechanical distance pins, positioning lasers, and optical distance indicator (ODI).
POSITION Physicist
EQUIPMENT Linear Accelerator, Co-60 machine, Simulator
CBLT_LINAC Cobalt or Linear Accelerator
CUES Monthly check as recommended by the AAPM and ACMP
CONDITIONS During morning warmup and output checks, or other time machine not in use.
STANDARD Within 2 mm and 1 deg.
INTERACT None
COMM_SUBJ None
COM_MODE Results written in physics data log
DIFFICULTY 2
TIME_REQ 20 min
FREQUENCY Monthly
LIKLI_H_E 2
LIK_UNDET 2
ERRORS_POS Failure to detect inaccuracies in patient positioning aids.
EROR_COMNT See below
ERRCONS1 1C
ERRCONS2 2C
ERRCONS3 3C
ERRCONS4 4C
ERRCONS5 5C
COMMENTS1 n/a
COMMENTS2

FUNCT_NO	3.00
FUNCTION	Treatment and Safety Equipment Checks, Adjustments and Maintenance
SUBFUN_NO	5.00
SUBFUN_STA	Annual Output and Constancy Checks, Calibrations and Adjustments
TASK_NO	1.00
NUMBER	0305010
TASK_STATE	Perform central axis dose calibration on linear accelerator or Co-60 treatment machine.
POSITION	Physicist
EQUIPMENT	Calibrated dosimetry systems
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Annual equipment checks as per AAPM and ACMP protocols, JCAHO and State standards, NRC regs (10 CFR-35)
CONDITIONS	Treatment machine made available for maintenance.
STANDARD	+/- 2% for all linear accelerator-produced beams, +/- 2% for Co-60 beam (note: standards vary somewhat).
INTERACT	None
COMM_SUBJ	None
COM_MODE	Results written in physics data log
DIFFICULTY	4
TIME_REQ	4 hr per beam
FREQUENCY	Annually
LIKLI_H_E	3
LIK_UNDET	4
ERRORS_POS	Undetected inaccurate calibration.
EROR_COMNT	See error effects below
ERRCONS1	1C
ERRCONS2	2C
ERRCONS3	
ERRCONS4	
ERRCONS5	
COMMENTS1	If this error occurs, it will likely go undected for a long time since none of the periodic checks will determine absolute output.
COMMENTS2	

FUNCT_NO	3.00
FUNCTION	Treatment and Safety Equipment Checks, Adjustments and Maintenance
SUBFUN_NO	5.00
SUBFUN_STA	Annual Output and Constancy Checks, Calibrations and Adjustments
TASK_NO	2.00
NUMBER	0305020
TASK_STATE	Check/evaluate jaw symmetry on treatment machines, simulator, and ensure correspondence.
POSITION	Physicist
EQUIPMENT	Linear Accelerator, Co-60 machine, and Simulator, treatment head collimator jaws, beam alignment phantom
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Annual check as recommended by the AAPM
CONDITIONS	Treatment machine made available for maintenance.
STANDARD	Jaw symmetry (within 2 mm) so that beams edges align with each other when rotated by 180 deg.
INTERACT	None
COMM_SUBJ	None
COM_MODE	None
DIFFICULTY	4
TIME_REQ	1 hr per beam
FREQUENCY	Annually (recommended minimum) or as required
LIKLI_H_E	2
LIK_UNDET	4
ERRORS_POS	Undetected deviations in jaw symmetry and hence beam symmetry. Non-correspondence between treatment machine and simulator.
EROR_COMNT	Deviation in constancy between treatment machine and simulator jaw symmetry would cause inaccuracy in positioning the radiation beam on the patient to be treated.
ERRCONS1	1C
ERRCONS2	2C
ERRCONS3	3C
ERRCONS4	4C
ERRCONS5	5C
COMMENTS1	n/a
COMMENTS2	

FUNCT_NO	3.00
FUNCTION	Treatment and Safety Equipment Checks, Adjustments and Maintenance
SUBFUN_NO	5.00
SUBFUN_STA	Annual Output and Constancy Checks, Calibrations and Adjustments
TASK_NO	3.00
NUMBER	0305030
TASK_STATE	Check "focal spot" or effective source position.
POSITION	Physicist
EQUIPMENT	Linear Accelerator, Co-60 machine, and Simulator, treatment light field, dosimeter, x-ray film, (or ion chamber).
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Annual check as recommended by the AAPM
CONDITIONS	Treatment machine made available for maintenance.
STANDARD	Need to get data on the divergence of the beam and the intensity of the beam so that a (functional) focal spot position may be determined.
INTERACT	None
COMM_SUBJ	None
COM_MODE	None
DIFFICULTY	3
TIME_REQ	1 hr
FREQUENCY	Annually
LIKLI_H_E	2
LIK_UNDET	4
ERRORS_POS	Undetected deviations in focal spot position and hence beam symmetry (same effect as jaw symmetry error). Noncorrespondence between treatment machine and simulator.
ERROR_COMNT	SSD measurements would be inaccurate affecting both radiation intensity, and beam dispersion (size of actual radiation field).
ERRCONS1	1C
ERRCONS2	2C
ERRCONS3	3C
ERRCONS4	4C
ERRCONS5	5C
COMMENTS1	n/a
COMMENTS2	

FUNCT_NO 3.00
 FUNCTION Treatment and Safety Equipment Checks, Adjustments and Maintenance
 SUBFUN_NO 6.00
 SUBFUN_STA Perform Maintenance on Treatment Equipment
 TASK_NO 1.00
 NUMBER 0306010
 TASK_STATE Receive request for maintenance.
 POSITION Maintenance Engineer, Biomedical Engineer
 EQUIPMENT Telephone
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES As needed
 CONDITIONS Oncology dept. staff, typically technologist, notices a suspected or actual malfunction of treatment equipment.
 STANDARD Equipment must be placed in safe operating order, may have to request additional expertise.
 INTERACT Technologist, Dosimetrist, Oncologist, or Physicist
 COMM_SUBJ Equipment status requiring maintenance.
 COM_MODE Verbal and/or written
 DIFFICULTY 1
 TIME_REQ 1-5 min
 FREQUENCY As needed
 LIKLI_H_E 2
 LIK_UNDET 1
 ERRORS_POS Not responding to or following up on maintenance request.
 [Pending further investigation: the assumption is that treatment equipment will be placed out of service if suspected problem is directly involved with the radiation beam]
 EROR_COMNT If treatment equipment is used, will increase likelihood of treatment error resulting from degraded equipment condition.
 ERRCONS1 7A
 ERRCONS2
 ERRCONS3
 ERRCONS4
 ERRCONS5
 COMMENTS1 It is assumed, pending further investigation, that treatment equipment will be placed out of service immediately if a problem is suspected with the radiation production components of the equipment.
 COMMENTS2

FUNCT_NO 3.00
 FUNCTION Treatment and Safety Equipment Checks, Adjustments and Maintenance
 SUBFUN_NO 6.00
 SUBFUN_STA Perform Maintenance on Treatment Equipment
 TASK_NO 2.00
 NUMBER 0306020
 TASK_STATE Evaluate immediate maintenance requirement and determine if maintenance can be performed in-house or by a manufacturer's representative.
 POSITION Physicist, Physician, Technologist (person in charge of maint)
 EQUIPMENT None
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES As needed
 CONDITIONS Oncology dept. staff, typically technologist, notices a suspected or actual malfunction of treatment equipment.
 STANDARD Equipment must be maintained by experienced individual. Equipment must be placed in safe operating order, may have to request additional expertise.
 INTERACT Bio-medical engineering, department maintenance engineer, equipment manufacturer representative.
 COMM_SUBJ Clarification of equipment status requiring maintenance.
 COM_MODE Verbal and/or written
 DIFFICULTY 1
 TIME_REQ Variable
 FREQUENCY As needed
 LIKLI_H_E 2
 LIK_UNDET 2
 ERRORS_POS Allowing equipment to be repaired by non-qualified personnel.
 EROR_COMNT ** Any kind of dose or mechanical error could conceivably occur. Error could effect one patient or many.
 ERRCONS1 *C
 ERRCONS2
 ERRCONS3
 ERRCONS4
 ERRCONS5
 COMMENTS1 Approximately 60% of facilities use third party or manufacturer maintenance for virtually all maintenance. About 30% of facilities have Biomedical engineers capable of performing sig. maintenance with guidance over the phone from manufacturer rep., *
 COMMENTS2

FUNCT_NO 3.00
 FUNCTION Treatment and Safety Equipment Checks, Adjustments and Maintenance
 SUBFUN_NO 6.00
 SUBFUN_STA Perform Maintenance on Treatment Equipment
 TASK_NO 2.01
 NUMBER 0306021
 TASK_STATE Contact manufacturer service representative or third party maintenance company.
 POSITION Physicist, Physician, Technologist (person in charge of maint)
 EQUIPMENT Telephone
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES As needed
 CONDITIONS Department does not have a factory-trained service engineer. Equipment problem requires this level of expertise.
 STANDARD Equipment must ultimately be placed in safe operating condition.
 INTERACT Service representative.
 COMM_SUBJ Request for equipment repair.
 COM_MODE Verbal
 DIFFICULTY 1
 TIME_REQ Variable
 FREQUENCY As needed
 LIKLI_H_E 1
 LIK_UNDET 2
 ERRORS_POS Failure to contact service representative in a timely manner.
 ERROR_COMNT ** Any kind of dose or mechanical error could conceivably occur. Error could effect one patient or many.
 ERRCONS1 *C
 ERRCONS2
 ERRCONS3
 ERRCONS4
 ERRCONS5
 COMMENTS1 * continued from previous task: only about 10% of radiation oncology facilities have an engineer on staff qualified to repair teletherapy equipment to the extent of quarterly preventative maintenance, troubleshooting, and replacing major components.
 COMMENTS2

FUNCT_NO 3.00
 FUNCTION Treatment and Safety Equipment Checks, Adjustments and Maintenance
 SUBFUN_NO 6.00
 SUBFUN_STA Perform Maintenance on Treatment Equipment
 TASK_NO 3.00
 NUMBER 0306030
 TASK_STATE Perform maintenance on treatment machines or associated equipment.
 POSITION Hospital biomedical engineer, on-site factory trained engineer
 EQUIPMENT Linear accelerator, simulator, and associated equipment. Note: NRC requirements prevent maintenance on Cobalt machines by anyone other than a certified factory representative.
 CBLT_LINAC Linear Accelerator only
 CUES As needed
 CONDITIONS Equipment malfunction noticed, or regularly scheduled periodic maintenance.
 STANDARD Equipment must ultimately be placed in safe operating condition.
 INTERACT Individual in charge of equipment, individual noticing problem
 COMM_SUBJ Symptoms of suspected equipment malfunction
 COM_MODE Verbal and/or written
 DIFFICULTY 3
 TIME_REQ Variable
 FREQUENCY As needed
 LIKLI_H_E 3
 LIK_UNDET 2
 ERRORS_POS Making an error in performing preventative or as-needed maintenance.
 EROR_COMNT ** Any kind of dose or mechanical error could conceivably occur. Error could effect one patient or many.
 ERRCONS1 *C
 ERRCONS2
 ERRCONS3
 ERRCONS4
 ERRCONS5
 COMMENTS1 * Biomedical engineers (in the majority of facilities that do not have specifically trained service personnel), may replace such items as bulbs, deionizer cartridges, some pumps and motors, some LEDs or liq. crystal displays, and some fuzes.*
 COMMENTS2

FUNCT_NO 3.00
 FUNCTION Treatment and Safety Equipment Checks, Adjustments and Maintenance
 SUBFUN_NO 6.00
 SUBFUN_STA Perform Maintenance on Treatment Equipment
 TASK_NO 3.01
 NUMBER 0306031
 TASK_STATE Perform basic maintenance on treatment machines or associated equipment.
 POSITION Hospital biomedical engineer
 EQUIPMENT Basic repair tools. Linear accelerator, simulator, and associated equipment. Note: NRC requirements prevent maintenance on Cobalt machines by anyone other than a licensed factory representative.
 CBLT_LINAC Linear Accelerator only
 CUES As needed
 CONDITIONS Treatment machines or accociated equipment require basic repair to include replacing bulbs deionizer cartridges, etc.
 STANDARD Equipment must ultimately be placed in safe operating condition.
 INTERACT Individual in charge of equipment, individual noticing problem
 COMM_SUBJ Symptoms of suspected equipment malfunction
 COM_MODE Verbal and/or written
 DIFFICULTY 2
 TIME_REQ Variable
 FREQUENCY As needed
 LIKLI_H_E 2
 LIK_UNDET 2
 ERRORS_POS PRINT Performing basic component replacement maintenance task incorrectly.
 ERROR_COMNT ** Any kind of dose or mechanical error could concieveably occur. Error could effect one patient or many.
 ERRCONS1 *C
 ERRCONS2
 ERRCONS3
 ERRCONS4
 ERRCONS5
 COMMENTS1 * Biomedical engineers (in the majority of facilities that do not have specifically trained service personnel), may replace such items as bulbs, deionizer cartridges, some pumps and motors, some LEDs or liq. crystal displays, and some fuzes.*
 COMMENTS2

FUNCT_NO 3.00
FUNCTION Treatment and Safety Equipment Checks, Adjustments and Maintenance
SUBFUN_NO 6.00
SUBFUN_STA Perform Maintenance on Treatment Equipment
TASK_NO 3.02
NUMBER 0306032
TASK_STATE Perform intermediate maintenance on treatment machines with assistance from manufacturer service representative over the telephone.
POSITION Hospital biomedical engineer
EQUIPMENT Basic repair tools, telephone. Note: NRC requirements prevent maintenance on Cobalt machines by anyone other than a licensed factory representative.
CBLT_LINAC Linear Accelerator only
CUES As needed
CONDITIONS Facility biomedical engineer receives instructions over the telephone from service representative as maintenance is performed
STANDARD Equipment must ultimately be placed in safe operating condition.
INTERACT Individual in charge of equipment, individual noticing problem
COMM_SUBJ Symptoms of suspected equipment malfunction
COM_MODE Verbal and/or written
DIFFICULTY 3
TIME_REQ Variable
FREQUENCY As needed
LIKLI_H_E 3
LIK_UNDET 2
ERRORS_POS Making an error in performing intermediate level maintenance, confusion between facility engineer and manufacturer or third party service representative about components or process.
EROR_COMNT ** Any kind of dose or mechanical error could conceivably occur. Error could effect one patient or many.
ERRCONS1 1A
ERRCONS2 2A
ERRCONS3 3A
ERRCONS4 4A
ERRCONS5 5A
COMMENTS1 * Biomedical engineers (in the majority of facilities that do not have specifically trained service personnel), may replace such items as bulbs, deionizer cartridges, some pumps and motors, some LEDs or liq. crystal displays, and some fuzes.*
COMMENTS2

FUNCT_NO 3.00
 FUNCTION Treatment and Safety Equipment Checks, Adjustments and Maintenance
 SUBFUN_NO 6.00
 SUBFUN_STA Perform Maintenance on Treatment Equipment
 TASK_NO 3.04
 NUMBER 0306034
 TASK_STATE Perform complex maintenance on treatment machines or associated equipment.
 POSITION On-site factory trained engineer (approx. 10% of facilities)
 EQUIPMENT Variable
 CBLT_LINAC Linear Accelerator only
 CUES As needed
 CONDITIONS Equipment malfunction noticed, or regularly scheduled periodic maintenance.
 STANDARD Equipment must ultimately be placed in safe operating condition.
 INTERACT Individual in charge of equipment, individual noticing problem
 COMM_SUBJ Symptoms of suspected equipment malfunction
 COM_MODE Verbal and/or written
 DIFFICULTY 4
 TIME_REQ Variable
 FREQUENCY As needed
 LIKLI_H_E 3
 LIK_UNDET 2
 ERRORS_POS PRINT Making an error in performing preventative or as-needed maintenance. Not reporting to Physicist if any work is being done on radiation production related equipment components.
 EROR_COMNT ** Any kind of dose or mechanical error could conceivably occur. Error could effect one patient or many.
 ERRCONS1 *C
 ERRCONS2
 ERRCONS3
 ERRCONS4
 ERRCONS5
 COMMENTS1 A factory trained individual may perform complex maintenance on an as-needed basis, and may also perform quarterly preventative maintenance as is recommended by treatment equipment manufacturers.
 COMMENTS2

FUNCT_NO 3.00
 FUNCTION Treatment and Safety Equipment Checks, Adjustments and Maintenance
 SUBFUN_NO 6.00
 SUBFUN_STA Perform Maintenance on Treatment Equipment
 TASK_NO 3.05
 NUMBER 0306035
 TASK_STATE Work with Physicist on complex maintenance involving radiation production components of treatment machine.
 POSITION On-site factory trained engineer, Physicist
 EQUIPMENT Tools and test equipment as required. Linear Accelerator, simulator.
 CBLT_LINAC Linear Accelerator only
 CUES As needed
 CONDITIONS Equipment maintenance required. Components involved may impact the process of radiation generation.
 STANDARD Equipment must ultimately be placed in safe operating condition.
 INTERACT Individual in charge of equipment, individual noticing problem
 COMM_SUBJ Equipment function and impact on characteristics of beam produced
 COM_MODE Verbal
 DIFFICULTY 4
 TIME_REQ Variable
 FREQUENCY As needed
 LIKLI_H_E 3
 LIK_UNDET 2
 ERRORS_POS PRINT Physicist not ensuring that impact of maintenance on beam is controlled for. Engineer making an error in performing preventative or as-needed maintenance on equipment involved with the production of a radiation beam.
 EROR_COMNT ** Any kind of dose error could conceivably occur. Error could effect one patient or many.
 ERRCONS1 *C
 ERRCONS2
 ERRCONS3
 ERRCONS4
 ERRCONS5
 COMMENTS1
 COMMENTS2

FUNCT_NO 4.00
FUNCTION Simulation
SUBFUN_NO 1.00
SUBFUN_STA Explain Simulation Procedure to Patient
TASK_NO 1.00
NUMBER 0401010
TASK_STATE Explain simulation procedure to patient.
POSITION Simulation Technologist/Oncologist
EQUIPMENT None
CBLT_LINAC Cobalt or Linear Accelerator
CUES Standard procedure.
CONDITIONS Patient to be simulated is present
STANDARD Must present key components of process in a professional and understandable manner.

INTERACT Patient
COMM_SUBJ How the simulation process will be performed
COM_MODE Verbal/Written
DIFFICULTY 1
TIME_REQ 5-10 min (variable)
FREQUENCY 1 time per simulation
LIKLI_H_E 1
LIK_UNDET 2
ERRORS_POS Miscommunication of essential concepts of simulation process.
EROR_COMNT Patient may not understand the importance of simulation/treatment requirements for patient cooperation such as holding still. This could lead to deviations in the treatment to target tissue and surrounding non-target tissue.

ERRCONS1 3B
ERRCONS2 4B
ERRCONS3 5B
ERRCONS4
ERRCONS5
COMMENTS1
COMMENTS2

FUNCT_NO	4.00
FUNCTION	Simulation
SUBFUN_NO	2.00
SUBFUN_STA	Simulation Planning
TASK_NO	1.00
NUMBER	0402010
TASK_STATE	Discuss simulation requirements with Oncologist.
POSITION	Simulation Technologist
EQUIPMENT	Prescription, diagnosis, and supporting documentation and studies
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Simulation schedule.
CONDITIONS	Could be just before simulation or earlier for more complex cases (e.g. the day before the simulation)
STANDARD	Understanding reached between simulation technologist and oncologist on the most important aspects of the simulation procedure.
INTERACT	Oncologist
COMM_SUBJ	Immobilization, patient positioning, radio-opaque markers, etc.
COM_MODE	Verbal. Also simulation schedule/prescription/pre-simulation worksheet may contain Onc's comments.
DIFFICULTY	1
TIME_REQ	2 - 10 min
FREQUENCY	1 time per simulation
LIKLI_H_E	1
LIK_UNDET	2
ERRORS_POS	Misunderstanding or miscommunication of simulation requirements.
EROR_COMNT	Increase in time and effort to complete simulation procedure or possibly cancellation of simulation.
ERRCONS1	n
ERRCONS2	
ERRCONS3	
ERRCONS4	
ERRCONS5	
COMMENTS1	Sim Technologist and Oncologist will discuss the simulation before and throughout the simulation.
COMMENTS2	

FUNCT_NO	4.00
FUNCTION	Simulation
SUBFUN_NO	2.00
SUBFUN_STA	Simulation Planning
TASK_NO	2.00
NUMBER	0402020
TASK_STATE	Obtain appropriate data and/or worksheets(s) (as per anatomical location simulated) and ensure availability for simulation.
POSITION	Simulation Technologist
EQUIPMENT	Worksheets.
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Simulation schedule, and/or planning discussion with Oncologist or prescription.
CONDITIONS	Prior to beginning simulation is best
STANDARD	Appropriate data recording and/or worksheets obtained
INTERACT	(Previously interacted with Oncologist)
COMM_SUBJ	None
COM_MODE	None
DIFFICULTY	1
TIME_REQ	1 min
FREQUENCY	1 time per simulation
LIKLI_H_E	1
LIK_UNDET	*
ERRORS_POS	Obtaining incorrect data and/or worksheets/omission of pertinent data.
EROR_COMNT	Increase in time and effort to complete simulation.
ERRCONS1	1A
ERRCONS2	2A
ERRCONS3	
ERRCONS4	
ERRCONS5	
COMMENTS1	Possible overdose of critical structure if incorrect worksheed chosen and data not obtained.
COMMENTS2	

FUNCT_NO 4.00
FUNCTION Simulation
SUBFUN_NO 3.00
SUBFUN_STA Patient Immobilization or Positioning Devices
TASK_NO 1.00
NUMBER 0403010
TASK_STATE Detect need for patient immobilization or positioning devices.
POSITION Simulation Technologist/Oncologist
EQUIPMENT None
CBLT_LINAC Cobalt or Linear Accelerator
CUES As deemed necessary during simulation due to patient condition
and position required.
CONDITIONS Could be standard practice for case type, or as simulation is
being performed, or during pre-simulation planning discussion
STANDARD Must notice need for immobilization as required.
INTERACT Physics staff member
COMM_SUBJ None
COM_MODE None
DIFFICULTY 2
TIME_REQ 1 min
FREQUENCY > 90% of cases require some kind of support or positioning device
LIKLI_H_E 1
LIK_UNDET 1
ERRORS_POS Not detecting requirement for immobilization device.
EROR_COMNT Over or under-exposure to target tissue, or overexposure to
healthy tissue due to patient movement.
ERRCONS1 3B
ERRCONS2 4B
ERRCONS3 5B
ERRCONS4
ERRCONS5
COMMENTS1
COMMENTS2

FUNCT NO	4.00
FUNCTION	Simulation
SUBFUN_NO	3.00
SUBFUN_STA	Patient Immobilization or Positioning Devices
TASK NO	2.00
NUMBER	0403020
TASK STATE	Construct immobilization or positioning devices.
POSITION	Simulation Technologist, or Dosimetrist
EQUIPMENT	Immobilization devices include such commercial names as "Alpha cradle", or "Aqua Plast", or could include plaster of paris cast material and other materials depending on the facility.
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Requirement for immobilization or support device detected.
CONDITIONS	May be constructed before or during actual simulation.
STANDARD	Immobilization or positioning device must hold patient in position safely and comfortably during treatment.
INTERACT	Other Technologist, or aide as available
COMM SUBJ	Materials required and how immobilization device is to be made
COM MODE	Verbal
DIFFICULTY	2
TIME REQ	5-30 min
FREQUENCY	As required
LIKLI_H E	1
LIK UNDET	2
ERRORS_POS	Not creating or using immobilization or support device(s) properly
EROR_COMNT	Repeat simulation and immobilization/positioning device construction, patient discomfort during treatment. Patient movement during treatment could cause underexposure to target area, and over exposure non target area.
ERRCONS1	3B
ERRCONS2	4B
ERRCONS3	5B
ERRCONS4	
ERRCONS5	
COMMENTS1	
COMMENTS2	

FUNCT_NO	4.00
FUNCTION	Simulation
SUBFUN_NO	4.00
SUBFUN_STA	Simulate Treatment
TASK_NO	0.00
NUMBER	0404000
TASK_STATE	(see tasks under this subfunction)
POSITION	Simulation Technologist, Oncologist
EQUIPMENT	Treatment Simulator and associated equipment.
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	New patient or change of treatment course, or verification of present treatment fields.
CONDITIONS	Patient, Oncologist, and Simulation Technologist in simulation room.
STANDARD	Performed as accurately as possible. Simulation must provide data and instructions necessary to allow accurate treatment administration.
INTERACT	Oncologist and Dosimetrist or Physicist as required
COMM_SUBJ	Details of simulation process, adjustments necessary, and instructions to patient on how to modify or hold position.
COM_MODE	Verbal
DIFFICULTY	4
TIME_REQ	1-2 hrs per sim
FREQUENCY	1 - 2 times per patient
LIKLI_H_E	3
LIK_UNDET	2
ERRORS_POS	Failure to record critical simulation parameters completely and/or accurately. Failure to ensure that patient treatment position is reproducible.
EROR_COMNT	Could cause small to large treatment errors including underexposure to target tissue, overexposure to non-target tissue, and deviations in the dose delivered.
ERRCONS1	1B
ERRCONS2	2B
ERRCONS3	3B
ERRCONS4	4B
ERRCONS5	5B
COMMENTS1	Note: Cobalt treatment units typically employ a SAD of 80" while linear accelators typically employ a SAD of 100". This and other differences between simulators and treatment equipment have to be accounted for in the setup of simulation equipment.
COMMENTS2	

FUNCT_NO	4.00
FUNCTION	Simulation
SUBFUN_NO	4.00
SUBFUN_STA	Simulate Treatment
TASK_NO	1.00
NUMBER	0404010
TASK_STATE	Position patient on simulation table.
POSITION	Simulation Technologist
EQUIPMENT	Simulator treatment table. Patient immobilization and support devices.
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Required for each simulation.
CONDITIONS	Patient is present and all immobilization devices to be used during treatment are available.
STANDARD	Patient position is comfortable and reproducible (i.e. patient is positioned with all immobilization aids that will be used in treatment
INTERACT	Patient, transporter, technologist, or Aide as available.
COMM_SUBJ	How to get into and hold required position on treatment table.
COM_MODE	Verbal
DIFFICULTY	2
TIME_REQ	5-15 min
FREQUENCY	1 time per simulation
LIKLI_H_E	2
LIK_UNDET	2
ERRORS_POS	Not using patient immobilization and/or support devices. Place patient in incorrect position. Injury to patient while helping patient onto simulation table and positioning.
ERROR_COMNT	Increased time required to perform simulation. Negative impact on daily schedule.
ERRCONS1	1B
ERRCONS2	2B
ERRCONS3	3B
ERRCONS4	4B
ERRCONS5	5B
COMMENTS1	Note: error consequence 7A also possible.
COMMENTS2	

FUNCT_NO 4.00
 FUNCTION Simulation
 SUBFUN_NO 4.00
 SUBFUN_STA Simulate Treatment
 TASK_NO 2.00
 NUMBER 0404020
 TASK_STATE Administer contrast medium or contrast markers as required for treatment area to be simulated.
 POSITION Simulation Technologist, Oncologist
 EQUIPMENT Contrast markers, i.e. I.V. apparatus, rectal or vaginal markers, catheters, barium solution and enema apparatus.
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES Standard procedure for case type or instructions from Oncologist
 CONDITIONS Patient placed on simulation table, all immobilization devices and cushions in place.
 STANDARD Contrast markers or material administered such that they will adequately aid in identifying anatomical landmarks in simulation radiographs.
 INTERACT Oncologist, patient
 COMM_SUBJ Obtain instructions and assistance from Oncologist, explain process and request cooperation from patient (informed consent for I.V. administration)
 COM_MODE Verbal
 DIFFICULTY 3
 TIME_REQ 5-15 min
 FREQUENCY 1 time per simulation
 LIKLI_H_E 1
 LIK_UNDET 1
 ERRORS_POS Contrast medium or markers administered incorrectly. I.V. "dye" could cause anaphalactic shock resulting in the possibility of death.
 EROR_COMNT Could cause inappropriate conclusions of the position of sensitive anatomical structures in relation to the treatment field. Leading to a treatment plan that would unintentionally overdose these structures.
 ERRCONS1 3B
 ERRCONS2 4B
 ERRCONS3 5B
 ERRCONS4 7A
 ERRCONS5
 COMMENTS1
 COMMENTS2

FUNCT_NO 4.00
FUNCTION Simulation
SUBFUN_NO 4.00
SUBFUN_STA Simulate Treatment
TASK_NO 3.00
NUMBER 0404030
TASK_STATE Set approximate field size and adjust patient position to area of interest.
POSITION Simulation Technologist
EQUIPMENT Simulator collimator controls, simulation table position controls.
CBLT_LINAC Cobalt or Linear Accelerator
CUES Instructions from Oncologist
CONDITIONS Patient placed on treatment table, all immobilization devices and cushions in place.
STANDARD Set approximate field position size and position.
INTERACT Oncologist
COMM_SUBJ Field size and treatment location
COM_MODE Verbal, prescription or notes from previous discussions of case or its marked on diagnostic film.
DIFFICULTY 1
TIME_REQ 1-3 min
FREQUENCY 1 time per site
LIKLI_H_E 1
LIK_UNDET n
ERRORS_POS Inappropriate field size or preliminary treatment location used. (This is an expected part of the simulation process).
ERROR_COMNT A main feature of the simulation is to repeatedly adjust field size and location as verified by simulation radiographs until field size and location is consistent with suspected target volume and neighboring critical structures.
ERRCONS1 n
ERRCONS2
ERRCONS3
ERRCONS4
ERRCONS5
COMMENTS1 In this task, initial errors of field size are expected and comprise a major portion of typical simulation process.
COMMENTS2

FUNCT_NO	4.00
FUNCTION	Simulation
SUBFUN_NO	4.00
SUBFUN_STA	Simulate Treatment
TASK_NO	4.00
NUMBER	0404040
TASK_STATE	Locate treatment volume and proximity of treatment field to anatomical landmarks using fluoroscopy.
POSITION	Simulation Technologist, Oncologist
EQUIPMENT	Simulation table and gantry position controls, fluoroscope controls.
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Instructions from Oncologist
CONDITIONS	Patient in correct position.
STANDARD	Oncologist will determine when treatment field is appropriate from viewing fluoroscope display, before taking simulation film (radiographic film).
INTERACT	Oncologist
COMM_SUBJ	Position of treatment field, and adjustments necessary.
COM_MODE	Verbal
DIFFICULTY	3
TIME_REQ	2-10 min
FREQUENCY	1 time per field
LIKLI H E	3
LIK UNDET	1
ERRORS_POS	Incorrect site treated, (dependent entirely on ability of Oncologist).
EROR_COMNT	Incorrect location treated. Based on Oncologist's expertise.
ERRCONS1	3B
ERRCONS2	4B
ERRCONS3	5B
ERRCONS4	8B
ERRCONS5	
COMMENTS1	The errors associated with this task are based on the skills of the Oncologist. This study does not evaluate the Oncologist's training or expertise. Note: this task is performed iteratively in conjunction with the following task.
COMMENTS2	

FUNCT_NO 4.00
 FUNCTION Simulation
 SUBFUN_NO 4.00
 SUBFUN_STA Simulate Treatment
 TASK_NO 5.00
 NUMBER 0404050
 TASK_STATE Adjust simulation table to set correct source-to-surface distance (SSD), or target-to-surface distance (TSD) (for isocentric treatments).
 POSITION Simulation Technologist
 EQUIPMENT Simulator treatment table controls
 CBLT_LINAC Cobalt or Linear Accelerator
 TUES Instructions from Oncologist, or standard procedure for case type
 CONDITIONS Preliminary field position and location set.
 STANDARD SAD should be consistent for that of the treatment machine, (i.e. either 80 cm or 100 cm). For mid-depth, isocentric treatments, TSD = FAD - 1/2 IFD.
 INTERACT None
 COMM_SUBJ None
 COM_MODE None
 DIFFICULTY 1
 TIME_REQ 1 min
 FREQUENCY 1 time per field
 LIKLI_H_E 2
 LIK_UNDET 1
 ERRORS_POS Wrong SSD used (more likely in facilities that have treatment machines with 80 cm and others with 100 cm" SSD)*
 EROR_COMNT Variation in the intensity of treatmnet beam and the size of the treatment field. (It is likely that this error would be caught before the patient is treated).
 ERRCONS1 1B
 ERRCONS2 2B
 ERRCONS3
 ERRCONS4
 ERRCONS5
 COMMENTS1 Cobalt treatment units typically employ a SAD measurement of 80 cm while linear accelerators typically employ a SAD of 100 cm. This difference has to be accounted for in setting up the TSD during simulation.
 COMMENTS2

FUNCT_NO	4.00
FUNCTION	Simulation
SUBFUN_NO	4.00
SUBFUN_STA	Simulate Treatment
TASK_NO	6.00
NUMBER	0404060
TASK_STATE	Set simulator to required position.
POSITION	Simulation Technologist
EQUIPMENT	Treatment simulator and associated controls
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Tumor volume, critical structure, and/or bony landmark feedback from flouroscopy.
CONDITIONS	Flouroscopy is being performed and is used (an iterative process) to direct placement of simulator field.
STANDARD	Oncologist will approve simulated port position
INTERACT	Oncologist
MM SUBJ	Adequacy of port position.
OM MODE	Verbal
DIFFICULTY	3
TIME_REQ	15 minutes per field
FREQUENCY	1-2 times per field, (1-5 fields per simulation)
LIKLI_H_E	1
LIK_UNDET	1
ERRORS_POS	Fields set up inaccurately or slowly.
EROR_COMNT	IF INACCURATE FIELD POSITION IS APPROVED BY ONCOLOGIST, incorrect target area may be treated. Portions of the actual target may be underdosed, or not treated at all. Negative effect on daily schedule.
ERRCONS1	1B
ERRCONS2	2B
ERRCONS3	3B
ERRCONS4	4B
ERRCONS5	5B
COMMENTS1	The errors associated with this task are primarily based on the skills of the Oncologist. This study does not evaluate the Oncologist's training or expertise. Note: this task is performed iteratively in conjunction with the previous task.
COMMENTS2	The possibility of an error in field placement at this point is about a "4", however the possibility of the field being placed erroneously AND that field being approved by the Oncologist is much less, a "1" in this case.

FUNCT_NO 4.00
 FUNCTION Simulation
 SUBFUN_NO 4.00
 SUBFUN_STA Simulate Treatment
 TASK_NO 7.00
 NUMBER 0404070
 TASK_STATE Determine exposure technique, select film/screen combination necessary to produce adequate radiograph, and take preliminary simulation radiograph.
 POSITION Simulation Technologist
 EQUIPMENT Treatment simulator, x-ray unit, cassettes and film, and markers as needed.
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES Required for each simulation.
 CONDITIONS Oncologist satisfied that field setup is close to desired position. Note: the initial radiograph may indicate further *
 STANDARD All borders of the treatment port must be included in the film, a technique chart may be used to follow appropriate technique.
 INTERACT Oncologist as required
 COMM_SUBJ Final adjustments of patient position before radiograph is taken.
 COM_MODE Verbal
 DIFFICULTY 1
 TIME_REQ < 1 min to 3 min
 FREQUENCY 1 time per field
 LIKLI_H_E 3
 LIK_UNDET *
 ERRORS_POS Forget to place x-ray film in holder. Over- or underexposure of film. Incorrect film/screen combination.
 ERROR_COMNT Resulting simulation film detail will be obscured. Oncologist may miss a critical anatomical structure, and may accept an improper field position. As a consequence, target volume may be missed and non-target tissue may be treated.
 ERRCONS1 3B
 ERRCONS2 4B
 ERRCONS3 5B
 ERRCONS4
 ERRCONS5
 COMMENTS1 * adjustments required. Physician should never accept a film as final on which field position is questionable. Questionable field position always requires further films to be taken.
 COMMENTS2

FUNCT_NO	4.00
FUNCTION	Simulation
SUBFUN_NO	4.00
SUBFUN_STA	Simulate Treatment
TASK_NO	7.01
NUMBER	0404071
TASK_STATE	Develop simulation films.
POSITION	Simulation Technologist
EQUIPMENT	Radiograph cassette, film processor
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Sim film taken
CONDITIONS	Simulation radiograph has been exposed.
STANDARD	Must develop radiographs properly
INTERACT	None
COMM_SUBJ	None
COM_MODE	None
DIFFICULTY	1
TIME_REQ	2-3 min
FREQUENCY	1-3 times per port
LIKLI_H_E	1
LIK_UNDET	2
ERRORS_POS	Failure to write patient's name on simulation film; incorrect orientation (i.e. RT-LT; AP/PA).
EROR_COMNT	Confusion of simulation films possibly causing resimulation. Slight chance that a simulation film may be placed in the incorrect patient's chart, and treatment plan will be inappropriate, (i.e. under- or overexposure of target*
ERRCONS1	1B
ERRCONS2	2B
ERRCONS3	3B
ERRCONS4	4B
ERRCONS5	5B
COMMENTS1	* volume, and/or exposure of non-target tissue. Incorrect orientation leading to shift of field in incorrect direction.
COMMENTS2	

FUNCT_NO	4.00
FUNCTION	Simulation
SUBFUN_NO	4.00
SUBFUN_STA	Simulate Treatment
TASK_NO	7.02
NUMBER	0404072
TASK_STATE	Verify simulation films with Oncologist.
POSITION	Simulation Technologist
EQUIPMENT	X-ray viewbox.
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Required for each simulation.
CONDITIONS	Simulation radiograph is developed
STANDARD	Oncologist must sign approved simulation (port) film(s).
INTERACT	Oncologist
COMM_SUBJ	Adequacy of simulation film(s). If not adequate, improvements for additional films are discussed.
COM_MODE	Verbal and written sign-off by Oncologist.
DIFFICULTY	1
TIME_REQ	2-15 min *
FREQUENCY	1 time per "set" of sim films
LIKLI_H_E	2
LIK_UNDET	3
ERRORS_POS	Misunderstanding of Oncologist's input. Acceptance (by Oncologist) of suboptimal simulation film.
EROR_COMNT	Increased time to complete the simulation causing patient discomfort and inability for the patient to hold the required position. Acceptance of inappropriate simulation films by the Oncologist could have multiple effects on*
ERRCONS1	1B
ERRCONS2	2B
ERRCONS3	3B
ERRCONS4	4B
ERRCONS5	5B
COMMENTS1	* the treatment administered. Note: the time required is variable because the simulation tech typically has to locate the oncologist after the simulation films are developed before proceeding.
COMMENTS2	

FUNCT_NO	4.00
FUNCTION	Simulation
SUBFUN_NO	4.00
SUBFUN_STA	Simulate Treatment
TASK_NO	8.00
NUMBER	0404080
TASK STATE	Take manual measurements of patient's external anatomy.
POSITION	Simulation Technologist
EQUIPMENT	Measuring calipers, "contour wire" plaster of paris strips, ultrasound, or other contouring devices, worksheet to record measurements.
CBLT LINAC	Cobalt or Linear Accelerator
CUES	Required for each simulation.
CONDITIONS	Performed at completion of simulation.
STANDARD	Measurements should be accurate to within 2-3 mm.
INTERACT	None
COMM SUBJ	None
COM MODE	None
DIFFICULTY	4
TIME REQ	2-5 min per patient*
FREQUENCY	1-3 times per simulation
LIKLI_H_E	n
LIK UNDET	n
ERRORS_POS	See subtasks
EROR_COMNT	See subtasks
ERRCONS1	n
ERRCONS2	
ERRCONS3	
ERRCONS4	
ERRCONS5	
COMMENTS1	* could take longer if multiple planes within the treatment field are contoured.
COMMENTS2	

FUNCT_NO	4.00
FUNCTION	Simulation
SUBFUN_NO	4.00
SUBFUN_STA	Simulate Treatment
TASK_NO	8.01
NUMBER	0404081
TASK_STATE	Obtain contour of patients body.
POSITION	Simulation Technologist
EQUIPMENT	Contour wire, ultrasound, or other contouring devices.
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Required if other methodology (i.e. CT) is not available or used to obtain patient body contour.*
CONDITIONS	Performed at completion of simulation.
STANDARD	Measurements should be accurate to within 2-3 mm. Note: could involve multiple contours in different planes of treatment area.
INTERACT	Dosimetrist
COMM_SUBJ	Discuss placement and method of contouring
COM_MODE	Verbal
DIFFICULTY	2
TIME_REQ	2-5 min per patient*
FREQUENCY	1 time per simulation
LIKLI_H_E	2
LIK_UNDET	*
ERRORS_POS	Inaccuracies in obtaining patient contour.
EROR_COMNT	Will affect dose calculations resulting in under- or over-exposure of treatment area (3-5% error in beam intensity for each cm of error)
ERRCONS1	1B
ERRCONS2	2B
ERRCONS3	
ERRCONS4	
ERRCONS5	
COMMENTS1	* and patient contour is required. Contours are required if > 2 fields are used, or if computerized isodose curves are needed. Simple simulations do not require contours, IFDS and TSDs (target-to-skin distance) will suffice.
COMMENTS2	

FUNCT_NO	4.00
FUNCTION	Simulation
SUBFUN_NO	4.00
SUBFUN_STA	Simulate Treatment
TASK_NO	8.02
NUMBER	0404082
TASK_STATE	Measure anatomy of treatment area with calipers.
POSITION	Simulation Technologist
EQUIPMENT	Measurement calipers
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Required for all cases regardless of other methods used (CT, MRI, etc.)
CONDITIONS	Patient being simulated. Performed at same time during simulation.
STANDARD	Measurements should be accurate to within 2-3 mm.
INTERACT	Patient
COMM_SUBJ	Explanation of process and importance of holding position.
COM_MODE	Verbal
DIFFICULTY	2
TIME_REQ	1-2 min per patient
FREQUENCY	1 time per treatment area, typically one time per simulation
LIKLI_H_E	2
LIK_UNDET	*
ERRORS_POS	Inaccuracies in measuring diameter of anatomy containing treatment volume.
EROR_COMNT	Will affect dose calculations resulting in under- or over-exposure of treatment area (3-5% error in beam intensity for each cm of error)
ERRCONS1	1B
ERRCONS2	2B
ERRCONS3	
ERRCONS4	
ERRCONS5	
COMMENTS1	* Caliper measurements are more crucial when SSD treatment method is used.
COMMENTS2	

FUNCT_NO	4.00
FUNCTION	Simulation
SUBFUN_NO	4.00
SUBFUN_STA	Simulate Treatment
TASK_NO	9.00
NUMBER	0404090
TASK_STATE	Mark field borders with dye or colored markers.
POSITION	Simulation Technologist
EQUIPMENT	Cotton swab and dye, or marker pens.
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Required for each simulated field that can be marked.
CONDITIONS	Simulation field light in position verified by flourosocopy and radiography process and approved by Oncologist.
STANDARD	Marks must be in exact position of treatment field.
INTERACT	Patient
COMM_SUBJ	Must tell patient to hold still, and describe what is being done.
COM_MODE	Verbal
DIFFICULTY	1
TIME_REQ	2-5 min
FREQUENCY	1 set of tattoos per simulated field
LIKLI_H_E	1
LIK_UNDET	*
ERRORS_POS	Field border marks placed in incorrect position.
EROR_COMNT	Incorrect positioning of field border marks could lead to underdose to target tissue, and overdose to non-target tissue.
ERRCONS1	3B
ERRCONS2	4B
ERRCONS3	5B
ERRCONS4	
ERRCONS5	
COMMENTS1	On dark-skinned patients, the tatoos and field border marks are difficult to see at times. Some facilities take no additional precautions for dark skinned patients. Others use a combination of bright blue and white marker lines for better visability.
COMMENTS2	

FUNCT_NO 4.00
 FUNCTION Simulation
 SUBFUN_NO 4.00
 SUBFUN_STA Simulate Treatment
 TASK_NO 10.00
 NUMBER 0404101
 TASK_STATE Mark treatment field with permanent mark (tattoo) on set-up points.
 POSITION Simulation Technologist
 EQUIPMENT Sterile tattoo needle, tattooing ink, gloves, gauze.
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES Required for each simulated field that is marked
 CONDITIONS Skin marks (see previous task) have been applied correctly
 STANDARD Tattoos must be in exact position of treatment field and applied without injury to patient or to the simulation technologist (AIDS concern)
 INTERACT Patient
 COMM_SUBJ Patient must be told to hold still if necessary. Procedure should be explained as it is performed.
 COM_MODE Verbal
 DIFFICULTY 1
 TIME_REQ 2-5 min
 FREQUENCY 1 set of tattoos per simulated field
 LIKLI_H_E 1
 LIK_UNDET *
 ERRORS_POS Tattoos and or field border marks placed in incorrect position.
 ERROR_COMNT Incorrect positioning of tattoos could lead to underdose to target tissue, and overdose to non-target tissue.
 ERRCONS1 3B
 ERRCONS2 4B
 ERRCONS3 5B
 ERRCONS4
 ERRCONS5
 COMMENTS1 Tattoos do not show up well on some dark-skinned patients. This exacerbates the problems of field border marks not showing up well.
 COMMENTS2

FUNCT_NO	4.00
FUNCTION	Simulation
SUBFUN_NO	4.00
SUBFUN_STA	Simulate Treatment
TASK_NO	11.00
NUMBER	0404110
TASK_STATE	Schedule first treatment appointment.
POSITION	Simulation Technologist, or Supervisor
EQUIPMENT	Department's treatment schedule book
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Patient's involvement in simulation has been concluded.
CONDITIONS	Patient or responsible family member is available.
STANDARD	Patient or family member responsible for patient is made aware of the time and date of the first appointment.
INTERACT	Patient or family member responsible for patient.
COMM_SUBJ	The time and date of the first treatment.
COM_MODE	Verbal. Written, complete appointment card.
DIFFICULTY	1
TIME_REQ	30 sec - 2 min
FREQUENCY	One time per simulation
LIKLI_H_E	1
LIK_UNDET	1
ERRORS_POS	Forgetting to schedule appointment, incorrect appointment time given.
EROR_COMNT	Delay in starting patient's treatment.
ERRCONS1	n
ERRCONS2	
ERRCONS3	
ERRCONS4	
ERRCONS5	
COMMENTS1	
COMMENTS2	

FUNCT_NO 4.00
 FUNCTION Simulation
 SUBFUN_NO 5.00
 SUBFUN_STA Treatment Prescription and Identification of Critical Anatomical Structures in Treatment Area
 TASK_NO 1.00
 NUMBER 0405010
 TASK_STATE Mark treatment volume and other critical anatomical structures of interest on simulation film.
 POSITION Oncologist
 EQUIPMENT Simulation radiographs, supporting patient examination data
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES Approved simulation radiographs available.
 CONDITIONS Treatment-related simulation data has been acquired.
 STANDARD Outline of treatment volume, critical structures, and areas to be blocked should maximize dose to tumor and minimize dose to healthy tissue.*
 INTERACT None
 COMM_SUBJ None
 COM_MODE None
 DIFFICULTY 4
 TIME_REQ variable
 FREQUENCY variable
 LIKLI_H_E 4
 LIK_UNDET 4
 ERRORS_POS Outline of treatment volume is too large or too small. Blocked areas do not successfully block critical structures, or block part of the tumor location. Critical structures are drawn in improper location.
 EROR_COMNT Treatment volume specified is either too large or too small.
 ERRCONS1 3B
 ERRCONS2 4B
 ERRCONS3 5B
 ERRCONS4 8B
 ERRCONS5
 COMMENTS1 * this is the process that requires the most expertise. Again, the expertise and training of the Oncologist is not evaluated in this study, however this task is included for general information and completeness.
 COMMENTS2

FUNCT_NO 4.00
 FUNCTION Simulation
 SUBFUN_NO 5.00
 SUBFUN_STA Treatment Prescription and Identification of Critical
 Anatomical Structures in Treatment Area
 TASK_NO 2.00
 NUMBER 0405020
 TASK_STATE Write (or complete) prescription.
 POSITION Oncologist
 EQUIPMENT Prescription form on patient treatment record
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES Treatment plan formulated
 CONDITIONS The completion of the perscription may evolve during or after the
 initial examination and simulation processes.
 STANDARD At a minimum, prescription should include the number of fields,
 the total dose, the daily dose, the duration of treatment, the
 site of the treatment,*
 INTERACT None
 COMM_SUBJ None
 COM_MODE None
 DIFFICULTY n
 TIME_REQ variable
 FREQUENCY variable
 LIKLI_H_E 1
 LIK_UNDET 2
 ERRORS_POS Treatment parameters illegible, unclear or incomplete. Change
 prescription prior to treatment prior to treatment without
 adequate notification to simulation or treatment team.
 EROR_COMNT Deviation from intended dose, or other planned treatment
 parameters.
 ERRCONS1 1B
 ERRCONS2 2B
 ERRCONS3 3B
 ERRCONS4 4B
 ERRCONS5 5B
 COMMENTS1 * the energy to be used, the calculation point, or isodose line.
 Also the signature (and date) of the Oncologist is required.
 Usually, the diagnosis of the disease for which treatment is
 prescribed. Note: error consequence 8B applies also.
 COMMENTS2

FUNCT NO	4.00
FUNCTION	Simulation
SUBFUN_NO	6.00
SUBFUN_STA	Document Simulation Data
TASK_NO	1.00
NUMBER	0406010
TASK_STATE	Take photograph of patient in treatment position.
POSITION	Simulation Technologist
EQUIPMENT	Camera (typically Polaroid)
CBLT LINAC	Cobalt or Linear Accelerator
CUES	Simulation of treatment field is complete.
CONDITIONS	Patient in approved treatment position.
STANDARD	Photograph must convey the location of the treatment field on patient's body and patient's position on treatment table.
INTERACT	Patient
COMM_SUBJ	Instruct patient not to move.
COM_MODE	Verbal
DIFFICULTY	1
TIME_REQ	1 min
FREQUENCY	One photograph per treatment field simulated.
LIKLI_H_E	1
LIK_UNDET	*
ERRORS_POS	Not taking photograph of treatment field and treatment position.
ERROR_COMNT	Additional time required for setup. Possibility of treating incorrect location, or incorrect immobilization or positioning devices used.
ERRCONS1	2A
ERRCONS2	2B
ERRCONS3	
ERRCONS4	
ERRCONS5	
COMMENTS1	
COMMENTS2	

FUNCT_NO 4.00
FUNCTION Simulation
SUBFUN_NO 6.00
SUBFUN_STA Document Simulation Data
TASK_NO 2.00
NUMBER 0406020
TASK_STATE Take identification photograph of patient's face.
POSITION Simulation Technologist
EQUIPMENT Camera (typically Polaroid)
CBLT_LINAC Cobalt or Linear Accelerator
CUES Identification photo not yet taken.*
CONDITIONS Identification photo not yet taken.*
STANDARD Patient's face must be recognizable from photograph.
INTERACT Patient
COMM_SUBJ Look at camera.
COM_MODE Verbal
DIFFICULTY 1
TIME_REQ 1 min
FREQUENCY One identification photograph per patient simulated.
LIKLI_H_E 1
LIK_UNDET *
ERRORS_POS Not taking identification photograph of patient's face.
EROR_COMNT Possibility of treating incorrect patient.
ERRCONS1 1A
ERRCONS2 2A
ERRCONS3 3A
ERRCONS4 4A
ERRCONS5
COMMENTS1 * This task may be performed at various times in the treatment process, such as on initial consultation visit to department, or not at all, i.e. some locations do not use photographs of patient's face in patient chart.
COMMENTS2

FUNCT_NO	4.00
FUNCTION	Simulation
SUBFUN_NO	6.00
SUBFUN_STA	Document Simulation Data
TASK_NO	3.00
NUMBER	0406030
TASK STATE	Fill out simulation worksheet.
POSITION	Simulation Technologist
EQUIPMENT	Simulation data sheet, data taken from simulation equipment.
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Required for each simulation.
CONDITIONS	During simulation and at completion of simulation.
STANDARD	Documentation should include all crucial aspects of simulation and treatment position parameters, and particulars of the case.
INTERACT	None
COMM_SUBJ	None
COM_MODE	None
DIFFICULTY	3
TIME_REQ	10-30 min per sim
FREQUENCY	One time per simulation
LIKLI_H_E	3
LIK_UNDET	*
ERRORS_POS	Inaccuracies or omissions in recording simulation data.
EROR_COMNT	Could lead to incorrect calculation of dose, or possible treatment of improper location.
ERRCONS1	1B
ERRCONS2	2B
ERRCONS3	3B
ERRCONS4	4B
ERRCONS5	
COMMENTS1	
COMMENTS2	

FUNCT NO 4.00
FUNCTION Simulation
SUBFUN_NO 6.00
SUBFUN_STA Document Simulation Data
TASK_NO 3.01
NUMBER 0406031
TASK_STATE Compare simulation worksheet with printout of simulator
parameters (if available).
POSITION Simulation Technologist
EQUIPMENT Simulation data sheet, computer generated printout of simulator
parameters used
CBLT_LINAC Cobalt or Linear Accelerator
CUES Required for each simulation if computer printout available
CONDITIONS Printout of final simulation parameters is available.
STANDARD Simulation worksheet should agree with printout on all critical
simulation parameters.
INTERACT None
COMM_SUBJ None
COM_MODE None
DIFFICULTY 1
TIME_REQ 2 min per port
FREQUENCY One time for each field simulated
LIKLI_H_E 2
LIK_UNDET *
ERRORS_POS Failure to compare worksheet with printout, clerical errors on
specific numerical parameters go unnoticed.
EROR_COMNT Could lead to incorrect calculation of dose, or possible
treatment of improper location.
ERRCONS1 1B
ERRCONS2 2B
ERRCONS3 3B
ERRCONS4 4B
ERRCONS5
COMMENTS1
COMMENTS2

FUNCT_NO	4.00
FUNCTION	Simulation
SUBFUN_NO	6.00
SUBFUN_STA	Document Simulation Data
TASK_NO	4.00
NUMBER	0406040
TASK_STATE	Sketch important anatomical landmarks, location of tattoos (if present), and write setup instructions on these diagrams.
POSITION	Simulation Technologist
EQUIPMENT	Simulation data sheet, patient chart
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Required for each simulation.
CONDITIONS	Simulation films approved for all fields to be treated.
STANDARD	Sufficient detail of anatomical landmarks and setup instructions included to facilitate patient setup by the technologist.
INTERACT	None
COMM_SUBJ	None
COM_MODE	None
DIFFICULTY	3
TIME_REQ	10-15 min per sim
FREQUENCY	One time per simulation
LIKLI_H_E	3
LIK_UNDET	*
ERRORS_POS	Inaccuracies or omissions in recording simulation data.
EROR_COMNT	Could lead to incorrect calculation of dose, or possible treatment of improper location and setup errors.
ERRCONS1	3B
ERRCONS2	4B
ERRCONS3	
ERRCONS4	
ERRCONS5	
COMMENTS1	
COMMENTS2	

FUNCT_NO 5.00
FUNCTION Treatment Computer Data Files Setup
SUBFUN_NO 1.00
SUBFUN_STA Data file setup specific to Co-60.
TASK_NO 1.00
NUMBER 0501010
TASK_STATE Enter Co-60 beam parameters in treatment planning computer data files.
POSITION Physicist
EQUIPMENT Co-60 output calibration data, treatment planning computer and software.
CBLT_LINAC Cobalt only
CUES Required for initial setup and each time source is replaced.
CONDITIONS Before treatment planning computer is used to create a treatment plan.
STANDARD Source output must be entered accurately.
INTERACT None
COMM_SUBJ None
COM_MODE None
DIFFICULTY 3
TIME_REQ 10 min
FREQUENCY Once per source change, about one time per 4 years
LIKLI_H_E 3
LIK_UNDET 4
ERRORS_POS Entering incorrect beam output parameters.
ERROR_COMNT This error would be hard to detect and could affect many patients.
ERRCONS1 1C
ERRCONS2 2C
ERRCONS3 3C
ERRCONS4 4C
ERRCONS5 5C
COMMENTS1
COMMENTS2

FUNCT_NO	5.00
FUNCTION	Treatment Computer Data Files Setup
SUBFUN_NO	2.00
SUBFUN_STA	Data file setup specific to linear accelerators.
TASK_NO	1.00
NUMBER	0502010
TASK_STATE	Enter beam, energies and parameters in treatment planning computer data files.
POSITION	Physicist
EQUIPMENT	Linear accelerator calibration data, treatment planning computer and software.
CBLT_LINAC	Linear Accelerator only
CUES	Required for initial setup of TPC, or anytime beam quality is affected.
CONDITIONS	Before treatment planning computer is used to create a treatment plan.
STANDARD	Source output parameters must be entered accurately.
INTERACT	None
COMM_SUBJ	None
COM_MODE	None
DIFFICULTY	4
TIME_REQ	1-2 days per energy
FREQUENCY	As conditions require, see above.
LIKLI_H_E	3
LIK_UNDET	4
ERRORS_POS	Entering beam-related data incorrectly.
EROR_COMNT	This error would be hard to detect and could affect many patients.
ERRCONS1	1C
ERRCONS2	2C
ERRCONS3	3C
ERRCONS4	4C
ERRCONS5	5C
COMMENTS1	
COMMENTS2	

FUNCT_NO	5.00
FUNCTION	Treatment Computer Data Files Setup
SUBFUN_NO	3.00
SUBFUN_STA	Data file setup common to Co-60 and Linear Accelerators.
TASK_NO	1.00
NUMBER	0503010
TASK_STATE	Enter treatment machine identification
POSITION	Physicist
EQUIPMENT	Treatment machine identification scheme and treatment planning computer and software.
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Required for initial setup and anytime a machine is replaced or removed.
CONDITIONS	Before treatment planning computer is used to create a treatment plan.
STANDARD	Treatment machines must be identified consistently throughout the department.
INTERACT	None
COMM_SUBJ	None
COM_MODE	None
DIFFICULTY	1
TIME_REQ	5 min
FREQUENCY	Infrequent, see conditions above.
LIKLI_H_E	1
LIK_UNDET	4
ERRORS_POS	Entering incorrect treatment machine identification codes, or using coding scheme that is inconsistent throughout the department.
EROR_COMNT	This error would be hard to detect at first and could conceivably affect many patients.
ERRCONS1	1C
ERRCONS2	2C
ERRCONS3	3C
ERRCONS4	4C
ERRCONS5	5C
COMMENTS1	
COMMENTS2	

FUNCT_NO 5.00
 FUNCTION Treatment Computer Data Files Setup
 SUBFUN_NO 3.00
 SUBFUN_STA Data file setup common to both Co-60 and linear accelerators.
 TASK_NO 2.00
 NUMBER 0503020
 TASK_STATE Enter wedge identification and beam attenuation factors for all wedges to be used in treatment machines.
 POSITION Physicist
 EQUIPMENT Beam modification pattern caused by wedge as measured by Physicist, treatment planning computer and software.
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES Any time a wedge is added to the inventory of wedges used.
 CONDITIONS Before treatment planning computer is used to create a treatment plan.
 STANDARD Wedge identification and beam modification factors must be accurate for each wedge used at the facility.
 INTERACT None
 COMM_SUBJ None
 COM_MODE None
 DIFFICULTY 2
 TIME_REQ 1 hr
 FREQUENCY Infrequent, see conditions above.
 LIKLI_H_E 2
 LIK_UNDET 4
 ERRORS_POS Misidentifying wedge, failure to update wedge files when new wedges are used, entry of incorrect beam attenuation factor for wedge.
 EROR_COMNT Any of these errors would be hard to detect and could affect many patients.
 ERRCONS1 1C
 ERRCONS2 2C
 ERRCONS3 3C
 ERRCONS4 5C
 ERRCONS5
 COMMENTS1 A concern with some treatment planning computer software is the inability to designate old data files (i.e. pre source change) in the files. It is possible for the Dosimetrist to accidentally or to be told incorrectly to use these files.
 COMMENTS2

FUNCT_NO	5.00
FUNCTION	Treatment Computer Data Files Setup
SUBFUN_NO	3.00
SUBFUN_STA	Data file setup common to both Co-60 and linear accelerators.
TASK_NO	3.00
NUMBER	0503030
TASK_STATE	Enter physical properties of treatment machine such as SSD.
POSITION	Physicist
EQUIPMENT	Treatment planning computer and software.
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	For initial setup of treatment planning computer or new machine.
CONDITIONS	Before treatment planning computer is used to create a treatment plan.
STANDARD	Machine data must be entered accurately.
INTERACT	None
COMM_SUBJ	None
COM_MODE	None
DIFFICULTY	1
TIME_REQ	10 min
FREQUENCY	Infrequent
LIKLI_H_E	2
LIK_UNDET	4
ERRORS_POS	Entering incorrect treatment machine data.
EROR_COMNT	This error is difficult to detect and could affect many patients.
ERRCONS1	1C
ERRCONS2	2C
ERRCONS3	3C
ERRCONS4	4C
ERRCONS5	5C
COMMENTS1	
COMMENTS2	

FUNCT_NO 5.00
 FUNCTION Treatment Computer Data Files Setup
 SUBFUN_NO 3.00
 SUBFUN_STA Data file setup common to both Co-60 and linear accelerators.
 TASK_NO 4.00
 NUMBER 0503040
 TASK_STATE Remove old data file from treatment planning computer, or render it inaccessible by anyone in the department.
 POSITION Physicist
 EQUIPMENT Treatment planning computer and software.
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES Treatment planning computer data file has been successfully updated.
 CONDITIONS Before treatment planning computer is used to create a treatment plan.
 STANDARD It must be ensured that outdated treatment computer file data is not able to be used by dosimetrists.
 INTERACT None
 COMM_SUBJ None
 COM_MODE None
 DIFFICULTY 1
 TIME_REQ 10 min
 FREQUENCY Infrequent
 LIKLI_H_E 2
 LIK_UNDET 4
 ERRORS_POS Not ensuring that outdated treatment planning computer data is deleted or made inaccessible to personnel.
 ERROR_COMNT This error is difficult to detect and could affect many patients.
 ERRCONS1 1C
 ERRCONS2 2C
 ERRCONS3 3C
 ERRCONS4 5C
 ERRCONS5
 COMMENTS1
 COMMENTS2

FUNCT_NO	6.00
FUNCTION	Treatment Planning
SUBFUN_NO	1.00
SUBFUN_STA	Obtain Treatment Data
TASK_NO	1.00
NUMBER	0601010
TASK_STATE	Acquire prescription and simulation data, and ensure completeness and internal consistency.
POSITION	Dosimetrist (or Physicist, Contractor or Technologist)
EQUIPMENT	None
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Daily simulation schedule or schedule of new patients, or staff member states that material is ready
CONDITIONS	Prior to treatment planning
STANDARD	Prescription and all simulation data must be present in patient file, and simulation data must be consistent with subject matter or prescription.
INTERACT	Oncologist, Simulation Technologist
COMM_SUBJ	Treatment-related data. Any ambiguities with respect to simulation data or perscription.
COM_MODE	Essential information and instructions will be contained in chart. Clarifications may be verbal.
DIFFICULTY	2
TIME_REQ	30 min
FREQUENCY	One time per simulation
LIKLI_H_E	2
LIK_UNDET	*
ERRORS_POS	Acceptance of and proceeding with perscription and/or simulation data that is not complete, or is unclear.
EROR_COMNT	Over- or underexposure of treatment area. Treatment of incorrect treatment area.
ERRCONS1	1B
ERRCONS2	2B
ERRCONS3	3B
ERRCONS4	4B
ERRCONS5	5B
COMMENTS1	* Most treatment planning is typically done by dosimetrists. If not on the staff, the Physicist may perform this. If also not on the staff, treatment planning may be contracted out to a remote location or performed by technologists on the staff.
COMMENTS2	

FUNCT_NO 6.00
 FUNCTION Treatment Planning
 SUBFUN_NO 1.00
 SUBFUN_STA Obtain Treatment Data
 TASK_NO 2.00
 NUMBER 0601020
 TASK_STATE Acquire essential treatment related data to enable emergency treatment.
 POSITION Technologist (therapist)
 EQUIPMENT None
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES Oncologist informs of emergency case.
 CONDITIONS Emergency condition (patient must be treated immediately). Treatment is performed with minimal treatment planning.
 STANDARD Patient must be treated quickly without simulation and minimal treatment planning
 INTERACT Oncologist
 COMM_SUBJ Location of treatment area. Dose level required.
 COM_MODE Treatment information should be written. Clarifications may be verbal.
 DIFFICULTY 3
 TIME_REQ Variable
 FREQUENCY As needed. (One V.A. hospitals treats about 2 a month this way.)
 LIKLI_H_E 4
 LIK_UNDET 2
 ERRORS_POS Treatment very inappropriate. Virtually any possible treatment-related error could occur.
 ERROR_COMNT Over- or underexposure of treatment area. Treatment of incorrect treatment area.
 ERRCONS1 1A
 ERRCONS2 2A
 ERRCONS3 3A
 ERRCONS4 4A
 ERRCONS5 5A
 COMMENTS1 Because the overriding priority is to treat the tumor quickly (the tumor may be blocking the patient's breathing) normal quality assurance requirements must be severely curtailed.
 COMMENTS2

FUNCT_NO 6.00
 FUNCTION Treatment Planning
 SUBFUN_NO 2.00
 SUBFUN_STA Treatment Plan Calculations Without Treatment Planning
 Computer
 TASK_NO 1.00
 NUMBER 0602010
 TASK_STATE Produce Treatment Plan Calculations.
 POSITION Dosimetrist (or Physicist, Contractor or Technologist)
 EQUIPMENT Hand calculator, treatment unit, data tables, patient chart.
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES Typically done for fixed field treatments without blocking which
 require only central axis calculations.
 CONDITIONS Prescription is available as well as simulator and compensator
 information. Treatment unit data tables are used.
 STANDARD Treatment calculations must be accurate and complete
 INTERACT None
 COMM_SUBJ None
 COM_MODE None
 DIFFICULTY 4
 TIME_REQ 20 - 30 min
 FREQUENCY One time per simulation.
 LIKLI_H E 3
 LIK_UNDET 2
 ERRORS_POS Use of incorrect data, incorrect calculation methods, incorrect
 interpretation of prescription, mathematical errors.
 EROR_COMNT Over- or underexposure of treatment area. Treatment of incorrect
 treatment area. Negative impact on treatment schedule.
 ERRCONS1 1B
 ERRCONS2 2B
 ERRCONS3 5B
 ERRCONS4
 ERRCONS5
 COMMENTS1 * (see comment for first treatment planning task). This is done
 for simple setups or in cases for which an isodose curve is not
 needed. Note: plans developed without a treatment planning
 computer are called "non-graphic" plans.
 COMMENTS2

FUNCT_NO 6.00
FUNCTION Treatment Planning
SUBFUN_NO 3.00
SUBFUN_STA Treatment Plan Calculations on Treatment Planning
Computer
TASK_NO 1.00
NUMBER 0603010
TASK_STATE Select patient name in computer directory, or enter name if not
in directory.
POSITION Dosimetrist (or Physicist, Contractor or Technologist)
EQUIPMENT Treatment Planning Computer
CBLT_LINAC Cobalt or Linear Accelerator
CUES New computer calculation required for new patient or modification
required on a current patient.
CONDITIONS Treatment planning on treatment planning computer is being
initiated.
STANDARD Correct patient must be selected or entered
INTERACT None
COMM_SUBJ None
COM_MODE None
DIFFICULTY 1
TIME_REQ 30 sec
FREQUENCY One time per treatment plan, or modification
LIKLI_H_E 1
LIK_UNDET 1
ERRORS_POS Use incorrect patient file
EROR_COMNT A slight chance that the treatment plan may be developed for the
incorrect patient.
ERRCONS1 1B
ERRCONS2 2B
ERRCONS3 3B
ERRCONS4 4B
ERRCONS5 5B
COMMENTS1 * (see comment for first treatment planning task) Note: treatment
plan developed with a treatment planning computer is called a
"graphic plan".
COMMENTS2

FUNCT_NO 6.00
 FUNCTION Treatment Planning
 SUBFUN_NO 3.00
 SUBFUN_STA Treatment Plan Calculations on Treatment Planning
 Computer
 TASK_NO 2.00
 NUMBER 0603020
 TASK_STATE Obtain patient's body contour from simulation technologist, or
 from storage area.
 POSITION Dosimetrist (or Physicist, Contractor or Technologist)
 EQUIPMENT Patient's body contour (see function x, task x. xx)
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES Any case requiring computer-derived isodose curves with contour
 taken on simulator v.s. obtained by C.T.
 CONDITIONS Contour or contour data available. Contour is required for
 treatment planning computer to generate isodose curves.
 STANDARD Body contour must be entered accurately
 INTERACT Simulation technologist, Oncologist.
 COMM_SUBJ Clarification of contour data. Treatment volume placement within
 contour.
 COM_MODE Written or verbal
 DIFFICULTY 2
 TIME_REQ 5 min
 FREQUENCY One time per treatment plan
 LIKLI_H_E 1
 LIK_UNDET 3
 ERRORS_POS Obtaining contour from wrong patient. Incorrect contour
 reconstruction. Incorrect contour interpretation.
 EROR_COMNT Treatment plan based on incorrect amount of tissue. Amount of
 radiation dose delivered to the target would vary by 6% per each
 1 cm of error from patients true dimension along central axis
 (depending on beam energy).
 ERRCONS1 1B
 ERRCONS2 2B
 ERRCONS3 3B
 ERRCONS4 4B
 ERRCONS5 5B
 COMMENTS1 Error comnt cont.: Incorrect contour in computer could result in
 large field placement error (normal tissues exposed\target
 missed). Serious error could occur if the beam placement marks on
 the contour are misinterpreted, (i.e. field edge used as cen
 COMMENTS2 tral axis). Note: Simulation contours are obtained by various
 methods. Some are simple 1:1 outlines (plaster or solder), others
 may require reconstruction from TSDs taken at simulation or
 demagnification of simulator films. (error prob. + for these)

FUNCT_NO 6.00
 FUNCTION Treatment Planning
 SUBFUN_NO 3.00
 SUBFUN_STA Treatment Plan Calculations on Treatment Planning
 Computer
 TASK_NO 2.01
 NUMBER 0603021
 TASK_STATE Enter patient contour into treatment planning computer patient
 file.
 POSITION Dosimetrist (or Physicist, Contractor or Technologist)
 EQUIPMENT Treatment Planning Computer, tracing of patient external contour
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES Plan required for patient who has been contoured. Data entry
 screen or prompts.
 CONDITIONS Patient file is open. Treatment plan will use available contour
 as input rather than from CT (direct data) or other source.
 STANDARD Body contour must be entered accurately, within 3 mm.
 INTERACT None
 COMM_SUBJ None
 COM_MODE None
 DIFFICULTY 2
 TIME_REQ 5 min
 FREQUENCY One time per treatment plan
 LIKLI_H_E 2
 LIK_UNDET 3
 ERRORS_POS Inaccurate entry of patient contour, or entry of contour from
 wrong patient. Use of incorrect magnification factor (if
 required).
 EROR_COMNT Treatment plan based on incorrect amount of tissue. Intensity of
 beam could vary by 6% per each 1 cm of error from patients true
 dimension along central axis depending on treatment unit energy.
 ERRCONS1 1B
 ERRCONS2 2B
 ERRCONS3 3B
 ERRCONS4 4B
 ERRCONS5 5B
 COMMENTS1 Incorrectly entered contour could result in incorrect beam
 placement which could result in treatment of normal tissues and
 insufficient coverage of the treatment volume or complete miss of
 treatment volume.
 COMMENTS2

FUNCT_NO 6.00
 FUNCTION Treatment Planning
 SUBFUN_NO 3.00
 SUBFUN_STA Treatment Plan Calculations on Treatment Planning
 Computer
 TASK_NO 2.02
 NUMBER 0603022
 TASK_STATE Enter dose limiting ("critical") structures within patient's body
 contour entered previously.
 POSITION Dosimetrist (or Physicist, Contractor or Technologist)
 EQUIPMENT Treatment Planning Computer, tracing of location, size and shape
 of dose limiting structures.
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES Data entry screen or prompts.
 CONDITIONS Patient file is open. Treatment plan will use contour as input
 rather than from CT (direct data) or other source.
 STANDARD Dose limiting structures must be entered accurately
 INTERACT None
 COMM_SUBJ None
 COM_MODE None
 DIFFICULTY 2
 TIME_REQ 10 - 50 min
 FREQUENCY One time per treatment plan
 LIKLI_H_E 2
 LIK_UNDET 3
 ERRORS_POS Inaccurate entry of patient contours, critical structures, or
 entry of critical structure contour from wrong patient.
 EROR_COMNT Incorrect entry of critical structures could result in higher
 doses to these structures than what is shown by plan. Also
 therapeutic dose to the treatment volume may be compromised by
 trying to limit the dose to an incorrectly *
 ERRCONS1 1B
 ERRCONS2 2B
 ERRCONS3 3B
 ERRCONS4 4B
 ERRCONS5 5B
 COMMENTS1 * placed critical structure.
 COMMENTS2

FUNCT_NO	6.00
FUNCTION	Treatment Planning
SUBFUN_NO	3.00
SUBFUN_STA	Treatment Plan Calculations on Treatment Planning Computer
TASK_NO	2.03
NUMBER	0603023
TASK_STATE	Enter the identification of the treatment machine.
POSITION	Dosimetrist (or Physicist, Contractor or Technologist)
EQUIPMENT	Treatment Planning Computer, simulation results, perscription
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	A screen is generated by the treatment planning software with blanks for treatment parameter entry.
CONDITIONS	Data is available from physician's prescription*
STANDARD	Treatment parameters must be entered correctly
INTERACT	None
COMM_SUBJ	None
COM_MODE	None
DIFFICULTY	1
TIME_REQ	< 1 min
FREQUENCY	One time per treatment plan
LIKLI_H_E	2
LIK_UNDET	1
ERRORS_POS	Use incorrect treatment machine parameters.
EROR_COMNT	Treatment unit data in the computer may vary greatly between treatment units with respect to %DD (depth dose), profiles, sedge data, output, and in other aspects. Use of incorrect treatment unit data files could result in **
ERRCONS1	1B
ERRCONS2	2B
ERRCONS3	3B
ERRCONS4	4B
ERRCONS5	5B
COMMENTS1	* Occasionally, during the computer planning process, several treatment units must be evaluated to determine which give the lowest best overall plan. When this occurs, the time required increases drastically for this task.
COMMENTS2	** isodose plans which deviate extensively from the actual case.

FUNCT_NO	6.00
FUNCTION	Treatment Planning
SUBFUN_NO	3.00
SUBFUN_STA	Treatment Plan Calculations on Treatment Planning Computer
TASK_NO	4.00
NUMBER	0603040
TASK_STATE	Enter beam parameters into treatment planning computer treatment plan file.
POSITION	Dosimetrist (or Physicist, Contractor or Technologist)
EQUIPMENT	Treatment planning computer, simulation documentation
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Data entry screen or prompts.
CONDITIONS	Beam data may be known from simulator data or may be decided upon in computer planning process *
STANDARD	All treatment beam parameters specified in the simulation must be entered accurately.
INTERACT	None
COMM_SUBJ	None
COM_MODE	None
DIFFICULTY	2
TIME_REQ	5-10 min
FREQUENCY	One time per set of selected treatment plans
LIKLI_H_E	2
LIK_UNDET	2
ERRORS_POS	Entering incorrect data for treatment beam parameters.
ERROR_COMNT	Treatment plan developed will be inappropriate. Could lead to mistreatment, most likely to include over- or under-exposure of target area, or missing the target area and overexposure to normal tissues.
ERRCONS1	1B
ERRCONS2	2B
ERRCONS3	3B
ERRCONS4	4B
ERRCONS5	5B
COMMENTS1	Parameters entered will include beam energy, collimator and gantry angles, field size, TSD, modifiers (wedge, block, compensator). Note: modifications may be required as per review by Oncologist of candidate plans (see tasks that follow).
COMMENTS2	* The beam data to be used may be determined at simulation or it may take "trial and error" approach at the planning computer to arrive at the optimal beam parameters.

FUNCT_NO 6.00
 FUNCTION Treatment Planning
 SUBFUN_NO 3.00
 SUBFUN_STA Treatment Plan Calculations on Treatment Planning
 Computer
 TASK_NO 5.00
 NUMBER 0603050
 TASK_STATE Enter beam position relative to graphic representation of patient
 contour and target area on treatment planning computer screen.
 POSITION Dosimetrist (or Physicist, Contractor or Technologist)
 EQUIPMENT Treatment planning computer and software
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES Required to generate isodose curve printout.
 CONDITIONS Patient contour w/critical structures and target have been
 entered on computer.
 STANDARD Beam data entered as per requirements required treatment, or, if
 beam placement was determined at simulation, the beams must be
 entered as simulated.
 INTERACT None
 COMM_SUBJ None
 COM_MODE None
 DIFFICULTY 3
 TIME_REQ 10-30 min
 FREQUENCY One time per field treated
 LIKLI_H_E 2
 LIK_UNDET 2
 ERRORS_POS Inappropriate beam position entered.
 EROR_COMNT Incorrect beam placement may result in a plan which is obviously
 incorrect and therefore would not be accepted. However, in some
 situations, the misplaced beam may go unnoticed. Beam placement
 relative to target volume, critical *
 ERRCONS1 1B
 ERRCONS2 2B
 ERRCONS3 3B
 ERRCONS4 4B
 ERRCONS5 5B
 COMMENTS1 The quality of this task is dependent on the training, experience
 and skill of the dosimetrist.
 COMMENTS2 * structures, volume of tissue intercepted by the beam and
 relative placement of other beams may cause increased dose to
 normal tissues/decreased dose to target volume.

FUNCT_NO 6.00
 FUNCTION Treatment Planning
 SUBFUN_NO 3.00
 SUBFUN_STA Treatment Plan Calculations on Treatment Planning
 Computer
 TASK_NO 5.01
 NUMBER 0603051
 TASK_STATE Produce alternate treatment plans (dose levels and beam
 positions) that maximize desirable or minimize undesirable
 aspects of treatment (may be printed or reviewed on computer
 screen).
 POSITION Dosimetrist (or Physicist, Contractor or Technologist)
 EQUIPMENT Treatment planning computer and software, plotter
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES Required for treatment plan
 CONDITIONS Treatment parameters have been entered.
 STANDARD Plan must contain target area isodose distributions, beam
 parameters such as beam positions, beam dimensions and modifiers
 such as wedges or blocks.
 INTERACT None
 COMM_SUBJ None
 COM_MODE None
 DIFFICULTY 4
 TIME_REQ 10-90 min
 FREQUENCY Variable, frequently a minimum of three alternate plans are made
 LIKLI_H_E 2
 LIK_UNDET 3
 ERRORS_POS Failure to produce treatment plan alternatives that represent all
 of the viable alternatives for maximizing treating to the
 treatment volume and minimizing exposure to critical structures
 and/or healthy tissue.
 EROR_COMNT Failure to produce viable alternatives may result in the
 physician choosing to go with an inferior plan.
 ERRCONS1 1B
 ERRCONS2 2B
 ERRCONS3 3B
 ERRCONS4 4B
 ERRCONS5 5B
 COMMENTS1 The quality of this task is dependent on the training, experience
 and skill of the dosimetrist. The dosimetrist typically produces
 2, 3 or more candidate treatment plans for reviewt. Each plan
 will have unique advantages and disadvantages.
 COMMENTS2

FUNCT_NO	6.00
FUNCTION	Treatment Planning
SUBFUN_NO	3.00
SUBFUN_STA	Treatment Plan Calculations on Treatment Planning Computer
TASK_NO	6.00
NUMBER	0603060
TASK STATE	Run copy of treatment plan to plotter.
POSITION	Dosimetrist (or Physicist, Contractor or Technologist)
EQUIPMENT	Treatment planning computer and software, plotter
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Required for treatment plan
CONDITIONS	Treatment parameters including beam position is as desired for candidate treatment plan.
STANDARD	Must include all important aspects of proposed treatment to include beam positions, relative intensity, target area, and patient contour.
INTERACT	None
COMM_SUBJ	None
COM_MODE	None
DIFFICULTY	1
TIME REQ	2-3 min
FREQUENCY	One time per candidate treatment plan
LIKLI_H_E	1
LIK_UNDET	1
ERRORS_POS	Misidentifying or misfiling treatment plan so that the wrong plan is used for the wrong patient.
EROR_COMNT	Could result in use of incorrect plan.
ERRCONS1	1B
ERRCONS2	2B
ERRCONS3	3B
ERRCONS4	4B
ERRCONS5	5B
COMMENTS1	
COMMENTS2	

FUNCT_NO	6.00
FUNCTION	Treatment Planning
SUBFUN_NO	3.00
SUBFUN_STA	Treatment Plan Calculations on Treatment Planning Computer
TASK_NO	7.00
NUMBER	0603070
TASK_STATE	Present treatment plan options to Oncologist for review and approval.
POSITION	Dosimetrist (or Physicist, Contractor or Technologist)
EQUIPMENT	"Candidate" treatment plans
CBLT LINAC	Cobalt or Linear Accelerator
CUES	"Candidate" treatment plans successfully completed, physician approval required.
CONDITIONS	A set of "candidate" treatment plans has been completed.
STANDARD	Candidate treatment plans must reflect multiple approaches to maximize desired results and minimize undesirable results of treatment*
INTERACT	Oncologist
COMM_SUBJ	Adequacy of plans, requirements for additional options.
COM_MODE	Verbal and/or written on treatment plans by Oncologist.
DIFFICULTY	1
TIME_REQ	Variable
FREQUENCY	One time per set of candidate treatment plans
LIKLI_H_E	1
LIK_UNDET	1
ERRORS_POS	Omission of this task. Miscommunication between dosimetrist and
EROR_COMNT	Omission unlikely. Miscommunication or failure to get approval could result in the use of a less than optimum or completely inappropriate treatment plan.
ERRCONS1	1B
ERRCONS2	2B
ERRCONS3	3B
ERRCONS4	4B
ERRCONS5	5B
COMMENTS1	The treatment plan selected will represent a tradeoff between higher dose to the desired target at the expense of additional dose to non-target tissue, and lower dose to non-target tissue at the expense of lower dose to target tissue. Also, varying
COMMENTS2	the degree of treatment difficulty must be placed in the context of likelihood of additional errors during actual treatment of an optimal albeit complex plan.

FUNCT_NO 6.00
 FUNCTION Treatment Planning
 SUBFUN_NO 4.00
 SUBFUN_STA Treatment Planning on Computer System with CT Data
 Handling Capability
 TASK_NO 1.00
 NUMBER 0604010
 TASK_STATE Take simulator films to localize internal and external anatomy of
 patient prior to treatment planning CT.
 POSITION Sim tech., or Dosimetrist, Physicist, Contractor or Technologist)
 EQUIPMENT Simulator, x-ray film, radio-opaque dye, cotton swab, and/or
 tattoo needle, radio-opaque markers.
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES As per facility procedure, or request by Oncologist.
 CONDITIONS May or may not be required for case. Will enable greater accuracy
 in specifying CT.
 STANDARD 90 deg. opposing coordinate films. Simulation Tech must also mark
 port locations on patient (i.e. field center, edge) so these may
 be used in the CT.
 INTERACT Oncologist, Physicist (if performed by Sim Tech, Dosimetrist, or
 Contractor) as required.
 COMM_SUBJ Correct position of simulator films
 COM_MODE Verbal
 DIFFICULTY 2
 TIME_REQ <= 30 min
 FREQUENCY Quite variable between facilities
 LIKLI_H_E 1
 LIK_UNDET 2
 ERRORS_POS Field location not correctly marked and improper location is
 radiographed. Inadequate immobilization used and patient moves
 between films.
 EROR_COMNT CT scan will be based on incorrect anatomical location. Treatment
 field specified by Oncologist based on the CT may not be
 consistent with the patient's true condition.
 ERRCONS1 8B
 ERRCONS2
 ERRCONS3
 ERRCONS4
 ERRCONS5
 COMMENTS1 All facilities do not use simulator films to support the CT
 process.
 COMMENTS2

FUNCT_NO 6.00
 FUNCTION Treatment Planning
 SUBFUN_NO 4.00
 SUBFUN_STA Treatment Planning on Computer System with CT Data
 Handling Capability
 TASK_NO 2.00
 NUMBER 0604020
 TASK_STATE Schedule CT with CT technologist.
 POSITION Dosimetrist (or Physicist, Contractor or Technologist)
 EQUIPMENT None
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES Oncologist request for CT-based treatment plan or facility
 protocol
 CONDITIONS Prior to CT for treatment planning data.
 STANDARD CT scheduled in time to prepare treatment plan and proceed with
 treatment as per Oncologist's desires. Appointment time must be
 agreeable to patient.
 INTERACT CT Technologist (not part of Teletherapy department), Oncologist,
 Patient.
 COMM_SUBJ CT appointment.
 COM_MODE Verbal
 DIFFICULTY 1
 TIME_REQ 5 min
 FREQUENCY One time per CT-based treatment plan
 LIKLI_H_E 1
 LIK_UNDET 1
 ERRORS_POS Failure to schedule CT. Miscommunication with Oncologist or
 Patient.
 EROR_COMNT Delay in the treatment planning process, or Oncologist may
 perform treatment planning without CT data.
 ERRCONS1 8B
 ERRCONS2
 ERRCONS3
 ERRCONS4
 ERRCONS5
 COMMENTS1 Use of treatment planning computer equipment is typically
 performed on the more complex cases at facilities so equipped.
 Depending on the staffing operating philosophies of these
 facilities.
 COMMENTS2

FUNCT_NO 6.00
 FUNCTION Treatment Planning
 SUBFUN_NO 4.00
 SUBFUN_STA Treatment Planning on Computer System with CT Data
 Handling Capability
 TASK_NO 3.00
 NUMBER 0604030
 TASK_STATE Assist with setup and direction of CT for treatment planning
 purposes.
 POSITION Dosimetrist (or Physicist, Contractor or Technologist)
 EQUIPMENT CT scanner, CT technologist, perscription, [notes from
 pre-treatment planning session], radio-opaque catheters or other
 markers to mark port locations as per sim films previously taken.
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES Previously scheduled planning CT appointment.
 CONDITIONS Patient is placed in treatment position. Opaque markers to mark
 simulation ports are in place.
 STANDARD CT scan must support treatment planning for the treatment area;
 recognizable external anatomy must be incorporated, and patient
 in treatment position.
 INTERACT Oncologist, Physicist (if performed by Dosimetrist) as required
 COMM_SUBJ Aspects of case, anatomical landmarks, intended treatment port
 position, proximity of critical structures.
 COM_MODE Verbal
 DIFFICULTY 3
 TIME_REQ 60 min
 FREQUENCY Quite variable between facilities*
 LIKLI_H_E 2
 LIK_UNDET 4
 ERRORS_POS Could take scan of wrong area, or take insufficient number of
 slices, etc. Patient movement during scan. Incorrect positioning
 of patient. Incorrect placement of localization catheters.
 ERROR_COMNT CT scan might have to be repeated causing delay in patient's
 treatment. Inappropriate data could be used causing decreased
 accuracy in tumor localization and the identification of critical
 structures.
 ERRCONS1 1B
 ERRCONS2 2B
 ERRCONS3 3B
 ERRCONS4 4B
 ERRCONS5 5B
 COMMENTS1 Use of treatment planning computer equipment is typically
 performed on the more complex cases at facilities so equipped.
 Depending on the staffing operating philosophies of these
 facilities, the % of computer aided plans will range from 20 to
 90%.
 COMMENTS2 Note error consequence 8B also applies.

FUNCT_NO 6.00
FUNCTION Treatment Planning
SUBFUN_NO 4.00
SUBFUN_STA Treatment Planning on Computer System with CT Data
Handling Capability
TASK_NO 3.01
NUMBER 0604031
TASK_STATE Position patient for CT scan.
POSITION Dosimetrist, CT Technologist
EQUIPMENT CT Scanner, all immobilization devices that will be used during
treatment,
CBLT_LINAC Cobalt or Linear Accelerator
CUES CT scheduled
CONDITIONS Patient will be set up with all immobilization devices and
cushions that will be used in simulation and treatment.
STANDARD Patient must be in the exact position that will be used in
treatment
INTERACT CT Technologist
COMM_SUBJ
COM_MODE
DIFFICULTY 2
TIME_REQ 2-10 min
FREQUENCY One time per CT
LIKLI_H_E 2
LIK_UNDET 2
ERRORS_POS Allowing scan to proceed with patient in incorrect position.
ERROR_COMNT If undetected, this error could cause inappropriate tumor
localization and identification of critical structures.
ERRCONS1 8B
ERRCONS2
ERRCONS3
ERRCONS4
ERRCONS5
COMMENTS1
COMMENTS2

FUNCT_NO 6.00
 FUNCTION Treatment Planning
 SUBFUN_NO 4.00
 SUBFUN_STA Treatment Planning on Computer System with CT Data
 Handling Capability
 TASK_NO 3.02
 NUMBER 0604032
 TASK_STATE Request CT "cuts".
 POSITION Dosimetrist (or Physicist, Contractor or Technologist)
 EQUIPMENT CT Scanner
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES CT scheduled, patient positioned on CT table.
 CONDITIONS CT is set up. Dosimetrist knows the anatomical area for treatment
 and the surrounding area required for context.
 STANDARD Patient must be in the exact position that will be used in
 treatment. Cuts will be as per requests by treatment team,
 standard practice, or protocol.
 INTERACT CT Technologist, Oncologist
 COMM_SUBJ Where to take CT slices. Number and thickness of slices.
 COM_MODE Verbal, Oncologist may have provided written notes.
 DIFFICULTY 1
 TIME_REQ 2-10 min
 FREQUENCY One time per CT cut
 LIKLI_H_E 2
 LIK_UNDET 2
 ERRORS_POS Requesting incorrect cut, or requesting too few cuts.
 ERROR_COMNT If undetected, this error could cause inaccurate tumor
 localization, unclear illustration of disease and surrounding
 critical structures. This error could result in a poor treatment
 plan if unrecognized. If recognized, error *
 ERRCONS1 1B
 ERRCONS2 2B
 ERRCONS3 3B
 ERRCONS4 4B
 ERRCONS5 5B
 COMMENTS1 * could cause delay and expense for repeating CT.
 COMMENTS2 Note: Error consequence 8B also applies.

FUNCT_NO 6.00
 FUNCTION Treatment Planning
 SUBFUN_NO 4.00
 SUBFUN_STA Treatment Planning on Computer System with CT Data
 Handling Capability
 TASK_NO 4.00
 NUMBER 0604040
 TASK_STATE Load CT data into patient directory in treatment planning host
 computer.
 POSITION Dosimetrist (or Physicist, Contractor or Technologist)
 EQUIPMENT CT data tape, tape drive on host treatment planning computer
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES Patient data on tape from CT scan
 CONDITIONS CT data is available (typically on tape).
 STANDARD Computer acknowledgement of successful load of data, data entered
 into correct patient directory
 INTERACT None
 COMM_SUBJ None
 COM_MODE None
 DIFFICULTY 1
 TIME_REQ 10 min
 FREQUENCY Typically used with the more complex cases*
 LIKLI_H_E 1
 LIK_UNDET 2
 ERRORS_POS Input data into incorrect patient file
 EROR_COMNT Would cause a delay in treatment schedule for that patient if
 error was detected. If undetected (very unlikely) could cause
 over- or underexposure, or incorrect treatment area.
 ERRCONS1 1B
 ERRCONS2 2B
 ERRCONS3 3B
 ERRCONS4 4B
 ERRCONS5 5B
 COMMENTS1 Use of treatment planning computer equipment is typically
 performed on the more complex cases at facilities so equipped.
 Depending on the staffing operating philosophies of these
 facilities, the % of computer aided plans will range from 20 to
 90%.
 COMMENTS2

FUNCT_NO 6.00
 FUNCTION Treatment Planning
 SUBFUN_NO 4.00
 SUBFUN_STA Treatment Planning on Computer System with CT Data
 Handling Capability
 TASK_NO 5.00
 NUMBER 0604050
 TASK_STATE Outline contours of interest (i.e. target volume and critical
 structures (i.e. bony landmarks, lungs, etc.).
 POSITION Dosimetrist (or Physicist, Contractor or Technologist)
 EQUIPMENT CT image, treatment planning computer and software
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES Patient chart, simulation radiographs, CT data successfully read
 by treatment planning computer.
 CONDITIONS CT data present on treatment planning computer video display. CT
 hardcopy available with target volume outlined by Oncologist
 STANDARD Contours of interest are accurately outlined.
 INTERACT None
 COMM_SUBJ None
 COM_MODE None
 DIFFICULTY 2
 TIME_REQ <= 30 min
 FREQUENCY variable
 LIKLI_H_E 2
 LIK_UNDET 4
 ERRORS_POS Contour outline is not precise to the contour or incorrect (i.e.
 wrong contour), target volume or critical structures drawn at
 incorrect anatomical level on contour (in relation to beam).
 ERROR_COMNT Unnecessary normal tissue exposure, and/or inadequate tumor dose
 ERRCONS1 1B
 ERRCONS2 2B
 ERRCONS3 3B
 ERRCONS4 4B
 ERRCONS5 5B
 COMMENTS1 Note: Error consequence 8B also applies.
 COMMENTS2

FUNCT_NO 6.00
 FUNCTION Treatment Planning
 SUBFUN_NO 4.00
 SUBFUN_STA Treatment Planning on Computer System with CT Data
 Handling Capability
 TASK_NO 5.01
 NUMBER 0604051
 TASK_STATE Outline contours of interest (i.e. target volume and critical
 structures (i.e. bony landmarks, lungs, etc.) with "auto contour"
 capability.*
 POSITION Dosimetrist (or Physicist, Contractor or Technologist)
 EQUIPMENT CT image, treatment planning computer, monitor and software (auto
 contour subroutine)
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES Patient chart, patient CT images
 CONDITIONS CT data present on treatment planning computer video display. CT
 hardcopy available with target volume outlined by Oncologist
 STANDARD Ensure that contour developed by system is correct and accurate
 INTERACT Oncologist, Physicist (if performed by Dosimetrist) as req.
 COMM_SUBJ Clarification of details of CT data as required.
 COM_MODE Verbal
 DIFFICULTY 2
 TIME_REQ <= 30 min
 FREQUENCY As per case type and preference**
 LIKLI_H_E 2
 LIK_UNDET 4
 ERRORS_POS Failure to notice contour is inaccurate or inappropriate
 ERROR_COMNT Undesired exposure of portions of critical structures, and/or
 undesired shielding of intended target area.
 ERRCONS1 1B
 ERRCONS2 2B
 ERRCONS3 3B
 ERRCONS4 4B
 ERRCONS5 5B
 COMMENTS1 * The mouse is placed on the edge of a structure to be contoured.
 Tolerances for tissue density value differences, contour
 structure and surrounding structure are entered, and auto contour
 is activated. **Some Physicists/Dosi prefer manual contouring
 COMMENTS2 Note: Error consequence 8B also applies.

FUNCT_NO 6.00
 FUNCTION Treatment Planning
 SUBFUN_NO 4.00
 SUBFUN_STA Treatment Planning on Computer System with CT Data Handling Capability
 TASK_NO 5.02
 NUMBER 0604052
 TASK_STATE Outline contours of interest (i.e. tumor (target) and critical structures (i.e. bony landmarks, lungs, etc.) manually.
 POSITION Dosimetrist (or Physicist, Contractor or Technologist)
 EQUIPMENT CT image, treatment planning computer, monitor and software (manual contour subroutine) mouse, light pen or other device.
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES Patient chart, patient CT images
 CONDITIONS CT data present on treatment planning computer video display. CT hardcopy available with target volume outlined by Oncologist
 STANDARD Ensure that contour "drawn" follows the edges of the contour accurately.
 INTERACT Oncologist, Physicist (if performed by Dosimetrist) as req.
 COMM_SUBJ Clarification of details of CT data as required.
 COM_MODE Verbal
 DIFFICULTY 2
 TIME_REQ 30 min
 FREQUENCY As per case type and preference**
 LIKLI_H_E 2
 LIK_UNDET 4
 ERRORS_POS Failure to draw accurate contour or notice if contour is inaccurate or inappropriate
 ERROR_COMNT Undesired exposure of portions of critical structures, and/or undesired shielding of intended target area.
 ERRCONS1 1B
 ERRCONS2 2B
 ERRCONS3 3B
 ERRCONS4 4B
 ERRCONS5 5B
 COMMENTS1 * The mouse is placed on the edge of a structure to be contoured. The contour line is then drawn on the CT image with the mouse. **Some Physicists/Dosi prefer this manual contour drawing to the automatic version.
 COMMENTS2 Note: Error consequence 8B also applies.

FUNCT_NO 6.00
 FUNCTION Treatment Planning
 SUBFUN_NO 5.00
 SUBFUN_STA Setup and Verify Patient Chart
 TASK_NO 1.00
 NUMBER 0605010
 TASK_STATE Setup treatment chart.
 POSITION Dosimetrist (or Physicist, Contractor or Technologist)
 EQUIPMENT Simulation data sheet and/or treatment plan, and completed dose calculation worksheet
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES Treatment chart and process log sheet (if used)
 CONDITIONS
 STANDARD Should include all critical aspects of simulation: monitor units or exposure time, immobilization requirements, gantry and collimator settings, wedges*
 INTERACT None
 COMM_SUBJ None
 COM_MODE None
 DIFFICULTY 2
 TIME_REQ 30 min per simulation
 FREQUENCY One time per simulation
 LIKLI_H_E 3
 LIK_UNDET 3
 ERRORS_POS Inaccuracies or omissions in transcribing simulation data.
 EROR_COMNT Could lead to incorrect delivery of dose, or possible treatment of improper location.
 ERRCONS1 1B
 ERRCONS2 2B
 ERRCONS3 3B
 ERRCONS4 4B
 ERRCONS5 5B
 COMMENTS1 * or blocks, or tissue compensators required, treatment table height and angle, SSD, SAD. In addition: Setup parameters, calculations, and graphic plan should be double checked (Physicist) for correct data transcription and correct dose computation.
 COMMENTS2

FUNCT_NO 6.00
 FUNCTION Treatment Planning
 SUBFUN_NO 5.00
 SUBFUN_STA Setup and Verify Patient Chart
 TASK_NO 2.00
 NUMBER 0605020
 TASK_STATE Check patient chart for completeness and accuracy periodically during course of treatment.
 POSITION Physicist/Dosimetrist
 EQUIPMENT Patient treatment chart, hand calculator
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES Standard quality assurance procedure
 CONDITIONS This is typically performed on a weekly basis.
 STANDARD Accurate check of chart parameters such as: Correct MU or exposure time, wedges, compensators, or bolus being used (as required), total dose summed to
 INTERACT Treatment plan originator, Dosimetrist, Physicist, Sim tech
 COMM_SUBJ Clarifications of omissions or ambiguities in treatment plan data.
 COM_MODE Verbal
 DIFFICULTY 3
 TIME_REQ 10-40 min
 FREQUENCY Variable between facilities, typically weekly for every chart
 LIKLI_H_E 2
 LIK_UNDET 3
 ERRORS_POS Lack of attention to detail; errors undetected.
 EROR_COMNT Errors remain undetected.
 ERRCONS1 1B
 ERRCONS2 2B
 ERRCONS3 3B
 ERRCONS4 4B
 ERRCONS5 5B
 COMMENTS1 * to date is correct (addition), that IFS/TSD are being checked periodically, and the general overall condition of the chart, (i.e. white-out not used, data is not entered slopily, etc.).
 COMMENTS2 This is a quality assurance task designed to detect and stop errors.

FUNCT_NO	7.00
FUNCTION	Custom Blocks and Compensators
SUBFUN_NO	1.00
SUBFUN_STA	Receive Block Request
TASK_NO	1.00
NUMBER	0701010
TASK_STATE	Receive simulation films with block area marked by Oncologist.
POSITION	Block Cutter*
EQUIPMENT	n/a
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Simulation films, and/or verbal or written request from Sim Tech, Physicist or Dosimetrist
CONDITIONS	These are typically taken to the block making room by the simulation technologist.
STANDARD	n/a
INTERACT	Sim Tech, Treatment Technologist, Dosimetrist, Physicist or Oncologist
COMM_SUBJ	Missing data, special conditions, i.e. patient supine or prone, or reversed on table, collimator angle, correct TFD, current treatment unit, or urgent need for blocks.
COM_MODE	Written request for modification, may also include verbal discussion and clarifications.
DIFFICULTY	1
TIME_REQ	1-5 min
FREQUENCY	Variable, depends on extent of use of custom blocks
LIKLI_H_E	1
LIK_UNDET	1
ERRORS_POS	Incorrect transfer of information
EROR_COMNT	Incorrect information could result in incorrect block fabricatin.
ERRCONS1	2B
ERRCONS2	3B
ERRCONS3	4B
ERRCONS4	5B
ERRCONS5	
COMMENTS1	* Some facilities have a designated block cutter. Others use dosimitrists or rotate technologists or trainee technologists through this position.
COMMENTS2	

FUNCT_NO	7.00
FUNCTION	Custom Blocks and Compensators
SUBFUN_NO	2.00
SUBFUN_STA	Setup Block Cutting Machine
TASK_NO	0.00
NUMBER	0702000
TASK_STATE	(See tasks)
POSITION	Block Cutter
EQUIPMENT	Block cutting machine, simulation film, styrofoam block mold material
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Simulation film for next block to be made
CONDITIONS	Block request received
STANDARD	See tasks
INTERACT	None
COMM_SUBJ	None
COM_MODE	None
DIFFICULTY	3
TIME_REQ	1-5 min
FREQUENCY	Variable, depends on extent of use of custom blocks
LIKLI_H_E	2
LIK_UNDET	2
ERRORS_POS	Block created so that geometry is inconsistent with intended use.
EROR_COMNT	If block is created with "up/down" reversed, or with incorrect focus film distance or with simulation film incorrectly centered on cutter, the block will not properly fit the divergence of the treatment beam. The effect of the *
ERRCONS1	3B
ERRCONS2	4B
ERRCONS3	5B
ERRCONS4	
ERRCONS5	
COMMENTS1	* block will be reduced at the edges. There will be overexposure to the area intended to be blocked. If block placement on the tray is incorrect due to collimator angle, incorrect film positioning on cutter, etc. then the block may cover intended volume and allow dose to normal tissues outside the intended volume.
COMMENTS2	

FUNCT_NO	7.00
FUNCTION	Custom Blocks and Compensators
SUBFUN_NO	2.00
SUBFUN_STA	Setup Block Cutting Machine
TASK_NO	1.00
NUMBER	0702010
TASK_STATE	Place simulation film on view box portion of block cutting machine.
POSITION	Block Cutter
EQUIPMENT	Block cutting machine, simulation film
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Simulation film for next block to be made
CONDITIONS	Block maker is beginning to work at the block cutting machine.
STANDARD	Film must be placed securely and accurately in holder with centers aligned. Simulation film must be placed right side up and with the correct film*
INTERACT	None
COMM_SUBJ	None
COM_MODE	None
DIFFICULTY	3
TIME_REQ	1 min
FREQUENCY	Variable, depends on extent of use of custom blocks
LIKLI_H_E	2
LIK_UNDET	2
ERRORS_POS	Incorrect film orientation on cutter (upside down, or rotated 90 or 180 deg.) Blocks cut on incorrect up-down orientation. (see error comments below). Film placed with center incorrectly aligned to block cutter center. If the film is oriented **
EROR_COMNT	Blocks will not be cut with the required "taper" to fit the divergence of the treatment beam. The effect of the block will be reduced at the edges. There will be overexposure to the area intended to be blocked ("Geometry Problem")
ERRCONS1	3B
ERRCONS2	4B
ERRCONS3	5B
ERRCONS4	
ERRCONS5	
COMMENTS1	* orientation (Rt:Lt, patient prone:supine and correct collimator angle. Note: Blocks "hang" from or "sit" on the block tray on different machines. In facilities having machines with both orientations, the correct direction must be used when making the blocks. **incorrectly the block will be attached to the tray in an incorrect position within the field. The block may cover a portion of the intended volume and not cover the normal tissue that it was to block.
COMMENTS2	

FUNCT_NO	7.00
FUNCTION	Custom Blocks and Compensators
SUBFUN_NO	2.00
SUBFUN_STA	Setup Block Cutting Machine
TASK_NO	2.00
NUMBER	0702020
TASK STATE	Set correct TTD and TFD as indicated on block request sheet.
POSITION	Block Cutter
EQUIPMENT	Block cutting machine, block mold blank holder
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Information contained on block request sheet.
CONDITIONS	Block maker is setting up block mold to be cut at block cutting machine.
STANDARD	Geometric alignment of block cutter must match the treatment unit to be used and the FFD used for the simulation film must be set on the block cutter
INTERACT	None
COMM_SUBJ	None
COM_MODE	None
DIFFICULTY	2
TIME_REQ	1-3 min
FREQUENCY	Variable, depends on extent of use of custom blocks
LIKLI_H_E	2
LIK_UNDET	2
ERRORS_POS	TTD/TFD not set accurately.
EROR_COMNT	Incorrect TTF or TFD will result in incorrect block divergence which compromises block effectiveness at its edges. Great errors in TFD or TTD will cause the block size to be incorrect.
ERRCONS1	2B
ERRCONS2	3B
ERRCONS3	4B
ERRCONS4	5B
ERRCONS5	
COMMENTS1	TTD and TFD can also be referred to as STD (Source-Target-Distance) and SFD (Source-Film-Distance).
COMMENTS2	

FUNCT NO	7.00
FUNCTION	Custom Blocks and Compensators
SUBFUN NO	2.00
SUBFUN STA	Setup Block Cutting Machine
TASK NO	3.00
NUMBER	0702030
TASK STATE	Place block mold blank to be cut in block cutting machine.
POSITION	Block Cutter
EQUIPMENT	Block cutting machine, block mold blank
CBLT LINAC	Cobalt or Linear Accelerator
CUES	Required procedure for cutting block mold
CONDITIONS	Block maker is setting up block mold to be cut at block cutting machine.
STANDARD	Block mold must be placed securely in holder
INTERACT	None
COMM SUBJ	None
COM MODE	None
DIFFICULTY	2
TIME REQ	< 1 min
FREQUENCY	Variable, depends on extent of use of custom blocks
LIKLI H E	1
LIK UNDET	1
ERRORS_POS	Not securing block mold adequately leading to inaccurate block due to movement of mold while cutting. Using block mold of incorrect thickness (see comments below).
EROR COMNT	Errors assume block is used for treatment.
ERRCONS1	1B
ERRCONS2	2B
ERRCONS3	3B
ERRCONS4	4B
ERRCONS5	5B
COMMENTS1	Incorrect thickness of mold material for energy of machine (i.e., 4 MV machines require blocks 6-7", while 15 MV machines require blocks 9" thick. If styrofoam blank is not of proper thickness (too thin), it will cause block to be too thin also.
COMMENTS2	

FUNCT_NO	7.00
FUNCTION	Custom Blocks and Compensators
SUBFUN_NO	3.00
SUBFUN_STA	Make Block
TASK_NO	1.00
NUMBER	0703010
TASK_STATE	Trace the marked block outline on simulation film with block cutting stylus.
POSITION	Block Cutter
EQUIPMENT	Block cutting machine, stylus of block cutting "hot wire".
CBLT LINAC	Cobalt or Linear Accelerator
CUES	Required procedure for cutting block mold
CONDITIONS	Block mold blank, and simulation radiograph are in place.
STANDARD	Cutting rate must be within acceptable range to assure proper "following" of outline on film by cutter wire.
INTERACT	None
COMM_SUBJ	None
COM_MODE	None
DIFFICULTY	4
TIME_REQ	2-5 min
FREQUENCY	Variable, depends on extent of use of custom blocks
LIKLI_H_E	2
LIK_UNDET	2
ERRORS_POS	Tracing block inaccurately, cutting too fast.
EROR_COMNT	Errors assume that block will be used for treatment. Inaccurate tracing of block may result in incorrect block size or shape which may result in the block covering the intended volume or not covering normal tissue which was to be
ERRCONS1	2B
ERRCONS2	3B
ERRCONS3	4B
ERRCONS4	5B
ERRCONS5	
COMMENTS1	
COMMENTS2	

FUNCT_NO	7.00
FUNCTION	Custom Blocks and Compensators
SUBFUN_NO	3.00
SUBFUN_STA	Make Block
TASK_NO	2.00
NUMBER	0703020
TASK_STATE	Pour molten lead alloy ("cerrobend") into block mold, and allow to solidify.
POSITION	Block Cutter
EQUIPMENT	Molten lead alloy ("cerrobend") and block mold
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Block mold cut successfully
CONDITIONS	Block mold has been successfully cut.
STANDARD	Alloy must completely fill block mold with minomal bubbles. Thickness must be appropriate for treatment machine, i.e. linear accelerator or cobalt.
INTERACT	None
COMM_SUBJ	None
COM_MODE	None
DIFFICULTY	2
TIME_REQ	1-3 min
FREQUENCY	Variable, depends on extent of use of custom blocks
LIKLI_H_E	2
LIK_UNDET	3
ERRORS_POS	Allowing bubbles in alloy. Not filling block mold to the required level.
EROR_COMNT	Block will not be thick enough to block all radiation, and areas intended to by blocked will receive some radiation dose. Bubbles in allow will cause effective thickness to be less than the apparent thickness.
ERRCONS1	3B
ERRCONS2	
ERRCONS3	
ERRCONS4	
ERRCONS5	
COMMENTS1	* Block thickness for Cobalt and high energy Linear Accelerators may differ, but not necessarily. Note: There is usually a shelf with cooling tray or other specific area for hot, recently poured blocks to solidify. (Use of alloy subject to OSHA stds)
COMMENTS2	

FUNCT_NO 7.00
 FUNCTION Custom Blocks and Compensators
 SUBFUN_NO 3.00
 SUBFUN_STA Make Block
 TASK_NO 3.00
 NUMBER 0703030
 TASK_STATE Position solidified blocks on block tray, and ensure that they match the blocked portions of the simulation film.
 POSITION Block Cutter
 EQUIPMENT Blocks, block tray, block cutter positioning light, simulation film
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES Block(s) have solidified
 CONDITIONS The simulation film is accurately attached to the view box position of the cutter and the TTD and TFD are correctly set on *
 STANDARD Block should cast shadow from verification light to within 1-3 mm of blocked area on simulation film. If multiple templates exist for different **
 INTERACT None
 COMM_SUBJ None
 COM_MODE None
 DIFFICULTY 1
 TIME_REQ 2-3 min
 FREQUENCY Variable, depends on extent of use of custom blocks
 LIKLI_H_E 1
 LIK_UNDET 2
 ERRORS_POS Placing block so that blocked area does not fall on the area indicated on the sim film. Incorrectly mounting blocks so they do not match patient position in treatment beam. Center of tray not marked correctly or aligned correctly to cutter.
 EROR_COMNT Underexposure to target tissue, and overexposure to non-target tissue.
 ERRCONS1 3B
 ERRCONS2 4B
 ERRCONS3 5B
 ERRCONS4
 ERRCONS5
 COMMENTS1 * the cutter. Verification light and sim film show blocks in correct position. ** treatment machines in a facility, must ensure that the correct template is used. Note: Often, the film is removed from the cutter and the TTD and TFD are changed after the mold is cut and before the blocks are positioned on the template to allow another set of blocks to be cut while present blocks are cooling. Therefore the block cutter must again go through setting up the block cutter correctly.
 COMMENTS2

FUNCT_NO	7.00
FUNCTION	Custom Blocks and Compensators
SUBFUN_NO	3.00
SUBFUN_STA	Make Block
TASK_NO	3.01
NUMBER	0703031
TASK STATE	Mark position of block(s) on block tray.
POSITION	Block Cutter
EQUIPMENT	Block(s), block tray, marking pen
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Block(s) have been correctly positioned on the block tray.
CONDITIONS	Block tray is in correct position and blocks have been positioned correctly. Their position is outlined on the tray.
STANDARD	Block position must be marked accurately on tray.
INTERACT	None
COMM SUBJ	None
COM_MODE	None
DIFFICULTY	4
TIME REQ	1-2 min
FREQUENCY	Variable, depends on extent of use of custom blocks
LIKLI_H_E	2
LIK_UNDET	2
ERRORS_POS	Marking block position inaccurately.
EROR_COMNT	Incorrect marking results in incorrect block placement which results in underexposure to target tissue, and overexposure to non-target tissue, or negative impact on treatment schedule from having to remake block.
ERRCONS1	2B
ERRCONS2	3B
ERRCONS3	4B
ERRCONS4	5B
ERRCONS5	
COMMENTS1	
COMMENTS2	

FUNCT_NO	7.00
FUNCTION	Custom Blocks and Compensators
SUBFUN_NO	3.00
SUBFUN_STA	Make Block
TASK_NO	3.02
NUMBER	0703032
TASK_STATE	Attach block(s) to block tray.
POSITION	Block Cutter
EQUIPMENT	Block(s), block tray, drill, screws, screwdriver
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	The position of the block(s) has been marked
CONDITIONS	Blocks have been placed in correct position on tray along lines marked.
STANDARD	Block should be in correct position on tray after attachment
INTERACT	None
COMM_SUBJ	None
COM_MODE	None
DIFFICULTY	4
TIME_REQ	5-10 min
FREQUENCY	Variable, depends on extent of use of custom blocks
LIKLI_H_E	2
LIK_UNDET	1
ERRORS_POS	Attaching block in incorrect position. Not attaching block securely.
EROR_COMNT	Incorrect block placement may result in underexposure to target tissue, and overexposure to non-target tissue. Block not securely attached could fall off and injure or kill a patient.
ERRCONS1	2B
ERRCONS2	3B
ERRCONS3	4B
ERRCONS4	5B
ERRCONS5	7A
COMMENTS1	
COMMENTS2	

FUNCT_NO 7.00
FUNCTION Custom Blocks and Compensators
SUBFUN_NO 3.00
SUBFUN_STA Make Block
TASK_NO 3.03
NUMBER 0703033
TASK_STATE Recheck block position against simulation film.
POSITION Block Cutter
EQUIPMENT Blocks attached to block tray, block cutting machine projection
light, simulator film
CBLT_LINAC Cobalt or Linear Accelerator
CUES Block successfully attached
CONDITIONS New block(s) are attached to block tray, tray is correctly
positioned on cutter. TTD and TFD are correctly set.
STANDARD Shadow of blocks case by verification light falls on sim film to
within 1-3 mm of the area marked by the oncologist. Correct
patient name is used.
INTERACT None
COMM_SUBJ None
COM_MODE None
DIFFICULTY 1
TIME_REQ 1 min
FREQUENCY Variable, depends on extent of use of custom blocks
LIKLI_H_E 2
LIK_UNDET 4
ERRORS_POS Not checking block position against simulation film after
attaching block.
ERROR_COMNT This is a quality assurance step to help insure that the blocks
have been attached to the tray correctly. Omission of this step
will not cause errors, but will allow errors to continue.
ERRCONS1 3B
ERRCONS2 4B
ERRCONS3 5B
ERRCONS4
ERRCONS5
COMMENTS1
COMMENTS2

FUNCT_NO	7.00
FUNCTION	Custom Blocks and Compensators
SUBFUN_NO	3.00
SUBFUN_STA	Make Block
TASK_NO	4.00
NUMBER	0703040
TASK_STATE	Label block tray with patient's name, and block orientation information.
POSITION	Block Cutter
EQUIPMENT	Blocks attached to block tray
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Block successfully attached
CONDITIONS	May be performed before or after blocks are attached to block tray.
STANDARD	Correct patient name is used. Correct field name label for the blocks, i.e. anterior, posterior, left, right.
INTERACT	None
COMM_SUBJ	None
COM_MODE	None
DIFFICULTY	1
TIME_REQ	1 min
FREQUENCY	Variable, depends on extent of use of custom blocks
LIKLI_H E	1
LIK_UNDET	1
ERRORS_POS	Placing incorrect patient name on block tray. Writing name illegibly. Incorrect field name labeled on tray.
EROR_COMNT	Incorrect name or field label will result in possible misuse of block tray. If tray is used for incorrect patient or for incorrect field, the blocks will not cover the intended area. This error may be caught by treatment tech. if
ERRCONS1	1B
ERRCONS2	2B
ERRCONS3	3B
ERRCONS4	4B
ERRCONS5	5B
COMMENTS1	if the blocking is significantly different than that drawn on the setup diagram or if the simulator films are available for comparison.
COMMENTS2	There are a variety of ways that block trays are labeled. These include magic marker on masking tape to grease pencil marks.

FUNCT_NO 7.00
FUNCTION Custom Blocks and Compensators
SUBFUN_NO 4.00
SUBFUN_STA Create "Ellis" Compensator
TASK_NO 1.00
NUMBER 0704010
TASK_STATE Receive perscription including specification for compensator.
POSITION Technologist/Dosimetrist
EQUIPMENT Perscription
CBLT_LINAC Cobalt or Linear Accelerator
CUES Compensator specified in prescription
CONDITIONS Measurements for compensator are taken on the treatment machine
STANDARD Proceed with development of compensator when specified.
INTERACT None
COMM_SUBJ None
COM_MODE None
DIFFICULTY 1
TIME_REQ 1 min
FREQUENCY Varies, usually a small percentage of patients
LIKLI_H_E 1
LIK_UNDET 2
ERRORS_POS Not proceeding with the development of compensator when this is requested.
ERROR_COMNT
ERRCONS1 5B
ERRCONS2
ERRCONS3
ERRCONS4
ERRCONS5
COMMENTS1
COMMENTS2

FUNCT_NO 7.00
 FUNCTION Custom Blocks and Compensators
 SUBFUN_NO 4.00
 SUBFUN_STA Create "Ellis" Compensator
 TASK_NO 2.00
 NUMBER 0704020
 TASK_STATE Take measurements required to make compensator.
 POSITION Technologist/Dosimetrist
 EQUIPMENT Compensation filter measurement device
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES Compensator specified in prescription
 CONDITIONS Patient is on treatment table in treatment position.
 STANDARD Rods must be pulled completely to the surface of the patient and not moved after this has been done.
 INTERACT Patient
 COMM_SUBJ Importance of holding position. Explanation of process.
 COM_MODE Verbal
 DIFFICULTY 2
 TIME_REQ 5 min
 FREQUENCY All patients for which compensator will be used
 LIKLI_H_E 1
 LIK_UNDET 4
 ERRORS_POS Not using compensation device correctly to reproduce variations in distance from treatment beam of treatment area.
 EROR_COMNT Not ensuring that patient is in exact position for treatment, from not pulling compensator rods accurately to the surface of the patient, or from changing the rod position after measurement before recording compensator data.
 ERRCONS1 5B
 ERRCONS2
 ERRCONS3
 ERRCONS4
 ERRCONS5
 COMMENTS1 The measurements are taken by sliding the compensation filter measurement device at in the tray that will hold the compensator on the treatment head of the treatment machine, then pulling each of the rods down to the surface of the patient. When this
 COMMENTS2 is completed, the measurements of the rod position are transcribed to a data sheet (see later tasks).

FUNCT_NO 7.00
 FUNCTION Custom Blocks and Compensators
 SUBFUN_NO 4.00
 SUBFUN_STA Create "Ellis" Compensator
 TASK_NO 3.00
 NUMBER 0704030
 TASK_STATE Measure measurement device rod position and transcribe to data sheet.
 POSITION Technologist/Dosimetrist
 EQUIPMENT Compensation filter data recording device, data sheet
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES Rod positioning of measurement device has been completed and device has been removed.
 CONDITIONS Measurement device has been removed from treatment machine, inverted and placed on a flat surface with support on edges only.
 STANDARD Rod position must be accurately measured and transcribed to data collection sheet (see comments).
 INTERACT None
 COMM_SUBJ None
 COM_MODE None
 DIFFICULTY 4
 TIME_REQ 1-8 min
 FREQUENCY All patients for which compensator will be used
 LIKLI_H_E 3
 LIK_UNDET 4
 ERRORS_POS Not measuring rod position correctly, Not transcribing rod position data accurately to data sheet.
 EROR_COMNT The rod position is measured with respect to the shortest rod. This is done by placing a piece of cardboard with a piece of graph paper held by paper clips behind the row of rods which include the shortest rod, and sliding the *
 ERRCONS1 5B
 ERRCONS2
 ERRCONS3
 ERRCONS4
 ERRCONS5
 COMMENTS1 * graph paper down to the level of the shortest rod. The position of the other rods are then measured from this level, i.e. the position of the shortest rod would be 0. Because the measurement device is now inverted, the data recording must be done in a reversed direction from left to right on the data recording sheet. This is somewhat confusing. In addition, care must be taken so that the position of the rods does not change after the measurement device is removed from the treatment machine.
 COMMENTS2

FUNCT_NO 7.00
FUNCTION Custom Blocks and Compensators
SUBFUN_NO 4.00
SUBFUN_STA Create "Ellis" Compensator
TASK_NO 4.00
NUMBER 0704040
TASK_STATE Attach data recording sheet to compensator tray.
POSITION Technologist/Dosimetrist
EQUIPMENT Compensation filter data recording device, compensator tray (a clear sheet of plastic)
CBLT_LINAC Cobalt or Linear Accelerator
CUES Measurements transcribed to data collection sheet
CONDITIONS Measurements have been transcribed to data collection sheet.
STANDARD Date collection sheet must be attached accurately to correspond exactly to treatment beam position.
INTERACT None
COMM_SUBJ None
COM_MODE None
DIFFICULTY 2
TIME_REQ 1 min
FREQUENCY All patients for which compensator will be used
LIKLI_H_E 2
LIK_UNDET 2
ERRORS_POS Not attaching data sheet accurately.
EROR_COMNT
ERRCONS1 5B
ERRCONS2
ERRCONS3
ERRCONS4
ERRCONS5
COMMENTS1
COMMENTS2

FUNCT_NO 7.00
FUNCTION Custom Blocks and Compensators
SUBFUN_NO 4.00
SUBFUN_STA Create "Ellis" Compensator
TASK_NO 5.00
NUMBER 0704050
TASK_STATE Place metal cubes on compensator tray and secure.
POSITION Technologist/Dosimetrist
EQUIPMENT Compensator tray with fixed data sheet
CBLT_LINAC Cobalt or Linear Accelerator
CUES Data recording sheet accurately affixed to compensator tray.
CONDITIONS Data recording sheet has been accurately affixed to compensatory tray.
STANDARD Cubes must be placed on compensator tray in correct position and in correct quantity for material used, i.e. aluminum counts .5 value of brass.
INTERACT None
COMM_SUBJ None
COM_MODE None
DIFFICULTY 2
TIME_REQ 5-15 min
FREQUENCY All patients for which compensator will be used
LIKLI_H_E 2
LIK_UNDET 4
ERRORS_POS Not using correct thickness of metal blocks. Getting relative thickness requirements for blocks and thier position mixed up. Not securing blocks in position adequately.
EROR_COMNT Double sided tape is typically used to hold cubes to tray. If the tape isn't holding well, tap may be placed over the tops of the cubes also.
ERRCONS1 5B
ERRCONS2
ERRCONS3
ERRCONS4
ERRCONS5
COMMENTS1
COMMENTS2

FUNCT_NO 8.00
FUNCTION Treatment Setup
SUBFUN_NO 1.00
SUBFUN_STA Verify Patient Identity and Critical Treatment
Parameters
TASK_NO 1.00
NUMBER 0801010
TASK_STATE Ensure that setup information and dose specified in treatment
plan is not grossly inappropriate for prescription.
POSITION Technologist (therapist)
EQUIPMENT Patient chart with completed perscription, (some may use hand
calculator, however visual inspection is typical)
CBLT_LINAC Cobalt or Linear Accelerator
CUES Prior to each treatment to ensure that treatment is correct.
CONDITIONS Prior to starting beam, typically before bringing patient into
room.
STANDARD All treatment parameters and setup information must be checked
INTERACT None
COMM_SUBJ None
COM_MODE None
DIFFICULTY 2
TIME_REQ 1 min
FREQUENCY 1 time per field treated
LIKLI_H_E 2
LIK_UNDET 2
ERRORS_POS Not finding erroneous portions of treatment plan before
treatment.
EROR_COMNT Inappropriate anatomy will be treated or inappropriate dose will
be applied to target area.
ERRCONS1 1B
ERRCONS2 2B
ERRCONS3 3B
ERRCONS4 4B
ERRCONS5 5B
COMMENTS1 This is most important on the first treatment. Not all facilities
require the technologist to do this.
COMMENTS2

FUNCT_NO	8.00
FUNCTION	Treatment Setup
SUBFUN_NO	1.00
SUBFUN_STA	Verify Patient Identity and Critical Treatment Parameters
TASK_NO	2.00
NUMBER	0801020
TASK_STATE	Ensure patient identity consistent with patient named in treatment plan.
POSITION	Technologist (therapist)
EQUIPMENT	Depends on facility, may be picture in chart, social security number, questioning patient, or patient ID (wristband).
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Prior to each patient treatment to ensure treatment is correct.
CONDITIONS	Patient present just prior to treatment
STANDARD	Must ensure that correct patient is being treated
INTERACT	Patient
COMM_SUBJ	Ask patient's name
COM_MODE	Verbal, visual inspection of photo taken at time of simulation
DIFFICULTY	1
TIME_REQ	30 sec - 1 min
FREQUENCY	All patients
LIKLI_H_E	1
LIK_UNDET	1
ERRORS_POS	Treating a patient with a treatment plan from another patient.
EROR_COMNT	Incorrect anatomy, and/or improper treatment of anatomy of interest may occur.
ERRCONS1	1A
ERRCONS2	2A
ERRCONS3	3A
ERRCONS4	4A
ERRCONS5	5A
COMMENTS1	The patient identification process will inevitably become a matter of visual recognition as the course of treatment continues with the same technologist. Note that identification is most critical before the first treatment.
COMMENTS2	

FUNCT_NO	8.00
FUNCTION	Treatment Setup
SUBFUN_NO	2.00
SUBFUN_STA	Patient Setup
TASK_NO	0.00
NUMBER	0802000
TASK_STATE	See Tasks
POSITION	Technologist (therapist)
EQUIPMENT	Treatment unit controls and displays, patient chart and immobilization devices.
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Treatment specifications from treatment chart.
CONDITIONS	Patient present at beginning of treatment
STANDARD	Performed as accurately and efficiently as possible.
INTERACT	Patient and other technologist or aide as available
COMM_SUBJ	Direct patient on how to move & hold position. Technologists or other treatment team members will discuss setup instructions from treatment chart, (i.e. positioning and immobilization devices)
COM_MODE	Verbal
DIFFICULTY	3
TIME_REQ	5-7 min
FREQUENCY	1 to 2 times per patient
LIKLI_H_E	n
LIK_UNDET	n
ERRORS_POS	Treatment field set up incorrectly.
EROR_COMNT	Treatment will be inaccurate, i.e. underexposure to target area, and overexposure to non-target area.
ERRCONS1	1A
ERRCONS2	2A
ERRCONS3	3A
ERRCONS4	4A
ERRCONS5	5A
COMMENTS1	Patient setup and treatment machine setup are presented as separate subfunctions, but are performed simulataneously in practice.
COMMENTS2	

FUNCT_NO	8.00
FUNCTION	Treatment Setup
SUBFUN_NO	2.00
SUBFUN_STA	Patient Setup
TASK_NO	1.00
NUMBER	0802010
TASK_STATE	Assist patient into treatment room.
POSITION	Technologist or Aide
EQUIPMENT	Wheel chairs, gurney, associated medical support equipment as required.
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Treatment schedule
CONDITIONS	Patient has been properly identified.
STANDARD	Technologist must monitor accessory medical equipment attached to patient, (e.g., IVs, oxygen masks, catheters). Must also evaluate whether patient*
INTERACT	Patient and other technologist or aide as available
COMM_SUBJ	Introduce patient to technical staff and walk them into the treatment room, provide instructions for getting onto table as necessary.
COM_MODE	Verbal
DIFFICULTY	3
TIME_REQ	30 sec - 2 min
FREQUENCY	1 time per patient treatment
LIKLI_H_E	1
LIK_UNDET	1
ERRORS_POS	Improper attention provided to patient's associated medical equipment. Treating patient when medical condition is serious.
EROR_COMNT	Injury to patient, or threat to life.
ERRCONS1	7A
ERRCONS2	
ERRCONS3	
ERRCONS4	
ERRCONS5	
COMMENTS1	* should receive treatment or be seen by an M.D. Note: these are non-radiation related errors.
COMMENTS2	

FUNCT_NO	8.00
FUNCTION	Treatment Setup
SUBFUN_NO	2.00
SUBFUN_STA	Patient Setup
TASK_NO	2.00
NUMBER	0802020
TASK STATE	Explain treatment proccess to patient.
POSITION	Technologist (therapist)
EQUIPMENT	None
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Important on first day, or as needed to make patient as comfortable as possible.
CONDITIONS	Patient is present in treatment room.
STANDARD	Patient must be aware of the treatment process and the importance of holding position, and that the technologists can see and hear them from outside.
INTERACT	Patient
COMM SUBJ	What to expect during treatment.
COM MODE	Verbal
DIFFICULTY	1
TIME REQ	1 - 2 min
FREQUENCY	Typically one time at the start of treatment or as needed
LIKLI H E	1
LIK UNDET	1
ERRORS_POS	Not conveying the importance of holding still during treatment, or putting the patient at ease in the treatment setting.
EROR_COMNT	Small deviations in treatment accuracy if patient moves while beam is active.
ERRCONS1	3A
ERRCONS2	4A
ERRCONS3	5A
ERRCONS4	
ERRCONS5	
COMMENTS1	It is widely suspected within the profession (teletherapy) that the patients position may shift significantly due to the amount of tension a patient experiences between treatments or between simulation and treatment.
COMMENTS2	

FUNCT_NO 8.00
FUNCTION Treatment Setup
SUBFUN_NO 2.00
SUBFUN_STA Patient Setup
TASK_NO 3.00
NUMBER 0802030
TASK_STATE Assist patient onto treatment table.
POSITION Technologist (therapist)
EQUIPMENT Treatment table controls, foot stool.
CBLT_LINAC Cobalt or Linear Accelerator
CUES Treatment schedule
CONDITIONS Patient present in treatment room
STANDARD Performed as efficiently as possible with respect for the patient's comfort and safety.
INTERACT Patient and other technologist or aide as available
COMM_SUBJ Instructions to patient for getting on table. Instructions to other technologist (if present) for helping patient.
COM_MODE Verbal
DIFFICULTY 2
TIME_REQ 30 sec - 2 min
FREQUENCY 1 time per patient treatment
LIKLI_H_E 2
LIK_UNDET 1
ERRORS_POS Injuring the patient or technologist during the transfer to the treatment table.
EROR_COMNT Patient or technologist injury unrelated to radiation treatment (i.e. falling off of treatment table).
ERRCONS1 7A
ERRCONS2
ERRCONS3
ERRCONS4
ERRCONS5
COMMENTS1 Likelihood of patient or technologist injury is directly affected by the availability of additional personnel to assist with this task and the time pressures of the immediate work environment.
COMMENTS2

FUNCT_NO	8.00
FUNCTION	Treatment Setup
SUBFUN_NO	2.00
SUBFUN_STA	Patient Setup
TASK_NO	4.00
NUMBER	0802040
TASK_STATE	Move patient into correct anatomical (i.e. supine, prone) position prior to setup of treatment field.
POSITION	Technologist (therapist)
EQUIPMENT	Patient support and immobilization devices. Treatment table position controls, setup instructions in treatment chart.
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Patient on treatment table. Patient chart (setup instructions) describes treatment position.
CONDITIONS	Patient on treatment table prior to complete setup.
STANDARD	Performed accurately with respect for the patient's comfort and safety.
INTERACT	Patient and other technologist or aide as available
COMM_SUBJ	Instructions to patient on how to lie on treatment table.
COM_MODE	Verbal
DIFFICULTY	2
TIME_REQ	1-2 min
FREQUENCY	1-2 times per treatment
LIKLI_H_E	2
LIK_UNDET	1
ERRORS_POS	Patient placed in incorrect position. Patient support devices positioned incorrectly.
EROR_COMNT	Final treatment setup will be more time consuming, and final accuracy achieved will be decreased. Patient could move during treatment due to improper placement of supports.
ERRCONS1	1A
ERRCONS2	2A
ERRCONS3	3A
ERRCONS4	4A
ERRCONS5	5A
COMMENTS1	Severity depends on how much impact support equipment has on desired position.
COMMENTS2	

FUNCT_NO 8.00
 FUNCTION Treatment Setup
 SUBFUN_NO 2.00
 SUBFUN_STA Patient Setup
 TASK_NO 5.00
 NUMBER 0802050
 TASK_STATE Secure Patient in Treatment Position.
 POSITION Technologist (therapist)
 EQUIPMENT Immobilization devices: chin straps, arm and hand supports, "aqua
 plast", cast material, safety straps, side rails on table, even
 tape.
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES Treatment chart setup instructions
 CONDITIONS Patient in correct anatomical position
 STANDARD Patient is secured in correct position for setup
 INTERACT Patient and other technologist or aide as available
 COMM_SUBJ Request patient to hold position.
 COM_MODE Verbal
 DIFFICULTY 3
 TIME_REQ 3-5 min
 FREQUENCY 1 to 2 times per patient
 LIKLI_H_E 3
 LIK_UNDET 3
 ERRORS_POS Failure to use or improper use of immobilization devices will
 allow patient to move during treatment. SMEs suggest that all
 patients should be restrained at least by safety straps to keep
 them from falling off of the treatment table.
 EROR_COMNT Patient may move during treatment causing underexposure to target
 area, and overexposure to non-target area. Setup time may be
 increased causing delay in daily schedule. Patient may fall off
 of treatment table.
 ERRCONS1 3A
 ERRCONS2 4A
 ERRCONS3 5A
 ERRCONS4 7A
 ERRCONS5
 COMMENTS1 Restraining devices are used for situations in which the patient
 is likely to move during treatment. The treatment position may be
 difficult to hold due to recent surgery, etc. or the patient may
 be young, old, mentally unstable, etc.
 COMMENTS2

FUNCT_NO	8.00
FUNCTION	Treatment Setup
SUBFUN_NO	2.00
SUBFUN_STA	Patient Setup
TASK_NO	6.00
NUMBER	0802060
TASK_STATE	Apply bolus material to patient's body.
POSITION	Technologist (therapist)
EQUIPMENT	Bolus material, usually a gelatin and glycerine mix, or a similar material. May be enclosed in plastic bag, or applied directly to patient's skin.
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Treatment plan requires bolus, prescription notes bolus, and setup diagram describes bolus position.
CONDITIONS	Patient on treatment table ready for treatment with the exception of bolus
STANDARD	Bolus must be applied consistently and as specified.
INTERACT	Other technologist as available
COMM_SUBJ	Location of bolus material.
COM_MODE	Verbal
DIFFICULTY	2
TIME_REQ	1-2 minutes
FREQUENCY	Approximately 5% of cases use tissue bolus.
LIKLI_H_E	2
LIK_UNDET	4
ERRORS_POS	Forgetting to use bolus or applying bolus incorrectly, or incorrect thickness of bolus used.
EROR_COMNT	Underexposure to skin in target volume.
ERRCONS1	1A
ERRCONS2	2A
ERRCONS3	3A
ERRCONS4	5A
ERRCONS5	
COMMENTS1	Bolus material is used to boost the radiation dose to the skin in situations in which the skin is involved in the disease being treated.
COMMENTS2	

FUNCT_NO 8.00
FUNCTION Treatment Setup
SUBFUN_NO 2.00
SUBFUN_STA Patient Setup
TASK_NO 7.00
NUMBER 0802070
TASK_STATE Position TV monitor so that visual contact is made with patient as required.
POSITION Technologist (therapist)
EQUIPMENT TV monitor camera or camera position controls
CBLT_LINAC Cobalt or Linear Accelerator
CUES Patient has been set up in treatment room. Required for quality assurance and patient safety.
CONDITIONS Patient in treatment room in position on treatment table.
STANDARD TV camera must be able to monitor patient continuously throughout treatment.
INTERACT Other technologist as available
COMM_SUBJ Adequacy of TV camera position
COM_MODE Verbal
DIFFICULTY 1
TIME_REQ 1-2 min
FREQUENCY 1 time per patient
LIKLI_H_E 1
LIK_UNDET 1
ERRORS_POS Not positioning TV camera so that patient may be observed.
ERROR_COMNT Patient may move during treatment causing underexposure to target area, and overexposure to non-target area. Patient could also have medical problems that would not be noticed visually resulting in the endangerment of wellbeing.
ERRCONS1 3A
ERRCONS2 4A
ERRCONS3 5A
ERRCONS4 7A
ERRCONS5
COMMENTS1
COMMENTS2

FUNCT_NO	8.00
FUNCTION	Treatment Setup
SUBFUN_NO	2.00
SUBFUN_STA	Patient Setup
TASK_NO	8.00
NUMBER	0802080
TASK_STATE	Assist technologist with difficult patient and treatment machine setups.
POSITION	Dosimetrist, Physicist, Supervisor
EQUIPMENT	Treatment unit controls and displays in treatment room.
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Technologist advises dosimetrist of difficult setup, or dosimetrist aware of complex case from T.P.
CONDITIONS	Patient in treatment room. May be in treatment position, or dosimetrist may assist technologist with getting patient on table
STANDARD	Patient must be setup accurately according to instructions in patient chart.
INTERACT	Tchnologist
COMM_SUBJ	How to set up patient and treatment equipment for accurate treatment.
COM_MODE	Verbal
DIFFICULTY	3
TIME_REQ	5-10 min
FREQUENCY	1 time per patient with difficult setup
LIKLI_H_E	2
LIK_UNDET	3
ERRORS_POS	Not setting up patient or treatment equipment accurately.
EROR_COMNT	
ERRCONS1	1A
ERRCONS2	2A
ERRCONS3	3A
ERRCONS4	4A
ERRCONS5	5A
COMMENTS1	
COMMENTS2	

FUNCT_NO	8.00
FUNCTION	Treatment Setup
SUBFUN_NO	3.00
SUBFUN_STA	Treatment Machine Setup
TASK_NO	1.00
NUMBER	0803010
TASK_STATE	(Site Specific) Program computer controlled linear accelerator control system prior to course of treatment.
POSITION	Technologist or Dosimetrist
EQUIPMENT	Computer console and system control software
CBLT_LINAC	Linear Accelerator only
CUES	Quality control sheet
CONDITIONS	
STANDARD	Treatment parameters must be accurate as per dose calculations and simulation, as affected by facility procedures and manufacturer's recommendations.
INTERACT	None
COMM_SUBJ	None
COM_MODE	None
DIFFICULTY	3
TIME_REQ	2-3 min per field
FREQUENCY	One time per simulation/course of treatment
LIKLI_H_E	3
LIK_UNDET	2
ERRORS_POS	Entry of incorrect dose or treatment parameters.
EROR_COMNT	Over- or underexposure of treatment area. Treatment of incorrect treatment area.
ERRCONS1	1B
ERRCONS2	2B
ERRCONS3	3B
ERRCONS4	4B
ERRCONS5	5B
COMMENTS1	This task is only performed for computer controlled linear accelerator equipment. Note: this technology only just beginning to be developed, however it may be more representative of the industry in the near future.
COMMENTS2	

FUNCT_NO	8.00
FUNCTION	Treatment Setup
SUBFUN_NO	3.00
SUBFUN_STA	Treatment Machine Setup
TASK_NO	2.00
NUMBER	0803020
TASK_STATE	Rotate gantry to correct angle for treatment.
POSITION	Technologist (therapist)
EQUIPMENT	Gantry rotation controls, (may use computer terminal in treatment room if so equipped)
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Treatment plan (setup diagram or display monitor in treatment room)
CONDITIONS	Patient in treatment position on treatment table.
STANDARD	Gantry angle as specified in treatment plan within 1 deg.
INTERACT	Other technologist as available
COMM_SUBJ	Gantry position
COM_MODE	Verbal
DIFFICULTY	2
TIME_REQ	1 min per field
FREQUENCY	1-4 times per patient
LIKLI_H_E	2
LIK_UNDET	*
ERRORS_POS	Incorrect gantry angle used.
EROR_COMNT	Underexposure of target area, overexposure of non-target area.
ERRCONS1	2A
ERRCONS2	3A
ERRCONS3	4A
ERRCONS4	5A
ERRCONS5	
COMMENTS1	
COMMENTS2	

FUNCT_NO	8.00
FUNCTION	Treatment Setup
SUBFUN_NO	3.00
SUBFUN_STA	Treatment Machine Setup
TASK_NO	3.00
NUMBER	0803030
TASK_STATE	Adjust collimator size to prescribed size.
POSITION	Technologist (therapist)
EQUIPMENT	Collimator controls, patient chart setup instructions.
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Required by treatment plan setup instructions.
CONDITIONS	May be set before or after patient is on treatment table.
STANDARD	Field size conforms to treatment field to within 1-3 mm.
INTERACT	Patient and other technologist or aide as available
COMM_SUBJ	Technologist may request patient to hold position. May discuss field position details with other technologist or aide.
COM_MODE	Verbal
DIFFICULTY	3
TIME_REQ	1 min per field
FREQUENCY	1 time per field treated
LIKLI_H_E	2
LIK_UNDET	*
ERRORS_POS	Inaccurate field size set.
EROR_COMNT	Treatment of unacceptable margin of healthy tissue, and/or underexposure to target area.
ERRCONS1	3A
ERRCONS2	4A
ERRCONS3	5A
ERRCONS4	
ERRCONS5	
COMMENTS1	The accuracy of the performance of this function is reportedly susceptible to the time pressure exerted on the technologist. Technologist should always set correct field size regardless of time constraints.
COMMENTS2	

FUNCT_NO 8.00
 FUNCTION Treatment Setup
 SUBFUN_NO 3.00
 SUBFUN_STA Treatment Machine Setup
 TASK_NO 4.00
 NUMBER 0803040
 TASK_STATE Readjust field light (via collimator) to field borders and/or permanent marks on patient's skin as prescribed before treatment.
 POSITION Technologist (therapist)
 EQUIPMENT Collimator controls, patient chart setup instructions, field borders and/or permanent marks on patients skin. Treatment field photographs.
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES Treatment field light not yet adjusted specifically to treatment field marks.
 CONDITIONS Patient in on treatment table, in correct treatment position.
 STANDARD Field size conforms to treatment field to within 1-3 mm.
 INTERACT Patient and other technologist or aide as available
 COMM_SUBJ Technologist may request patient to hold position. May discuss field position details with other technologist or aide.
 COM MODE Verbal
 DIFFICULTY 3
 TIME_REQ 3-5 min per field
 FREQUENCY 1 time per field treated
 LIKLI_H_E 2
 LIK_UNDET 3
 ERRORS_POS Inaccurate positioning of field light on target area.
 ERROR_COMNT Treatment of unacceptable margin of healthy tissue, and/or underexposure to target area.
 ERRCONS1 3A
 ERRCONS2 4A
 ERRCONS3 5A
 ERRCONS4
 ERRCONS5
 COMMENTS1 The accuracy of the performance of this functions is reportedly susceptible to the time pressure exerted on the technologist. Technologist should always take time to position field correctly regardless of patient scheduling.
 COMMENTS2 Note: if this particular treatment did not require a port verification film (typically done 1X per week or so), and the field light was not lined up accurately, it is likely that nobody would know that the error occurred.

FUNCT_NO 8.00
 FUNCTION Treatment Setup
 SUBFUN_NO 3.00
 SUBFUN_STA Treatment Machine Setup
 TASK_NO 5.00
 NUMBER 0803050
 TASK_STATE Position patient for proper SSD.
 POSITION Technologist (therapist)
 EQUIPMENT Optical distance indicator (range finder light), treatment table controls, setup instructions in patient's chart.
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES Treatment plan (hardcopy or display monitor in treatment room) and setup instructions
 CONDITIONS Patient in treatment position on treatment table, gantry rotated to treatment position.
 STANDARD SSD is accurate as per treatment chart specification
 INTERACT None
 COMM_SUBJ None
 COM_MODE None
 DIFFICULTY 2
 TIME_REQ 1 min.
 FREQUENCY 1-2 times per patient
 LIKLI_H_E 4
 LIK_UNDET 4
 ERRORS_POS Improper SSD used.
 ERROR_COMNT Increase or decrease in treatment beam intensity causing over or underexposure respectively.
 ERRCONS1 1A
 ERRCONS2 2A
 ERRCONS3
 ERRCONS4
 ERRCONS5
 COMMENTS1 Performed concurrent with previous task. Note: SSD for linear accelerators is typically 100 cm while it is 80 cm for cobalt. There is a new cobalt unit being built by Theratronics that has a 100 cm SSD.
 COMMENTS2

FUNCT_NO	8.00
FUNCTION	Treatment Setup
SUBFUN_NO	3.00
SUBFUN_STA	Treatment Machine Setup
TASK_NO	6.00
NUMBER	0803060
TASK_STATE	Position standard (non-custom) blocks on block template.
POSITION	Technologist (therapist)
EQUIPMENT	Standard blocks, block template, treatment field position light
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Treatment plan (or display monitor in treatment room) treatment set-up sheet and block position diagram
CONDITIONS	Patient in on treatment table ready for treatment.
STANDARD	Field position light as modified by standard blocks should conform to treatment field marked on patients body within 1-3 mm.
INTERACT	Other technologist as available
COMM_SUBJ	Block placement
COM_MODE	Verbal
DIFFICULTY	3
TIME_REQ	30-60 sec/field
FREQUENCY	Varies with facility, between 5-85% of cases use standard blocks
LIKLI_H_E	3
LIK_UNDET	2
ERRORS_POS	Improper positioning of blocks. Blocks neglected. Block dropped on technologist or patient.
EROR_COMNT	Underexposure of target area, overexposure of non-target area. Injury from dropped block.
ERRCONS1	3A
ERRCONS2	4A
ERRCONS3	5A
ERRCONS4	7A
ERRCONS5	
COMMENTS1	The degree to which a facility uses standard blocks varies greatly. This mainly due to whether or not the facility has a custom block cutter, as well as standard practice of the department.
COMMENTS2	

FUNCT_NO	8.00
FUNCTION	Treatment Setup
SUBFUN_NO	3.00
SUBFUN_STA	Treatment Machine Setup
TASK_NO	7.00
NUMBER	0803070
TASK_STATE	Attach custom block assembly to treatment head.
POSITION	Technologist (therapist)
EQUIPMENT	Custom block, treatment machine block holder
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Treatment plan requires custom blocks. Setup sheet showing block position.
CONDITIONS	Patient on treatment table ready for treatment
STANDARD	Block should be inserted completely and securely. If it is possible to insert the block in more than one direction, must ensure block is not inverted.
INTERACT	None
COMM_SUBJ	None
COM_MODE	None
DIFFICULTY	1
TIME_REQ	30 sec
FREQUENCY	Varies with facility, range of 15% to 95% for use of custom block
LIKLI_H_E	2
LIK_UNDET	3
ERRORS_POS	Placing block in block holder in inverted position. Forgetting to use block, or using an incorrect block. Dropping block on patient or technologist.
EROR_COMNT	Treatment of improper anatomy, and/or underexposure of target area or portions of target area. Injury to patient or technologist from dropped block.
ERRCONS1	3A
ERRCONS2	4A
ERRCONS3	5A
ERRCONS4	7A
ERRCONS5	
COMMENTS1	The degree to which a facility uses custom blocks varies greatly. This mainly due to whether or not the facility has a custom block cutter, as well as standard practice of the department.
COMMENTS2	

FUNCT_NO	8.00
FUNCTION	Treatment Setup
SUBFUN_NO	3.00
SUBFUN_STA	Treatment Machine Setup
TASK_NO	8.00
NUMBER	0803080
TASK_STATE	Attach wedge to wedge holder in treatment head.
POSITION	Technologist (therapist)
EQUIPMENT	Standard wedge, head of treatment machine.
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Treatment plan requires wedge. Setup diagram should show wedge orientation to the beam.
CONDITIONS	Patient in on treatment table ready for treatment
STANDARD	Correct wedge inserted completely and securely. If it is possible to insert the wedge in more than one direction, must ensure wedge is not inverted.
INTERACT	None
COMM_SUBJ	None
COM_MODE	None
DIFFICULTY	2
TIME_REQ	30 sec
FREQUENCY	Approximately 30% of treatments involve wedges
LIKLI_H_E	1
LIK_UNDET	3
ERRORS_POS	Placing wedge in wedge holder in inverted position. Forgetting to use wedge, or using an incorrect wedge.
EROR_COMNT	Treatment of improper anatomy, and/or underexposure or overexposure of target area or portions of target area.
ERRCONS1	1A
ERRCONS2	2A
ERRCONS3	3A
ERRCONS4	4A
ERRCONS5	5A
COMMENTS1	Omitting wedge produces a large overdose to entire portal. Incorrect wedge may either increase or decrease dose. Improper orientation of wedge will cause dose to be greater than desired in part of the field, and less than desired in other part.
COMMENTS2	

FUNCT_NO 8.00
 FUNCTION Treatment Setup
 SUBFUN_NO 3.00
 SUBFUN_STA Treatment Machine Setup
 TASK_NO 9.00
 NUMBER 0803090
 TASK_STATE Position tissue compensator in treatment beam.
 POSITION Technologist (therapist)
 EQUIPMENT Tissue compensation substances (e.g. cubes of aluminum, or brass, wax, or commercially available gel material.)
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES Treatment plan requires tissue compensators. Patient setup diagram should indicate compensator use.
 CONDITIONS Patient on treatment table.
 STANDARD Compensators must be placed accurately and appropriately.
 INTERACT Other technologist as available
 COMM_SUBJ Location of tissue compensator.
 COM_MODE Verbal
 DIFFICULTY 2
 TIME_REQ 2-3 min
 FREQUENCY Approximately 5-10% of cases use tissue compensators
 LIKLI_H_E 2
 LIK_UNDET 3
 ERRORS_POS Forgetting to use tissue compensators. Applying tissue compensator incorrectly or in incorrect position.
 EROR_COMNT Under- or overexposure of target area or portions of target area.
 ERRCONS1 1A
 ERRCONS2 2A
 ERRCONS3 3A
 ERRCONS4 5A
 ERRCONS5
 COMMENTS1
 COMMENTS2

FUNCT_NO	8.00
FUNCTION	Treatment Setup
SUBFUN_NO	3.00
SUBFUN_STA	Treatment Machine Setup
TASK_NO	10.00
NUMBER	0803100
TASK_STATE	Attach electron cone to treatment machine head.
POSITION	Technologist (therapist)
EQUIPMENT	Electron cone, treatment machine treatment head.
CBLT_LINAC	Linear Accelerator only
CUES	Treatment plan (hardcopy or display monitor in treatment room) requires electron beam treatment.
CONDITIONS	Could be before patient is on treatment table or after.
STANDARD	Correct electron cone is attached and secured.
INTERACT	Other technologist as available
COMM_SUBJ	Selection of the correct electron cone.
COM_MODE	Verbal
DIFFICULTY	1
TIME_REQ	2-3 min
FREQUENCY	Approximately ??% of cases are treated with electron beams.
LIKLI_H_E	1
LIK_UNDET	2
ERRORS_POS	Forgetting to attach electron beam cone. Using cone of incorrect size. Not attaching cone securely resulting in injury to patient and/or technologist.
EROR_COMNT	Note: all electron treatments require an electron cone.
ERRCONS1	1A
ERRCONS2	2A
ERRCONS3	3A
ERRCONS4	4A
ERRCONS5	5A
COMMENTS1	Electron beams are used primarily when the treatment volume is relatively shallow. Note: electron beam treatment is not possible with Cobalt 60 treatment machines.
COMMENTS2	Note: Error consequence 7A also applies.

FUNCT_NO	9.00
FUNCTION	Treatment Administration from Control Console
SUBFUN_NO	1.00
SUBFUN_STA	Entry of Treatment Parameters
TASK_NO	1.00
NUMBER	0901010
TASK_STATE	Select beam type on linear accelerator control console.
POSITION	Technologist (therapist)
EQUIPMENT	Linear accelerator control console
CBLT_LINAC	Linear Accelerator only
CUES	Treatment plan, prescription.
CONDITIONS	Patient and treatment machine in correct position, beam type provided by perscription in patient chart.
STANDARD	Beam type as specified is selected
INTERACT	None
COMM_SUBJ	None
COM_MODE	None
DIFFICULTY	1
TIME_REQ	1-2 seconds
FREQUENCY	All patients treated on multi-energy linear accelerator
LIKLI_H_E	3
LIK_UNDET	2
ERRORS_POS	Select incorrect beam type
EROR_COMNT	Incorrect treatment depth, over- or underexposure of treatment area
ERRCONS1	2A
ERRCONS2	3A
ERRCONS3	5A
ERRCONS4	
ERRCONS5	
COMMENTS1	Note: This task does not apply to basic linear accelerator models with fixed energy and beam type.
COMMENTS2	

FUNCT_NO	9.00
FUNCTION	Treatment Administration from Control Console
SUBFUN_NO	1.00
SUBFUN_STA	Entry of Treatment Parameters
TASK_NO	2.00
NUMBER	0901020
TASK_STATE	Select beam energy for beam type selection.
POSITION	Technologist (therapist)
EQUIPMENT	Linear accelerator control console, beam energy selection buttons (note, does not apply to some of the more basic models).
CBLT_LINAC	Linear Accelerator only
CUES	Treatment Plan, multi-energy linear accelerator
CONDITIONS	Patient and treatment machine in correct position, beam energy provided by prescription in patient chart.
STANDARD	Must select the required beam energy.
INTERACT	None
COMM_SUBJ	None
COM_MODE	None
DIFFICULTY	1
TIME_REQ	1-2 seconds
FREQUENCY	All patients treated on multi-energy linear accelerator
LIKLI_H_E	1
LIK_UNDET	2
ERRORS_POS	Selection of incorrect beam type.
EROR_COMNT	Over- or under exposure of target area due to differing intensity and penetrating characteristics of beam types.
ERRCONS1	1A
ERRCONS2	2A
ERRCONS3	3A
ERRCONS4	
ERRCONS5	
COMMENTS1	
COMMENTS2	

FUNCT_NO	9.00
FUNCTION	Treatment Administration from Control Console
SUBFUN_NO	1.00
SUBFUN_STA	Entry of Treatment Parameters
TASK_NO	3.00
NUMBER	0901030
TASK_STATE	Select rotating (moving) or fixed treatment.
POSITION	Technologist (therapist)
EQUIPMENT	Treatment machine control console "rotating" or "fixed" treatment selection button
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Treatment plan
CONDITIONS	Patient and treatment machine in correct position, rotating or fixed treatment method specified in patient chart.
STANDARD	Correct option must be selected (rotating or non-rotating treatment)
INTERACT	None
COMM_SUBJ	None
COM_MODE	None
DIFFICULTY	1
TIME_REQ	10 sec
FREQUENCY	All patients treated on equipment with moving field option
LIKLI_H_E	2
LIK_UNDET	2
ERRORS_POS	Incorrect type of treatment entered, (i.e. rotating treatment when fixed treatment was planned, or vice versa).
EROR_COMNT	Significant overexposure of non-target area and underexposure of target area (fixed field planned, moving field used), or significant overexposure of non-target area (moving field planned, fixed field used).
ERRCONS1	1A
ERRCONS2	2A
ERRCONS3	3A
ERRCONS4	4A
ERRCONS5	5A
COMMENTS1	
COMMENTS2	

FUNCT_NO	9.00
FUNCTION	Treatment Administration from Control Console
SUBFUN_NO	1.00
SUBFUN_STA	Entry of Treatment Parameters
TASK_NO	3.01
NUMBER	0901031
TASK_STATE	Enter degree of rotation on moving field, "start" and "stop" angles.
POSITION	Technologist (therapist)
EQUIPMENT	Treatment machine control console (rotating field angle definition entry devices)
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Treatment plan
CONDITIONS	Specifics of rotation treatment as supplied in patient chart.
STANDARD	Must enter correct start and stop angles and degree of rotation.
INTERACT	None
COMM_SUBJ	None
COM_MODE	None
DIFFICULTY	1
TIME_REQ	30 sec
FREQUENCY	All patients treated with moving field treatment
LIKLI_H_E	2
LIK_UNDET	3
ERRORS_POS	Entering incorrect rotating treatment data into treatment machine control console.
EROR_COMNT	Significant overexposure of non_target area and underexposure of target area, or significant overexposure of non-target area if incorrect start and stop angles are programmed. Or if moving field is required and fixed field is *
ERRCONS1	1A
ERRCONS2	2A
ERRCONS3	3A
ERRCONS4	4A
ERRCONS5	5A
COMMENTS1	used or vice versa.
COMMENTS2	

FUNCT_NO 9.00
FUNCTION Treatment Administration from Control Console
SUBFUN_NO 1.00
SUBFUN_STA Entry of Treatment Parameters
TASK_NO 4.00
NUMBER 0901040
TASK_STATE Enter treatment dose in monitor units.
POSITION Technologist (therapist)
EQUIPMENT Linear accelerator control console, monitor units input keys and associated digital displays
CBLT_LINAC Linear Accelerator only
CUES Necessary action for delivery of treatment (beam will not activate if monitor units are not input).
CONDITIONS Monitor units are provided in treatment plan in patient chart and the patient is ready to be treated.
STANDARD Must input the correct monitor units
INTERACT None
COMM_SUBJ None
COM_MODE None
DIFFICULTY 1
TIME_REQ 1-2 seconds
FREQUENCY All patients treated on linear accelerator
LIKLI_H_E 2
LIK_UNDET 2
ERRORS_POS Input incorrect monitor units.
EROR_COMNT Over- or under exposure of target area.
ERRCONS1 1A
ERRCONS2 2A
ERRCONS3
ERRCONS4
ERRCONS5
COMMENTS1 This task lends itself to the potential errors associated with any data keying task, (i.e. reversals of numbers, pressing wrong keys) and may also include looking at the wrong source of data (i.e. wrong treatment chart).
COMMENTS2

FUNCT_NO 9.00
FUNCTION Treatment Administration from Control Console
SUBFUN_NO 1.00
SUBFUN_STA Entry of Treatment Parameters
TASK_NO 5.00
NUMBER 0901050
TASK_STATE Specify dose in exposure time.
POSITION Technologist (therapist)
EQUIPMENT Treatment machine control console treatment time set dial or digital input
CBLT_LINAC Cobalt only
CUES Necessary action for delivery of treatment.
CONDITIONS Exposure time is provided in patient chart, and the patient is ready to be treated.
STANDARD Treatment time must be entered accurately
INTERACT None
COMM_SUBJ None
COM_MODE None
DIFFICULTY 1
TIME_REQ
FREQUENCY All patients
LIKLI_H_E 2
LIK_UNDET 2
ERRORS_POS Incorrect exposure time entered.
EROR_COMNT Over- or underexposure of target area
ERRCONS1 1A
ERRCONS2 2A
ERRCONS3
ERRCONS4
ERRCONS5
COMMENTS1 Some cobalt units have a digital input for treatment time, while others have a rotary control ("clock") that the technologist spins around to the required time (in minutes and seconds). The latter style of control seems to be the most prevalent.
COMMENTS2

FUNCT_NO	9.00
FUNCTION	Treatment Administration from Control Console
SUBFUN_NO	1.00
SUBFUN_STA	Entry of Treatment Parameters
TASK_NO	6.00
NUMBER	0901060
TASK_STATE	Ensure all treatment parameters are correct.
POSITION	Technologist (therapist)
EQUIPMENT	Computer control display if available. Control console. Patient chart.
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Expected for good quality treatment and error reductions.
CONDITIONS	Just prior to actuating beam on button.
STANDARD	All critical treatment parameters should be correct.
INTERACT	Other technologist if available and if required.
COMM_SUBJ	Accuracy of treatment parameters.
COM_MODE	Verbal
DIFFICULTY	2
TIME_REQ	10-30 seconds
FREQUENCY	All patients
LIKLI_H_E	2
LIK_UNDET	2
ERRORS_POS	Patient treated with incorrect setup or exposure.
EROR_COMNT	The computer display provides valuable assistance for this because it displays equipment position to the technologist at the control console. Standard linear accelerator consoles provide less information, and Co-60 provides *
ERRCONS1	1A
ERRCONS2	2A
ERRCONS3	3A
ERRCONS4	4A
ERRCONS5	5A
COMMENTS1	* only treatment time.
COMMENTS2	

FUNCT_NO 9.00
 FUNCTION Treatment Administration from Control Console
 SUBFUN_NO 2.00
 SUBFUN_STA Radiation Treatment Delivery
 TASK_NO 1.00
 NUMBER 0902010
 TASK_STATE Press "beam on" button.
 POSITION Technologist (therapist)
 EQUIPMENT Treatment machine control console "beam on" button
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES Necessary action for delivery of treatment. Treatment parameters have been entered correctly.
 CONDITIONS All treatment parameters accurately set on control console, patient (as viewed on monitor) is not moving or in distress.
 STANDARD Button pressed.
 INTERACT None
 COMM_SUBJ None
 COM_MODE None
 DIFFICULTY 1
 TIME_REQ 1-2 sec
 FREQUENCY One time for each field treated
 LIKLI_H_E 1
 LIK_UNDET 1
 ERRORS_POS Unlikely
 ERROR_COMNT Note: Errors would result from incorrect input of parameters on previous tasks.
 ERRCONS1 n
 ERRCONS2
 ERRCONS3
 ERRCONS4
 ERRCONS5
 COMMENTS1
 COMMENTS2

FUNCT_NO 9.00
FUNCTION Treatment Administration from Control Console
SUBFUN_NO 2.00
SUBFUN_STA Radiation Treatment Delivery
TASK_NO 2.00
NUMBER 0902020
TASK_STATE Monitor patient on visual TV monitor.
POSITION Technologist (therapist)
EQUIPMENT Treatment room patient monitor (occasionally a thick glass window also)
CBLT_LINAC Cobalt or Linear Accelerator
CUES Standard practice. Quality assurance for patient's safety.
CONDITIONS At all times after door to treatment room is shut. Particularly while under treatment beam, or just prior to activating beam.
STANDARD Tech must ensure that the patient is not having any sudden medical problems, is falling off the table, is moving, or seems distressed.
INTERACT None
COMM_SUBJ None
COM_MODE None
DIFFICULTY 1
TIME_REQ while treating 1-5 min
FREQUENCY Continuous for each field treated after tech leaves treatment rm.
LIKLI_H_E 1
LIK_UNDET 4
ERRORS_POS Not detecting if patient moves or has problems.
EROR_COMNT Injury to patient. Inaccurate treatment.
ERRCONS1 3A
ERRCONS2 4A
ERRCONS3 5A
ERRCONS4 6A
ERRCONS5 7A
COMMENTS1
COMMENTS2

FUNCT_NO 9.00
FUNCTION Treatment Administration from Control Console
SUBFUN_NO 2.00
SUBFUN_STA Radiation Treatment Delivery
TASK_NO 3.00
NUMBER 0902030
TASK_STATE Monitor patient on audio monitor.
POSITION Technologist (therapist)
EQUIPMENT Audio monitor (speaker) from treatment room
CBLT_LINAC Cobalt or Linear Accelerator
CUES Standard practice. Quality assurance for patient's safety and comfort.
CONDITIONS At all times after door to treatment room is shut.
STANDARD Tech must ensure that the patient is heard if the patient communicates any problems or distress.
INTERACT Patient
COMM_SUBJ Tech frequently establishes verbal communication with patient from the control console before and during administration of treatment.
COM_MODE Verbal
DIFFICULTY 1
TIME_REQ while treating 1-5 min
FREQUENCY Continuous for each field treated after tech leaves the t. room.
LIKLI_H_E 1
LIK_UNDET 4
ERRORS_POS Not hearing if patient is trying to communicate
EROR_COMNT Injury to patient. Inaccurate treatment.
ERRCONS1 3A
ERRCONS2 4A
ERRCONS3 5A
ERRCONS4 6A
ERRCONS5 7A
COMMENTS1
COMMENTS2

FUNCT_NO 9.00
FUNCTION Treatment Administration from Control Console
SUBFUN_NO 2.00
SUBFUN_STA Radiation Treatment Delivery
TASK_NO 4.00
NUMBER 0902040
TASK_STATE Stop treatment as necessary.
POSITION Technologist (therapist)
EQUIPMENT Emergency stop buttons/beam stop button
CBLT_LINAC Cobalt or Linear Accelerator
CUES Technologist observes patient moving on treatment table, patient is in distress*
CONDITIONS Patient in treatment room and beam is on.
STANDARD Must stop treatment promptly if necessary.
INTERACT Patient
COMM_SUBJ Patient may communicate distress over audio speaker. Technologist will tell patient that treatment is being stopped.
COM MODE Verbal
DIFFICULTY 1
TIME_REQ 2-5 sec
FREQUENCY Very rare
LIKLI_H_E 2
LIK_UNDET 2
ERRORS_POS Delay in understanding communication from patient in distress, or seeing that patient has moved
EROR_COMNT Overexposure to non-target area, or physical injury to patient, i.e. falling off table.
ERRCONS1 3A
ERRCONS2 4A
ERRCONS3 5A
ERRCONS4 6A
ERRCONS5 7A
COMMENTS1
COMMENTS2

FUNCT_NO 9.00
 FUNCTION Treatment Administration from Control Console
 SUBFUN_NO 2.00
 SUBFUN_STA Radiation Treatment Delivery
 TASK_NO 5.00
 NUMBER 0902050
 TASK_STATE Detect that source is stuck in open position.
 POSITION Technologist (therapist)
 EQUIPMENT Cobalt machine control console. Radiation detector and treatment unit "beam on" indicator lights.
 CBLT_LINAC Cobalt only
 CUES Timer for treatment has elapsed, and radiation on indicators remain lit, characteristic sound*
 CONDITIONS As stated in "Cues" above.
 STANDARD Must notice condition promptly.
 INTERACT Patient
 COMM_SUBJ Must communicated to patient that patient will be quickly taken from the treatment room (if source is not re-shielded by other means, see following tasks).
 COM_MODE Verbal
 DIFFICULTY 1
 TIME_REQ 2-3 sec
 FREQUENCY Very rare
 LIKLI_H_E 2
 LIK_UNDET *
 ERRORS_POS Delay in noticing that source is has not been shielded
 EROR_COMNT Overexposure to treatment volume, healthy tissue, and technologist.
 ERRCONS1 1A
 ERRCONS2 6A
 ERRCONS3
 ERRCONS4
 ERRCONS5
 COMMENTS1 *if source being shielded is not heard. Cobalt machine control console has a required warning light that goes on if the source is not reshielded at the appropriate time.
 COMMENTS2

FUNCT_NO	9.00
FUNCTION	Treatment Administration from Control Console
SUBFUN_NO	2.00
SUBFUN_STA	Radiation Treatment Delivery
TASK_NO	5.01
NUMBER	0902051
TASK_STATE	Re-shield source stuck in open position with emergency reshielding capability from control console (if available).
POSITION	Technologist (therapist)
EQUIPMENT	Cobalt machine control console if there is an emergency system to re-shield the source.
CBLT_LINAC	Cobalt only
CUES	Source is stuck in open position.
CONDITIONS	Patient in treatment room, timer has elapsed, source is stuck in open position
STANDARD	Must take action to re-shield source promptly.
INTERACT	None required
COMM_SUBJ	None
COM_MODE	None
DIFFICULTY	1
TIME_REQ	2-3 sec
FREQUENCY	Very rare
LIKLI_H_E	2
LIK_UNDET	1
ERRORS_POS	Delay in taking action to re-shield source.
EROR_COMNT	Overexposure to treatment area, or total body if patient panics and tries to move out of treatment beam.
ERRCONS1	1A
ERRCONS2	3A
ERRCONS3	
ERRCONS4	
ERRCONS5	
COMMENTS1	Most but not all equipment has an emergency capability to re-shield a stuck cobalt source.
COMMENTS2	

FUNCT_NO 9.00
 FUNCTION Treatment Administration from Control Console
 SUBFUN_NO 2.00
 SUBFUN_STA Radiation Treatment Delivery
 TASK_NO 5.02
 NUMBER 0902052
 TASK_STATE Escort patient from treatment room when source is stuck open.
 POSITION Technologist (therapist)
 EQUIPMENT Wheelchair or stretcher for non-ambulatory patients
 CBLT_LINAC Cobalt only
 CUES Source is stuck in open position patient in treatment room receiving excess exposure.
 CONDITIONS Patient is in treatment room. Source is stuck open and attempt to re-shield source from control console fails.
 STANDARD Must remove patient as quickly as possible with consideration for patient and technologist's safety, and minimal exposure to source.
 INTERACT Patient and other technologists, aides, or any available personnel
 COMM_SUBJ That source is stuck in an unshielded position, and how to exit from room without coming in close proximity to source.
 COM_MODE Verbal
 DIFFICULTY 4
 TIME_REQ 1-3 min
 FREQUENCY Very rare
 LIKLI_H_E 2
 LIK_UNDET 2
 ERRORS_POS Placing body in position unnecessarily close to source. Escorting patient from treatment room inefficiently.
 EROR_COMNT Overexposure to technologist or patient.
 ERRCONS1 1A
 ERRCONS2 6A
 ERRCONS3
 ERRCONS4
 ERRCONS5
 COMMENTS1 As soon as technologist enters room to remove patient, he/she should close primary collimators to minimize field size.
 COMMENTS2

FUNCT_NO 9.00
 FUNCTION Treatment Administration from Control Console
 SUBFUN_NO 2.00
 SUBFUN_STA Radiation Treatment Delivery
 TASK_NO 5.03
 NUMBER 0902053
 TASK_STATE Manually re-shield source stuck in open position in treatment room.
 POSITION Technologist/Physicist/Oncologist/Radiation Safety Officer
 EQUIPMENT A tool to re-shield the source called a "T bar" which is inserted into the treatment head to manually move the source to a shielded position.
 CBLT_LINAC Cobalt only
 CUES Source is stuck in open position, attempt to re-shield source from control console fails.
 CONDITIONS Patient has been removed from treatment room. Technologist would have someone assisting at this point if available.
 STANDARD Source is re-shielded as quickly as possible, treatment room is sealed off as soon as possible and Radiation Safety Officer is notified.
 INTERACT Anyone available in the vicinity, preferably a Physicist or Oncologist.
 COMM_SUBJ That source is stuck in an unshielded position, and how to re-shield the source manually.
 COM MODE Verbal
 DIFFICULTY 4
 TIME REQ 1-3 min
 FREQUENCY Very rare
 LIKLI_H_E 2
 LIK_UNDET *
 ERRORS_POS Placing body in position unnecessarily close to source.
 ERROR_COMNT Overexposure to technologist and assistant.
 ERRCONS1 6A
 ERRCONS2
 ERRCONS3
 ERRCONS4
 ERRCONS5
 COMMENTS1
 COMMENTS2

FUNCT_NO 9.00
 FUNCTION Treatment Administration from Control Console
 SUBFUN_NO 3.00
 SUBFUN_STA Treatment Equipment Malfunctions
 TASK_NO 1.00
 NUMBER 0903010
 TASK_STATE Detect equipment malfunctions and report these to the proper authority.
 POSITION Technologist (therapist)
 EQUIPMENT Treatment equipment
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES Treatment machinery "sounds" or "acts" unusual. Output parameters seem unusual, during daily tests.
 CONDITIONS At any time during patient treatment or equipment warmup.
 STANDARD Technologist should know criticality of probable malfunction by symptoms or indicator lights, or error codes, and react accordingly, (i.e. which *
 INTERACT Other technologists, Supervisor, Physicist or person in authority.
 COMM_SUBJ Equipment malfunction, or suspected malfunction.
 COM_MODE Verbal
 DIFFICULTY 1
 TIME_REQ 1-5 min
 FREQUENCY As required
 LIKLI_H_E 1
 LIK_UNDET 4
 ERRORS_POS Not noticing or not reporting malfunction in timely fashion.
 EROR_COMNT Over or under-exposure, injury to patient from mechanical components of treatment equipment.
 ERRCONS1 1A
 ERRCONS2 2A
 ERRCONS3 7A
 ERRCONS4
 ERRCONS5
 COMMENTS1 faults must be cleared immediately, and which may be dealt with after treatment is finished. If faults are serious, treatment must be discontinued and physicist or engineer notified.
 COMMENTS2

FUNCT_NO	9.00
FUNCTION	Treatment Administration from Control Console
SUBFUN_NO	4.00
SUBFUN_STA	Record Treatment Data
TASK_NO	1.00
NUMBER	0904010
TASK_STATE	Document details of daily treatment administered in patient chart.
POSITION	Technologist (therapist)
EQUIPMENT	Patient chart
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Beam has stopped, and patient is finished with daily treatment.
CONDITIONS	Patient may still be on treatment couch or being escorted out of treatment room by other technologist if available.
STANDARD	Treatment parameters and other technical details must be recorded accurately and immediately
INTERACT	None
COMM_SUBJ	None
COM_MODE	None
DIFFICULTY	1
TIME_REQ	1-2 minutes
FREQUENCY	Each field treated on each patient.
LIKLI_H_E	2
LIK_UNDET	2
ERRORS_POS	Recording treatment data inaccurately. Failure to record treatment data.
EROR_COMNT	Possible over-exposure or under exposure depending on the recording error. Patient may be given extra treatments if technologist neglects to record daily treatment data.
ERRCONS1	1B
ERRCONS2	2B
ERRCONS3	
ERRCONS4	
ERRCONS5	
COMMENTS1	If port films (see following tasks) are reviewed by the Oncologist and feels that they are off, the Oncologist will write on the port film that the patient should be "re-reported". If the next port film is similarly off, the Oncologist will instruct that the field be moved (written on port film, or verbal). It is then the responsibility of the treatment tech to adjust the treatment field during the next treatment and document this change in the patient's chart. This must be documented.
COMMENTS2	

FUNCT_NO 9.00
 FUNCTION Treatment Administration from Control Console
 SUBFUN_NO 5.00
 SUBFUN_STA Portal Localization (Verification) Films
 TASK_NO 0.00
 NUMBER 0905000
 TASK_STATE See tasks
 POSITION Technologist (therapist)
 EQUIPMENT Localization cassette and special film (not regular X-ray film), treatment machine, treatment control console, collimator controls.
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES As per standard practice for facility, (i.e. once per week, per two weeks, per day, or case type)*
 CONDITIONS Performed just prior to or just after treatment at same portal
 STANDARD Verification film must be readable by the Oncologist, and accurately reflect the port treated.
 INTERACT Oncologist/Other technologist as required
 COMM_SUBJ Oncologist may alert the technologist to the need for a port film particularly if the previous port film was judged to be "off".
 COM_MODE Special requests for verification film are frequently wirtten on previous port films or verbal.
 DIFFICULTY 2
 TIME_REQ 5 min
 FREQUENCY see Cues
 LIKLI_H_E 2
 LIK_UNDET 1
 ERRORS_POS Not using the correct (high resistance) x-ray film, or cassette, incorrect exposure, failure to include all of field, failure to correctly label film with patient's name and field position.
 EROR_COMNT Unusable verification film. Would have to take another film. This could cause delay in patient schedule, and delay in finding problems with existing field port locations.
 ERRCONS1 1B
 ERRCONS2 2B
 ERRCONS3 3B
 ERRCONS4 4B
 ERRCONS5 5B
 COMMENTS1 * The professional community believes that verification films should be taken before the first treatment whenever possible.
 COMMENTS2

FUNCT_NO 9.00
 FUNCTION Treatment Administration from Control Console
 SUBFUN_NO 5.00
 SUBFUN_STA Portal Localization (Verification) Films
 TASK_NO 1.00
 NUMBER 0905010
 TASK_STATE Place localization (x-ray) film in film receptacle on treatment machine.
 POSITION Technologist (therapist)
 EQUIPMENT Localization cassette and film, treatment machine.
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES As per standard practice for facility, (i.e. once per week, per two weeks, per day, or case type)*
 CONDITIONS Patient in treatment position.
 STANDARD Verification film must be readable by the Oncologist, and accurately reflect the portal treated.
 INTERACT Other technologist as required
 COMM_SUBJ
 COM_MODE Special requests for verification film could be written or verbal.
 DIFFICULTY 2
 TIME_REQ 5 min
 FREQUENCY see Cues
 LIKLI_H_E 2
 LIK_UNDET 2
 ERRORS_POS Not using the correct (high resistance) x-ray film
 ERROR_COMNT Unusable verification film. Would have to take another film. This could cause delay in patient schedule.
 ERRCONS1 n
 ERRCONS2
 ERRCONS3
 ERRCONS4
 ERRCONS5
 COMMENTS1
 COMMENTS2

FUNCT_NO 9.00
 FUNCTION Treatment Administration from Control Console
 SUBFUN_NO 5.00
 SUBFUN_STA Portal Localization (Verification) Films
 TASK_NO 2.00
 NUMBER 0905020
 TASK_STATE Enter exposure time in monitor units (linear acceleraor) or exposure time (Co-60) required for verification film.
 POSITION Technologist (therapist)
 EQUIPMENT Treatment machine control console
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES Required to make exposure.
 CONDITIONS Radiograph film is in position, patient in treatment position.
 STANDARD Monitor units or exposure time entered must be correct in that the exposure created is neither over- or underexposed.
 INTERACT None
 COMM_SUBJ None
 COM_MODE None
 DIFFICULTY 2
 TIME_REQ 10 sec
 FREQUENCY Twice for each verification film
 LIKLI_H_E 2
 LIK_UNDET 2
 ERRORS_POS Entering the incorrect monitor units or exposure time, (M.U. or exposure times may be set for treatment rather than film, causing overexposure to patient for that treatment.
 ERROR_COMNT Over- or underexposed unusable verification film.
 ERRCONS1 1A
 ERRCONS2
 ERRCONS3
 ERRCONS4
 ERRCONS5
 COMMENTS1
 COMMENTS2

FUNCT_NO	9.00
FUNCTION	Treatment Administration from Control Console
SUBFUN_NO	5.00
SUBFUN_STA	Portal Localization (Verification) Films
TASK_NO	3.00
NUMBER	0905030
TASK_STATE	Make verification film exposure.
POSITION	Technologist (therapist)
EQUIPMENT	Treatment machine control console, beam on button.
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Correct monitor units or exposure time entered.
CONDITIONS	X-ray film is in position, patient is in treatment position, technologist is at control console.
STANDARD	Beam must be activated to make exposure.
INTERACT	None
COMM_SUBJ	None
COM_MODE	None
DIFFICULTY	1
TIME_REQ	1 sec
FREQUENCY	Twice for each verification film
LIKLI_H_E	1
LIK_UNDET	1
ERRORS_POS	Unlikely
EROR_COMNT	Other errors are possible as process continues.
ERRCONS1	n
ERRCONS2	
ERRCONS3	
ERRCONS4	
ERRCONS5	
COMMENTS1	
COMMENTS2	

FUNCT_NO	9.00
FUNCTION	Treatment Administration from Control Console
SUBFUN_NO	5.00
SUBFUN_STA	Portal Localization (Verification) Films
TASK_NO	4.00
NUMBER	0905040
TASK_STATE	Open collimator fully.
POSITION	Technologist (therapist)
EQUIPMENT	Collimator controls.
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Initial treatment area exposure made, required to make second exposure of wider area for context info.
CONDITIONS	Initial radiograph of treatment field has been taken.
STANDARD	Collimator must be opened completely.
INTERACT	None
COMM_SUBJ	None
COM_MODE	None
DIFFICULTY	1
TIME_REQ	1 min
FREQUENCY	one time per verification film
LIKLI_H_E	1
LIK_UNDET	1
ERRORS_POS	Technologist forgets to open collimator before second exposure.
EROR_COMNT	Mistake would be obvious. Must re-take verification film.
ERRCONS1	n
ERRCONS2	
ERRCONS3	
ERRCONS4	
ERRCONS5	
COMMENTS1	
COMMENTS2	

FUNCT_NO	9.00
FUNCTION	Treatment Administration from Control Console
SUBFUN_NO	5.00
SUBFUN_STA	Portal Localization (Verification) Films
TASK_NO	5.00
NUMBER	0905050
TASK_STATE	Make second exposure of open treatment field rectangle.
POSITION	Technologist (therapist)
EQUIPMENT	Treatment machine control console "beam on" button.
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Collimators opened to maximum size. Required to make exposure of adjacent anatomical features.
CONDITIONS	Collimator is opened fully and correct exposure time of M.U. is set for exposure.
STANDARD	Adequate exposure is taken and treatment field is well presented on developed film.
INTERACT	None
COMM_SUBJ	None
COM_MODE	None
DIFFICULTY	1
TIME_REQ	1 min
FREQUENCY	One time after initial exposure per verification film
LIKLI_H_E	1
LIK_UNDET	1
ERRORS_POS	Forget to open collimators, forget to take a second exposure.
EROR_COMNT	Mistake would be so obvious that another verification film would have to be taken.
ERRCONS1	n
ERRCONS2	
ERRCONS3	
ERRCONS4	
ERRCONS5	
COMMENTS1	The second exposure provides contextual anatomical information so that the exact position of the treatment field (exposed twice and therefore of a distinctly darker shade) may be determined.
COMMENTS2	

FUNCT_NO	9.00
FUNCTION	Treatment Administration from Control Console
SUBFUN_NO	5.00
SUBFUN_STA	Portal Localization (Verification) Films
TASK_NO	6.00
NUMBER	0905060
TASK_STATE	Mark patient's name, date, and treatment parameters on verification film.
POSITION	Technologist (therapist)
EQUIPMENT	Grease pen or other marker
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Must identify verification film
CONDITIONS	Film has been exposed and developed.
STANDARD	Data recorded must be accurate and legible.
INTERACT	None
COMM_SUBJ	None
COM_MODE	None
DIFFICULTY	1
TIME_REQ	1 - 2 min
FREQUENCY	One time per portal field verified
LIKLI_H_E	1
LIK_UNDET	2
ERRORS_POS	Data marked on verification film is inaccurate, incomplete or illegible. Incorrect films accepted and signed by Oncologist.
EROR_COMNT	Oncologist would not sign. If Oncologist does sign and the films are placed in the incorrect patient's file, the treatment planning and subsequent treatment could be affected. This error should be caught by the recording of port*
ERRCONS1	1A
ERRCONS2	2A
ERRCONS3	3A
ERRCONS4	4A
ERRCONS5	5A
COMMENTS1	*films in the treatment chart.
COMMENTS2	

FUNCT_NO	9.00
FUNCTION	Treatment Administration from Control Console
SUBFUN_NO	5.00
SUBFUN_STA	Portal Localization (Verification) Films
TASK_NO	7.00
NUMBER	0905070
TASK_STATE	Record verification film taken in patient chart.
POSITION	Technologist (therapist)
EQUIPMENT	Pen, patient's chart
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Chart documentation
CONDITIONS	Verification film taken
STANDARD	Data recorded must be accurate and legible.
INTERACT	None
COMM_SUBJ	None
COM_MODE	None
DIFFICULTY	1
TIME_REQ	1 - 2 min
FREQUENCY	One time per treatment field verified
LIKLI_H_E	1
LIK_UNDET	2
ERRORS_POS	Port film not documented in chart or wrong port film recorded in chart.
EROR_COMNT	Will not have an accurate documentation of port films taken. May result in refilming if ports already taken.
ERRCONS1	1A
ERRCONS2	3A
ERRCONS3	
ERRCONS4	
ERRCONS5	
COMMENTS1	*films in the treatment chart.
COMMENTS2	

FUNCT_NO	9.00
FUNCTION	Treatment Administration from Control Console
SUBFUN_NO	6.00
SUBFUN_STA	Conclude Daily Treatment of Patient
TASK_NO	1.00
NUMBER	0906010
TASK_STATE	Remove patient from treatment table and escort from room.
POSITION	Technologist (therapist)
EQUIPMENT	Gurney, wheelchair as needed
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Patient treatment has been concluded
CONDITIONS	Treatment has been concluded and treatment beam is off
STANDARD	As efficiently as possible with respect for the patient's safety
INTERACT	Patient and other technologist as required
COMM_SUBJ	Variable
COM_MODE	Verbal
DIFFICULTY	1
TIME_REQ	2-3 min
FREQUENCY	1 time per patient treatment
LIKLI_H_E	2
LIK_UNDET	1
ERRORS_POS	Injuring patient while getting off of the treatment table.
EROR_COMNT	
ERRCONS1	7A
ERRCONS2	
ERRCONS3	
ERRCONS4	
ERRCONS5	
COMMENTS1	
COMMENTS2	

FUNCT_NO 9.00
 FUNCTION Treatment Administration from Control Console
 SUBFUN_NO 6.00
 SUBFUN_STA Conclude Daily Treatment of Patient
 TASK_NO 2.00
 NUMBER 0906020
 TASK_STATE Schedule next appointment for patient.
 POSITION Technologist (therapist)
 EQUIPMENT Patient chart, daily schedule
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES Patient needs to know next appointment time/preparation of
 schedule for next day is required.
 CONDITIONS Patient or responsible family member is present.
 STANDARD Patient or family member responsible for patient is made aware of
 the next appointment time.
 INTERACT Patient or family member responsible for patient
 COMM_SUBJ Time and date of next treatment appointment.
 COM_MODE Verbal
 DIFFICULTY 1
 TIME_REQ 30 sec - 2 min
 FREQUENCY 1 time per patient treatment
 LIKLI_H_E 2
 LIK_UNDET 4
 ERRORS_POS Scheduling patient for additional treatment after treatment
 should have been concluded. Wrong appointment time causing
 inconvenience to both patient and technologist.
 EROR_COMNT Patient is given more treatments than planned; overexposure of
 treatment area.
 ERRCONS1 1A
 ERRCONS2
 ERRCONS3
 ERRCONS4
 ERRCONS5
 COMMENTS1 This error results from inefficient or absence of communication
 during the course of treatment, typically between the
 technologist and oncologist, or from forgetting to record daily
 treatment at some time during the course of treatment.
 COMMENTS2

FUNCT_NO	10.00
FUNCTION	Monitor Patient Progress and Treatment Adequacy
SUBFUN_NO	1.00
SUBFUN_STA	Review Port Localization (Verification) Films
TASK_NO	1.00
NUMBER	1001010
TASK_STATE	Review port localization (verification) film.
POSITION	Oncologist, Technologist
EQUIPMENT	Light box for viewing x-rays.
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Verification films taken as per standard procedure or special request.
CONDITIONS	Usable films have been developed by technologist.
STANDARD	Verification films should show treatment field in proper position within 1-3 mm compared with sim. films. Film should be checked within 24-48 hrs.
INTERACT	Technologist
COMM_SUBJ	Changes required in treatment field position to match position on simulation film.
COM_MODE	Verbal as well as written on verification film.
DIFFICULTY	2
TIME_REQ	Variable
FREQUENCY	One time per verification film.
LIKLI_H_E	1
LIK_UNDET	4
ERRORS_POS	Not noticing that treatment field position is incorrect.
EROR_COMNT	Not noticing that field is mispositioned or not ordering change when required, or failure to communicate effectively with techs. Must also take another verification film to verify change if made.
ERRCONS1	1B
ERRCONS2	2B
ERRCONS3	3B
ERRCONS4	4B
ERRCONS5	5B
COMMENTS1	Technologists should review their own films prior to the next treatment delivery, if they note a change (shift) is needed, they should either make the change and document with additional ver. film (if authorized) or bring to attention of Oncologist.
COMMENTS2	

FUNCT_NO 10.00
FUNCTION Monitor Patient Progress and Treatment Adequacy
SUBFUN_NO 1.00
SUBFUN_STA Review Port Localization (Verification) Films
TASK_NO 1.01
NUMBER 1001011
TASK_STATE Communicate unacceptability of treatment field location and document acceptable modification.
POSITION Oncologist, Technologist
EQUIPMENT Verification field, light board.
CBLT_LINAC Cobalt or Linear Accelerator
CUES Error detected in treatment field position on verification film.
CONDITIONS Variable
STANDARD Position of treatment field should be corrected to within 1-3 mm of simulation film.
INTERACT Technologist, dosimetrist, simulation technologist as required
COMM_SUBJ Re-simulation, adjustment in patient position, recalculation of patient dose, new blocks or immobilization devices required, etc.
COM_MODE Verbal and/or written
DIFFICULTY 1
TIME_REQ Variable
FREQUENCY For each treatment field found to be incorrect.
LIKLI_H_E 2
LIK_UNDET 1
ERRORS_POS Not effectively communicating problem and/or not following through with resolution to the issue.
EROR_COMNT The existing problem with the treatment will continue.
ERRCONS1 1B
ERRCONS2 2B
ERRCONS3 3B
ERRCONS4 4B
ERRCONS5 5B
COMMENTS1
COMMENTS2

FUNCT NO	10.00
FUNCTION	Monitor Patient Progress and Treatment Adequacy
SUBFUN NO	2.00
SUBFUN STA	Check accuracy of data in patient chart
TASK NO	1.00
NUMBER	1002010
TASK STATE	Check accuracy of data in patient chart.
POSITION	Physicist
EQUIPMENT	Patient chart
CBLT LINAC	Cobalt or Linear Accelerator
CUES	Standard quality assurance procedure.
CONDITIONS	Active chart not immediately in use.
STANDARD	Correct MU or exposure time is being used, wedges, compensators, and/or bolus(es) are used if required, that correct accumulated doses are being*
INTERACT	None
COMM SUBJ	None
COM MODE	Written notification to dosimetrist for correction of erroneous calculations
DIFFICULTY	3
TIME REQ	10-40 min
FREQUENCY	Variable between facilities, typically weekly for every chart.
LIKLI H E	2
LIK UNDET	3
ERRORS POS	Lack of attention to detail.
EROR COMNT	Errors in chart go undetected.
ERRCONS1	1B
ERRCONS2	2B
ERRCONS3	3B
ERRCONS4	4B
ERRCONS5	5B
COMMENTS1	* carried for each treatment, that IFS/TSD are being periodically remeasured, and that the general overall condition of the chart is acceptable (white-out not used in prohibited areas, data is not entered sloppily).
COMMENTS2	

FUNCT_NO 10.00
 FUNCTION Monitor Patient Progress and Treatment Adequacy
 SUBFUN_NO 3.00
 SUBFUN_STA Chart Rounds Meetings
 TASK_NO 1.00
 NUMBER 1003010
 TASK_STATE Present or review treatment-related issues for each patient at "chart rounds" (meetings).
 POSITION Oncologists, Physicists, Dosimetrists, Technologists*
 EQUIPMENT Patient charts, portal films
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES As per facility policy.
 CONDITIONS Meeting is typically held in a conference room. All staff involved with treatment attends. Each patient is discussed.
 STANDARD Each patient, course of treatment, chart and portal films is discussed.
 INTERACT Ideally, all staff is typically free to interact, comment etc.
 COMM_SUBJ Treatment progress, treatment-related problems or questions, prescription, reproducibility of portals.
 COM_MODE Verbal discussions. Decisions impacting future treatment are noted {on patient's chart}
 DIFFICULTY 1
 TIME_REQ Variable
 FREQUENCY As per facility schedule. (1x/wk, 1x/2 wk, none)
 LIKLI_H_E 1
 LIK_UNDET 4
 ERRORS_POS Patient not reviewed. Not effectively communicating patient- or treatment- related problem, and/or not productively discussing the issue and reaching resolution.
 EROR_COMNT See error effects below
 ERRCONS1 1B
 ERRCONS2 2B
 ERRCONS3 3B
 ERRCONS4 4B
 ERRCONS5 5B
 COMMENTS1 Most facilities at least attempt to have regular chart rounds. It seems that the value placed on this process is quite variable between facilities. * Nurses, Dieticians and Social Workers may also attend.
 COMMENTS2

FUNCT_NO 10.00
 FUNCTION Monitor Patient Progress and Treatment Adequacy
 SUBFUN_NO 3.00
 SUBFUN_STA Chart Rounds Meetings
 TASK_NO 2.00
 NUMBER 1003020
 TASK_STATE Execute corrections and/or adjustments in treatment plan,
 prescription or other aspects of treatment.
 POSITION Oncologists, Physicists, Dosimetrists, Technologists*
 EQUIPMENT Patient charts, and simulation equipment, immobilization devices,
 tissue compensators, blocks, etc. as necessary.
 CBLT_LINAC Cobalt or Linear Accelerator
 CUES Changes approved during chart rounds meeting.
 CONDITIONS Simple modifications may be made to treatment chart during the
 meeting, notes will be taken for more demanding modifications.
 STANDARD The personnel whose expertise is required for modification must
 follow up on all actions required for modification, (i.e.
 resimulate, etc.)
 INTERACT All staff whose expertise is required. Technologist must always
 be informed of change at a minimum.
 COMM_SUBJ The nature of the modification to treatment. How modification
 will be facilitated.
 COM_MODE Verbal, and or written notes in patient chart.
 DIFFICULTY 3
 TIME_REQ Variable
 FREQUENCY As needed
 LIKLI_H_E 3
 LIK_UNDET 3
 ERRORS_POS Not effectively following up on recommendations for correction
 and/or adjustment to treatment.
 EROR_COMNT Continuation of problem discussed in chart rounds meeting.
 ERRCONS1 1B
 ERRCONS2 2B
 ERRCONS3 3B
 ERRCONS4 4B
 ERRCONS5 5B
 COMMENTS1 Most facilities at least attempt to have regular chart rounds
 meetings. It seems that the value placed on this process is quite
 variable between facilities.
 COMMENTS2

FUNCT_NO	10.00
FUNCTION	Monitor Patient Progress and Treatment Adequacy
SUBFUN_NO	4.00
SUBFUN_STA	Periodic Examination/Re-evaluation of Patient Status (On Treatment Visits (OTV))
TASK_NO	1.00
NUMBER	1004010
TASK_STATE	Evaluate patient status and progress of treatment.
POSITION	Oncologist
EQUIPMENT	
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	A component of the treatment process.
CONDITIONS	Periodic examinations are held usually about one time per week or on an "as needed" basis
STANDARD	Tumor response is evaluated, as well as adverse effects of treatment to include both expected and unexpected side effects of radiation therapy.
INTERACT	Patient
COMM_SUBJ	Treatment progress, treatment-related problems or questions, questions about health, pain, etc.
COM_MODE	Verbal, On-Treatment-Visits must be documented in patients treatment record (JCAHO, ACR reqts.)
DIFFICULTY	n
TIME_REQ	Variable
FREQUENCY	About one time per week, as needed or per facility practice.
LIKLI_H_E	n
LIK_UNDET	n
ERRORS_POS	Not identifying treatment-related problems in a timely manner, to include both side effects of radiation therapy, and the degree to which the tumor may not be responding to treatment.
EROR_COMNT	Treatment inadequacy based on Oncologist's skill and ability.
ERRCONS1	1B
ERRCONS2	2B
ERRCONS3	3B
ERRCONS4	4B
ERRCONS5	5B
COMMENTS1	
COMMENTS2	

FUNCT_NO	10.00
FUNCTION	Monitor Patient Progress and Treatment Adequacy
SUBFUN_NO	4.00
SUBFUN_STA	Periodic Examination/Re-evaluation of Patient Status
TASK_NO	1.01
NUMBER	1004011
TASK_STATE	Evaluate unexpected side effects of radiation treatment.
POSITION	Oncologist/Technologist
EQUIPMENT	
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Technologist should evaluate patient before each daily treatment, if problem is observed, should
CONDITIONS	Patient undergoing radiation treatment will require periodic evaluations of symptoms.
STANDARD	Unexpected side effects must be noticed, evaluated, and corrective action taken promptly.
INTERACT	Patient, hospital staff (i.e. lab reports, etc.)
COMM_SUBJ	Specifics from patient on symptoms, lab reports and observations of patient from hospital staff and radiation therapy technologists respectively.
COM_MODE	Verbal, written
DIFFICULTY	n
TIME_REQ	Variable
FREQUENCY	As needed
LIKLI_H_E	n
LIK_UNDET	n
ERRORS_POS	Not identifying treatment-related problems in a timely manner, to include both side effects of radiation therapy, and the degree to which the tumor may not be responding to treatment.
EROR_COMNT	Treatment inadequacy based on Oncologist's skill and ability.
ERRCONS1	1B
ERRCONS2	3B
ERRCONS3	5B
ERRCONS4	
ERRCONS5	
COMMENTS1	* mention to Oncologist. Patient also report problems to technologists. Technologist may decide to postpone daily treatment until Oncologist determines the nature of the problem.
COMMENTS2	

FUNCT_NO	10.00
FUNCTION	Monitor Patient Progress and Treatment Adequacy
SUBFUN_NO	4.00
SUBFUN_STA	Periodic Examination/Re-evaluation of Patient Status
TASK_NO	1.02
NUMBER	1004012
TASK_STATE	Monitor patient for changes in body size (that may affect treatment setup).
POSITION	Technologist (therapist)
EQUIPMENT	
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	A component of the treatment process.
CONDITIONS	Patient undergoing radiation treatment.
STANDARD	Significant changes in body size must be noticed promptly so that adjustments in treatment may be made.
INTERACT	Oncologist, Dosimetrist
COMM_SUBJ	Changes in SSD and relationship to portal and skin marks.
COM_MODE	Verbal/Written
DIFFICULTY	n
TIME_REQ	Variable
FREQUENCY	As per schedule for periodic evaluation or as needed
LIKLI_H_E	2
LIK_UNDET	2
ERRORS_POS	Not identifying change in size of patient's body in a timely manner.
EROR_COMNT	Change in the size of patient's body that was not accounted for in the treatment simulation and planning will affect the intensity of the radiation beam to the target area and/or the location of the target area.
ERRCONS1	1A
ERRCONS2	2A
ERRCONS3	
ERRCONS4	
ERRCONS5	
COMMENTS1	Note: significant changes in body dimensions during the course of treatment are not uncommon. These may require replanning and recalculation of treatment parameters.
COMMENTS2	

FUNCT_NO	10.00
FUNCTION	Monitor Patient Progress and Treatment Adequacy
SUBFUN_NO	4.00
SUBFUN_STA	Periodic Examination/Re-evaluation of Patient Status
TASK_NO	2.00
NUMBER	1004020
TASK_STATE	Modify prescription for patient treatment as per evaluation of unexpected side effects or lack of tumor response
POSITION	Oncologist
EQUIPMENT	Patient chart
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Patient condition requires modification of treatment.
CONDITIONS	Patient exhibits condition requiring modification of treatment as per the expert opinion of the Oncologist.
STANDARD	Treatment must be altered in a timely manner so that dangerous side effects may be eliminated or reduced, and the tumor may be effectively treated.*
INTERACT	Treatment staff.
COMM_SUBJ	Change in treatment.
COM_MODE	Verbal, written*
DIFFICULTY	n
TIME_REQ	Variable
FREQUENCY	As needed
LIKLI_H_E	2
LIK_UNDET	3
ERRORS_POS	Not communicating change in treatment prescription verbally and/or in writing to ensure that the change is noticed and implimented by the technologist.
EROR_COMNT	Treatment inadequacy based on Oncologist's skill and ability. Side effects exacerbated, and/or tumor continues to exist, or grow.
ERRCONS1	1B
ERRCONS2	2B
ERRCONS3	3B
ERRCONS4	4B
ERRCONS5	5B
COMMENTS1	Problematic tumor response during treatment may include new extention of the tumor mass, or metastasis of disease to other parts of the body. * Treatment must also be radically reduced or stopped due to a significant decline in patients overall cond
COMMENTS2	

FUNCT_NO	10.00
FUNCTION	Monitor Patient Progress and Treatment Adequacy
SUBFUN_NO	4.00
SUBFUN_STA	Periodic Examination/Re-evaluation of Patient Status
TASK_NO	3.00
NUMBER	1004030
TASK_STATE	Investigate cause of unexpected side effects or lack of tumor response if treatment error is suspected.
POSITION	Oncologist/Technologist/Physicist/Dosimetrist
EQUIPMENT	Patient chart, all supporting documentation of treatment plan, (i.e. simulation, portal, and verification films), treatment plans, etc.
CBLT_LINAC	Cobalt or Linear Accelerator
CUES	Patient condition indicates problems with treatment.
CONDITIONS	Patient's condition indicates that a problem with treatment may exist as per the opinion of the Oncologist, or Technologist.
STANDARD	Cause of treatment problem must be determined and dealt with in a timely manner to avoid continuation of treatment-related problems.
INTERACT	Treatment staff.
COMM_SUBJ	Problems with treatment program.
COM_MODE	Verbal
DIFFICULTY	n
TIME_REQ	Variable
FREQUENCY	As needed
LIKLI_H_E	
LIK_UNDET	
ERRORS_POS	Not noticing and correcting problem due to problems with treatment administration in a timely fashion.
EROR_COMNT	Treatment inadequacy is ultimately based on Oncologist's and or Technologist's skill and ability. Effects of over- or underexposure continue. Responsibility for error ultimately the primary responsibility of the Oncologist.
ERRCONS1	8A
ERRCONS2	
ERRCONS3	
ERRCONS4	
ERRCONS5	
COMMENTS1	
COMMENTS2	

Subfunction No.: 1:00

Develop Job Descriptions for Staff Positions

Task 1:00

Develop description of duties for each teletherapy staff position.

Task 2:00

Develop minimum performance standards for each teletherapy staff position.

Task 3:00

State minimum experience and education requirements for each teletherapy staff position.

Subfunction No.: 2:00

Hiring of Radiation Therapy Technology Personnel

Task 1:00

Detect need for additional staff member.

Task 2:00

Evaluate cost/benefit of additional staff member.

Task 3:00

Determine if requirement for additional staff is full or part time.

Task 4:00

Contact tempory agency or professional network for part-time or temporary position.

Task 5:00

Advertise for full time position as necessary.

Task 6:00

Interview applicants.

Task 7:00

Select candidate.

Subfunction No.: 3:00

Policy for Orienting and Training New Employees

Task 1:00

Describe departmental policies and procedures and code of conduct.

Task 2:00

Assign new employee to experienced employee for orientation and OJT as per departmental policy.

Task 3:00

Monitor performance of new hire during probationary period as per departmental policy.

Task 4:00

Perform performance appraisal at the conclusion of probationary period as per departmental policy.

Subfunction No.: 4:00

Periodic Performance Appraisals for Teletherapy Staff

Task 1:00

Monitor on-the-job performance of teletherapy staff.

Task 2:00

Develop performance evaluation instruments for each teletherapy staff position.

Task 3:00

Conduct performance evaluations.

Task 4:00

Make career development and advancement opportunities known to teletherapy staff.

Subfunction No.: 5:00

Shift Schedules for Teletherapy Staff

Task 1:00

Develop shift schedule.

Task 2:00

Monitor adequacy of shift schedule.

Task 3:00

Develop procedures for on-call services for after-hours emergencies and sick leave coverage.

Task 4:00

Develop on-call procedures for after-hour emergencies and sick leave coverage.

Subfunction No.: 6:00

Quality Assurance Plan

Task 1:00

Delineate scope of QA plan.

Task 2:00

Specify QA responsibilities of teletherapy staff.

Task 3:00
Ensure all staff members understand QA responsibilities.

Task 4:00
Implement systematic procedures for monitoring the QA process.

Task 5:00
Identify deviation from accepted performance.

Task 6:00
Develop plan for corrective action when indications are identified.

Task 7:00
Monitor effectiveness of corrective actions.

Subfunction No.: 7:00
Continued Education and Training

Task 1:00
Identify staff needs for continuing education and training.

Task 2:00
Develop facility policy for continued education time-off, reimbursement, and other training.

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10. SUPPLEMENTARY NOTES

11. ABSTRACT (200 words or less)

A series of human factors evaluations were undertaken to better understand the contributing factors to human error in the teletherapy environment. Teletherapy is a multi-disciplinary methodology for treating cancerous tissue through selective exposure to an external beam of ionizing radiation. A team of human factors specialists, assisted by a panel of radiation oncologists, medical physicists, and radiation therapists, conducted site visits to radiation oncology departments at community hospitals, university centers, and free-standing clinics. A function and task analysis was initially performed to guide subsequent evaluations in the areas of system-user interfaces, procedures, training and qualifications, and organizational policies and practices. The present work focuses solely on training and qualifications of personnel (e.g., training received before and during employment), and the potential impact of organizational factors on the performance of teletherapy. Organizational factors include such topics as adequacy of staffing, performance evaluations, commonly occurring errors, implementation of quality assurance programs, and organizational climate.

12. KEY WORDS/DESCRIPTORS (List words or phrases that will assist researchers in locating the report.)

Teletherapy	Human-System Interfaces
Medical Device(s)	Training and Qualification
Human Factors Evaluation	Task Analysis
Human Error	Teletherapy Procedures
Teletherapy Errors	Organizational Policies and Practices
Medical Misadministration	Teletherapy Training
Organizational Analysis	
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