RSP+ MAYO CLINIC

REGION 6 ASHE

MAGNETO-WHAT? Lessons Learned from Design & Construction of Mayo Clinic's Magnetoencephalography (MEG) Lab

1 LEARNING OBJECTIVES

2 TEAM INTRODUCTION

3 WHAT IS MAGNETOENCEPHALOGRAPHY?

4 PRE-DESIGN THROUGH CONSTRUCTION

5 PROJECT PHOTOGRAPHY

6 Q&A

LEARNING OBJECTIVES

LEARNING OBJECTIVES

DEFINE

- The diagnostic and treatment functions of MEG equipment

IDENTIFY

- The appropriate sites, delivery paths, and staging areas for a MEG Lab based on vendor requirements

EVALUATE

- The programmatic elements and engineering considerations for a MEG Lab

TEAM INTRODUCTIONS

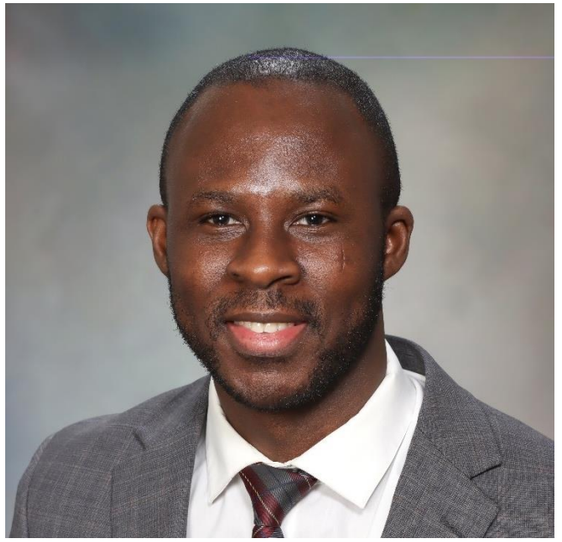
PRESENTATION TEAM

ERIC STRICKLAND

Senior Healthcare Planner
RSP Architects

BENJAMIN BRINKMANN, PH.D.

Professor of Neurology and
Associate Professor of
Biomedical Engineering
Mayo Clinic



CHARLES ASAMOAH, P.E.

Project Manager
Department of Facilities
Project Services
Mayo Clinic

CRAIG NEUSER

Construction Manager
Department of Facilities
Project Services
Mayo Clinic

PROJECT TEAM

Design Team

- RSP Architects – Architecture & Interior Design
- Design Engineers – Mechanical, Electrical And Plumbing Engineer
- MBJ – Structural Engineer

Equipment Vendors

- Megin – Magnetoencephalography (MEG) Equipment Vendor
- Vacuumschmelze (VAC) – Magnetically Shielded Room Vendor

General Contractor

- Benike Construction

WHAT IS MAGNETOENCEPHALOGRAPHY (MEG)?

WHAT IS MEG?

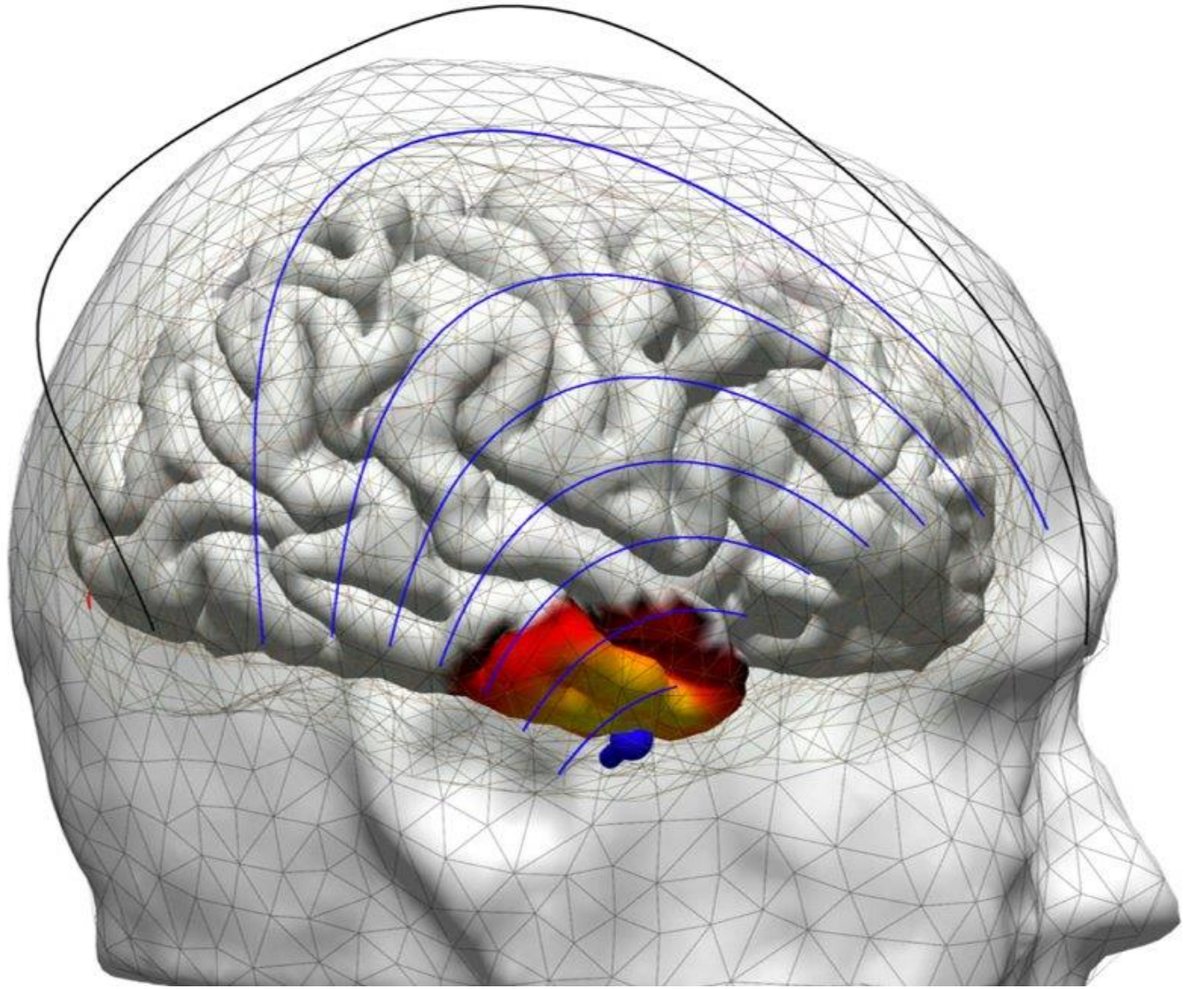
- A technician can measure the magnetic fields that arise from neuronal activity in the brain.
- **MEG does not use any magnets**. Rather, the test uses very sensitive detectors to measure magnetic fields from the brain.
- The MEG test takes place in a room built to block external magnetic fields.
- During MEG, a patient sits or lies on their back without moving. Sensors in the helmet record magnetic activity in the brain.

Source: https://www.mayoclinic.org/tests-procedures/magnetoencephalography-meg/about/pac-20575365

WHAT IS MEG?

Indications

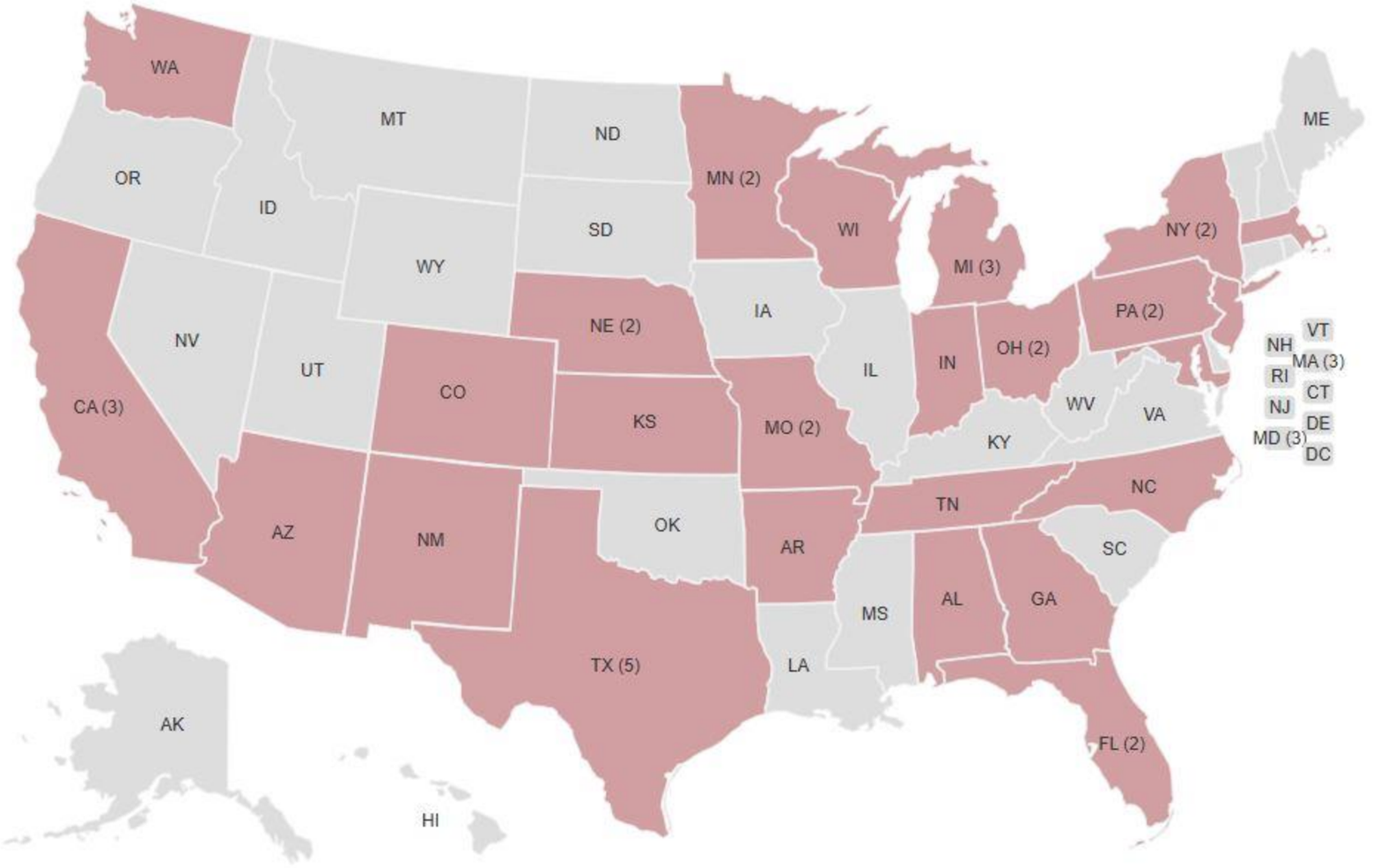
- **Epilepsy** – Pre-surgical evaluation in patients with intractable focal epilepsy to **identify and localize area(s) of epileptiform activity**.
- **Mapping Functional Brain Areas -** Pre-surgical brain mapping **to identify, localize and preserve eloquent cortex** before resective surgery
  (tumors and vascular malformations, epilepsy)
- **MEG is not a stand-alone test** for epilepsy. A comprehensive evaluation is necessary, in context with other presurgical tests
- **MEG cannot replace**, but may guide the placement of intracranial EEG



Source: https://www.aan.com/globals/axon/assets/5641.pdf

Clinical MEG Locations

ACMEGS Center Member MEG sites by state. Send corrections to info@acmegs.org



Source: https://www.acmegs.org/center-directory/

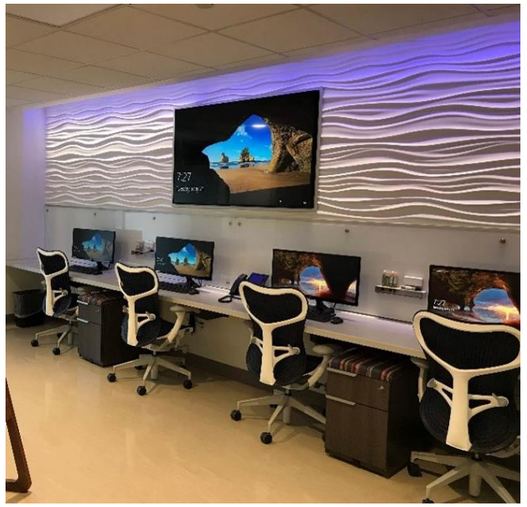
WHAT IS MEG?

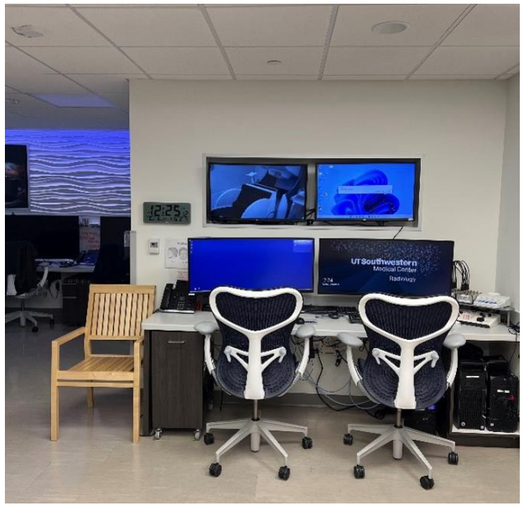
PRE-DESIGN

PRE-DESIGN SITE VISIT - UT SOUTHWESTERN MEDICAL CENTER

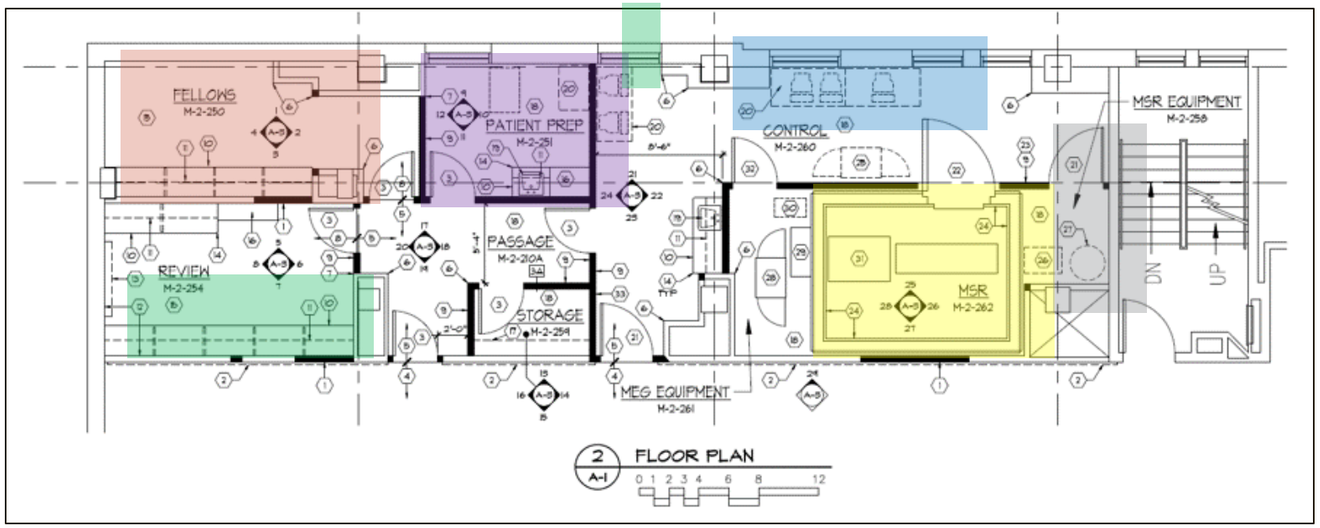
- Office
- Control Desk
- 4 work stations
- 1 station for anesthesia
- EEG prep and charting
- Research area

MEG Unit and Shielded Room

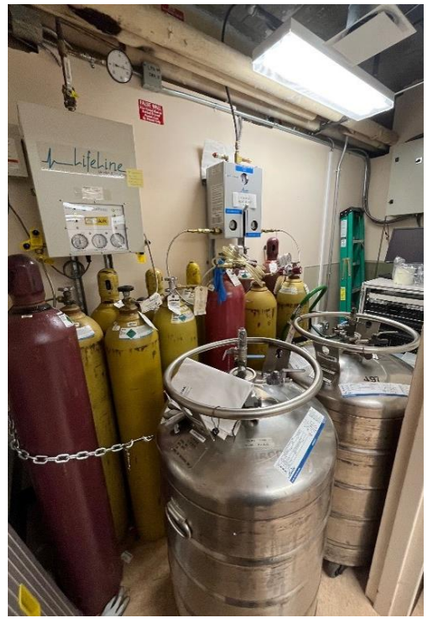


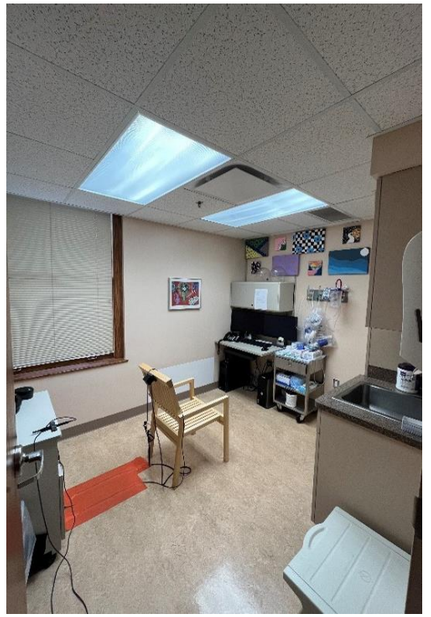


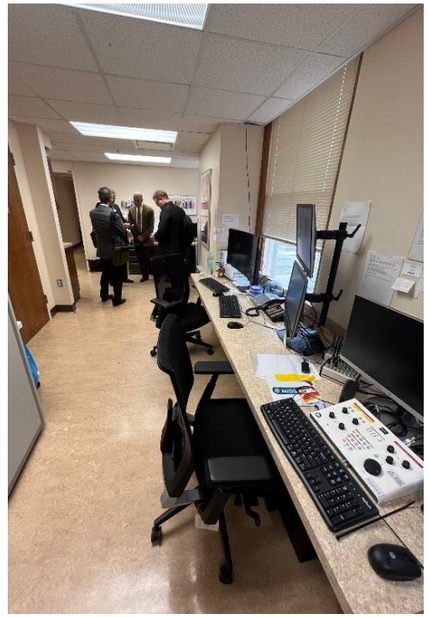
PRE-DESIGN SITE VISIT - CLEVELAND CLINIC



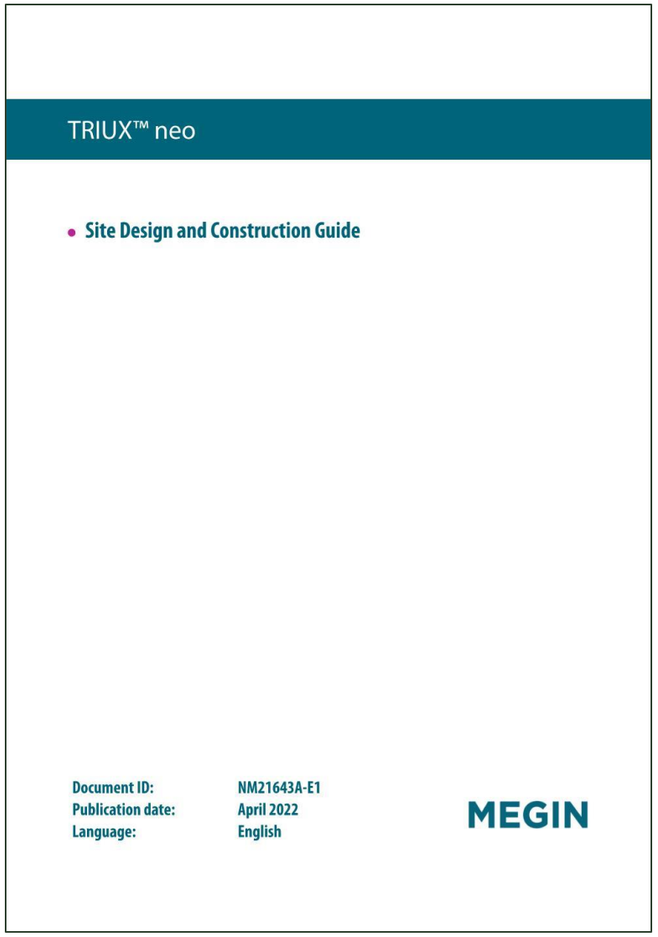
Workstations
Office
EEG Prep and Charting
MEG Unit and Shielded Room
Control Desk
Helium Tanks







VENDOR DESIGN RESOURCES

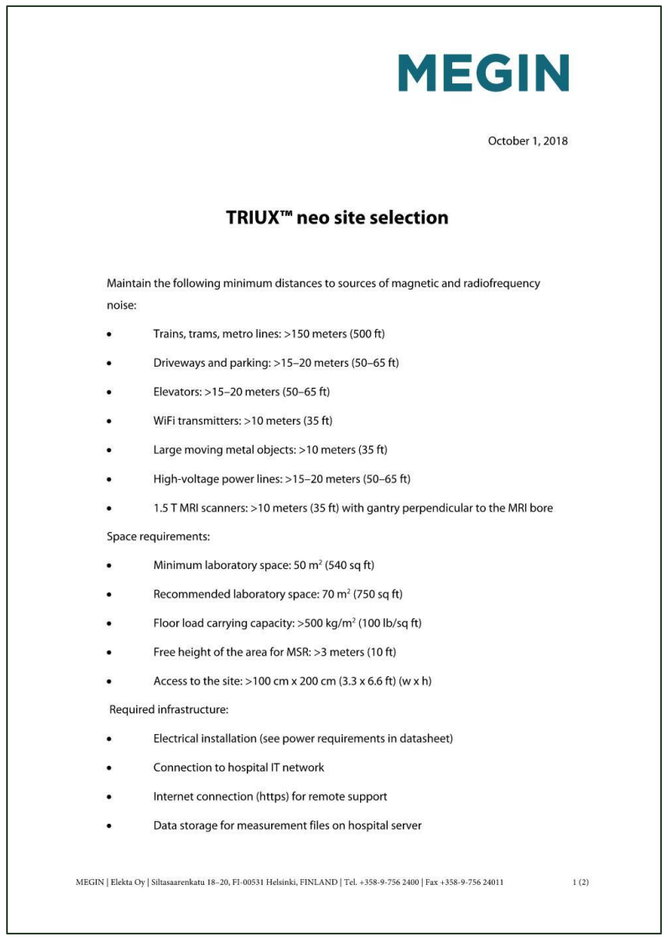


TRIUX™ neo

- **Site Design and Construction Guide**

Document ID: NM21643A-E1
Publication date: April 2022
Language: English

MEGIN



MEGIN

October 1, 2018

TRIUX™ neo site selection

Maintain the following minimum distances to sources of magnetic and radiofrequency noise:

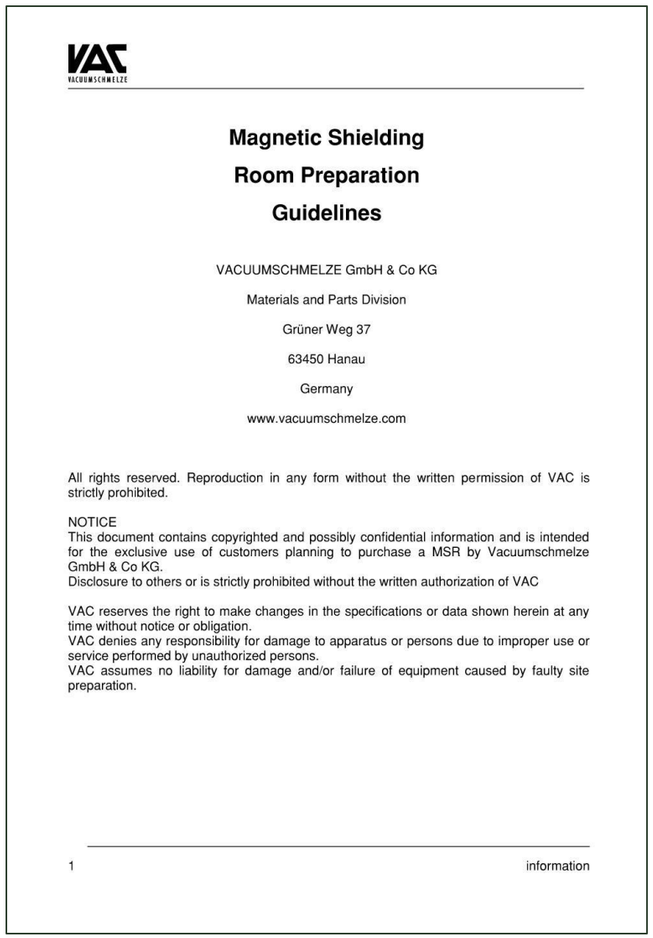
- Trains, trams, metro lines: >150 meters (500 ft)
- Driveways and parking: >15–20 meters (50–65 ft)
- Elevators: >15–20 meters (50–65 ft)
- WiFi transmitters: >10 meters (35 ft)
- Large moving metal objects: >10 meters (35 ft)
- High-voltage power lines: >15–20 meters (50–65 ft)
- 1.5 T MRI scanners: >10 meters (35 ft) with gantry perpendicular to the MRI bore

Space requirements:

- Minimum laboratory space: 50 m^2 (540 sq ft)
- Recommended laboratory space: 70 m^2 (750 sq ft)
- Floor load carrying capacity: >500 kg/m^2 (100 lb/sq ft)
- Free height of the area for MSR: >3 meters (10 ft)
- Access to the site: >100 cm x 200 cm (3.3 x 6.6 ft) (w x h)

Required infrastructure:

- Electrical installation (see power requirements in datasheet)
- Connection to hospital IT network
- Internet connection (https) for remote support
- Data storage for measurement files on hospital server



VAC
VACUUMSCHMELZE

Magnetic Shielding
Room Preparation
Guidelines

VACUUMSCHMELZE GmbH & Co KG
Materials and Parts Division
Grüner Weg 37
63450 Hanau
Germany
www.vacuumschmelze.com

PROGRAMMING

PROGRAMMING - MEGIN ELEMENTS

Vendor Program Elements

- Operator Area
- Magnetically Shielded Room (Provided by VAC)
- Two (2) Technical Areas
- Shower/Changing Area/Toilet
- Storage Room

5 Designing MEG laboratory layout

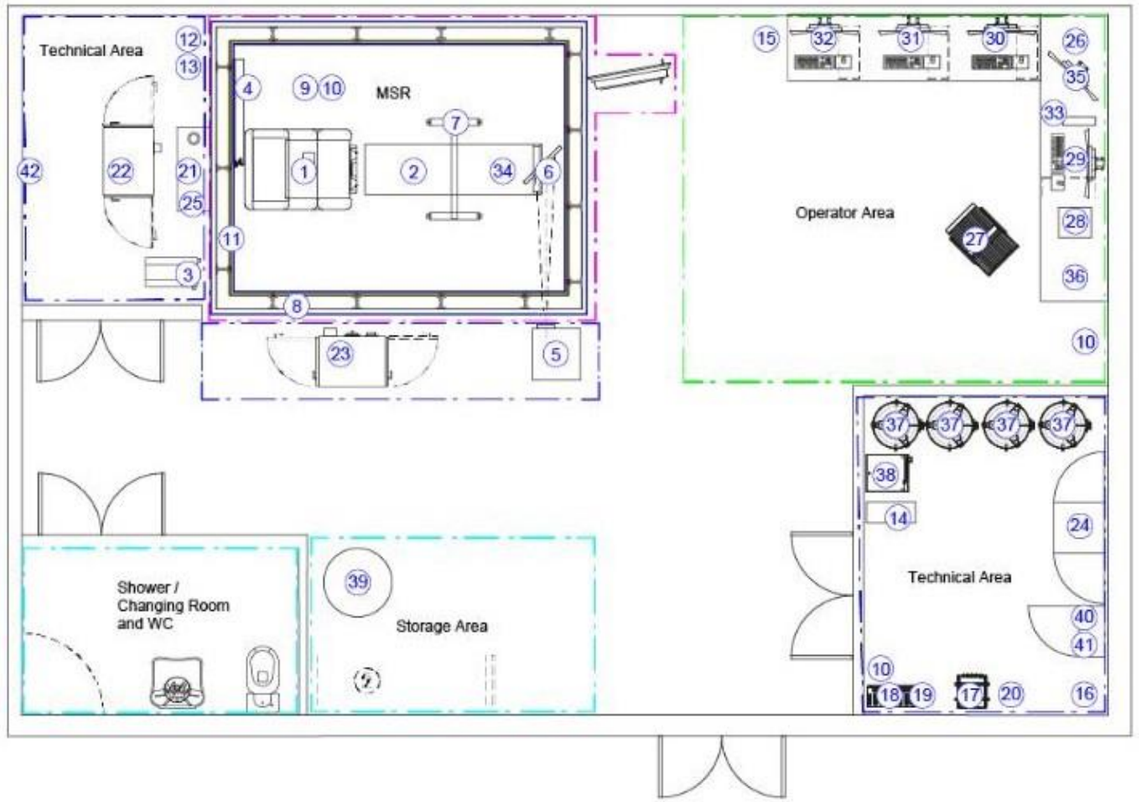


Figure 5.2 Layout example of an MEG laboratory

Source: NM21643A-E1_TRIUX_neo_SDCG_Release candidate_2022-04-13.pdf

PROGRAMMING – VAC MAGNETICALLY SHIELDED ROOM

Magnetically Shielded Room (MSR)

- Outside dimensions:
  - 14′-9 ¾″L x 11′-6″W x 9′-5″H
- Inside dimensions:
  - 12′-11 ½″L x 9′-7 5/8″W x 7′-10 ½″H
- Level entry is preferred. Recessed pit dimensions:
  - 14′-11″L x 11′-7 ¾″W x 9″D
- Required minimum room height (without pit):
  - 9′-6″

VACUUMSCHMELZE

Each MSR is being tested on site after its setup following our test guideline and the achieved performance is filed in a test report which will be handed over.

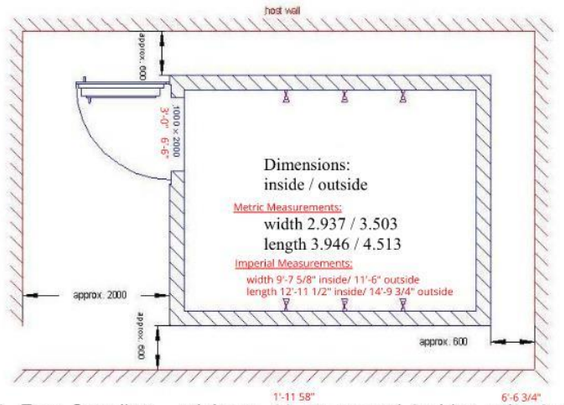
2.2. Dimensions

The following table refers to our standard type VACOSHIELD ADVANCED (Ak3b) with 3x4m² and two layers of MUMETALL®.
Multilayer solutions and additional standard sizes are available like 2,5x2,5 m² and 4x5 m². Customized solutions are possible as well.

	length	width	Height
Inside Mumetall surface	4.008 m 13'-2"	2.999 m 9'-10"	2.480 m 8'-1 5/8"
Inside decoration surface	3.946 m 12'-11 1/2"	2.937 m 9'-7 5/8"	2.400 m 7'-10 1/2"
Outside Mumetall surface	4.355 m 14'-3 1/2"	3.345 m 10'-11 3/4"	2.850 m 9'-4 1/4"
Outside decoration surface	4.513 m 14'-9 3/4"	3.503 m 11'-6"	2.870 m 9'-5"
Pit for standard door	4,55 m (min) 14'-11"	3,55 m (min) 11'-7 3/4"	115mm (max) 4 1/2"
Pit for level entry door	4,55 m (min) 14'-11"	3,55 m (min) 11'-7 3/4"	236mm (max) 9"

2.3. Assembly possibilities

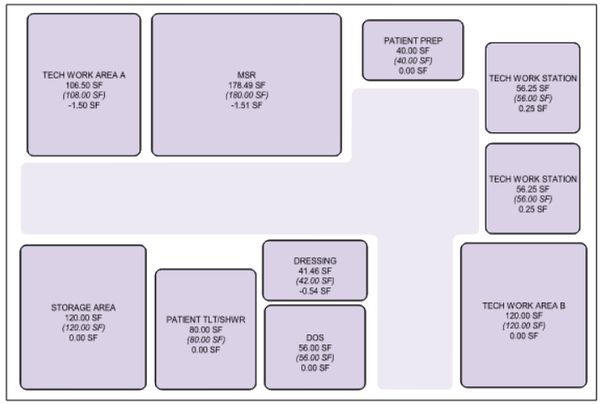
WALL THICKNESS - INTERIOR: 13'-2" / 12'-11 1/2" / 0'-2 1/2" — 9'-10" / 9'-7 1/2" / 0'-2 1/2"
WALL THICKNESS - EXTERIOR: 14'-9 3/4" / 14'-3 1/2" / 0'-6 1/4" — 11'-6" / 10'-11 3/4" / 0'-6 1/4"

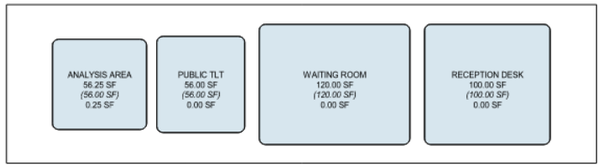


1. Free Standing – minimum 60 cm around 3 sides, min. 2 m on the door wall. **Required minimum room height 2.9 meters**
9'-6"

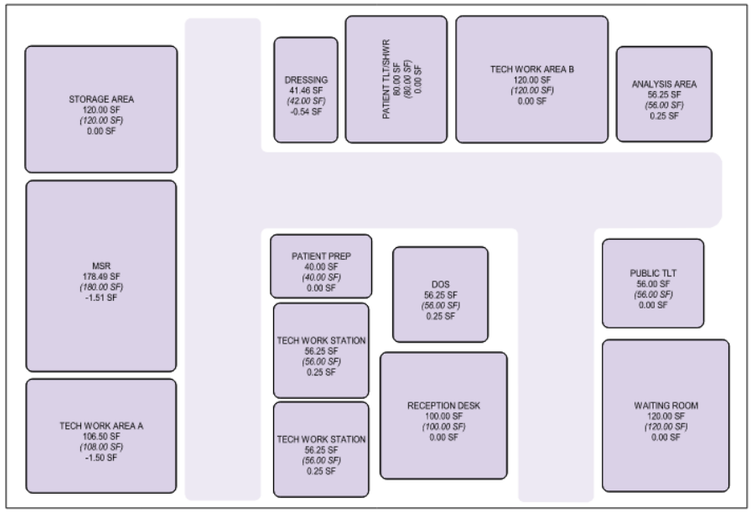
Source: MSR Preparation Guideline Advanced 3x4 - LB.pdf

PROGRAMMING – PROGRAM AND DIAGRAMS





BLOCKING DIAGRAM 'A'



BLOCKING DIAGRAM 'B'

MAYO CLINIC

SPACE PROGRAM

Prepared by Division of Architectural and Engineering Services

Project: Magnetoencephalography

Project # ROXX22C0170
Date : 12 October 2022
Revisions :
Prepared By : RSP Architects

		REQUESTED			PROPOSED			
#	FUNCTION/AREA	#	NSF AREA	NSF TOTAL	#	NSF AREA	NSF TOTAL	COMMENTS
1								
2	**Public Areas**							
3	Reception/Check-In	1	100	100				Could share existing reception with another department
4	Waiting Room	1	120	120				Could share existing waiting room with another department
5	Public Toilet/s	1	56	56				Coud share existing public toilet/s with another department
6	Subtotal Public Spaces (NSF)			**276**				
7								
8	**MEG Laboratory**							
9	Desk Operations Specialist (DOS)	1	56	56				
10	Sub-Wait	1	90	90				6 chairs x 15 NSF/chair
11	Dressing Room	1	42	42				Mayo Reference Standard E2034.03.01-16
12	Patient Toilet	1	56	56				Mayo Reference Standard RS 1021.02.01-10
13	Analysis Work Station	4	56	224				1 tech, 1 fellow, 1 staff, 1 other in shared worked area
14	Patient Prep Area	1	100	100				Hand-wash sink, hair-wash sink, cap wash sink,drying space;3D digi-chair
15	Magnetically Shielded Room (MSR)	1	180	180				Two-layer MSR assumed
16	Equipment Room A (adjacent to MSR)	1	108	108				lifting unit, filter cabinet, electronics cabinet
17	Equipment Room B (reqd dist from MSR)	1	120	120				He tanks & recycler,cryocooler compressor,air compressor,MEG servers
18	Storage Room	1	100	100				Liquid HE transfer dewar,siphons,He transfer tools,safety devices,cyrokit
19	Subtotal MSR Laboratory (NSF)			**1,076**				
20								
21	**Building Support**							
22	Electrical Room	0	120	0				
23	Point of Presence Room	0	126	0				MEG servers will be located in MEG Lab
24	Environmental Services Room	0	200	0				Not required per Mayo EVS
25	Subtotal Building Support(NSF)			**0**				
26								
27								
28								
29								
30								
31								
32								
33								
34								
35								
36								
37								
38								
39								
40								
41								
42	**Total net square feet (NSF)**			**1,352**				
43	Net to Gross Factor			1.3				
44	**Department Gross Square Feet (DGSF)**			**1,758**				

PROGRAMMING – SITE ANALYSIS

ALFRED BUILDING, THIRD LEVEL

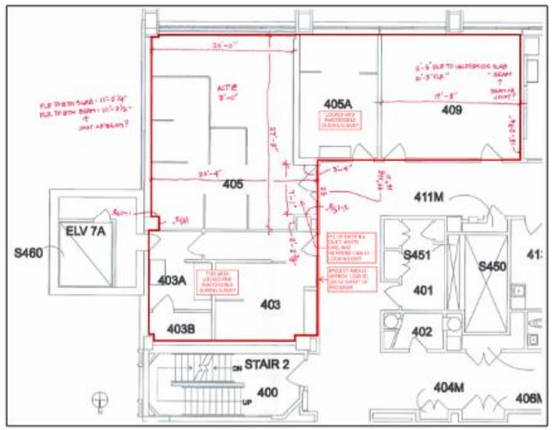
Year Built: Original drawings are dated 1964

Structural System: Cast-in-place concrete pan and joist system supported by concrete beams and concrete columns

Floor-to-Floor height: 12'-0"

Floor to bottom of structure height: 10'-4" below the concrete joists and concrete beams. Concrete beams and joists are the same depth

Floor Live Load Capacity: Past structural calculations for the existing floor structure indicate the steel reinforcing used in the concrete is undersized for the existing 3" deep non-structural topping slab. The dead load of the topping slab reduces the floor live load capacity to approximately 50 PSF.



(Alfred 03 - Site Observations for Potential MEG Location, 12/05/2022)

JOSEPH BUILDING, FOURTH LEVEL

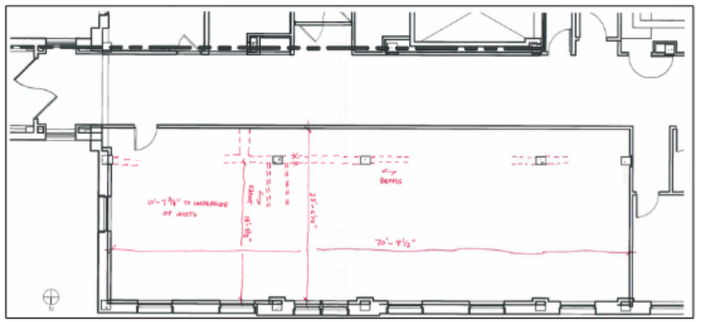
Year Built: Original drawings are dated 1920

Structural System: Cast-in-place concrete pan and joist system supported by concrete beams and concrete columns

Floor to Floor Height: 12'-0"

Floor to Bottom of Structure Height: Varies from 10'-11" below the concrete joists to 9'-5" below concrete beams

Load Capacity of Floor: The building was originally a bed tower with surgical suites on the upper floors. The original Floor Live Load capacity in the patient room areas was 40 PSF.



(Joseph 04 - Site Observations for Potential MEG Location, 12/05/2022)

DOMITILLLA BUILDING, MAIN LEVEL

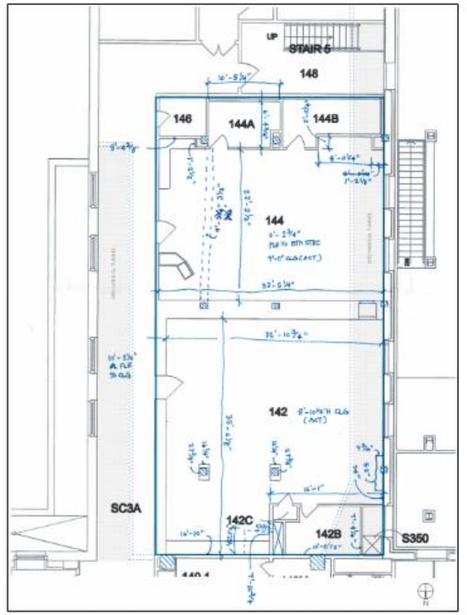
Year Built: Original drawings are dated 1954

Structural System: Cast-in-place concrete with the Main Level area of consideration a concrete slab-on-grade. Floor structure above is a flat concrete slab supported by concrete beams and concrete columns.

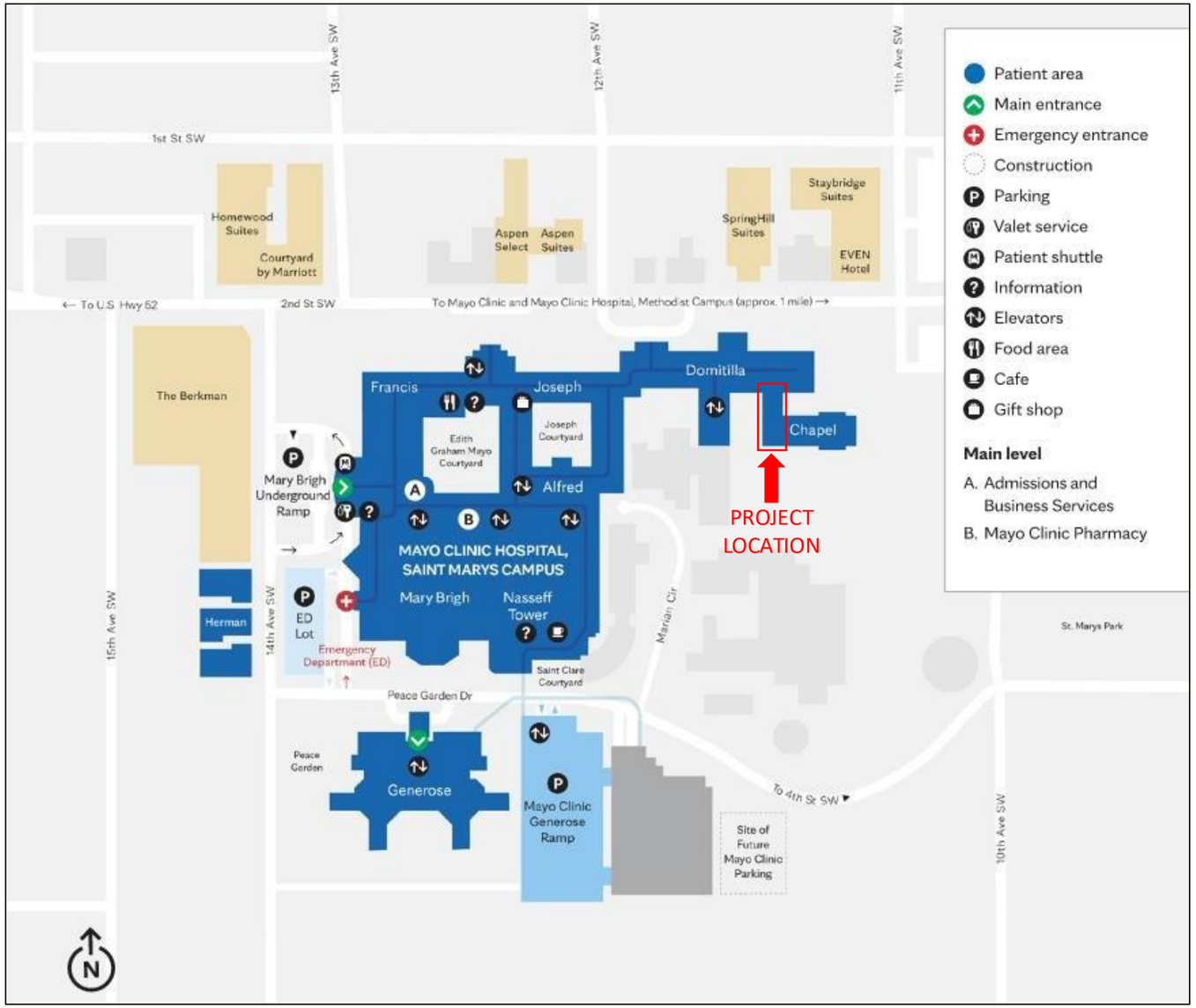
Floor to Floor Height: 11'-9"

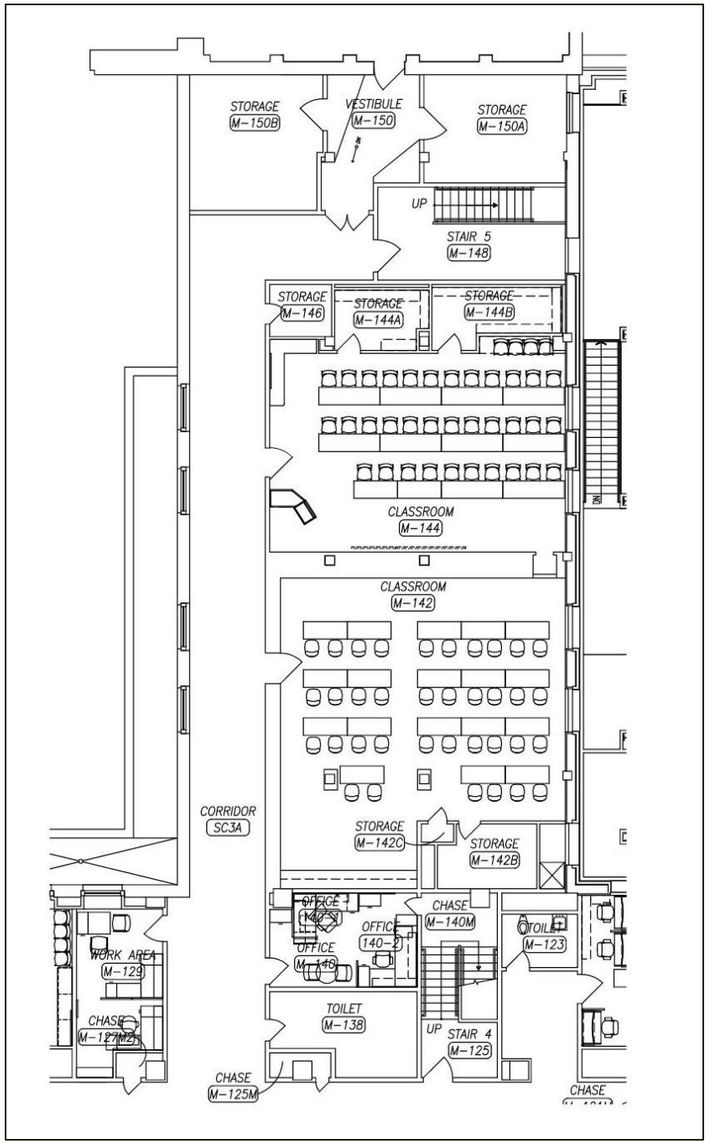
Floor to bottom of flat slab: 11'-3" to bottom of slab and 9'-5" to bottom of concrete beams

Floor load capacity: The Main Level concrete slab-on-grade in the area of consideration could support 100 PSF or more with some additional investigation required.



(Domitilla Main Floor - Site Observations for Potential MEG Location, 11/16/2022)

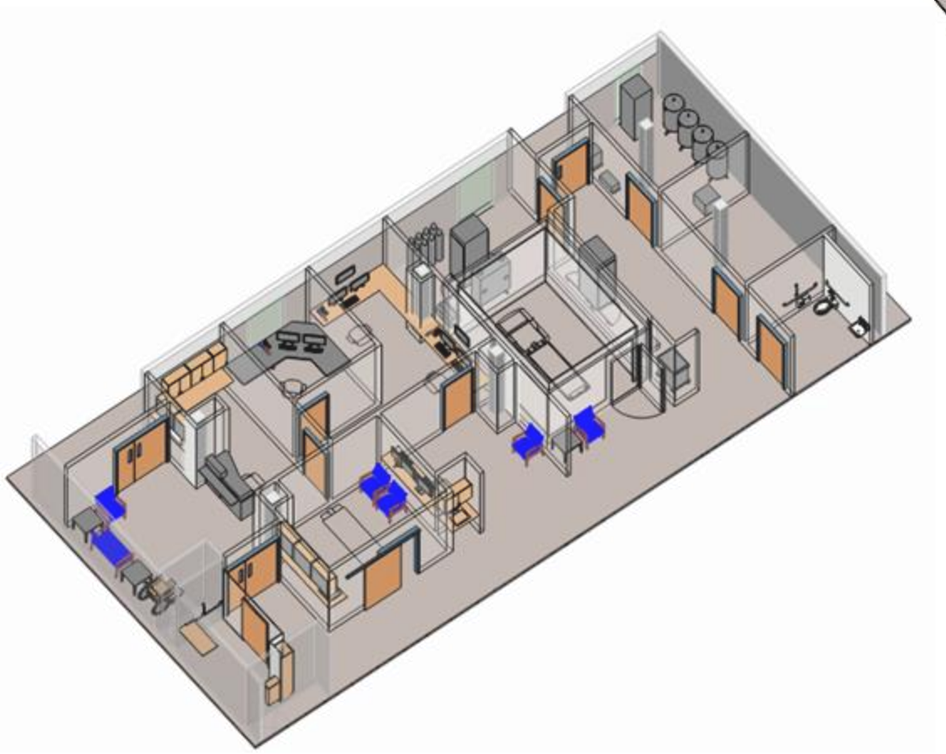


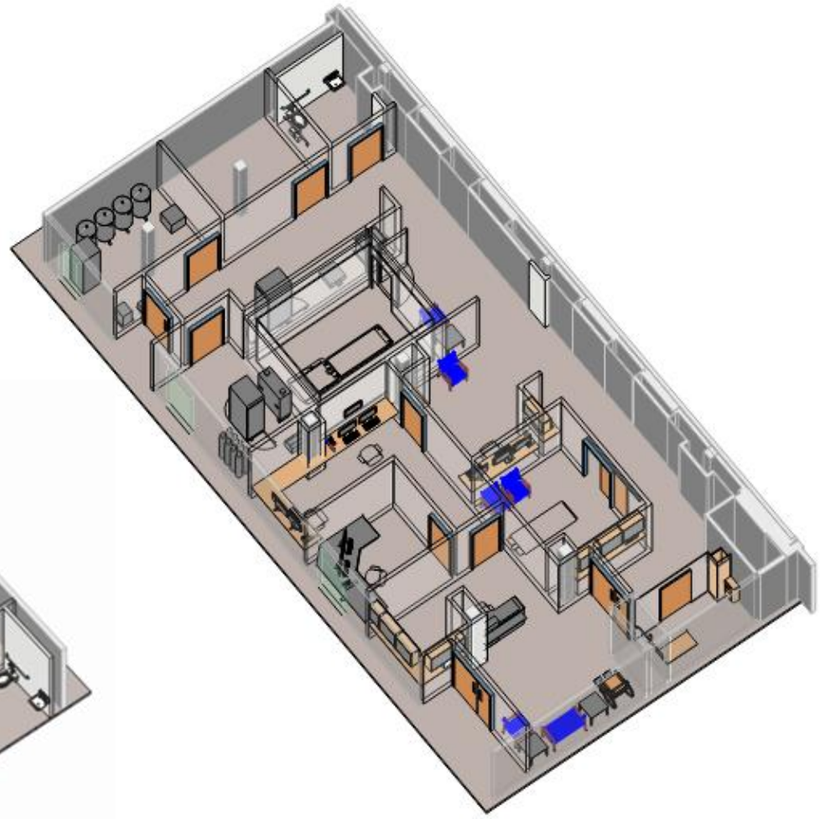


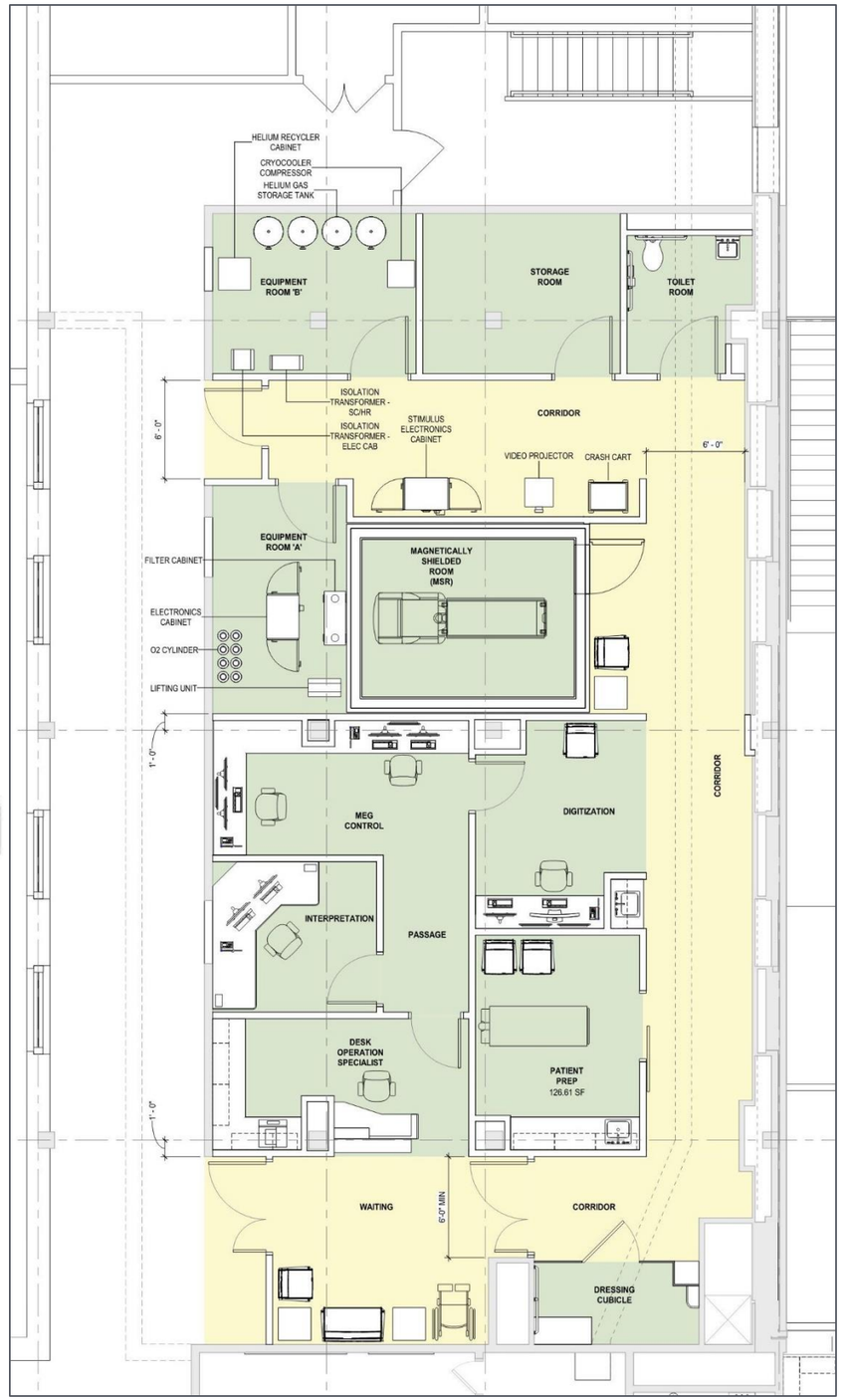
PROGRAMMING – PROJECT LOCATION

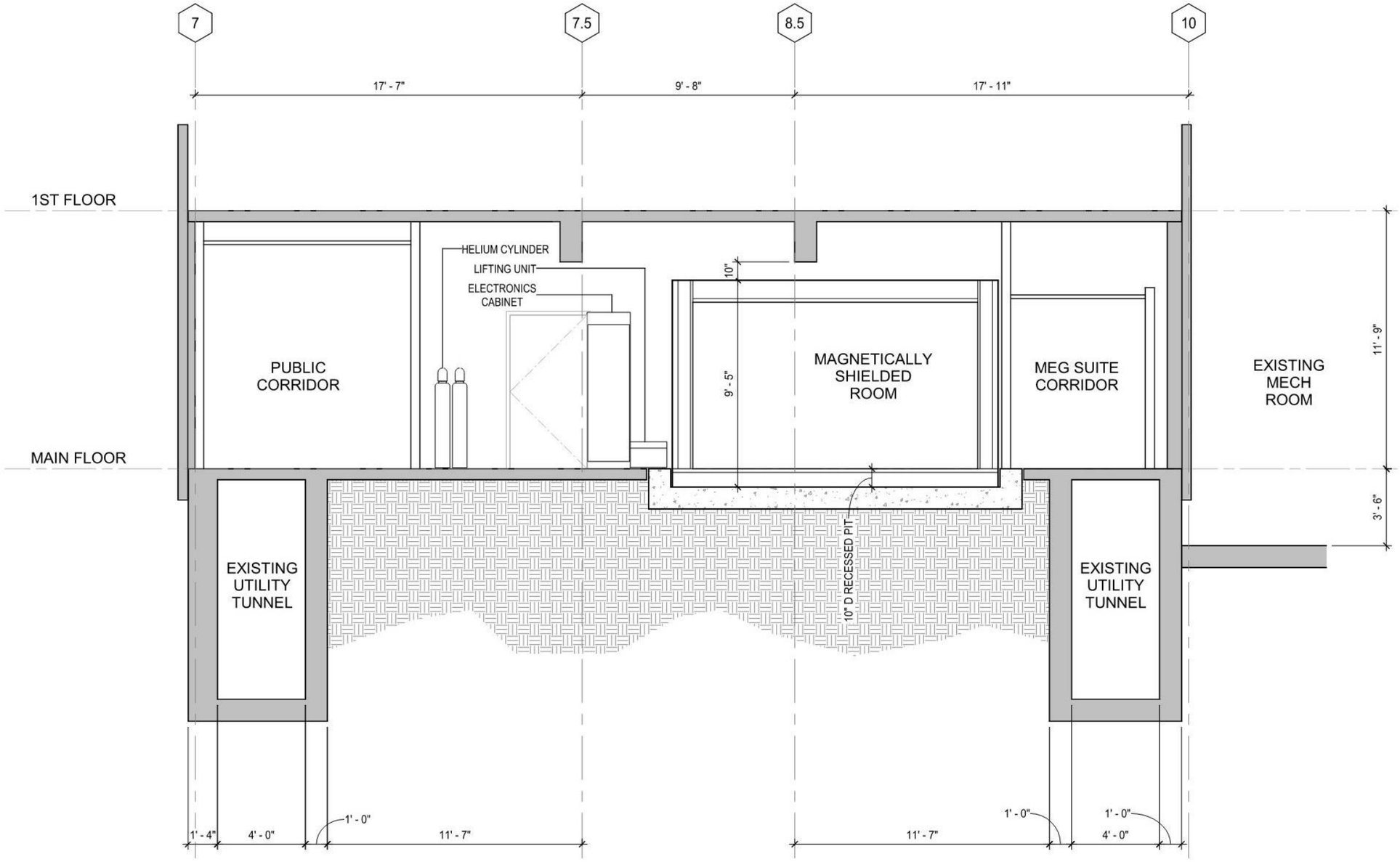
SCHEMATIC DESIGN

SCHEMATIC DESIGN





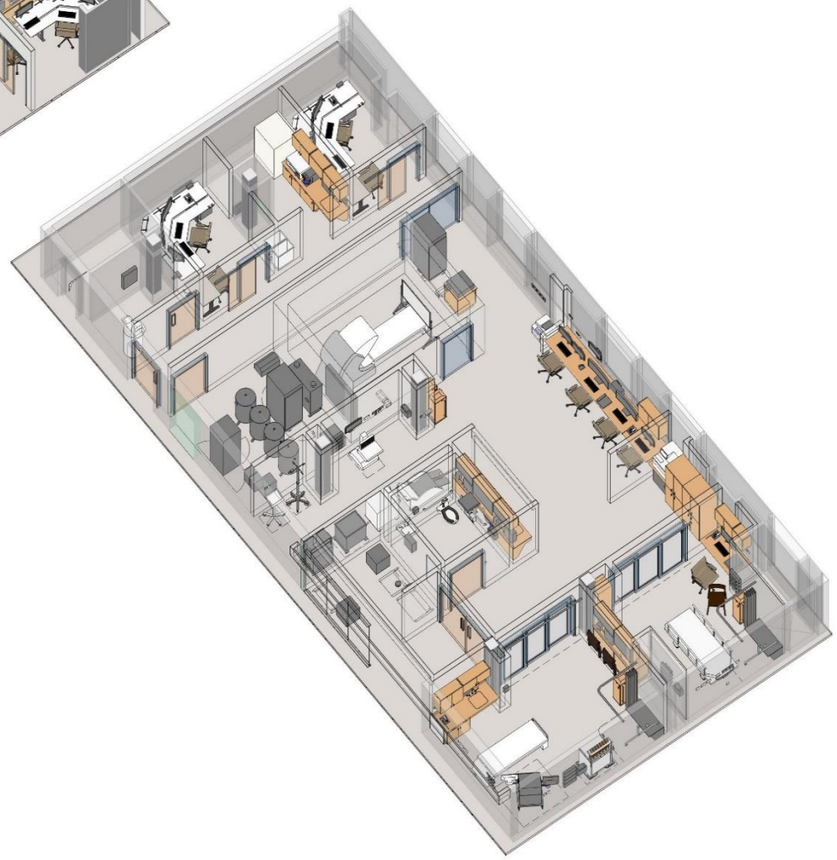


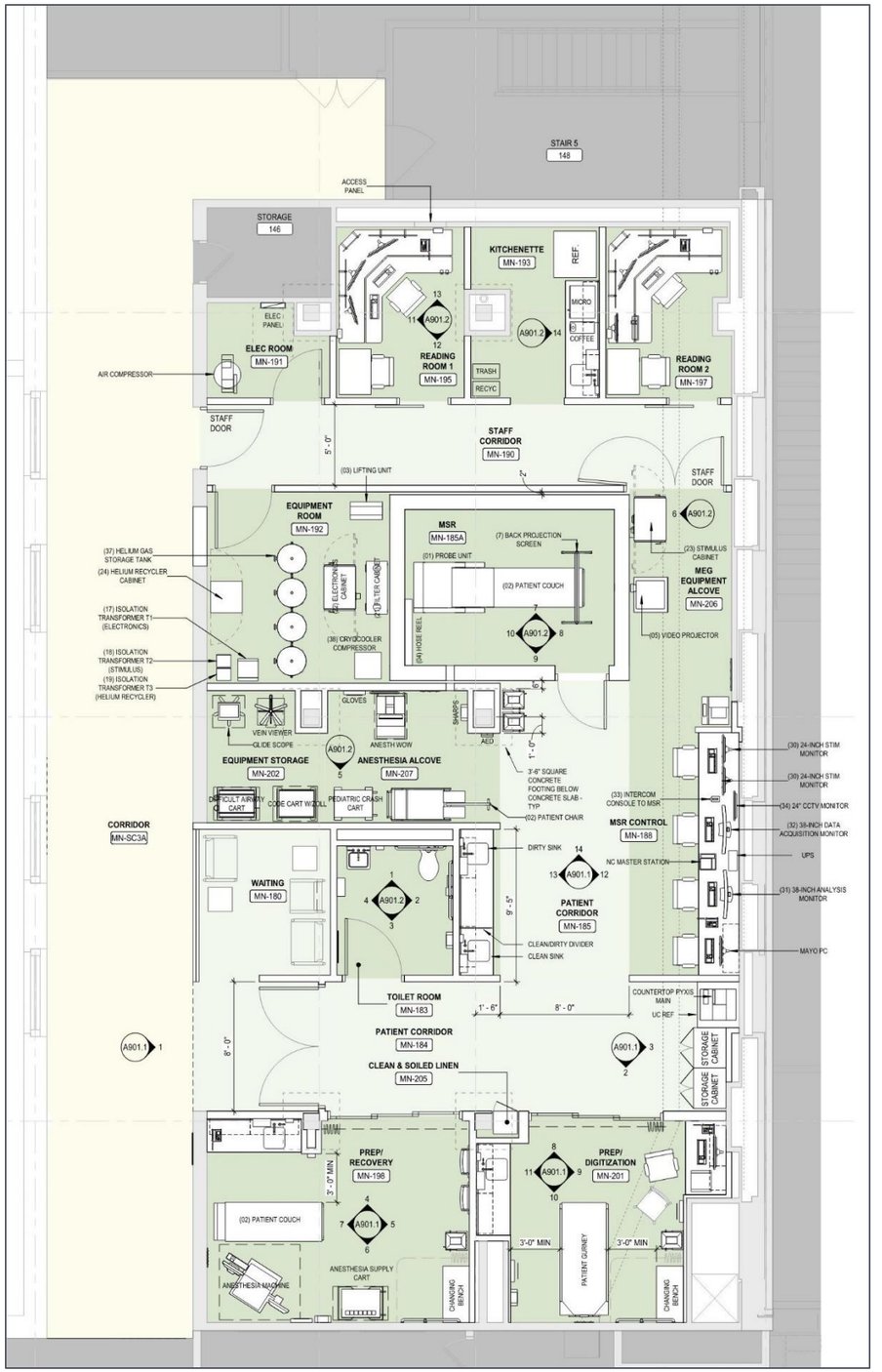


SCHEMATIC DESIGN– BUILDING SECTION

DESIGN DEVELOPMENT

DESIGN DEVELOPMENT





DESIGN DEVELOPMENT

The block diagram shows the main modules in the MEG system used for signals and control electronics.

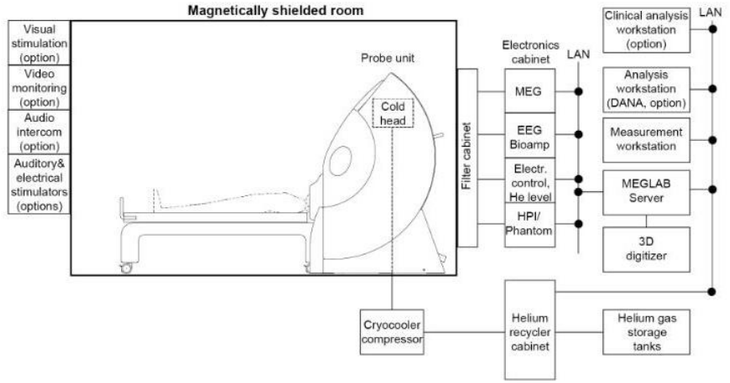


Figure 3.4 Block diagram of the MEG system

The probe unit is the main part of the MEG system and it is located in the MSR.

The MSR protects the probe unit inside the MSR and the MEG SQUID sensors inside the probe unit from environmental disturbance. The MEG SQUID signal cables, the EEG signal cables and the control cables entering the MSR are isolated to eliminate noise from penetrating the MSR and to maintain a low environmental noise level for measurements inside the MSR.

The noise isolation for the signal, power and control cables takes place in the filter cabinet. The filter cabinet is connected to electronics cabinet. The electronics network in the electronics cabinet is connected to a switch and further with optical fibers to MEGLAB network switch.

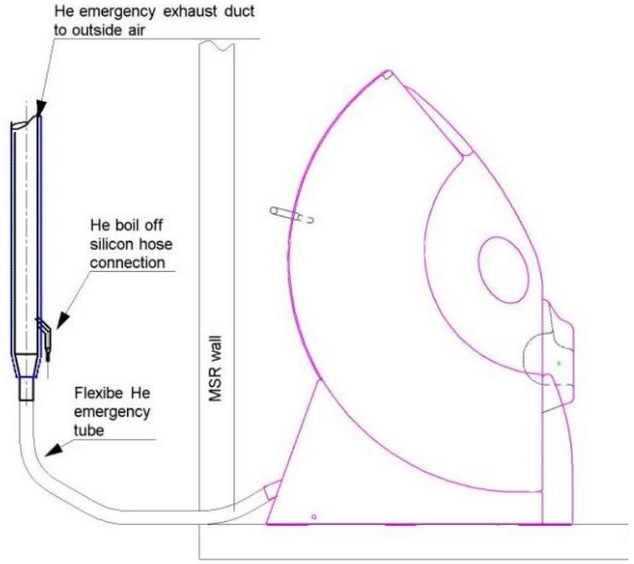


Figure 3.15 Helium emergency exhaust duct

For more information, see the dimensional drawing for the tube which the customer needs t
Appendix A *Helium emergency exhaust design.*

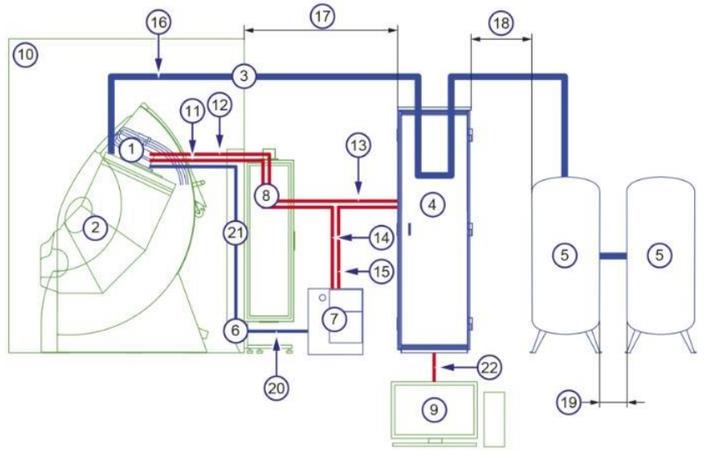


Figure 5.1 Helium recycler modules and cables

(1) Cryocooler cold head
(2) Probe unit
(3) Helium gas lines
(4) Helium recycler cabinet
(5) Helium gas storage tanks
(6) Cryocooler gas lines
(7) Cryocooler compressor
(8) Cryocooler compressor control and power cables (through the filter cabinet)
(9) Measurement workstation
(10) Magnetically shielded room (MSR)
(11) Cryocooler filtered side power cable
(12) Cryocooler shielded side thermometer cable
(13) Control cables between the helium recycler cabinet and filter cabinet
(14) Cryocooler unshielded side power cable
(15) Cryocooler control interface cable set
(16) Helium gas line
(20) Cryocooler gas line
(21) Cryocooler gas line
(22) MEGLAB network switch using VLAN meg.lab.

Source: NM21643A-E1_TRIUX_neo_SDCG_Release candidate_2022-04-13.pdf

CONSTRUCTION DOCUMENTS

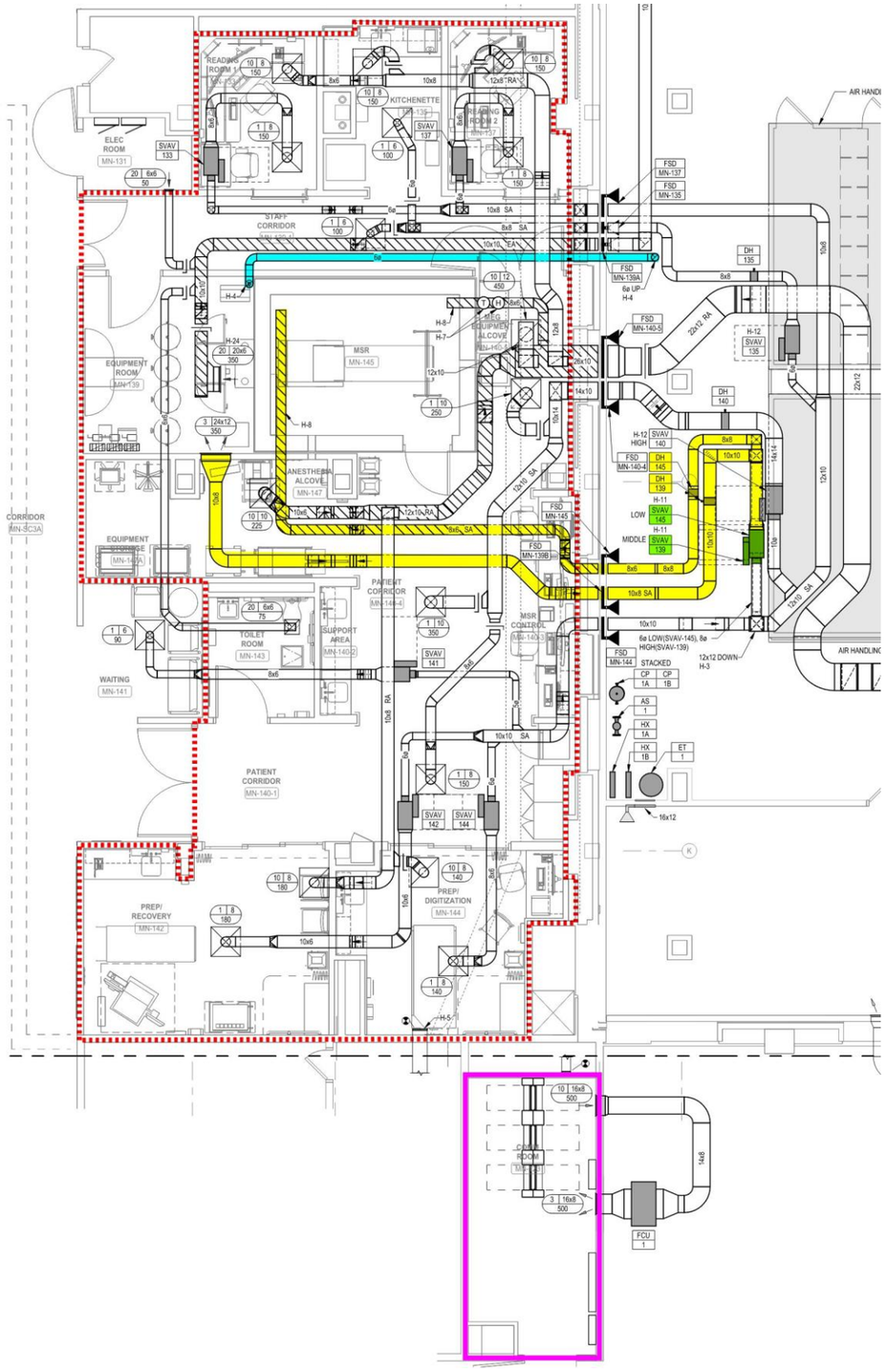
CONSTRUCTION DOCUMENTS

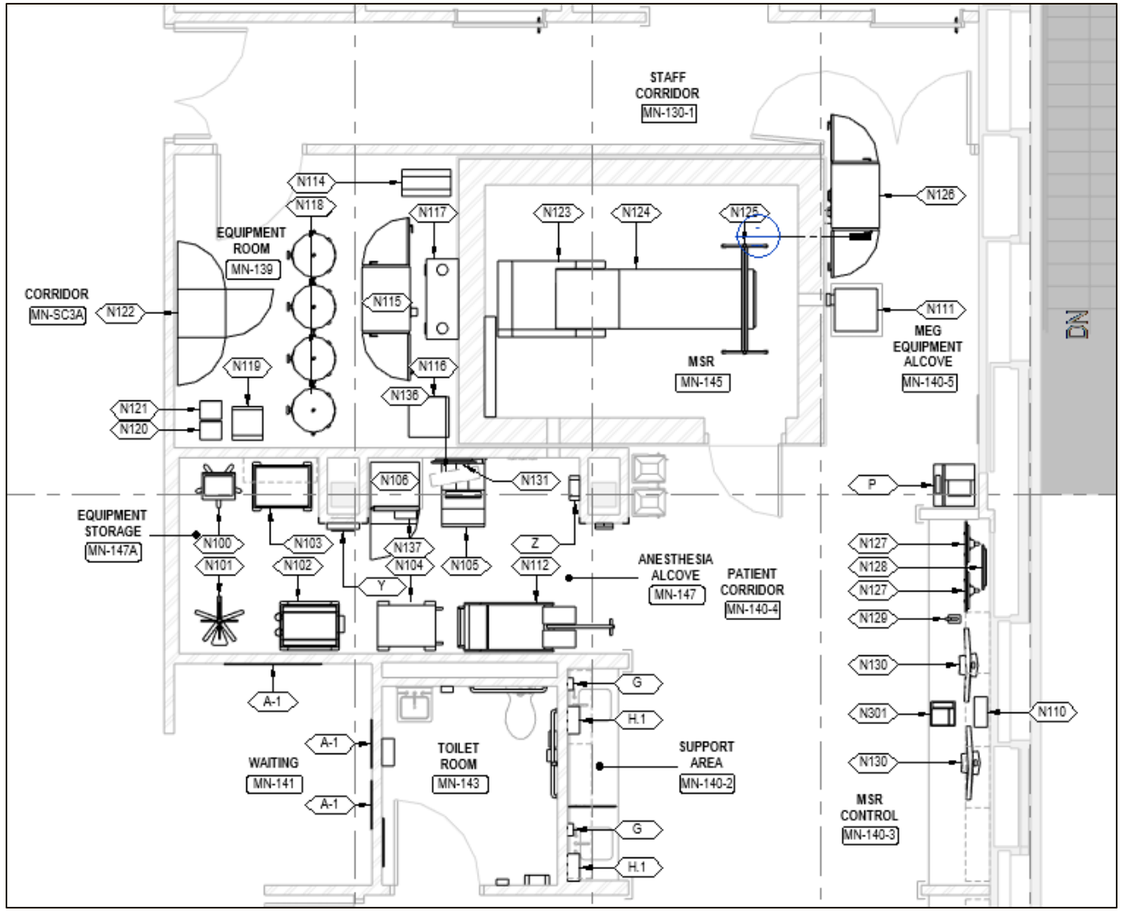
Mechanical & Electrical Challenges

- 40% relative humidity
- No rotating equipment near Equip Room or MSR
- Tight space between ceiling and structure above
- Existing Comm Room not large enough for MEG Lab comm

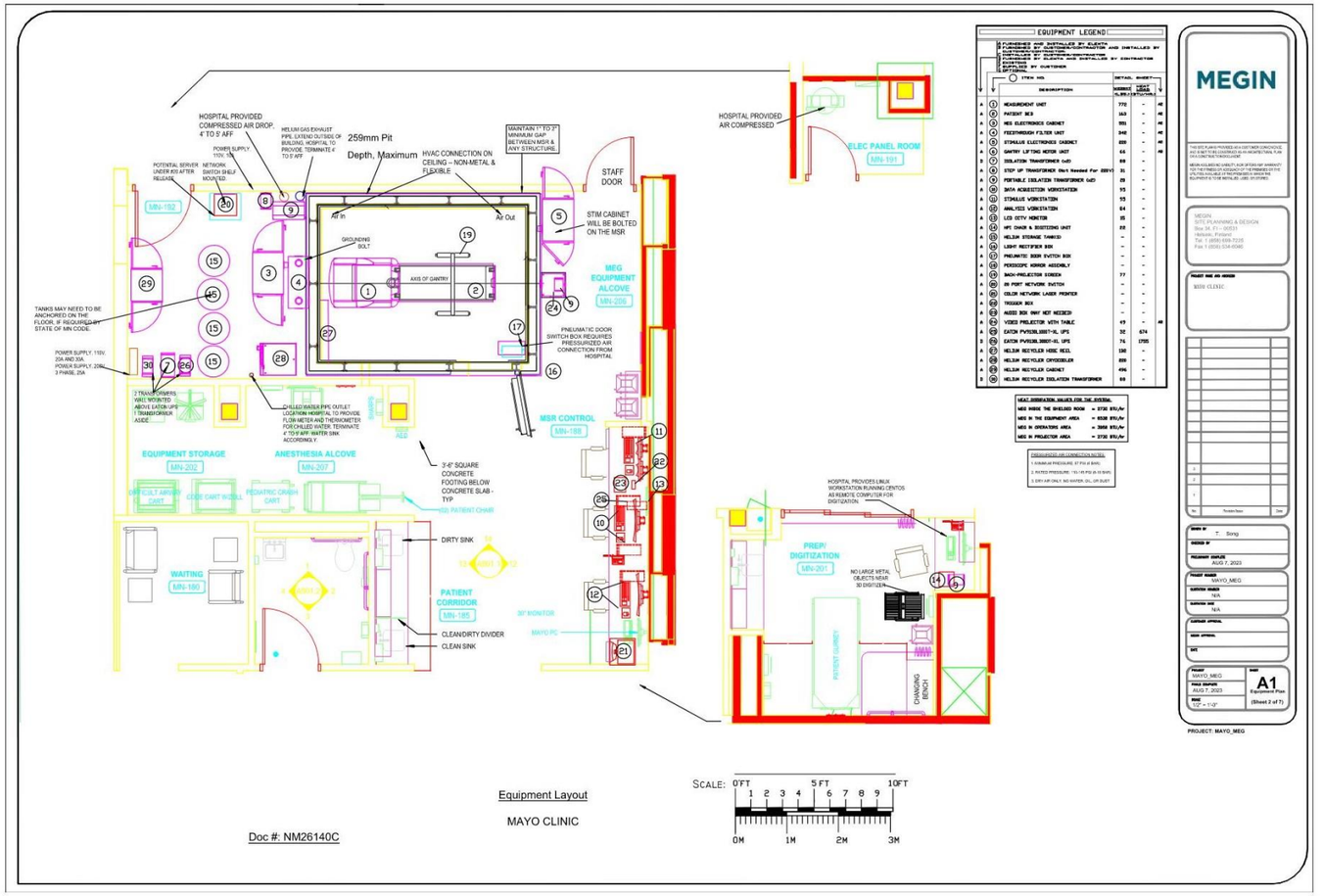
Mechanical & Electrical Solutions

- 4 mil vapor in MEG Lab perimeter and humidifiers in adjacent Mech Room
- VAVs in adjacent Mech Room instead of FCU in Equip Room
- Converted an existing Toilet Room into a Comm Room





Architectural Equipment Plan



Megin Site-Specific Equipment Installation Plan

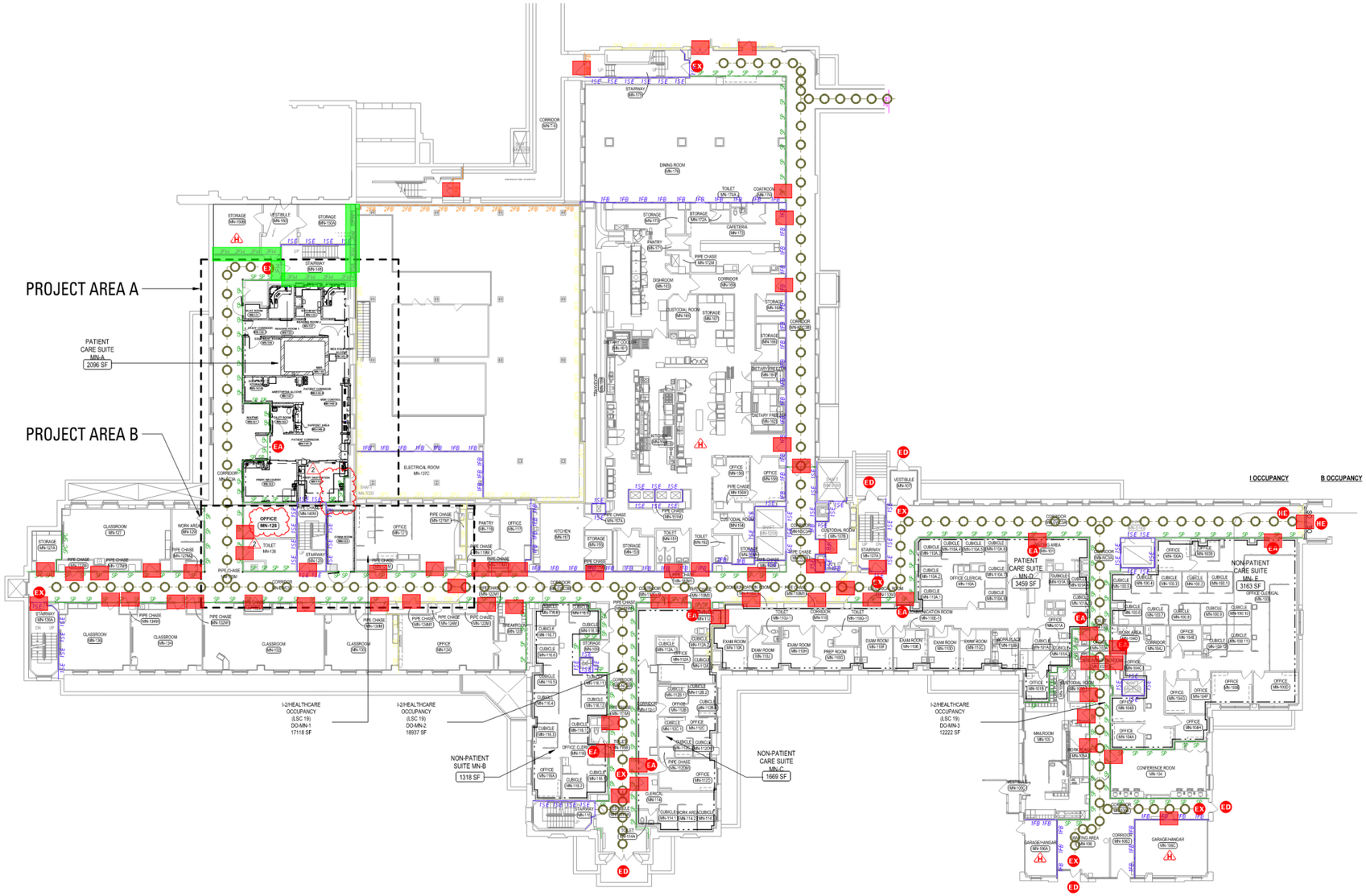
CONSTRUCTION DOCUMENTS – EQUIPMENT COORDINATION

Occupancy Classification – **Challenges**

- Originally an I-2 Occupancy Building with inpatient bedrooms but had been converted to a B occupancy
- Occasional Neurology inpatient treatments in MEG suite required conversion back to I-2

Occupancy Classification – **Solutions**

- Collaborative effort between Mayo, Intertec, and Construction Team to inspect all rated doors, penetrations, and rated caulking in life safety walls



CONSTRUCTION DOCUMENTS – LIFE SAFETY AND CODE REVIEW

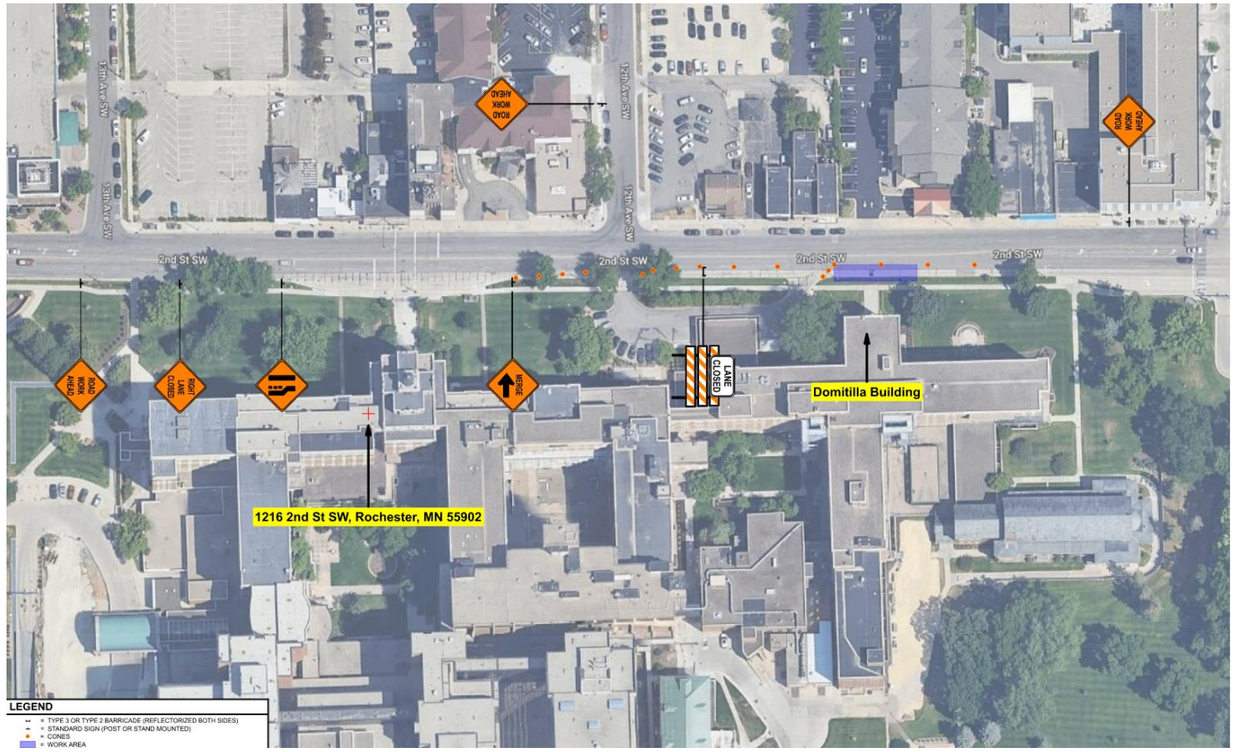
CONSTRUCTION ADMINISTRATION

CONSTRUCTION ADMINISTRATION

Equipment Delivery - **Challenges**

- Coordination with overseas shipping
- Coordination between Mayo Clinic, VAC, and Beltmann Transportation
- Distance from loading dock to project site
- Equipment weight of 1200 - 5300 pounds and structural capacity of existing floors
- Maintaining patient and visitor safety during delivery

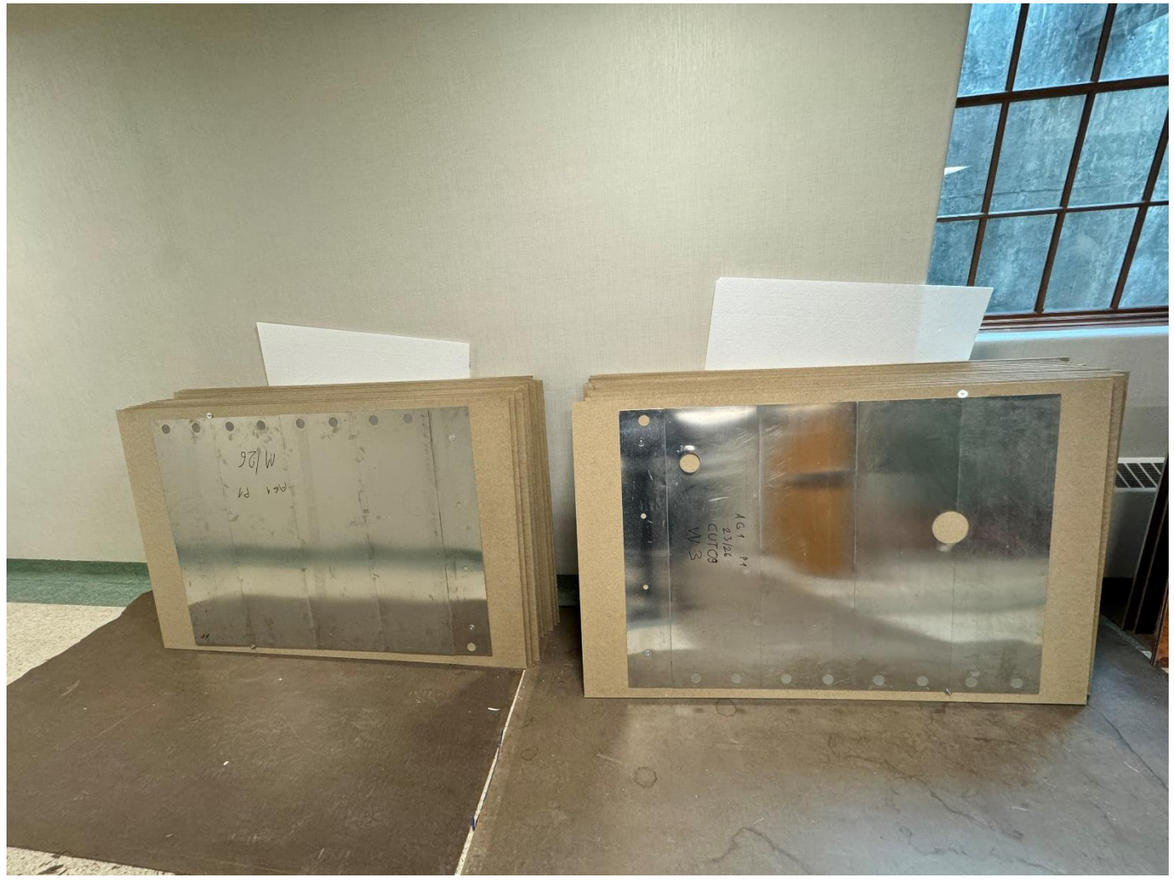
CONSTRUCTION ADMINISTRATION



Equipment Delivery - **Solutions**

- Coordinated delivery from Second Street SW.
- Street closure with City of Rochester and Mayo Transportation
- Coordinated with structural engineer for evaluation of floor system.

CONSTRUCTION ADMINISTRATION



Equipment Delivery/Assembly

- Component parts for Magnetically Shielding Room removed from boxes and thoughtfully placed according to location of assembly with limited space in built-out MEG suite.

CONSTRUCTION ADMINISTRATION

Assembly of Magnetically Shielded Room:

- Tight existing conditions made assembly challenging.

CONSTRUCTION ADMINISTRATION

Salon-style hair-wash sink added during construction:

- Either a salon-style sink or wipes are used by care team to clean metallic material from patient's hair before application of electrode cap. Metallic materials are common in hair care products and will distort MEG images.
- Resolve during design-phase to avoid construction phase floor slab demolition, sink supports, and routing of new waste and water lines.

PROJECT PHOTOGRAPHY

Corridor SC3A, MEG Suite Entry

Before – Corridor SC3A

Corridor SC3A

View Looking Back Towards Entry

After – Prep Room with Anesthesia Infrastructure and Salon Sink

After – Prep Room with Digitizing Computer, Electrode Cap and Digitizing Chair

Before

MEG Tech Work Area and Magnetically Shielded Room

MEG Equipment Room

Interior Magnetically Shielded Room

Interpretation Room

Open House – Magnetically Shielded Room Blessing

Mayo Clinic Proponent Team

PROJECT KEY TAKEAWAYS

- MEG does not use any magnets. The test uses very sensitive detectors to measure magnetic fields from the brain.
- Existing MEG Facilities site visits are helpful to the Proponents and Design Team.
- Vendor Design Guides provide minimum programmatic requirements. Discuss additional needs with the Proponent Team.
- Determine if MEG patients will be anesthetized and if inpatients will be tested in the MEG Lab. Both impact occupancy classification.
- 40% relative humidity is required for the MEG Lab.
- Consider the MEG and MSR equipment drop-off location and delivery path to project site.

QUESTIONS & ANSWERS

THANK YOU!

QUESTIONS? CONTACT US

ERIC STRICKLAND
Senior Healthcare Planner
RSP Architects
eric.strickland@rsparch.com

BENJAMIN BRINKMANN, PH.D.
Professor of Neurology and
Associate Professor of
Biomedical Engineering
Mayo Clinic
Brinkmann.Benjamin@mayo.edu

CHARLES ASAMOAH, P.E.
Project Manager
Department of Facilities
Project Services
Mayo Clinic
Asamoah.Charles@mayo.edu

CRAIG NEUSER
Construction Manager
Department of Facilities
Project Services
Mayo Clinic
Neuser.Craig@mayo.edu

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