Facility Design

American Association of Physicists in Medicine
2007 Summer School

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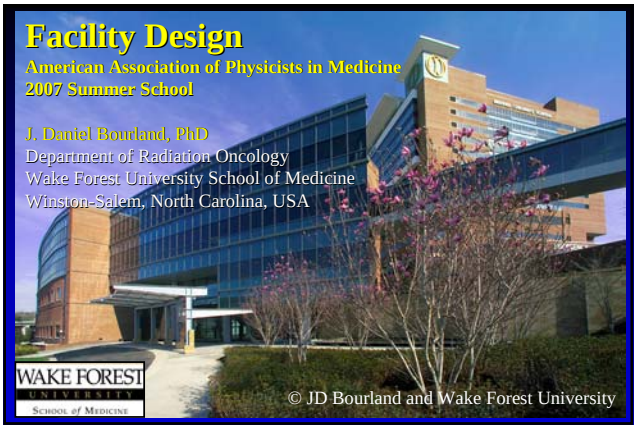


Outline

- Facility Purposes
- Facility Design Process
- Design Team Functions
- Functional Plan To Spatial Reality
- Example: A Radiation Oncology Facility
- Keys For Successful Planning
- Summary

Healthcare Facility Purposes

- Accomplish Mission – Program, Department, Institution, other relevant groups (community, etc)
- A Facility is a Tool - a basic resource, facilitating component which programs and people depend on
  - Facilities house people – workers, patients, others
  - Facilities honor people; memorialize people
  - Facilities provide for visual response – art

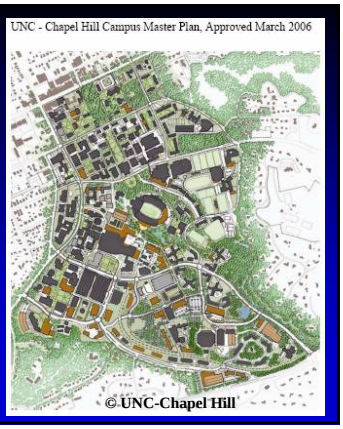
Point – the physical structure is about people

Facility Design Process

- Identify **Need** and General Solution
- **Vision** – For the Future
  - What is desired to be accomplished?
  - Facilities – a 100-year event – future revisions
- Identify **Players**
  - Proponents, participants, related programs, infrastructure, administration
- **Proposal** – A convincing argument

Planning On The Grand Scale

- All spaces designated
- How will your plan fit?
- Challenges can be extreme



Design Process and People

Thorough planning provides for a successful facility and minimizes mistakes that may cost dollars or limit usefulness. This process may take a long time, depending on the project scale.

- Planner/Coordinator – in-house, architectural firm
  - Key individuals to hold everything together, organize, etc
- Design Team – participating programs, departments, infrastructure (IS, utilities), administration

Design Process – Continual, Iterative

- Designate Architect, Planner, Coordinator
- Define Design Team – Participants – "The Owners"
  - There are different levels of ownership – "Physics"
- Planning Questionnaire - Program Objectives
- Functional Space Program
- Spatial Relationships of Functions (review)
  - Space Functions (rev) → Block Diagram (rev) → Floor Plan
- Plan Review
- Specifications (Systems, Equipment, Shielding, Vendors)
- Plan Review and Acceptance
- Then, Construction Phase (a different, important, story!)

Facility Planning Process - Detail

Meeting 1 – Month 1

- **Discuss Departmental Objectives**
- **Review Space Needs Questionnaires**
- **Identify Potential Options for Planning**
- **Review Connections with other Medical Center Functions**
- **Brief Overview of Site Planning Considerations**
- **Overview Construction Budget Requirements**
- **Evaluate Preliminary Milestone Schedule**
- **Discuss Major Medical Equipment Selection and Specification**

Meeting 2 – Month 2

- **Review First Draft of Program and Space Requirements**
- **Evaluate Preliminary Sketches of Department Adjacency Options**
- **Identify Major Engineering Components and Obtain Base Engineering Data**
- **Review Preliminary Sketches Indicating Room-By-Room Adjacencies**
- **Discuss Building Design Objectives**
- **Review Parking and Site Objectives/Parameters**
- **Review Construction Budget Requirements**
- **Discuss Preliminary Building Materials**
- **Review Major Medical Equipment Selection and Specification**

Facility Planning Process - Detail

Meeting 3 – Months 3-4

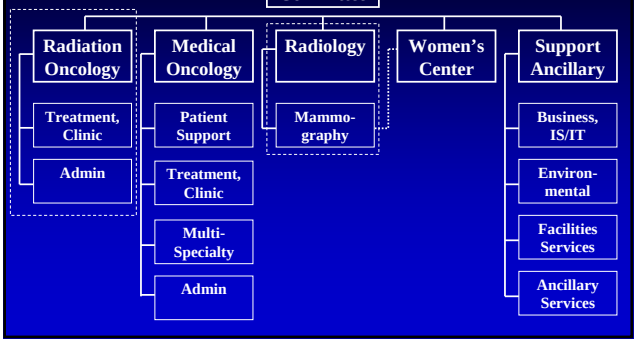
- **Review and Approve Final Draft of Program and Space Requirements**
- **Confirm Departmental Adjacencies**
- **Confirm Room-By-Room Adjacencies**
- **Review Preliminary Engineering Concepts**
- **Evaluate Building Design Options**
- **Confirm Construction Budget Requirements**
- **Review Preliminary Life-Safety Plans**
- **Review First Draft of Schematic Design Narrative**
- **Confirm Major Medical Equipment Selections**

Meeting 4 – Months 5-9

- **Present Final Program of Space Requirements**
- **Present Final Building Design**
- **Present Final Floor Plans**
- **Present Final Site Plan Indicating Parking, Entrances, Landscaping, Etc**
- **Deliver Final Schematic Design Submission**
- **Initiate Preparation of Preliminary Estimate of Project Cost**

Physicist – an important member of the Design Team

User Group Organizational Chart



Design Teams and Sub-Teams

Planning Questionnaire

For each department, program, or service
The future is 5 years from now (or so)

- Scope of Services, Goals, and Objectives
  - Current and Future; Special future equipment or space (**Vision**)
- Workloads: Past, Current, Projected (Stats, Growth)
- Internal Functional Relationships → **Flow**
  - A map of how your department works (or doesn't work)
  - Opportunity for revision
- Important External Relationships → **Flow, Collaborators**
- Staffing: Current, Projected, Organizational Chart (**Flow**)
- Existing Conditions – perceptions of current spaces

Planning Questionnaire - Existing Conditions

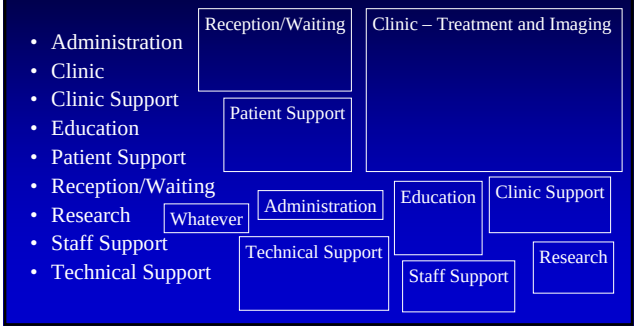
Grade as: Excellent, Adequate, Inadequate

- Systems
  - Heating, A/C
  - Communications
  - Electrical Service
  - Lighting
  - Plumbing
  - Medical Gases
  - Transportation
- Medical Equipment
  - Linear Accelerators, other Treatment
  - CT, MR, other Imaging
  - Patient support
- Space
  - Architectural Finishes
  - Efficiency of Layout
  - Size of Department
- Location
  - Relationship to Other Programs
  - Relationship to Outpatient Flow
  - Relationship to Inpatient Flow
  - Relationship to Supply Flow
- General Comments
- What is liked about current space?

Functional Space Program

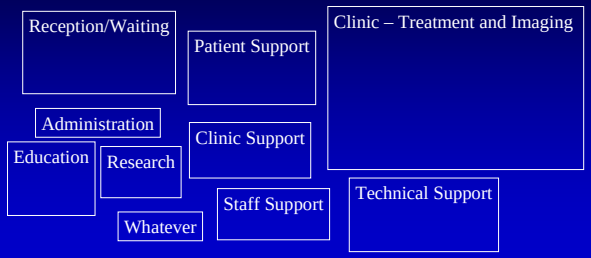
An Outline of Functions – A Relationship Map

- Administration
- Clinic
- Clinic Support
- Education
- Patient Support
- Reception/Waiting
- Research
- Staff Support
- Technical Support



Functional Space Program

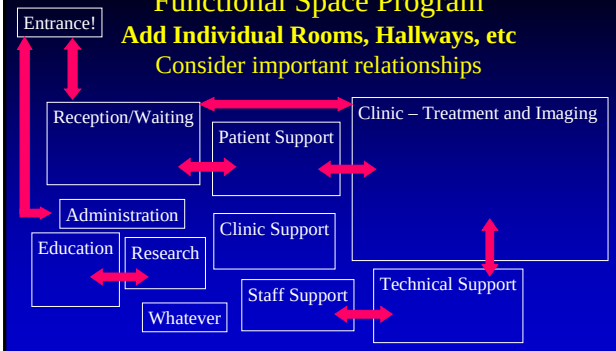
Spatial Relationships - Clustering



Functional Space Program

Add Individual Rooms, Hallways, etc

Consider important relationships



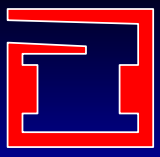
Important Planning Activities

(vary with project size and scope)

- Site visits to other facilities
  - Facility design aspects – with architects
  - Equipment – with vendors
  - Reps: technologists, therapists, physics, MDs, admin
- Equipment decisions and specifications
- Equipment routes to rooms for installation - riggers
- Specific room layouts, shielding consultant/specification
- Planning for the future: potential and unknowns
- Clustering/Segregation of areas
- Communication and review of **all** plans: follow process
- Requirements: State, Local Building Codes; Rad Prot Regs
- Timeline for Planning and Construction

Possible Problem Areas

A large number of possibilities



- Net vs Gross space – use room templates
- Specification of shielded doors
  - mechanical and radiological parameters
- Thru-wall penetrations (signal cables, utilities): 2^o, 1^o
- Design/layout of operator control areas
- Laser wall-mounting systems; Signage; Interlocks
- Route for equipment entry (size and weight)
- Lead vs concrete shielding (diagnostic vs therapy)
- 18 feet slab-to-slab thickness for therapy rooms

Possible Problem Areas
A large number of possibilities

- Room accommodations for the future?
- Location of network access ports (eg, in-room)
- Designation of utility chases – they always eat up space in the end
- When possible, overstate site footprint relative to building – don't run out of land
- Main structural columns – widest placement possible
- Corridor width – standard 8 ft (code)
- Education of participants on unique or important items

Example: Comprehensive Cancer Center
Wake Forest University Baptist Medical Center

Comprehensive Cancer Center
Facility Rationale

- Cancer services spread in disparate locations throughout the institution
- Patients required to travel to multiple locations for specialty care: med + surg + rad onc; labs, etc
- Few multidisciplinary clinic locations where specialty physicians could visit the patient
- Radiation oncology facilities over 30 years old, limited for expansion opportunities: 16,000 sq ft

Comprehensive Cancer Center
Desirable Characteristics (Solutions)

RadOnc Vision
"A premier academic radiation oncology department committed to reducing the burden of human cancer."

- "One Stop Shop" for cancer services
- Multidisciplinary clinics
  - for efficient patient visits with reduced patient burden
  - to facilitate interactions across physician specialties
- State-of-the-art facilities for radiation oncology, medical oncology, multidisciplinary clinics, and outpatient radiology (with a cancer emphasis)
- Provision of existing/additional quality cancer support services in a pleasing and comforting environment
- **Radiation Oncology:** Four same-class linear accelerators (IMRT, EPID), gamma/linac radiosurgery, 3 dedicated simulators (R/F, PET-CT, MR), dedicated HDR + imaging, increase in exam rooms, academic-admin offices, computing, trainee space …(etc)

Functional Space Program – RadOnc Example

Administration
- Asst. Clinical Director
- Business Manager
- Chairman
- Chairman Secretary
- Clinical Director
- Clinical Engineer
- Coder/Billing
- Computer Programmer
- Dosimetrists
- Nurse Manager
- Nurses
- Physician Faculty-NCBH
- Physician Faculty-Rotate
- Physics Faculty-NCBH
- Physics Faculty-Rotate
- Protocol Manager
- Rad. Biology Faculty
- Secretarial Pool
- Senior Transcriptionist
- Transcription Pool

Clinic
- Cast/Immobilization
- CT Scanning
- CT Scanning Control
- Examination
- Linac Treatment
- Linac Control
- Linac Film Stor/Review
- Linac Modulator Rooms
- Scrub Room for IORT
- Minor Procedures, HDR/ Orthovolt. Treatment
- Orthovolt./HDR Control
- Rad./Fluoro. Control
- Patient Dressing
- Simulation
- Simulation Control
- Radiosurgery Suite

Clinic Support
- Environmental Services
- Linen Holding, Clean
- Linen Holding, Soiled
- Nurses Sta./Work Room
- Pat. Records/Film Storage
- Patient Transportation
- Physician Work Room
- Utility, Clean
- Utility, Soiled (Reproces)

Education
- Class Room
- Seminar Room
- Conference Room
- Library
- Medical Residents
- Medical Students
- Nursing Education
- Physics Residents
- Physics Students
- RadBio Postdocs/RAs

Patient Support
- Cancer Support Program
- Dietary
- Social Work
- Restrooms

Functional Space Program – RadOnc Example

Reception/Waiting
- Appointments/Sched'ing
- Clinic Lobby
- Clinic Reception
- Waiting, Inpatient
- Waiting, Outpat Treatment
- Waiting, Outpat FU/Cons.
- Admin. Recept./Waiting
- Admin/Chair Meeting

Research
- Computer Laboratory
- Protocol Review Room
- Rad. Biology Labs
- Clinical/Resident Lab
- Cesium Irradiator
- Supplies Storage
- Equipment Room
- Equipment Space - currently "borrowed"
- Cold Room
- Warm Room
- Dark Room
- Dishwashing/Sterilizing
- Lounge/Food Storage
- Restrooms

Technical Support
- Clinical Physics Lab.
- Communications Closets
- Computer Room
- Clinical Engineer Shop
- Electrical Closets
- Equipment Storage
- Film Processing/Storage
- Isotope Storage/Prep.
- Mold Rm/Machine Shop
- Treatment Planning

Staff Support
- Copier/Fax, Office Stor.
- Lounge
- Mail Center (Copy Rm?)
- Restrooms
- Therapist/Nurse Lockers

Functional Space Program – RadOnc Example

Category	Required Space			Existing Space			New Space Needed
Clinic	Num.	Sq. Ft.	Total	Num.	Sq. Ft.	Total	Sq. Ft.
Cast/Immobilization	1	140	140	0		0	140
CT Scanning	1	300	300	0		0	300
CT Scanning Control	1	100	100	0		0	100
Examination	12	120	1440	4	108	432	
				1	120	120	
				1	192	192	696
Linac Treatment	4	1200	4800	1	775	775	
				1	816	816	
				1	825	825	
				1	1232	1232	1152
Linac Control	4	80	320	4	48	192	128
Linac Film Stor/Review	4	80	320	4	8	32	288
Linac Modulator Rooms	4	50	200	1	67	67	133
Scrub Room for IORT	1	90	90	0		0	90
Minor Procedures/HDR/ Orthovolt. Treatment	1	400	400	1	224	224	176
Orthovolt./HDR Control	1	70	70	1	14	14	56
Rad./Fluoro. Control	1	70	70	0		0	70
Patient Dressing	4	160	640	2	250	500	140
Simulation	1	350	350	1	234	234	
				1	378	378	-262
Simulation Control	1	100	100	1	64	64	36
Radiosurgery Suite	1	800	800	0		0	800
Sub Total Sq. Ft.		Req'd:	10140		Have:	6097	Need: 4043

Plan Review Comments

Comments: July, 2000

1. Group the Physics Section offices as a cluster – current plans have a few intervening offices.
2. The main staff entrance enters through the main patient waiting area. This will not work.
3. In general, it looks like a long walk from the Main Entry to the clinic area. If this length could be reduced, it might be helpful for some of our patients.
4. We suggest that "customer service" and patient flow be examined carefully to make the facility as patient oriented and patient friendly as possible. We suggest the following approach for patient reception and "calling" of patients for treatment: The following process is proposed:
   1. Patients wait in Rad Onc waiting area, whether for consults, sim, or on-treatment
   2. Patients only enter the consult/sim/treatment area when accompanied by a therapist or other staff
5. Treatment Planning for the Gamma Knife and HDR may be too small for both planning systems.
6. Two Virtual Simulation rooms are needed in the Simulation area
7. Two of four Linear Accelerator Rooms need the 3.5 meter isocenter-to-wall distance.
8. At one point large common conference room areas were shown. Have these been moved to another floor?

Comments: September, 2002

1. CT-PET Layout? Major column in space. Meet with vendor. Location of patient prep and injection areas? Use stretcher holding. Lead shielding required?
2. MR Layout? (Ok? Are there changes to 3T design) Meet with vendor. Patient access acceptable? Door size?
3. Linen cart alcove totally useless now.
4. Location of blanket warmers? Place in one of Storage Rooms.
5. Badge controlled door access only to MR area.
6. Move doors for Storage Rooms within MR/CT-PET form West side to North side
7. Location of emergency OFFs in Linac rooms
8. Gamma Knife room – plan for "Model C Unit" – vendor to review?
9. Location of Radiation Monitor in HDR room (1620)
10. Short conduit runs for Linac rooms, HDR, and Gamma Knife?
11. Review of door design for Linac rooms
12. Review of communication plan so far
13. Review of lighting plan, especially rooms with dimmable lighting?
14. Lateral laser heights for Linac shown at incorrect height. Height needs to match isocenter height (plan A810). 14 A, B & C.

WFUBMC Radiation Oncology

Functional Areas

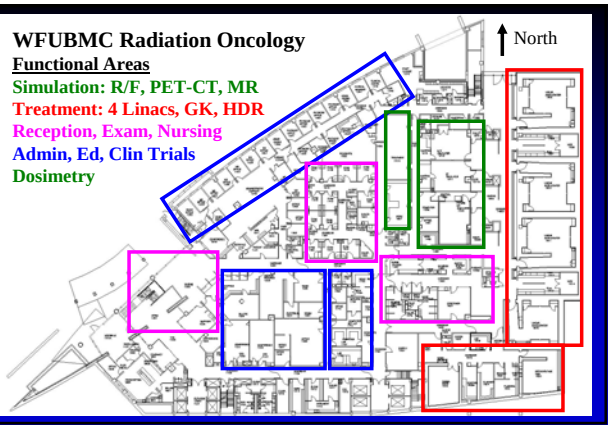
Simulation: R/F, PET-CT, MR

Treatment: 4 Linacs, GK, HDR

Reception, Exam, Nursing

Admin, Ed, Clin Trials

Dosimetry



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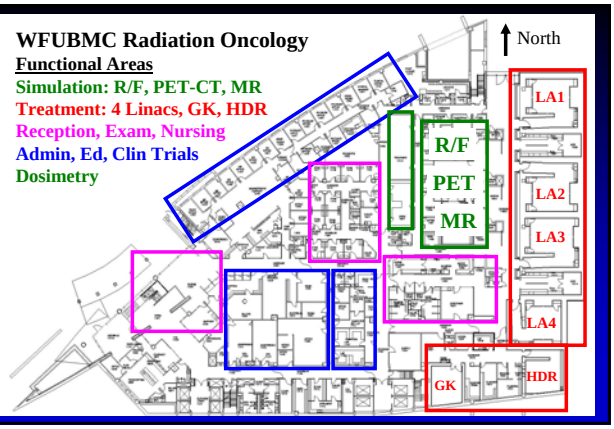


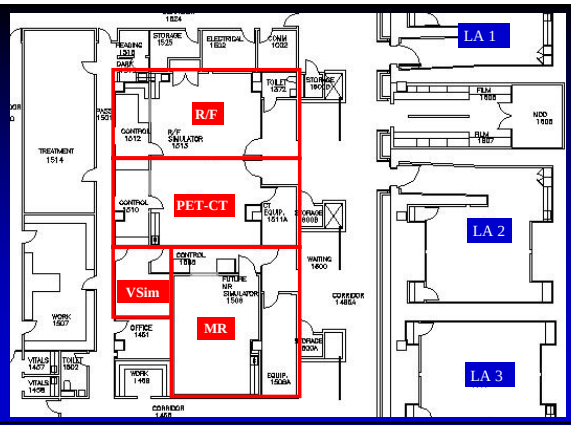
Outpatient Comprehensive Cancer Center
Bioanatomic Imaging and Simulation Tools

GE Discovery ST PET-CT Scanner

8 slice, helical scan, LightSpeed (Ultra) CT scanner, extra large FOV, BGO detectors, 2D/3D, gated acquisition, Exact couch, LAP laser marking.

GE 3T MRI Scanner – Short Bore

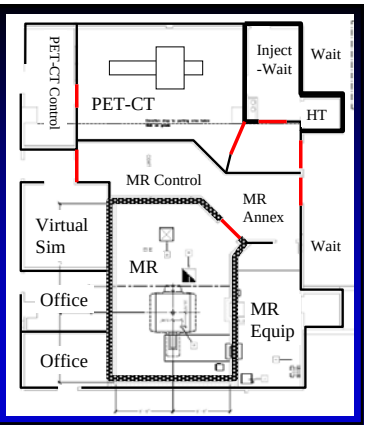
3.0T (short bore), 3D brain and prostate spect, fMRI, MR angio, diffusion-weighted imaging, diffusion tensor imaging, multi-nuclear spect, Excite technology, LAP laser marking



Simulation-Treatment Relationship

PET-CT

- Adjacent control, scanner, inject-wait, lab, and toilet
- 1/8 in Pb; control, scanner
  - adjacent waiting, scanner bkg
- 1/2 in Pb; inject-wait, toilet
- Isotope prep near on-site
- Shared Virtual Simulation
- Laser marking system
- Automated PACS archive, selective push to TPS
- Normal access security

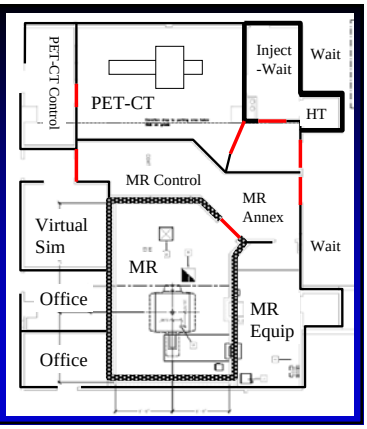


View from Operator Entry

Patient Access, Injection Room

3.0T MR

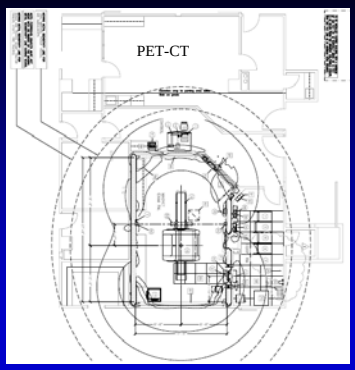
- Adjacent control, view window, scanner, plus annex
- RF- and B-Field shielding – 5 gauss line containment
- Shared Virtual Simulation
- Laser marking system (work)
- Med gases, port for monitoring
- Equipment is very stable, excellent field homogeneity, meets ACR accreditation criteria for 3.0T
- Examining MRSI stability
- Automated PACS archive, selective push to TPS
- Postings per magnetic field in English and Spanish
- All entry points carded for security



View from Annex Entry

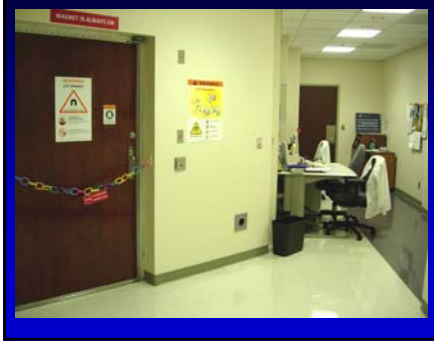
Gauss Line Shielding Computation

- 5 gauss containment
- 0.5 gauss at operator – lower at PET-CT
- Institutional approval
- Performed by vendor
- Implemented at time of construction
- Surveys show effective

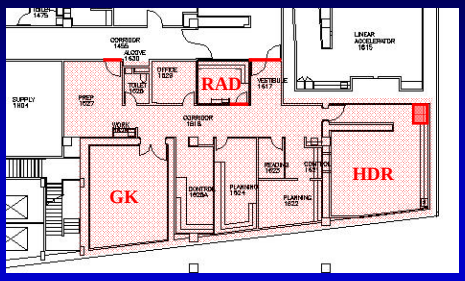


MR Shield Materials "mu metal" and Copper

View from Annex

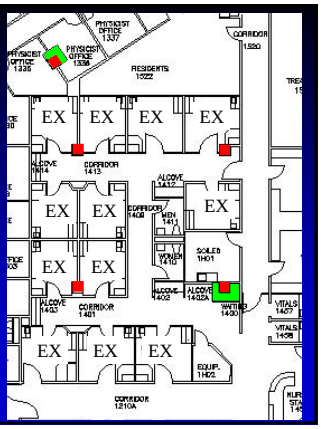


Radioactive Materials Control
Friendly to Homeland Security



Exam Rooms, Structural Columns and Utility Chases

- Exam Rooms – Standard, ENT, and In-patient
- Structural columns have to go somewhere ■
- Utility chases often added to columns ┐
  - to the demise of adjacent space
  - designate as soon as possible!



Keys For Successful Planning

- Excellent communication
  - Make written comments, dated and sent; maintain records
  - Attend all User Meetings or send designee in your place
- Ask for high-quality architects, contractors, sub-contractors
  - Probably not your choice, but Administration's;
  - Architect experience, level of expertise, match to the scope of the project – choose a good one you can work with
- A critical eye for detail – learn to read plans (A, E, P, S)
  - A: Top-view floor plans; E: Electrical P: Plumbing
  - S: Structural (concrete, shielding) C: Communications
  - Obtain Sections – vertical planes; Know "Plan North"

Keys For Successful Planning

- **Well-written [Device] specifications**: radiological treatment and imaging devices, their receipt, installation, and acceptance testing
- **Well-written [Shielding] specifications**: shielding materials, thicknesses, shielded door mechanical and radiological properties, receipt of all devices, materials, and components and match to specifications [concrete density = 147 lb/ft^3]
- Ask to be consulted on any potential changes on vendors for any radiological devices or components
- Be innovative to help solve problems – You're a Physicist!
- Never revise anyone else's space without their permission
- There are always constraints – make reasonable requests

Summary

- Facility Design: an important process
- Small- or large-scale
- Vision and Proposal are important
- Participants are varied – multi-disciplinary
- Communication is key
- Physicist plays a key technical role – Get Involved!
  - Equipment, facility design, shielding specifications
- Have a great time designing and building!

(hard hat time!)

You're Invited

Please Come Visit

WAKE FOREST UNIVERSITY SCHOOL of MEDICINE

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