Design

- Basis of Design
- Conceptual Drawings

CDR -	1	Site Plan
CDR -	2	Landscape Plan
CDR -	3	1st Floor Plan
CDR -	4	2nd & 3rd Floor Plan
CDR -	5	Elevations
CDR -	6	Sections
CDR -	7	Sections
CDR -	8	Enlarged Plans
CDR -	9	Enlarged Elevations
CDR -	10	Wall Sections
CDR -	11	Wall Sections
CDR -	12	Wall Sections
CDR -	13	Wall Sections
CDR -	14	Details
CDR -	15	Details
CDR -	16	Lunchroom Perspectives
CDR -	17	Office Layout – Option A
CDR -	18	Office Layout – Option B
CDR -	19	Office Layout – Option C
CDR -	20	Office Layout – Option D
CDR -	21	Structural Caisson Plan
CDR -	22	1st Floor Structural Plan
CDR -	23	2nd Floor Framing Plan
CDR -	24	3rd Floor Framing Plan
CDR -	25	Roof Framing Plan
CDR -	26	3-D Rendering - Structural
CDR -	27	1st Floor Mechanical
CDR -	28	2nd Floor Mechanical
CDR -	29	3rd Floor Mechanical
CDR -	30	Roof Plan
CDR -	31	Mechanical Riser Diagrams
CDR -	32	1st Floor Electrical Plan
CDR -	33	2nd Floor Electrical Plan
CDR -	34	3rd Floor Electrical Plan
CDR -	35	Electrical Riser Diagrams
CDR -	36	1st Floor Plumbing Plan
CDR -	37	2nd Floor Plumbing Plan
CDR -	38	3rd Floor Plumbing Plan
CDR -	39	Roof Plumbing Plan
CDR -	40	Plumbing Riser Diagrams
CDR -	41	Radiation Safety Plan
CDR -	42	Radiation Safety Sections
CDR -	43	Radiation Safety Sections

- Soil Borings Report

The following data was compiled as a Basis of Design for design of the building systems.

A.1 REFERENCE MATERIALS

Following are a list of applicable codes and standards followed for the design of the OTE Building.

A.1.1 Applicable Codes

- Illinois Accessibility Code, State of Illinois, Capital Development Board, April 24, 1997
- Illinois Plumbing Code
- NFPA 101, Life Safety Code
- (ICC) International Building Code 2009
- (ICC) International Plumbing Code 2009
- (ICC) International Mechanical Code 2009
- (ICC) International Fuel Gas Code 2009
- (ICC) International Fire Code 2009
- (NEC) National Electrical Code 2005
- (ICC) International Energy Conservation Code 2009
- 2005 National Electrical Code NFPA 70
- 2007 National Fire Alarm Code NFPA 72

A.1.2 Applicable Standards

- NFPA 13 – Standard for the Installation of Sprinkler Systems
- NFPA 14 – Standard for Standpipe Systems
- NFPA 20 – Standard for the Installation of Centrifugal Fire Pumps
- American Society of Civil Engineers – SEI/ASCE 7-05 Minimum Design Loads for Buildings and Other Structures
- American Concrete Institute 318-08/318R-08: Building Code Requirements for Structural Concrete and Commentary
- American Institute of Steel Construction – Manual of Steel Construction 13th Edition – Load and Resistance Factor Design
- American Institute of Steel Construction – Steel Design Guide Series, Design Guide 11: Floor Vibrations Due To Human Activity
- ASHRAE Standard 90.1 – 2007 Energy Standard for Buildings Except Low-Rise Residential Buildings
- ASHRAE Standard 62.1 – 2007 Ventilation for Acceptable Indoor Air Quality
- ASHRAE 55 – 2004.Thermal Environmental Conditions for Human

Occupancy

A.2 STRUCTURAL

A.2.1 Loads

A.2.1.1 Gravity Loading

Superimposed dead loads and live loads are general and pertain to both beam and column design. Some structural elements have specific loading demands in addition to the loads specified here. Live load reduction factors will be used for the design of columns and foundations for all occupiable floor loads less than 100 pounds per square foot. Specific concentrated loads to be determined include the following:

- Elevators
- Overhead doors at Tech spaces
- 3-ton capacity crane in Light Tech spaces – either an overhead bridge crane or a mobile gantry crane, currently identified as an alternate scope addition in this report
- Additional loading TBD

A.2.1.2 Dead Loading

All dead loads are to be calculated as the self weight of the structure.

A.2.1.3 Superimposed Dead Loading

Superimposed dead loads will be determined from the architectural design and the design of other building systems. Preliminary values for typical superimposed dead loading are indicated in the table below.

Loading Type	**Loading Value (PSF)**
Floor finishes	15
Ceiling and services, typical	10
Partitions	20
Equipment pads	TBD
Green roof assembly	TBD
Cladding (measured on a vertical face)	15
Others TBD	

A.2.1.4 Floor Live Loading

Occupancy/Use	**Loading Value (PSF)**
Public spaces	100

Egress corridors and stairs	100
Offices	
General (reducible)	50
Partitions	20
Mechanical equipment rooms – specific loading from heavy equipment will be accommodated in design	150
Light Tech spaces	
General (reducible)	600
Moveable partitions	20
Light storage rooms	125
Heavy storage rooms	250
Roof, with the exception of snow drift loading – see following section	30
Accessible roof gardens	100

A.2.1.5 Snow Loading

Snow loads will be in accordance with Section 7 of ASCE 7. Values to be used in snow load calculation per Chapter 7 of ASCE 7 are indicated in the table below. Special drift areas shall be marked on the plans.

Factor	Symbol	Value
Ground snow load	P_g	25 psf
Exposure factor	C_e	0.9
Thermal factor	C_t	1.0
Importance factor	I	1.1

A.2.1.6 Wind Loading

Wind loads for the preliminary design of the façade support structures as well as the lateral stability system of the building will be in accordance with IBC 2006 and Section 6 of ASCE 7. Values to be used in wind load calculation per Chapter 6 of ASCE 7 are indicated in the table below.

Factor	Symbol	Value
Basic Wind Speed	V	90 mph
Importance Factor	I	1.00
Building Category		II
Exposure		C
Gust Factor	G	0.85
Enclosure		Enclosed
Directionality Factor	K_d	0.85

A.2.1.7 Seismic Loading

Seismic loads for the design of the Fermilab IARC facility will be in accordance with IBC 2006 and ASCE 7.

A.2.1.8 Deflection

Vertical deflection of typical composite floor beams shall be limited as follows:

Live load deflection < L / 360

Total deflection < L / 240

Where L = beam span (for cantilevers, L = 2x the cantilever length)

Vertical deflection of composite floor beams vertically supporting façade members shall be limited as follows:

Post composite deflection < L / 360 or ¾”

Vertical deflection of roof structures shall be limited as follows:

Total deflection < L / 180

Live load deflection < L / 240

Lateral deflection of structures shall be limited as follows:

Lateral wind deflection < H / 500(over full building height)

Lateral wind deflection < H / 400(inter-story drift)

Lateral seismic deflection < H / 50, and compatible with building finishes

A.2.2 Floor Vibration Criteria

The susceptibility of the floors to excessive vibrations due to walking excitation shall be assessed according to the provisions set forth by AISC Steel Design Guide, “Floor Vibrations Due to Human Activity,” (Murray, Allen, Ungar, 1997). The vibration acceptance criteria shall be based on an “Office” occupancy per Table 4.1 of that publication.

A.3 MECHANICAL

A.3.1 Design Criteria

A.2.1.1 Temperature/Occupancy

Interior spaces will be designed in accordance with the following criteria

- Office Spaces
  - Winter Design 72° F (±2)
  - Summer Design 75° F(±2)/50% RH Maximum
  - 1 person/150 SF
- Tech
  - Winter Design 72° F (±2)
  - Summer Design 75° F(±2)/50% RH Maximum
  - 1 person/300 SF
- Lobbies
  - Winter Design 72° F(±2)
  - Summer Design 75° F(±2)/50% RH Maximum
  - 1 person/50 SF
- Classrooms and Conference Rooms
  - Winter Design 72° F(±2)
  - Summer Design 75° F(±2)/50% RH Maximum
  - 1 person/25 SF
- Lunch Room
  - Winter Design 72° F(±2)
  - Summer Design 75° F(±2)/50% RH Maximum
  - 1 person/25 SF
- Back of House (Mech/Elec rooms)
  - Winter Design 60° F(±2)
  - Summer Design – No Cooling
  - Unoccupied

A.2.1.2 Ventilation

Outside air ventilation will be based on the requirements as set out in ASHRAE 62.1-2004. When outside air is supplied to an interior, it has to be cooled or heated for large parts of the year and strategies to minimize the quantity of outside air, whilst maintaining internal air quality standards, can save significant amounts of energy. Demand Control Ventilation will be implemented to make sure that minimum ventilation air is provided to each zone at all times.

Occupancy values shall be based on those suggested by ASHRAE 62.1-2007 or based on actual where specific occupancy can be determined.

A.2.1.3 Building Envelope

The following criteria for the selection of the building envelope components are targeted.

- Roof – Maximum U=0.033 Btu/sf*°F (R=30 or better)
- Exterior Walls – Maximum U=0.05 Btu/sf*°F (R=20 or better)
- Vision Glass
  - Shading Coefficient – Maximum 0.32
  - U-Value 0.29 Btu/sf*°F (Center of Glass)
  - U-Value 0.35 Btu/sf*°F (Overall glass/frame combined)
- Spandrel Glass
  - Shading Coefficient – Maximum 0.32
  - U-Value 0.05 Btu/sf*°F
  - U-Value 0.10 Btu/sf*°F (Overall glass/frame combined)
  -

A.2.1.4 Lighting/Equipment

- Office Space
  - Lighting 1.0 Watts/SF
  - Equipment 1 Computer/Person
  - Miscellaneous Equipment – 0.5 Watts/SF
- Lite-Tech
  - Lighting - 5.0 Watts/SF
  - Computers - 1 Per Person (150 Watts)
  - Miscellaneous Equipment – 0.5 Watts/SF
- Lobbies
  - Lighting 1.0 Watts/SF
  - Miscellaneous Equipment – 0.5 Watts/SF
- Classrooms and Conference Rooms
  - Lighting 1.0 Watts/SF

  - Computers 1 Per Person (150 Watts)
  - Miscellaneous Equipment – 1.5 Watts/SF
- Lunch Room
  - Lighting – 1.4 Watts/SF
  - Miscellaneous Equipment – 1.5 Watts/SF
- Back of House (Mech/Elec rooms)
  - Lighting 1.0 Watts/SF

A.2.1.5 Duct and Pipe Sizing Criteria

The maximum duct velocities in ductwork are the following:

Service	**Maximum Velocity**	**Pressure Class**	**Seal Class**
Medium pressure ductwork from AHU discharge to terminal unit	1,800 FPM	4”	A
Main ducts from air handling units in mechanical rooms and in shafts:	1,500 FPM	2”	B
Main branch ducts on each floor:	1,000 FPM	2”	B
Secondary branch ducts:	750 FPM	2”	B
Branch ducts to and from diffuser and grilles, etc.:	500 FPM	2”	B
Exhaust	1500	2” (Negative)	B

Hydronic piping systems (chilled water, heating hot water, condensate drain) shall be Type L copper for sizes 2 ½” and smaller and Schedule 40 steel for sizes 3” and larger. All chemical treatment piping shall be PVC.

On chilled water piping, all insulation shall be a closed cell elastomeric or cellular glass type with vapor barrier and PVC jacket. If piping is run in an exterior space or in equipment rooms, an aluminum jacket shall be provided. On all condensate drain piping, provide elastomeric insulation with vapor barrier and PVC jacket.

In hydronic systems, provide manual air vents at all high points, manual drain valves at all low points, and automatic air vents at the high points of all risers.

The following design criteria have been used in pipe sizing:

Pipe Size (inches)	Velocity (m/s)	Friction (ft H2O/100 ft)	Max. Flow (GPM)
3/4”	2	2.81	3
1	2.35	2.73	6
1-1/4”	2.82	2.91	11
1-1/2”	3.44	3.35	19
2”	3.97	3.08	38
2-1/2”	4.52	2.98	67
3”	4.99	3.11	115
4”	5.85	3.0	232
6”	8.26	3.51	744
8”	8.98	2.05	1400

A.4 PLUMBING

A.4.1 Domestic Water System

The building’s domestic cold and hot water system will be sized based on Section 604 of the 2009 International Plumbing Code.

Domestic cold and hot water system pipe sizing will be based on a maximum velocity of 6 feet per second and a maximum allowable pressure loss of 2 psi per 100 feet.

System will be designed to prevent water hammer conditions by providing shock arrestors for batteries of flush valve fixtures, and for quick closing valves.

Wall hydrants will be provided at intervals around the building perimeter and also in mechanical rooms. External wall hydrants will be supplied from the ICW service.

Isolation valves will be provided at all pieces of equipment, the base of all main risers, at branches to each floor and at main bathroom areas and groups of plumbing fixtures.

Valved and capped connections will be provided at each floor to allow the future installation of plumbing fixtures that may be outside the core areas.

Tech areas will be provided with capped cold and hot water connections and floor drains.

Backflow devices will be located on all connections to HVAC equipment.

A.4.2 Sanitary Waste and Vent System

The building sanitary waste and vent system will be sized based on the International Plumbing Code, Chapter 7, Table 709.1, Table 710.1.1 and Table 710.1.2.

Horizontal drainage piping installation will be installed with uniform slopes. The minimum slope shall be based on Table 704.1 of the International Plumbing Code.

Capped connections will be provided to allow the future installation of plumbing fixtures that may be outside the core areas.

A.4.3 Storm Drainage System

Roof drainage system shall be sized based on Section 1106 of the 2009 Edition of the International Plumbing Code, Table 1106.2 and Table 1106.3.

A roof drainage system will be provided for the roof of the building Parapet scuppers are provided to handle overflow drainage requirements.

A.4.4 Plumbing Fixtures

Fixtures will be provided with chromium-plated brass trim and individual stop valves.

Appropriate 'barrier free' fixtures will be provided in accordance with the disabled access codes.

A.4.5 Insulation

All hot water piping system will be insulated.

All storm drain piping below roof will also be insulated up to connection with risers.

All piping, components, and equipment subject to sweating or heat loss will be insulated in accordance with the local energy code with appropriate thickness of insulation.

Additional insulation will be provided to ensure that noise transmission from any overhead and / or in wall plumbing systems are mitigated.

A.4.6 Miscellaneous

New Fire Hydrants shall be Waterous 5 1/4 with 1 - 4.5” steamer port with NH Threads, and 2- 2.5”hose connections with NH Threads.

All underground bolts shall be stainless steel.

Post Indicators Valves (PIV’s) shall be American Flow Control Mode IP. 71

Gate Valves shall be American Flow Series 2500 Resilient Wedge Gate Valve

Mechanical joint fittings attached to HDPE Water Main or PVC Water Main shall se restrained joints by Megalug, with a internal stainless steel stiffener for HDPE Pipe.

A.5 ELECTRICAL

All new equipment and pads shall be placed to maximize the central clearance area for future equipment maintenance and replacement.

A.6 FIRE PROTECTION

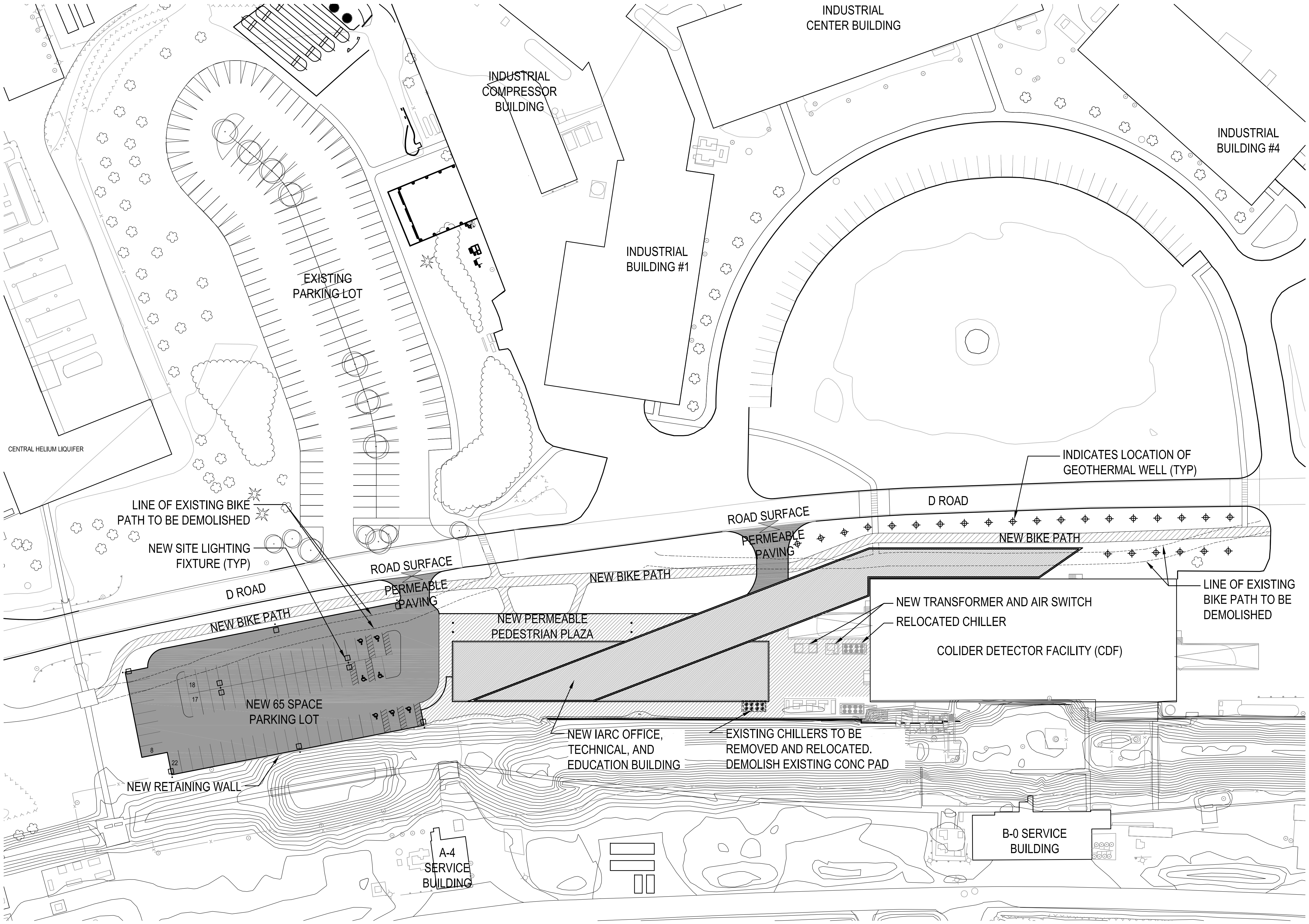
Sprinkler design densities will be provided per NFPA 13 provisions

All areas of the building will be provided with sprinkler protection unless not required by code.

Sprinkler system will be provided with automatic sprinklers, control valves, drain valves, water flow switches, tamper switches and alarm panel.

Each floor or level will be annunciated as a separate zone at the main fire alarm panel.

Dry sprinkler systems will be provided for unheated areas



① SITE PLAN

SCALE: 1"=80'

ARUP

r_barc
ross barney architects
10 west hubbard street chicago illinois 60610
t312 832 0600 f312 832 0601
www.r-barc.com

N
E
S
W

IARC
OFFICE, TECHNICAL, AND EDUCATION BUILDING
SITE PLAN

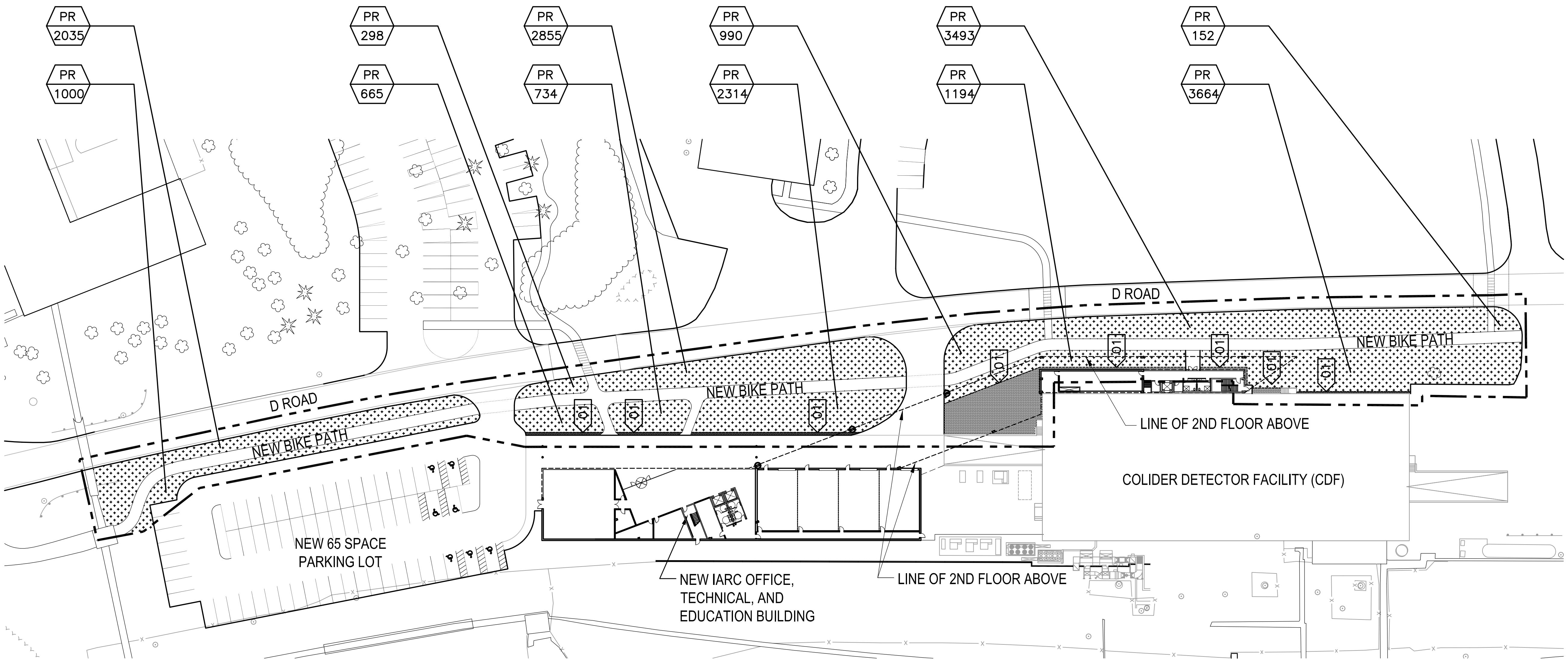
Fermilab

U.S. DEPARTMENT OF ENERGY

DATE
10.06.2010

PROJECT NO.
10-8-1

DRAWING NO.
CDR-1



LEGEND

▨ – NATIVE PLANTS

■ – LANDSCAPE ROCK (DARK GRAY, 12" D, SIZE RANGE 3"–4")

B / 12 – PLANT KEY – PLANT QUANTITY

01 – STEEL EDGING (3/16" W X 4" D, BLACK)

– – – LIMIT OF WORK (THIS SHEET SHOWS EXTENT OF NEW PLANTING WORK ONLY. SEE SITE PLAN FOR OTHER SITE WORK LIMIT UNDER THIS PROJECT.)

NOTES

1. RESTORE ALL AREAS DISTURBED BY CONSTRUCTION UNLESS NOTED OTHERWISE. RESTORATION SHOULD INCLUDE 8 FEET MINIMUM BEYOND CONSTRUCTION FENCE.
2. ALL NEW PLANTING BEDS SHALL HAVE FINELY SHREDDED HARDWOOD BARK MULCH, 3" DEPTH. DO NOT COVER GEO-THERMAL WELLS WITH MULCH.
3. SEE SURVEY DRAWING FOR EXISTING CONDITIONS. SEE SITE PLAN FOR INFORMATION ON SITE DEMOLITION WORK.
4. IF A DISCREPANCY EXISTS BETWEEN THE NUMBER OF PLANTS SHOWN IN THE PLANT MATERIALS SCHEDULE AND THE PLANS, THE PLANS SHALL GOVERN.
5. MATCH FINISHED TOP ELEVATION OF MULCH AND LANDSCAPE ROCK WITH FINISHED ELEVATION OF ADJACENT SIDEWALK AND PLAZA.

PLANT MATERIALS SCHEDULE

KEY	COMMON NAME / BOTANICAL NAME	QTY	ROOT	SIZE	REMARKS
	NATIVE PLANTS				
PR	LITTLE BLUESTEM Schizachyrium scoparium PRAIRIE DROPSEED Sporobolus heterolepis PRAIRIE BLAZING STAR Liatris pycnostachya HUSKER RED FOXGLOVE BEARDTONGUE Penstemon digitalis 'Husker Red'	19,394	CONT.	#1	MIX THESE PLANTS EVENLY IN EACH AREA SHOWN. PLANT AT 15" O.C., TYP. QTY. SHOWN IN EACH AREA INDICATES TOTAL NUMBER OF PLANTS COMBINED.

1 LANDSCAPE PLAN

SCALE: 1"=80'

0 40' 80' 160'

ross barney architects
10 west hubbard street chicago illinois 60610
t312 832 0600 f312 832 0601
www.r-barc.com

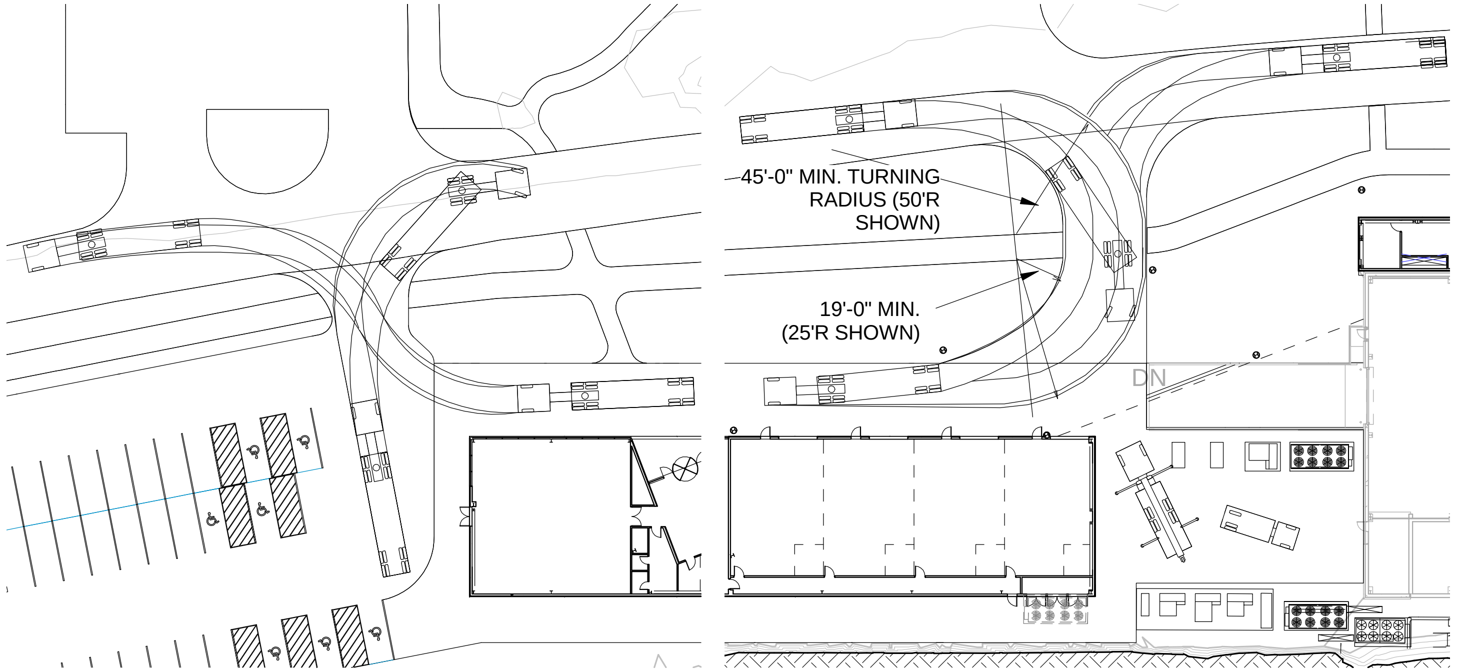
ARUP

IARC
OFFICE, TECHNICAL, AND EDUCATION BUILDING
LANDSCAPE PLAN

Fermilab

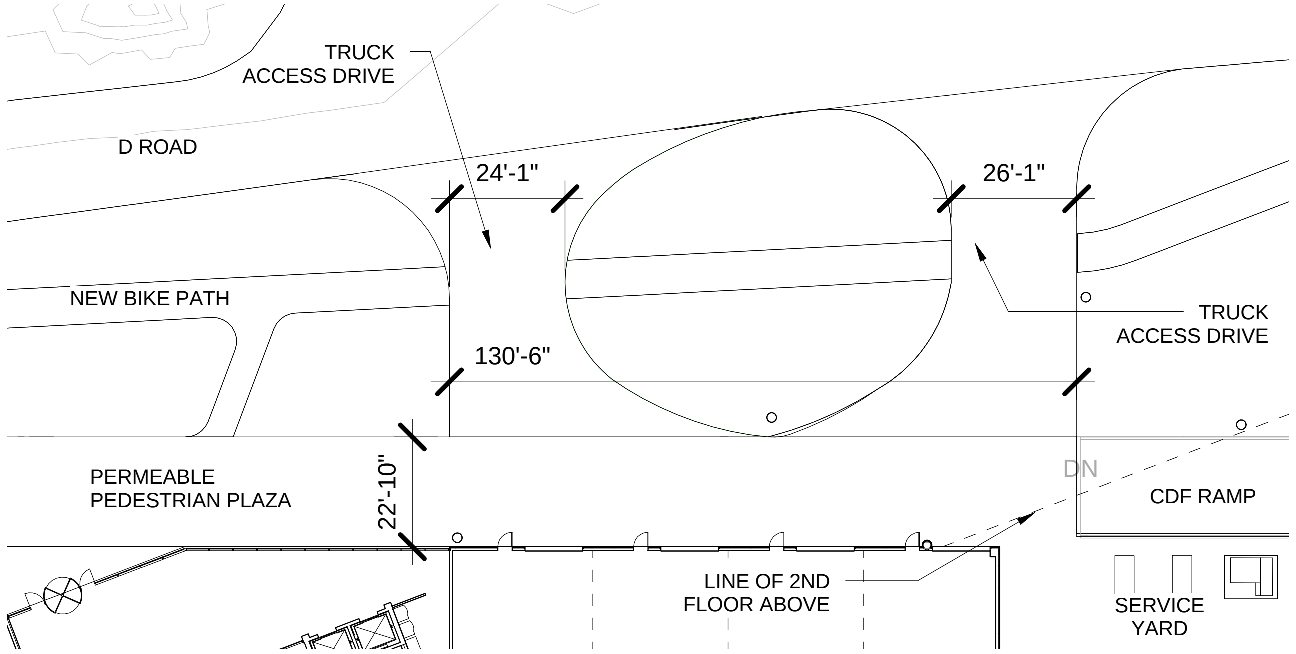
U.S. DEPARTMENT OF ENERGY

DATE
10.06.2010
PROJECT NO.
10-8-1
DRAWING NO.
CDR-2



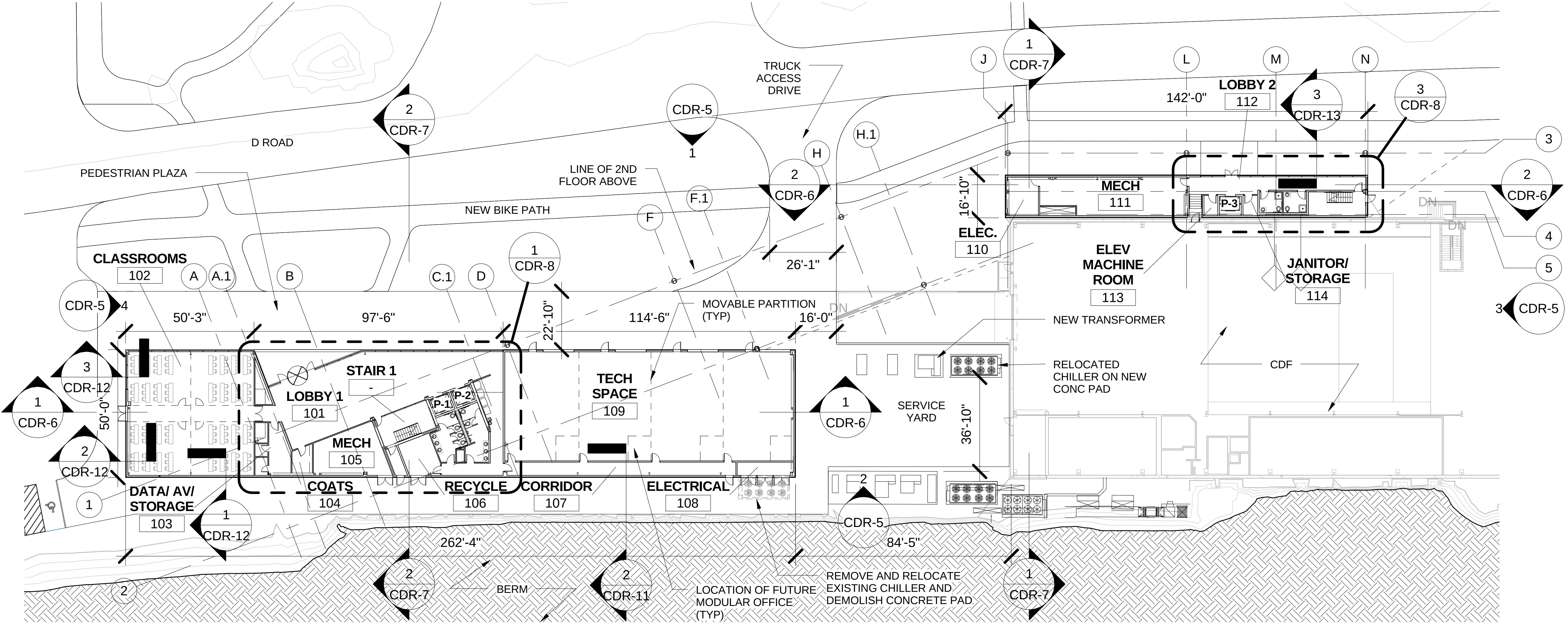
2 TRUCK ACCESS DIAGRAM

SCALE: NTS



3 SERVICE DRIVE ALT. PLAN

SCALE: 1" = 40'-0"



1 1st FLOOR PLAN

SCALE: 1" = 40'-0"

r_barc
ross barney architects
10 west hubbard street chicago illinois 60610
t312 832 0600 f312 832 0601
www.r-barc.com

ARUP

N
E
S
W

IARC
OFFICE, TECHNICAL, AND
EDUCATION BUILDING

1ST FLOOR PLAN

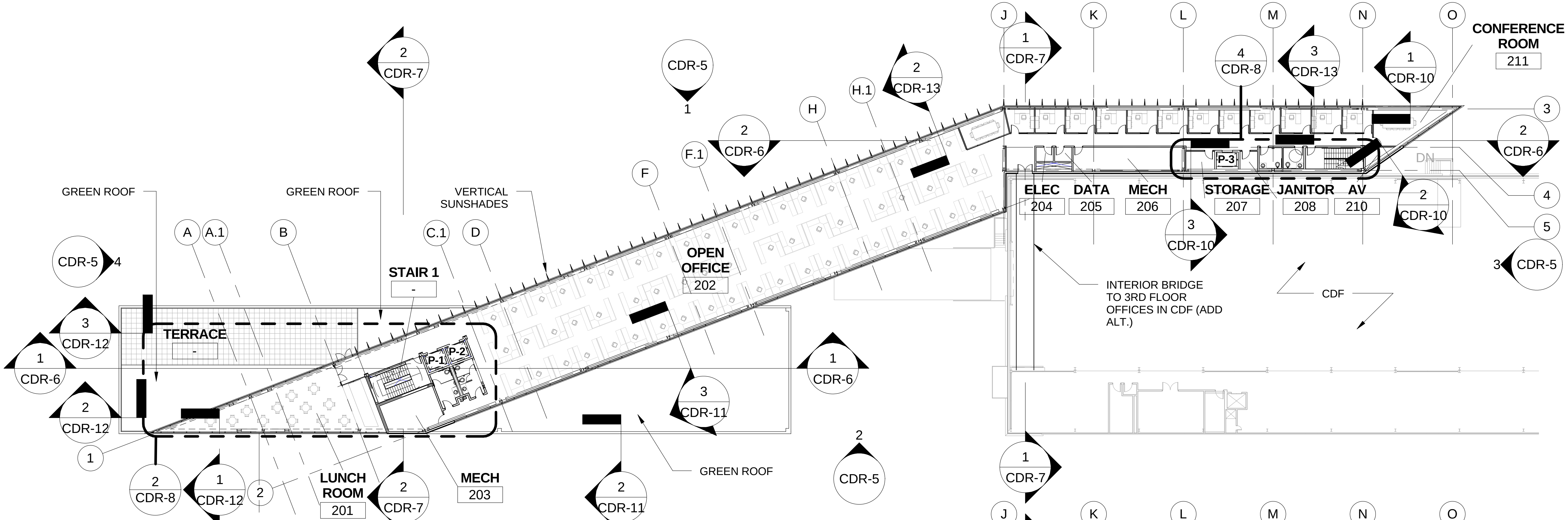
Fermilab

U.S. DEPARTMENT OF ENERGY

DATE
10.06.2010

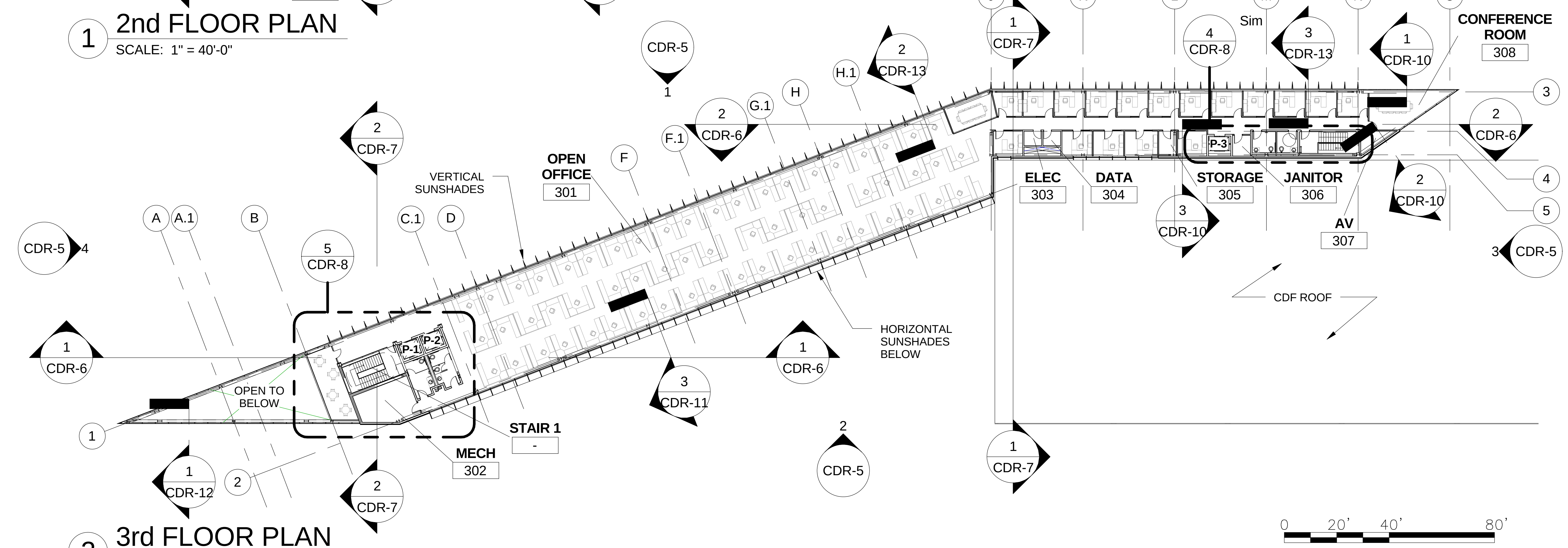
PROJECT NO.
10-8-1

DRAWING NO.
CDR-3



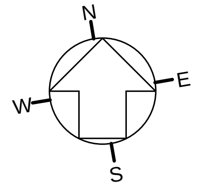
1 2nd FLOOR PLAN

SCALE: 1" = 40'-0"



2 3rd FLOOR PLAN

SCALE: 1" = 40'-0"



r_barc
ross barney architects
10 west hubbard street chicago illinois 60610
t312 832 0600 f312 832 0601
www.r-barc.com

ARUP

IARC
OFFICE, TECHNICAL, AND EDUCATION BUILDING

2ND + 3RD FLOOR PLAN

Fermilab

U.S. DEPARTMENT OF ENERGY

DATE

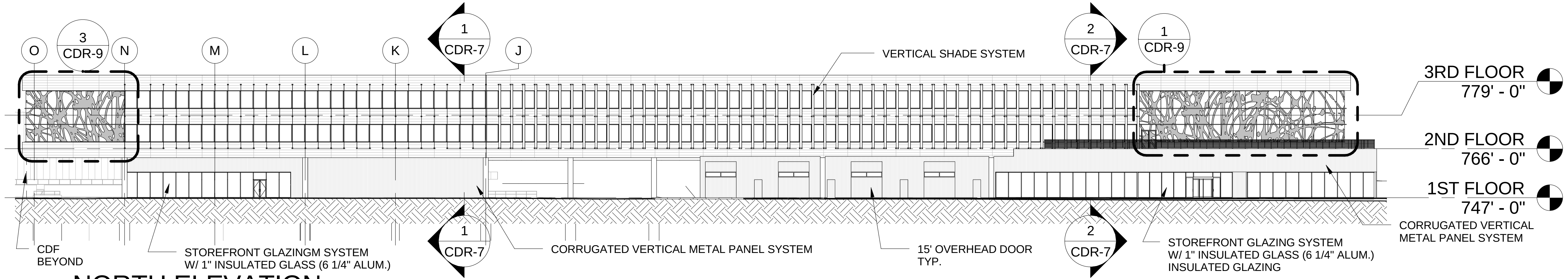
10.06.2010

PROJECT NO.

10-8-1

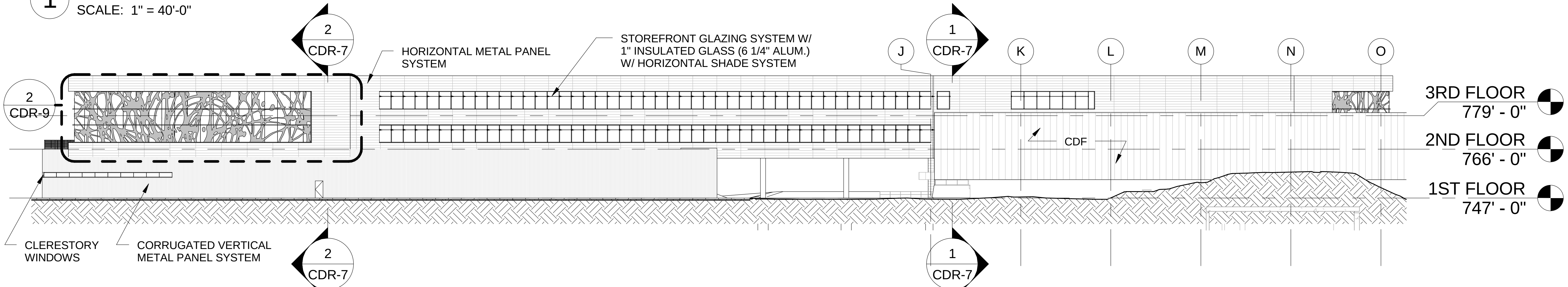
DRAWING NO.

CDR-4



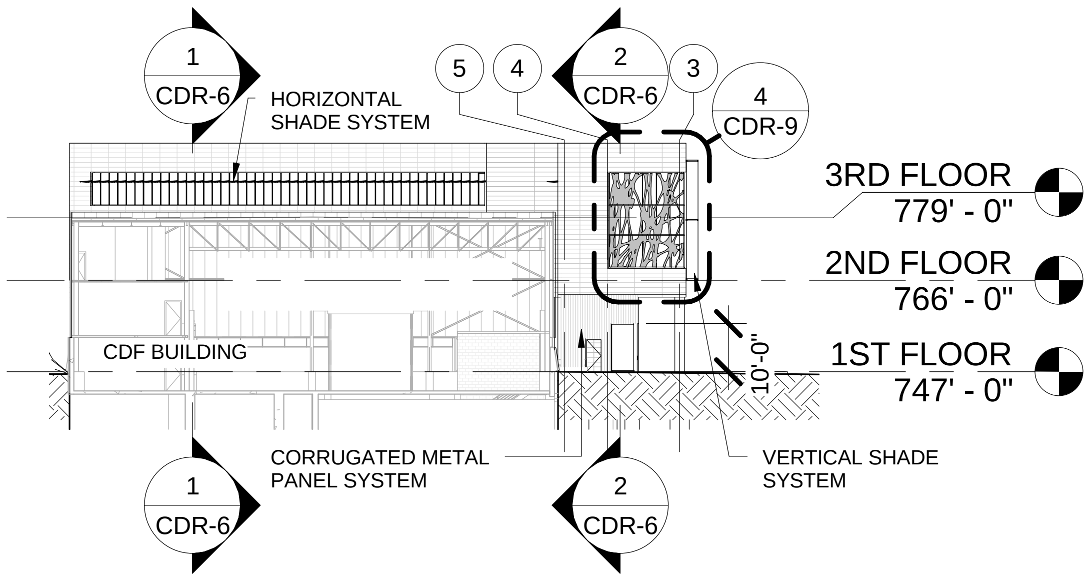
1 NORTH ELEVATION

SCALE: 1" = 40'-0"



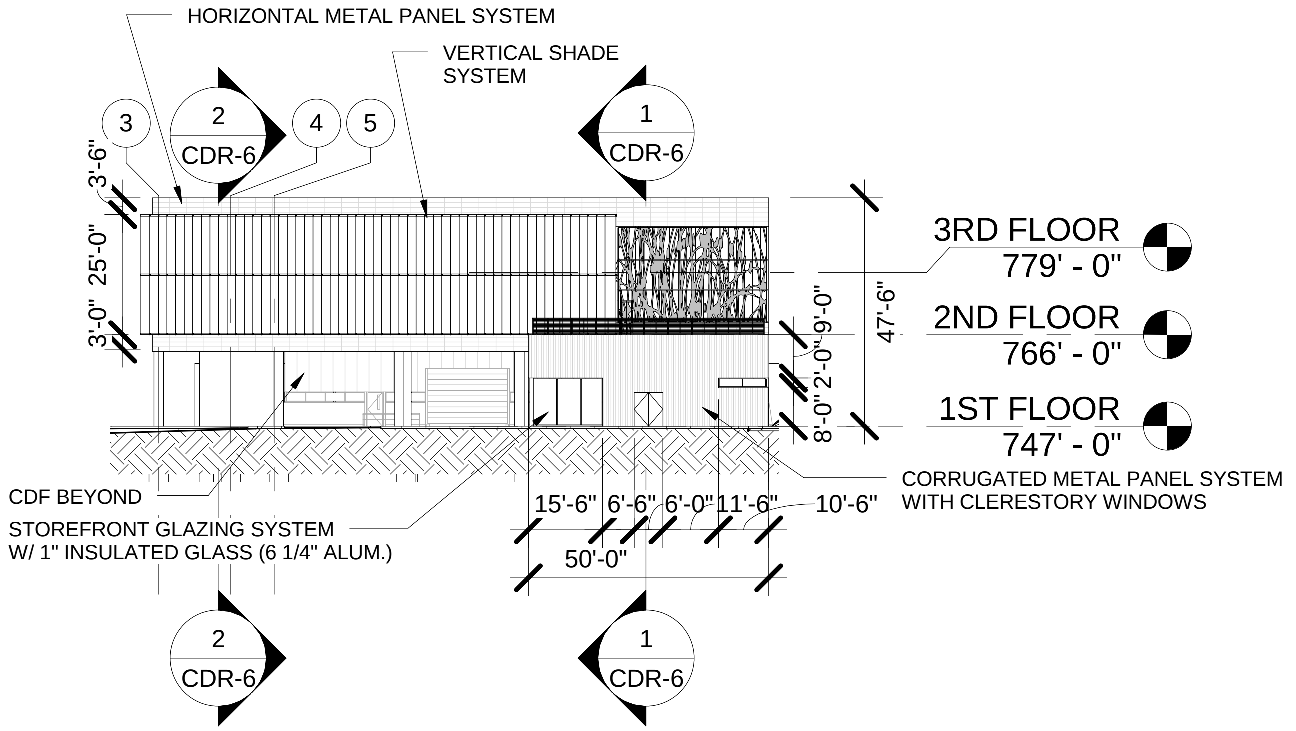
2 SOUTH ELEVATION

SCALE: 1" = 40'-0"



3 EAST ELEVATION

SCALE: 1" = 40'-0"



4 WEST ELEVATION

SCALE: 1" = 40'-0"

0 20' 40' 80'

r_barc ARUP

ross barney architects

10 west hubbard street chicago illinois 60610
t312 832 0600 f312 832 0601
www.r-barc.com

N
E
S
W

IARC
OFFICE, TECHNICAL, AND EDUCATION BUILDING

ELEVATIONS

Fermilab

U.S. DEPARTMENT OF ENERGY

DATE

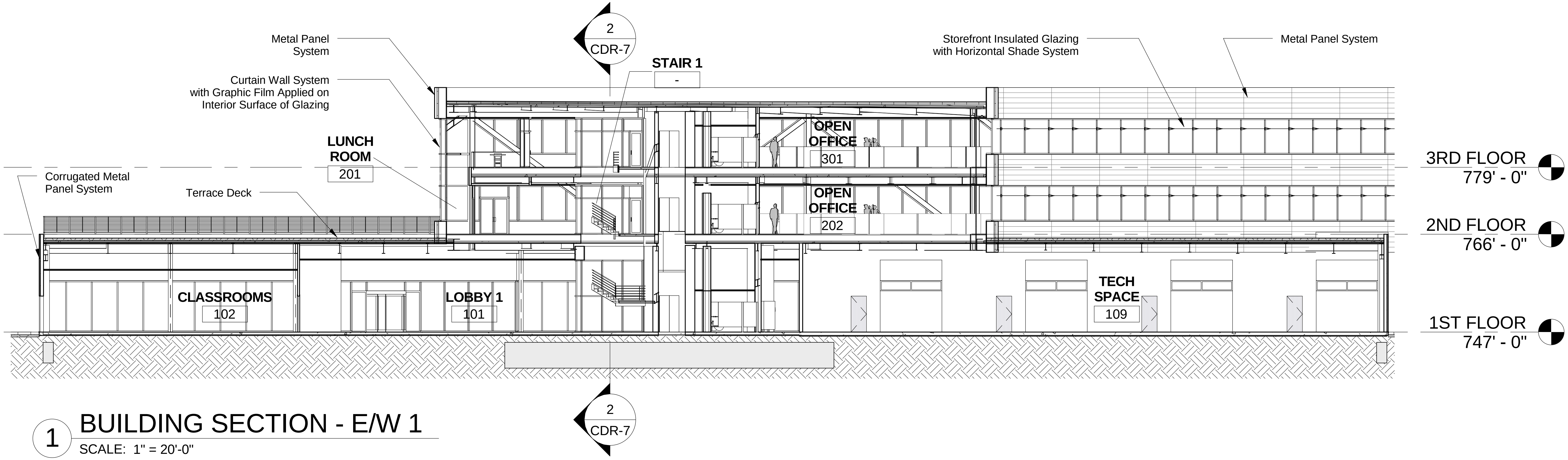
10.06.2010

PROJECT NO.

10-8-1

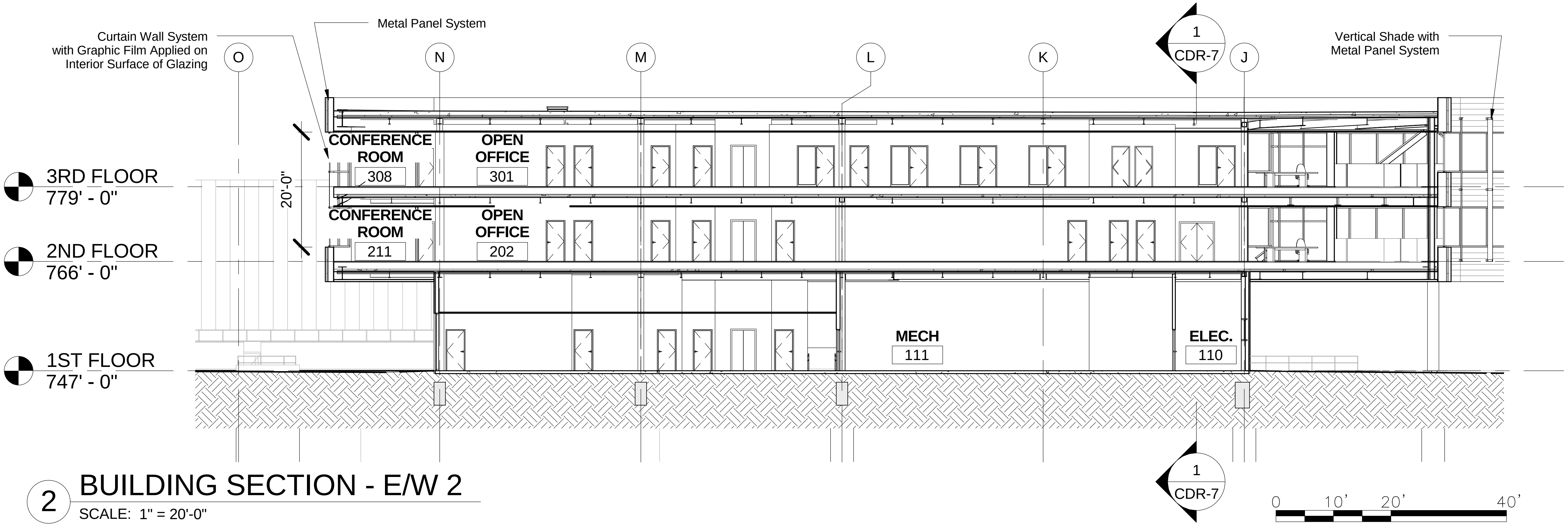
DRAWING NO.

CDR-5



1 BUILDING SECTION - E/W 1

SCALE: 1" = 20'-0"



2 BUILDING SECTION - E/W 2

SCALE: 1" = 20'-0"

r_barc ARUP

ross barney architects
10 west hubbard street chicago illinois 60610
t312 832 0600 f312 832 0601
www.r-barc.com

N
E
S
W

IARC
OFFICE, TECHNICAL, AND EDUCATION BUILDING
SECTIONS

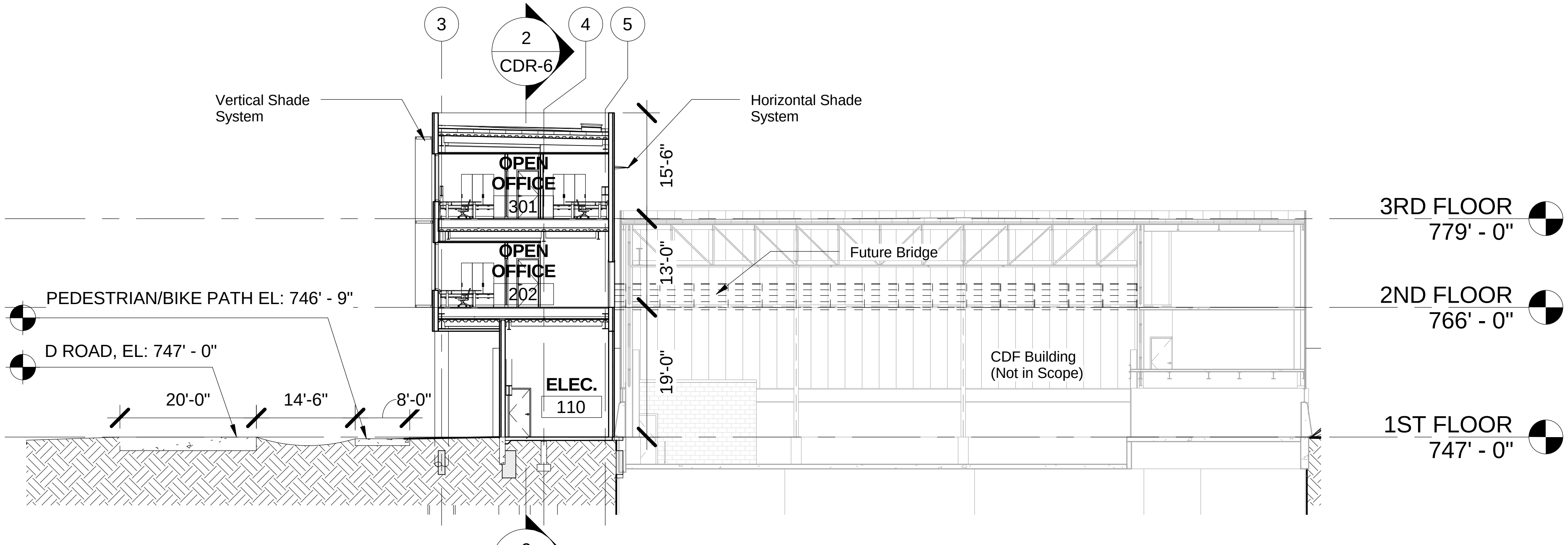
Fermilab

U.S. DEPARTMENT OF ENERGY

DATE
10.06.2010

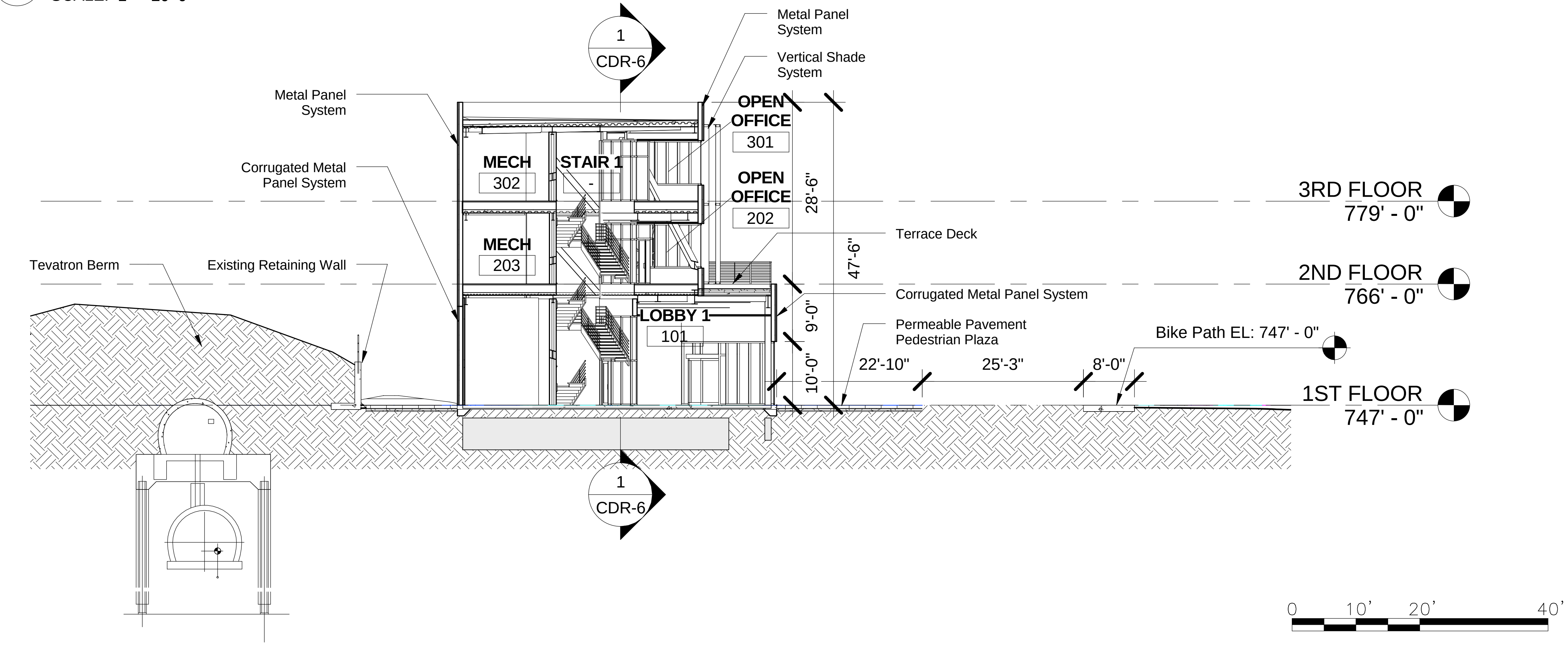
PROJECT NO.
10-8-1

DRAWING NO.
CDR-6



1 BUILDING SECTION - N/S 1

SCALE: 1" = 20'-0"



2 BUILDING SECTION - N/S 2

SCALE: 1" = 20'-0"

r_barc ARUP

ross barney architects

10 west hubbard street chicago illinois 60610
t312 832 0600 f312 832 0601
www.r-barc.com

N
E
S
W

IARC
OFFICE, TECHNICAL, AND EDUCATION BUILDING

SECTIONS

Fermilab

U.S. DEPARTMENT OF ENERGY

DATE

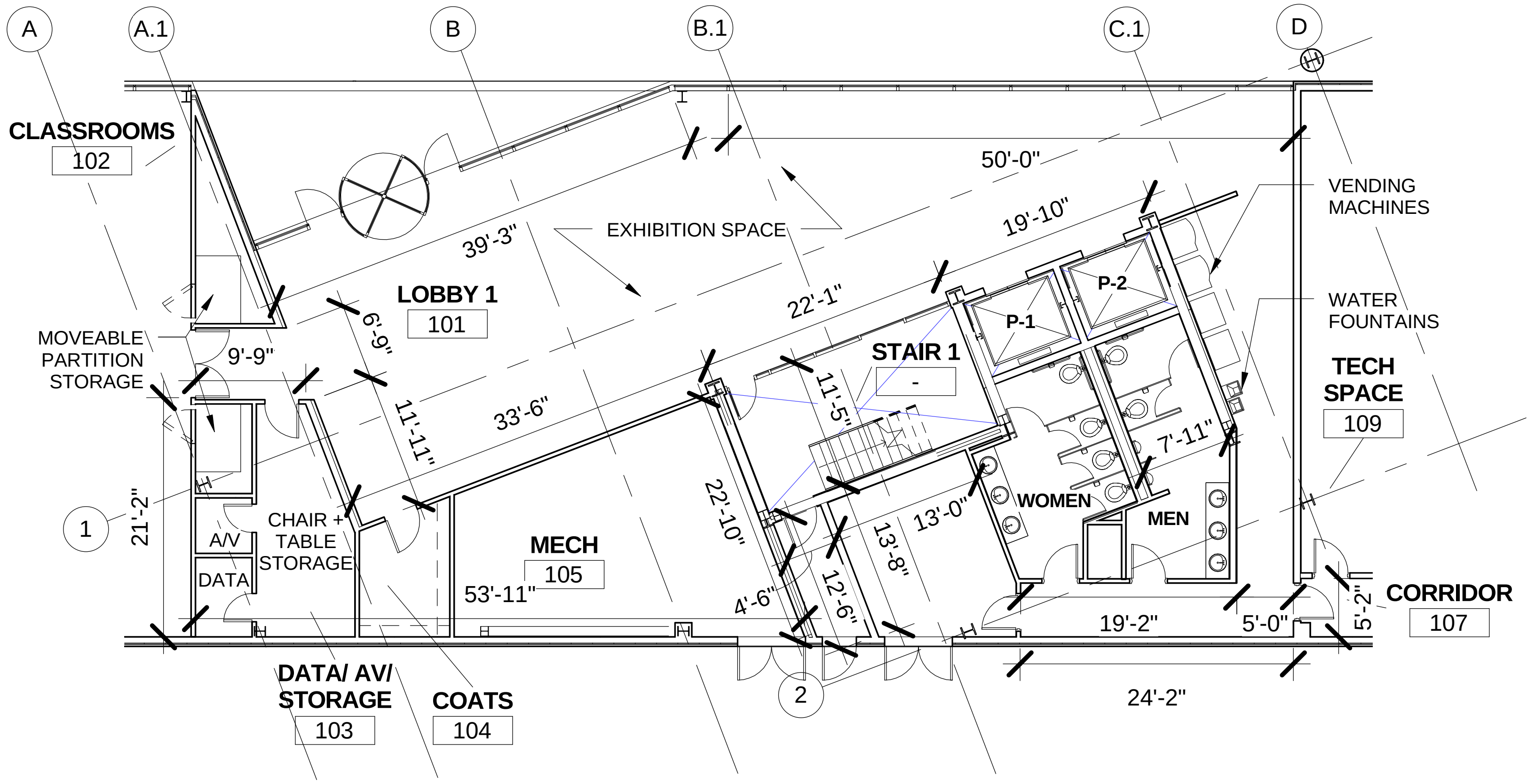
10.06.2010

PROJECT NO.

10-8-1

DRAWING NO.

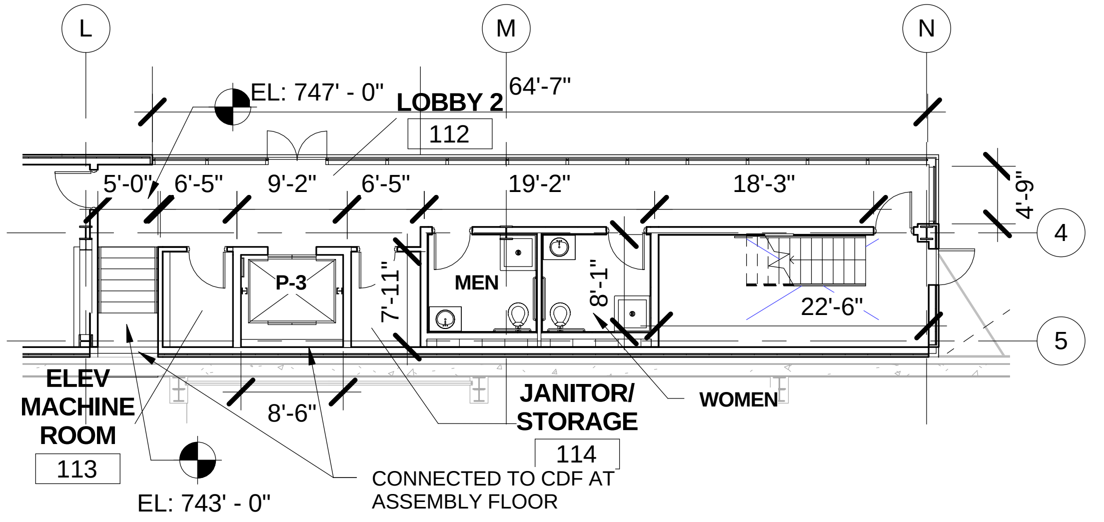
CDR-7



ENLARGED PLAN - WEST LOBBY

1

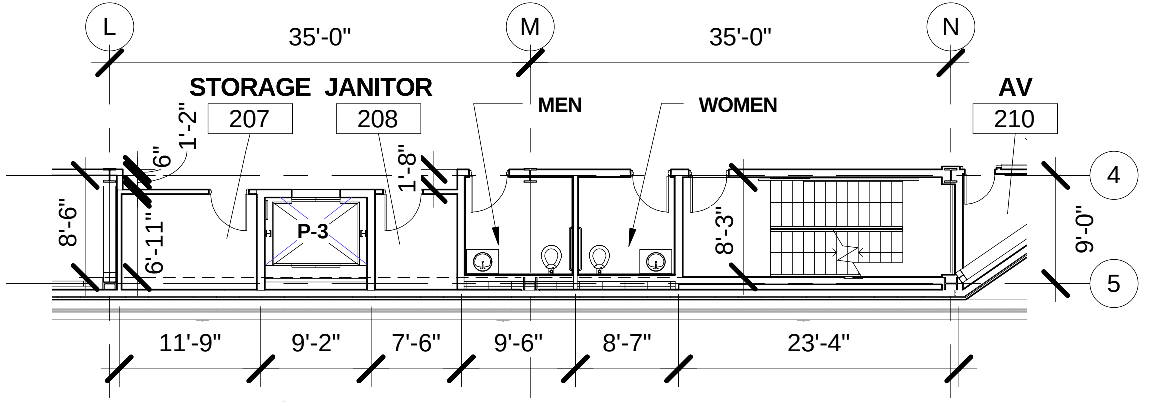
SCALE: 1/16" = 1'-0"



ENLARGED PLAN - EAST LOBBY

3

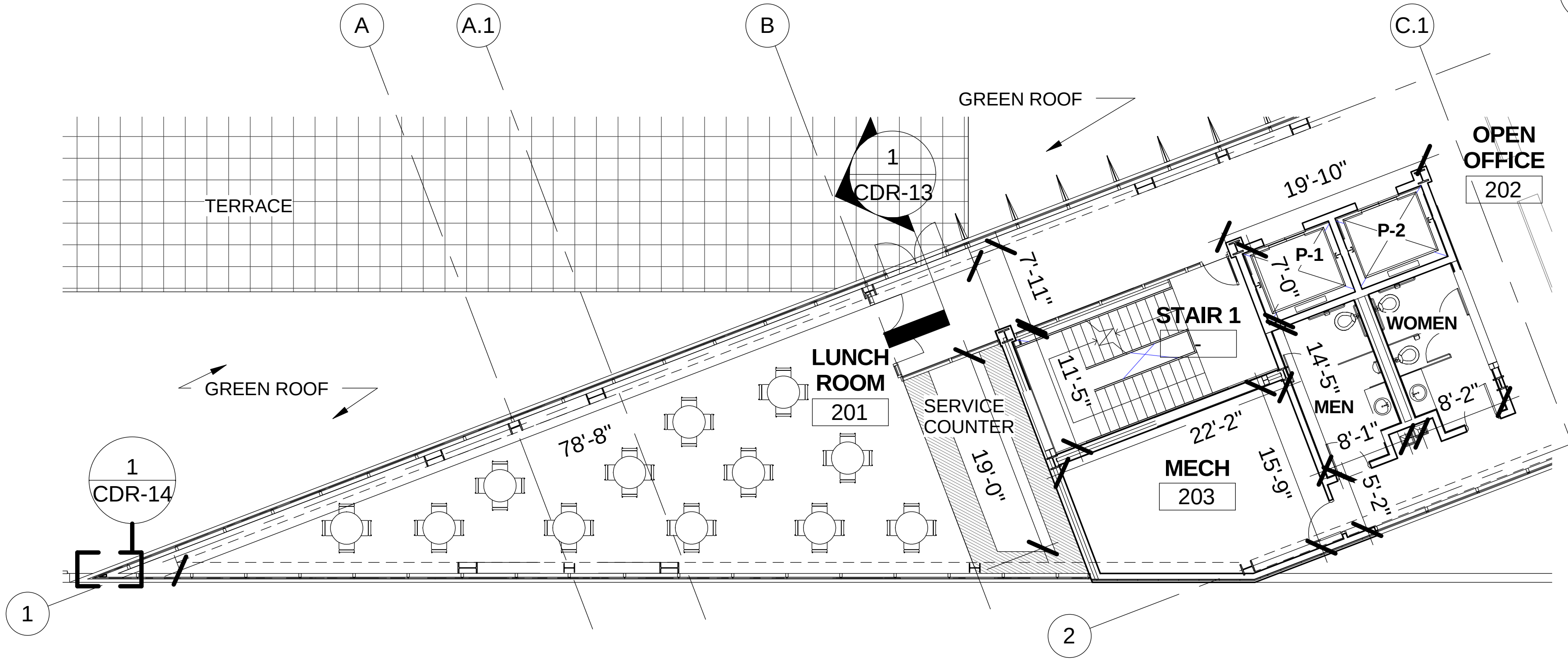
SCALE: 1/16" = 1'-0"



ENLARGED PLAN - 2ND+3RD FLR, EAST CORE

4

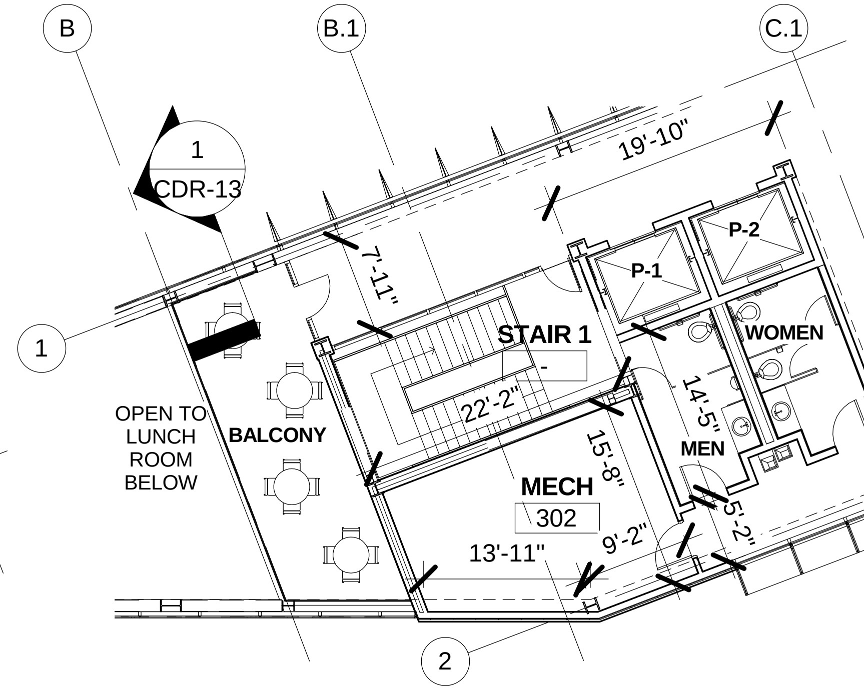
SCALE: 1/16" = 1'-0"



ENLARGED PLAN - 2ND FLR CORE AND LUNCHROOM

2

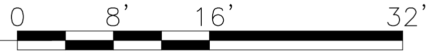
SCALE: 1/16" = 1'-0"



ENLARGED PLAN - 3RD FLR CORE AND LUNCHROOM

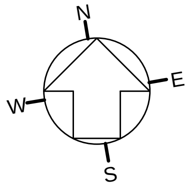
5

SCALE: 1/16" = 1'-0"



r_barc ARUP

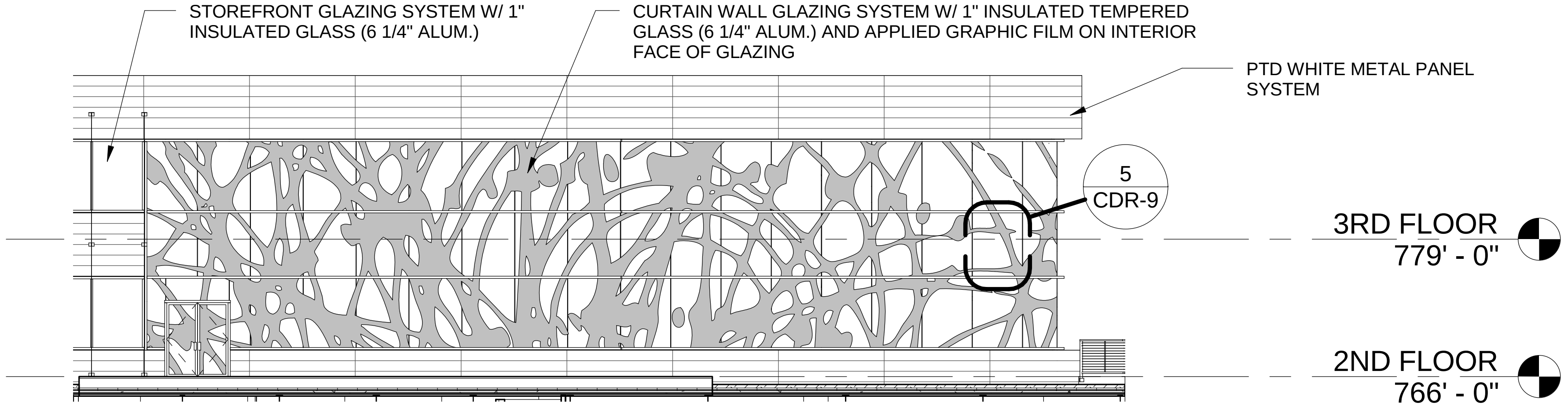
ross barney architects
10 west hubbard street chicago illinois 60610
t312 832 0600 f312 832 0601
www.r-barc.com



IARC
OFFICE, TECHNICAL, AND EDUCATION BUILDING
ENLARGED PLANS

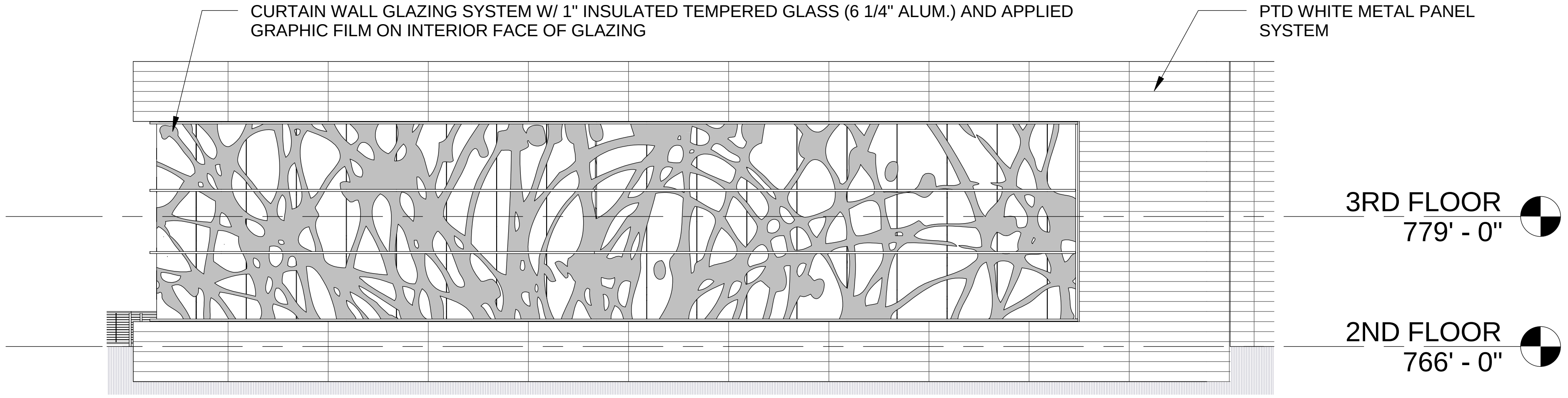
Fermilab
U.S. DEPARTMENT OF ENERGY

DATE
10.06.2010
PROJECT NO.
10-8-1
DRAWING NO.
CDR-8



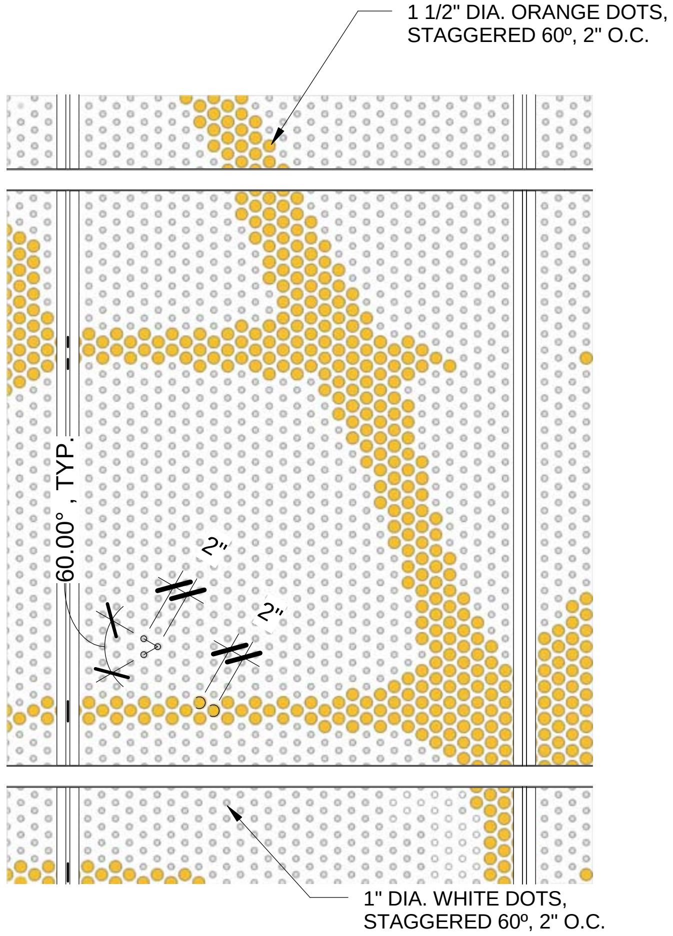
1 ENLARGED NORTH ELEVATION - LUNCH ROOM

SCALE: 1/16" = 1'-0"



2 ENLARGED SOUTH ELEVATION - LUNCH ROOM

SCALE: 1/16" = 1'-0"

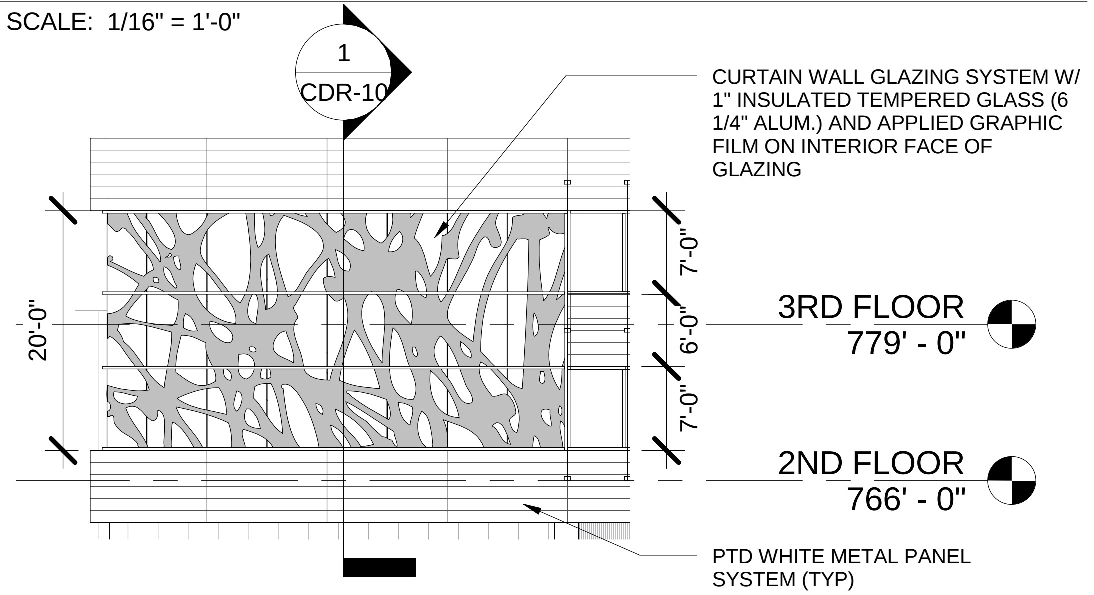


* GENERAL NOTE: TRANSPARENT GRAPHIC FILM WITH OPAQUE PRINT AS SHOWN TO BE INSTALLED AT INTERIOR FACE OF GLAZING. MOCK-UP TO BE PROVIDED AND APPROVED BY OWNER REPRESENTATIVE BEFORE INSTALLATION.

5 DETAIL - APPLIED GRAPHIC FILM

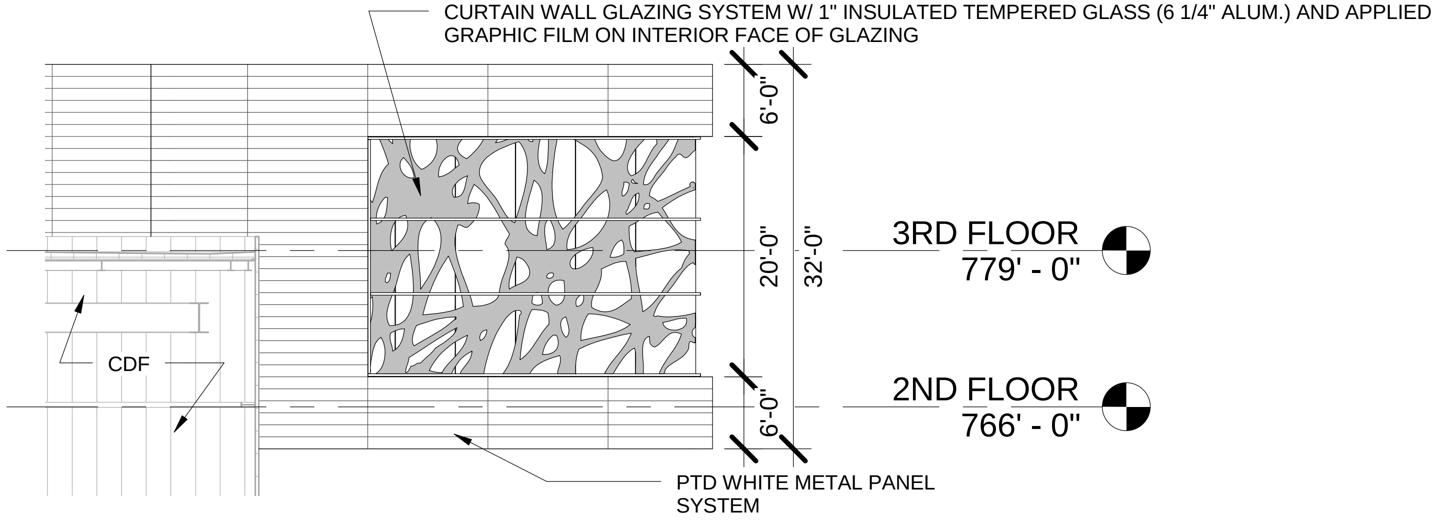
SCALE: 1/2" = 1'-0"

0 1' 2' 4'



3 ENLARGED NORTH ELEVATION - CONFERENCE ROOM

SCALE: 1/16" = 1'-0"



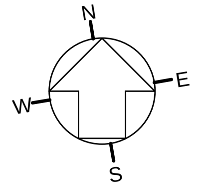
4 ENLARGED SOUTH ELEVATION - CONFERENCE ROOM

SCALE: 1/16" = 1'-0"

0 8' 16' 32'

ARUP

r_barc
ross barney architects
10 west hubbard street chicago illinois 60610
t312 832 0600 f312 832 0601
www.r-barc.com



IARC
OFFICE, TECHNICAL, AND EDUCATION BUILDING

ENLARGED ELEVATIONS

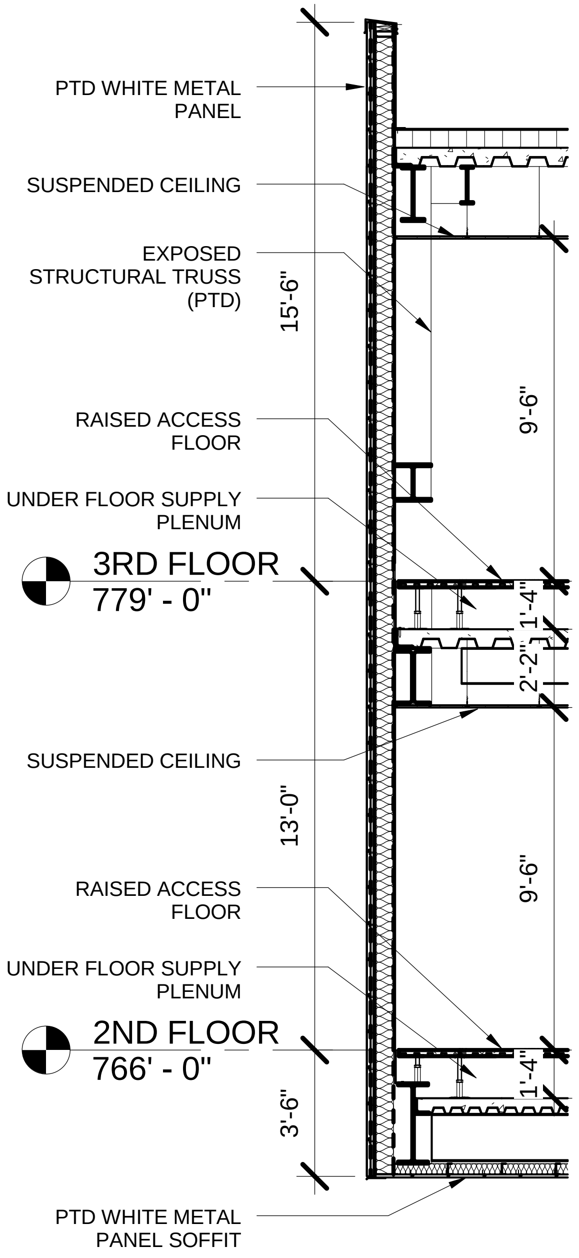
Fermilab

U.S. DEPARTMENT OF ENERGY

DATE
10.06.2010

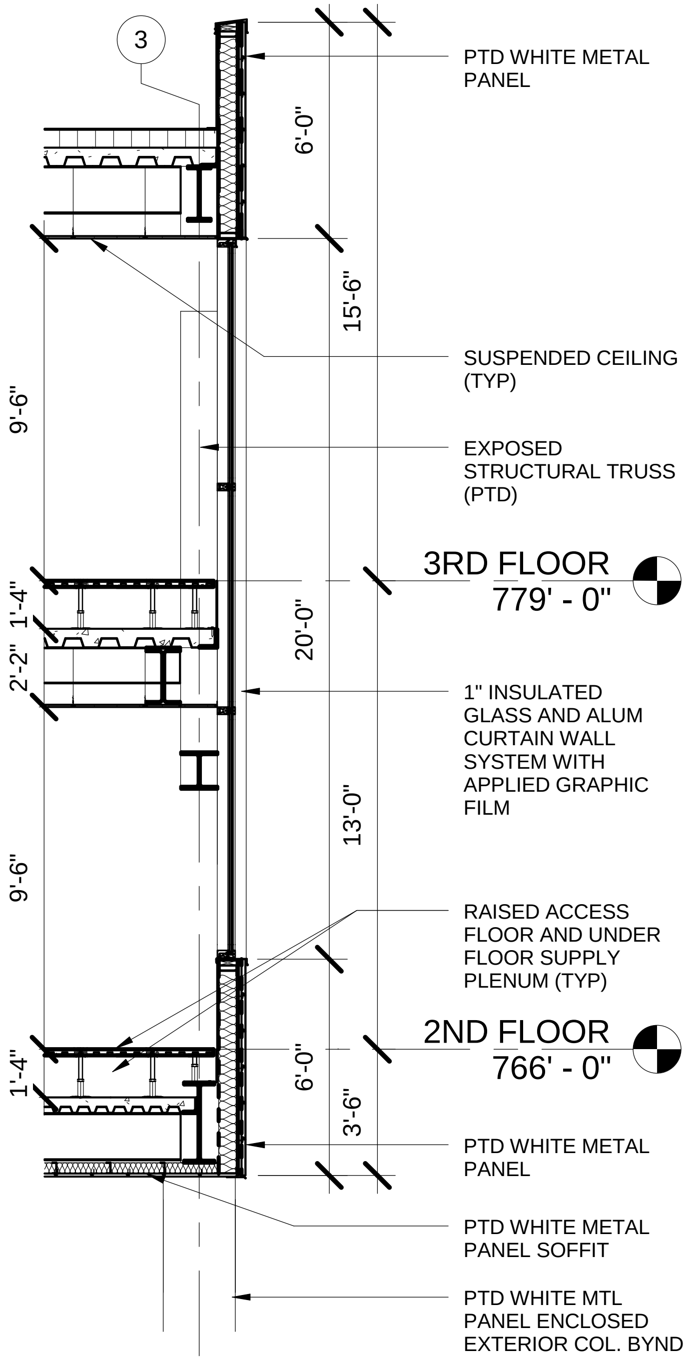
PROJECT NO.
10-8-1

DRAWING NO.
CDR-9



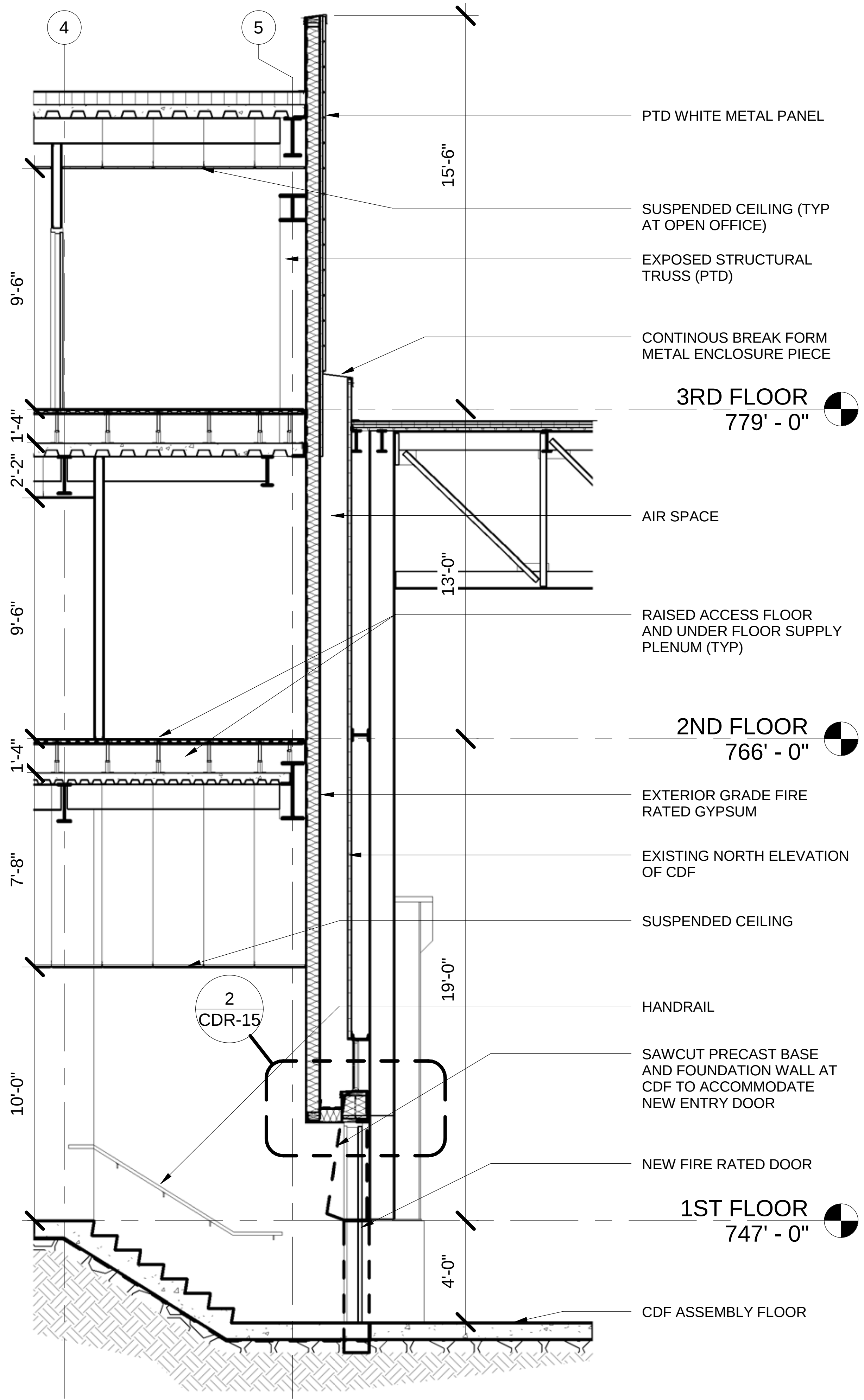
2 Wall Section 01

SCALE: 3/16" = 1'-0"



1 Wall Section 02

SCALE: 3/16" = 1'-0"



3 Wall Section 03

SCALE: 3/16" = 1'-0"

0 4' 8' 16'

r_barc ross barney architects
10 west hubbard street chicago illinois 60610
t312 832 0600 f312 832 0601
www.r-barc.com

ARUP

N E S W

IARC
OFFICE, TECHNICAL, AND EDUCATION BUILDING

WALL SECTIONS

Fermilab

U.S. DEPARTMENT OF ENERGY

DATE

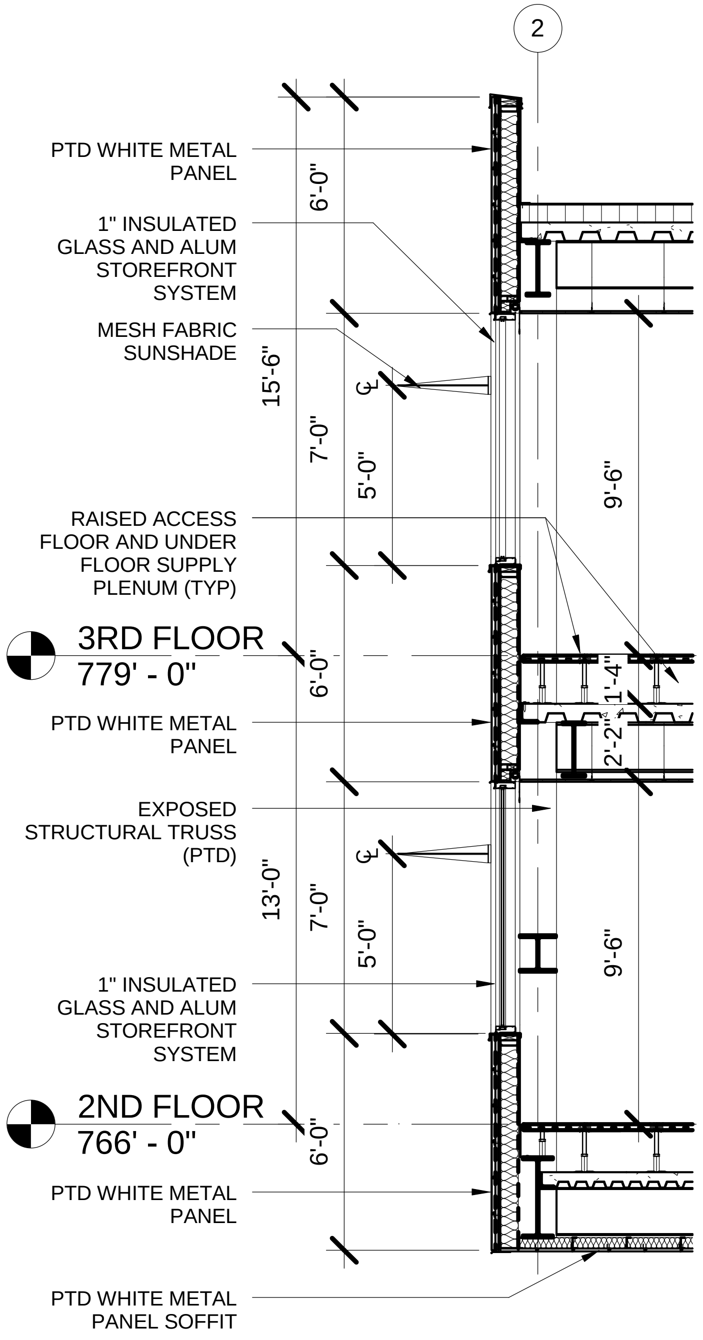
10.06.2010

PROJECT NO.

10-8-1

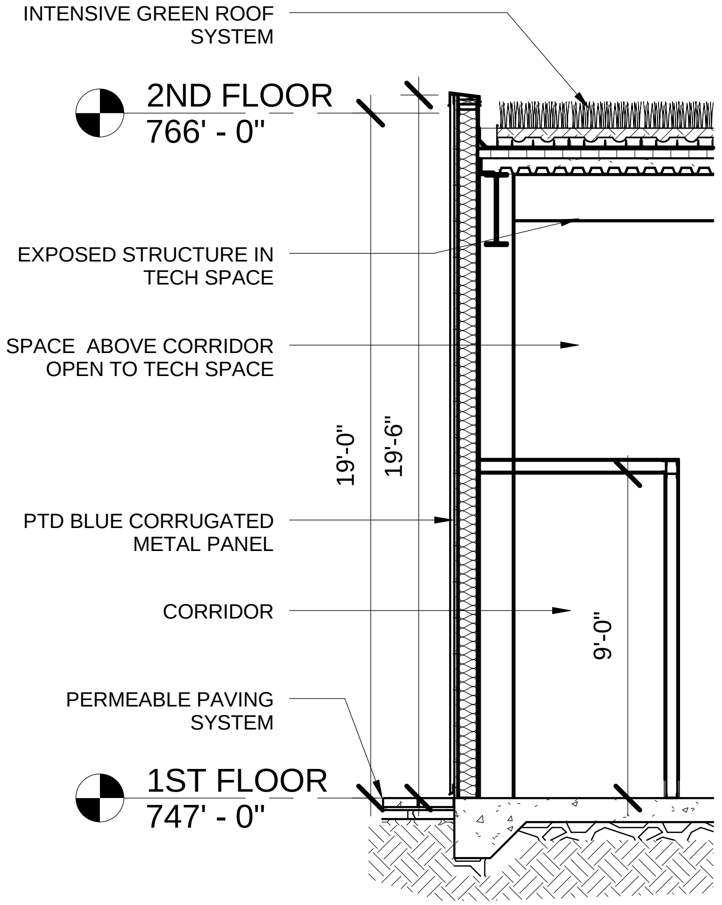
DRAWING NO.

CDR-10



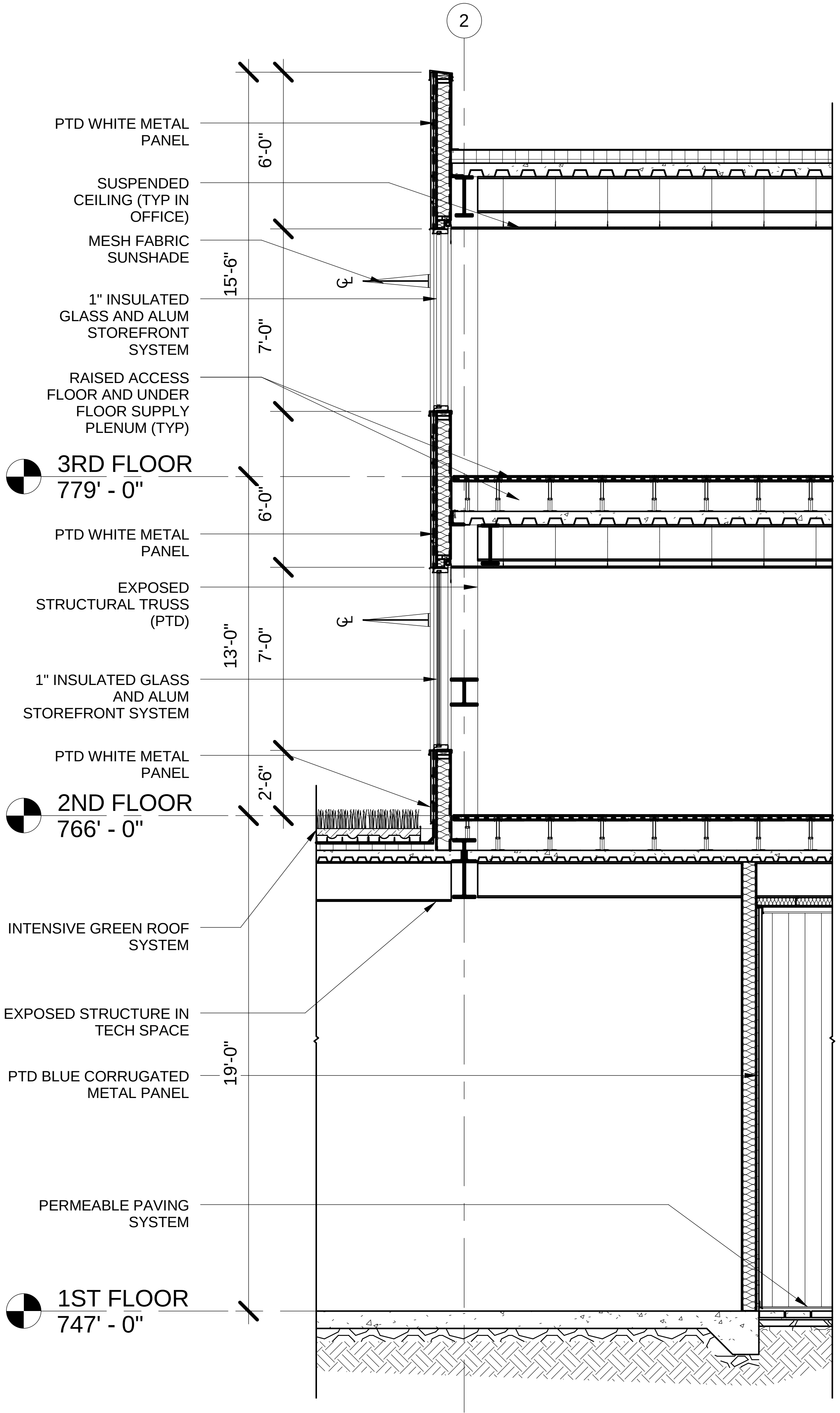
1 Wall Section 04

SCALE: 3/16" = 1'-0"



2 Wall Section 05

SCALE: 3/16" = 1'-0"



3 Wall Section 06

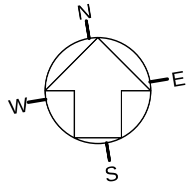
SCALE: 3/16" = 1'-0"

0 4' 8' 16'

r_barc ARUP

ross barney architects

10 west hubbard street chicago illinois 60610
t312 832 0600 f312 832 0601
www.r-barc.com



IARC
OFFICE, TECHNICAL, AND EDUCATION BUILDING

WALL SECTIONS

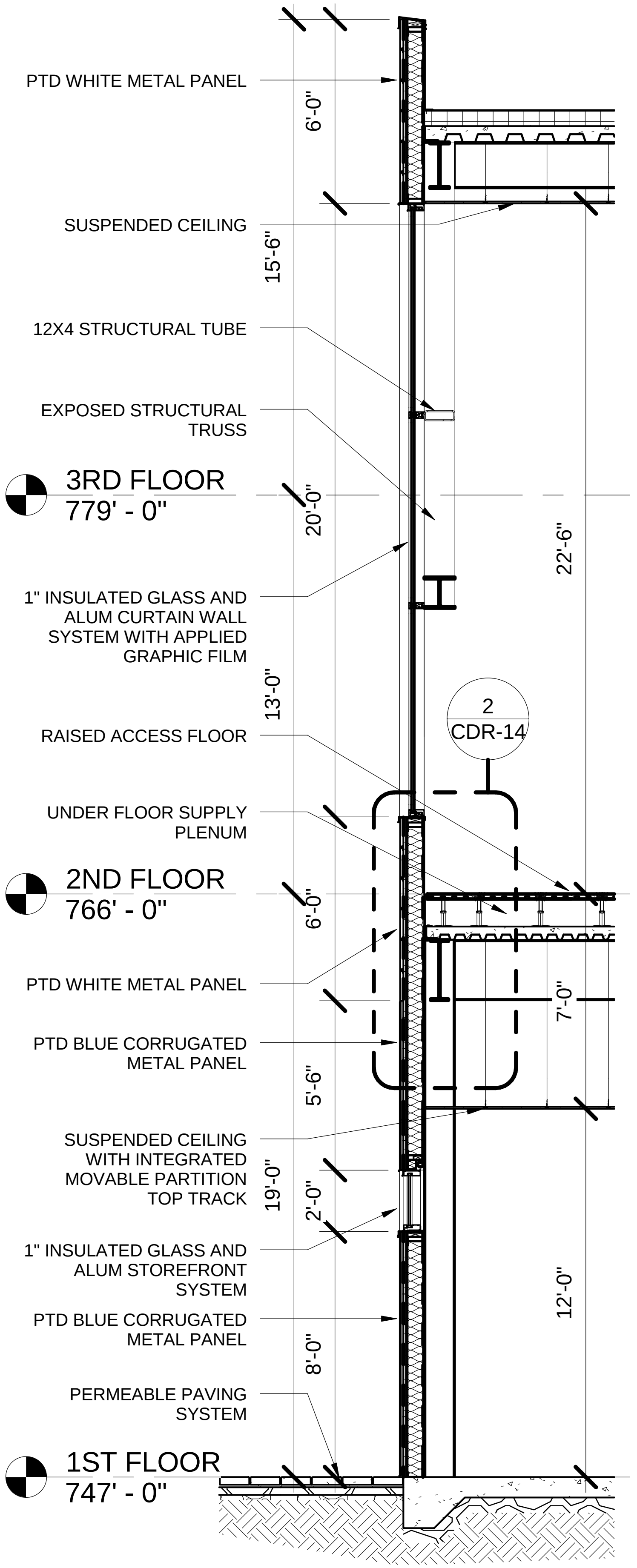
Fermilab

U.S. DEPARTMENT OF ENERGY

DATE
10.06.2010

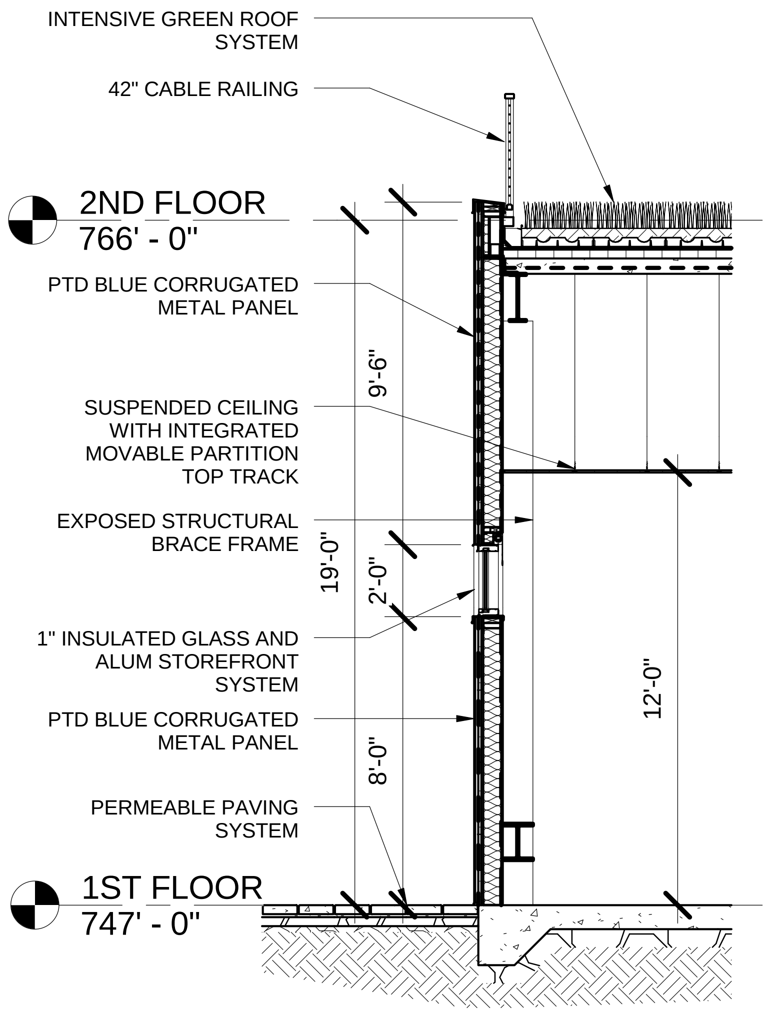
PROJECT NO.
10-8-1

DRAWING NO.
CDR-11



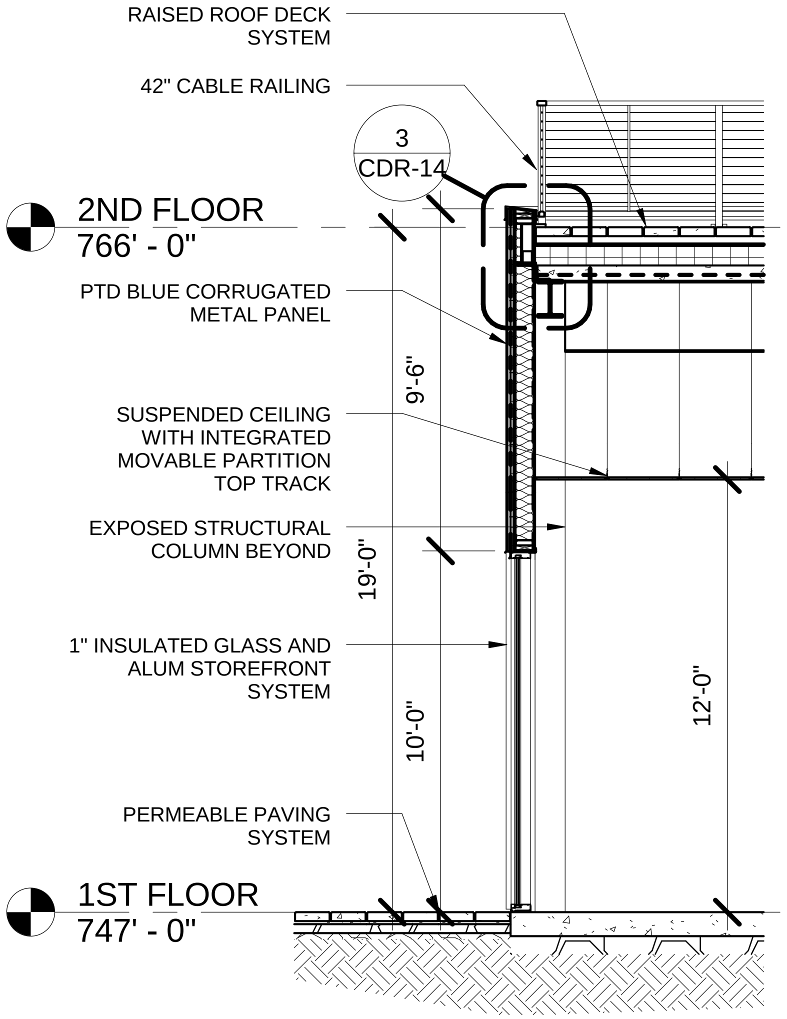
① Wall Section 07

SCALE: 3/16" = 1'-0"



② Wall Section 08

SCALE: 3/16" = 1'-0"



③ Wall Section 09

SCALE: 3/16" = 1'-0"

0 4' 8' 16'

r_barc
ross barney architects
10 west hubbard street chicago illinois 60610
t312 832 0600 f312 832 0601
www.r-barc.com

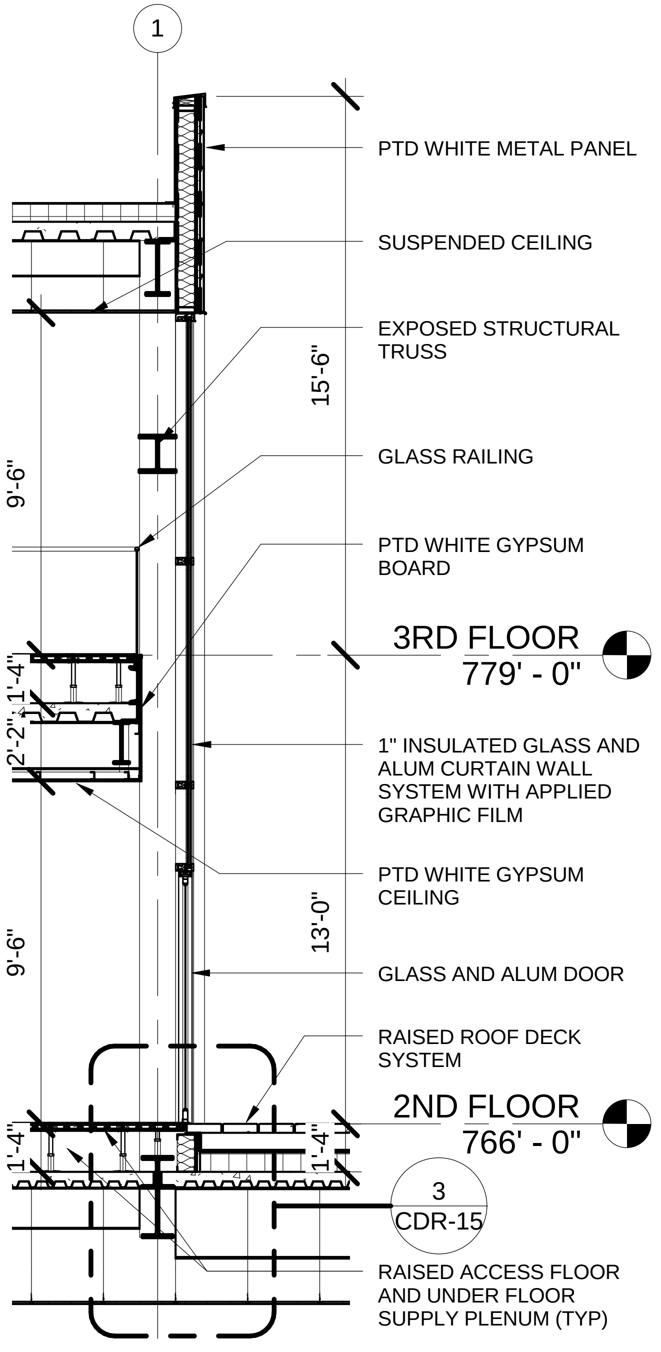
ARUP

IARC
OFFICE, TECHNICAL, AND EDUCATION BUILDING
WALL SECTIONS

Fermilab

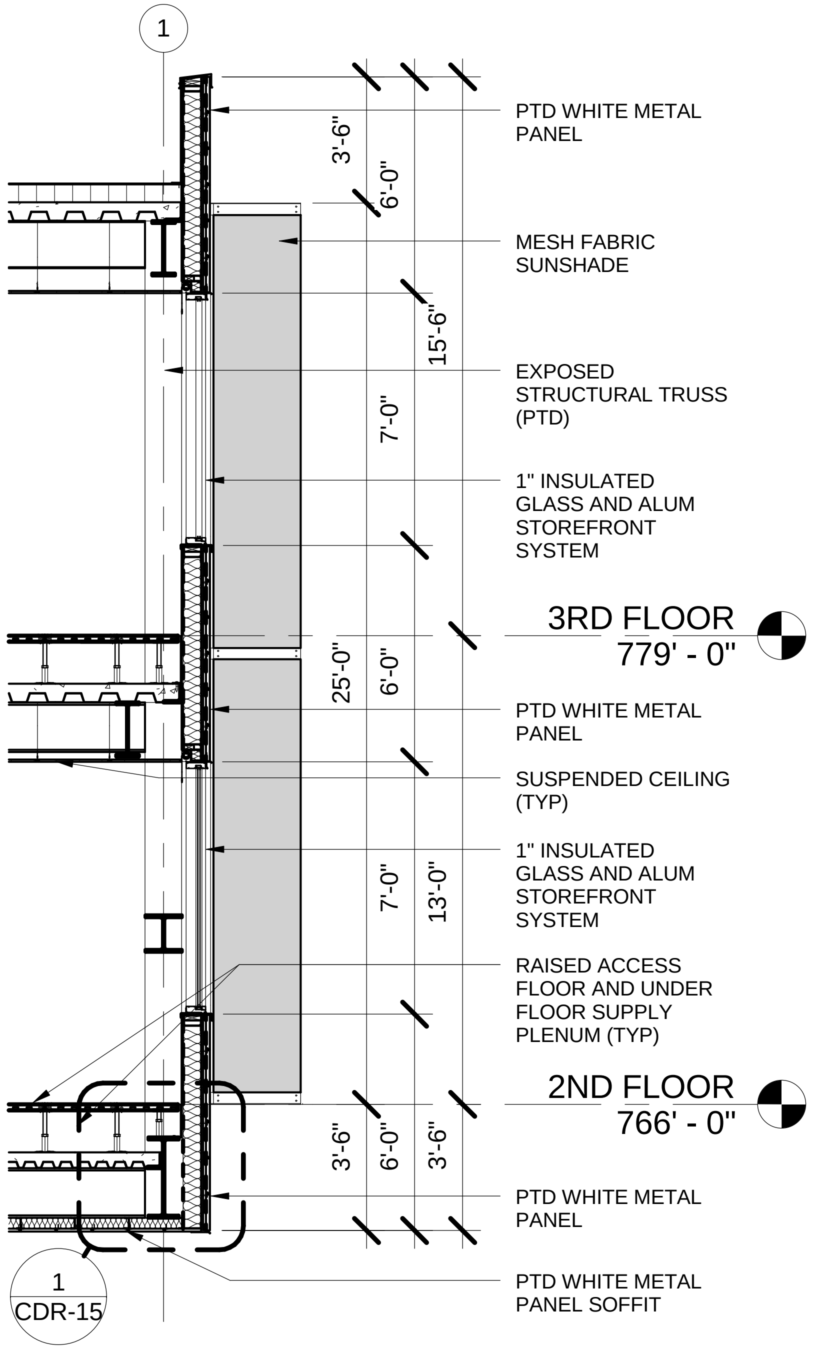
U.S. DEPARTMENT OF ENERGY

DATE	**10.06.2010**
PROJECT NO.	**10-8-1**
DRAWING NO.	**CDR-12**



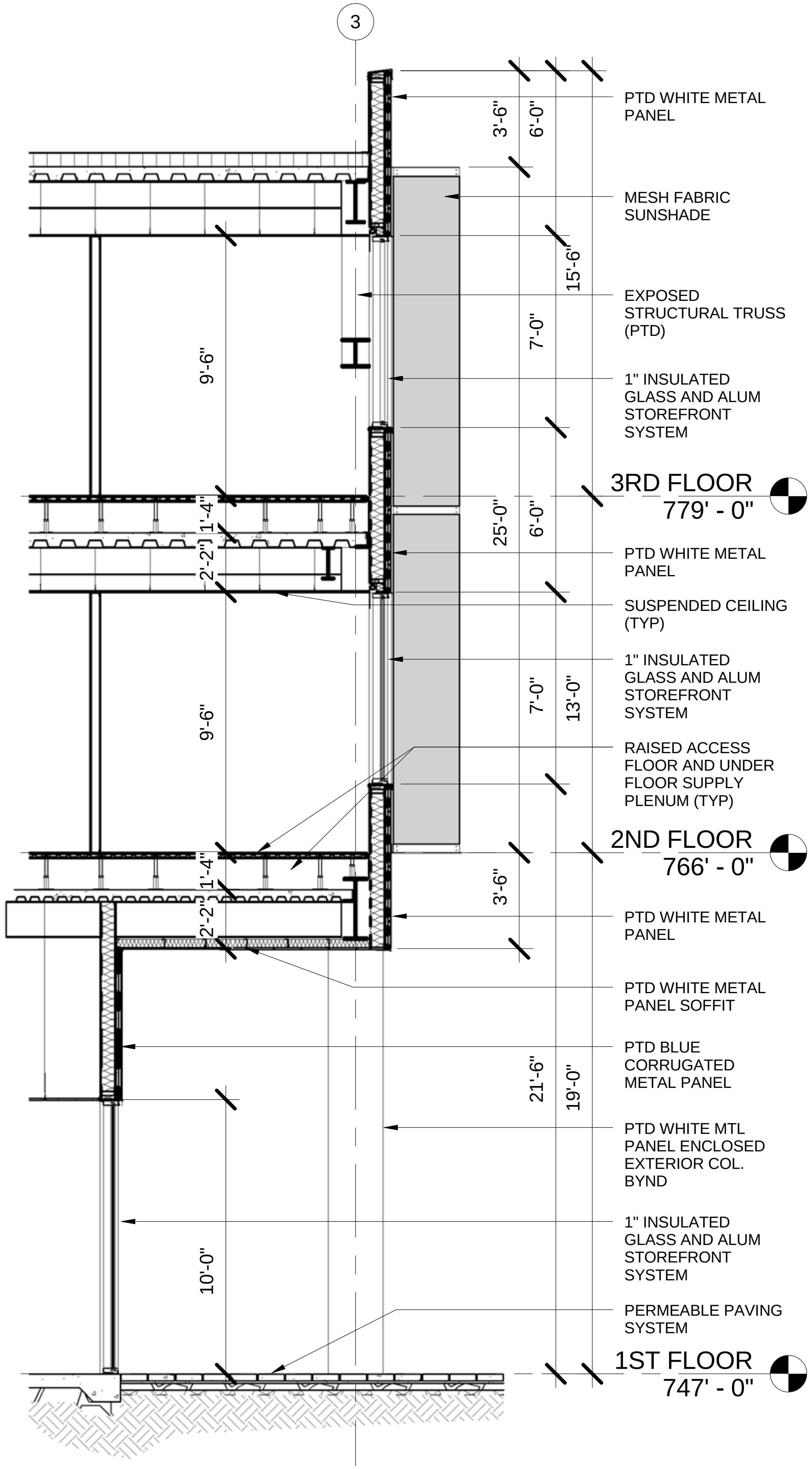
1 Wall Section 10

SCALE: 3/16" = 1'-0"



2 Wall Section 11

SCALE: 3/16" = 1'-0"



3 Wall Section 12

SCALE: 3/16" = 1'-0"

0 4' 8' 16'

r_barc ARUP

ross barney architects

10 west hubbard street chicago illinois 60610
t312 832 0600 f312 832 0601
www.r-barc.com

N E S W

IARC
OFFICE, TECHNICAL, AND EDUCATION BUILDING

WALL SECTIONS

Fermilab

U.S. DEPARTMENT OF ENERGY

DATE

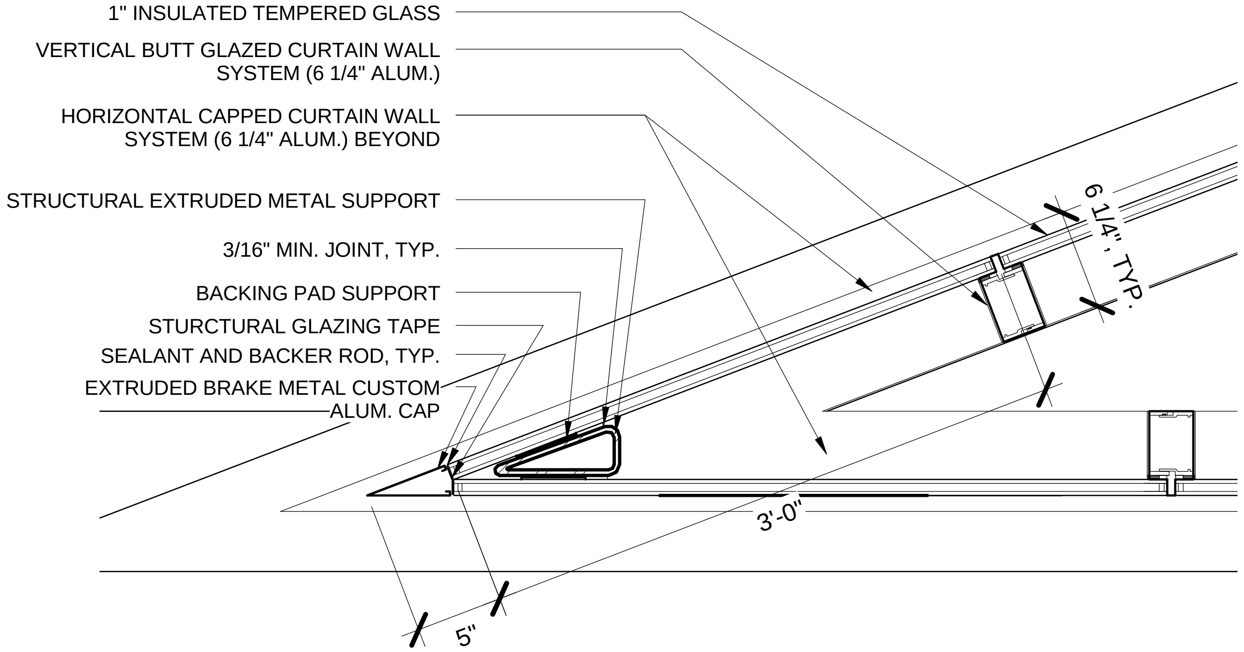
10.06.2010

PROJECT NO.

10-8-1

DRAWING NO.

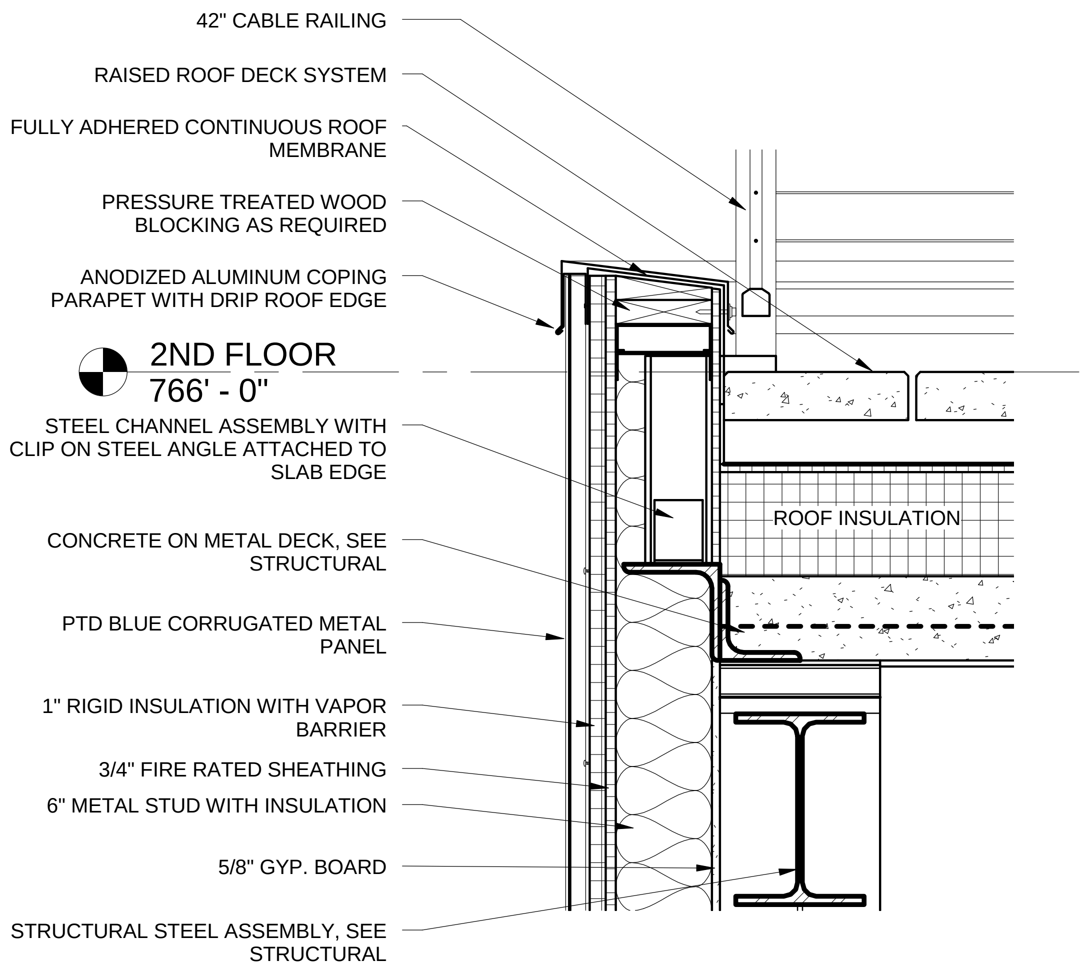
CDR-13



DETAIL AT LUNCH ROOM WEST CORNER

1

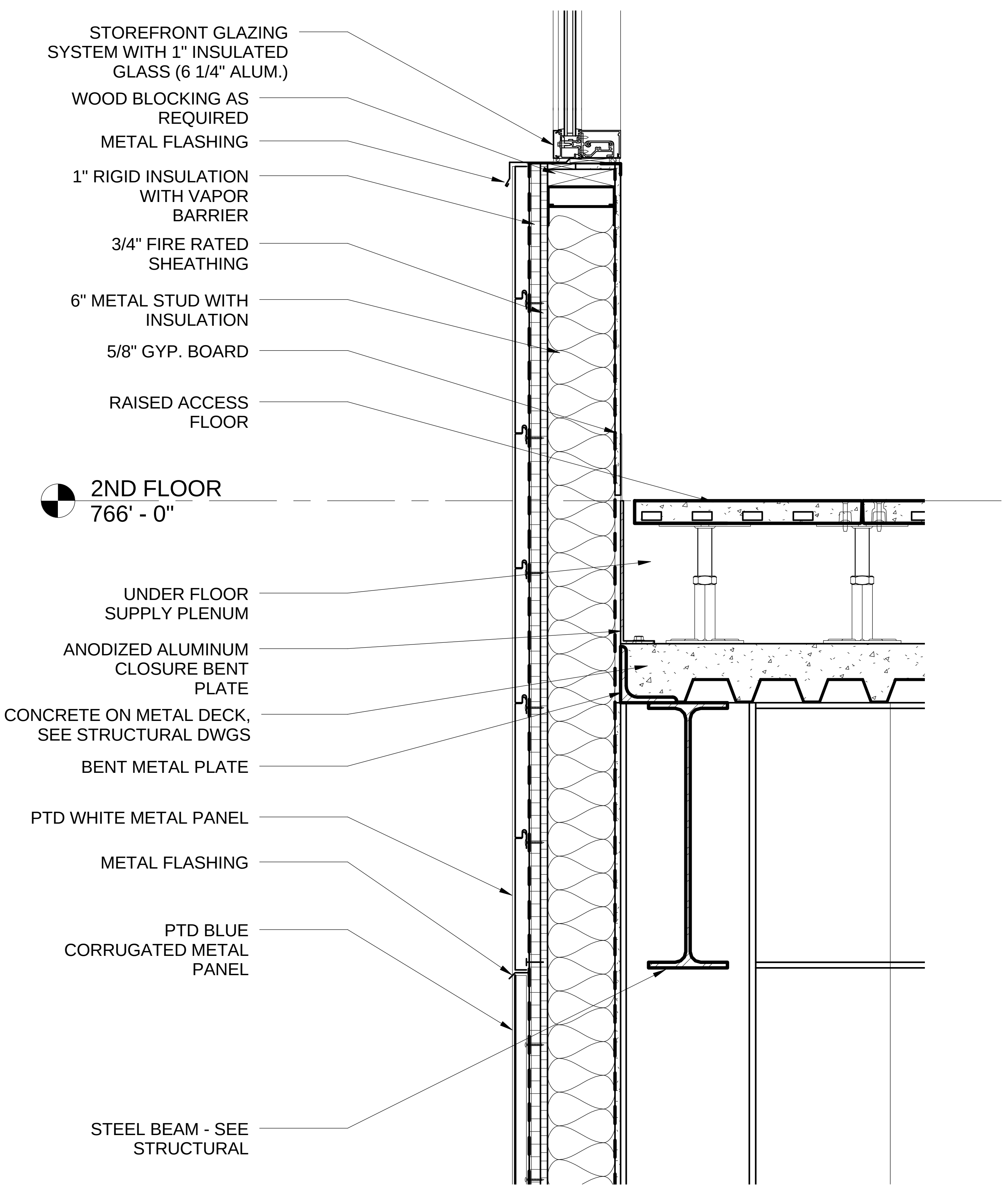
SCALE: 1" = 1'-0"



SECTION DETAIL AT ROOF DECK PARAPET

3

SCALE: 1" = 1'-0"



SECTION DETAIL AT WALL 01

2

SCALE: 1" = 1'-0"

0 1/2' 1' 2'

r_barc ARUP

ross barney architects
10 west hubbard street chicago illinois 60610
t312 832 0600 f312 832 0601
www.r-barc.com

N E S W

IARC
OFFICE, TECHNICAL, AND EDUCATION BUILDING

DETAILS

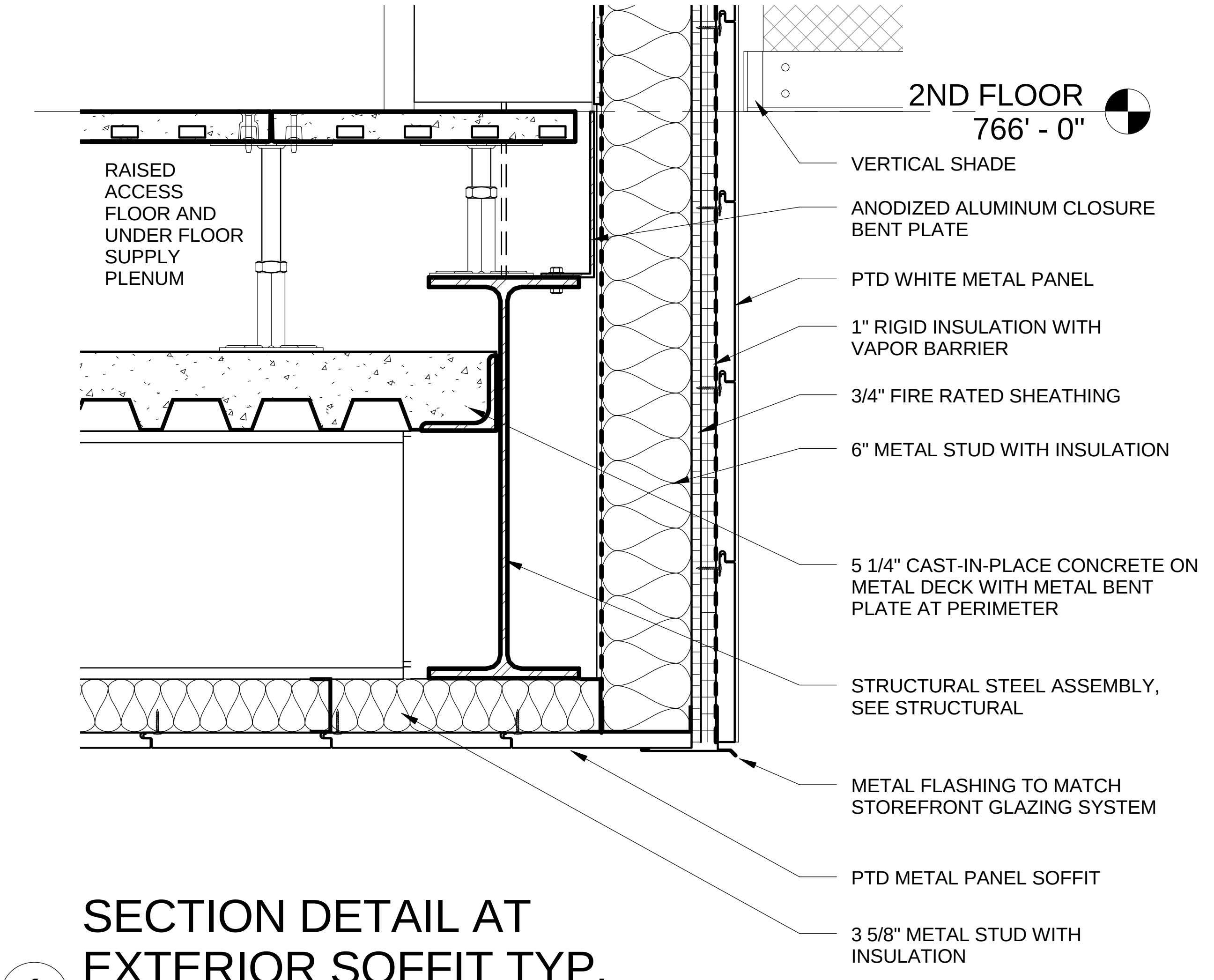
Fermilab

U.S. DEPARTMENT OF ENERGY

DATE
10.06.2010

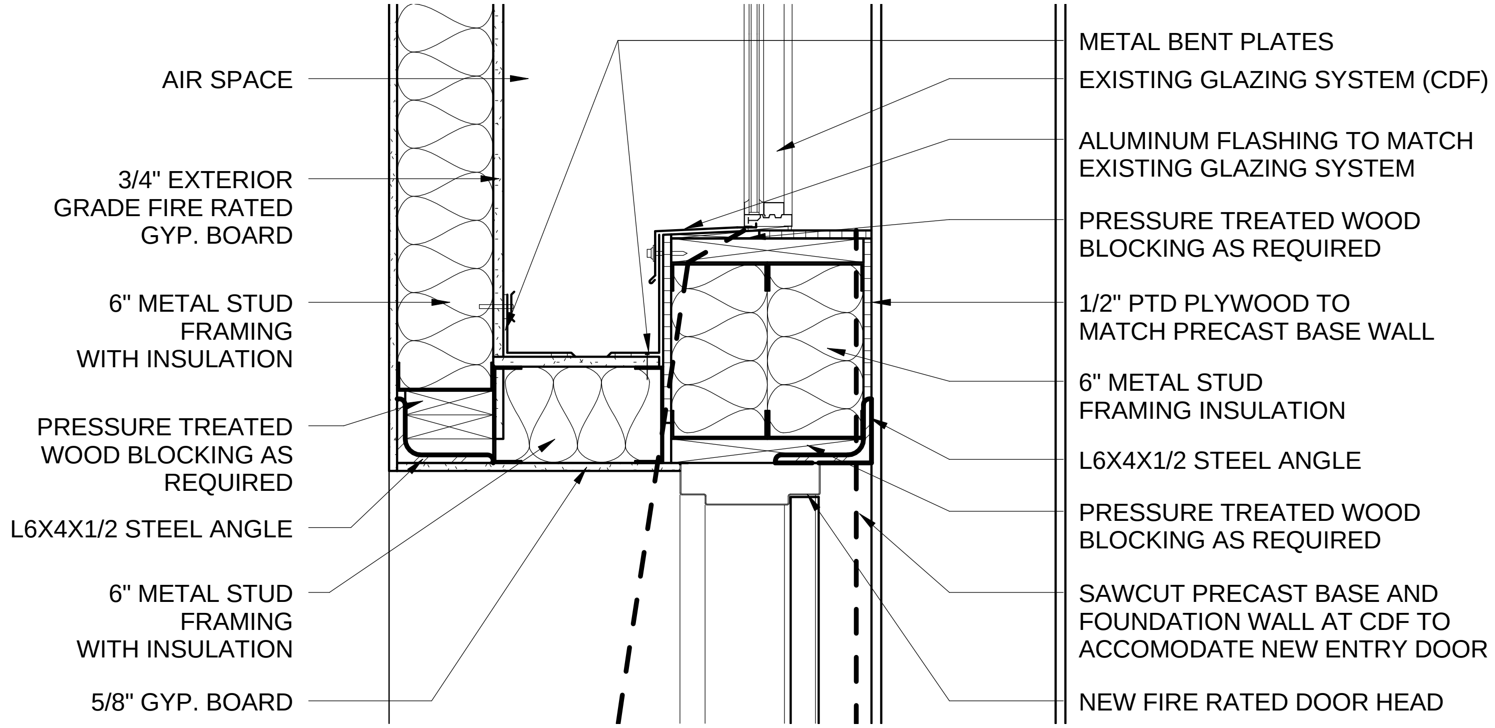
PROJECT NO.
10-8-1

DRAWING NO.
CDR-14



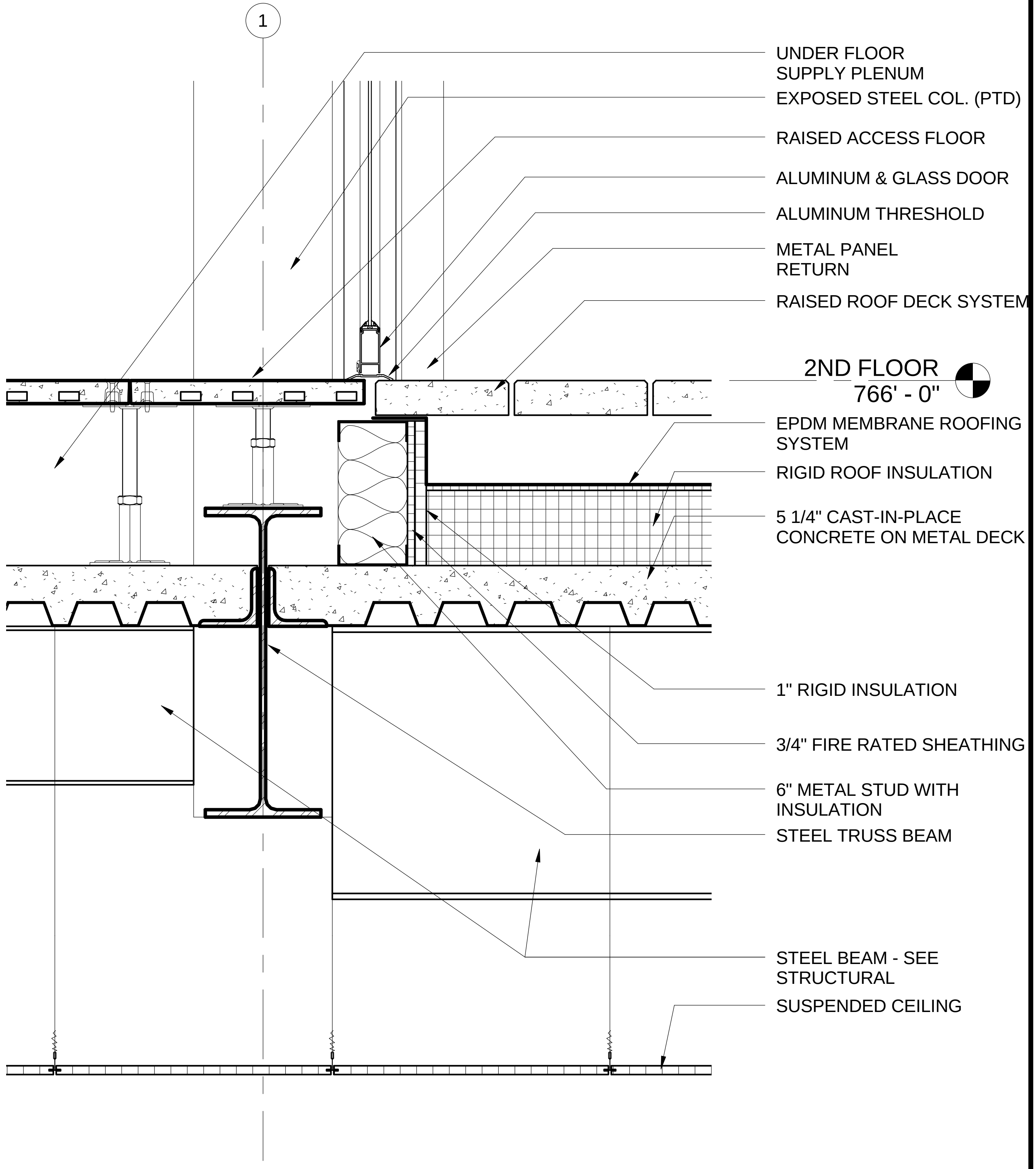
1 SECTION DETAIL AT EXTERIOR SOFFIT TYP.

SCALE: 1" = 1'-0"



2 SECTION DETAIL AT CDF ENTRY

SCALE: 1" = 1'-0"



3 THRESHOLD DETAIL

SCALE: 1" = 1'-0"

0 1/2' 1' 2'

r_barc ARUP

ross barney architects

10 west hubbard street chicago illinois 60610
t312 832 0600 f312 832 0601
www.r-barc.com

N E S W

IARC
OFFICE, TECHNICAL, AND EDUCATION BUILDING

DETAILS

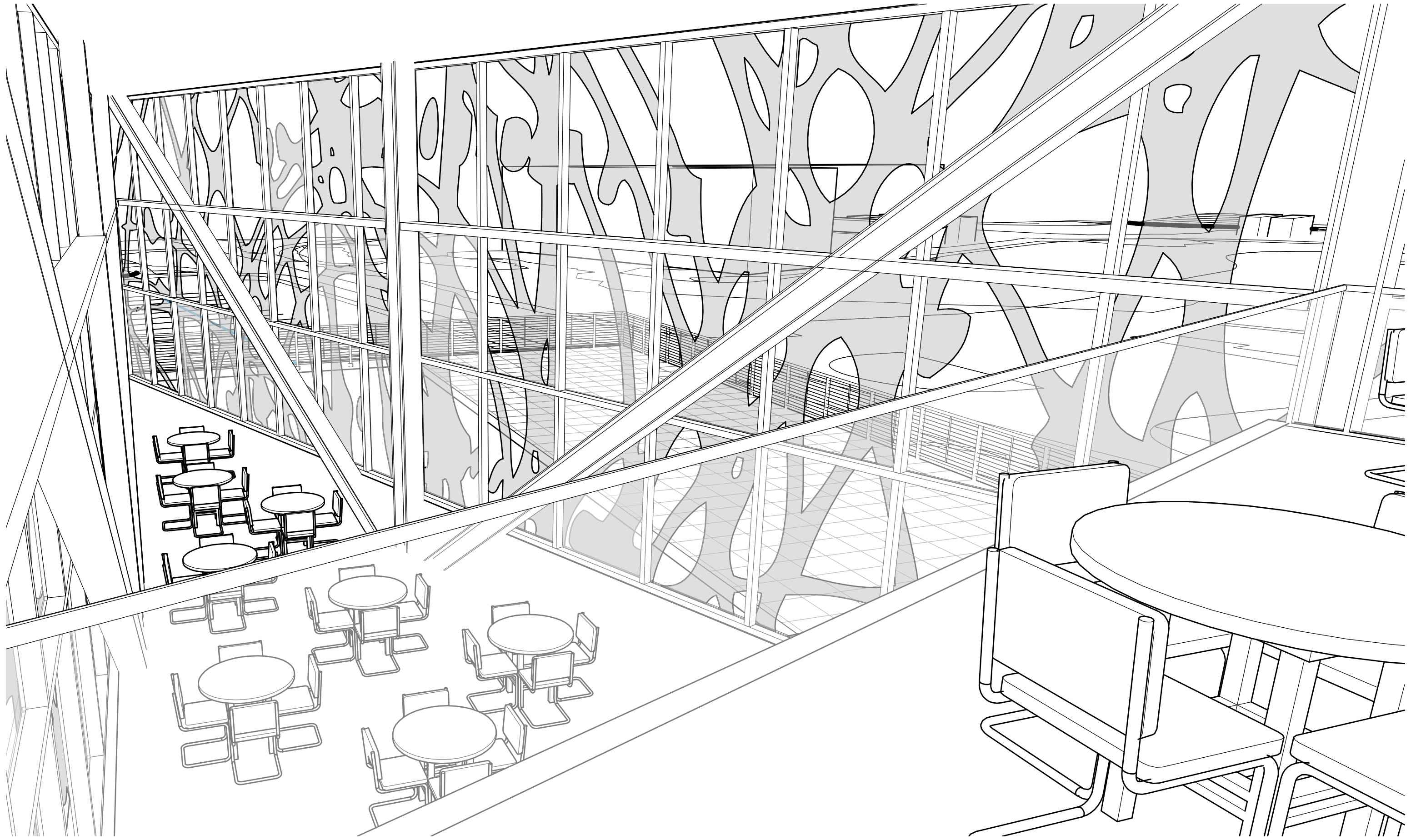
Fermilab

U.S. DEPARTMENT OF ENERGY

DATE
10.06.2010

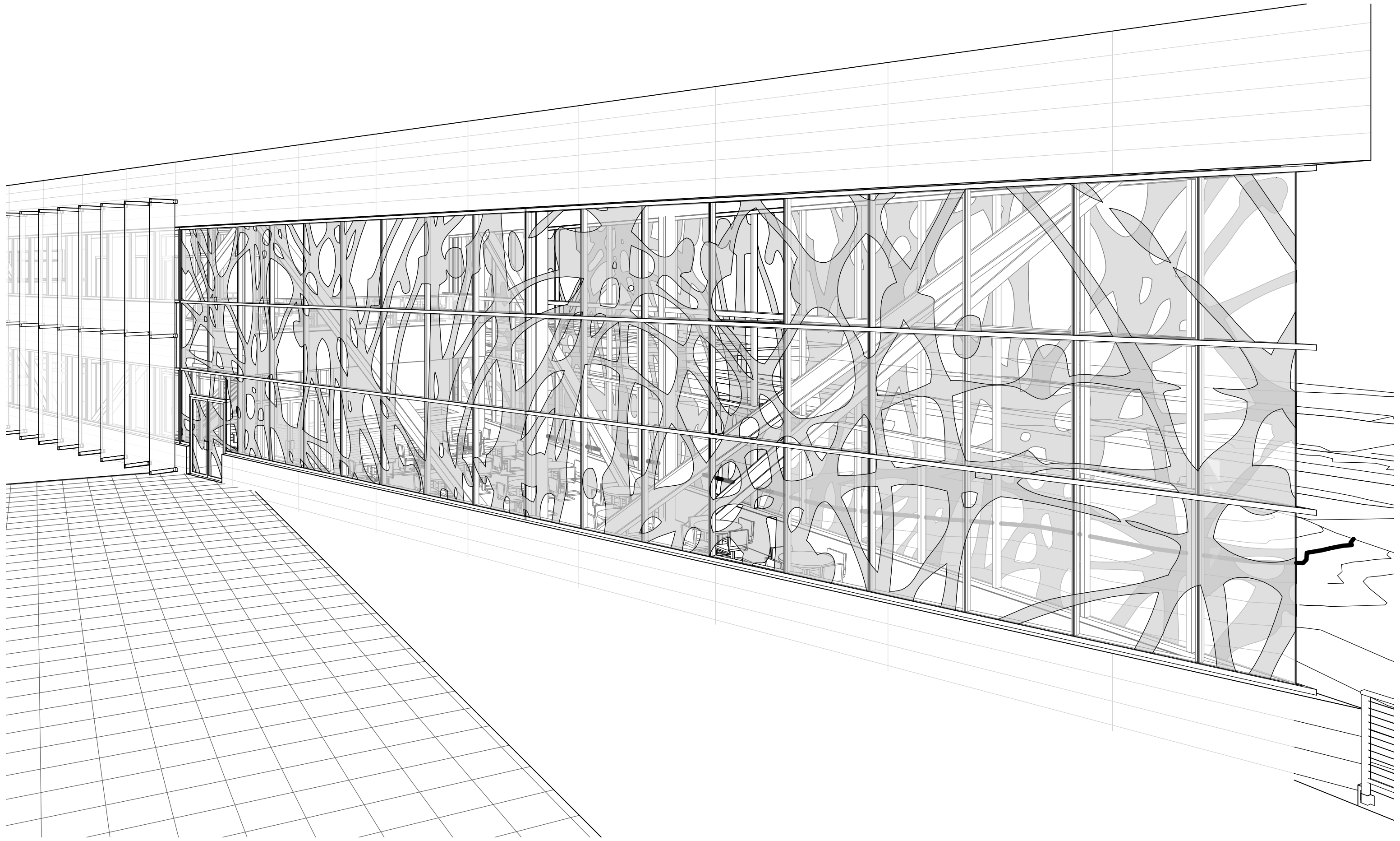
PROJECT NO.
10-8-1

DRAWING NO.
CDR-15



1 LUNCHROOM VIEW FROM 3RD FLOOR

SCALE:



2 LUNCHROOM VIEW FROM EXTERIOR

SCALE:

ARUP

r_barc
ross barney architects
10 west hubbard street chicago illinois 60610
t312 832 0600 f312 832 0601
www.r-barc.com

N
E
S
W

IARC
OFFICE, TECHNICAL, AND EDUCATION BUILDING
LUNCHROOM PERSPECTIVES

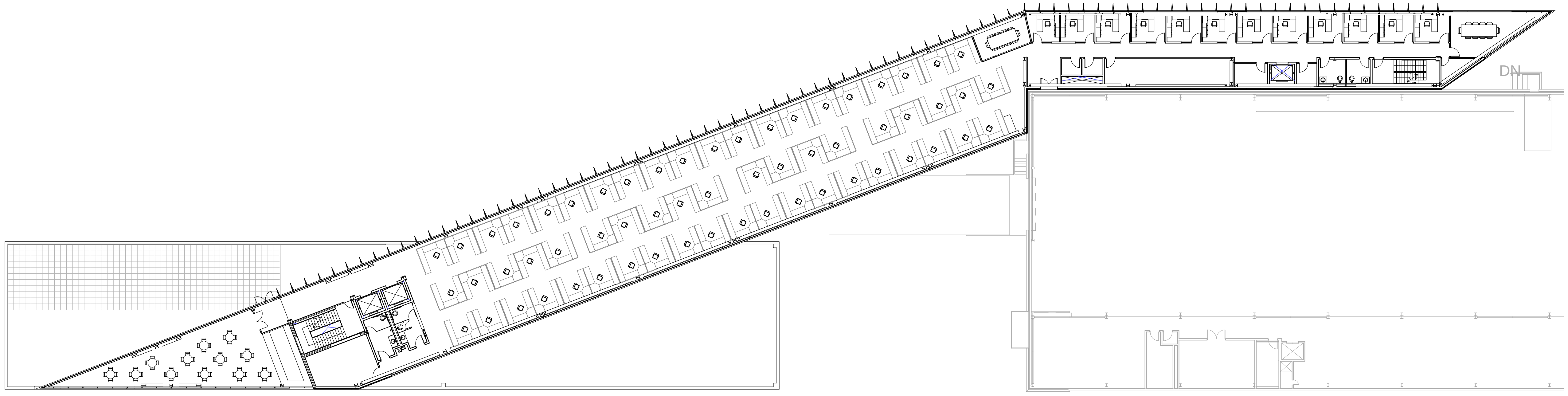
Fermilab

U.S. DEPARTMENT OF ENERGY

DATE
10.06.2010

PROJECT NO.
10-8-1

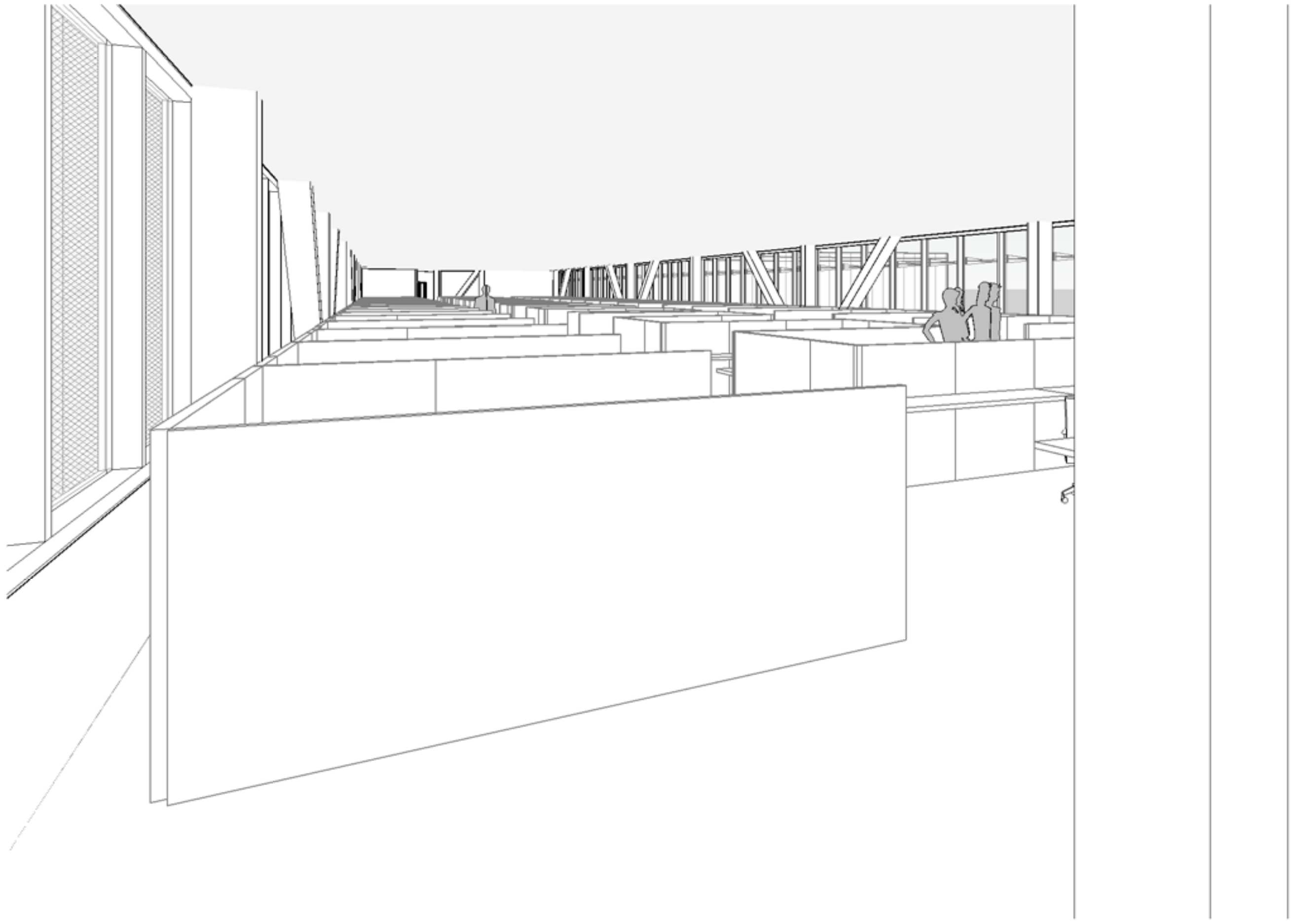
DRAWING NO.
CDR-16



1 Office Layout - Option A

SCALE: 1" = 40'-0"

0 20' 40' 80'



2 3D View - Option A

SCALE:

N
E
S
W

ARUP

r_barc
ross barney architects
10 west hubbard street chicago illinois 60610
t312 832 0600 f312 832 0601
www.r-barc.com

IARC
OFFICE, TECHNICAL, AND EDUCATION BUILDING

OFFICE LAYOUT - OPTION A

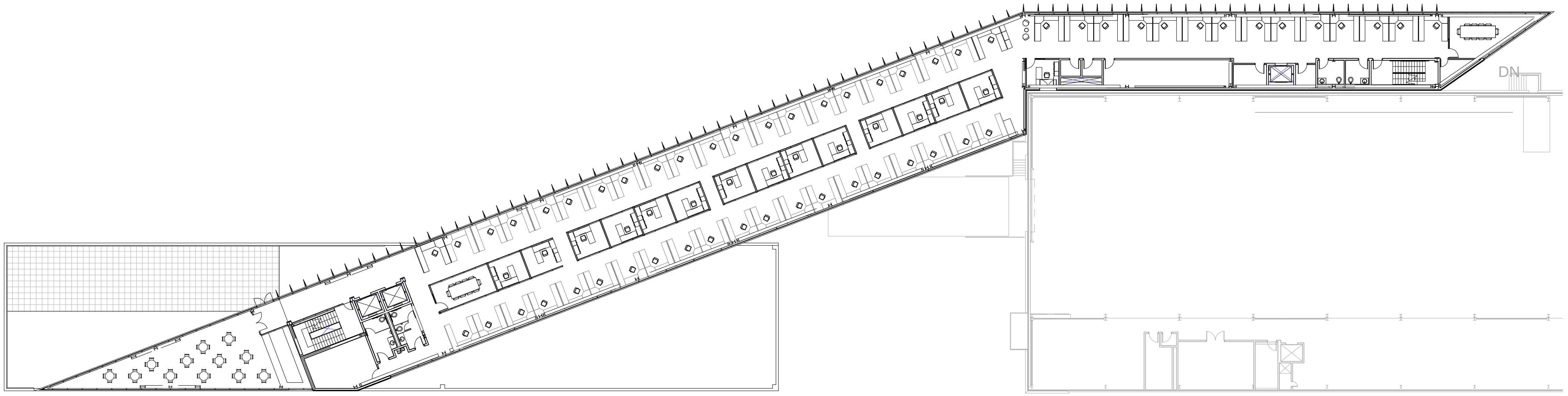
Fermilab

U.S. DEPARTMENT OF ENERGY

DATE
10.06.2010

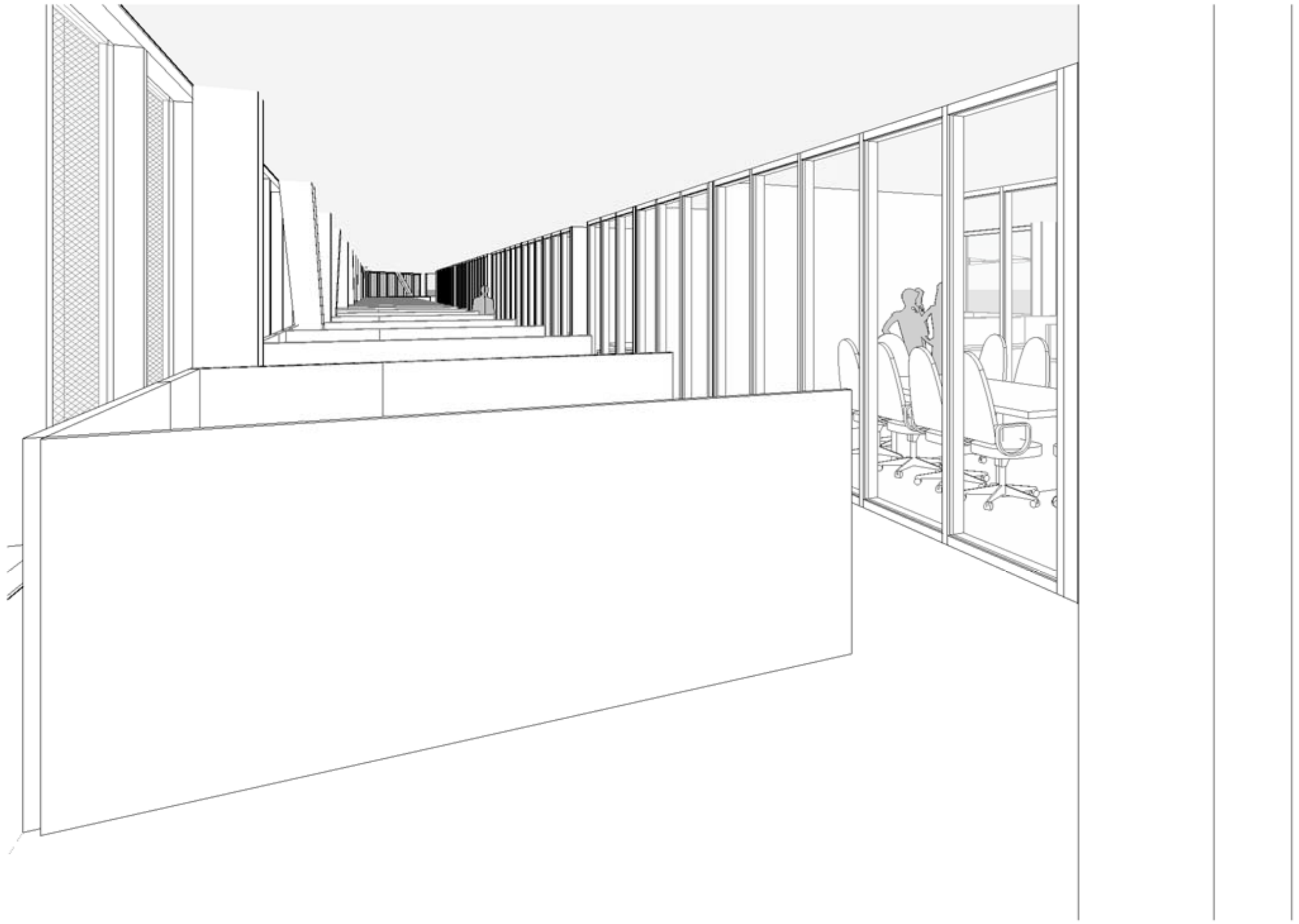
PROJECT NO.
10-8-1

DRAWING NO.
CDR-17



1 Office Layout - Option B

SCALE: 1" = 40'-0"



2 3D View - Option B

SCALE:

r_barc

ross barney architects

10 west hubbard street chicago illinois 60610
t312 832 0600 f312 832 0601
www.r-barc.com

ARUP

IARC
OFFICE, TECHNICAL, AND EDUCATION BUILDING

OFFICE LAYOUT - OPTION B

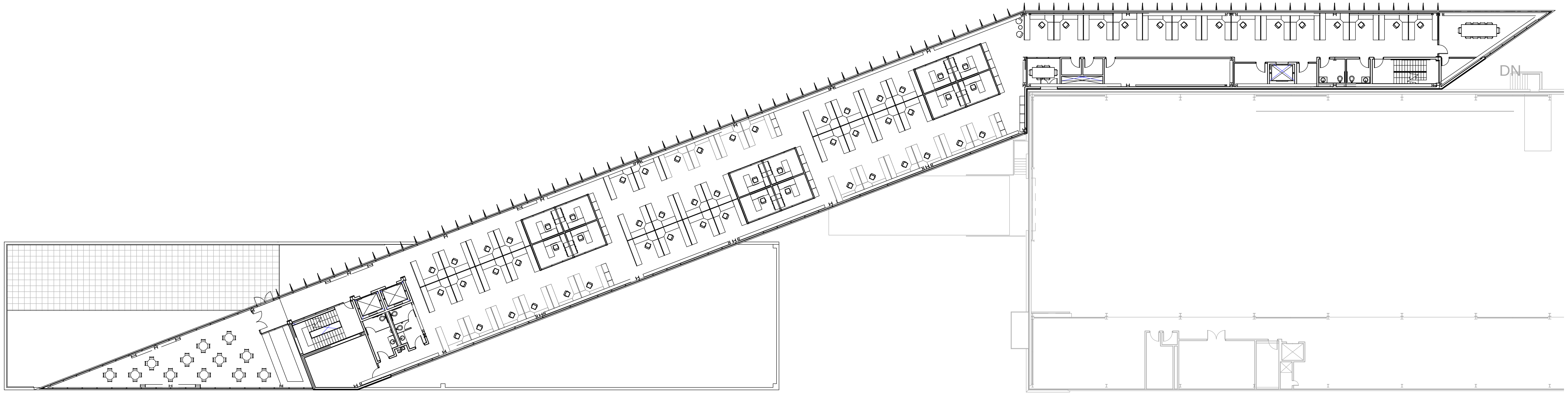
Fermilab

U.S. DEPARTMENT OF ENERGY

DATE
10.06.2010

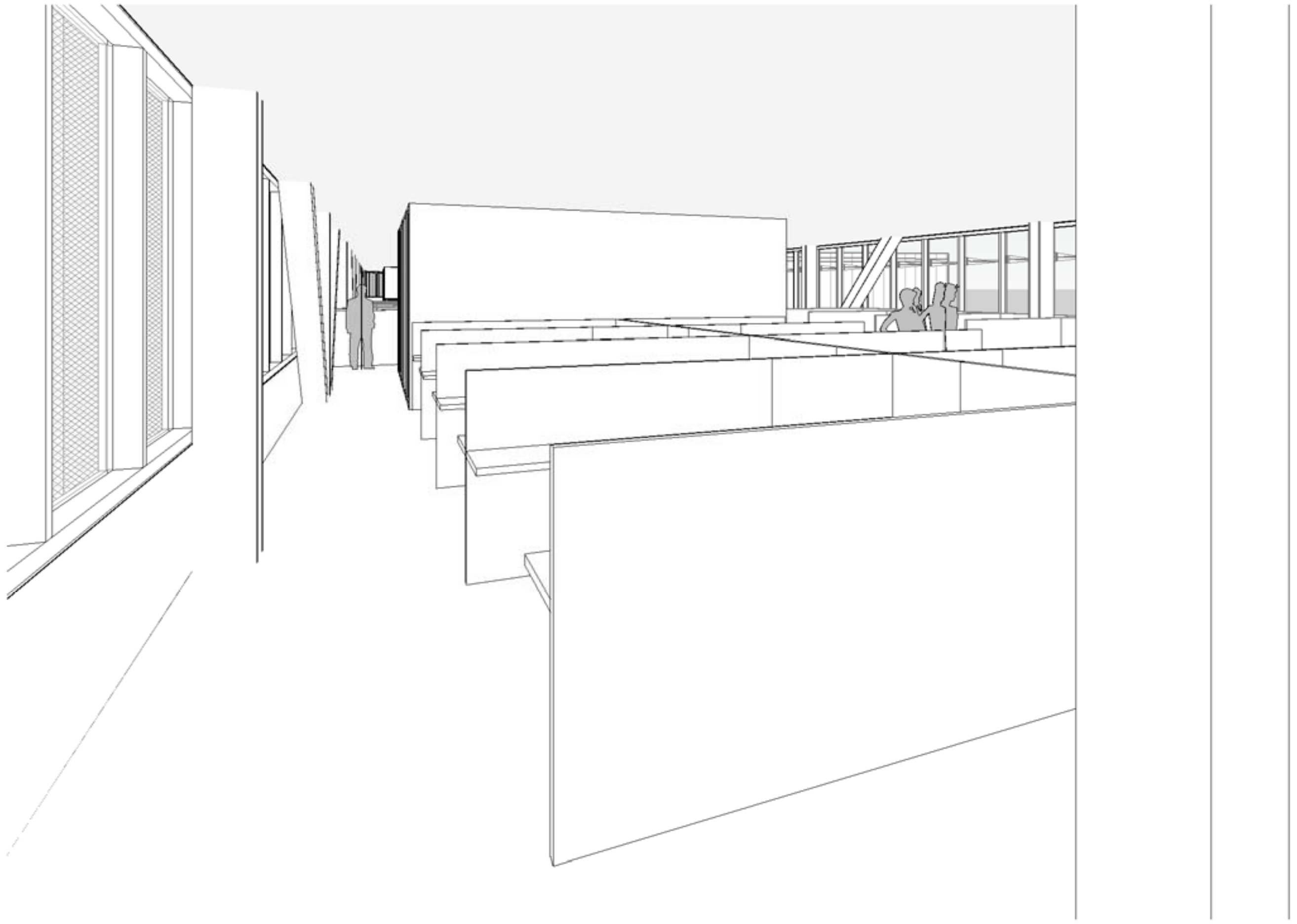
PROJECT NO.
10-8-1

DRAWING NO.
CDR-18



1 Office Layout - Option C

SCALE: 1" = 40'-0"

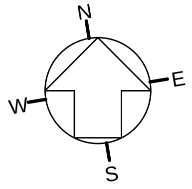


2 3D View - Option C

SCALE:

r_barc
ross barney architects
10 west hubbard street chicago illinois 60610
t312 832 0600 f312 832 0601
www.r-barc.com

ARUP



IARC
OFFICE, TECHNICAL, AND EDUCATION BUILDING

OFFICE LAYOUT - OPTION C

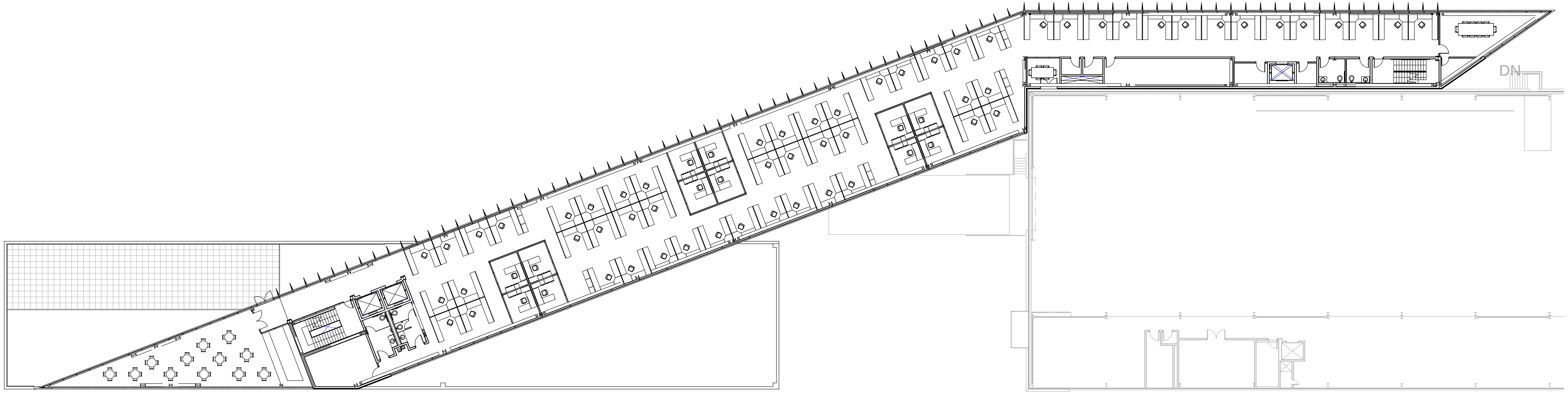
Fermilab

U.S. DEPARTMENT OF ENERGY

DATE
10.06.2010

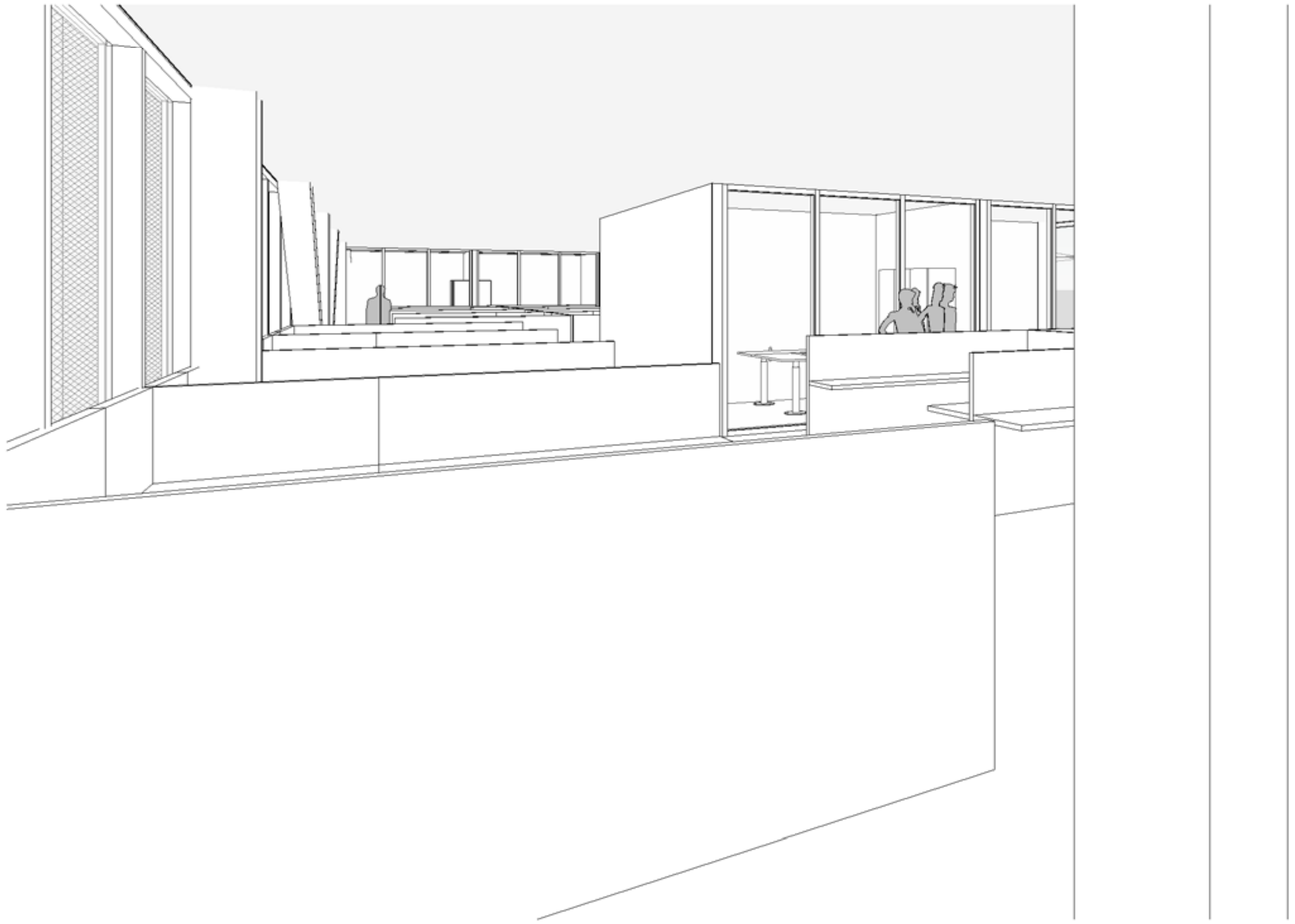
PROJECT NO.
10-8-1

DRAWING NO.
CDR-19



1 **Office Layout - Option D**

SCALE: 1" = 40'-0"



2 **3D View - Option D**

SCALE:

r_barc ross barney architects
10 west hubbard street chicago illinois 60610
t312 832 0600 f312 832 0601
www.r-barc.com

ARUP

N
W
E
S

IARC
OFFICE, TECHNICAL, AND EDUCATION BUILDING

OFFICE LAYOUT - OPTION D

Fermilab

U.S. DEPARTMENT OF ENERGY

DATE
10.06.2010

PROJECT NO.
10-8-1

DRAWING NO.
CDR-20

LEGEND:

BELLED CAISSON - INNER DIAMETER INDICATES SHAFT, OUTER DIAMETER INDICATES OUTER EDGE OF BELL AT BASE

INDICATES COLUMN ABOVE (STARTS AT THIS LEVEL)

INDICATES COLUMN BELOW (STOPS AT THIS LEVEL)

INDICATES DIRECTION OF DECK SPAN

INDICATES TWO-WAY CONCRETE SLAB

DOWNWARD BRACE OR TRUSS WEB DIAGONAL MEMBER

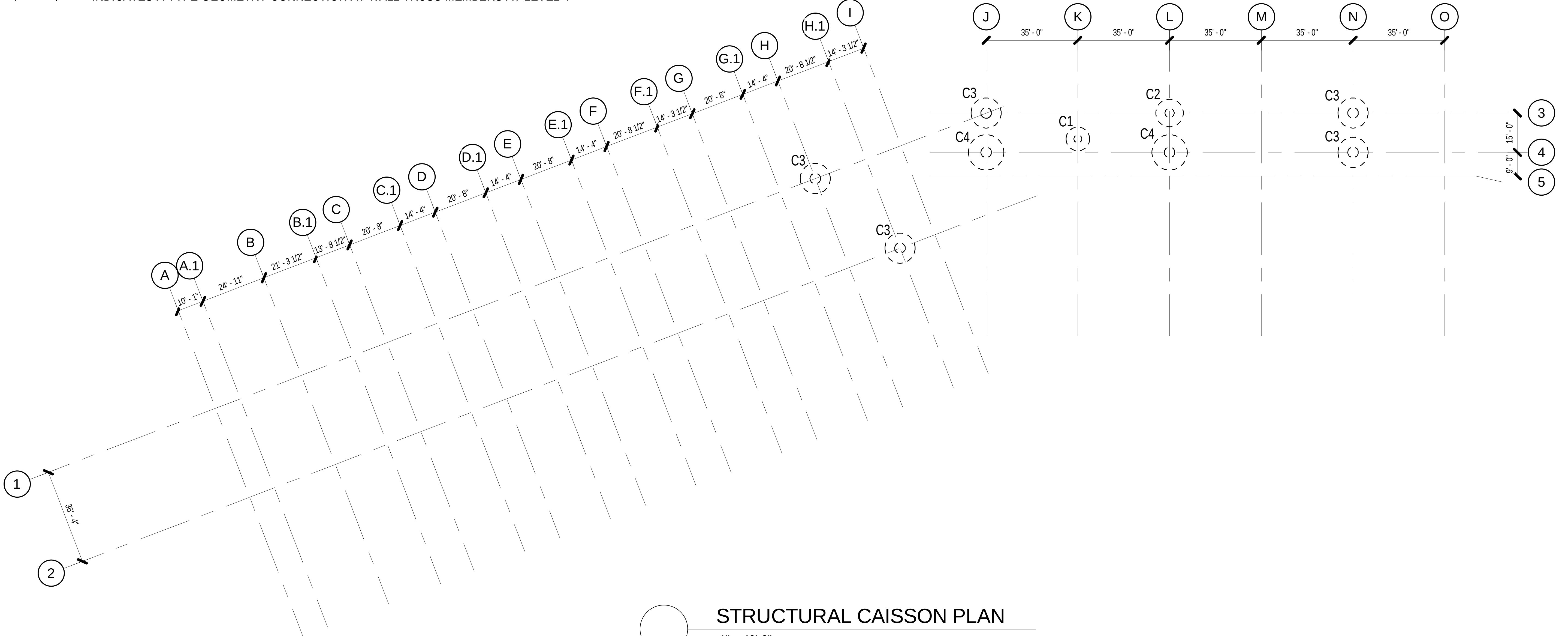
UPWARD BRACE OR TRUSS WEB DIAGONAL MEMBER

INDICATES V-TYPE GEOMETRY CONNECTION AT WALL TRUSS MEMBERS AT LEVEL 2

INDICATES A-TYPE GEOMETRY CONNECTION AT WALL TRUSS MEMBERS AT LEVEL 4

BELLED CAISSON SCHEDULE

MARK	SHAFT DIAMETER (ft)	BELL DIAMETER (ft)	CAP			MAX SERVICE LOAD (KIPS)
			B (IN.)	W (IN.)	D (IN.)	
C1	3' - 0"	9' - 0"	48"	48"	48"	405
C2	3' - 6"	10' - 6"	54"	54"	48"	573
C3	4' - 0"	11' - 6"	60"	60"	48"	694
C4	4' - 0"	13' - 6"	60"	60"	48"	1020



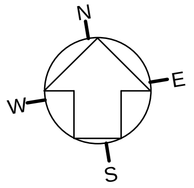
STRUCTURAL CAISSON PLAN

1" = 40'-0"

0 20' 40' 80'

ARUP

ross barney architects
10 west hubbard street chicago illinois 60610
t312 832 0600 f312 832 0601
www.r-barc.com



IARC
OFFICE, TECHNICAL, AND EDUCATION BUILDING
STRUCTURAL CAISSON PLAN

Fermilab

U.S. DEPARTMENT OF ENERGY

DATE
10.06.2010

PROJECT NO.
10-8-1

DRAWING NO.
CDR-21

LEGEND:

BELLED CAISSON - INNER DIAMETER INDICATES SHAFT, OUTER DIAMETER INDICATES OUTER EDGE OF BELL AT BASE

INDICATES COLUMN ABOVE (STARTS AT THIS LEVEL)

INDICATES COLUMN BELOW (STOPS AT THIS LEVEL)

INDICATES DIRECTION OF DECK SPAN

INDICATES TWO-WAY CONCRETE SLAB

DOWNWARD BRACE OR TRUSS WEB DIAGONAL MEMBER

UPWARD BRACE OR TRUSS WEB DIAGONAL MEMBER

INDICATES V-TYPE GEOMETRY CONNECTION AT WALL TRUSS MEMBERS AT LEVEL 2

INDICATES A-TYPE GEOMETRY CONNECTION AT WALL TRUSS MEMBERS AT LEVEL 4

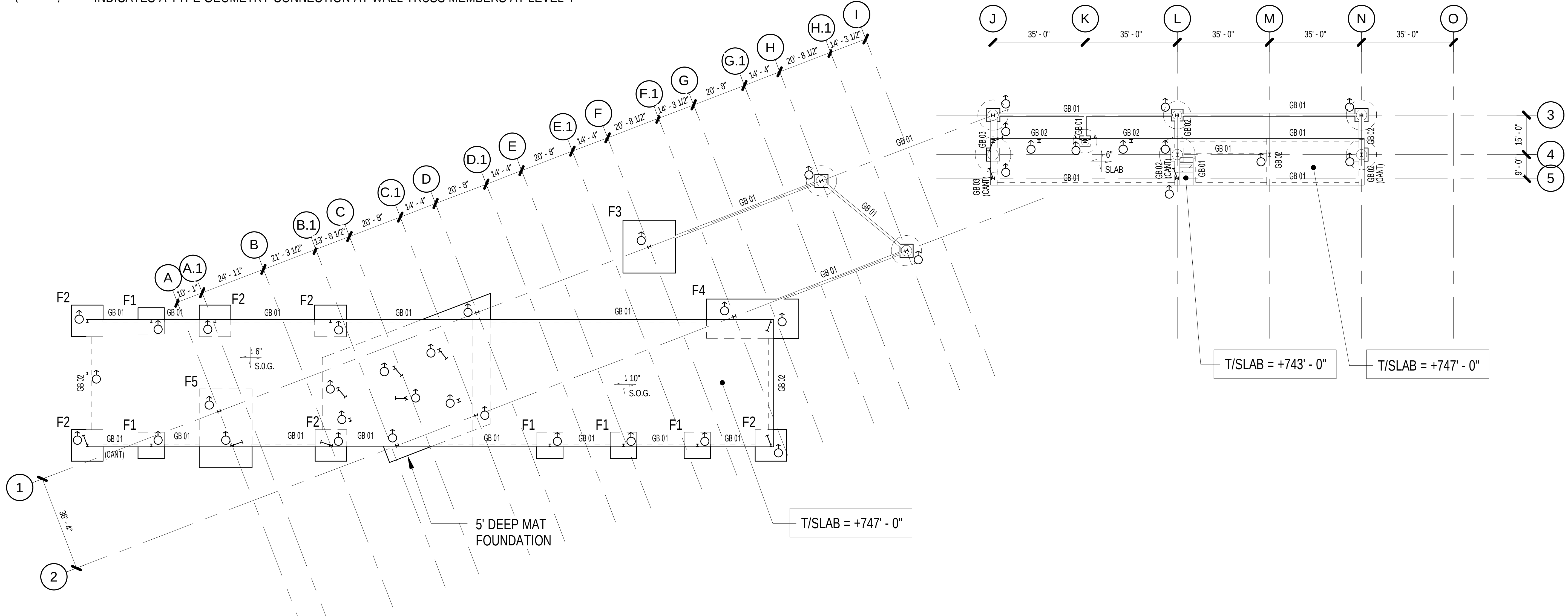
SPREAD FOOTING SCHEDULE

MARK	B (FT.)	W (FT.)	DEPTH (IN.)
F1	10'	10'	18"
F2	12'	12'	24"
F3	20'	20'	33"
F4	15'	35'	40"
F5	20'	30'	40"

NOTE: SPREAD FOOTINGS TO BEAR BELOW FROST DEPTH.

GRADE BEAM SCHEDULE

MARK	WIDTH (IN.)	DEPTH (IN.)
GB 01	12"	42"
GB 02	24"	48"
GB 03	30"	54"



1ST FLOOR STRUCTURAL PLAN

1" = 40'-0"

0 20' 40' 80'

IARC
OFFICE, TECHNICAL, AND EDUCATION BUILDING
1ST FLOOR STRUCTURAL PLAN

DATE
10.06.2010
PROJECT NO.
10-8-1
DRAWING NO.
CDR-22

LEGEND:

BELLED CAISSON - INNER DIAMETER INDICATES SHAFT, OUTER DIAMETER INDICATES OUTER EDGE OF BELL AT BASE

INDICATES COLUMN ABOVE (STARTS AT THIS LEVEL)

INDICATES COLUMN BELOW (STOPS AT THIS LEVEL)

INDICATES DIRECTION OF DECK SPAN

INDICATES TWO-WAY CONCRETE SLAB

DOWNWARD BRACE OR TRUSS WEB DIAGONAL MEMBER

UPWARD BRACE OR TRUSS WEB DIAGONAL MEMBER

INDICATES V-TYPE GEOMETRY CONNECTION AT WALL TRUSS MEMBERS AT LEVEL 2

INDICATES A-TYPE GEOMETRY CONNECTION AT WALL TRUSS MEMBERS AT LEVEL 4

NOTES:

1. SLAB ON METAL DECK TYPE ARE AS FOLLOWS:

   D-1 3" 18 GAUGE METAL DECK + 3 1/4" LWC ABOVE FLUTES W/ 6x6-W2.9xW2.9 WWF REINFORECEMENT. (TOTAL DEPTH = 6 1/4") STUDS ARE 3/4" x 4 1/2"

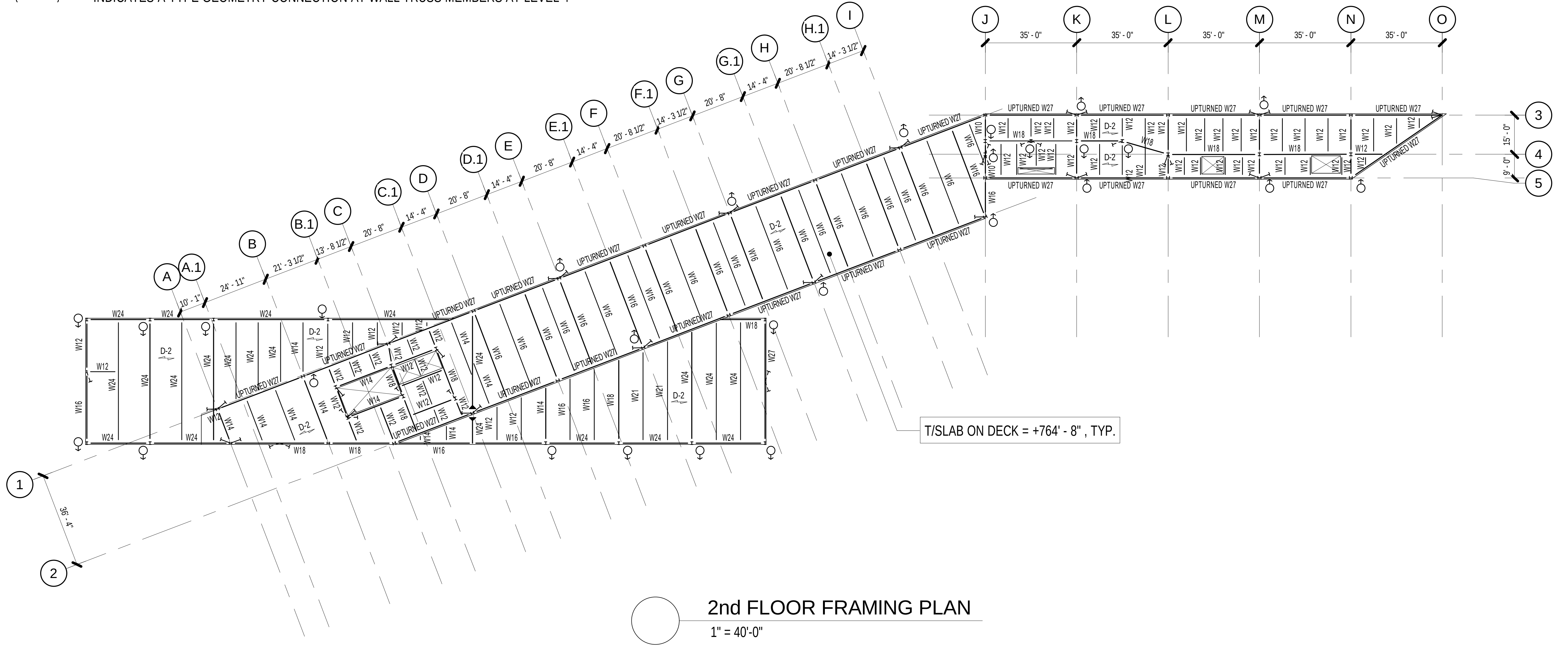
   D-2 2" 18 GAUGE METAL DECK + 3 1/4" LWC ABOVE FLUTES W/ 6x6-W2.9xW2.9 WWF REINFORECEMENT. (TOTAL DEPTH = 6 1/4") STUDS ARE 3/4" x 4 1/2"

2. ESTIMATED STEEL QUANTITIES ARE AS FOLLOWS:

   A. STEEL WEIGHT IN AREAS UNDER COMPOSITE METAL DECK (INCLUDES BEAMS AND COLUMNS):
   8.0 PSF

   B. BRACED FRAME STEEL WEIGHT PER FLOORPLATE (NOT INCLUDING TRUSS) - INCLUDES COLUMNS, BEAMS, AND BRACES:
   3.0 PSF

   C. EXTERIOR TRUSS STEEL WEIGHT (INCLUDES BEAMS, COLUMNS, AND BRACES):
   293 TONS



T/SLAB ON DECK = +764' - 8" , TYP.

2nd FLOOR FRAMING PLAN

1" = 40'-0"

0 20' 40' 80'

r_barc
ross barney architects
10 west hubbard street chicago illinois 60610
t312 832 0600 f312 832 0601
www.r-barc.com

ARUP

N
E
S
W

IARC
OFFICE, TECHNICAL, AND EDUCATION BUILDING

2ND FLOOR FRAMING PLAN

Fermilab

U.S. DEPARTMENT OF ENERGY

DATE
10.06.2010

PROJECT NO.
10-8-1

DRAWING NO.
CDR-23

LEGEND:

BELLED CAISSON - INNER DIAMETER INDICATES SHAFT, OUTER DIAMETER INDICATES OUTER EDGE OF BELL AT BASE

INDICATES COLUMN ABOVE (STARTS AT THIS LEVEL)

INDICATES COLUMN BELOW (STOPS AT THIS LEVEL)

INDICATES DIRECTION OF DECK SPAN

INDICATES TWO-WAY CONCRETE SLAB

DOWNWARD BRACE OR TRUSS WEB DIAGONAL MEMBER

UPWARD BRACE OR TRUSS WEB DIAGONAL MEMBER

INDICATES V-TYPE GEOMETRY CONNECTION AT WALL TRUSS MEMBERS AT LEVEL 2

INDICATES A-TYPE GEOMETRY CONNECTION AT WALL TRUSS MEMBERS AT LEVEL 4

NOTES:

1. SLAB ON METAL DECK TYPE ARE AS FOLLOWS:

   D-1 3" 18 GAUGE METAL DECK + 3 1/4" LWC ABOVE FLUTES W/ 6x6-W2.9xW2.9 WWF REINFORECEMENT. (TOTAL DEPTH = 6 1/4") STUDS ARE 3/4" x 4 1/2"

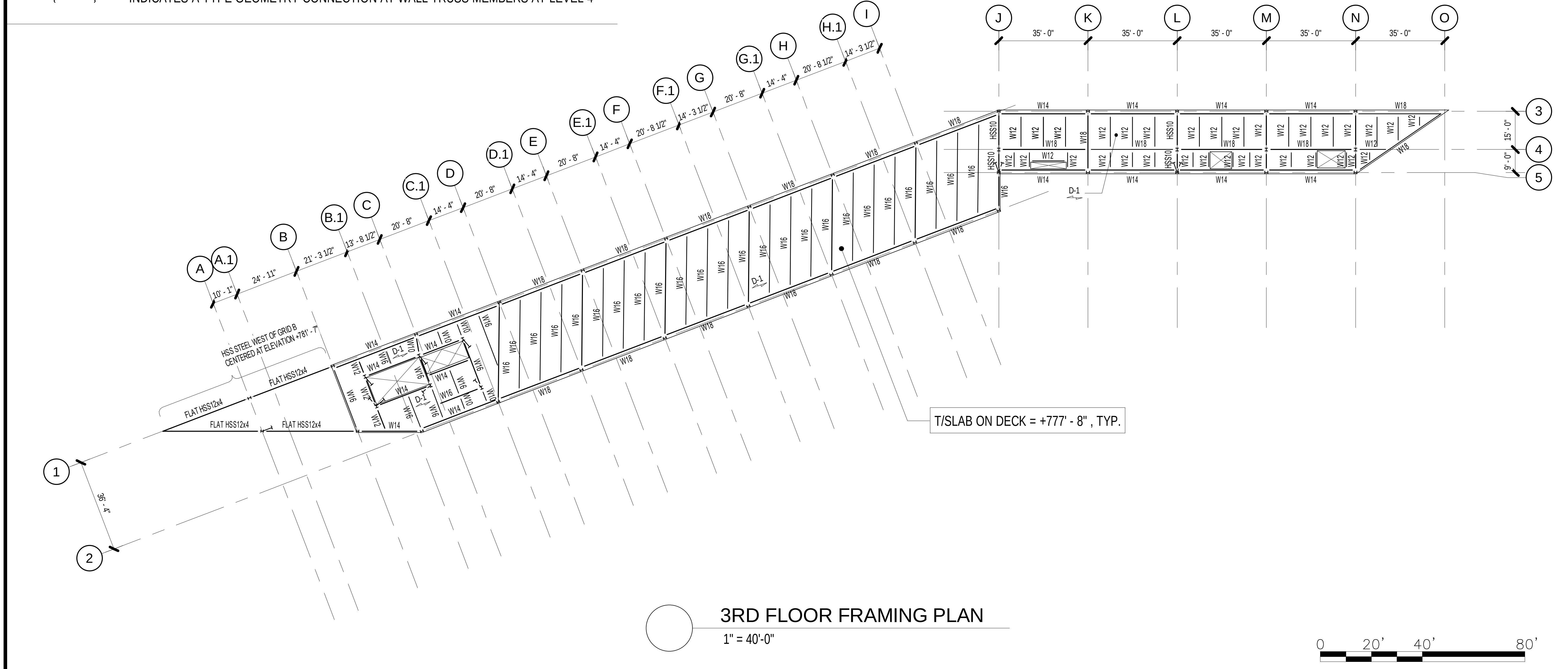
   D-2 2" 18 GAUGE METAL DECK + 3 1/4" LWC ABOVE FLUTES W/ 6x6-W2.9xW2.9 WWF REINFORECEMENT. (TOTAL DEPTH = 6 1/4") STUDS ARE 3/4" x 4 1/2"

2. ESTIMATED STEEL QUANTITIES ARE AS FOLLOWS.

   A. STEEL WEIGHT IN AREAS UNDER COMPOSITE METAL DECK (INCLUDES BEAMS AND COLUMNS):
   8.0 PSF

   B. BRACED FRAME STEEL WEIGHT PER FLOORPLATE (NOT INCLUDING TRUSS) - INCLUDES COLUMNS, BEAMS, AND BRACES:
   3.0 PSF

   C. EXTERIOR TRUSS STEEL WEIGHT (INCLUDES BEAMS, COLUMNS, AND BRACES):
   293 TONS



3RD FLOOR FRAMING PLAN

1" = 40'-0"

r_barc
ross barney architects
10 west hubbard street chicago illinois 60610
t312 832 0600 f312 832 0601
www.r-barc.com

ARUP

IARC
OFFICE, TECHNICAL, AND EDUCATION BUILDING

3RD FLOOR FRAMING PLAN

Fermilab

U.S. DEPARTMENT OF ENERGY

DATE
10.06.2010

PROJECT NO.
10-8-1

DRAWING NO.
CDR-24

LEGEND:

BELLED CAISSON - INNER DIAMETER INDICATES SHAFT, OUTER DIAMETER INDICATES OUTER EDGE OF BELL AT BASE

INDICATES COLUMN ABOVE (STARTS AT THIS LEVEL)

INDICATES COLUMN BELOW (STOPS AT THIS LEVEL)

INDICATES DIRECTION OF DECK SPAN

INDICATES TWO-WAY CONCRETE SLAB

DOWNWARD BRACE OR TRUSS WEB DIAGONAL MEMBER

UPWARD BRACE OR TRUSS WEB DIAGONAL MEMBER

INDICATES V-TYPE GEOMETRY CONNECTION AT WALL TRUSS MEMBERS AT LEVEL 2

INDICATES A-TYPE GEOMETRY CONNECTION AT WALL TRUSS MEMBERS AT LEVEL 4

NOTES:

1. SLAB ON METAL DECK TYPE ARE AS FOLLOWS:

   D-1 3" 18 GAUGE METAL DECK + 3 1/4" LWC ABOVE FLUTES W/ 6x6-W2.9xW2.9 WWF REINFORECEMENT. (TOTAL DEPTH = 6 1/4") STUDS ARE 3/4" x 4 1/2"

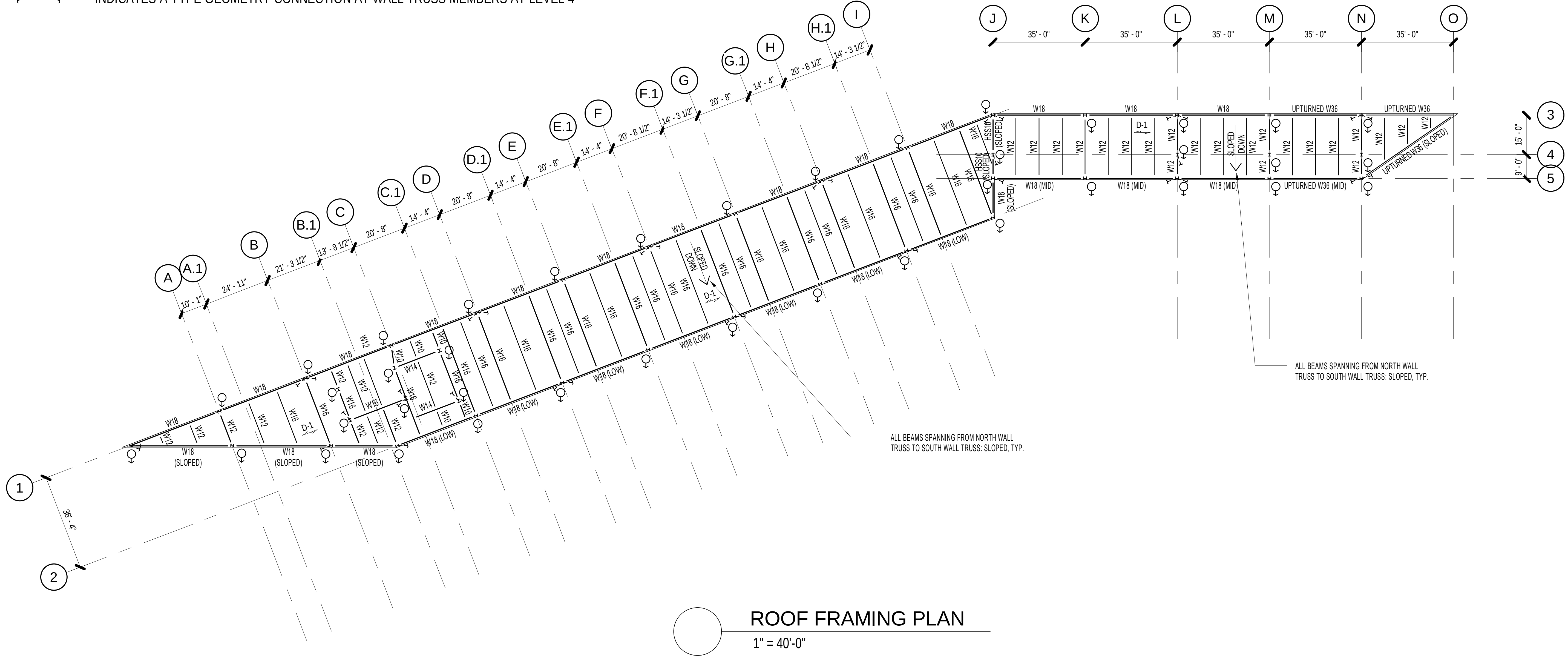
   D-2 2" 18 GAUGE METAL DECK + 3 1/4" LWC ABOVE FLUTES W/ 6x6-W2.9xW2.9 WWF REINFORECEMENT. (TOTAL DEPTH = 6 1/4") STUDS ARE 3/4" x 4 1/2"

2. ESTIMATED STEEL QUANTITIES ARE AS FOLLOWS.

   A. STEEL WEIGHT IN AREAS UNDER COMPOSITE METAL DECK (INCLUDES BEAMS AND COLUMNS):
   8.0 PSF

   B. BRACED FRAME STEEL WEIGHT PER FLOORPLATE (NOT INCLUDING TRUSS) - INCLUDES COLUMNS, BEAMS, AND BRACES:
   3.0 PSF

   C. EXTERIOR TRUSS STEEL WEIGHT (INCLUDES BEAMS, COLUMNS, AND BRACES):
   293 TONS



ROOF FRAMING PLAN
1" = 40'-0"

ross barney architects
10 west hubbard street chicago illinois 60610
t312 832 0600 f312 832 0601
www.r-barc.com

ARUP

IARC
OFFICE, TECHNICAL, AND EDUCATION BUILDING
ROOF FRAMING PLAN

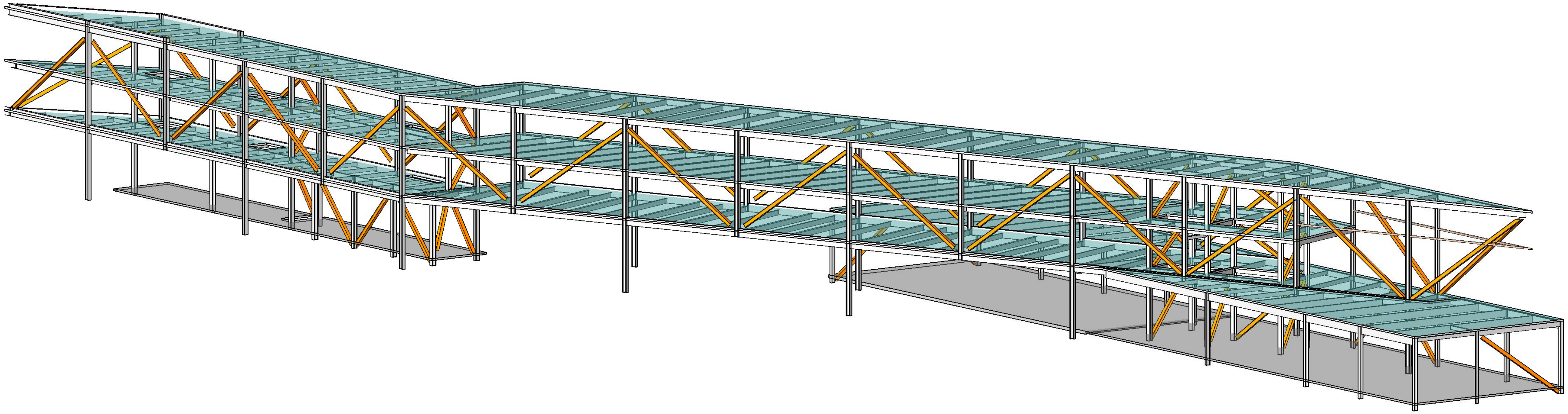
Fermilab

U.S. DEPARTMENT OF ENERGY

DATE
10.06.2010

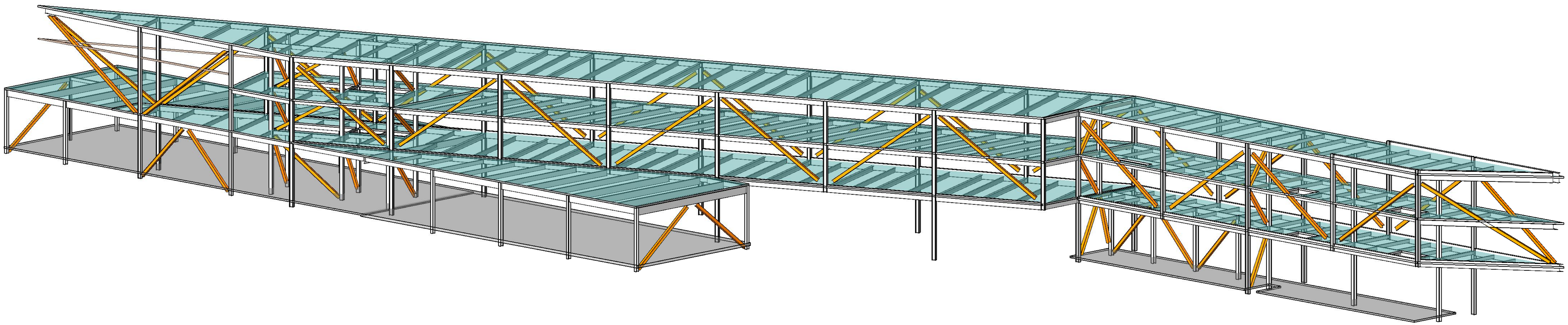
PROJECT NO.
10-8-1

DRAWING NO.
CDR-25



A

3D VIEW OF BUILDING FROM NORTHWEST



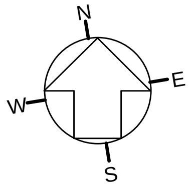
B

3D VIEW OF BUILDING FROM SOUTHEAST

ARUP

ross barney architects

10 west hubbard street chicago illinois 60610
t312 832 0600 f312 832 0601
www.r-barc.com



IARC
OFFICE, TECHNICAL, AND EDUCATION BUILDING

3D RENDERING OF BUILDING, VIEW FROM NORTH WEST

Fermilab

U.S. DEPARTMENT OF ENERGY

DATE

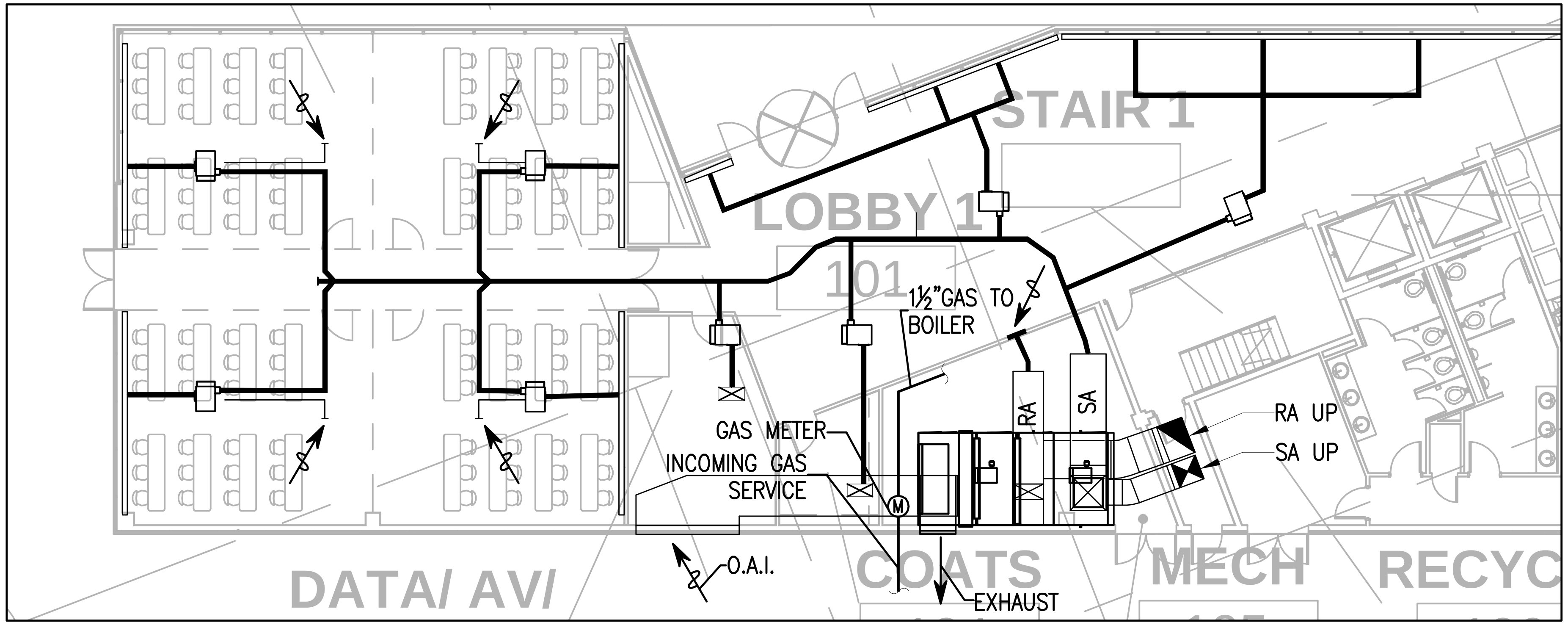
10.06.2010

PROJECT NO.

10-8-1

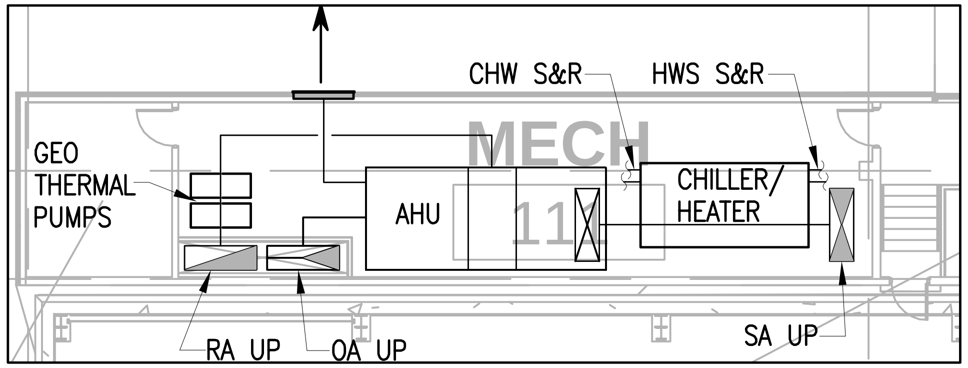
DRAWING NO.

CDR-26



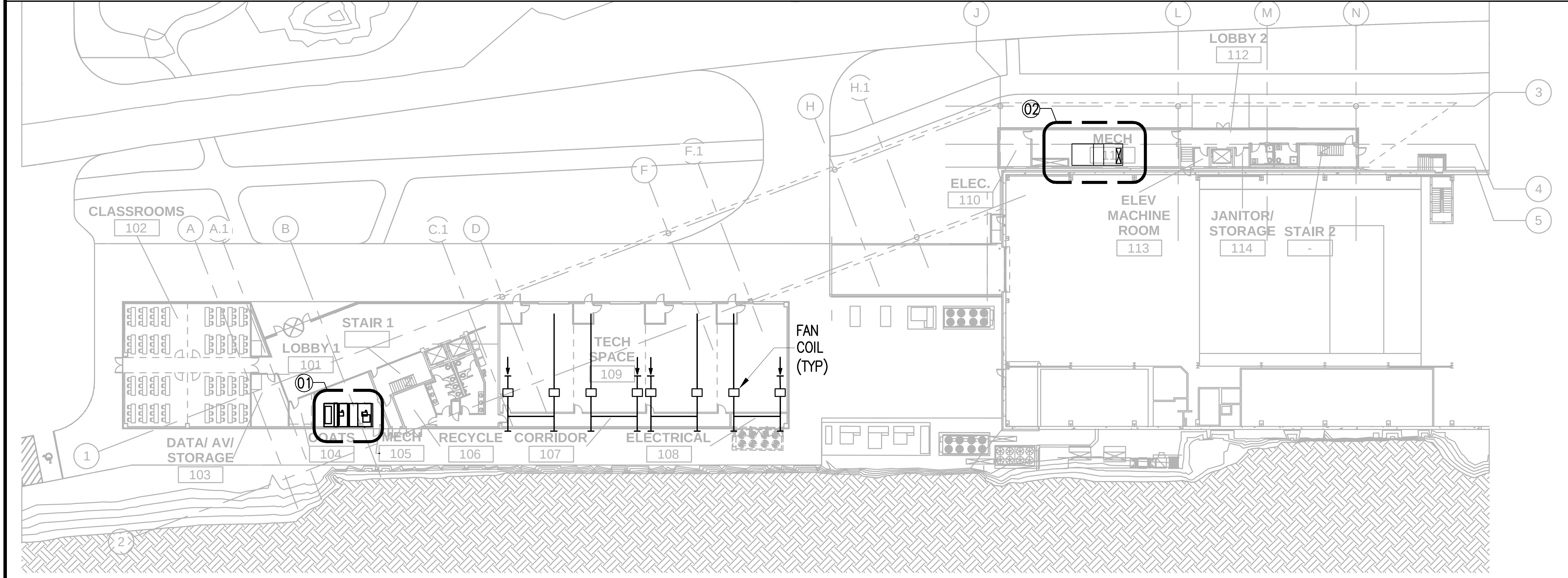
01 1ST FLOOR WEST MECHANICAL ROOM

1/16" = 1'-0"



02 1ST FLOOR EAST MECHANICAL ROOM

1/16" = 1'-0"



03 1ST FLOOR MECHANICAL PLAN

1" = 40'-0"

ARUP

r_barc
ross barney architects
10 west hubbard street chicago illinois 60610
t312 832 0600 f312 832 0601
www.r-barc.com

N
E
S
W

IARC
OFFICE, TECHNICAL, AND EDUCATION BUILDING
1ST FLOOR MECHANICAL

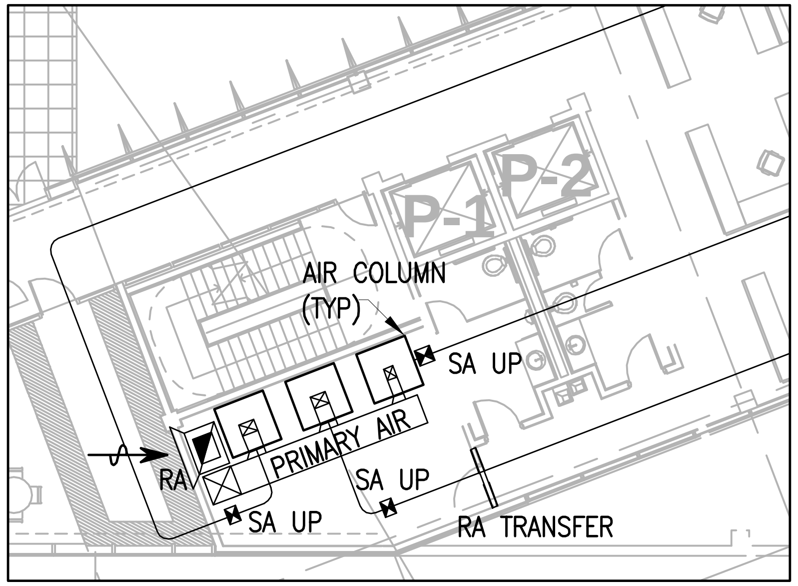
Fermilab

U.S. DEPARTMENT OF ENERGY

DATE
10.06.2010

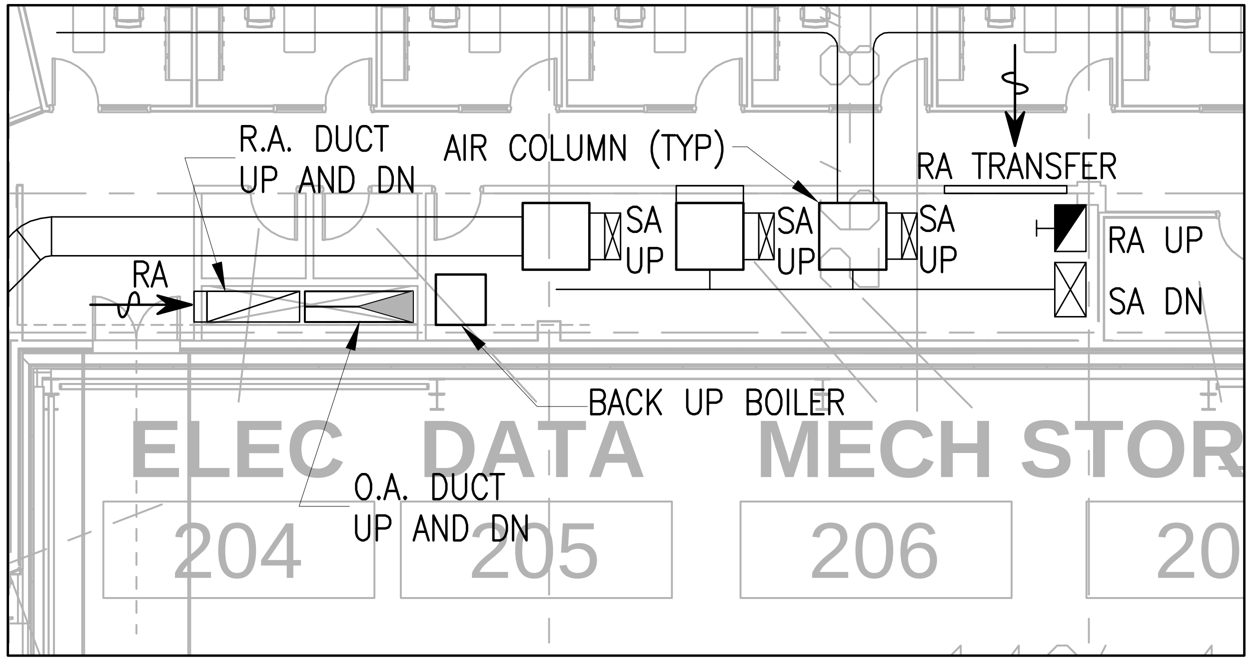
PROJECT NO.
10-8-1

DRAWING NO.
CDR-27



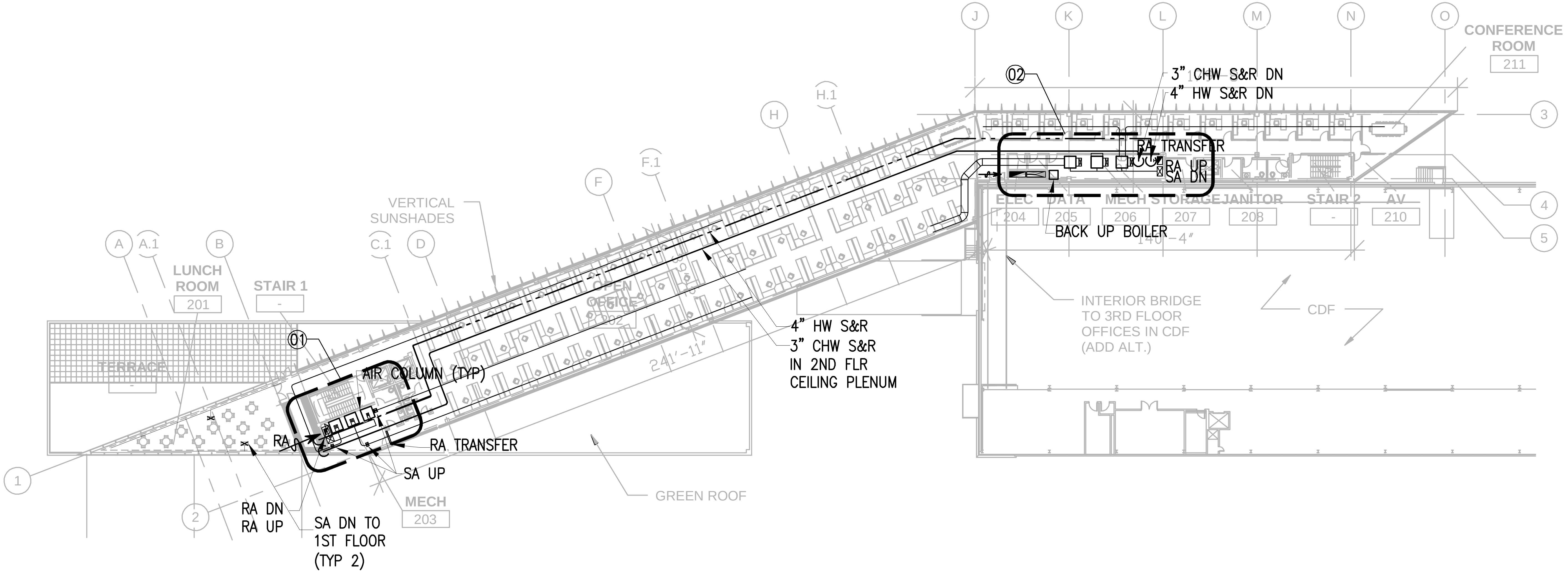
01 2ND FLOOR WEST MECHANICAL ROOM

1/16" = 1'-0"



02 2ND FLOOR EAST MECHANICAL ROOM

1/16" = 1'-0"



03 2ND FLOOR MECHANICAL PLAN

1" = 40'-0"

0 20' 40' 80'

r_barc ross barney architects

10 west hubbard street chicago illinois 60610
t312 832 0600 f312 832 0601
www.r-barc.com

ARUP

N
E
S
W

IARC
OFFICE, TECHNICAL, AND EDUCATION BUILDING
2ND FLOOR MECHANICAL

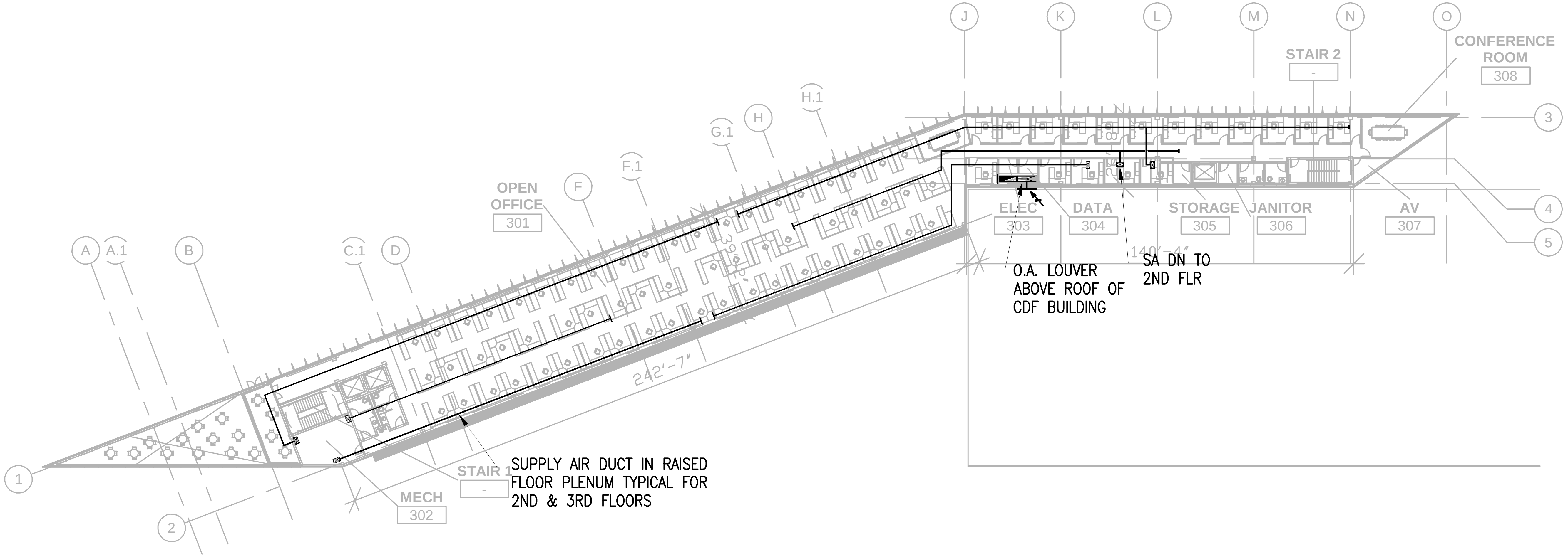
Fermilab

U.S. DEPARTMENT OF ENERGY

DATE
10.06.2010

PROJECT NO.
10-8-1

DRAWING NO.
CDR-28



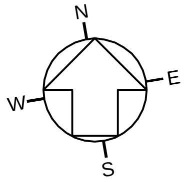
01

3RD FLOOR MECHANICAL PLAN

1" = 40'-0"

ARUP

r_barc
ross barney architects
10 west hubbard street chicago illinois 60610
t312 832 0600 f312 832 0601
www.r-barc.com



IARC
OFFICE, TECHNICAL, AND EDUCATION BUILDING

3RD FLOOR MECHANICAL

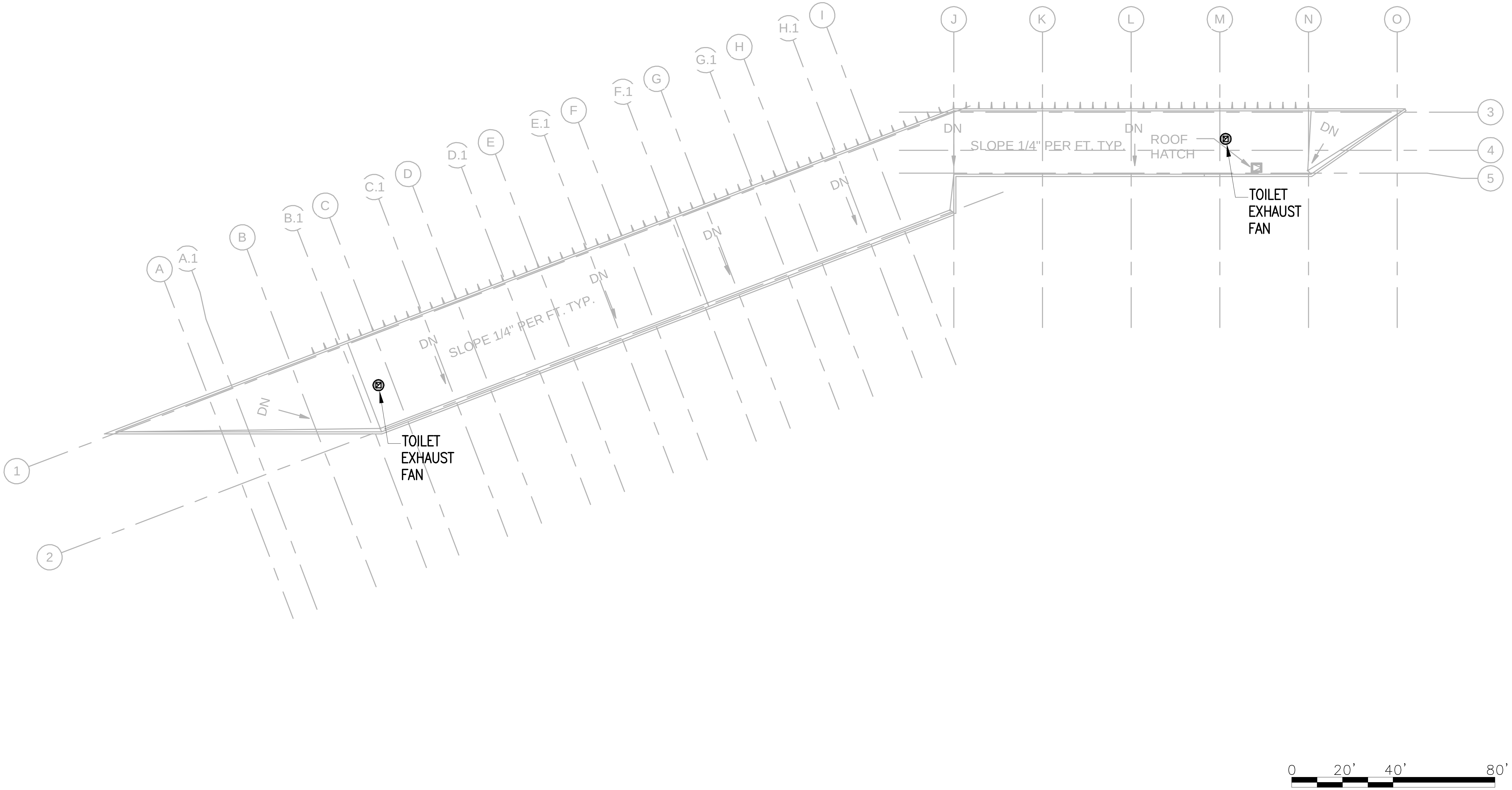
Fermilab

U.S. DEPARTMENT OF ENERGY

DATE
10.06.2010

PROJECT NO.
10-8-1

DRAWING NO.
CDR-29



ARUP

r_barc
ross barney architects
10 west hubbard street chicago illinois 60610
t312 832 0600 f312 832 0601
www.r-barc.com

N
E
S
W

IARC
OFFICE, TECHNICAL, AND EDUCATION BUILDING
ROOF MECHANICAL

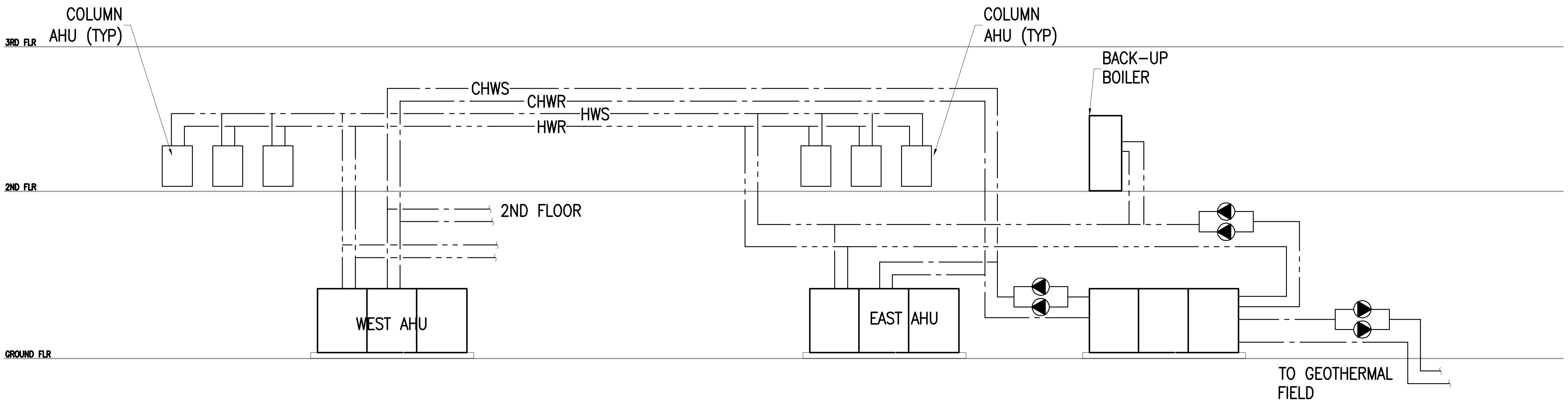
Fermilab

U.S. DEPARTMENT OF ENERGY

DATE
10.06.2010

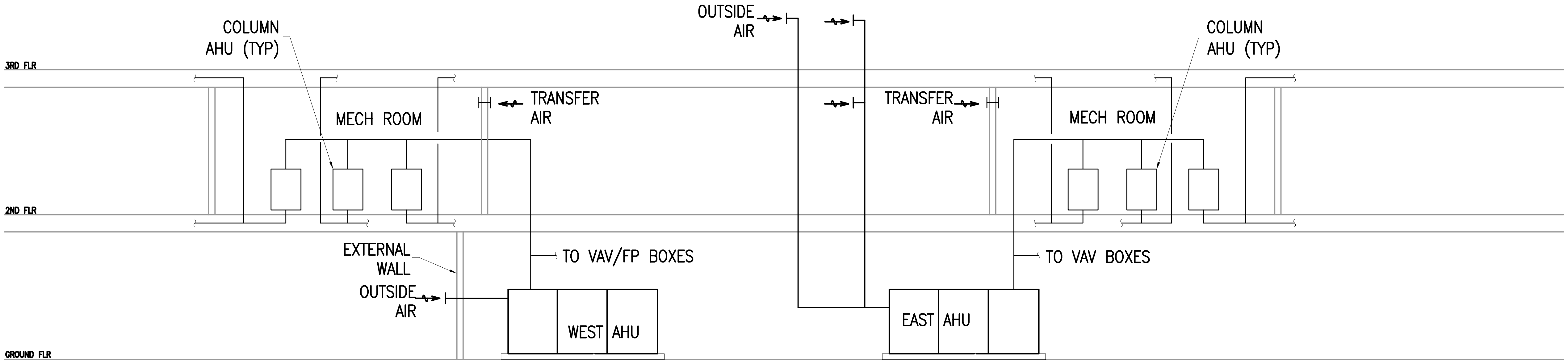
PROJECT NO.
10-8-1

DRAWING NO.
CDR-30



1 HOT WATER/CHILLED WATER DIAGRAM

NTS



2 AIR SUPPLY RISER DIAGRAM

NTS

0 20' 40' 80'

r_barc ross barney architects

10 west hubbard street chicago illinois 60610
t312 832 0600 f312 832 0601
www.r-barc.com

ARUP

N E S W

IARC
OFFICE, TECHNICAL, AND EDUCATION BUILDING

RISER DIAGRAMS

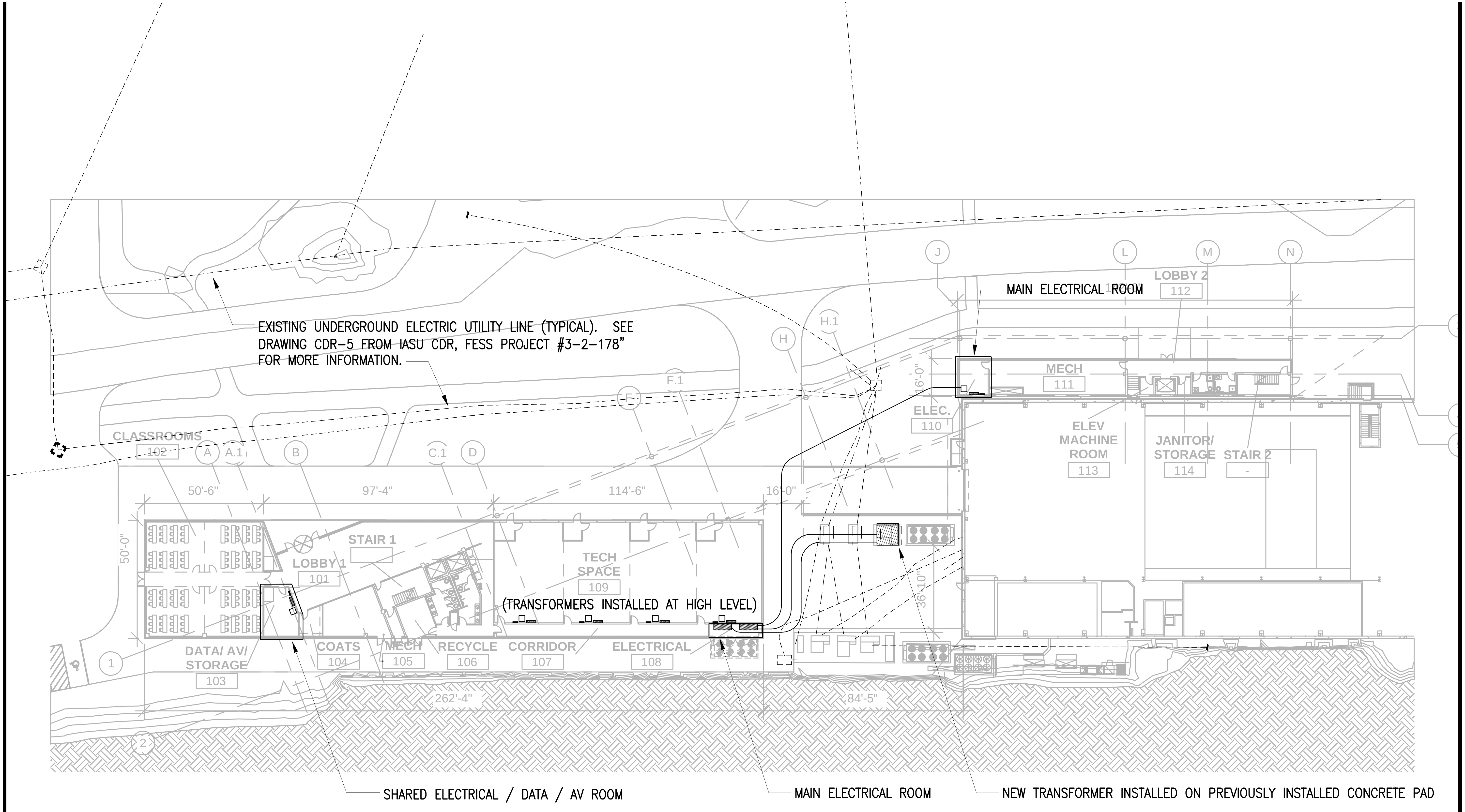
Fermilab

U.S. DEPARTMENT OF ENERGY

DATE
10.06.2010

PROJECT NO.
10-8-1

DRAWING NO.
CDR-31



1 IST FLOOR ELECTRICAL PLAN

1" = 40'-0"

0 20' 40' 80'

r_barc
ross barney architects
10 west hubbard street chicago illinois 60610
t312 832 0600 f312 832 0601
www.r-barc.com

ARUP

N
E
S
W

IARC
OFFICE, TECHNICAL, AND EDUCATION BUILDING
1ST FLOOR ELECTRICAL PLAN

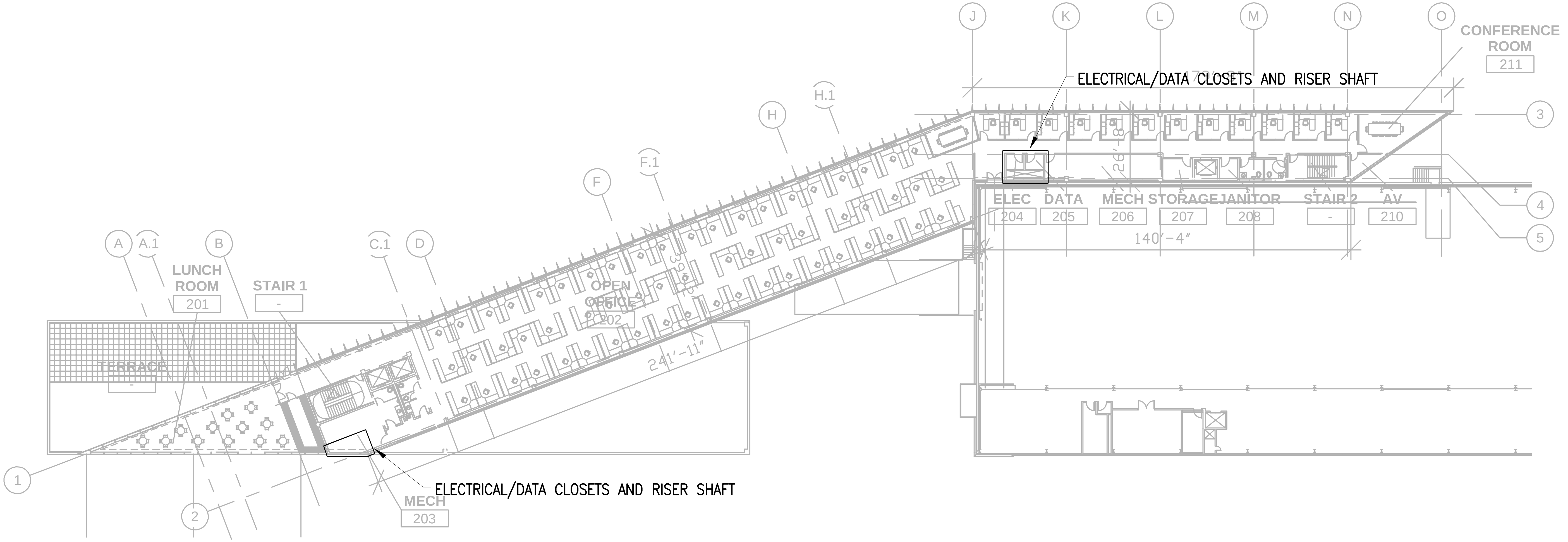
Fermilab

U.S. DEPARTMENT OF ENERGY

DATE
10.06.2010

PROJECT NO.
10-8-1

DRAWING NO.
CDR-32



2 2ND FLOOR ELECTRICAL PLAN
1" = 40'-0"

0 20' 40' 80'

ARUP

r_barc
ross barney architects
10 west hubbard street chicago illinois 60610
t312 832 0600 f312 832 0601
www.r-barc.com

N
E
S
W

IARC
OFFICE, TECHNICAL, AND
EDUCATION BUILDING
2ND FLOOR ELECTRICAL PLAN

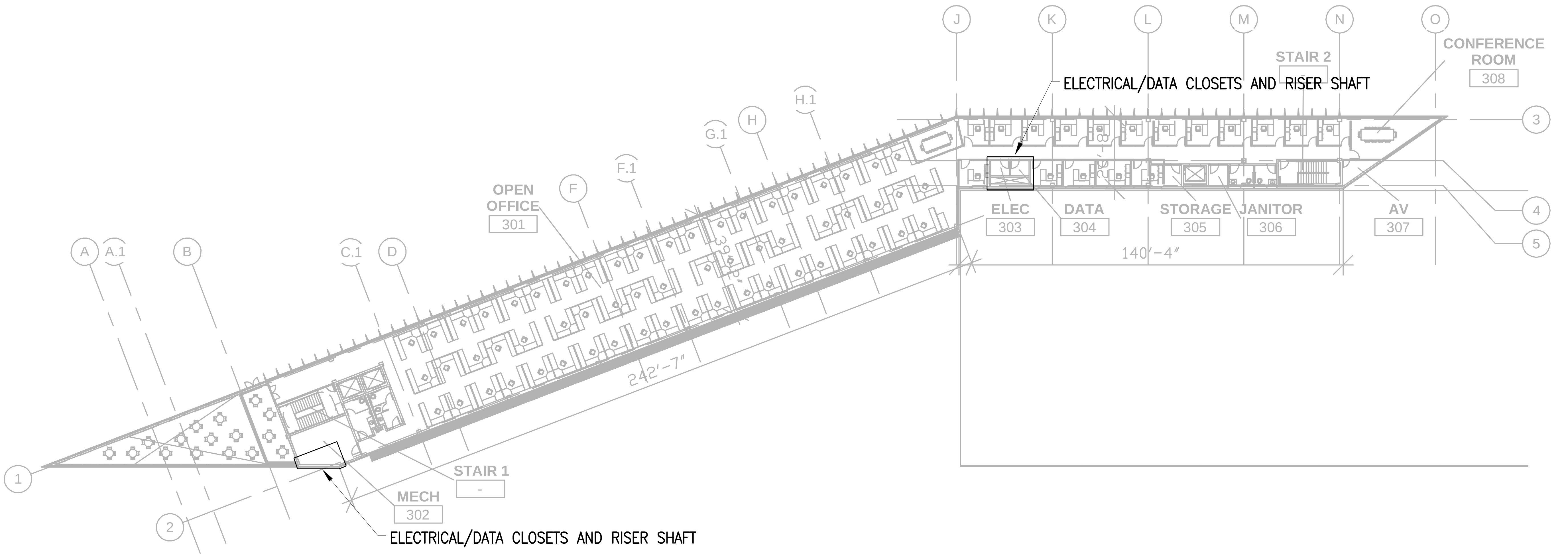
Fermilab

U.S. DEPARTMENT OF
ENERGY

DATE
10.06.2010

PROJECT NO.
10-8-1

DRAWING NO.
CDR-33



3

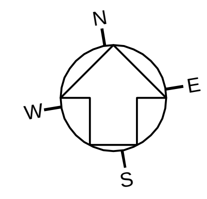
3RD FLOOR ELECTRICAL PLAN

1" = 40'-0"

0 20' 40' 80'

ARUP

r_barc
ross barney architects
10 west hubbard street chicago illinois 60610
t312 832 0600 f312 832 0601
www.r-barc.com



IARC
OFFICE, TECHNICAL, AND EDUCATION BUILDING
3RD FLOOR ELECTRICAL PLAN

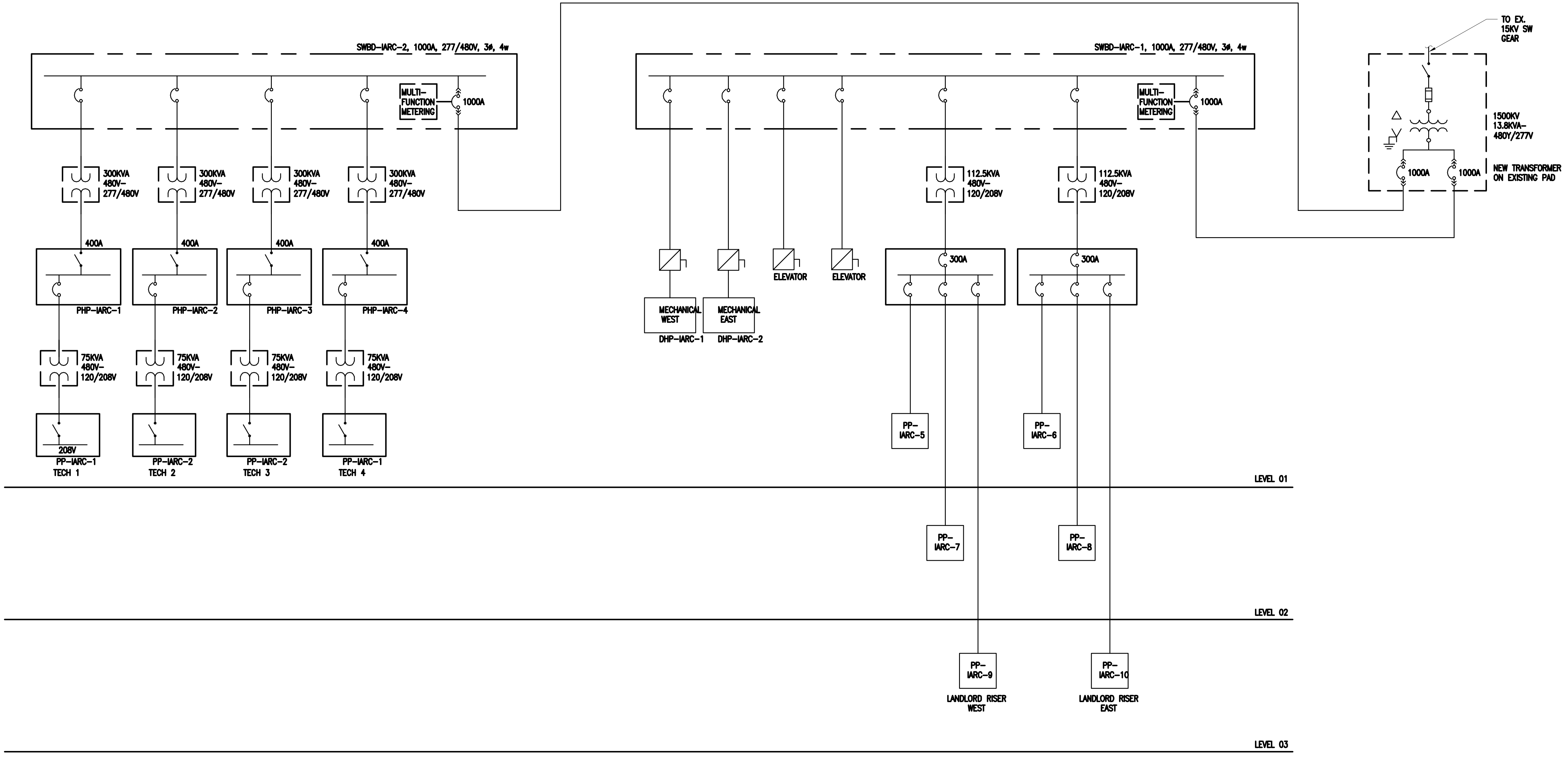
Fermilab

U.S. DEPARTMENT OF ENERGY

DATE
10.06.2010

PROJECT NO.
10-8-1

DRAWING NO.
CDR-34



1 ELECTRICAL ONE LINE DIAGRAM

N.T.S.

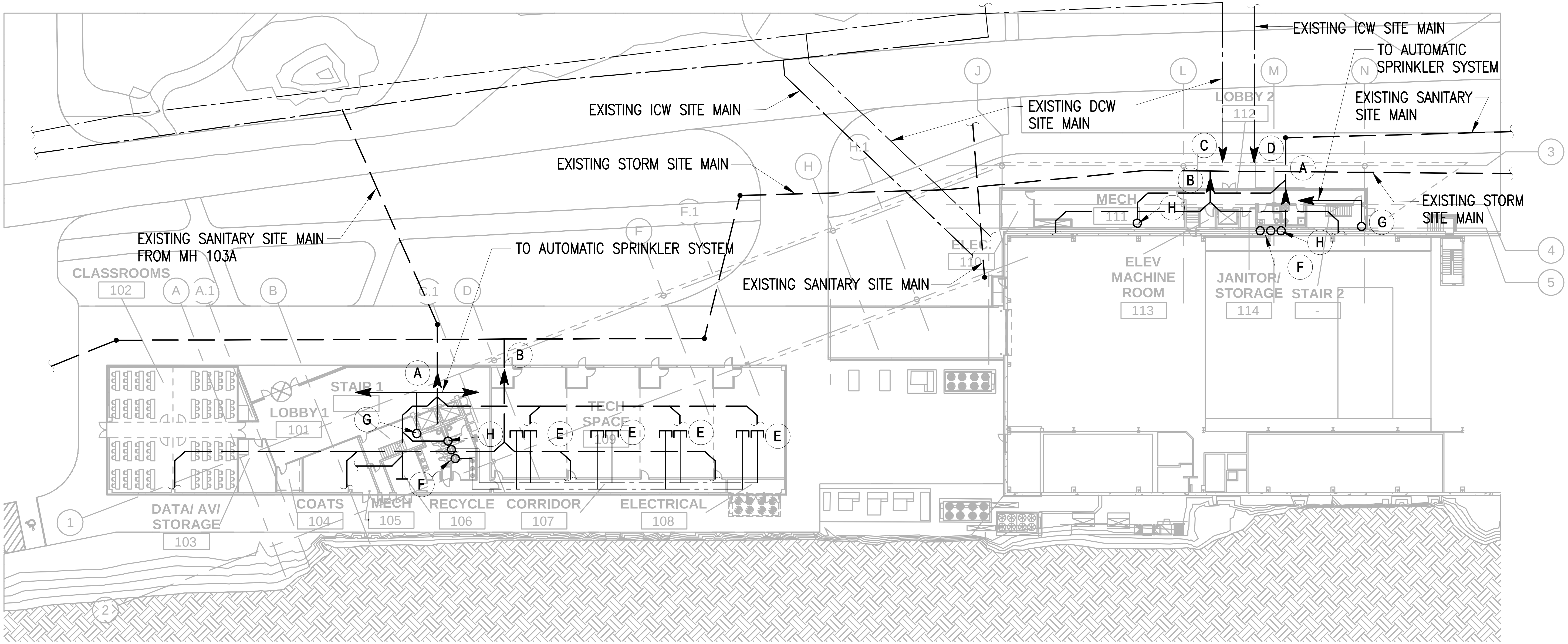
IARC
OFFICE, TECHNICAL, AND EDUCATION BUILDING

ELECTRICAL RISER DIAGRAM

DATE
10.06.2010

PROJECT NO.
10-8-1

DRAWING NO.
CDR-35



1 IST FLOOR PLUMBING PLAN

1" = 40'-0"

KEY NOTES

- Ⓐ SANITARY LATERAL TO SITE MAIN
- Ⓑ STORM LATERAL TO SITE MAIN
- Ⓒ DOMESTIC WATER LATERAL TO BUILDING FROM SITE MAIN (DCW)
- Ⓓ FIRE LATERAL TO BUILDING FROM SITE MAIN (ICW)
- Ⓔ COLD & HOT WATER TO TECH SPACE
- Ⓕ DOMESTIC HOT & COLD WATER RISERS
- Ⓖ FIRE SPRINKLER & STANDPIPE RISER
- Ⓗ SANITARY RISER
- Ⓙ ROOF DRAIN

r_barc ross barney architects
10 west hubbard street chicago illinois 60610
t312 832 0600 f312 832 0601
www.r-barc.com

ARUP

N W E S

IARC
OFFICE, TECHNICAL, AND EDUCATION BUILDING

1ST FLOOR PLUMBING PLAN

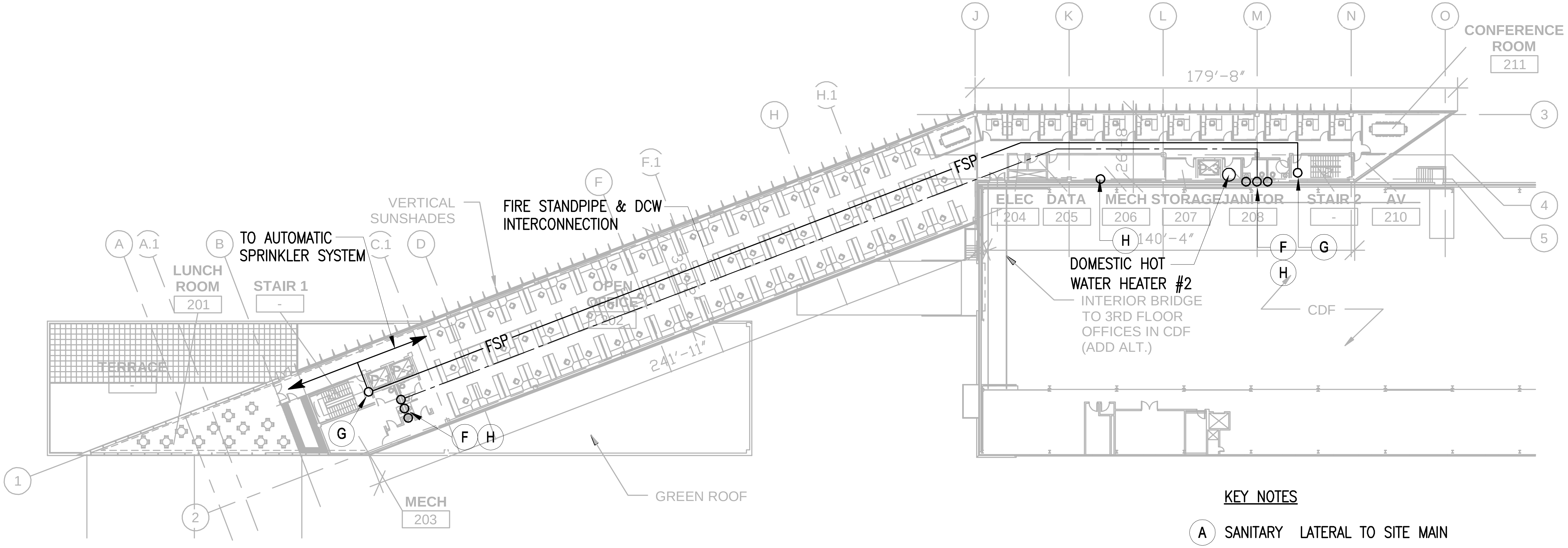
Fermilab

U.S. DEPARTMENT OF ENERGY

DATE
10.06.2010

PROJECT NO.
10-8-1

DRAWING NO.
CDR-36



KEY NOTES

- Ⓐ SANITARY LATERAL TO SITE MAIN
- Ⓑ STORM LATERAL TO SITE MAIN
- Ⓒ DOMESTIC WATER MAIN TO BUILDING (DCW)
- Ⓓ FIRE MAIN TO BUILDING (ICW)
- Ⓔ COLD & HOT WATER TO TECH SPACE
- Ⓕ DOMESTIC HOT & COLD WATER RISERS
- Ⓖ FIRE SPRINKLER & STANDPIPE RISER
- Ⓗ SANITARY RISER
- Ⓙ ROOF DRAIN

② 2ND FLOOR PLUMBING PLAN

1" = 40'-0"

0 20' 40' 80'

ARUP

r_barc
ross barney architects
10 west hubbard street chicago illinois 60610
t312 832 0600 f312 832 0601
www.r-barc.com

N
E
S
W

IARC
OFFICE, TECHNICAL, AND EDUCATION BUILDING

2ND FLOOR PLUMBING PLAN

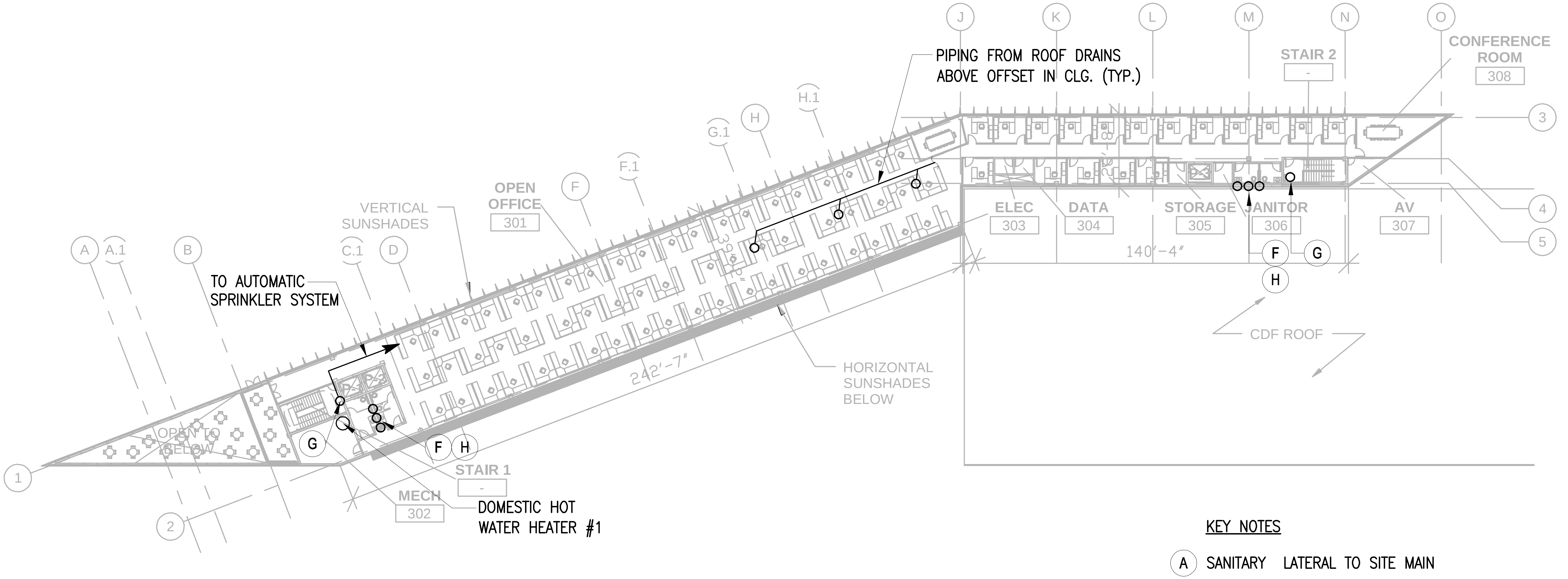
Fermilab

U.S. DEPARTMENT OF ENERGY

DATE
10.06.2010

PROJECT NO.
10-8-1

DRAWING NO.
CDR-37



3 3RD FLOOR PLUMBING PLAN

1" = 40'-0"

KEY NOTES

A	SANITARY LATERAL TO SITE MAIN
B	STORM LATERAL TO SITE MAIN
C	DOMESTIC WATER MAIN TO BUILDING (DCW)
D	FIRE MAIN TO BUILDING (ICW)
E	COLD & HOT WATER TO TECH SPACE
F	DOMESTIC HOT & COLD WATER RISERS
G	FIRE SPRINKLER & STANDPIPE RISER
H	SANITARY RISER
J	ROOF DRAIN

0 20' 40' 80'

ARUP

r_barc
ross barney architects
10 west hubbard street chicago illinois 60610
t312 832 0600 f312 832 0601
www.r-barc.com

IARC
OFFICE, TECHNICAL, AND EDUCATION BUILDING
3RD FLOOR PLUMBING PLAN

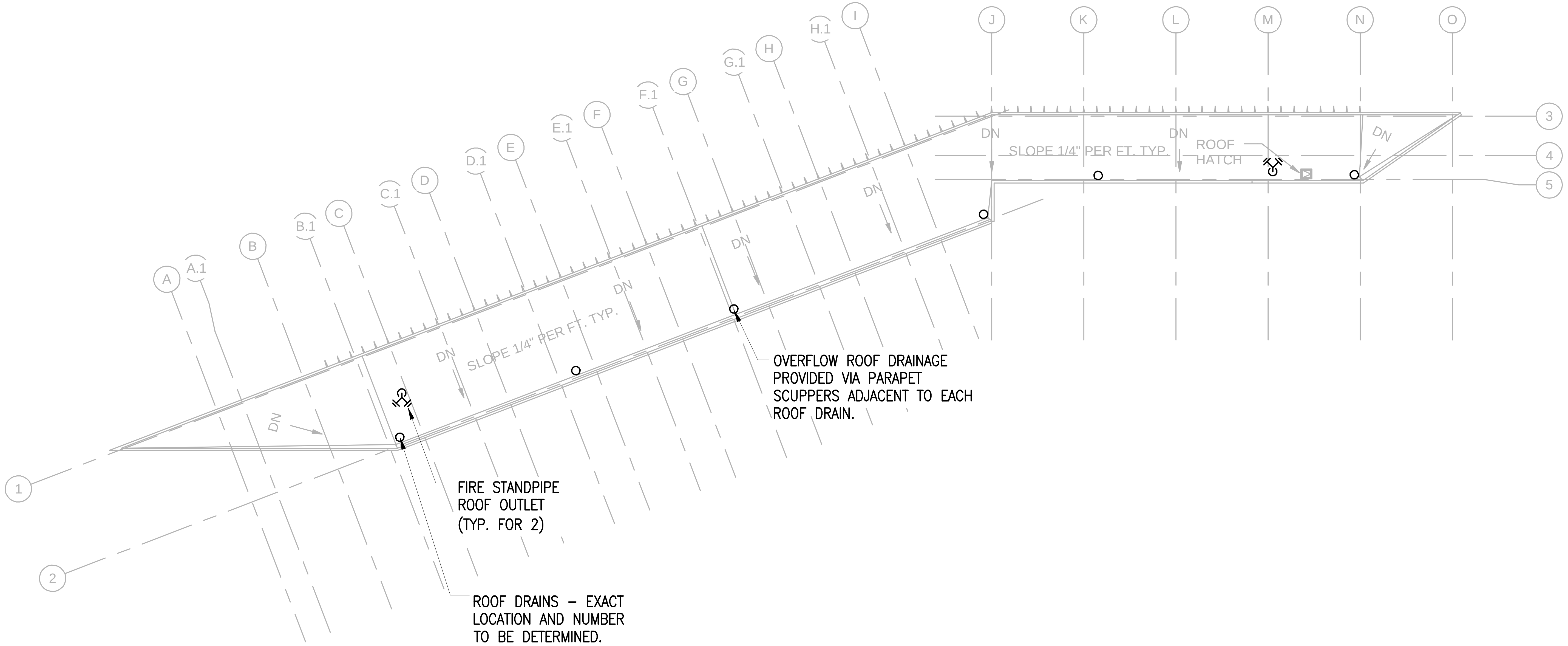
Fermilab

U.S. DEPARTMENT OF ENERGY

DATE
10.06.2010

PROJECT NO.
10-8-1

DRAWING NO.
CDR-38



OVERFLOW ROOF DRAINAGE PROVIDED VIA PARAPET SCUPPERS ADJACENT TO EACH ROOF DRAIN.

FIRE STANDPIPE ROOF OUTLET (TYP. FOR 2)

ROOF DRAINS – EXACT LOCATION AND NUMBER TO BE DETERMINED.

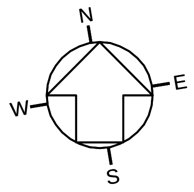
4 ROOF PLUMBING PLAN

1" = 40'-0"

0 20' 40' 80'

r_barc ross barney architects
10 west hubbard street chicago illinois 60610
t312 832 0600 f312 832 0601
www.r-barc.com

ARUP



IARC
OFFICE, TECHNICAL, AND EDUCATION BUILDING

ROOF PLUMBING PLAN

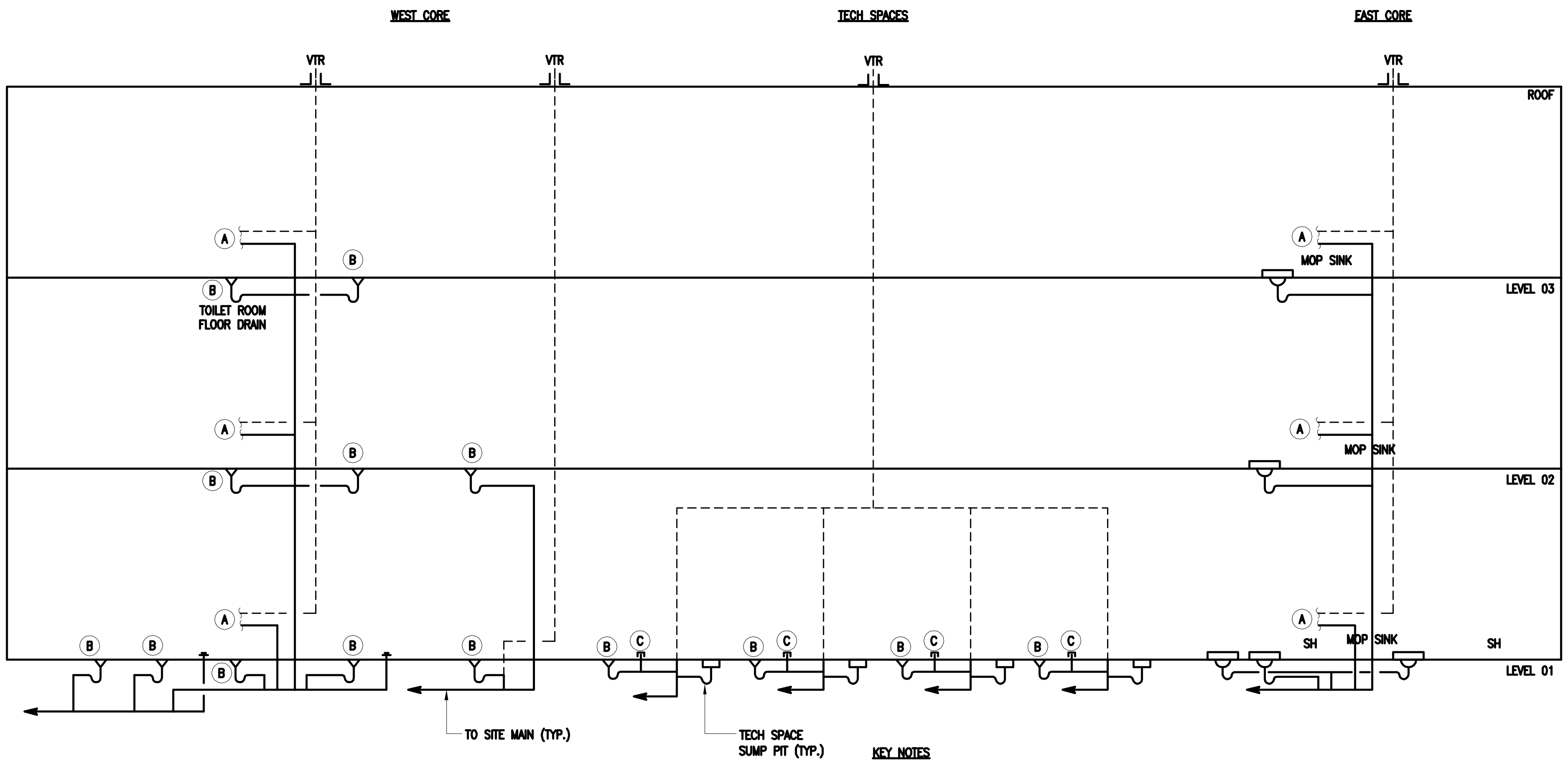
Fermilab

U.S. DEPARTMENT OF ENERGY

DATE
10.06.2010

PROJECT NO.
10-8-1

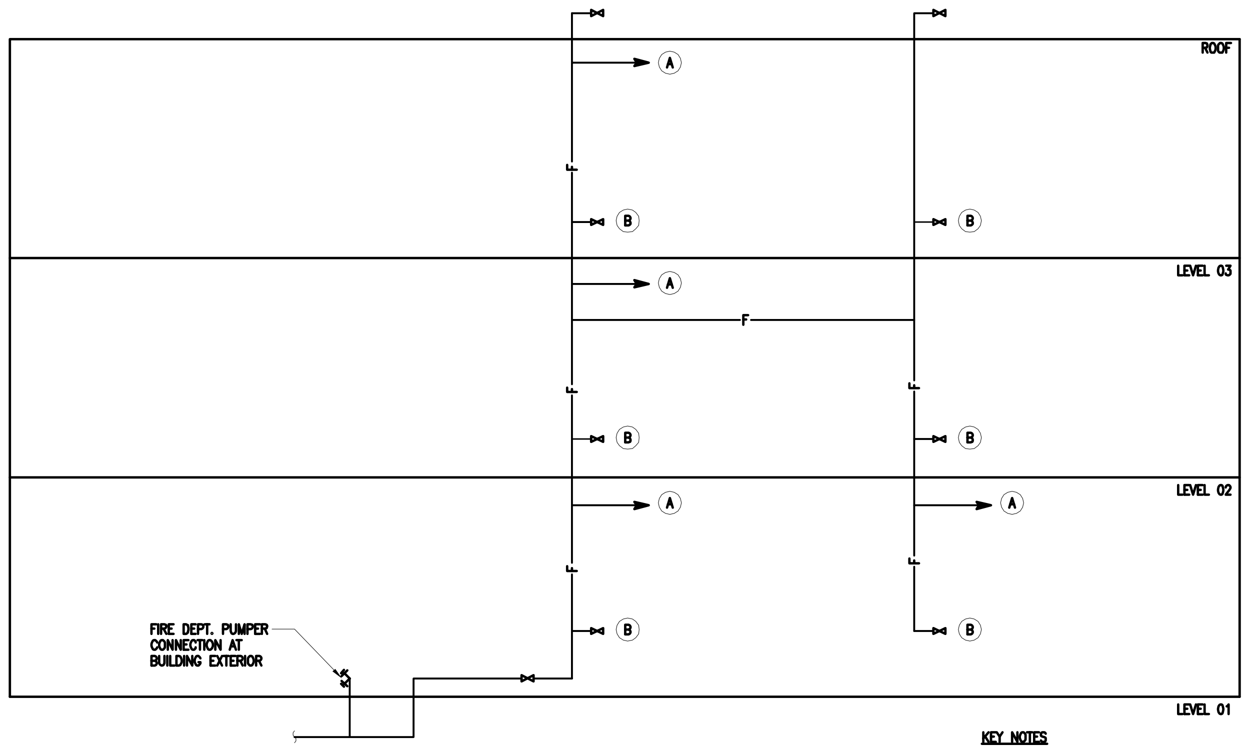
DRAWING NO.
CDR-39



1 SANITARY WASTE DIAGRAM
N.T.S.

KEY NOTES

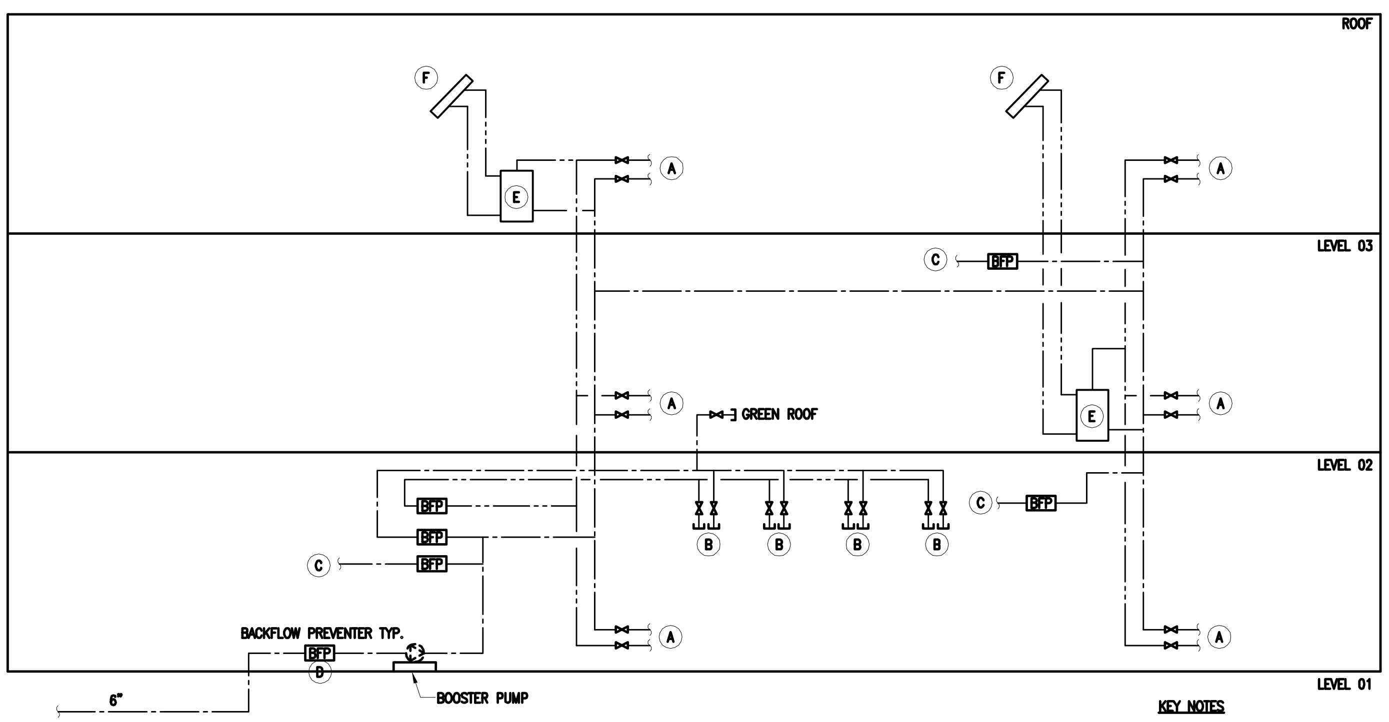
Ⓐ TO PLUMBING FIXTURES
Ⓑ FLOOR DRAINS
Ⓒ 4" CAPPED STUB.



KEY NOTES

Ⓐ TO AUTOMATIC SPRINKLER SYSTEM
Ⓑ HOSE VALVE

2 AUTOMATIC SPRINKLER & STANDPIPE DIAGRAM
N.T.S.



3 DOMESTIC WATER DIAGRAM
N.T.S.

KEY NOTES

Ⓐ TO PLUMBING FIXTURES
Ⓑ TO TECH ROOMS
Ⓒ TO MECHANICAL EQUIPMENT
Ⓓ BACKFLOW DEVICE
Ⓔ WATER HEATER
Ⓕ SOLAR PANELS

ARUP

r_barc
ross barney architects
10 west hubbard street chicago illinois 60610
t312 832 0600 f312 832 0601
www.r-barc.com

N
E
S
W

IARC
OFFICE, TECHNICAL, AND EDUCATION BUILDING

PLUMBING RISER DIAGRAMS

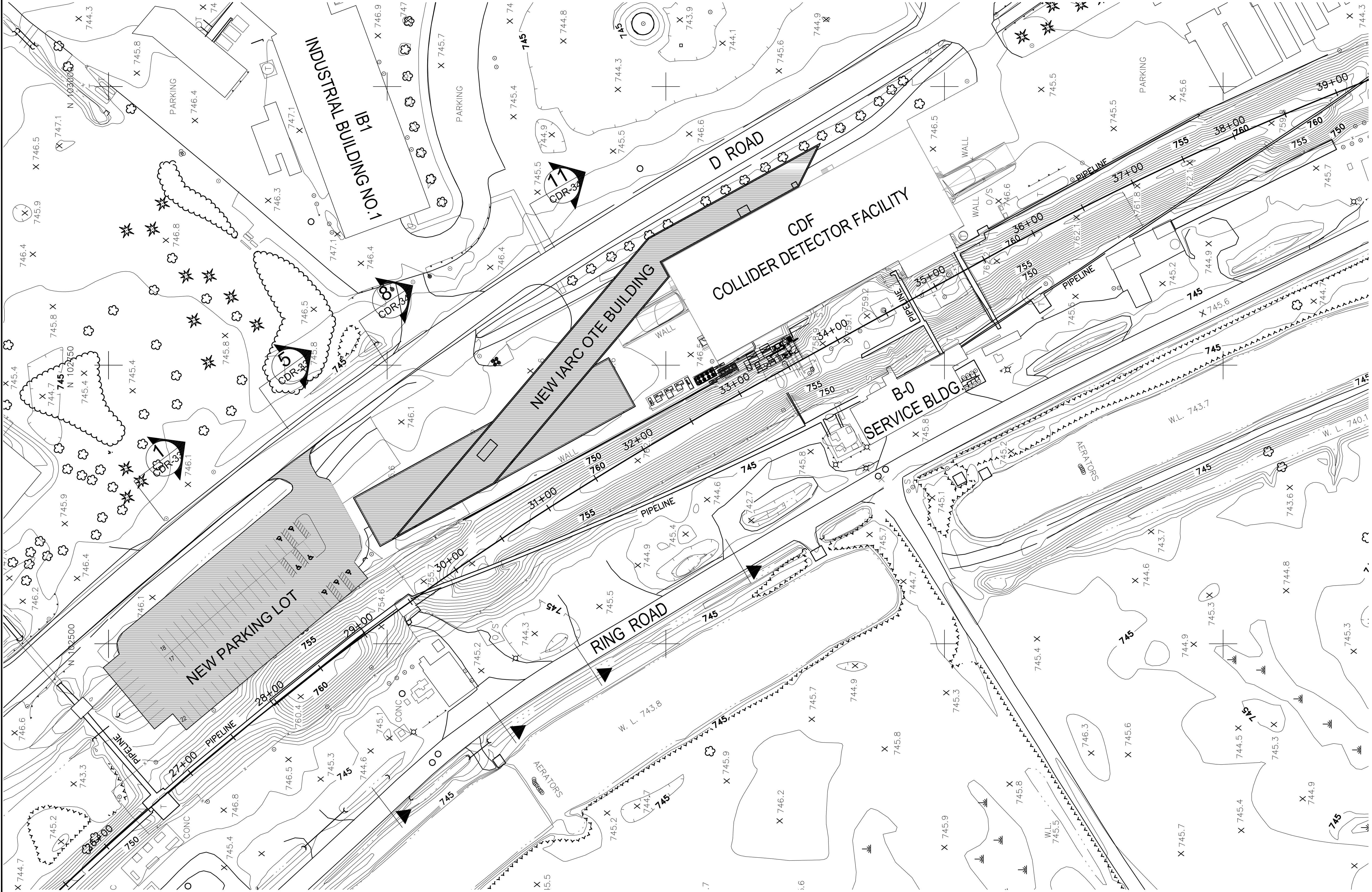
Fermilab

U.S. DEPARTMENT OF ENERGY

DATE
10.06.2010

PROJECT NO.
10-8-1

DRAWING NO.
CDR-40



1 PLAN

SCALE: 1"=80'

RAD SAFETY DRAWINGS PLAN
PROJECT NO. 10-8-1

0 40' 80' 160'

ross barney architects
10 west hubbard street chicago illinois 60610
t312 832 0600 f312 832 0601
www.r-barc.com

r_barc

ARUP

N
E
S
W

IARC
OFFICE, TECHNICAL, AND EDUCATION BUILDING
RADIATION SAFETY - PLAN

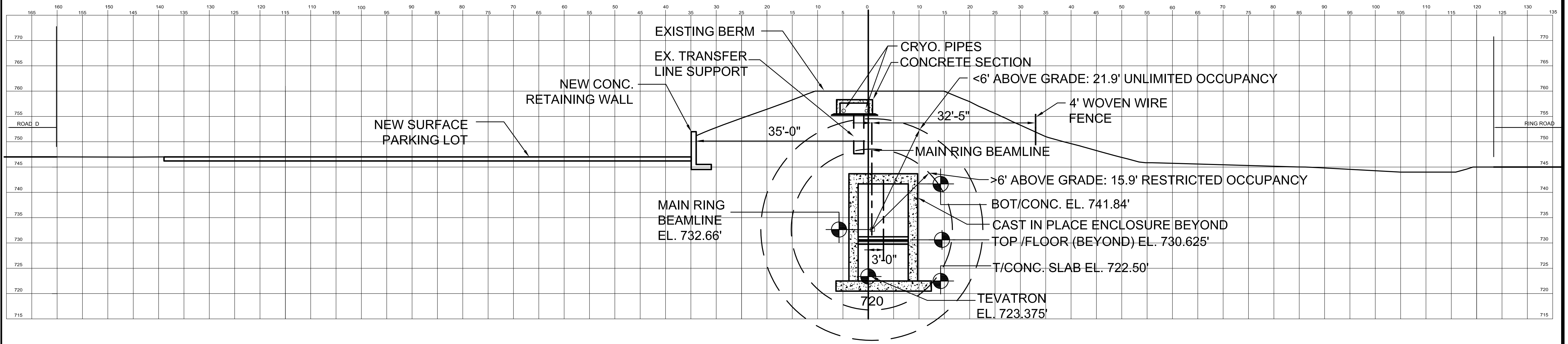
Fermilab

U.S. DEPARTMENT OF ENERGY

DATE
10.06.2010

PROJECT NO.
10-8-1

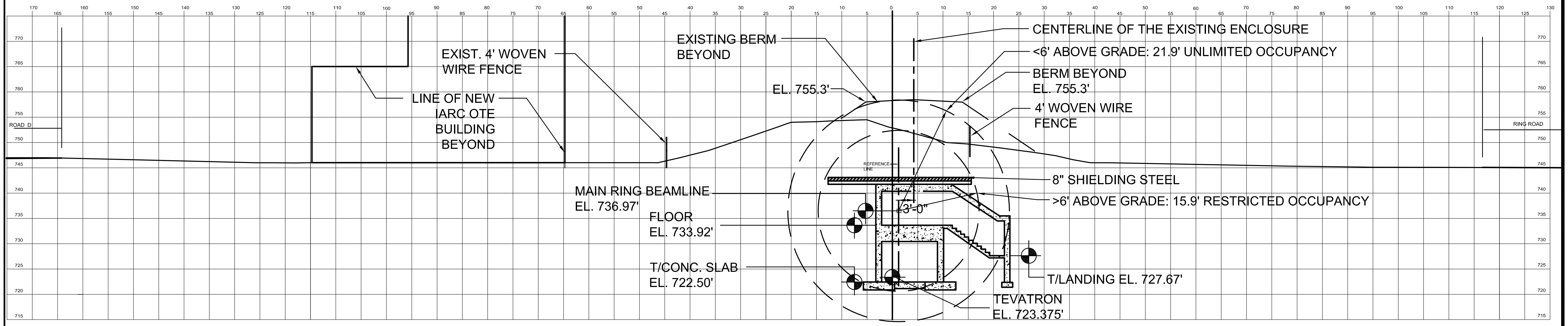
DRAWING NO.
CDR-41



1 SECTION

SCALE: 1"=20' STA. 28+20

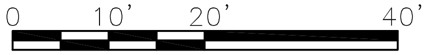
RAD SAFETY DRAWINGS SECTION
PROJECT NO. 10-8-1



5 SECTION

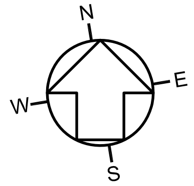
SCALE: 1"=20' STA. 28+20

RAD SAFETY DRAWINGS SECTION
PROJECT NO. 10-8-1



r_barc ross barney architects
10 west hubbard street chicago illinois 60610
t312 832 0600 f312 832 0601
www.r-barc.com

ARUP

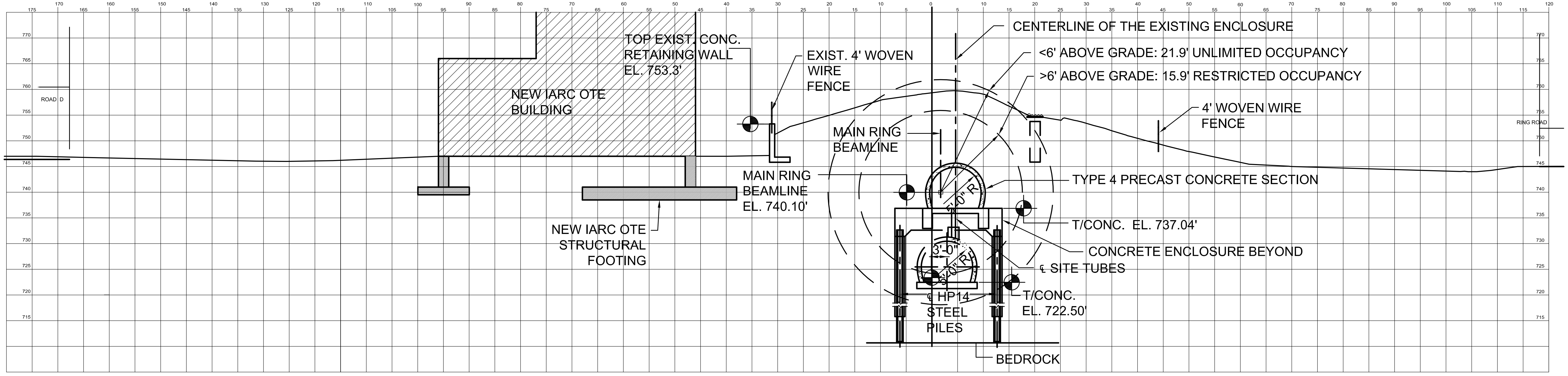


IARC
OFFICE, TECHNICAL, AND EDUCATION BUILDING
RADIATION SAFETY - SECTIONS

Fermilab

U.S. DEPARTMENT OF ENERGY

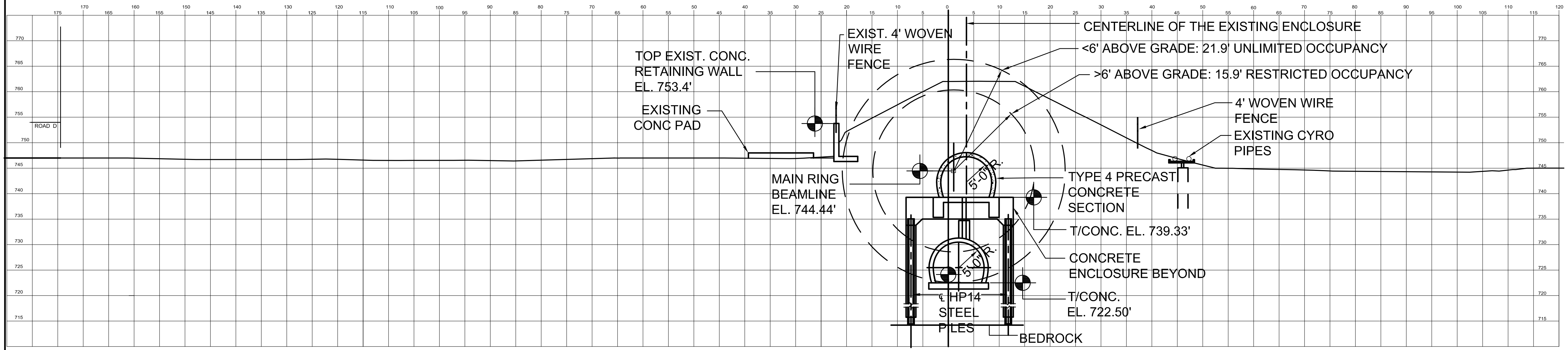
DATE
10.06.2010
PROJECT NO.
10-8-1
DRAWING NO.
CDR-42



8 SECTION

SCALE: 1"=20' STA. 28+20

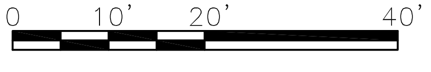
RAD SAFETY DRAWINGS SECTION
PROJECT NO. 10-8-1



11 SECTION

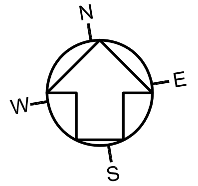
SCALE: 1"=20' STA. 29+53

RAD SAFETY DRAWINGS SECTION
PROJECT NO. 10-8-1



ARUP

r_barc
ross barney architects
10 west hubbard street chicago illinois 60610
t312 832 0600 f312 832 0601
www.r-barc.com



IARC
OFFICE, TECHNICAL, AND EDUCATION BUILDING
RADIATION SAFETY - SECTIONS

Fermilab
U.S. DEPARTMENT OF ENERGY

DATE
10.06.2010
PROJECT NO.
10-8-1
DRAWING NO.
CDR-43

Geotechnical Engineering Report

for

IARC BUILDING
BATAVIA, ILLINOIS

Prepared for

FERMI NATIONAL ACCELERATOR LABORATORY

PROJECT NO. 21053.034

AUGUST 9, 2010

SUBMITTED BY:

PATRICK
ENGINEERING

TABLE OF CONTENTS

INTRODUCTION

This report presents the results of the geotechnical investigation performed by Patrick Engineering Inc. (Patrick) for the proposed Illinois Accelerator Research Center (IARC) Facility at the Fermi National Accelerator Laboratory in Batavia, Illinois (Fermilab).

This report was prepared according to the scope of services outlined in Patrick's proposal No. 2A953.631, dated April 26, 2010. The purpose of the geotechnical investigation, as outlined in our proposal, was to evaluate the subsurface conditions in the project area and provide recommendations regarding foundation design for the planned building. This report also includes demolition and site preparation recommendations and construction considerations.

PROJECT DESCRIPTION

The Project area is located adjacent to the CDF Building along B Road at Fermilab. The project will include a new three-story 40,000-square-foot slab-on-grade office building. The new building will be located in the existing parking lot with a façade that wraps in front of the CDF Building. A walkway between the new office building and the existing CDF Building is also being considered.

Additional parking will also be constructed in conjunction both building configurations. At this time, it has not been determined where the parking lot(s) will be located.

SITE INVESTIGATION

Field Exploration

Field exploration activities included drilling and sampling eight borings to depths ranging from 30 to 75 feet. Field exploration activities were performed on June 11 and June 14, 2010. The boring locations were selected and identified on site by representatives of Fermilab and Patrick. Ground surface elevations for the boring locations were estimated from an existing site conditions survey provided by Fermilab. The approximate boring locations and elevations are shown on the attached Boring Location Plan (Appendix A).

The boreholes were advanced using a truck-mounted CME-75 drill rig using 4¼″ ID hollow-stem augers. Disturbed soil samples were collected at 2.5-foot intervals down to 15 feet and at 5-foot intervals thereafter using a 2-inch OD split-spoon sampler as part of the Standard Penetration Test (SPT). The sampler was initially seated by driving it six inches, and then driven an additional 12 inches using a 140-pound hammer falling 30 inches. The number of blows required to drive the sampler the last 12 inches is designated as the SPT "N-Value". SPT sampling was performed in general accordance with ASTM D 1586. Several samples of cohesive soils were obtained using a 3-inch Shelby tube, in general accordance with ASTM D 1587.

Field exploration activities were supervised by an experienced Patrick geologist who logged the soil conditions and collected representative soil samples for visual classification and possible laboratory testing. The soils were logged according to the Soil Description Terminology and the locally adapted version of the Unified Soil Classification System, ASTM D 2487, as presented in Appendix B. The filed logs, together with laboratory test results, were used to develop the final boring logs presented in Appendix B.

LABORATORY TESTING

Soil samples were transported to a local laboratory for moisture content testing. Select samples were tested for Atterberg limits, grain size analysis, dry unit weights and unconfined compressive strength. Results of the testing program are presented on the logs in Appendix B, with the laboratory results included in Appendix C.

SITE CONDITIONS

Surface Conditions

The project area is currently an asphalt parking lot, with a depressed concrete loading dock entrance at the northwest corner of the building. The area is bounded to the south by the accelerator ring berm and perimeter fence. There is a large storm sewer and manhole in the center of the parking lot. The western edge of the parking lot drains to the vegetated wetland area adjacent to the west of the lot. A large drainage outlet from the storm sewer was observed flowing to this lower lying ditch area. This area is covered with large brush and tall grasses separating D Road from the accelerator ring berm. A pedestrian and bike path parallels D Road along the north side of the CDF Building. Large trees line the bike path for the length of the building.

Design drawings (6-1-37) for the CDF Building were provided by Fermilab. Based on these drawings the existing building has a basement extending to a depth of 36 feet below existing grade. The basement slab elevation is 709′ 11½″. The building is supported on a combination of shallow spread footings below the basement and caissons.

Soil Conditions

At most of the boring locations, the pavement section consisted of 3 to 4½ inches of asphalt underlain by crushed stone aggregate base. The aggregate base materials generally ranged in thickness from 1½ to 2 feet. Below the aggregate base materials in Boring S1408, approximately 3½ feet of ¾-inch limestone was also encountered. At the surface of Boring S1409 in the grass area, approximately 12 inches of topsoil and organic clay materials were encountered.

Subsurface soils below the pavement section and topsoil generally consisted of layers of silty clay, silt and silty sand underlain by limestone bedrock.

A layer of soft to medium stiff silty clay/clayey silt was encountered in most of the borings and extended to depths of about 13 to 17 feet below existing grade. Generally, this material had compressive strength values ranging from 0.25 to 1.0 ton per square foot (tsf). Laboratory unconfined compressive strength tests were performed on several samples of this material with results ranging from 0.24 to 0.59 tsf. Below the soft to medium stiff silty clay, stiff to very stiff silty clay was encountered which generally extended to depths of about 60 feet. These materials had compressive strength values ranging from 3 to 4.5 tsf. Borings S1404, S1407 and S1410 were terminated in this stiff layer at depths of 30 feet.

Boring S1411 encountered miscellaneous fill consisting of clay and sand layers through the depth of the boring. An obstruction was encountered at a depth of 18 feet and the boring was offset to continue to the planned terminal depth. Wood pieces were encountered in the sampler at depths of 25 to 30 feet.

Auger refusal was encountered upon reaching bedrock in each of the deep borings (S1405 and S1406) at depths of 70.4 and 70 feet, respectively.

Groundwater Observations

Groundwater observations were made while drilling by noting either the depth to water as measured on the drill rods or the presence of free water in the soil samples. Upon completion of the borehole and removal of the augers, groundwater was measured in the open borehole if the hole did not cave in.

While drilling, groundwater was encountered at depths ranging from 6 to 9.5 feet below grade. After drilling, groundwater was observed in Borings S1404, S1405 and S1406 at depths of 23 feet, 55 feet and 64 feet, respectively. Free groundwater was not observed in the remaining borings after drilling. Given the color change and moisture contents of the soils below a depth of 10 feet, it is anticipated that the long term groundwater elevation is consistently below this depth; however groundwater levels fluctuate, and higher water levels may be present after periods of precipitation and during prolonged wet periods.

Seismic Classification

In accordance with the 2009 International Building Code (IBC 2009) Section 1613, Table 1613.5.2, the Property has a Seismic Site Classification of D. The classification is based on the upper 100 feet of the soil profile having average undrained shear strengths between 1,000 and 2,000 psf, and SPT N values between 15 and 50. While the Site does exhibit soft soil layers near the surface, laboratory test results (plasticity indices and moisture contents) do not meet the Class E requirements.

ENGINEERING ANALYSIS AND RECOMMENDATIONS

The following recommendations for design and construction of the proposed foundations are based on the geotechnical data gathered in this investigation.

Demolition and Site Preparation Recommendations

The proposed building footprint is located within an existing parking lot, and it is anticipated that the existing pavements and retaining structures for the loading dock will be completely removed. Existing utilities that interfere with the proposed construction should be properly abandoned in place or removed / rerouted and the excavations backfilled with compacted structural fill to prevent settlement. It is recommended that any demolition excavations are backfilled with compacted structural fill as described below.

Landscaped areas of the Site should be cleared of trees and stumps, and grubbed to a suitable depth to remove all large roots (diameters greater than 2 inches).

Asphalt and aggregate base materials were encountered at the ground surface of most borings. These materials should be removed, and may be stockpiled on site (if possible) for possible reuse as general fill.

After initial clearing and grading, subgrade areas for slab-on-grade construction should be proofrolled with a fully-loaded, 10-wheel dump truck to check for soft or unstable soils. Zones of soil that exhibit instability, such as rutting or pumping in excess of 1 inch, should be recompacted or removed and replaced. The actual depth and volume of undercut should be determined at the time of construction based on observations and tests by an experienced geotechnical engineer. Excavated material should be replaced with approved structural fill and compacted according to the project specifications.

Fill Material and Placement.

Structural fill to be used at the Site should be approved inorganic soil, free of waste, debris, deleterious material, and excess moisture. The fill should be placed where dry and stable conditions exist at design or undercut subgrade.

Granular fill may consist of locally available crushed limestone, crushed gravel with sand, or recycled concrete meeting the gradation limits provided in Table 1. Where wet conditions are encountered, crushed limestone similar to the free draining 1.5- or 3-inch gradations in Table 1 should be used. Fill used at the Site should meet the following minimum requirements.

1. Fill material shall not contain more than 5% organic material when tested in accordance with ASTM D 2974, and shall be free of waste, debris, and frozen deleterious material.

2. Cohesive fill shall have a liquid limit less than 45 and a plasticity index less than 25 and greater than 10.

3. Materials unsatisfactory for use as fill include soils classified as silt or organic silt in the Unified Soil Classification System ASTM D 2847 (i.e., ML, MH, PT, OL, and OH).

4. Structural fill should be placed in foundation bearing areas in maximum 8-inch-thick loose lifts, and compacted to at least 95% of the modified Proctor density. Structural fill materials should extend 5 feet beyond the perimeter of any proposed foundation pads.

5. General fill should consist of free-draining granular material (no fines) placed in maximum 10-inch loose lifts and compacted to at least 92% of modified Proctor density to improve material density through particle interlock.

Table 1. Coarse Aggregate Gradations

Gradation (% Passing)	**Sieve Size ▸**	**3″**	**2.5″**	**2″**	**1.5″**	**1″**	**0.5″**	**No. 4**	**No. 16**	**No. 200***
	3-inch	100	95±5	60±15	15±15	3±3				
	1.5-inch				100	95±5	75±5	43±13	25±15	8±4
	1.5-inch FD				100	95±5	45±15	5±5		

FD – free draining

Groundwater Control

The upper native soils generally consist of silty clays and therefore it is not expected that significant groundwater control will be necessary during construction. However, if perched groundwater is encountered in the pavement base course or granular layers, it is Patrick’s opinion that any such water can be controlled using conventional sumps with pumps. Dewatering may be required, and it is our opinion that water from seepage and/or precipitation can be controlled during construction using conventional sumps and pumps.

Foundation Design Recommendations

Patrick has considered three possible options for the building foundation system, which are presented below. These include shallow foundations, an intermediate depth foundation system such as GeoPiers® and deep foundations such as drilled piers.

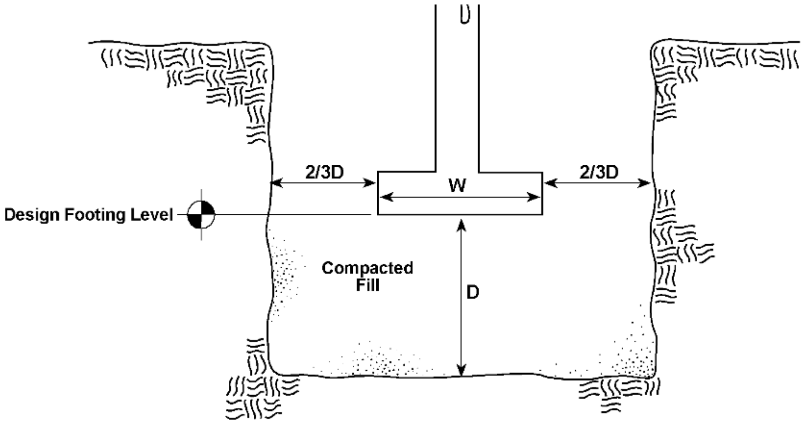
For all three foundation alternatives, the proximity of the proposed foundations to the existing CDF basement foundations and walls will need to be reviewed. Influence of the new foundation loads on the existing foundations could potentially cause settlement of the existing building and additional lateral loading on the basement walls.

Shallow Foundations

Based on the subsurface conditions encountered in the soil borings, subgrade soils are generally appropriate for properly designed and constructed shallow foundations.

Spread footings should bear at a depth of at least 42 inches below the finished exterior grades to protect against frost heave. Where soft native materials or existing fill (such as Boring S1411) are encountered at the design bearing elevation, overexcavation will be necessary. The existing fill materials in Boring S1411 are not considered suitable for support of shallow foundations. Where soft materials are encountered, it is anticipated that undercuts of 2 to 3 feet below proposed bearing elevation may be necessary.

Overexcavated footings should be backfilled with compacted structural fill to design bearing elevation. The overexcavated area should be widened 1⅓ feet for every foot of depth below design subgrade and backfilled with compacted structural fill, as shown below. Structural fill used to bring the grade to bearing elevation should be compacted granular fill placed in lifts less than 8 inches, loose measure.



Note: **Excavation sides are shown vertical for reference only; slopes should conform to OSHA requirements.**

For design purposes, spread footings should have a minimum width of 24 inches and continuous strip footings have a minimum width of 18 inches, provided they are founded below the frost penetration depth.

Allowable Bearing Pressure and Settlement

Shallow foundations can be designed using a maximum allowable bearing pressure of 2,000 pounds per square foot (psf) (includes a Factor of Safety of 3.0 against bearing capacity failure).

Based on this allowable bearing pressure, Patrick estimates total settlement of the new structures will be less than 1 inch.

Intermediate Depth Foundations

An intermediate depth foundation system such as GeoPiers® or Rammed Aggregate Piers® (RAP) could also be considered for support of the proposed building. This type of system would provide stabilization of the upper lower strength soils at the site and provide a significantly higher allowable bearing pressure for foundations. The Rammed Aggregate Pier system provides an *in situ* soil stabilization that would allow conventional footings to then be constructed.

Based on the site conditions, it is anticipated that shallow foundations constructed above a site stabilized with GeoPiers®, could be designed using a maximum allowable bearing pressure of 6,000 psf. It is estimated that total settlements would be less than 1 inch, with differential settlement on the order of ½ inch.

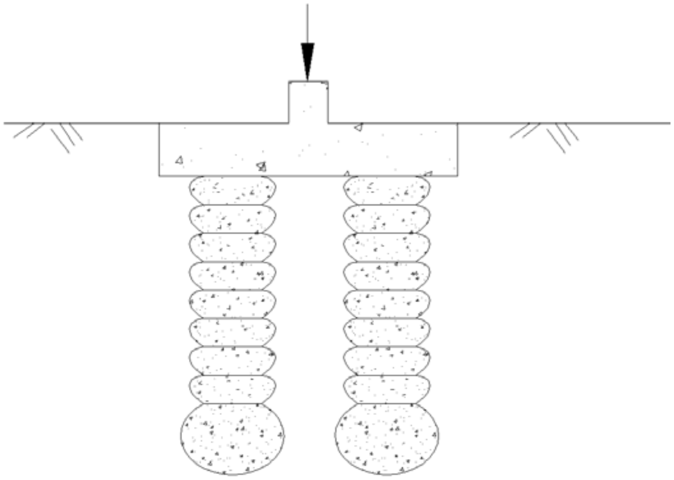


Figure: Example of conventional footing supported on GeoPiers®

RAP® Systems can also provide economical solutions for the support of conventional light to heavily loaded floor slabs, therefore eliminating the need for a structural slab. This foundation system also provides an alternative to costly deep foundations such as drilled piers.

Due to the proximity of the accelerator ring and the existing building to the proposed building footprint, construction disturbance and vibration will need to be considered when selecting a foundation system. Technical Bulletin No. 9 by the GeoPier® Foundation Co. Inc. on Vibration and Noise Levels is provided in Appendix D for consideration of this foundation alternative.

Additional design information for this foundation alternative can be provided upon request if this alternative is considered for the project.

Deep Foundations

Deep foundations can also be used to support the proposed building. Given the subsurface conditions, drilled piers (caissons) extending to the very stiff silty clay are recommended.

We estimate that caissons will need to extend to depths of approximately 40 to 45 feet below existing ground surface to provide adequate capacity with a factor of safety of 3 against bearing failure.

Drilled piers should extend through the compressible soils and into the underlying clay till materials. Straight shaft drilled piers with a minimum 12-inch diameter, extending to the very stiff clay at depths of 40 to 45 feet could be designed using an allowable bearing pressure of 9 ksf. Grade beams along the perimeter of the building should be constructed to extend below frost depth (approximately 3.5 feet below final grade).

Caissons designed and installed according to the above recommendations are anticipated to incur settlements less than 0.5 inches. Problems associated with downdrag forces on the caissons are not anticipated, as no appreciable fill will be placed for project construction.

Pavement Design and Construction

For light duty pavements, such as those in parking and drive areas limited to passenger vehicle use, we recommend a minimum pavement section consisting of a 1.5-inch bituminous surface course and a 2-inch bituminous binder on an 8-inch aggregate base. For heavy duty pavements, such as those in areas frequented by delivery trucks, we recommend a 2-inch bituminous surface course and a 3-inch bituminous binder course on a 10-inch aggregate base, or 8 inches of Portland cement concrete on a 4-inch granular subbase. Actual thickness and pavement type will depend on actual design loads, frequency of loads and turning conditions.

Aggregate base and granular subbase material should be similar in gradation to the 1.5 crushed aggregate listed in Table 1.

Subsurface drainage of the pavement section is important for pavement performance. To reduce the potential for subgrade failure and pavement cracking, low points in the pavement include subsurface drains discharging to the stormwater management system.

Construction Considerations

Excavations should follow Occupational Safety and Health Administration (OSHA) guidelines. Excavated soil and heavy construction equipment should not be permitted closer to the top of excavation than a distance equal to two times the depth of the excavation in order to reduce the possibilities of slope failure.

Temporary excavations should have a maximum slope of 1 horizontal to 1 vertical or flatter as required to provide stable side slopes. Excavations should be completed in accordance with OSHA Regulation 1926 Subpart P, Appendix B on “Sloping and Benching.” The bottom of excavations should extend a minimum of 1 foot beyond the plan dimension of the footings to allow for adequate working space.

The existing ground surface should be sloped or ditches should be provided to prevent precipitation and runoff from entering the foundation excavations during construction. Minor dewatering may be required, and it is our opinion that water from seepage and/or precipitation can be controlled during construction using conventional sumps and pumps.

Construction will likely be accomplished using standard construction equipment. Subgrade exposed to adverse weather and/or construction traffic is likely to soften, requiring improvement before construction of foundations and pavement sections. Site soils may pump and rut under heavy equipment traffic.

Construction Quality Control and Quality Assurance

Patrick recommends a geotechnical engineering firm be retained to assist with quality assurance and quality control (QA/QC) activities. A general review of final design plans and specifications should be completed by the geotechnical consultant to ensure that the intent of the recommendations contained in this report is incorporated as intended. QA/QC services should include subgrade and construction materials inspection, fill placement monitoring and compaction testing, as well as concrete and pavement subgrade inspection, and observation of proofrolling. Since construction materials testing and observation services will be an important part of the facility improvements, an experienced geotechnical engineer should be present to provide these services and/or monitor the construction activities.

LIMITATIONS

The recommendations contained in this report are based on the soils encountered at the boring locations. Should conditions encountered during excavation and construction operations differ from those encountered in the borings, Patrick should be notified so that the recommendations can be reviewed and revised if necessary.

This investigation was performed in accordance with accepted geotechnical engineering practices for determining soil conditions and preparing recommendations for the referenced site improvements only. Verification of the subsurface conditions for purposes of determining the extent of contaminated soils or groundwater, difficulty of excavation, dewatering, and trafficability is beyond the scope of this investigation. In the event that any changes in the nature, design or location of the proposed construction are made, the conclusions and recommendations contained in this report should not be considered valid until the changes are reviewed and the conclusions and recommendations in this report have been modified or verified in writing.

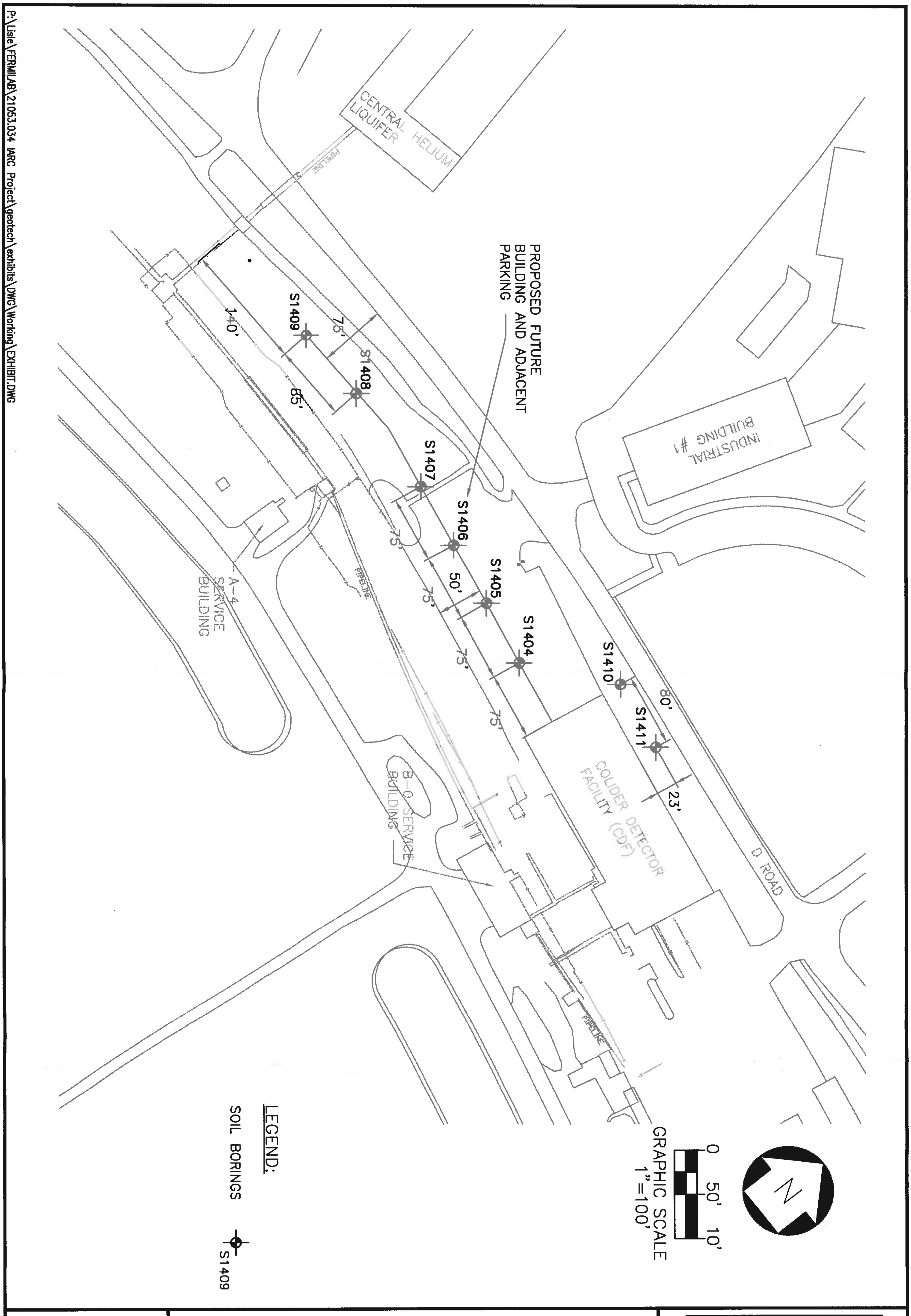
This report is for the exclusive use of the Client and no one else without written consent from Patrick Engineering Inc.

Report Prepared by: Dawn Edgell Dawn Edgell, P.E. Project Engineer	Report Reviewed by: Gary F. Goodheart, P.E. Senior Program Director

p:\lisle\fermilab\21053.034 iarc project\geotech\report\final\report.doc

APPENDIX A

BORING LOCATION PLAN



Date: 06-18-2010	FERMILAB IARC: OTE BUILDING	**PATRICK ENGINEERING INC.**
Proj No.: 21053.034	**SOIL BORING LOCATION PLAN**	4970 Varsity Drive TEL (630) 795-7200 Lisle, Illinois 60532-4101 FAX (630) 724-1681 PROFESSIONAL DESIGN FIRM LICENSE NO. 184-000409
App. By: DE		

APPENDIX B

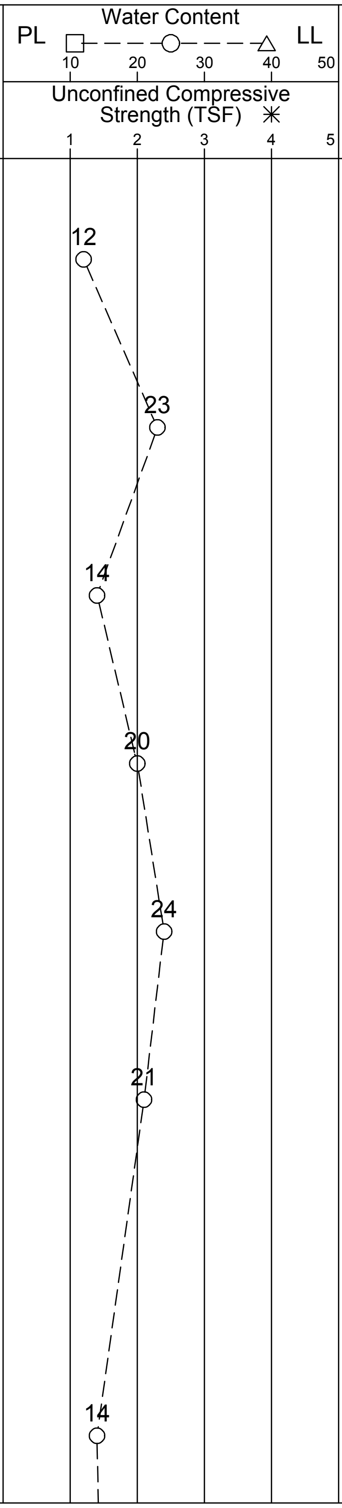
BORING LOGS
SOIL DESCRIPTION TERMINOLOGY

PATRICK ENGINEERING INC.

BORING NUMBER **S1404** SHEET **1** OF **2**
CLIENT **Fermi National Accelerator Laboratory**
PROJECT & NO. **IARC Building 21053.034**
LOCATION **Batavia, IL N41°50'26.6"; W88°15'03.3"**

LOGGED BY **SEK**
GROUND ELEVATION **745.5**

ELEV.	DEPTH (FT)	STRATA	SOIL/ROCK DESCRIPTION	SAMPLE TYPE & NO. DEPTH (FT) RECOVERY(IN)	BLOW COUNTS	Water Content PL □ — ○ — △ LL / Unconfined Compressive Strength (TSF) ✳	NOTES & TEST RESULTS
745.5	0.0		4.5" asphalt				
745.1	0.4		Crushed limestone base course				
				SS-1 1.0-2.5 12"R	11 8 5	12	qu=1.75*tsf
743.3	2.3		Dark gray silty clay, trace roots, medium stiff, moist CL				
				SS-2 3.5-5.0 16"R	6 4 5	23	qu=2.0*tsf
741.5	4.0		Brown and dark gray silty clay, trace roots, stiff, moist CL				
740.0	5.5		Grades to gray/brown clayey fine sandy silt, soft to very soft, moist SM/ML				
				SS-3 6.0-7.5 16"R	6 5 2	14	qu=0.5*tsf % Sand=33.7 % Silt=55.6 % Clay=10.7
				SS-4 8.5-10.0 8"R	4 5 3	20	qu=0.25*tsf
735.0	10.5		Gray to dark gray silty/clayey silt, very soft to medium stiff, moist to wet CL-ML				
				ST-1 11.0-13.0		24	Dry density=114pcf
				SS-5 13.5-15.0 18"R	1 4 4	21	qu=0.25*tsf qu=1.25*tsf
728.5	17.0		Brown/gray silty clay, little fine to coarse sand, stiff, moist CL				
				SS-6 18.5-20.0 14"R	11 12 15	14	qu=3.0*tsf



DRILLING CONTRACTOR **Groff Testing Corp.**
DRILLING METHOD **4.25" I.D. HSA**
DRILLING EQUIPMENT **CME 75**
DRILLING STARTED **6/11/10** ENDED **6/11/10**

REMARKS
Borehole filled with cuttings upon completion.

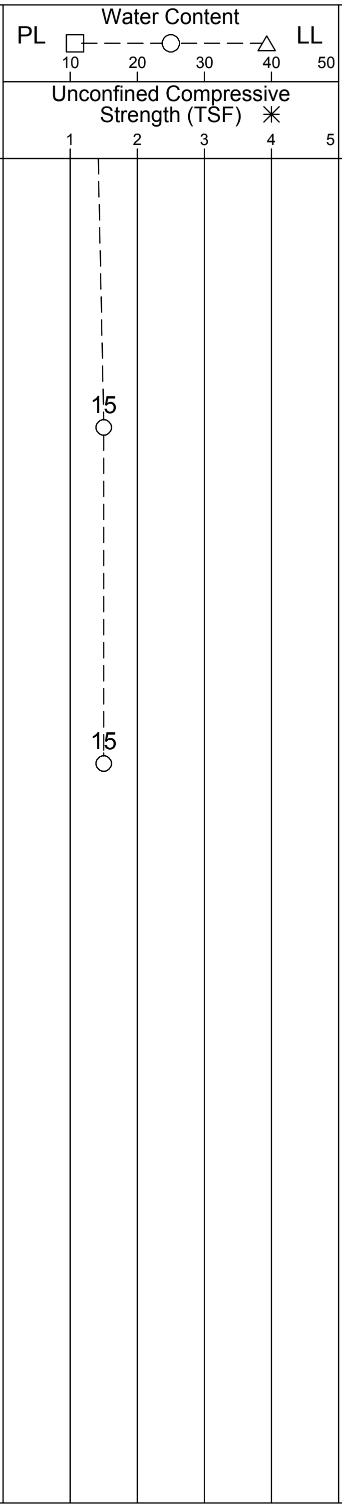
WATER LEVEL (ft.)
▽ **8.5'** while drilling
▼ **23.0'** after drilling
▼

PATRICK ENGINEERING INC.

BORING NUMBER **S1404** SHEET **2** OF **2**
CLIENT **Fermi National Accelerator Laboratory**
PROJECT & NO. **IARC Building 21053.034**
LOCATION **Batavia, IL N41°50'26.6"; W88°15'03.3"**

LOGGED BY **SEK**
GROUND ELEVATION **745.5**

ELEV.	DEPTH (FT)	STRATA	SOIL/ROCK DESCRIPTION	SAMPLE TYPE & NO. DEPTH (FT) RECOVERY(IN)	BLOW COUNTS	PL □ Water Content ○ LL △ (10 20 30 40 50) Unconfined Compressive Strength (TSF) ✳ (1 2 3 4 5)	NOTES & TEST RESULTS
725.5	20.0	▨	Gray silty clay, trace fine to coarse sand, very stiff, moist CL				
		▨		SS-7 23.5-25.0 12"R	7 5 7	15	qu=3.5*tsf
		▨		SS-8 28.5-30.0 14"R	8 8 11	15	qu>4.5*tsf
715.5	30.0		End of Boring at 30.0'				



DRILLING CONTRACTOR **Groff Testing Corp.**
DRILLING METHOD **4.25" I.D. HSA**
DRILLING EQUIPMENT **CME 75**
DRILLING STARTED **6/11/10** ENDED **6/11/10**

REMARKS
Borehole filled with cuttings upon completion.

WATER LEVEL (ft.)
▽ **8.5'** while drilling
▼ **23.0'** after drilling
▼

PATRICK ENGINEERING INC.

BORING NUMBER **S1405** SHEET **1** OF **4**
CLIENT **Fermi National Accelerator Laboratory**
PROJECT & NO. **IARC Building 21053.034**
LOCATION **Batavia, IL N41°50'27.0"; W88°15'04.4"**

LOGGED BY **SEK**
GROUND ELEVATION **745.5**

ELEV.	DEPTH (FT)	STRATA	SOIL/ROCK DESCRIPTION	SAMPLE TYPE & NO. DEPTH (FT) RECOVERY(IN)	BLOW COUNTS	PL □ Water Content ○ LL △ (10 20 30 40 50) Unconfined Compressive Strength (TSF) ✳ (1 2 3 4 5)	NOTES & TEST RESULTS
745.5	0.0		3.5" asphalt				
745.2	0.3		Crushed limestone base course				
				SS-1 1.0-2.5 12"R	5 3 4	12	qu=1.25*tsf
743.5	2.0		Light brown/gray silty clay, some sand and gravel, trace fine sand, medium stiff, low plasticity, moist CL				
				SS-2 3.5-5.0 16"R	5 3 5	21	qu=1.5*tsf
			Little fine sand, soft	SS-3 6.0-7.5 16"R	2 2 3	16	qu=0.5*tsf
737.5	8.0		Dark gray silty clay, trace organics, very soft, moist to wet CL-ML				
				SS-4 8.5-10.0 18"R	3 3 3	21	qu=0.25*tsf LOI=2%
				SS-5 11.0-12.5 18"R	2 1 1	21	qu=0.0*tsf LL=21 PI=8
732.5	13.0		Gray clayey silt, trace fine to coarse sand, medium stiff, moist ML				
				SS-6 13.5-15.0 14"R	3 5 4	16	qu=1.0*tsf % Silt=61.1 % Clay=10.1 % Sand=23.1 % Gravel=5.6
728.5	17.0		Gray silty clay, some sandy gravel, dense, moist CL				
				SS-7 18.5-20.0 4"R	12 13 10	14	

DRILLING CONTRACTOR **Groff Testing Corp.**
DRILLING METHOD **3.25" I.D. HSA**
DRILLING EQUIPMENT **CME 75**
DRILLING STARTED **6/14/10** ENDED **6/14/10**

REMARKS
Borehole filled with cuttings upon completion.

WATER LEVEL (ft.)
▽ **9.0'** while drilling
▼ **55.0'** after drilling
▼

PATRICK ENGINEERING INC.	BORING NUMBER	**S1405**	SHEET **2** OF **4**
	CLIENT	**Fermi National Accelerator Laboratory**	
	PROJECT & NO.	**IARC Building 21053.034**	
	LOCATION	**Batavia, IL N41°50'27.0"; W88°15'04.4"**	

LOGGED BY **SEK**
GROUND ELEVATION **745.5**

ELEV.	DEPTH (FT)	STRATA	SOIL/ROCK DESCRIPTION	SAMPLE TYPE & NO. DEPTH (FT) RECOVERY(IN)	BLOW COUNTS	PL ☐ Water Content ○ LL △ (10 20 30 40 50) / Unconfined Compressive Strength (TSF) ✳ (1 2 3 4 5)	NOTES & TEST RESULTS
725.5	20.0	▨					
		▨	Gray silty clay, little fine to coarse sand, trace gravel, very stiff, moist	SS-8 23.5-25.0 18"R	5 6 9	15	qu=3.5*tsf
		▨	Trace fine to medium sand	SS-9 28.5-30.0 16"R	5 7 9	16	qu=4.25*tsf
		▨		SS-10 33.5-35.0 18"R	6 7 9	18	qu=3.5*tsf
		▨	Medium stiff, wet	SS-11 38.5-40.0 18"R	3 4 7	11	qu=1.5*tsf

DRILLING CONTRACTOR **Groff Testing Corp.**
DRILLING METHOD **3.25" I.D. HSA**
DRILLING EQUIPMENT **CME 75**
DRILLING STARTED **6/14/10** ENDED **6/14/10**

REMARKS
Borehole filled with cuttings upon completion.

WATER LEVEL (ft.)
▽ **9.0'** while drilling
▼ **55.0'** after drilling
▼

PATRICK ENGINEERING INC.

BORING NUMBER **S1405** SHEET **3** OF **4**
CLIENT **Fermi National Accelerator Laboratory**
PROJECT & NO. **IARC Building 21053.034**
LOCATION **Batavia, IL N41°50'27.0"; W88°15'04.4"**

LOGGED BY **SEK**
GROUND ELEVATION **745.5**

ELEV.	DEPTH (FT)	STRATA	SOIL/ROCK DESCRIPTION	SAMPLE TYPE & NO. DEPTH (FT) RECOVERY(IN)	BLOW COUNTS	PL □ Water Content ○ LL △ 10 20 30 40 50 / Unconfined Compressive Strength (TSF) ✳ 1 2 3 4 5	NOTES & TEST RESULTS
705.5	40.0	▨					
			Brown/gray silty clay, trace fine sand, hard, moist	SS-12 43.5-45.0 12"R	5 10 15	19	qu>4.5*tsf
			Very stiff	SS-13 48.5-50.0 18"R	4 11 11	21	qu=3.0*tsf
				SS-14 53.5-55.0 18"R	3 6 9	21	qu=2.5*tsf
686.0	59.5			SS-15 58.5-60.0 18"R	5 13 12	8	

DRILLING CONTRACTOR **Groff Testing Corp.**
DRILLING METHOD **3.25" I.D. HSA**
DRILLING EQUIPMENT **CME 75**
DRILLING STARTED **6/14/10** ENDED **6/14/10**

REMARKS
Borehole filled with cuttings upon completion.

WATER LEVEL (ft.)
∇ **9.0'** while drilling
▼ **55.0'** after drilling
▼

PATRICK ENGINEERING INC.	
BORING NUMBER	**S1405** SHEET **4** OF **4**
CLIENT	**Fermi National Accelerator Laboratory**
PROJECT & NO.	**IARC Building 21053.034**
LOCATION	**Batavia, IL N41°50'27.0"; W88°15'04.4"**
LOGGED BY	**SEK**
GROUND ELEVATION	**745.5**

ELEV.	DEPTH (FT)	STRATA	SOIL/ROCK DESCRIPTION	SAMPLE TYPE & NO. DEPTH (FT) RECOVERY(IN)	BLOW COUNTS	PL □- - -○- - -△ LL Water Content 10 20 30 40 50 Unconfined Compressive Strength (TSF) ✳ 1 2 3 4 5	NOTES & TEST RESULTS
685.5	60.0		Fine to coarse sand and gravel, some silt and clay, dry SP-GP Weathered rock pieces	SS-16 63.5-65.0 12"R	20 21 7	9	
681.2	64.3		Brown/gray silty clay, little fine to coarse sand, soft, moist CL Silty fine sand seam at 69.0'	SS-17 68.5-70.0 14"R	12 12 50/1"	8	qu=3.5*tsf
676.0	69.5		Gray silty clay and weathered rock, hard, very dense, moist				
675.1	70.4		Auger refusal at 70.4' on apparent bedrock. End of Boring at 70.4'				

DRILLING CONTRACTOR **Groff Testing Corp.**
DRILLING METHOD **3.25" I.D. HSA**
DRILLING EQUIPMENT **CME 75**
DRILLING STARTED **6/14/10** ENDED **6/14/10**

REMARKS
Borehole filled with cuttings upon completion.

WATER LEVEL (ft.)
▽ **9.0'** while drilling
▼ **55.0'** after drilling
▼

PATRICK ENGINEERING INC.

BORING NUMBER **S1406** SHEET **1** OF **4**
CLIENT **Fermi National Accelerator Laboratory**
PROJECT & NO. **IARC Building 21053.034**
LOCATION **Batavia, IL N41°50'27.0"; W88°15'5.5"**

LOGGED BY **SEK**
GROUND ELEVATION **745.5**

ELEV.	DEPTH (FT)	SOIL/ROCK DESCRIPTION	SAMPLE TYPE & NO. DEPTH (FT) RECOVERY(IN)	BLOW COUNTS	Water Content PL □ ○ △ LL (10 20 30 40 50) / Unconfined Compressive Strength (TSF) ✳ (1 2 3 4 5)	NOTES & TEST RESULTS
745.5 745.2	0.0 0.3	4" asphalt				
		Crushed limestone base course	SS-1 1.0-2.5 10"R	9 6 8	7	
743.8	1.8	Brown clayey sand and gravel, medium dense, dry SC				
			SS-2 3.5-5.0 10"R	5 3 2	4	
		Moist				
740.0	5.5	Brown silty clay, soft, moist to wet CL	SS-3 6.0-7.5 10"R	4 2 2	22	qu=0.5*tsf
737.5	8.0	Gray/dark gray clayey silt, trace organics, very soft, wet CL-ML	SS-4 8.5-10.0 14"R	3 2 2	20	qu=0.0*tsf
			ST-1 10.0-12.0 22"R		22	qu=0.24tsf Dry density=112pcf
732.5	13.0	Gray silty clay, seams of fine sandy silt, soft, moist CL	SS-5 13.5-15.0 14"R	2 2 3	19	qu=1.0*tsf
		Gray silty clay, little fine to medium sand, medium stiff, moist	SS-6 18.5-20.0 6"R	7 6 8	16	qu=1.75*tsf

DRILLING CONTRACTOR **Groff Testing Corp.**
DRILLING METHOD **3.25" I.D. HSA**
DRILLING EQUIPMENT **CME 75**
DRILLING STARTED **6/14/10** ENDED **6/14/10**

REMARKS
Borehole filled with cuttings upon completion.

WATER LEVEL (ft.)
▽ **9.0'** while drilling
▼ **64.0'** after drilling
▼

PATRICK ENGINEERING INC.

BORING NUMBER **S1406** SHEET **2** OF **4**
CLIENT **Fermi National Accelerator Laboratory**
PROJECT & NO. **IARC Building 21053.034**
LOCATION **Batavia, IL N41°50'27.0"; W88°15'5.5"**

LOGGED BY **SEK**
GROUND ELEVATION **745.5**

ELEV.	DEPTH (FT)	STRATA	SOIL/ROCK DESCRIPTION	SAMPLE TYPE & NO. DEPTH (FT) RECOVERY(IN)	BLOW COUNTS	Water Content PL □ ○ △ LL (10 20 30 40 50) / Unconfined Compressive Strength (TSF) ✳ (1 2 3 4 5)	NOTES & TEST RESULTS
725.5	20.0	▨					
		▨	Gray silty clay, little fine to coarse sand and gravel, hard, moist	SS-7 23.5-25.0 18"R	4 6 10	15	qu>4.5*tsf
		▨		SS-8 28.5-30.0 16"R	5 8 16	14	qu=4.0*tsf
713.5	32.0	░	Gray sandy silt, fine to medium sand and gravel, very stiff, medium dense, dry SM-ML				
		░		SS-9 33.5-35.0 18"R	4 6 12	12	qu=3.5*tsf
708.5	37.0	▨	Brown gray silty clay, little fine to coarse sand and gravel, medium stiff to very stiff, moist CL				
		▨		SS-10 38.5-40.0 18"R	3 3 6	12	qu=2.5*tsf

DRILLING CONTRACTOR **Groff Testing Corp.**
DRILLING METHOD **3.25" I.D. HSA**
DRILLING EQUIPMENT **CME 75**
DRILLING STARTED **6/14/10** ENDED **6/14/10**

REMARKS
Borehole filled with cuttings upon completion.

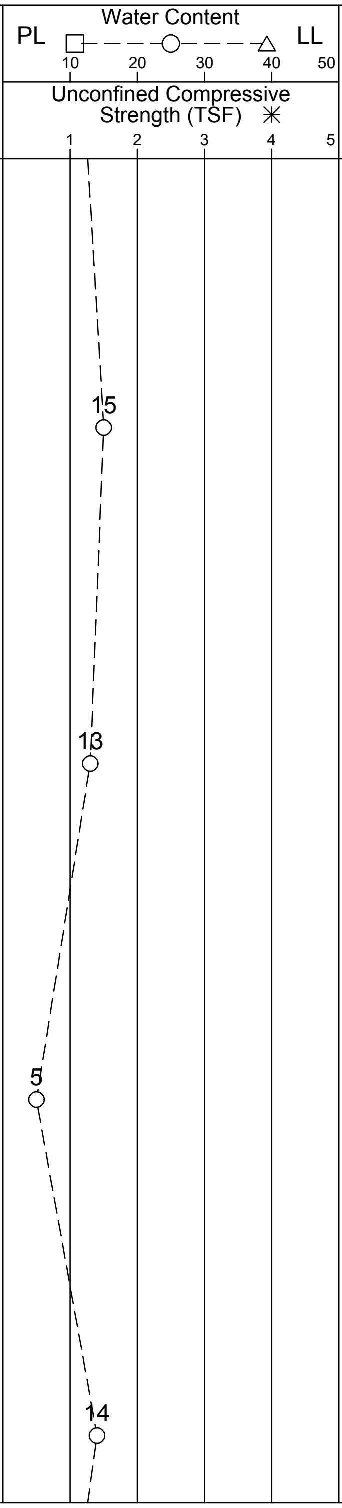
WATER LEVEL (ft.)
▽ **9.0'** while drilling
▼ **64.0'** after drilling
▼

PATRICK ENGINEERING INC.

BORING NUMBER **S1406** SHEET **3** OF **4**
CLIENT **Fermi National Accelerator Laboratory**
PROJECT & NO. **IARC Building 21053.034**
LOCATION **Batavia, IL N41°50'27.0"; W88°15'5.5"**

LOGGED BY **SEK**
GROUND ELEVATION **745.5**

ELEV.	DEPTH (FT)	STRATA	SOIL/ROCK DESCRIPTION	SAMPLE TYPE & NO. DEPTH (FT) RECOVERY(IN)	BLOW COUNTS	NOTES & TEST RESULTS
705.5	40.0	▨	Gray silty clay, little fine to medium sand and gravel, very stiff, dry			
		▨		SS-11 43.5-45.0 18"R	4 7 12	qu=3.5*tsf
		▨		SS-12 48.5-50.0 18"R	4 6 12	qu=4.0*tsf
691.5	54.0	░	Brown/gray fine silty sand, little coarse sand, medium dense, moist SM	SS-13 53.5-55.0 16"R	6 10 11	
688.5	57.0	▨	Brown/gray silty clay, with weathered bedrock fragments CL			
		▨		SS-14 58.5-60.0 16"R	6 27 48	
685.5	60.0					



DRILLING CONTRACTOR **Groff Testing Corp.**
DRILLING METHOD **3.25" I.D. HSA**
DRILLING EQUIPMENT **CME 75**
DRILLING STARTED **6/14/10** ENDED **6/14/10**

REMARKS
Borehole filled with cuttings upon completion.

WATER LEVEL (ft.)
▽ **9.0'** while drilling
▼ **64.0'** after drilling
▼

PATRICK ENGINEERING INC.

BORING NUMBER **S1406** SHEET **4** OF **4**
CLIENT **Fermi National Accelerator Laboratory**
PROJECT & NO. **IARC Building 21053.034**
LOCATION **Batavia, IL N41°50'27.0"; W88°15'5.5"**

LOGGED BY **SEK**
GROUND ELEVATION **745.5**

ELEV.	DEPTH (FT)	STRATA	SOIL/ROCK DESCRIPTION	SAMPLE TYPE & NO. DEPTH (FT) RECOVERY(IN)	BLOW COUNTS	PL □ Water Content ○ LL △ (10 20 30 40 50) / Unconfined Compressive Strength (TSF) ✳ (1 2 3 4 5)	NOTES & TEST RESULTS
685.5	60.0		Light gray silt, with trace fine to coarse sand, stiff, dense, moist ML (weathered bedrock fragments)				
				SS-15 63.5-65.0 4"R	31 50/5"	7	qu=1.5*tsf
			Gray clayey silt, with trace fine to coarse sand and gravel, soft, moist	SS-16 68.5-70.0 12"R	6 50/5"	10	
675.5	70.0						
			Auger refusal on apparent bedrock at 70.0' End of Boring at 70.0'				

DRILLING CONTRACTOR **Groff Testing Corp.**
DRILLING METHOD **3.25" I.D. HSA**
DRILLING EQUIPMENT **CME 75**
DRILLING STARTED **6/14/10** ENDED **6/14/10**

REMARKS
Borehole filled with cuttings upon completion.

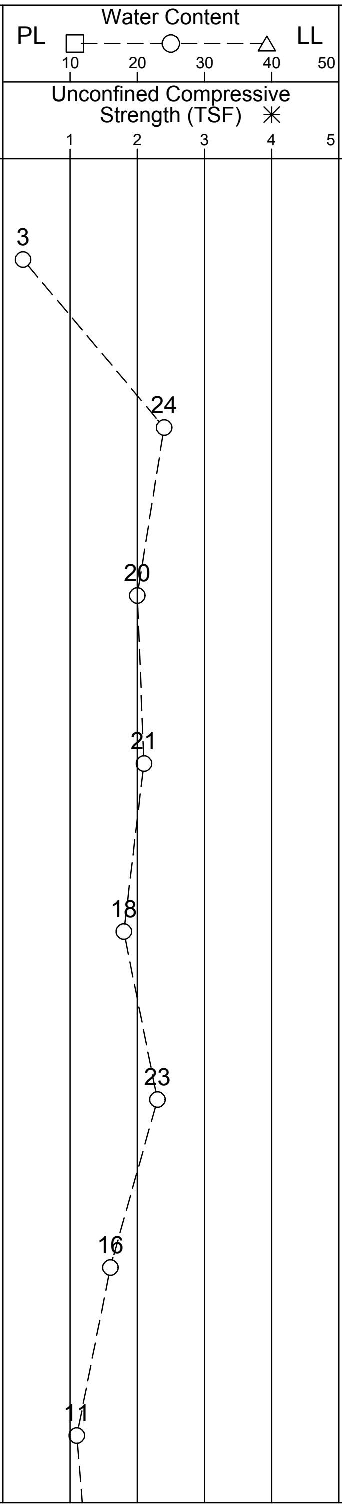
WATER LEVEL (ft.)
▽ **9.0'** while drilling
▼ **64.0'** after drilling
▼

PATRICK ENGINEERING INC.

BORING NUMBER **S1407** SHEET **1** OF **2**
CLIENT **Fermi National Accelerator Laboratory**
PROJECT & NO. **IARC Building 21053.034**
LOCATION **Batavia, IL N41°50'26.9"; W88°15'06.3"**

LOGGED BY **SEK**
GROUND ELEVATION **745.5**

ELEV.	DEPTH (FT)	STRATA	SOIL/ROCK DESCRIPTION	SAMPLE TYPE & NO. DEPTH (FT) RECOVERY(IN)	BLOW COUNTS	Water Content	NOTES & TEST RESULTS
745.5 745.1	0.0 0.4		4.5" asphalt				
			Crushed limestone base course	SS-1 1.0-2.5 6"R	7 8 7	3	
743.5	2.0		Gray silty clay, little sand, medium stiff, moist CL	SS-2 3.5-5.0 8"R	5 5 6	24	
740.0	5.5		Light brown silty clay, trace fine sand, very soft, low plasticity, saturated CL	SS-3 6.0-7.5 14"R	8 6 6	20	qu=0.0*tsf
			Medium stiff	SS-4 8.5-10.0 18"R	2 2 2	21	qu=1.5*tsf
736.5	9.0		Gray/black silt and clay, some organics, very soft, wet CL-ML	SS-5 11.0-12.5 18"R	0 0 1	18	qu=0.25*tsf
732.5	13.0		Brown/gray silty clay, little fine sand, very stiff, low plasticity, moist	ST-1 13.5-15.5 14"R		23	qu=0.58tsf Dry density=111pcf
				SS-6 16.0-17.5 18"R	4 5 6	16	qu=3.0*tsf LL=25 PI=11
				SS-7 18.5-20.0 16"R	5 6 6	11	qu>4.5*tsf



DRILLING CONTRACTOR **Groff Testing Corp.**
DRILLING METHOD **3.25" I.D. HSA**
DRILLING EQUIPMENT **CME 75**
DRILLING STARTED **6/11/10** ENDED **6/11/10**

REMARKS
Borehole filled with cuttings upon completion.

WATER LEVEL (ft.)
∇ **6.0'** while drilling
▼
▼

PATRICK ENGINEERING INC.

BORING NUMBER **S1407** SHEET **2** OF **2**
CLIENT **Fermi National Accelerator Laboratory**
PROJECT & NO. **IARC Building 21053.034**
LOCATION **Batavia, IL N41°50'26.9"; W88°15'06.3"**

LOGGED BY **SEK**
GROUND ELEVATION **745.5**

ELEV.	DEPTH (FT)	STRATA	SOIL/ROCK DESCRIPTION	SAMPLE TYPE & NO. DEPTH (FT) RECOVERY(IN)	BLOW COUNTS	Water Content PL □ ○ △ LL 10 20 30 40 50 Unconfined Compressive Strength (TSF) ✳ 1 2 3 4 5	NOTES & TEST RESULTS
725.5	20.0	▨	Brown/gray silty clay, little fine sand, very stiff, low plasticity, moist				
		▨		SS-8 23.5-25.0 18"R	2 5 7	15 ○	qu=2.5*tsf
		▨		SS-9 28.5-30.0 18"R	6 6 7		qu=3.0*tsf
715.5	30.0		End of Boring at 30.0'				

DRILLING CONTRACTOR **Groff Testing Corp.**
DRILLING METHOD **3.25" I.D. HSA**
DRILLING EQUIPMENT **CME 75**
DRILLING STARTED **6/11/10** ENDED **6/11/10**

REMARKS
Borehole filled with cuttings upon completion.

WATER LEVEL (ft.)
▽ **6.0'** while drilling
▼
▼

PATRICK ENGINEERING INC.

BORING NUMBER **S1408** SHEET **1** OF **1**
CLIENT **Fermi National Accelerator Laboratory**
PROJECT & NO. **IARC Building 21053.034**
LOCATION **Batavia, IL N41°50'27.0"; W88°15'07.4"**

LOGGED BY **SEK**
GROUND ELEVATION **745.0**

ELEV.	DEPTH (FT)	STRATA	SOIL/ROCK DESCRIPTION	SAMPLE TYPE & NO. DEPTH (FT) RECOVERY(IN)	BLOW COUNTS	Water Content PL □ ○ △ LL 10 20 30 40 50 Unconfined Compressive Strength (TSF) ✳ 1 2 3 4 5	NOTES & TEST RESULTS
745.0	0.0	■	4" asphalt				
744.7	0.3	●	Crushed limestone base course	SS-1 1.0-2.5 6"R	7 4 6		
743.0	2.0	●	3/4-inch limestone pieces	SS-2 3.5-5.0 0"R	7 5 6		
739.5	5.5	▨	Light brown/gray fine silty clay, some sand, soft, moist to wet CL	SS-3 6.0-7.5 12"R	4 5 6	15	qu=0.5*tsf
		▨		SS-4 8.5-10.0 16"R	4 3 3	21	qu=0.5*tsf
735.5	9.5	░	Brown fine silty sand, loose, wet SM				
735.0	10.0		End of Boring at 10.0'				

DRILLING CONTRACTOR **Groff Testing Corp.**
DRILLING METHOD **3.25" I.D. HSA**
DRILLING EQUIPMENT **CME 75**
DRILLING STARTED **6/11/10** ENDED **6/11/10**

REMARKS
Borehole filled with cuttings upon completion.

WATER LEVEL (ft.)
▽ **9.5'** while drilling
▼
▼

PATRICK ENGINEERING INC.

BORING NUMBER **S1409** SHEET **1** OF **1**
CLIENT **Fermi National Accelerator Laboratory**
PROJECT & NO. **IARC Building 21053.034**
LOCATION **Batavia, IL N41°50'27.1"; W88°15'09.0"**

LOGGED BY **SEK**
GROUND ELEVATION **745.0**

ELEV.	DEPTH (FT)	STRATA	SOIL/ROCK DESCRIPTION	SAMPLE TYPE & NO. DEPTH (FT) RECOVERY(IN)	BLOW COUNTS	Water Content PL ☐ ○ △ LL (10 20 30 40 50) Unconfined Compressive Strength (TSF) ✳ (1 2 3 4 5)	NOTES & TEST RESULTS
745.0	0.0	⊠	Topsoil Brown silty clay and sand/gravel				
744.0	1.0	▨	Gray/black silty clay, stiff, low plasticity, moist CL	SS-1 1.0-2.5 10"R	6 4 5	15	qu=2.5*tsf
742.0	3.0	▨	Gray/brown mottled silty clay, medium stiff, low plasticity, moist CL	SS-2 3.5-5.0 16"R	6 5 5	20	qu=1.0*tsf
			Seams of fine sand and silt	SS-3 6.0-7.5 18"R	4 2 3	21	qu=1.0*tsf
				SS-4 8.5-10.0 18"R	4 3 2	23	qu=1.0*tsf
735.5	9.5	▨	Dark gray silty clay, low plasticity, soft, wet CL				
735.0	10.0		End of Boring at 10.0'				

DRILLING CONTRACTOR **Groff Testing Corp.**
DRILLING METHOD **3.25" I.D. HSA**
DRILLING EQUIPMENT **CME 75**
DRILLING STARTED **6/11/10** ENDED **6/11/10**

REMARKS
Borehole filled with cuttings upon completion.

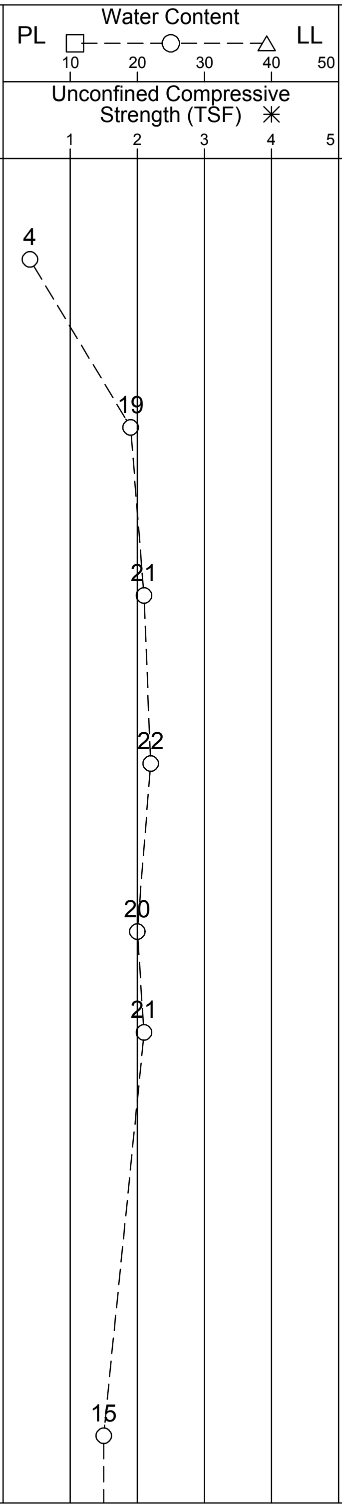
WATER LEVEL (ft.)
▽ **9.5'** while drilling
▼
▼

PATRICK ENGINEERING INC.

BORING NUMBER **S1410** SHEET **1** OF **2**
CLIENT **Fermi National Accelerator Laboratory**
PROJECT & NO. **IARC Building 21053.034**
LOCATION **Batavia, IL N41°50'27.4"; W88°15'02.2"**

LOGGED BY **SEK**
GROUND ELEVATION **746.5**

ELEV.	DEPTH (FT)	SOIL/ROCK DESCRIPTION	SAMPLE TYPE & NO. DEPTH (FT) RECOVERY(IN)	BLOW COUNTS	NOTES & TEST RESULTS
746.5	0.0	3" asphalt			
746.3	0.3	Crushed limestone base course	SS-1 1.0-2.5 8"R	7 8 5	
745.0	1.5	Sand and gravel fill			
743.5	3.0	Light brown/gray silty clay, little fine to medium sand, soft, moist CL	SS-2 3.5-5.0 0"R	3 2 4	
			SS-3 6.0-7.5 12"R	2 2 3	qu=0.25*tsf
738.5	8.0	Gray clayey silt, very soft, low plasticity, wet ML	SS-4 8.5-10.0 18"R	2 2 2	LL=20 PI=4
			SS-5 11.0-12.5 18"R	1 1 1	
			ST-1 12.5-14.5 26"R		qu=0.59tsf Dry density=115pcf
733.0	13.5	Gray silty clay, trace fine to coarse sand, very stiff, moist CL	SS-6 18.5-20.0 18"R	6 6 7	qu=4.0*tsf



DRILLING CONTRACTOR **Groff Testing Corp.**
DRILLING METHOD **3.25" I.D. HSA**
DRILLING EQUIPMENT **CME 75**
DRILLING STARTED **6/11/10** ENDED **6/11/10**

REMARKS
Borehole filled with cuttings upon completion.

WATER LEVEL (ft.)
∇ **9.0'** while drilling
▼
▼

PATRICK ENGINEERING INC.

BORING NUMBER **S1410** SHEET **2** OF **2**
CLIENT **Fermi National Accelerator Laboratory**
PROJECT & NO. **IARC Building 21053.034**
LOCATION **Batavia, IL N41°50'27.4"; W88°15'02.2"**

LOGGED BY **SEK**
GROUND ELEVATION **746.5**

ELEV.	DEPTH (FT)	STRATA	SOIL/ROCK DESCRIPTION	SAMPLE TYPE & NO. DEPTH (FT) RECOVERY(IN)	BLOW COUNTS	PL □ Water Content ○ LL △ (10 20 30 40 50) Unconfined Compressive Strength (TSF) ✳ (1 2 3 4 5)	NOTES & TEST RESULTS
726.5	20.0	▨					
		▨	Gray silty clay, trace fine to coarse sand, hard, low plasticity, moist	SS-7 23.5-25.0 18"R	5 7 9	15	qu>4.5*tsf
		▨		SS-8 28.5-30.0 3"R	9 9 12	14	
716.5	30.0		End of Boring at 30.0'				

DRILLING CONTRACTOR **Groff Testing Corp.**
DRILLING METHOD **3.25" I.D. HSA**
DRILLING EQUIPMENT **CME 75**
DRILLING STARTED **6/11/10** ENDED **6/11/10**

REMARKS
Borehole filled with cuttings upon completion.

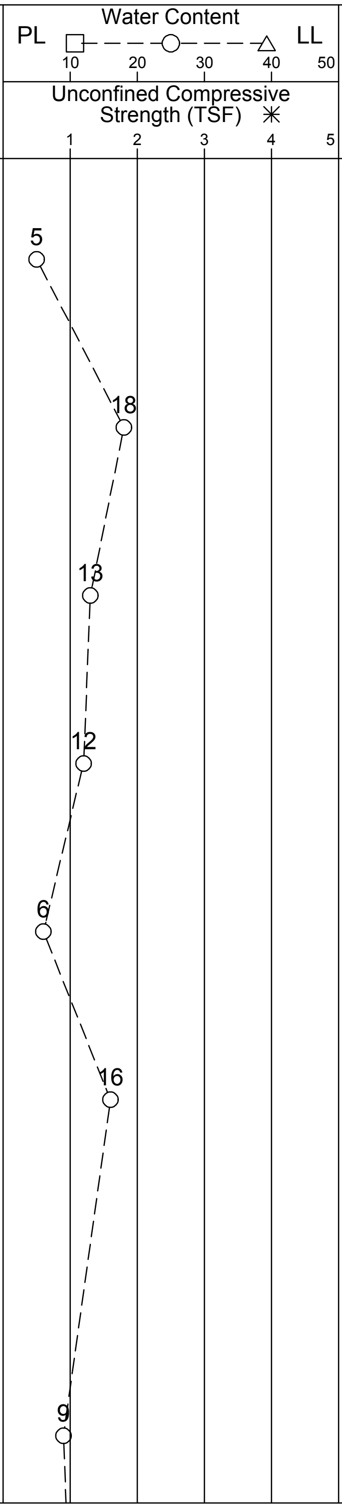
WATER LEVEL (ft.)
▽ **9.0'** while drilling
▼
▼

PATRICK ENGINEERING INC.

BORING NUMBER **S1411** SHEET **1** OF **2**
CLIENT **Fermi National Accelerator Laboratory**
PROJECT & NO. **IARC Building 21053.034**
LOCATION **Batavia, IL N41°50'27.5"; W88°15'01.3"**

LOGGED BY **SEK**
GROUND ELEVATION **746.0**

ELEV.	DEPTH (FT)	STRATA	SOIL/ROCK DESCRIPTION	SAMPLE TYPE & NO. DEPTH (FT) RECOVERY(IN)	BLOW COUNTS	Water Content	NOTES & TEST RESULTS
746.0	0.0		3.5" asphalt				
745.7	0.3		Crushed limestone base course	SS-1 1.0-2.5 10"R	5 10 7	5	
743.5	2.5		Gray silty clay, some sand and gravel, medium stiff, low plasticity, moist FILL	SS-2 3.5-5.0 12"R	4 2 2	18	qu=0.75*tsf
				SS-3 6.0-7.5 4"R	8 8 7	13	
738.0	8.0		Brown/gray-brown silty clay, some fine to coarse sand, little gravel, medium stiff/loose, moist FILL	SS-4 8.5-10.0 16"R	4 4 5	12	qu=1.5*tsf
				SS-5 11.0-12.5 14"R	5 8 6	6	
734.5	11.5		Brown fine to coarse sand and gravel, some clay, medium dense, moist				
732.5	13.5		Brown sandy, silty clay, little gravel, medium stiff, moist to wet FILL	SS-6 13.5-15.0 12"R	2 2 3	16	qu=1.0*tsf
			Grades to gray at 15.0'				Chatter sheared off two augers on obstruction at 18.0'. Offset 3.0' east; blind to 18.5', continued sampling.
728.0	18.0		Brown clayey sand, with gravel, loose, wet	SS-7 18.5-20.0 8"R	3 3 4	9	



DRILLING CONTRACTOR **Groff Testing Corp.**
DRILLING METHOD **3.25" I.D. HSA**
DRILLING EQUIPMENT **CME 75**
DRILLING STARTED **6/11/10** ENDED **6/11/10**

REMARKS
Borehole filled with cuttings upon completion.

WATER LEVEL (ft.)
∇
▼
▼

PATRICK ENGINEERING INC.

BORING NUMBER **S1411** SHEET **2** OF **2**
CLIENT **Fermi National Accelerator Laboratory**
PROJECT & NO. **IARC Building 21053.034**
LOCATION **Batavia, IL N41°50'27.5"; W88°15'01.3"**

LOGGED BY **SEK**
GROUND ELEVATION **746.0**

ELEV.	DEPTH (FT)	STRATA	SOIL/ROCK DESCRIPTION	SAMPLE TYPE & NO. DEPTH (FT) RECOVERY(IN)	BLOW COUNTS	Water Content PL □ — ○ — △ LL 10 20 30 40 50 / Unconfined Compressive Strength (TSF) ✳ 1 2 3 4 5	NOTES & TEST RESULTS
726.0	20.0	▨					
		▨	Brown clayey sand and gravel, loose, moist to wet FILL	SS-8 23.5-25.0 4"R	3 2 2	11	
		▨	Wood pieces				
		▨	Trace wood pieces	SS-9 28.5-30.0 6"R	2 2 2	8	
716.0	30.0		End of Boring at 30.0'				

DRILLING CONTRACTOR **Groff Testing Corp.**
DRILLING METHOD **3.25" I.D. HSA**
DRILLING EQUIPMENT **CME 75**
DRILLING STARTED **6/11/10** ENDED **6/11/10**

REMARKS
Borehole filled with cuttings upon completion.

WATER LEVEL (ft.)
▽
▽
▼

UNIFIED SOIL CLASSIFICATION SYSTEM

TABLE 1 SOIL CLASSIFICATION CHART

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests ^{A}				Soil Classification Group Symbol	Soil Classification Group Name ^{B}
Coarse–Grained Soils More than 50% retained on No. 200 sieve	Gravels More than 50% of coarse fraction retained on No.4 sieve	Clean Gravels Less than 5% fines ^{C}	Cu≥4 and 1≤Cc≤3 ^{E}	GW	Well–graded gravel ^{F}
			Cu<4 and/or 1>Cc>3 ^{E}	GP	Poorly graded gravel ^{F}
		Gravels with Fines More than 12% fines ^{C}	Fines classify as ML or MH	GM	Silty gravel ^{F,G,H}
			Fines classify as CL or CH	GC	Clayey gravel ^{F,G,H}
	Sands 50% or more of coarse fraction passes No.4 sieve	Clean Sands Less than 5% fines ^{D}	Cu≥6 and 1≤Cc≤3 ^{E}	SW	Well–graded sand
			Cu<6 and/or 1>Cc>3 ^{E}	SP	Poorly graded sand ^{I}
		Sands with Fines More than 12% fines ^{D}	Fines classify as ML or MH	SM	Silty sand ^{G,H,J}
			Fines classify as CL or CH	SC	Clayey sand ^{G,H,I}
Fine–Grained Soils 50% or more passes the No. 200 sieve	Silts and Clays Liquid Limit less than 50	Inorganic	PI>7 and plots on or above "A" line ^{J}	CL	Lean Clay ^{K,L,M}
			PI<4 or plots below "A" line	ML	Silt ^{K,L,M}
		Organic	Liquid limit–oven dried / Liquid limit–not dried <0.75	OL	Organic clay ^{K,L,M,N} Organic silt ^{K,L,M,O}
	Silts and Clays Liquid Limit 50 or more	Inorganic	PI plots on or above "A" line	CH	Fat Clay ^{K,L,M}
			PI plots below "A" line	MH	Elastic silt ^{K,L,M}
		Organic	Liquid limit–oven dried / Liquid limit–not dried <0.75	OH	Organic clay ^{K,L,M,P} Organic silt ^{K,L,M,Q}
Highly Organic Soils	Primarily organic matter, dark in color, and organic odor			PT	Peat

^{A} Based on the material passing the 3–in. (75mm) sieve.

^{B} If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

^{C} Gravels with 5 to 12% fines require dual symbols:
GW–GM well graded gravel with silt
GW–GC well graded gravel with clay
GP–GM poorly graded gravel with silt
GP–GC poorly graded gravel with clay

^{D} Sands with 5 to 12% fines require dual symbols:
SW–SM well graded sand with silt
SW–SC well graded sand with clay
SP–SM poorly graded sand with silt
SP–SC poorly graded sand with clay

^{E} $Cu=D_{60}/D_{10}$ $C_c=\frac{(D_{30})^2}{D_{10}\times D_{60}}$

*^{F} If soil contains≥15% sand, add "with sand" to group name.

^{G} If fines classify as CL–ML, use dual symbol GC–GM, or SC–SM.

*^{H} If fines are organic, add "with organic fines" to group name.

*^{I} If soil contains≥15% gravel, add "with gravel" to group name.

*^{J} If Atterberg limits plot in hatched area, soil is a CL–ML, silty clay.

^{K} If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

^{L} If soil contains≥30% plus No. 200, predominantly sand, add "sandy" to group name.

^{M} If soil contains≥30% plus No. 200, predominantly gravel, add "gravelly" to group name.

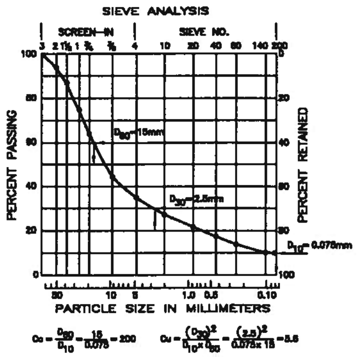
^{N} PI≥4 and plots on or above "A" line

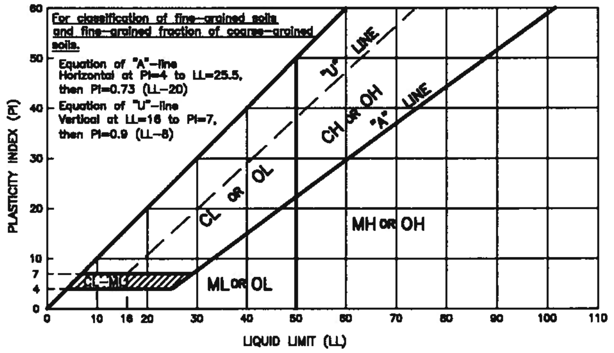
^{O} PI<4 or plots below "A" line

^{P} PI plots on or above "A" line

^{Q} PI plots below "A" line

* See Local Soil Description Terminology.





(ASTM) D–2487–98

ABBREVIATIONS USED ON BORING LOG

AU – Sample from Auger
SS – Split–Spoon Sampler, ASTM D 1586
ST – Thinwall Tube Sample
CA – Continuous Flight Auger
HA – Hand Auger
HSA – Hollow Stem Continuous Flight Auger
W – Partial Sample of Cuttings, Washed
S – Bag Sample from Test Pit, Excavation, etc.
BX – Rock Core 1–5/8" Diameter
NX – Rock Core 2–1/8" Diameter
CS – Sample from Continuous Sampler
O.D. – Outside Diameter
I.D. – Inside Diameter
SPT – Standard Penetration Test, ASTM D 1586
N – Summation of Last 2 SPT Values Reported on Log
WOR – Weight of Rod
WOH – Weight of Hammer
LL – Liquid Limit ASTM D4318
PI – Plasticity Index ASTM D4318
S_u – Undrained Shear Strength
q_u – Unconfined Compressive Strength Test, ASTM D 2166
$q_p = q_u^{*}$ – Estimated Unconfined Compressive Strength (Pocket Penetrometer)
γd=DD – Dry Unit Weight
MC%=w – Natural Water Content, ASTM D 2216
occ. – Occasional
LOI – Loss On Ignition ASTM 2974
PID – Photoionization Detector
v. – Very
med. – Medium
RECOV.=REC. – Sample Recovery: For SPT, 100% Recov.=18" For ST, 100% Recov.=24"
q_u^{**} – Estimated Unconfined Compressive Strength Using Rimac®Tester

PATRICK ENGINEERING INC.

LOCAL SOIL DESCRIPTION TERMINOLOGY

Soils are visually identified and classified on the boring logs and described in this report according to the Unified Soil Classification System with the following modifications:

RELATIVE DENSITY OF GRANULAR SOILS

Description	Blows/Foot
Very Loose	0 to 4
Loose	4 to 10
Medium Dense	10 to 30
Dense	30 to 50
Very Dense	50 to 80
Extremely Dense	80+

CONSISTENCY OF COHESIVE SOILS

Description	N	q_u(tsf)
Very Soft	2	0 to 0.25
Soft	2–4	0.25 to 0.50
Medium Stiff	4–8	0.5 to 1.0
Stiff	8–15	1.0 to 2.0
Very Stiff	15–30	2.0 to 4.0
Hard	30	4.0 to 8.0
Very Hard		8.0+

* N (blows/foot) are based on field measurements and not corrected.

PARTICLE SIZES

Components		Size or Sieve No.
Boulders	–	Over 12 in.
Cobbles	–	3 to 12 in.
Gravel	– Coarse	3/4 to 3 in.
	– Fine	No. 4 to 3/4 in.
Sand	– Coarse	No. 10 to No. 4
	– Medium	No. 40 to No. 10
	– Fine	No. 200 to No. 40
Fines (Silt and Clay)	–	Below No. 200

*SOIL MOISTURE

	Descriptive Term
Dry	– Dry to touch, dusty
Moist	– Moist to touch, damp, no visible water
Wet	– Wet to touch, soil is usually below the water table
Saturated	– Free Water in Sample

* RELATIVE PROPORTIONS (IN LIEU OF "WITH")

Descriptive Term	% By Weight
Trace/Occ.	1 to 10
Little	10 to 20
Some	20 to 30
And**	30 to 50

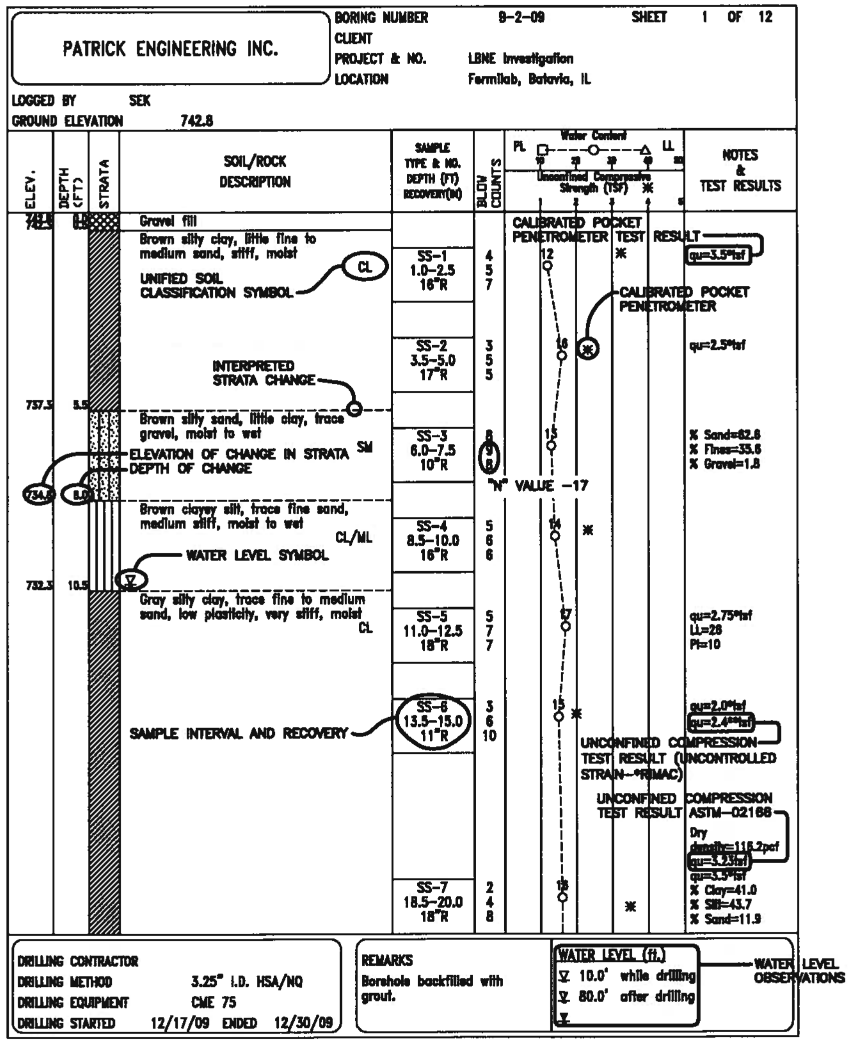
* RELATIVE PLASTICITY

Descriptive Term		Liquid Limit
Low	{Lean}	0 to 30
Medium		30 to 50
High	(Fat)	>50

**Alternatively "sandy" or "gravelly." "Silty clay" may be utilized in lieu of "Lean" or "Fat" Clay with the appropriate plasticity modifier.

NOTE: Visual classifications are approximate.

EXAMPLE BORING LOG



PATRICK ENGINEERING INC.
BORING NUMBER 9–2–09 SHEET 1 OF 12
CLIENT
PROJECT & NO. LBNE Investigation
LOCATION Fermilab, Batavia, IL
LOGGED BY SEK
GROUND ELEVATION 742.8

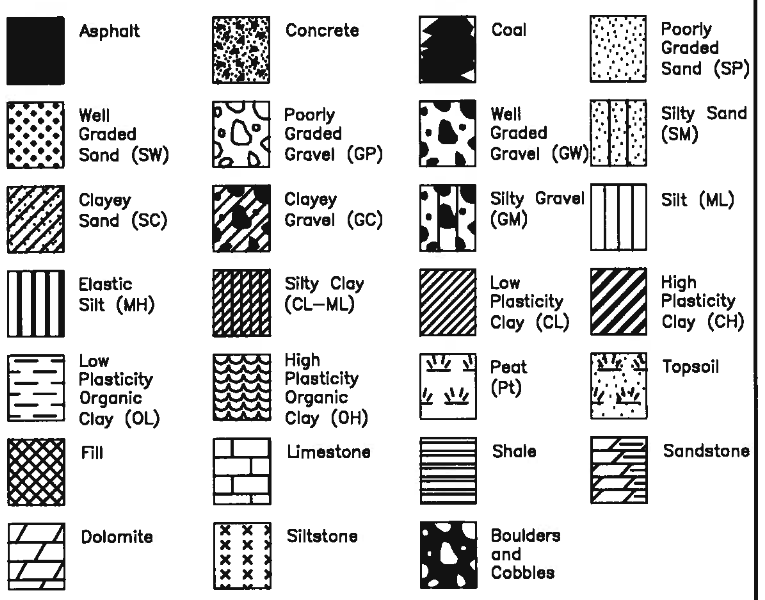
ELEV.	DEPTH (FT)	STRATA	SOIL/ROCK DESCRIPTION	SAMPLE TYPE & NO. DEPTH (FT) RECOVERY(IN)	BLOW COUNTS	NOTES & TEST RESULTS
			Gravel fill			
			Brown silty clay, little fine to medium sand, stiff, moist CL	SS–1 1.0–2.5 16"R	4 5 7	qu=3.5*tsf
				SS–2 3.5–5.0 17"R	3 5 5	qu=2.5*tsf
737.3	5.5		Brown silty sand, little clay, trace gravel, moist to wet SM	SS–3 6.0–7.5 10"R	8 9 8	% Sand=62.6 % Fines=35.6 % Gravel=1.8
734.8	8.0		Brown clayey silt, trace fine sand, medium stiff, moist to wet CL/ML	SS–4 8.5–10.0 16"R	5 6 6	
732.3	10.5		Gray silty clay, trace fine to medium sand, low plasticity, very stiff, moist CL	SS–5 11.0–12.5 18"R	5 7 7	qu=2.75*tsf LL=28 PI=10
				SS–6 13.5–15.0 11"R	3 6 10	qu=2.0*tsf qu=2.4**tsf
						Dry density=118.2pcf qu=3.23tsf
				SS–7 18.5–20.0 18"R	2 4 8	qu=3.5*tsf % Clay=41.0 % Silt=43.7 % Sand=11.9

DRILLING CONTRACTOR
DRILLING METHOD 3.25" I.D. HSA/NQ
DRILLING EQUIPMENT CME 75
DRILLING STARTED 12/17/09 ENDED 12/30/09

REMARKS
Borehole backfilled with grout.

WATER LEVEL (ft.)
10.0' while drilling
80.0' after drilling

GRAPHIC LOG SYMBOLS (OPTIONAL)



NOTE: Graphic log symbols may or may not be shown on the logs. Graphic symbols are shown for convenience. The typed soil descriptions and typed water level data are considered more exact than the graphic symbols.

WATER LEVEL SYMBOLS

$\underline{\nabla}$ Water Level, During Drilling
$\underline{\blacktriangledown}$ Water Level, After Drilling
$\underline{\blacktriangledown}$ Water Level, After 24 Hours

*The water level denotes the level encountered in the borehole and may not represent the water level in a specific layer or strata.

SOIL COLORS

Abbreviations for colors vary between loggers. In general the following abbreviations are used:

BLK = Black
BRN = Brown
YEL = Yellow
OLV = Olive
GR = Gray
GRN = Green
DK = Dark
ORG = Orange
BL = Blue
PK = Pink
STR = Strong

Mottling is a rust colored staining usually observed along cracks and fissures and resulting from the depositing or precipitation of iron and other natural materials. Mottling is typically found within the zone where groundwater levels have fluctuated in the past.

ROCK QUALITY DESIGNATION

The Rock Quality Designation (Deere, et. al., 1969) method of determining rock quality as reported here was obtained by summing up the total length of core recovered in each run, counting only those pieces of core which are four inches (10 cm) in length or longer and which are hard and sound. The sum is then represented as a percentage over the length of the run. If the core is broken by handling or by the drilling process, the fresh broken pieces are fitted together and counted as one piece provided that they form the requisite length of four inches (10 cm). RQD is reported as a percentage.

Relation of RQD and Rock Quality

RQD (%)	Description of Rock Quality
0 – 25	Very Poor
25 – 50	Poor
50 – 75	Fair
75 – 90	Good
90 – 100	Excellent

NOTE: Recovery denoted as REC=, is the length of core recovered in a run divided by the length of the run, reported as a percentage.

SOIL
DESCRIPTION TERMINOLOGY

UNIFIED SOIL CLASSIFICATION SYSTEM
KEY TO GRAPHIC LOG SYMBOLS
KEY TO ROCK CORE DATA
EXAMPLE BORING LOG

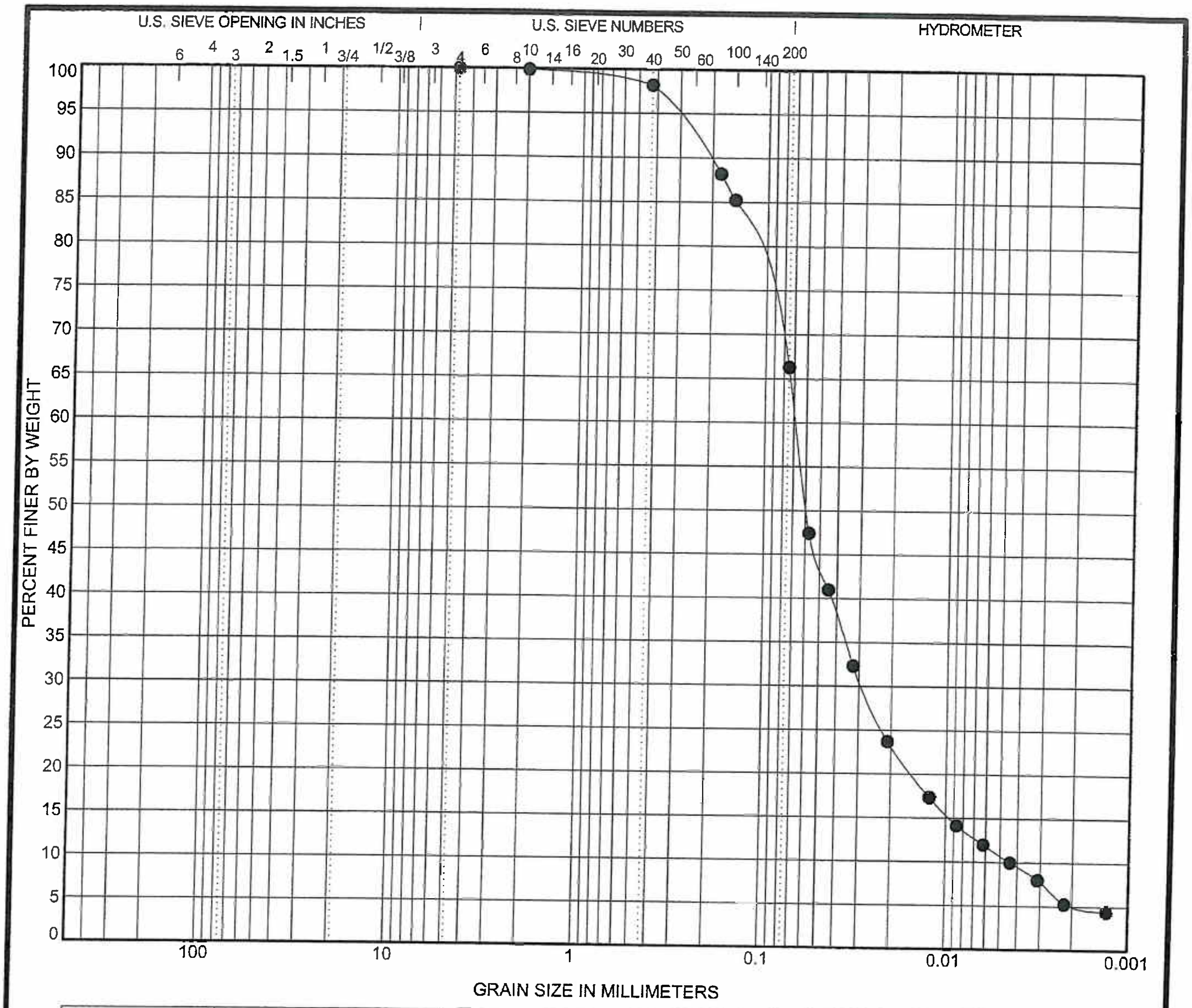
G:\CAD\Soil–Des–Term\Soil–Des–Term–2010.dwg EJB 07–06–10

APPENDIX C

LABORATORY TEST RESULTS
LABORATORY DATA

Laboratory Test Results
IARC Building - Fermi National Accelerator Laboratory - Batavia, Illinois

		USCS Soil Classification	Moisture Content	Atterberg Limits			Particle Size				Loss on Ignition	UC Strength	Density - unit weight
Applicable Standard for Lab Test		ASTM D2487	ASTM D2216	ASTM D4318			ASTM D422/D421					ASTM D2166	ASTM D
Parameter			w	LL	PL	PI	Gravel	Sand	Silt	Clay		Qu	
Sample Identification	Sample Depth (ft)		%	%	%	%	%	%	%	%	%	tsf	γ_d
B-1-10 SS-3	6-7.5	Brown fine sandy silt (SM)	--	--	--	--	0.0	33.7	55.6	10.7	--	--	--
B-1-10 ST-1	**11-13**	**Dark gray silty clay/clayey silt (CL-ML)**	**24**	--	--	--	--	--	--	--	--	--	**113.9**
B-2-10 SS-4	8.5-10	Dark gray silty clay (CL)	21	--	--	--	--	--	--	--	2.0	--	--
B-2-10 SS-5	**11-12.5**	**Dark gray silt clay (CL)**	--	**21**	**13**	**8**	--	--	--	--	--	--	--
B-2-10 SS-S	13.5-15	Dark gray clayey silt (ML)	--	--	--	--	5.6	23.1	61.1	10.1	--	--	--
B-3-10 ST-1	**10-12**	**Dark gray clayey silt (ML)**	**22**	--	--	--	--	--	--	--	--	**0.24**	**112**
B-4-10 SS-6	16-17.5	Brown/gray silty clay (CL)		25	14	11	--	--	--	--	--	--	--
B-4-10 ST-1	**13.5-15**	**Brown/gray silty clay (CL)**	**23**	--	--	--	--	--	--	--	--	**0.58**	**111**
B-7-10 ST-1	12.5-14.5	Gray silty clay (CL)	21	--	--	--	--	--	--	--	--	0.59	115
B-7-10 SS-4	**8.5-10**	**Gray clayey silt (ML)**	--	**20**	**16**	**4**	--	--	--	--	--	--	--
			--	--	--	--	--	--	--	--	--	--	--
			--	--	--	--	--	--	--	--	--	--	--
B - 1 (S1404)			--	--	--	--	--	--	--	--	--	--	--
B-2 (S1405)			--	--	--	--	--	--	--	--	--	--	--
B-3 (S1406)			--	--	--	--	--	--	--	--	--	--	--
B-4 (S1407)			--	--	--	--	--	--	--	--	--	--	--
B-7 (S1410)			--	--	--	--	--	--	--	--	--	--	--
			--	--	--	--	--	--	--	--	--	--	--
			--	--	--	--	--	--	--	--	--	--	--
			--	--	--	--	--	--	--	--	--	--	--
			--	--	--	--	--	--	--	--	--	--	--



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	USCS Classification	LL	PL	PI	Cc	Cu
● **B-1-10#** **6.0 ft**					**2.73**	**15.54**

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● **B-1-10#** **6.0 ft**	**4.75**	**0.068**	**0.029**	**0.004**	**0.0**	**33.7**	**55.6**	**10.7**

WEI
SINCE 1982

Wang Engineering, Inc.
1145 N Main Street
Lombard, IL 60148
Telephone: 630 953-9928
Fax: 630 953-9938

GRAIN SIZE DISTRIBUTION

Project: IARC Building

Location: Batavia, IL

Number: 190-18-85

AASHTO R18

DENSITY-UNIT WEIGHT DETERMINATION

Client: Patrick Engineering
Project: IARC Building
WEI Job No: 190-18-85

Analyst name: M. de los Reyes
Test date: 6/21/2010

	B-1-10 (11.0-13.0 ft)
Water content determination	
Mass of tare and wet soil (g) W_w =	330.11
Mass of tare and dry soil (g) W_d =	282.65
Mass of tare (g) W_t =	83.85
Water content w =	**24%**
Density--Unit Weight	
Diameter measurements (in) D_1 =	2.599
D_2 =	2.729
D_3 =	2.584
Average **diameter** (in) D =	2.637
Height measurements (in) H_1 =	1.208
H_2 =	1.239
H_3 =	1.204
Average **height** (in) H =	1.217
Total **weight** (g) W =	246.260
Bulk Unit Weight (pcf) γ =	**141.14**
Dry Unit Weight (pcf) γ_d =	**113.94**

Prepared by: M. de los Reyes Date: 6/23/10

Checked by: Date: 06/25/10

AASHTO R18

Organic Content - Loss On Ignition
ASTM D 2974, Method C

Client: *Patrick Engineering*
Project: *IARC Building*
WEI Job: *190-18-85*
Sample ID/Location: *B-2-10 (8.5-10.0 ft)*
Type/Condition: *SS*
Testing Furnace Temp °C.: 440

Analyst: *M. de los Reyes*
Date Received: *6/17/2010*
Date Tested: *6/17/2010*
Description: Gray Silt

Moisture Content	**Wet soil + tare (g)**	**Dry Soil + tare (g)**	**Tare mass (g)**	**w (%)**
oven-dry method	*30.18*	*26.86*	*11.05*	21

Ash Content	**Dry Soil + tare (g)**	**Ash + tare (g)**	**Tare mass (g)**	**Ash Content (%)**
Loss On Ignition	*26.86*	*26.54*	*11.05*	98

Organic Content (%)= 2.0

Notes:

Prepared by: M de los Reyes Date: 6/23/10

Checked by: Date: 06/2010

`s:\netprojects\1901885\lws_wang_mdlr_01901885loib-2-10(8.5-10ft)_20100622.xls`

WANG ENGINEERING, INC.
1145 N. Main Street, Lombard, IL 60148

LIQUID LIMIT, PLASTIC LIMIT, and PLASTICITY INDEX

AASHTO T 89, T 90 / ASTM D 4318

Client: Patrick Engineering
Project: IARC Building
WEI Job No: 190-18-85
Prep Method: air dried

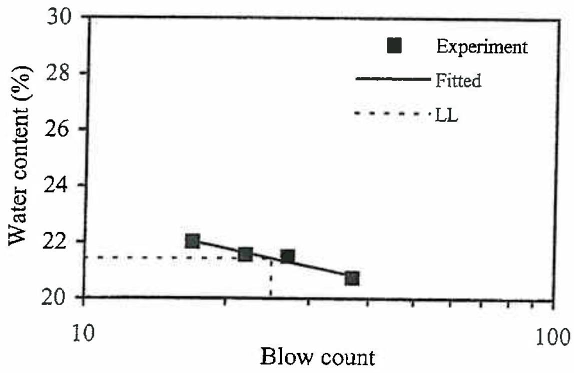
Analyst name: M. de lso Reyes
Test date: June 22, 2010
Soil Sample: B-2 (11.0-12.5 ft)
Sample description: Gray Silty Clay
% retained on #40 sieve: 43%

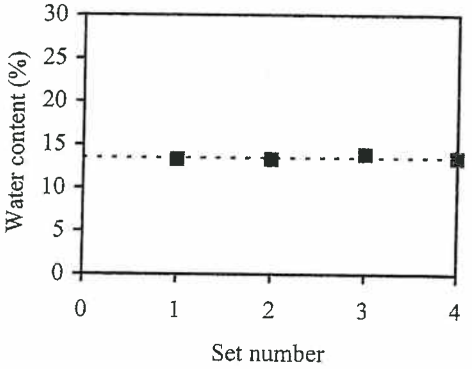
Set #	Tare mass (g) Wc	Tare with wet soil (g) Ww	Tare with dry soil (g) Wd	Blow count N	Water content (%) w	Water content fitted (%)
1	*11.39*	*21.26*	*19.51*	*22*	21.55	21.63
2	*11.10*	*21.46*	*19.68*	*37*	20.75	20.83
3	*11.29*	*21.86*	*19.99*	*27*	21.49	21.32
4	*11.32*	*20.52*	*18.86*	*17*	22.02	22.03

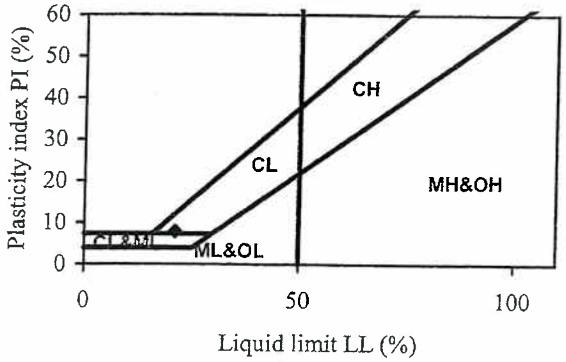
Liquid limit (%) = 21.43
Slope of flow line = 0.073

Set #	Tare mass (g) Mc	Tare with wet soil (g) Mw	Tare with dry soil (g) Md	Water content (%) w
1	*11.05*	*17.36*	*16.62*	13.29
2	*11.16*	*18.83*	*17.93*	13.29
3	*11.38*	*20.14*	*19.07*	13.91
4	*11.14*	*20.14*	*·19.07*	13.49

Plastic limit (%) = 13.50







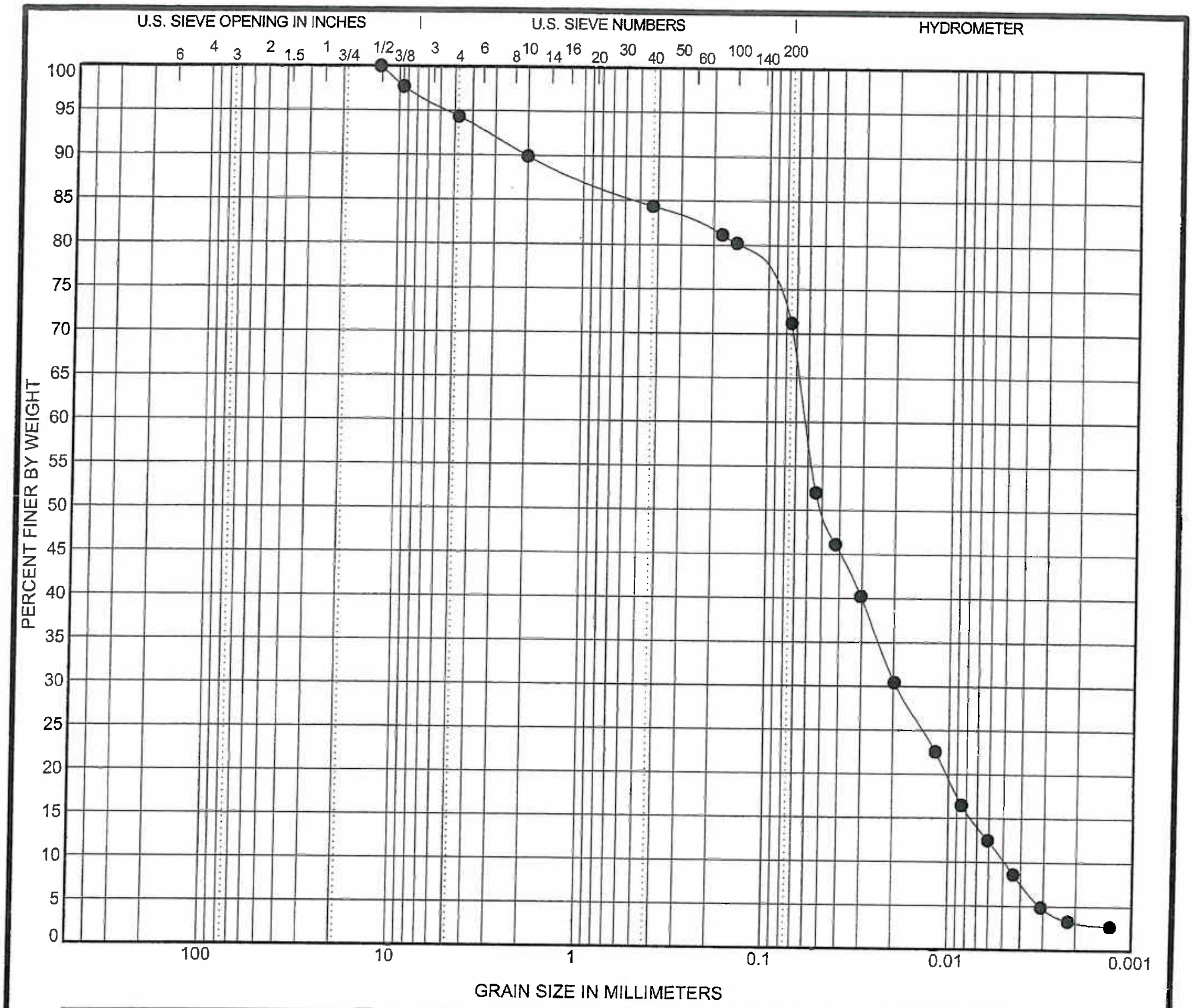
Liquid limit (%) = *21*
Plastic limit (%) = *13*
Plasticity index (%) = *8*

Prepared by: M. de los Reyes Date: 6/23/10

Checked by: Date: 06/2016

s:\netprojects\1901885\lws_wang_mdlr_01901885atterbergb-2(11-12.5ft)_20100623.xls

WANG ENGINEERING, INC.
1145 N. Main Street, Lombard, IL 60148



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		USCS Classification	LL	PL	PI	Cc	Cu
●	B-2-10#	13.5 ft					1.20	12.53

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-2-10#	13.5 ft	12.7	0.062	0.019	0.005	5.6	23.1	61.1	10.1

WEI
SINCE 1982

Wang Engineering, Inc.
1145 N Main Street
Lombard, IL 60148
Telephone: 630 953-9928
Fax: 630 953-9938

GRAIN SIZE DISTRIBUTION

Project: IARC Building
Location: Batavia, IL
Number: 190-18-85

AASHTO R18

UNCONFINED COMPRESSIVE STRENGTH
(AASHTO T 208 / ASTM 2166)

Project: IARC Building
Client: Patrick Engineering
WEI Job No.: 190-18-85
Sample ID/Location: B-3-10 (10.0-12. ft)
Type/Condition: Shelby Tube/undisturbed

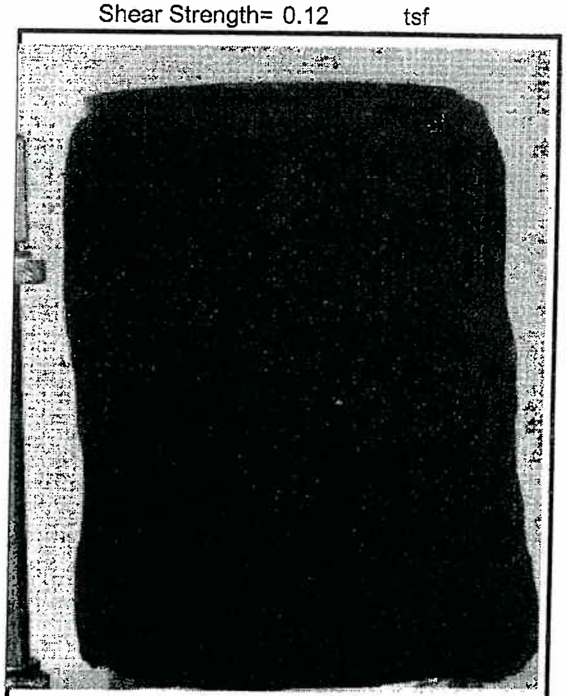
Analyst name: *M. de los Reyes*
Date received: *17-Jun-10*
Test date: *21-Jun-10*
Sample description:

Gray Silty Clay

Average initial height h_0 = *5.67* in
Average initial diameter d_0 = *2.97* in
Height to diameter ratio= *1.91*
Mass of wet sample and tare M_i = *1577.87* g
Mass of dry sample and tare M_d = *1322.60* g
Mass of tare M_t = *161.97* g
Mass of sample Ms= *1415.90* g
Estimated specific gravity G_s = *2.75*

Initial water content w = 21.99% entire sample
Initial unit weight g = 136.81 pcf
Initial dry unit weight g_d = 112.14 pcf
Initial void ratio e_0 = 0.53
Initial degree of saturation S_r = 100%
Young's modulus E = 2.20 tsf
Unconfined compressive strength q_u = 0.24 tsf
Shear Strength= 0.12 tsf

Displacement (in) Δh	Force (lbs) F	Strain (%) e	Stress (tsf) s
0.00	*0.00*	0.00	0.00
0.03	*2.07*	0.53	0.02
0.06	*3.11*	1.06	0.03
0.06	*4.15*	1.06	0.04
0.12	*5.19*	2.11	0.05
0.15	*6.22*	2.64	0.06
0.18	*6.22*	3.17	0.06
0.21	*8.30*	3.70	0.08
0.24	*10.37*	4.23	0.10
0.27	*12.44*	4.76	0.12
0.30	*13.48*	5.29	0.13
0.35	*15.56*	6.17	0.15
0.40	*18.67*	7.05	0.18
0.45	*20.74*	7.93	0.20
0.50	*20.74*	8.81	0.20
0.55	*21.78*	9.69	0.20
0.60	*22.81*	10.57	0.21
0.65	*22.81*	11.46	0.21
0.70	*24.89*	12.34	0.23
0.80	*24.89*	14.10	0.22
0.90	*27.38*	15.86	0.24



sketch/picture at failure

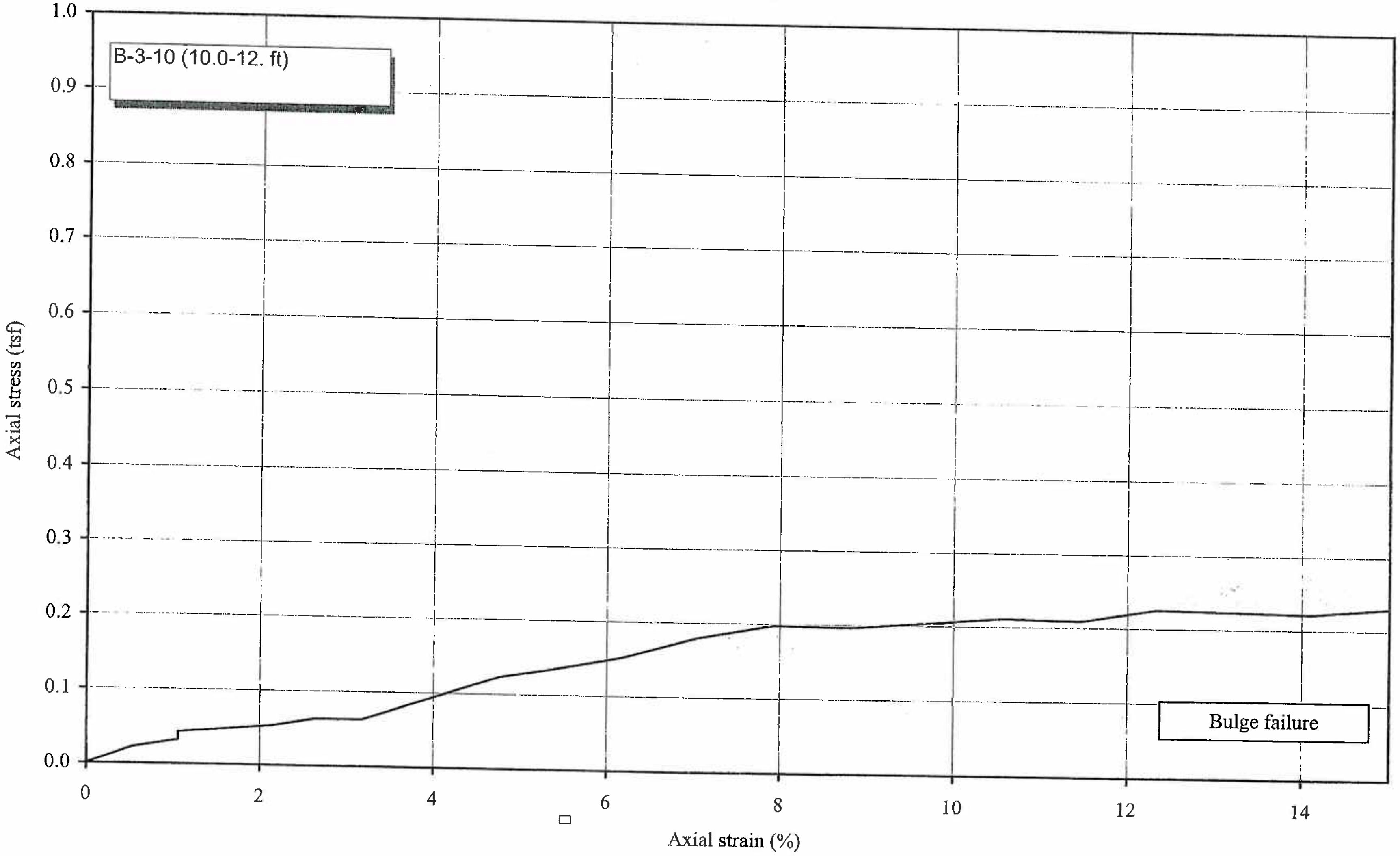
NOTES:

Prepared by: M. de los Reyes Date: 6/23/10

Checked by: Date: 06/25/10

AASHTO R18

Axial Stress vs. Axial Strain



s:\laboratory\labforms\soils\unconfined compressive strength.xls

WANG ENGINEERING, INC.
1145 N. Main Street, Lombard, IL 60148

AASHTO R18

LIQUID LIMIT, PLASTIC LIMIT, and PLASTICITY INDEX

AASHTO T 89, T 90 / ASTM D 4318

Client: Patrick Engineering
Project: IARC Building
WEI Job No: 190-18-85
Prep Method: air dried

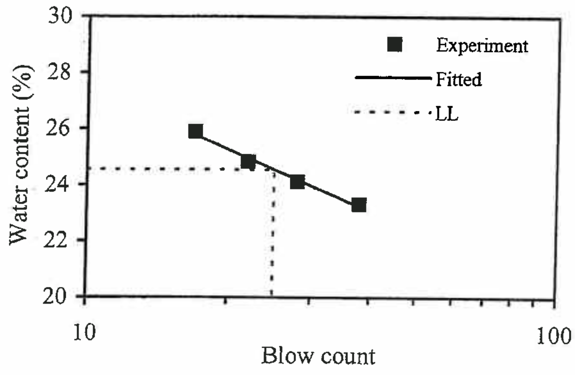
Analyst name: M. de los Reyes
Test date: June 23, 2010
Soil Sample: B-4-10 (16.0-17.5 ft)
Sample description: Gray Silty Clay
% retained on #40 sieve: 16%

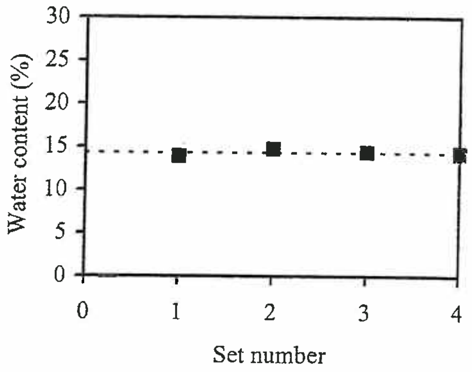
Set #	Tare mass (g) Wc	Tare with wet soil (g) Ww	Tare with dry soil (g) Wd	Blow count N	Water content (%) w	Water content fitted (%)
1	*13.90*	*24.50*	*22.44*	*28*	24.12	24.20
2	*13.86*	*24.49*	*22.48*	*38*	23.32	23.23
3	*13.52*	*28.30*	*25.36*	*22*	24.83	24.96
4	*13.89*	*26.24*	*23.70*	*17*	25.89	25.78

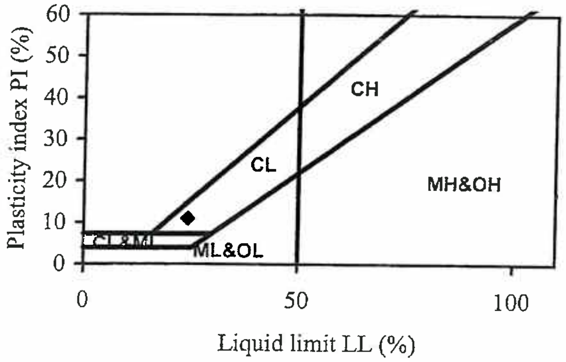
Liquid limit (%) = 24.56
Slope of flow line = 0.129

Set #	Tare mass (g) Mc	Tare with wet soil (g) Mw	Tare with dry soil (g) Md	Water content (%) w
1	*14.04*	*21.42*	*20.52*	13.89
2	*13.87*	*20.09*	*19.29*	14.76
3	*13.86*	*22.39*	*21.32*	14.34
4	*13.88*	*22.18*	*21.14*	14.33

Plastic limit (%) = 14.33







Liquid limit (%) = *25*
Plastic limit (%) = *14*
Plasticity index (%) = *11*

Prepared by: M. de los Reyes Date: 6/25/10

Checked by: Date: 06/25/10

UNCONFINED COMPRESSIVE STRENGTH
(AASHTO T 208 / ASTM 2166)

Project: IARC Building
Client: Patrick Engineering
WEI Job No.: 190-18-85
Sample ID/Location: B-4-10 (13.5.-15.0 ft)
Type/Condition: Shelby Tube/undisturbed

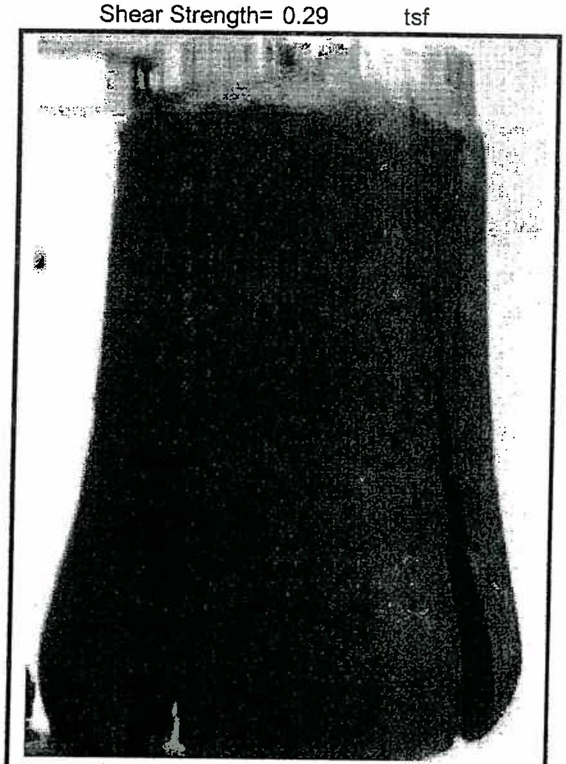
Analyst name: M. de los Reyes
Date received: 17-Jun-10
Test date: 21-Jun-10
Sample description:

Gray Silty Clay

Average initial height h_0 = 5.72 in
Average initial diameter d_0 = 2.86 in
Height to diameter ratio= 2.00
Mass of wet sample and tare M_i = 1327.13 g
Mass of dry sample and tare M_d = 1084.90 g
Mass of tare M_t = 13.23 g
Mass of sample Ms= 1313.90 g
Estimated specific gravity G_s = 2.75

Initial water content w = 22.60% entire sample
Initial unit weight g = 136.38 pcf
Initial dry unit weight g_d = 111.24 pcf
Initial void ratio e_0 = 0.54
Initial degree of saturation S_r = 100%
Young's modulus E = 7.70 tsf
Unconfined compressive strength q_u = 0.58 tsf
Shear Strength= 0.29 tsf

Displacement (in)	Force (lbs)	Strain (%)	Stress (tsf)
Δh	F	e	s
0.00	0.00	0.00	0.00
0.03	2.49	0.52	0.03
0.06	5.19	1.05	0.06
0.06	9.33	1.05	0.10
0.12	13.48	2.10	0.15
0.15	18.67	2.62	0.20
0.18	22.81	3.15	0.25
0.21	26.96	3.67	0.29
0.24	31.11	4.20	0.33
0.27	35.26	4.72	0.38
0.30	37.33	5.25	0.40
0.35	43.55	6.12	0.46
0.40	46.67	6.99	0.49
0.45	49.78	7.87	0.51
0.50	53.92	8.74	0.55
0.55	56.00	9.62	0.57
0.60	58.07	10.49	0.58
0.65	58.07	11.37	0.58
0.70	58.07	12.24	0.57
0.80	58.07	13.99	0.56
0.90	58.07	15.74	0.55



sketch/picture at failure

NOTES:

Prepared by: M. de los Reyes Date: 6/23/10

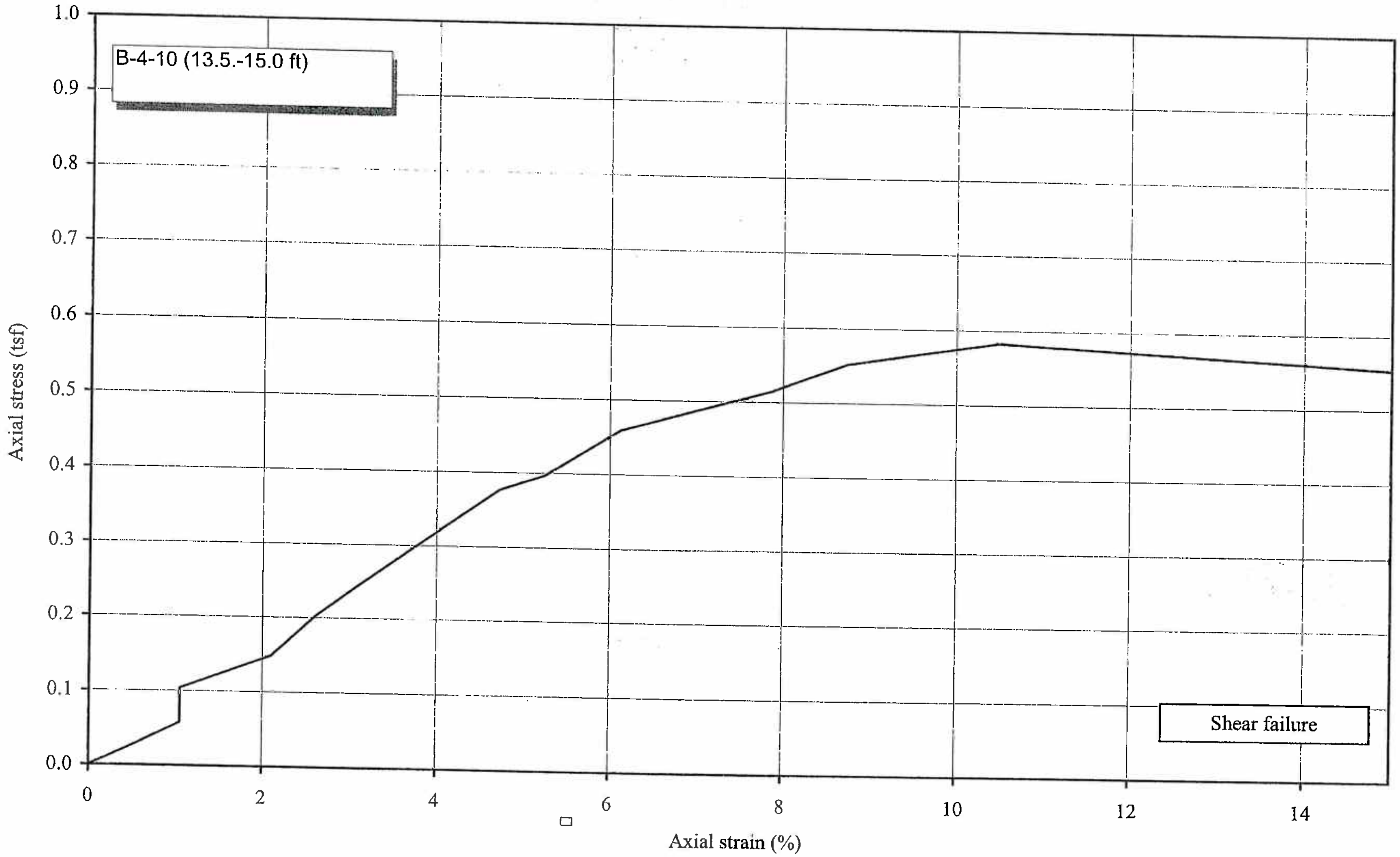
Checked by: Date: 06/25/10

s:\netprojects\1901885\lws_wang_mdlr_01901885ucb-4-10(13.5-15ft)_20100622.xls

WANG ENGINEERING, INC.
1145 N. Main Steet, Lombard, IL 60148

AASHTO R18

Axial Stress vs. Axial Strain



s:\laboratory\labforms\soils\unconfined compressive strength.xls

WANG ENGINEERING, INC.
1145 N. Main Street, Lombard, IL 60148

AASHTO R18

LIQUID LIMIT, PLASTIC LIMIT, and PLASTICITY INDEX

AASHTO T 89, T 90 / ASTM D 4318

Client: **Patrick Engineering**
Project: **IARC Building**
WEI Job No: **190-18-85**
Prep Method: **air dried**

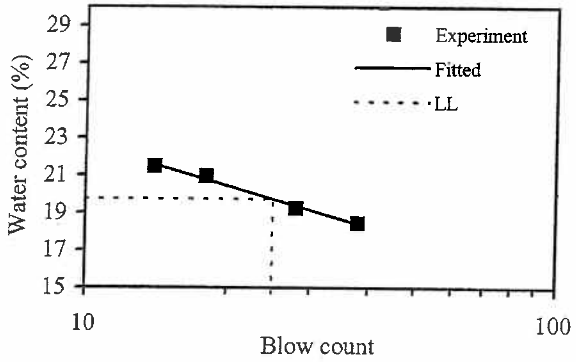
Analyst name: M. de los Reyes
Test date: June 23, 2010
Soil Sample: B-7-10 (8.5-10.0 ft)
Sample description: Brown & Gray Silty Clay
% retained on #40 sieve: 8%

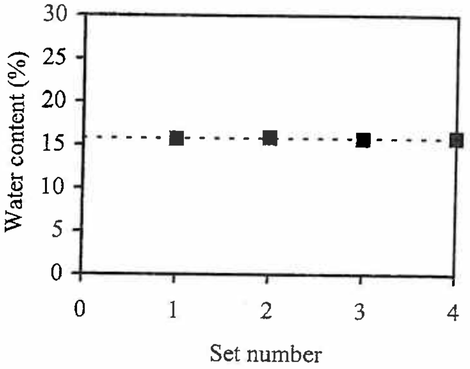
Set #	Tare mass (g) Wc	Tare with wet soil (g) Ww	Tare with dry soil (g) Wd	Blow count N	Water content (%) w	Water content fitted (%)
1	*13.75*	*24.10*	*22.27*	*14*	21.48	21.57
2	*13.91*	*24.07*	*22.31*	*18*	20.95	20.78
3	*13.62*	*27.25*	*25.05*	*28*	19.25	19.38
4	*13.75*	*28.45*	*26.16*	*38*	18.45	18.41

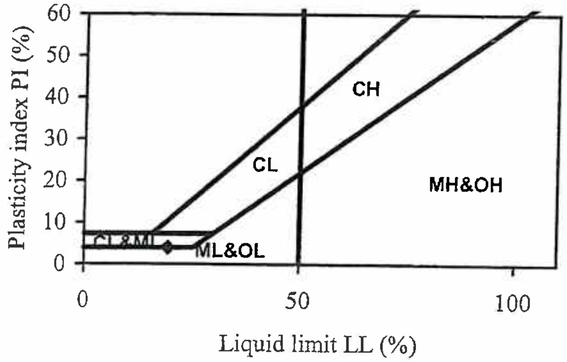
Liquid limit (%) = 19.73
Slope of flow line = 0.159

Set #	Tare mass (g) Mc	Tare with wet soil (g) Mw	Tare with dry soil (g) Md	Water content (%) w
1	*13.85*	*22.40*	*21.24*	15.70
2	*13.67*	*22.52*	*21.31*	15.84
3	*13.84*	*23.12*	*21.86*	15.71
4	*13.68*	*26.54*	*24.78*	15.86

Plastic limit (%) = 15.78







Liquid limit (%) = *20*
Plastic limit (%) = *16*
Plasticity index (%) = *4*

Prepared by: M. de los Reyes Date: 6/25/10

Checked by: Date: 06/25/10

s:\netprojects\1901885\lws_wang_mdlr_01901885atterbergb-7(8.5-10.0ft)_20100624.xls

WANG ENGINEERING, INC.
1145 N. Main Street, Lombard, IL 60148

UNCONFINED COMPRESSIVE STRENGTH
(AASHTO T 208 / ASTM 2166)

Project: IARC Building
Client: Patrick Engineering
WEI Job No.: 190-18-85
Sample ID/Location: B-7-10 (12.5.-14.5 ft)
Type/Condition: Shelby Tube/undisturbed

Analyst name: M. de los Reyes
Date received: 17-Jun-10
Test date: 21-Jun-10
Sample description:

Gray Silty Clay

Average initial height h_0 = *6.00* in
Average initial diameter d_0 = *2.84* in
Height to diameter ratio= *2.11*
Mass of wet sample and tare M_i = *1579.90* g
Mass of dry sample and tare M_d = *1340.10* g
Mass of tare M_t = *186.00* g
Mass of sample Ms= *1393.90* g
Estimated specific gravity G_s = *2.75*

Initial water content w = 20.78% entire sample
Initial unit weight g = 139.20 pcf
Initial dry unit weight g_d = 115.26 pcf
Initial void ratio e_0 = 0.49
Initial degree of saturation S_r = 100%
Young's modulus E = 8.17 tsf
Unconfined compressive strength q_u = 0.59 tsf
Shear Strength= 0.30 tsf

Displacement (in) Δh	Force (lbs) F	Strain (%) e	Stress (tsf) s
0.00	*0.00*	0.00	0.00
0.03	*2.49*	0.50	0.03
0.06	*5.19*	1.00	0.06
0.06	*9.33*	1.00	0.10
0.12	*13.48*	2.00	0.15
0.15	*18.67*	2.50	0.21
0.18	*22.81*	3.00	0.25
0.21	*26.96*	3.50	0.29
0.24	*31.11*	4.00	0.34
0.27	*35.26*	4.50	0.38
0.30	*37.33*	5.00	0.40
0.35	*43.55*	5.83	0.46
0.40	*46.67*	6.66	0.49
0.45	*49.78*	7.50	0.52
0.50	*53.92*	8.33	0.56
0.55	*56.00*	9.16	0.58
0.60	*58.07*	10.00	0.59
0.65	*58.07*	10.83	0.59
0.70	*58.07*	11.66	0.58
0.80	*58.07*	13.33	0.57
0.90	*58.07*	14.99	0.56

sketch/picture at failure

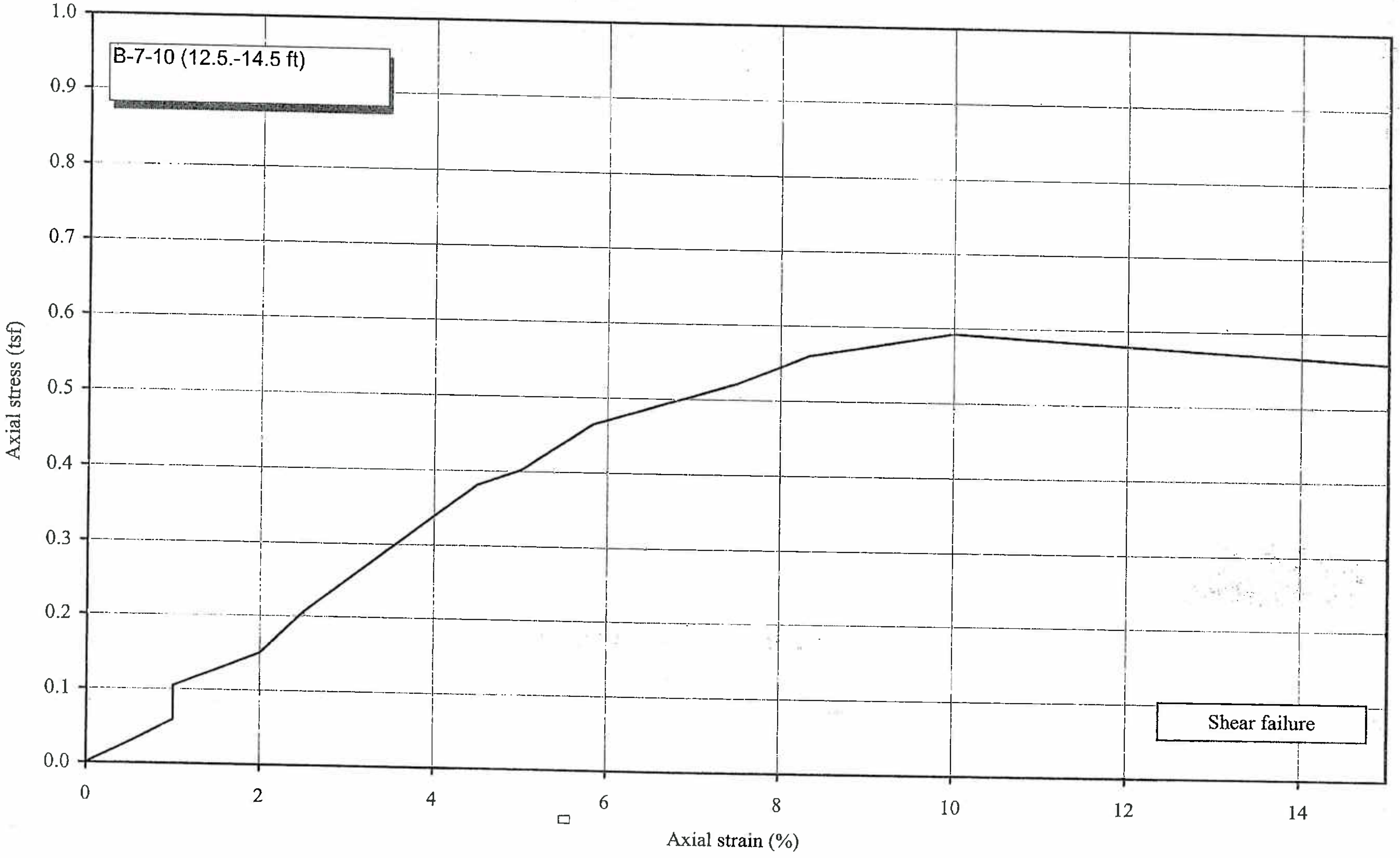
NOTES:

Prepared by: M. de los Reyes Date: 6/23/10

Checked by: Date: 06/25/10

WANG ENGINEERING, INC.
1145 N. Main Steet, Lombard, IL 60148

Axial Stress vs. Axial Strain



s:\netprojects\1901885\lws_wang_mdlr_01901885ucb-7-10(12.5-14.5ft)_20100622.xls

WANG ENGINEERING, INC.
1145 N. Main Street, Lombard, IL 60148

APPENDIX D

TECHNICAL BULLETIN NO. 9
GEOPIER FOUNDATION CO. INC.

GEOPIER FOUNDATION CO INC

TECHNICAL BULLETIN

Nº 9

VIBRATION AND NOISE LEVELS

Construction vibration and noise levels are important when considering the effect of construction activities on adjacent buildings, building additions and neighbors. This technical bulletin describes the results of vibration and noise monitoring performed adjacent to Geopier® and Impact™ Rammed Aggregate Pier (RAP) activities. This information should be used when evaluating the feasibility of a RAP solution at a particular site. For sites with increased vibration and noise sensitivity, a site-specific monitoring program should be considered.

I. CONSTRUCTION VIBRATIONS

Many construction activities result in the transmission of vibrations across the construction site. Vibration levels depend on the types of construction activities as well as the soil conditions at the site. The effect of vibrations on adjacent buildings depends on the building's construction (wood, masonry, steel, concrete), building age, distance of the adjacent building from the source of vibration, duration of vibration, vibration frequency, vibration amplitude and soil conditions. In general, low frequency (long period) motions result in a greater likelihood of building damage compared to high frequency (short period) motions. This is because of the significant damping effect that occurs in soils subjected to high frequency (short period) motions. In contrast, soils subjected to low frequency (long period) motions may amplify the vibrations.

In the United States, high frequency vibrations levels less than two in/sec at the building location are generally considered to be acceptable (Wiss 1981). These levels of vibrations are unlikely to lead to building damage. Vibration levels between 0.5 in/sec and 2 in/sec, are generally considered to be an annoyance but not structurally damaging. Vibration levels of less than 0.5 in/sec are often not noticeable.

2. RAMMED AGGREGATE PIER CONSTRUCTION

Rammed Aggregate Pier construction is described in detail in the Geopier Reference Manual (Fox and Cowell 1998). Geopier Rammed Aggregate Piers are constructed by drilling out a volume of compressible soil to create a cavity and then ramming select aggregate into the cavity in thin lifts using the patented beveled tamper. Impact Rammed Aggregate Piers are installed in caving soils through the use of a hollow mandrel driven to the design depth. Aggregate placed down the center of the hollow mandrel fills the cavity and is compacted in thin lifts as the mandrel is raised up and rammed down to achieve compaction. The ramming action during construction of Rammed Aggregate Piers causes the aggregate to compact vertically and to push laterally against the matrix soil, thereby increasing the horizontal stress in the matrix soil. Rammed Aggregate Pier construction results in a very dense aggregate pier with superior strength and stiffness. During installation, the hammers that produce the ramming action operate at ranges of 400 to 600 cycles per minute (7 to 10 cycles per second) for Geopier RAPs and 2,000 to 2,400 cycles per minute for Impact RAPs. These high frequency vibration levels are higher than most other construction activities resulting in a large amount of damping within the reinforced soils at the project site. Conversely, pile driving typically produces vibrations associated with low frequencies on the order of 60 cycles per minute (one cycle per second) and an associated period of one second. The RAP vibration levels are thus both lower in amplitude and higher in frequency than pile driving activities, resulting in lower vibrations measured at adjacent sites.

3. VIBRATION MONITORING

Vibration monitoring has been performed at a number of Rammed Aggregate Pier project sites to evaluate the amplitude and frequency of vibrations as a function of distance from the energy source. The following table contains summaries of the collected data. The table includes a description of the soil conditions, installation technique, distance ranges from source, as well as the field vibration data for each of the project sites.

Table 1.

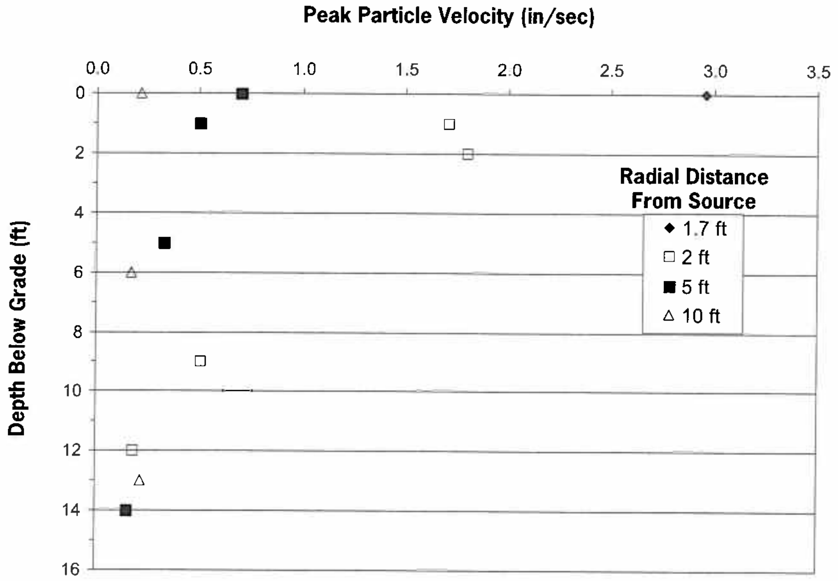
*Vibration Monitoring Results**

LOCATION	SOIL DESCRIPTION	REINFORCEMENT SOLUTION	DISTANCE FROM SOURCE (ft)	PEAK PARTICLE VELOCITY (ips)	FREQUENCY (Hz)
MEMPHIS, TN	MED. STIFF CLAY	GEOPIER RAP	1.7 - 2	.18 - 2.96	43 - 57
		GEOPIER RAP	5 - 10	.12 - .70	43 - 73
SOMERVILLE, MA	MED. DENSE GRANULAR FILL	GEOPIER RAP	1.5 - 10	.50 - .65	30 - 85
SAN LUIS OBISPO, CA	STIFF CLAY	GEOPIER RAP	7 - 15	.04 - .55	15 - 60
MINNEAPOLIS, MN	LOOSE SAND	GEOPIER RAP	3 - 50	.07 - .90	27 - 57
MINNEAPOLIS, MN	LOOSE SAND	IMPACT RAP	3 - 20	.56 - .99	21 - 47
		IMPACT RAP	30 - 100	.02 - .48	21 - 47
MANALAPAN, NJ	MED. DENSE SILTY SAND	IMPACT RAP	5 - 10	.57 - 3.19	37 - 64
		IMPACT RAP	25 - 50	.10 - .62	34 - 73

**Monitoring results are also plotted in Figures 2 and 3.*

At one project site, the Baptist Memorial Hospital Addition in Memphis, Tennessee, Geopier RAPs were installed in close proximity to existing hospital facilities. An accelerometer was used at the site to measure both accelerations and peak particle velocities (PPV) during the installation of the Geopier elements. The accelerometer was positioned at distances ranging from 1.7 feet to 10 feet away from the Geopier RAPs as the tamper head elevation ranged from the ground surface to greater than 13 feet below grade. The subsurface conditions consisted of medium-stiff clay with groundwater below the bottoms of the piers. The results of the accelerometer testing are shown graphically in Figure 1.

Figure 1.
Peak Particle Velocity
With Depth For Different
Energy Source Distances



4. DISCUSSION OF VIBRATION RESULTS

The results of the vibration monitoring data (Figure 1) indicate that RAP construction vibration amplitudes decrease with increasing depth below the ground surface. The highest vibration amplitudes are observed when the tamper is at the ground surface. Table 1 and Figures 2 to 4 show the ranges of peak particle velocity with distance from the source. The data indicates that vibration amplitudes reduce with radial distance from the energy source. This rapid dissipation of vibration amplitudes is attributed to the high frequency (low period) vibrations resulting from the hammers used during RAP construction. For Geopier RAP elements, the peak particle velocities are generally less than two in/sec at distances of two feet from the installation location and less than 0.75 in/sec at distances of five feet from the installation location. For Impact RAP elements, the peak particle velocities are less than two in/sec at distances on the order of 10 to 15 feet from the pier installation location and less than 0.75 in/sec at distances of 20 to 25 feet from the installation location. The higher amplitudes observed for the Impact RAP installations are likely attributed to the displacement installation procedure and the densification of the granular soils during installation. Figure 4 shows a comparison of Geopier RAP vibration levels from the site in San Luis Obispo, California compared with other construction equipment. As indicated, the measured vibration levels are comparable to those induced by a jack hammer or a large bulldozer and are considerably lower than pile driving operations.

Figure 2.
Peak Particle Velocities
For Geopier RAPs With
Distance From Energy Source

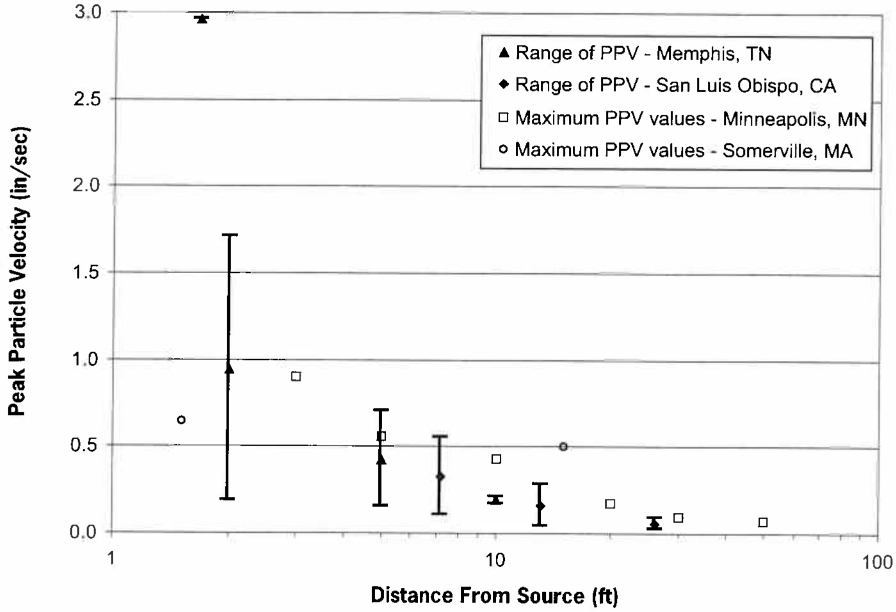


Figure 3.
Peak Particle Velocities
For Impact RAPs With
Distance From Energy Source

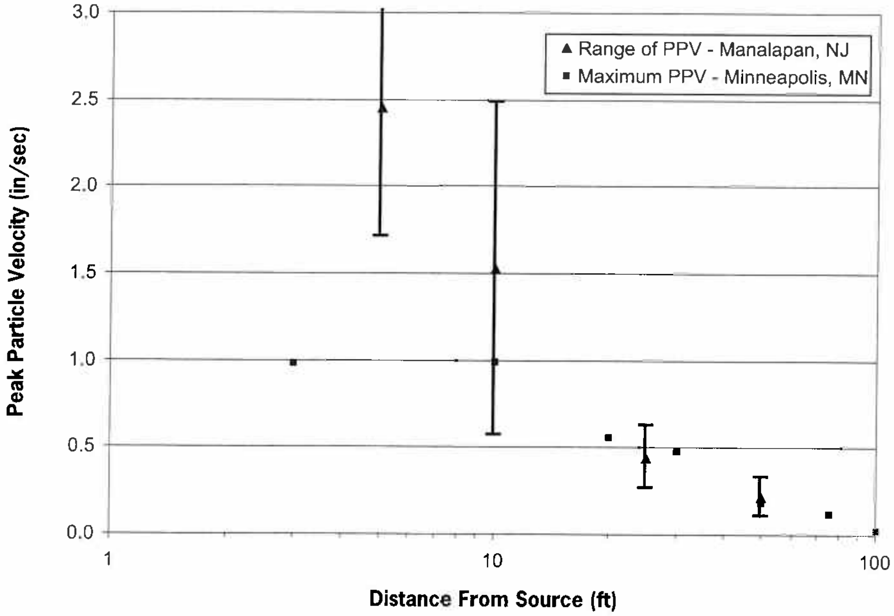


Figure 4.
Peak Particle Velocity With Distance
From Geopier RAP (Fiegel 2005)

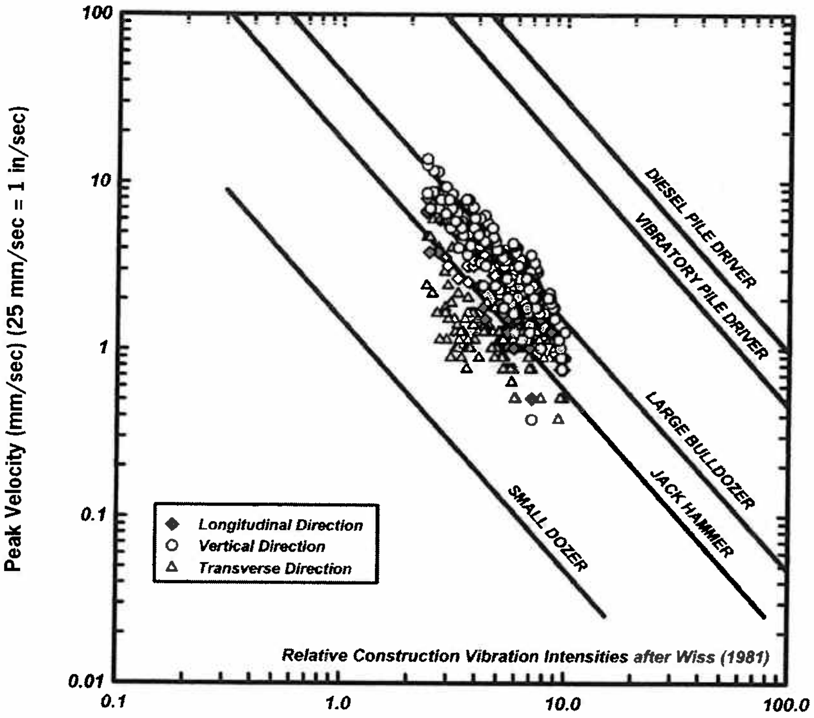
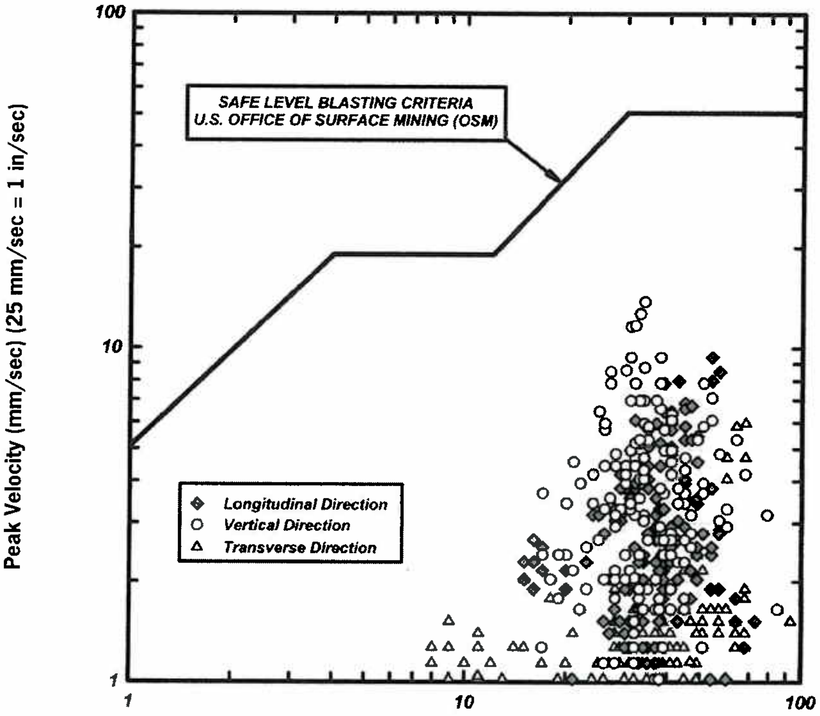


Figure 5 shows the peak particle velocities of the Geopier Rammed Aggregate Piers plotted with vibration frequency as measured at the San Luis Obispo, California project site. The figure indicates that the high frequency energy used during installations results in peak particle velocities lower than the recognized standard threshold for building damage.

Figure 5.
Peak Particle Velocity With
Vibration Frequency (Fiegel 2005)



Although the data from Table 1 and Figures 1 through 5 may be used for most project sites, settlement-sensitive sites should include a site-specific monitoring program to evaluate vibration levels.

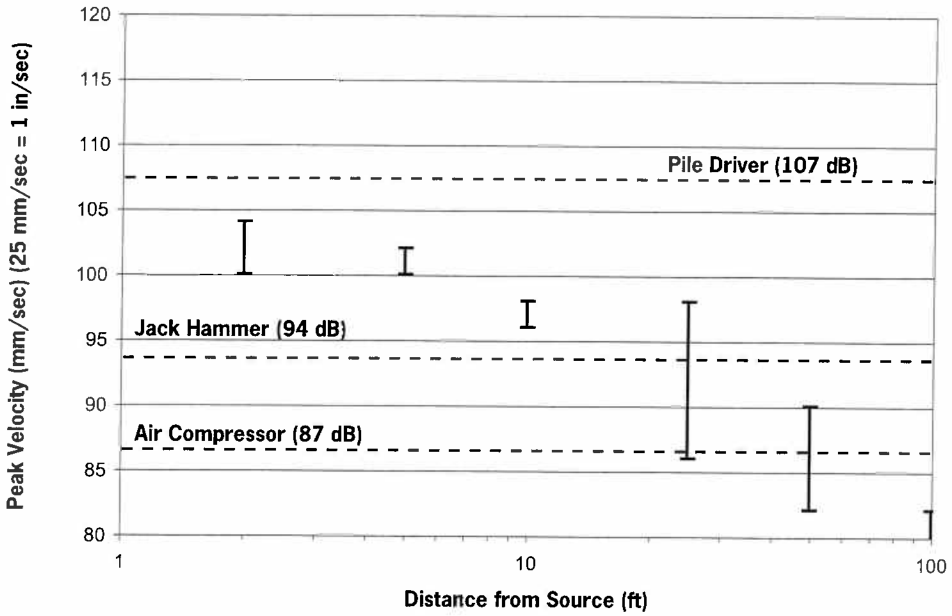
5. NOISE LEVELS

Construction noise decibel levels were recorded during the installation of Geopier Rammed Aggregate Pier elements at the Baptist Memorial Hospital project. Using a decibel meter, the noise levels were recorded with increasing distance from the Geopier RAP installation. At each distance, readings were recorded for the noise level while the ramming assembly was positioned at both the top and the bottom of the cavity. The results of the measurements are summarized in Table 2 and shown in Figure 6.

Table 2.
Summary Of Noise Levels

DISTANCE FROM RAMMING ASSEMBLY (ft)	DECIBEL LEVEL WITH TAMPER AT TOP (dB)	DECIBEL LEVEL WITH TAMPER AT BOTTOM (dB)
2	100	104
5	100	102
10	96	98
25	86	98
50	82	90
100	75	82

Figure 6.
Range Of Geopier RAP Noise Levels With Distance From Source



The decibel level for the Geopier RAP installation process reduces significantly with distance from the ramming assembly. The decibel levels drop from approximately 100 dB adjacent to the Geopier installation equipment to approximately 75 to 80 dB at a distance of 50 to 100 feet. For comparison purposes, it should be noted that interpersonal communication is on the order of 60 dB, heavy truck traffic is on the order of 85 dB and pile driving operations are on the order of 105 dB.

6. CONCLUSIONS

Rammed Aggregate Pier installations induce high frequency (low period) vibrations during the construction process. Vibration levels for Geopier Rammed Aggregate Piers are typically within acceptable levels at distances between 2 and 5 feet from the installation location, while vibration levels for Impact Rammed Aggregate Piers are within tolerable levels at distances between 10 and 20 feet from installation locations. Noise levels for Rammed Aggregate Piers are consistent with construction-type activities.

ACKNOWLEDGEMENTS

The authors are indebted to Peterson Contractors, Inc. for providing vibration results and JGI/Eastern, Inc., French and Parrello Associates, and American Engineering Testing, Inc. for providing vibration monitoring services.

REFERENCES

Fiegel, G. (2005). Measurement of Vibration and Noise During the Installation of Rammed Aggregate Piers - Preliminary Data Report Draft, Department of Civil and Environmental Engineering. California Polytechnic State University. San Luis Obispo, CA.

Fox, N.S. and Cowell, M.J. (1998). *Geopier Foundation and Soil Reinforcement Manual*, Geopier Foundation Company, Inc., Scottsdale, AZ.

Wiss, J.F. (1981). Construction Vibrations: State-of-the-Art. ASCE Journal of the Geotechnical Engineering Division, 107 (GT2), pp. 167-181.

AUTHORS

Brendan T. FitzPatrick, Director of Engineering / Development - North America, Geopier Foundation Company, Inc.
Kord J. Wissmann, Ph.D., P.E., President / Chief Engineer, Geopier Foundation Company, Inc.

NORTH AMERICA
AND SOUTH AMERICA

Geopier Foundation Company, Inc.
Telephone: (540) 951.8076 or (800) 371.7470
Fax: (540) 951.8078
Email: info@geopier.com
www.geopier.com

EUROPE AND ASIA

Geopier Global Corporation
Telephone: (480) 998.3522
Fax: (480) 998.3542
Email: natfox@geopierglobal.com
www.geopierglobal.com

GEOPIER
FOUNDATION COMPANY

Geopier Foundation Company, Inc.

800.371.7470
www.geopier.com

4_2006