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As the official journal of the AIA Academy of Architecture for Health (AAH), this publication explores subjects of interest to AAH members and others involved in the fields of health care architecture, planning, design, and construction. The goal is to promote awareness, educational exchange, and advancement of the overall project delivery process, building products, and medical progress that affect all involved in those fields.

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FGI Then and Now: The Modifications for Better Design and Planning for Imaging in the Operating Room

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ABSTRACT

More and more hospitals are recognizing the value of imaging-based surgeries when it comes to their patient care. Determining whether this space is an operating room or a fancy imaging center is a challenge for both owners and architects. Whether the facility is using the *FGI Guidelines* and which version is currently active in their state also can confuse the decision. This article compares the *2014 Facility Guidelines Institute (FGI)* imaging facility definitions and requirements with the *2018 FGI Guidelines*, the two most active documents currently adopted by a majority of U.S. states for health care occupancy design needs. Differences in requirements are reviewed and the impacts they present to facility designs are identified. Two case studies are reviewed—one a Class 3 Imaging Center/Hybrid OR and the other a Class 3 Imaging Center/Standard OR—to illustrate the differences and similarities based on the *2018 FGI requirements*. Depending on where the project lands in the above classification also presents specific requirements for the design of the space. This will include attention to details of spatial programming; equipment placement and access; and architectural, mechanical, and electrical detailing. Each of the varying classifications has differing requirements that need to be accommodated, translating into design and construction cost impacts to the project. No owner wants major project surprises down the road after budgets, schedules, and design planning have already been completed and commitments have been made to medical providers.

Facility Guidelines Institute

Consider:

- Forty-two states have adopted some edition of the *Guidelines* (this includes Wisconsin, which has adopted only the HVAC requirements).
- Six states (Colorado, Idaho, Kansas, Maine, Mississippi, New York—*also Washington, although not listed*) that have adopted the *Guidelines* permit use of a more recent edition than that adopted in some instances.
- Three states have not adopted the *Guidelines* but allow their use as an alternate path to compliance in some instances.
- Five states do not use the *Guidelines* in any official capacity, although most of these appear to use the documents for reference.

(Facility Guidelines Institute, Adoption of the *FGI Guidelines*, January 15, 2021, fgiguidelines.org)

So, what is the *FGI Guidelines* and why do they play such an important role in facility design that states would consider adopting them as the minimum requirements for health care design? According to the FGI website:

> The *FGI Guidelines* for Design and Construction has a long history as a federal and privately written document. The original General Standards appeared in the Federal Register on February 14, 1947, as part of implementing regulations for the Hill-Burton program. The standards were revised from time to time as needed. In 1974 the document was retitled Minimum Requirements of *Construction and Equipment for Hospital and Medical Facilities* to emphasize that the requirements were generally minimum, rather than ideal standards. The 1974 edition was the first for which public input and comment were requested (Facility Guidelines Institute, History of the Guidelines, fgiguidelines.org).

Through the last 45-plus years these *Guidelines* have been updated periodically to attempt to keep them current. At one point the updates were taken over by the American Institute of Architects Committee on Architecture for Health (AIA/CAH), which became the AIA Academy of Architecture for Health (AIA/AAH). Other organizations involved in updates included the American Society for Health Care Engineering (ASHE) and the National Institutes of Health (NIH). With the release of the *2014 FGI* document, a complete reformatting of the standards was completed, including dividing the document into differing health care occupancy types. Further, with the release of the *2018 FGI* document, the differing occupancy types were divided into separate volumes as well.

The adoption process by states, as noted above, has not been consistent. The FGI is not the only document published related to health care design, and some states and acute care/ambulatory care facilities choose to use

other organizations' documents for their guidance and third-party certification. For the purposes of this article, however, since the authors' practice is primarily within the state of Washington, only the FGI is reviewed for applications to the subject at hand.

2014 FGI or 2018 FGI?

Washington state happens to fall into the second category above. While currently the 2014 edition of the *Guidelines* is still formally the active document, the Washington State Department of Health (DoH) both allows and recommends the 2018 edition be used for health care projects in development. According to DoH, the 2018 edition would have been adopted by this time if the COVID-19 situation had not interrupted the normal path of code implementation.

Between the 2014 and 2018 editions, the definitions and requirements of imaging centers has changed substantially due to the desired medical procedures using imagery-guided surgeries. Owners and architects not involved in this market sector can be hit with big surprises if they have not committed the time to research the differences and understand the impact to design requirements and construction cost budgets. Even the imaging equipment vendors are somewhat behind in understanding the differences between the two *FGI* editions and what it means for their conceptual equipment layouts.

Once contracted by owners to provide design assistance and participate in these tenant improvements (typically they are hospital-based and not separate, stand-alone facilities), architects need to start having the difficult conversations with the medical providers to understand their usage intentions. In Washington state, using the *2018 FGI Guidelines* has helped define the requirements of an imagery-guided practice. Most of the definition differences relate to sedation of the patient and the type of procedures intended for the space. The owner could very easily end up with an imaging center that is required to be designed as a full-blown operating room. Looking first at the differences between the imaging center definitions from the perspective of the 2014 and 2018 editions (see Table 1) shows how the language has evolved.

Imaging Services	**2014 FGI Classification** **2.2-3.4 Imaging Services** **2.2-3.5 Interventional Imaging** **2.2-3.6 Nuclear Medicine** **2.2-3.7 Radiation Therapy**	**2018 FGI Classification** **2.3-3 Diagnostic and Treatment Areas** **Table 2.2-2 Classification of Room Types for Imaging Services**
Diagnostic radiography, fluoroscopy, mammography, computed tomography (CT), ultrasound, magnetic resonance imaging (MRI), and other imaging modalities	Each imaging service is given a distinct set of requirements with the Guidelines that are generic in description, no attempt has been made for groupings based on the procedures except for interventional, or image-guided procedures, and nuclear medicine; certain modalities present unique design characteristics for their rooms/suite, no specific requirements are identified relating to flooring, floor/wall base assemblies, wall finishes and ceiling	Class 1 Imaging Room - rated as an "Unrestricted area," accessed from an unrestricted area, specific requirements for flooring, wall finishes and ceiling.
Diagnostic and therapeutic procedures such as coronary, neurological, or peripheral angiography; electrophysicology procedures		Class 2 Imaging Room - rated as a "Semi-restricted area," accessed from an unrestricted area or a semi-restricted area, specific requirements for flooring, floor/wall base assemblies, wall finishes and ceiling.
Invasive procedures: Any Class 2 procedure during which the patient will require physiological monitoring and is anticipated to require active life support		Class 3 Imaging Room - rated as a "Restricted area," accessed from a semi-restricted area, specific requirements for flooring, floor/wall base assemblies, wall finishes and ceiling.

Table 1 – 2014 FGI vs. 2018 FGI Imaging Services

After determined with the client what type of imaging center standards they are going to be designing to, it is time to understand what those requirements are. This article presents two case studies of Class 3 facilities that are currently under design by the authors' firm. Both facilities are located within large metropolitan areas and use identical imaging equipment from the same manufacturer. Each, however, has chosen to classify their space differently. One facility is moving forward with their center as a Class 3 Imaging Center/Standard Operating Room; the other is moving forward with their center as a Class 3 Imaging Center/Hybrid Operating Room.

That begs the question—what's the difference between these two?

Class 3 Imaging Rooms classified as standard operating rooms differ slightly in their imaging equipment capabilities. The primary difference is that the imaging does not slide in and out of the working space of surgical procedures. The equipment is typically fixed to the floor and/or ceiling of the room. This limits the types of procedures that are normally conducted within the room itself. With this as the basic difference, the *2018 FGI* requires the Class 3 Imaging Room design to meet the requirements for a standard operating room (**2.2-3.3.3**). It also allows an operating room that meets the requirements of a hybrid operating room (**2.2-3.3.4**) to meet the requirements of a Class 3 Imaging Center.

According to the *2018 FGI*, hybrid operating rooms are those that use imaging systems integrated into the operating room to support imagery-guided procedures. These can be based on varying types of modalities, including from basic vascular imaging technologies to interoperative CT and MRI. Hybrid operating rooms allow for the imaging equipment to be mobile within the operating room—having the ability to slide in and out of the working space of the surgical procedure. Hybrid operating rooms are also considered Class 3 Imaging Rooms (*2018 FGI* **2.2-3.3.4 and 2.2-3.3.4.1**). The hybrid operating room is required to be designed in compliance with the requirements of operating rooms (**2.2-3.3.3**) and imaging services (**2.2-3.4**).

For the two case studies presented, both clients were made aware of these different definitions and requirements. They then made their choice on the classifications of the rooms based on the types of procedures they desired to provide within the rooms. The decision boiled down to the mobility of the imaging equipment and the overall size of the room that would be available to develop.

Case Study 1: Class 3 Imaging Center/ Standard Operating Room

This facility had an unused existing procedure room within the larger imaging suite. The room was never outfitted with the imaging equipment planned for it until 2021 when patient procedure needs had grown to the point where the room now needed to have the necessary imaging equipment installed. A biplane imaging system is proposed (ceiling-mounted C-arm and floor-mounted C-arm) primarily to support vascular and neuro procedure types. To accommodate the imaging equipment's physical needs, the procedure room will need to be modified both in size and volume.

During conceptual layout, once the owner agreed to use the *2018 FGI* and determined the suite would be a Class 3 Imaging Room/Standard Operating Room based on the procedures to be provided, the project team quickly recognized the original concept would not meet the *2018 FGI* requirements. The imaging equipment vendor had presented an original equipment concept plan based on their understanding of current requirements (see Figure 1, following page).

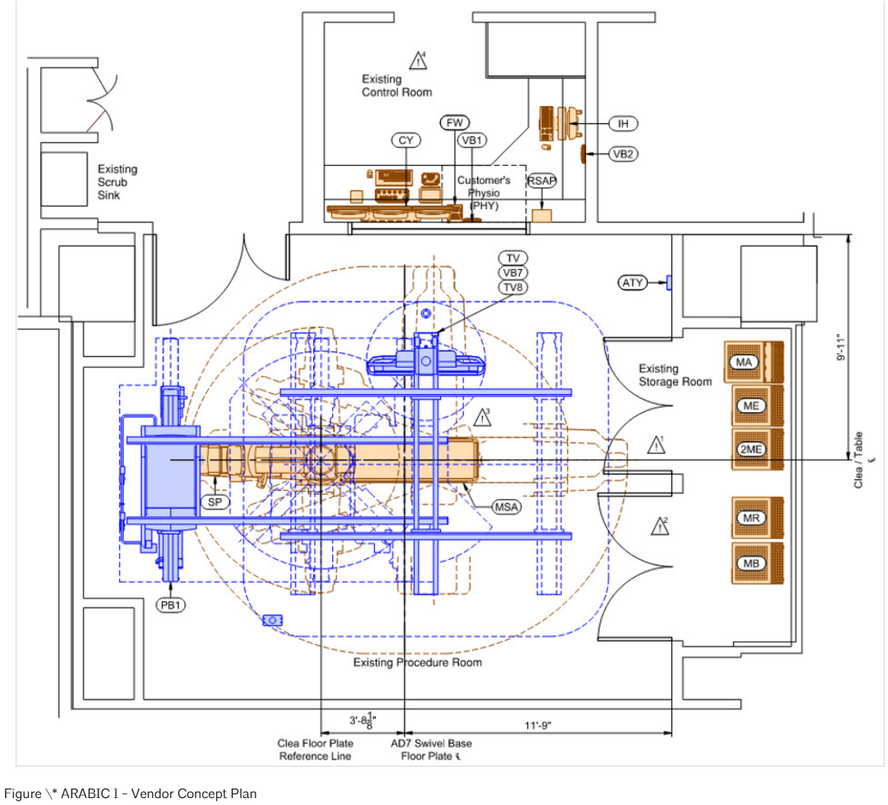

Figure 1 - SEQ Figure * ARABIC 1 - Vendor Concept Plan

The architect conducted a review of the applicable sections of the *FGI* and was able to graphically illustrate the design features that would prohibit this concept from complying with the *FGI* requirements. Those features were noted on the vendor concept plan and presented to the project team, including the equipment vendor (see Figure 2). The biggest impact to the overall concept was the requirement that the electronics equipment room be accessible from outside of the procedure room itself. This caused the owner to search for adjacent rooms that would be of adequate size to accommodate the multiple electronic cabinets while minimizing the relocation of other services within the suite.

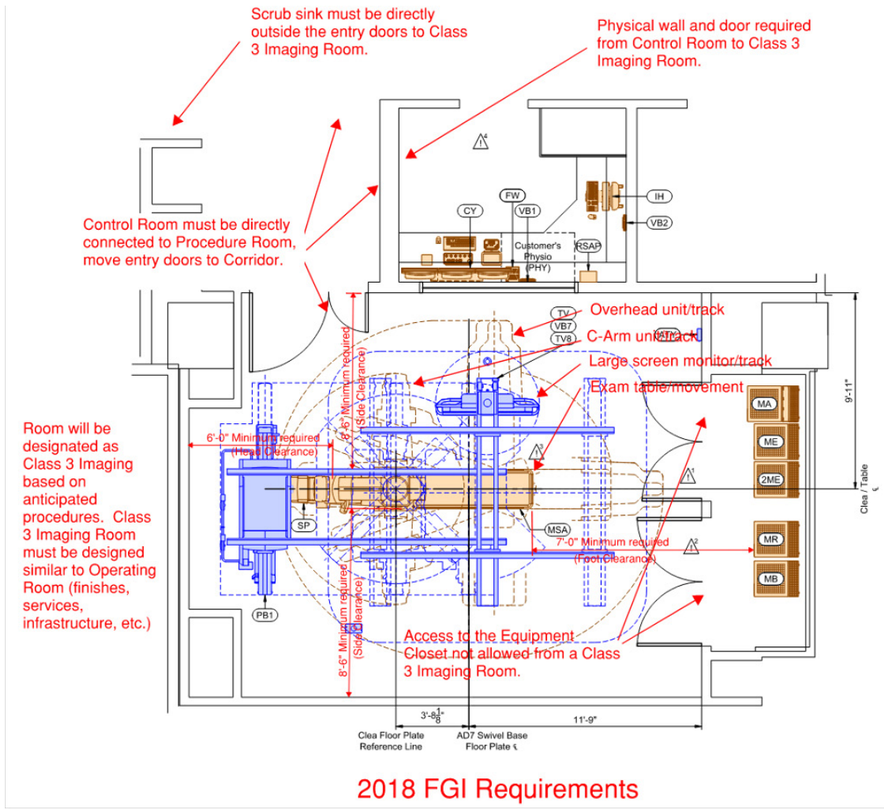

Figure 2 - FGI Impact to Vendor Concept Plan

Unfortunately, the only viable space that could be released for this purpose would cause a domino relocation effect involving several offices, storage rooms, and staff support areas. The overall imaging suite was reviewed with this need in mind, and the decision was made to capture the adjacent space and proceed with the other functional changes needed within the suite.

The captured space was verified for size and equipment layout with the imaging vendor. The concept plan proceeded into a full-scale mock-up/simulation to test the layout for clearances, procedures, and patient/staff/material movement within the proposed space. Modifications were made based on the input of 15 surgical/imaging staff members who participated in the mock-up/simulation. The mock-up/simulation exercise produced consensus among the participants for the preferred layout (resulting in rotating the head-end of the exam table 180 degrees from the original layout) based on actual testing completed as part of the exercise. The exercise resulted in the final concept plan that will now move forward for funding approval (see Figure 3) with a goal of occupancy and patient procedures starting in mid-2022.

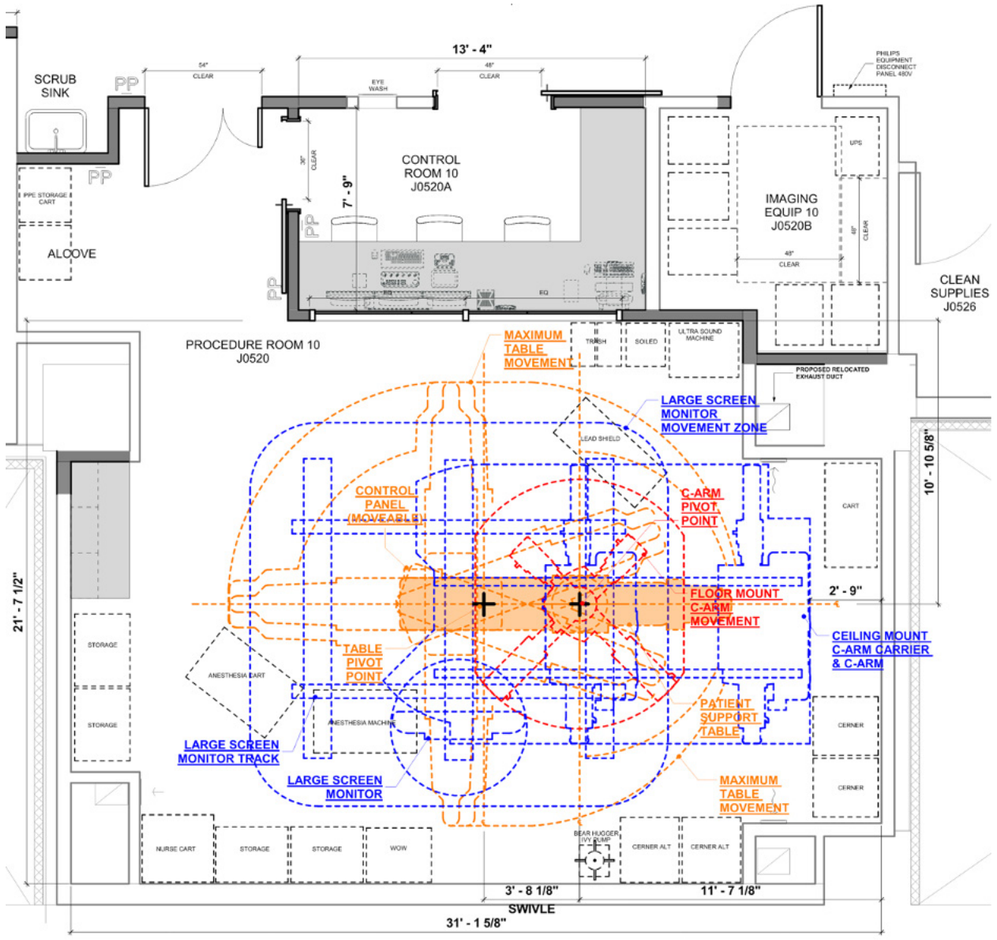

Figure 3 – Final Concept Plan

Case Study 2: Hybrid Operating Room

The architect and imaging equipment vendor coordinated with a second hospital for a new Hybrid OR using identical equipment as the first project design. The lessons learned from the first hospital staff reviews and the mockup process were extremely valuable to apply. This resulted in saving efforts and design steps that were found to be problematic with the first hospital's concept layout. Together, the architect and vendor were able to guide the owner's needs before any actual concept plans were created and offer recommendations based on verified staff input. A different approach was taken with the second project, however, since the physical attributes of the second room was not identical to the first room. The architect was able to utilize the FGI Guidelines and the project need analysis to find an acceptable solution to staff considering the requirements for the new imaging room proposed. In addition to this room being an imaging center, it was planned for an upgrade to a Hybrid Operating Room.

Design Requirements	**Class 3 Imaging Room** **2.2-3.3.3 Operating Rooms** **2.2-3.4 Imaging Services** **Tables 2.1-1, 2.1-2, 2.1-3** **Table 7.1**	**Hybrid Operating Room** **2.2-3.3.3 Operating Rooms** **2.2-3.3.4 Hybrid Operating Room** **2.2-3.4 Imaging Services** **Tables 2.1-1, 2.1-2, 2.1-3** **Table 7.1**
Operating Room minimum physical attributes	400 square feet clear floor area 8'-6" clear sides (from table) 6'-0" clear head 7'-0" clear foot	600 square feet clear floor area 20'-0" minimum clear dimension (Renovated rooms may be reduced to 500 square feet clear floor area, must maintain the 20'-0" minimum clear dimension). Actual room size dependent on imaging equipment.
Control Room requirements	Physically separated from the imaging room (door, walls, window), size as required to accommodate equipment placed in room. Door separating not required if Control Room serves only one OR and is built, maintained and controlled same as Operating Room.	Physically separated from the imaging room (door, walls, window), size as required to accommodate equipment placed in room. Door separating not required if Control Room serves only one OR and is built, maintained and controlled same as Operating Room.
Power/Data/Nurse Call/Medical Gas requirements	36 Outlets (16 convenient to table), 2 on each wall Staff assistance station Emergency call station 2 Oxygen, 5 vacuum, 1 medical air, 1 waste anesthesia gas disposal, 1 instrument air	36 Outlets (16 convenient to table), 2 on each wall Staff assistance station Emergency call station 2 Oxygen, 5 vacuum, 1 medical air, 1 waste anesthesia gas disposal, 1 instrument air
HVAC requirements	Minimum 3 outdoor air changes per hour Minimum 15 total air changes per hour Maximum 60% relative humidity Design temperatures 70-75 F range	Minimum 4 outdoor air changes per hour Minimum 20 total air changes per hour 20%-60% relative humidity range Design temperatures 68-75 F range

Table 2 – 2018 FGI Comparison Class 3 Imaging/Standard OR vs. Class 3 Imaging/Hybrid OR

Table 2 illustrates the differing requirements for the room size attributes of the operating room and the mechanical air system requirements of each. For concept planning, only the physical attributes of the room size are critical to understand. Starting with an existing OR that will be rededicated for use as the hybrid OR (see Figure 4), a mock-up/simulation exercise was conducted prior to developing the concept plan.

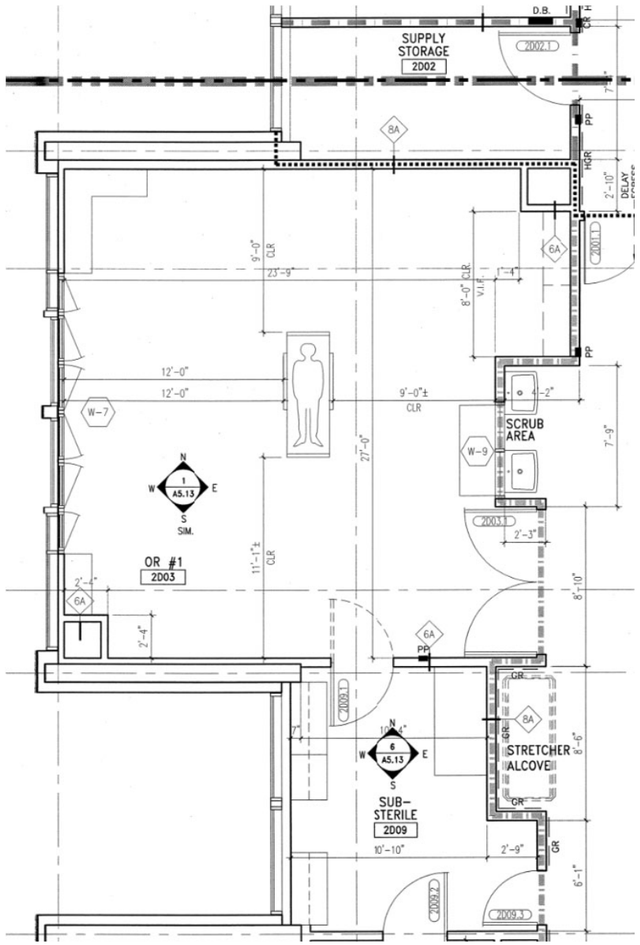

Figure 4 - Existing OR for Conversion to Hybrid OR

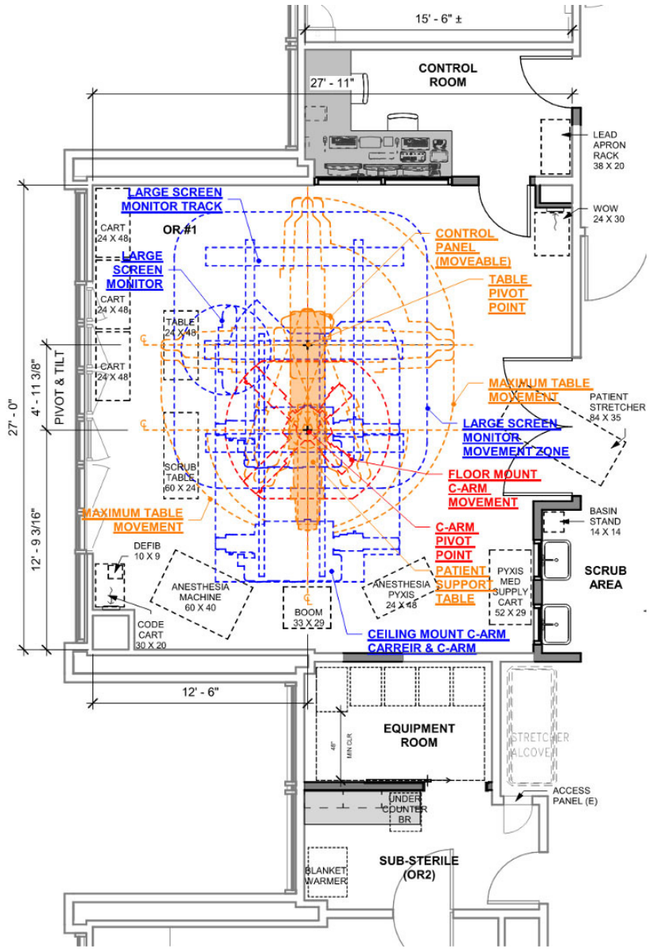

Figure 5 - Hybrid OR Concept Plan

By conducting the procedure simulation with the various equipment components placed around the operating room, the project team was able to create a concept plan that met the needs of both the surgical and imaging teams much sooner than with the case study 1 process. While the operating room has been slightly enlarged, the greater impact to the entire layout was capturing adjacent spaces, again, for the electronic equipment room and the creation of a new control room. Neither of these spaces existed in the original operating room, and it required the staff to be willing to concede available space for these purposes.

Turning the supply storage room into the control room forced staff to rethink how their supply chain and material processing will remain functional, as this location is a four-OR suite and shares supply storage in central locations. Capturing half of the sub-sterile room between OR 1 and OR 2 doesn't present quite as much challenge for surgical staff, as only half as much surgical storge is required (since OR 1 is being converted with its own internal storage).

The concept plan was able to move forward quickly because the needs of the spaces related to the hybrid OR were already determined and the surgical and imaging staff had participated in a mock-up/simulation exercise. The remaining effort for the architect consisted primarily of documenting the decisions for the project team and getting final agreement on the plan (see Figure 5).

The hybrid OR project is now moving through the design phases with a goal of occupancy and patient procedures starting in early 2022.

Conclusion

A Class 3 Imaging Room must be designed to meet specific requirements for imaging (Table 2.2-2) and as a standard operating room (Section 2.2-3.3.3, Section 2.3-4), with infrastructure requirements based on the designation received (Tables 2.1-1, 2.1-2, 2.1-3, 7.1).

A hybrid OR must also be designated as a Class 3 Imaging Room and designed to meet many of the same specific requirements for imaging (Table 2.2-2) along with the increased requirements (Section 2.2-3.3.3, Section 2.2-3.3.4, Section 2.3-4) for a hybrid operating room (over a standard operating room) with infrastructure requirements based on the designation received (Tables 2.1-1, 2.1-2, 2.1-3, 7.1).

When a new imaging project surfaces, the architect needs to open the discussion with the owner by verifying the imaging center designation. If it's to be Class 3, be sure to inform the owner about the operating room requirements that come with that designation.

References

Facility Guidelines Institute, *Guidelines for Design and Construction of Hospitals and Outpatient Facilities, 2014 Edition* fgiguidelines.org.

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