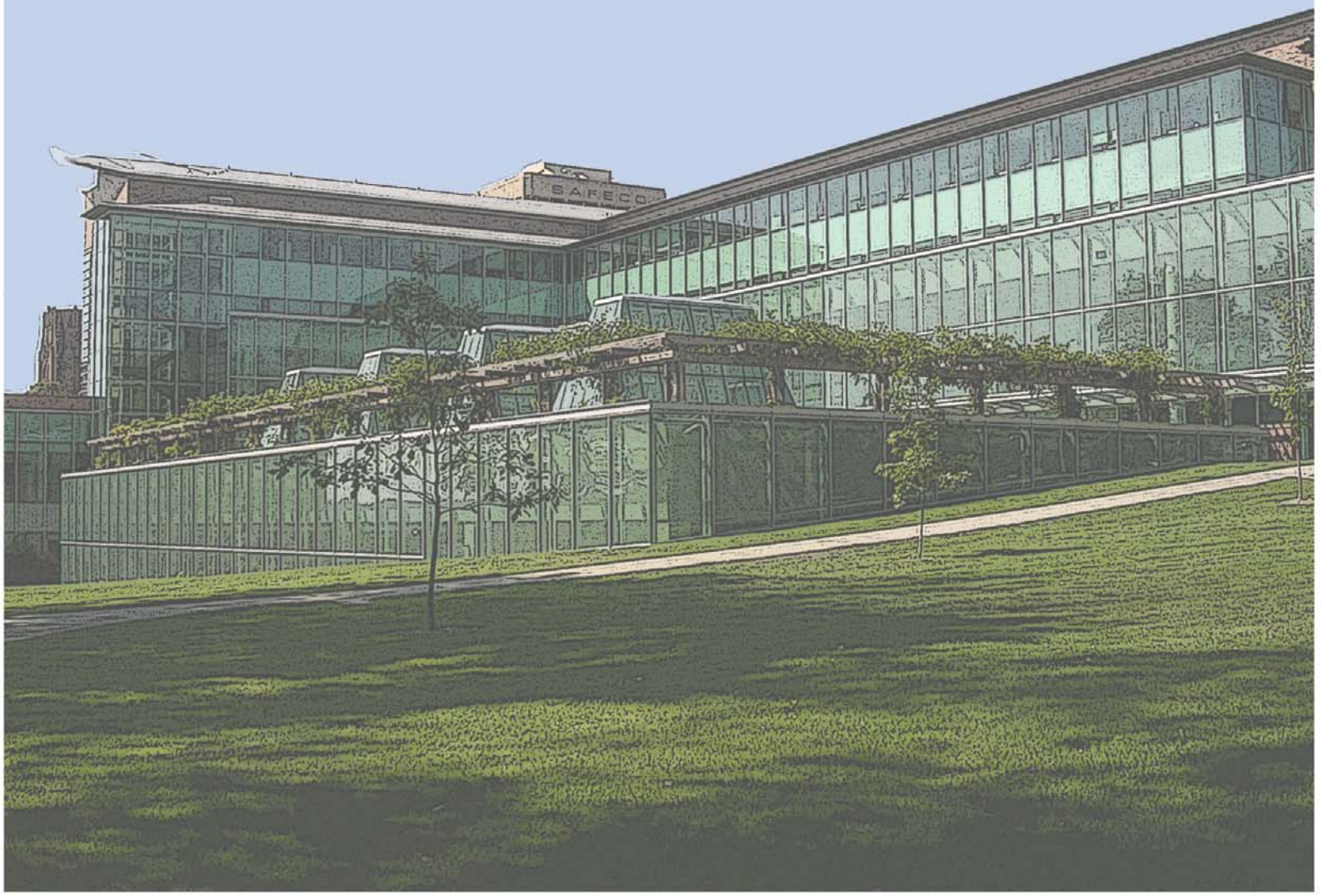
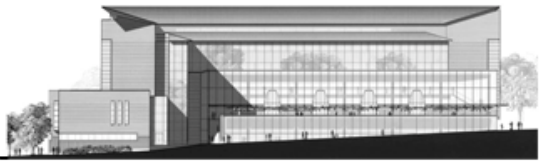
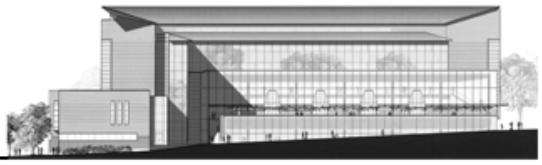
Electrical Depth





Electrical Coordination of Lighting Design



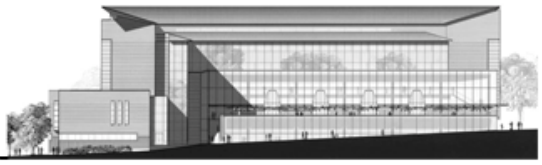
Introduction

The following study looks at the required electrical changes and coordination for the lighting designs proposed in the Lighting Depth. For each of the four spaces, the existing lighting loads and panelboards are evaluated and redesigned for the corresponding changes. Existing panelboards for each space are shown with the lighting loads and circuits to be removed or adjusted noted in yellow. The updated panelboard schedules reflect all lighting changes made in each of the spaces.

Demand factors used in creating panelboard design loads were determined according to those values used in the original design in order to keep panelboard calculations consistent. Please refer to Appendix B for all panel board worksheets that were used to help create the panelboards and determine connected and design loads.

A large majority of the existing panels in the building and those that are considered for the lighting redesign are extremely oversized. It is possible that the panels were oversized per the owner's request or to allow for future loads and building changes. While the reason for the original design criteria is unknown, this study will use this assumption that each of the panels will require a substantial spare capacity for future loads, but not to the extent that the panelboards were originally designed. In redesigning and resizing each of the panelboards, consideration is given to the fact that most of the panels are currently loaded very lightly and that future loads added to these panels could be fairly significant.

Feeder and conduit sizes for each revised panelboard are determined using the NEC 2005 Table 310.16 and NEC Chapter 9. Refer to Appendix B for conduit sizing worksheets.



Jeffrey & Susan Brotman Galleria

The existing lighting design of the two-story galleria utilizes circuits on five separate panelboards: one lighting panel and one emergency panel on the first floor and two lighting panels and one emergency panel on the second floor. These panels include panels PCB-NW01-N02 and PCB-NWB1-E02, which serve loads for the first level of the galleria, and panels PCB-NW02-N02, PCB-NE02-N04 and NW03-E02, which serve lighting loads for the galleria's second floor. Each of these panels will be used for the circuiting of the proposed lighting design in the galleria with the exception of the second lighting panel serving the second floor, panel PCB-NE02-N04.

All of the lighting loads, except the emergency lighting, will be placed on new lighting circuits dedicated to this area due to the desired control scheme for this space. Existing lighting loads for this area were circuited to all lighting loads in the main circulation areas on each respective floor. However, the new lighting design calls for the galleria lights to remain off during daytime hours due to the exceedingly high levels of daylight in the space, and therefore, these loads need to be circuited independently from the interior circulation areas. Two spare circuits from both panel PCB-NW01-N02 and panel PCB-NW02-N02 will be utilized to serve loads to the first and second floor, respectively.

Throughout the galleria, several luminaires will be integrated into the existing emergency circuit serving the space in order to meet emergency lighting requirements. The existing emergency loads in the galleria will be taken off of the circuits from panels PCB-NWB1-E02 and PCB-NW03-E02, and replaced with the emergency loads from the proposed lighting design.

As outlined in the Lighting Depth, each of the circuits serving the Galleria will be controlled via an automated relay system, with the exception of the emergency lighting circuit.

Please refer to the following Lighting Power Plan and Panelboard Schedules for further information on lighting circuitry and corresponding loads.

The following table outlines feeder and conduit sizes for each of the revised panelboards in the galleria.

Table 2.1 – Galleria Panelboard Feeder & Conduit Sizes

PANELBOARD	OVERCURRENT PROTECTION	FEEDER SIZE				CONDUIT SIZE
		NO. SETS	PHASE	NEUTRAL	GROUND	
PCB-NW01-N02	150A 3P C/B	1	3#1/0	1#1/0	1#6	1 1/2"
PCB-NWB1-E02	150A 3P C/B	1	3#1/0	1#1/0	1#6	1 1/2"
PCB-NE02-N04	150A 3P C/B	1	3#1/0	1#1/0	1#6	1 1/2"
PCB-NW03-E02	150A 3P C/B	1	3#1/0	1#1/0	1#6	1 1/2"

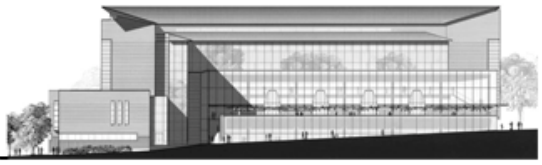
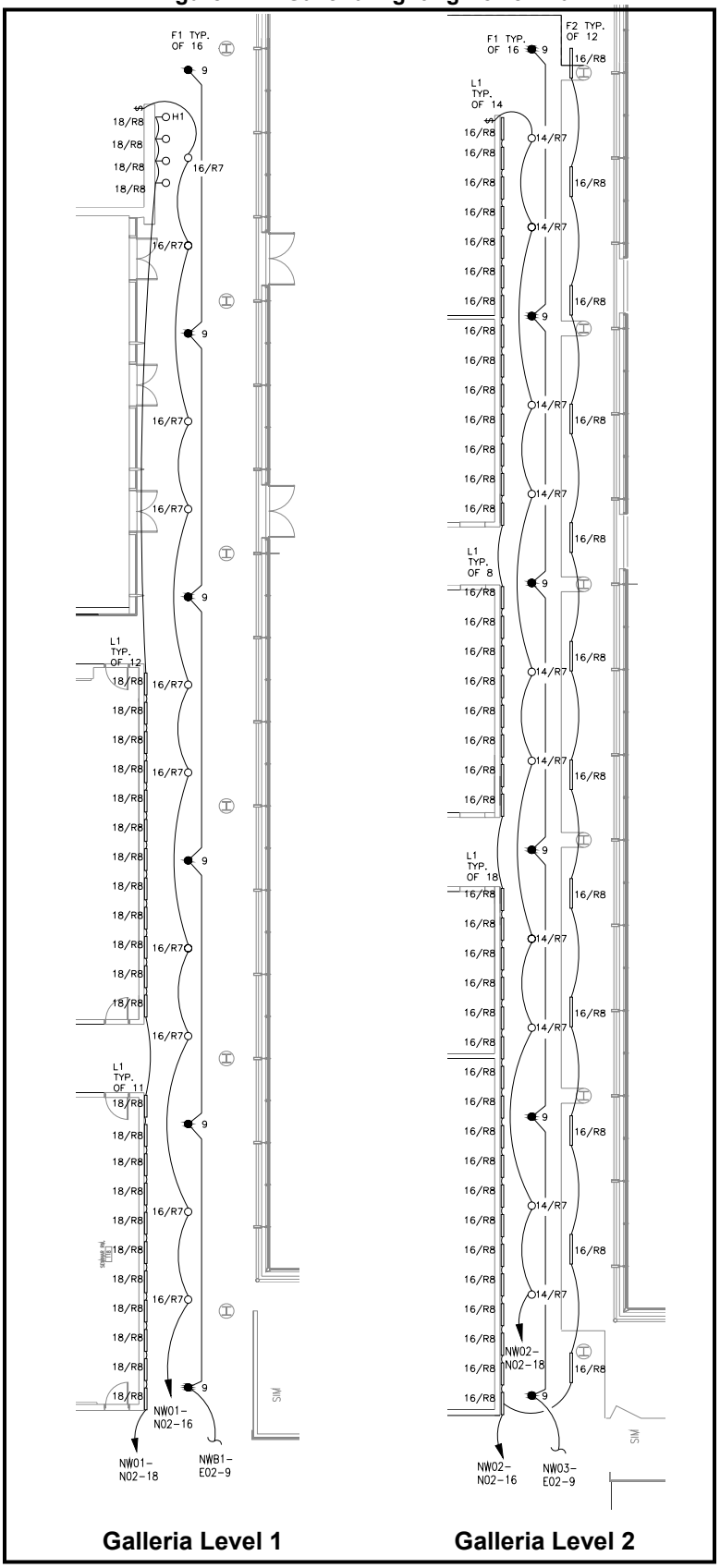


Figure 2.1 – Galleria Lighting Power Plan



Galleria Level 1 **Galleria Level 2**

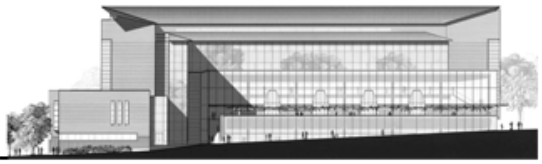


Figure 2.2 –Existing Panelboard Schedule PCB-NW01-N02

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 150A
SIZE/TYPE MAIN: 150A/3P C/B

PANEL TAG: PCB-NW01-N02
PANEL LOCATION: ELEC. ROOM NW - LEVEL 01
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 35K
OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
MECH FTU	WEST	6300	60A/3P	1	*			2	20A/1P	2850	SW ROOMS	LIGHTING
--	WEST	6400	--	3		*		4	20A/1P	950	NW ROOMS	LIGHTING
--	WEST	6200	--	5			*	6	20A/1P	1995	LOUNGE	LIGHTING
LIGHTING	RM 118	1235	20A/1P	7	*			8	20A/1P	3600	CORRIDOR	LIGHTING
SPARE		0	20A/1P	9		*		10	20A/1P	2280	SE EXTERIOR	LIGHTING
SPARE		0	20A/1P	11			*	12	20A/1P	1995	SE EXTERIOR	LIGHTING
MECH FTU	WEST	9500	60A/3P	13	*			14	20A/1P	500		ALC-1A
--	WEST	9500	--	15		*		16	20A/1P	0		SPARE
--	WEST	9500	--	17			*	18	20A/1P	0		SPARE
SPARE		0	60A/3P	19	*			20	20A/1P	0		SPARE
--		0	--	21		*		22	20A/1P	0		SPARE
--		0	--	23			*	24	20A/1P	0		SPARE
SPARE		0	20A/1P	25	*			26	20A/1P	0		SPARE
SPARE		0	20A/1P	27		*		28	20A/1P	0		SPARE
SPARE		0	20A/1P	29			*	30	20A/1P	0		SPARE
SPARE		0	20A/1P	31	*			32	20A/1P	0		SPARE
SPARE		0	20A/1P	33		*		34	20A/1P	0		SPARE
SPARE		0	20A/1P	35			*	36	20A/1P	0		SPARE
SPARE		0	20A/1P	37	*			38	20A/1P	0		SPARE
SPARE		0	20A/1P	39		*		40	20A/1P	0		SPARE
SPARE		0	20A/1P	41			*	42	20A/1P	0		SPARE

CONNECTED LOAD (KW) - A	23.99	TOTAL DESIGN LOAD (KW)	92.07
CONNECTED LOAD (KW) - B	19.13	POWER FACTOR	0.99
CONNECTED LOAD (KW) - C	19.69	TOTAL DESIGN LOAD (AMPS)	112

Figure 2.3 –Revised Panelboard Schedule PCB-NW01-N02

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 150A
SIZE/TYPE MAIN: 150A/3P C/B

PANEL TAG: PCB-NW01-N02
PANEL LOCATION: ELEC. ROOM NW - LEVEL 01
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 14K
OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
MECH FTU	WEST	6300	60A/3P	1	*			2	20A/1P	2850	SW ROOMS	LIGHTING
--	WEST	6400	--	3		*		4	20A/1P	950	NW ROOMS	LIGHTING
--	WEST	6200	--	5			*	6	20A/1P	1995	LOUNGE	LIGHTING
LIGHTING	RM 118	1235	20A/1P	7	*			8	20A/1P	1967	CORRIDOR	LIGHTING
SPARE		0	20A/1P	9		*		10	20A/1P	1920	TERRACE	LIGHTING
SPARE		0	20A/1P	11			*	12	20A/1P	1756	TERRACE	LIGHTING
MECH FTU	WEST	9500	60A/3P	13	*			14	20A/1P	500	ELEC. RM	ALC-1A
--	WEST	9500	--	15		*		16	20A/1P	340	GALLERIA	LIGHTING
--	WEST	9500	--	17			*	18	20A/1P	936	GALLERIA	LIGHTING
SPARE		0	60A/3P	19	*			20	20A/1P	0		SPARE
--		0	--	21		*		22	20A/1P	0		SPARE
--		0	--	23			*	24	20A/1P	0		SPARE
SPARE		0	20A/1P	25	*			26	20A/1P	0		SPARE
SPARE		0	20A/1P	27		*		28	20A/1P	0		SPARE
SPARE		0	20A/1P	29			*	30	20A/1P	0		SPARE
SPARE		0	20A/1P	31	*			32	20A/1P	0		SPARE
SPARE		0	20A/1P	33		*		34	20A/1P	0		SPARE
SPARE		0	20A/1P	35			*	36	20A/1P	0		SPARE
SPARE		0	20A/1P	37	*			38	20A/1P	0		SPARE
SPARE		0	20A/1P	39		*		40	20A/1P	0		SPARE
SPARE		0	20A/1P	41			*	42	20A/1P	0		SPARE

CONNECTED LOAD (KW) - A	22.35	TOTAL DESIGN LOAD (KW)	90.58
CONNECTED LOAD (KW) - B	19.11	POWER FACTOR	0.99
CONNECTED LOAD (KW) - C	20.39	TOTAL DESIGN LOAD (AMPS)	110

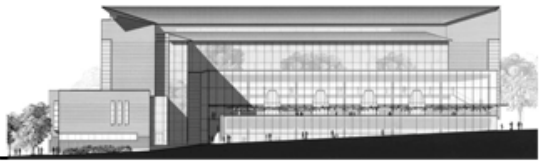


Figure 2.4 –Existing Panelboard Schedule PCB-NWB1-E02

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 225A
SIZE/TYPE MAIN: 225A/3P C/B

PANEL TAG: PCB-NWB1-E02
PANEL LOCATION: ELEC. RM NW - LEVEL B1
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 25K
OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
LIGHTING	EXIT SIGNS	95	20A/1P	1	*			2	20A/1P	380	STAIR 1	LIGHTING
LIGHTING	EGRESS	3135	20A/1P	3		*		4	20A/1P	190	STAIR 4	LIGHTING
LIGHTING	MECH/ELEC	380	20A/1P	5			*	6	20A/1P	1425	L107	LIGHTING
LIGHTING	EXIT SIGNS	95	20A/1P	7	*			8	20A/1P	0		SPARE
LIGHTING	EGRESS L-01	1235	20A/1P	9		*		10	20A/1P	0		SPARE
LIGHTING	MECH/ELEC	380	20A/1P	11			*	12	20A/1P	0		SPARE
SPARE		0	20A/1P	13	*			14	20A/1P	0		SPARE
SPARE		0	20A/1P	15		*		16	20A/1P	0		SPARE
SPARE		0	20A/1P	17			*	18	20A/1P	0		SPARE
SPARE		0	20A/1P	19	*			20	20A/1P	0		SPARE
SPARE		0	20A/1P	21		*		22	20A/1P	0		SPARE
SPARE		0	20A/1P	23			*	24	20A/1P	0		SPARE
SPARE		0	20A/1P	25	*			26	20A/1P	0		SPARE
SPARE		0	20A/1P	27		*		28	20A/1P	0		SPARE
SPARE		0	20A/1P	29			*	30	20A/1P	0		SPARE
SPARE		0	20A/1P	31	*			32	40A/3P	0		SPARE
SPARE		0	20A/1P	33		*		34	--	0		--
SPARE		0	20A/1P	35			*	36	--	0		--
SPARE		0	20A/1P	37	*			38	40A/3P	0		SPARE
SPARE		0	20A/1P	39		*		40	--	0		--
SPARE		0	20A/1P	41			*	42	--	0		--

CONNECTED LOAD (KW) - A	0.57	TOTAL DESIGN LOAD (KW)	11.43
CONNECTED LOAD (KW) - B	4.56	POWER FACTOR	0.95
CONNECTED LOAD (KW) - C	2.19	TOTAL DESIGN LOAD (AMPS)	14

Figure 2.4 – Revised Panelboard Schedule PCB-NWB1-E02

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 150A
SIZE/TYPE MAIN: 150A/3P C/B

PANEL TAG: PCB-NWB1-E02
PANEL LOCATION: ELEC. RM NW - LEVEL B1
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 14K
OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
LIGHTING	EXIT SIGNS	95	20A/1P	1	*			2	20A/1P	380	STAIR 1	LIGHTING
LIGHTING	EGRESS	3135	20A/1P	3		*		4	20A/1P	190	STAIR 4	LIGHTING
LIGHTING	MECH/ELEC	380	20A/1P	5			*	6	20A/1P	460	LIBRARY	LIGHTING
LIGHTING	EXIT SIGNS	95	20A/1P	7	*			8	20A/1P	0		SPARE
LIGHTING	EGRESS L-01	1116	20A/1P	9		*		10	20A/1P	0		SPARE
LIGHTING	MECH/ELEC	380	20A/1P	11			*	12	20A/1P	0		SPARE
SPARE		0	20A/1P	13	*			14	20A/1P	0		SPARE
SPARE		0	20A/1P	15		*		16	20A/1P	0		SPARE
SPARE		0	20A/1P	17			*	18	20A/1P	0		SPARE
SPARE		0	20A/1P	19	*			20	20A/1P	0		SPARE
SPARE		0	20A/1P	21		*		22	20A/1P	0		SPARE
SPARE		0	20A/1P	23			*	24	20A/1P	0		SPARE
SPARE		0	20A/1P	25	*			26	20A/1P	0		SPARE
SPARE		0	20A/1P	27		*		28	20A/1P	0		SPARE
SPARE		0	20A/1P	29			*	30	20A/1P	0		SPARE
SPARE		0	20A/1P	31	*			32	20A/1P	0		SPARE
SPARE		0	20A/1P	33		*		34	20A/1P	0		SPARE
SPARE		0	20A/1P	35			*	36	20A/1P	0		SPARE
SPARE		0	20A/1P	37	*			38	20A/1P	0		SPARE
SPARE		0	20A/1P	39		*		40	20A/1P	0		SPARE
SPARE		0	20A/1P	41			*	42	20A/1P	0		SPARE

CONNECTED LOAD (KW) - A	0.57	TOTAL DESIGN LOAD (KW)	13.63
CONNECTED LOAD (KW) - B	4.44	POWER FACTOR	0.95
CONNECTED LOAD (KW) - C	1.22	TOTAL DESIGN LOAD (AMPS)	17

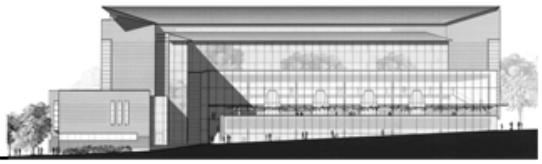


Figure 2.5 –Existing Panelboard Schedule PCB-NW02-N02

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 400A
SIZE/TYPE MAIN: 400A MLO

PANEL TAG: PCB-NW02-N02
PANEL LOCATION: ELEC. RM NW LEVEL 02
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 35K
OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
MECH FTU	WEST	3900	60A/3P	1	*			2	20A/1P	2565	WEST OFFICES	LIGHTING
--	WEST	3200	--	3		*		4	20A/1P	1805	SW CORRIDOR	LIGHTING
--	WEST	2400	--	5			*	6	20A/1P	1425	SW OFFICES	LIGHTING
SPARE	0	0	20A/1P	7	*			8	20A/1P	855	NW ROOMS	LIGHTING
SPARE		0	20A/1P	9		*		10	20A/1P	2185	CENTRAL CORR	LIGHTING
SPARE		0	20A/1P	11			*	12	20A/1P	570	CLEAR STORY	LIGHTING
SPARE		0	20A/1P	13	*			14	20A/1P	0		SPARE
--		0	--	15		*		16	20A/1P	0		SPARE
--		0	--	17			*	18	20A/1P	0		SPARE
SPARE		0	20A/1P	19	*			20	20A/1P	0		SPARE
SPARE		0	20A/1P	21		*		22	20A/1P	0		SPARE
SPARE		0	20A/1P	23			*	24	20A/1P	0		SPARE
SPARE		0	20A/1P	25	*			26	20A/1P	0		SPARE
SPARE		0	20A/1P	27		*		28	20A/1P	0		SPARE
SPARE		0	20A/1P	29			*	30	20A/1P	0		SPARE
SPARE		0	20A/1P	31	*			32	20A/1P	0		SPARE
SPARE		0	20A/1P	33		*		34	20A/1P	0		SPARE
SPARE		0	20A/1P	35			*	36	20A/1P	0		SPARE
SPARE		0	20A/1P	37	*			38	20A/1P	0		SPARE
SPARE		0	20A/1P	39		*		40	20A/1P	0		SPARE
SPARE		0	20A/1P	41			*	42	20A/1P	0		SPARE

CONNECTED LOAD (KW) - A	7.32	TOTAL DESIGN LOAD (KW)	29.54
CONNECTED LOAD (KW) - B	7.19	POWER FACTOR	0.97
CONNECTED LOAD (KW) - C	4.40	TOTAL DESIGN LOAD (AMPS)	36

Figure 2.6 – Revised Panelboard Schedule PCB-NW02-N02

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 150A
SIZE/TYPE MAIN: 150A C/B

PANEL TAG: PCB-NW02-N02
PANEL LOCATION: ELEC. RM NW LEVEL 02
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 14K
OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
MECH FTU	WEST	3900	60A/3P	1	*			2	20A/1P	2565	WEST OFFICES	LIGHTING
--	WEST	3200	--	3		*		4	20A/1P	1805	SW CORRIDOR	LIGHTING
--	WEST	2400	--	5			*	6	20A/1P	888	SW OFFICES	LIGHTING
SPARE	0	0	20A/1P	7	*			8	20A/1P	855	NW ROOMS	LIGHTING
SPARE		0	20A/1P	9		*		10	20A/1P	2185	CENTRAL CORR	LIGHTING
SPARE		0	20A/1P	11			*	12	20A/1P	570	CLEAR STORY	LIGHTING
SPARE		0	20A/1P	13	*			14	20A/1P	340	GALLERIA	LIGHTING
--		0	--	15		*		16	20A/1P	1640	GALLERIA	LIGHTING
--		0	--	17			*	18	20A/1P	0		SPARE
SPARE		0	20A/1P	19	*			20	20A/1P	0		SPARE
SPARE		0	20A/1P	21		*		22	20A/1P	0		SPARE
SPARE		0	20A/1P	23			*	24	20A/1P	0		SPARE
SPARE		0	20A/1P	25	*			26	20A/1P	0		SPARE
SPARE		0	20A/1P	27		*		28	20A/1P	0		SPARE
SPARE		0	20A/1P	29			*	30	20A/1P	0		SPARE
SPARE		0	20A/1P	31	*			32	20A/1P	0		SPARE
SPARE		0	20A/1P	33		*		34	20A/1P	0		SPARE
SPARE		0	20A/1P	35			*	36	20A/1P	0		SPARE
SPARE		0	20A/1P	37	*			38	20A/1P	0		SPARE
SPARE		0	20A/1P	39		*		40	20A/1P	0		SPARE
SPARE		0	20A/1P	41			*	42	20A/1P	0		SPARE

CONNECTED LOAD (KW) - A	7.66	TOTAL DESIGN LOAD (KW)	38.15
CONNECTED LOAD (KW) - B	8.83	POWER FACTOR	0.97
CONNECTED LOAD (KW) - C	3.86	TOTAL DESIGN LOAD (AMPS)	47

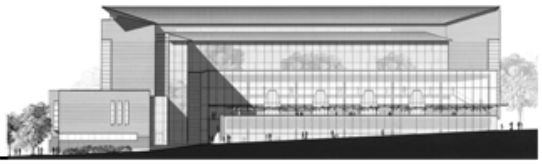


Figure 2.7 –Existing Panelboard Schedule PCB-NE02-N04

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 150A
SIZE/TYPE MAIN: 150A/3P C/B

PANEL TAG: PCB-NE02-N04
PANEL LOCATION: ELEC. RM NE -LEVEL 02
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 42K
OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
MECH FTU	EAST	4800	60A/3P	1	*			2	20A/1P	1330	S. FOYER	LIGHTING
--	EAST	700	--	3		*		4	20A/1P	2280	S. FOYER	LIGHTING
--	EAST	2600	--	5			*	6	20A/1P	2945	CENTRAL OFF.	LIGHTING
SPARE		0	20A/1P	7	*			8	20A/1P	760	LOCKERS	LIGHTING
SPARE		0	20A/1P	9		*		10	20A/1P	285	NE ROOMS	LIGHTING
SPARE	0	0	20A/1P	11			*	12	20A/1P	1235	E. FOYER	LIGHTING
SPARE		0	60A/3P	13	*			14	20A/1P	1805	RM. 217	LIGHTING
--		0	--	15		*		16	20A/1P	1235	RM. 213	LIGHTING
--		0	--	17			*	18	20A/1P	665	RM. 212	LIGHTING
SPARE		0	20A/1P	19	*			20	20A/1P	1615	RM. 222	LIGHTING
SPARE		0	20A/1P	21		*		22	20A/1P	500	ELEC. CLOS	ALC-2B
SPARE		0	20A/1P	23			*	24	20A/1P	0		SPARE
SPARE		0	20A/1P	25	*			26	20A/1P	0		SPARE
SPARE		0	20A/1P	27		*		28	20A/1P	0		SPARE
SPARE		0	20A/1P	29			*	30	20A/1P	0		SPARE
SPARE		0	20A/1P	31	*			32	20A/1P	0		SPARE
SPARE		0	20A/1P	33		*		34	20A/1P	0		SPARE
SPARE		0	20A/1P	35			*	36	20A/1P	0		SPARE
SPARE		0	20A/1P	37	*			38	20A/1P	0		SPARE
SPARE		0	20A/1P	39		*		40	20A/1P	0		SPARE
SPARE		0	20A/1P	41			*	42	20A/1P	0		SPARE

CONNECTED LOAD (KW) - A	10.31	TOTAL DESIGN LOAD (KW)	35.40
CONNECTED LOAD (KW) - B	5.00	POWER FACTOR	0.97
CONNECTED LOAD (KW) - C	7.45	TOTAL DESIGN LOAD (AMPS)	44

Figure 2.8 – Revised Panelboard Schedule PCB-NE02-N04

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 150A
SIZE/TYPE MAIN: 150A/3P C/B

PANEL TAG: PCB-NE02-N04
PANEL LOCATION: ELEC. RM NE -LEVEL 02
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 42K
OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
MECH FTU	EAST	4800	60A/3P	1	*			2	20A/1P	0	0	SPARE
--	EAST	700	--	3		*		4	20A/1P	0	0	SPARE
--	EAST	2600	--	5			*	6	20A/1P	2945	CENTRAL OFF.	LIGHTING
SPARE		0	20A/1P	7	*			8	20A/1P	760	LOCKERS	LIGHTING
SPARE		0	20A/1P	9		*		10	20A/1P	285	NE ROOMS	LIGHTING
SPARE	0	0	20A/1P	11			*	12	20A/1P	1235	E. FOYER	LIGHTING
SPARE		0	60A/3P	13	*			14	20A/1P	1805	RM. 217	LIGHTING
--		0	--	15		*		16	20A/1P	1235	RM. 213	LIGHTING
--		0	--	17			*	18	20A/1P	665	RM. 212	LIGHTING
SPARE		0	20A/1P	19	*			20	20A/1P	1615	RM. 222	LIGHTING
SPARE		0	20A/1P	21		*		22	20A/1P	500	ELEC. CLOS	ALC-2B
SPARE		0	20A/1P	23			*	24	20A/1P	0		SPARE
SPARE		0	20A/1P	25	*			26	20A/1P	0		SPARE
SPARE		0	20A/1P	27		*		28	20A/1P	0		SPARE
SPARE		0	20A/1P	29			*	30	20A/1P	0		SPARE
SPARE		0	20A/1P	31	*			32	20A/1P	0		SPARE
SPARE		0	20A/1P	33		*		34	20A/1P	0		SPARE
SPARE		0	20A/1P	35			*	36	20A/1P	0		SPARE
SPARE		0	20A/1P	37	*			38	20A/1P	0		SPARE
SPARE		0	20A/1P	39		*		40	20A/1P	0		SPARE
SPARE		0	20A/1P	41			*	42	20A/1P	0		SPARE

CONNECTED LOAD (KW) - A	8.98	TOTAL DESIGN LOAD (KW)	29.76
CONNECTED LOAD (KW) - B	2.72	POWER FACTOR	0.97
CONNECTED LOAD (KW) - C	7.45	TOTAL DESIGN LOAD (AMPS)	37

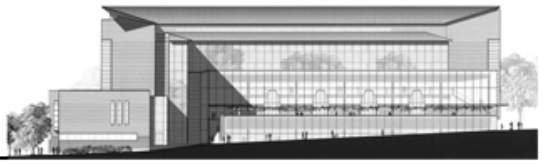


Figure 2.9 –Existing Panelboard Schedule PCB-NW03-E02

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 225A
SIZE/TYPE MAIN: 225A/3P C/B

PANEL TAG: PCB-NW03-E02
PANEL LOCATION: ELEC. RM NW - LEVEL 03
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 25K
OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
LIGHTING	EXIT SIGNS	95	20A/1P	1	*			2	20A/1P	95	EXIT SIGNS	LIGHTING
LIGHTING	EGRESS	1235	20A/1P	3		*		4	20A/1P	1615	EGRESS	LIGHTING
LIGHTING	MECH. EMER	285	20A/1P	5			*	6	20A/1P	285	MECH. EMER	LIGHTING
		0	20A/1P	7	*			8	20A/1P	0		
		0	20A/1P	9		*		10	20A/1P	0		
		0	20A/1P	11			*	12	20A/1P	0		
		0	20A/1P	13	*			14	20A/1P	0		
		0	20A/1P	15		*		16	20A/1P	0		
		0	20A/1P	17			*	18	20A/1P	0		
		0	20A/1P	19	*			20	20A/1P	0		
		0	20A/1P	21		*		22	20A/1P	0		
		0	20A/1P	23			*	24	20A/1P	0		
		0	20A/1P	25	*			26	20A/1P	0		
		0	20A/1P	27		*		28	20A/1P	0		
		0	20A/1P	29			*	30	20A/1P	0		
		0	20A/1P	31	*			32	20A/1P	0		
		0	20A/1P	33		*		34	20A/1P	0		
		0	20A/1P	35			*	36	20A/1P	0		
		0	20A/1P	37	*			38	20A/1P	0		
		0	20A/1P	39		*		40	20A/1P	0		
		0	20A/1P	41			*	42	20A/1P	0		

CONNECTED LOAD (KW) - A	0.19	TOTAL DESIGN LOAD (KW)	5.64
CONNECTED LOAD (KW) - B	2.85	POWER FACTOR	0.95
CONNECTED LOAD (KW) - C	0.57	TOTAL DESIGN LOAD (AMPS)	7

Figure 2.10 – Revised Panelboard Schedule PCB-NW03-E02

PANELBOARD SCHEDULE

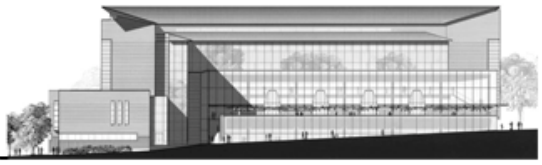
VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 150A
SIZE/TYPE MAIN: 150A/3P C/B

PANEL TAG: PCB-NW03-E02
PANEL LOCATION: ELEC. RM NW - LEVEL 03
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 14K
OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
LIGHTING	EXIT SIGNS	95	20A/1P	1	*			2	20A/1P	95	EXIT SIGNS	LIGHTING
LIGHTING	EGRESS	1235	20A/1P	3		*		4	20A/1P	1549	EGRESS	LIGHTING
LIGHTING	MECH. EMER	285	20A/1P	5			*	6	20A/1P	285	MECH. EMER	LIGHTING
		0	20A/1P	7	*			8	20A/1P	0		
		0	20A/1P	9		*		10	20A/1P	0		
		0	20A/1P	11			*	12	20A/1P	0		
		0	20A/1P	13	*			14	20A/1P	0		
		0	20A/1P	15		*		16	20A/1P	0		
		0	20A/1P	17			*	18	20A/1P	0		
		0	20A/1P	19	*			20	20A/1P	0		
		0	20A/1P	21		*		22	20A/1P	0		
		0	20A/1P	23			*	24	20A/1P	0		
		0	20A/1P	25	*			26	20A/1P	0		
		0	20A/1P	27		*		28	20A/1P	0		
		0	20A/1P	29			*	30	20A/1P	0		
		0	20A/1P	31	*			32	20A/1P	0		
		0	20A/1P	33		*		34	20A/1P	0		
		0	20A/1P	35			*	36	20A/1P	0		
		0	20A/1P	37	*			38	20A/1P	0		
		0	20A/1P	39		*		40	20A/1P	0		
		0	20A/1P	41			*	42	20A/1P	0		

CONNECTED LOAD (KW) - A	0.19	TOTAL DESIGN LOAD (KW)	6.64
CONNECTED LOAD (KW) - B	2.78	POWER FACTOR	0.95
CONNECTED LOAD (KW) - C	0.57	TOTAL DESIGN LOAD (AMPS)	8



Terrace

The existing lighting design of the terrace utilizes circuits on two panelboards: NW01-N02 and NEB1-N04. The two existing circuits on panel NW01-N02 feed all of the exterior lights in the terrace area. The existing lights used to light up the skylights were located on the interior of the skylights and the loads are fed by two circuits on panel NEB1-N04.

The proposed lighting design will reuse the circuits on panelboard NW01-N02. One circuit on this panel will feed all of the exterior lighting loads, and the other will power the luminaires located on the interior of the skylights. No circuits from panelboard NEB1-N04 will be utilized in the lighting redesign of this space.

As explained in the Lighting Depth, each of the circuits in the terrace will be controlled via an automated relay system.

Please refer to the following Lighting Power Plan and Panelboard Schedules for further information on lighting circuitry and corresponding loads.

The following table outlines feeder and conduit sizes for each of the revised panelboards in the terrace.

Table 2.2 – Terrace Panelboard Feeder & Conduit Sizes

PANELBOARD	OVERCURRENT PROTECTION	FEEDER SIZE				CONDUIT SIZE
		NO. SETS	PHASE	NEUTRAL	GROUND	
PCB-NW01-N02	150A 3P C/B	1	3#1/0	1#1/0	1#6	1 1/2"
PCB-NEB1-E04	150A 3P C/B	1	3#1/0	1#1/0	1#6	1 1/2"

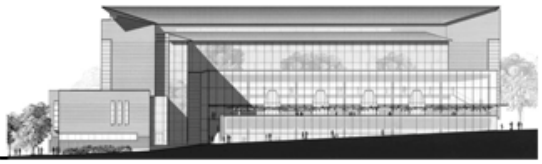
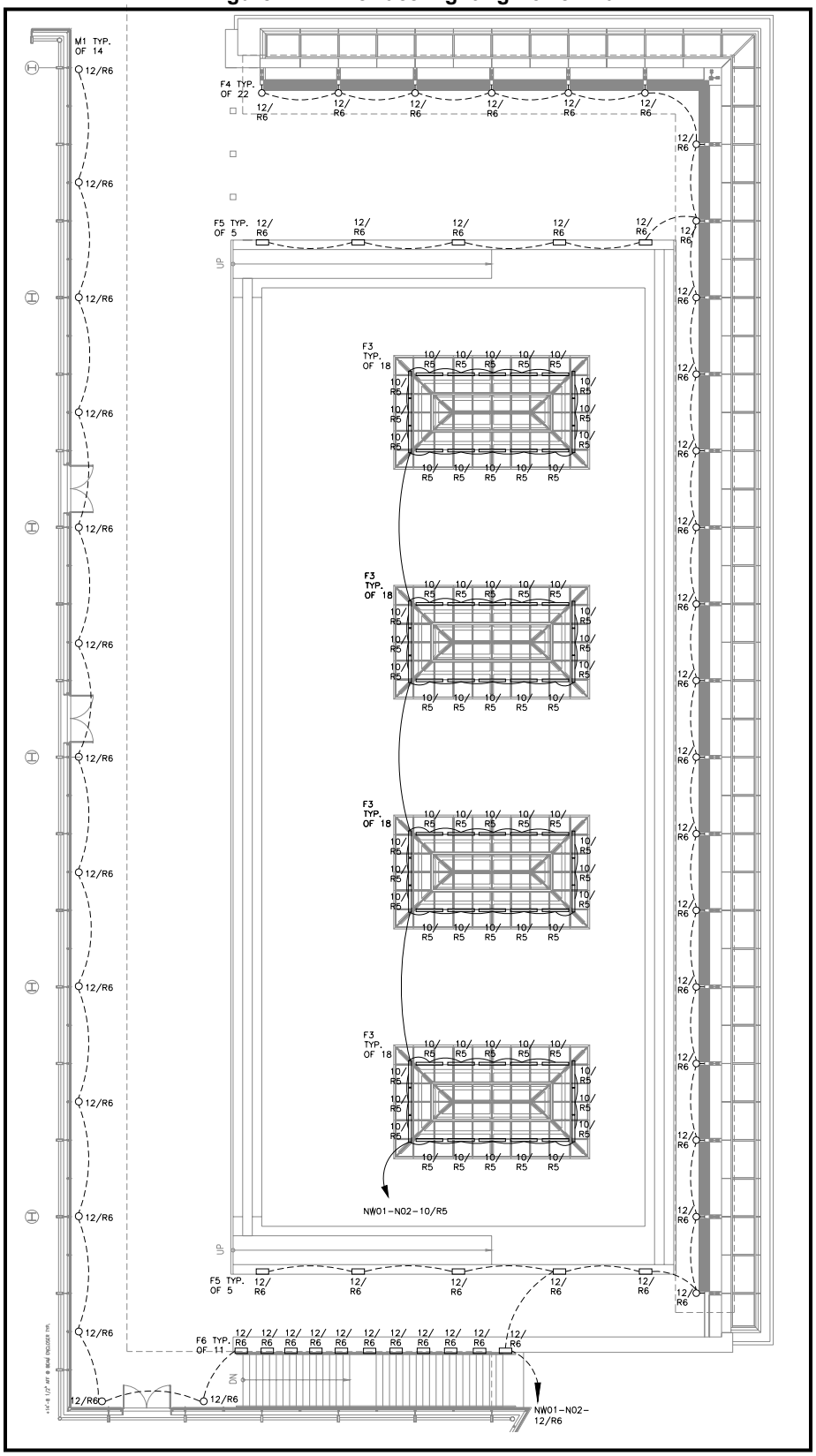


Figure 2.11 – Terrace Lighting Power Plan



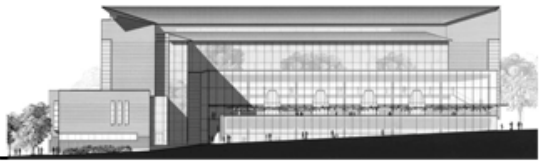


Figure 2.12 –Existing Panelboard Schedule PCB-NW01-N02

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 150A
SIZE/TYPE MAIN: 150A/3P C/B

PANEL TAG: PCB-NW01-N02
PANEL LOCATION: ELEC. ROOM NW - LEVEL 01
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 35K
OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
MECH FTU	WEST	6300	60A/3P	1	*			2	20A/1P	2850	SW ROOMS	LIGHTING
--	WEST	6400	--	3		*		4	20A/1P	950	NW ROOMS	LIGHTING
--	WEST	6200	--	5			*	6	20A/1P	1995	LOUNGE	LIGHTING
LIGHTING	RM 118	1235	20A/1P	7	*			8	20A/1P	3600	CORRIDOR	LIGHTING
SPARE		0	20A/1P	9		*		10	20A/1P	2280	SE EXTERIOR	LIGHTING
SPARE		0	20A/1P	11			*	12	20A/1P	1995	SE EXTERIOR	LIGHTING
MECH FTU	WEST	9500	60A/3P	13	*			14	20A/1P	500		ALC-1A
--	WEST	9500	--	15		*		16	20A/1P	0		SPARE
--	WEST	9500	--	17			*	18	20A/1P	0		SPARE
SPARE		0	60A/3P	19	*			20	20A/1P	0		SPARE
--		0	--	21		*		22	20A/1P	0		SPARE
--		0	--	23			*	24	20A/1P	0		SPARE
SPARE		0	20A/1P	25	*			26	20A/1P	0		SPARE
SPARE		0	20A/1P	27		*		28	20A/1P	0		SPARE
SPARE		0	20A/1P	29			*	30	20A/1P	0		SPARE
SPARE		0	20A/1P	31	*			32	20A/1P	0		SPARE
SPARE		0	20A/1P	33		*		34	20A/1P	0		SPARE
SPARE		0	20A/1P	35			*	36	20A/1P	0		SPARE
SPARE		0	20A/1P	37	*			38	20A/1P	0		SPARE
SPARE		0	20A/1P	39		*		40	20A/1P	0		SPARE
SPARE		0	20A/1P	41			*	42	20A/1P	0		SPARE

CONNECTED LOAD (KW) - A	23.99	TOTAL DESIGN LOAD (KW)	92.07
CONNECTED LOAD (KW) - B	19.13	POWER FACTOR	0.99
CONNECTED LOAD (KW) - C	19.69	TOTAL DESIGN LOAD (AMPS)	112

Figure 2.13 – Revised Panelboard Schedule PCB-NW01-N02

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 150A
SIZE/TYPE MAIN: 150A/3P C/B

PANEL TAG: PCB-NW01-N02
PANEL LOCATION: ELEC. ROOM NW - LEVEL 01
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 14K
OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
MECH FTU	WEST	6300	60A/3P	1	*			2	20A/1P	2850	SW ROOMS	LIGHTING
--	WEST	6400	--	3		*		4	20A/1P	950	NW ROOMS	LIGHTING
--	WEST	6200	--	5			*	6	20A/1P	1995	LOUNGE	LIGHTING
LIGHTING	RM 118	1235	20A/1P	7	*			8	20A/1P	1967	CORRIDOR	LIGHTING
SPARE		0	20A/1P	9		*		10	20A/1P	1920	TERRACE	LIGHTING
SPARE		0	20A/1P	11			*	12	20A/1P	1756	TERRACE	LIGHTING
MECH FTU	WEST	9500	60A/3P	13	*			14	20A/1P	500	ELEC. RM	ALC-1A
--	WEST	9500	--	15		*		16	20A/1P	340	GALLERIA	LIGHTING
--	WEST	9500	--	17			*	18	20A/1P	936	GALLERIA	LIGHTING
SPARE		0	60A/3P	19	*			20	20A/1P	0		SPARE
--		0	--	21		*		22	20A/1P	0		SPARE
--		0	--	23			*	24	20A/1P	0		SPARE
SPARE		0	20A/1P	25	*			26	20A/1P	0		SPARE
SPARE		0	20A/1P	27		*		28	20A/1P	0		SPARE
SPARE		0	20A/1P	29			*	30	20A/1P	0		SPARE
SPARE		0	20A/1P	31	*			32	20A/1P	0		SPARE
SPARE		0	20A/1P	33		*		34	20A/1P	0		SPARE
SPARE		0	20A/1P	35			*	36	20A/1P	0		SPARE
SPARE		0	20A/1P	37	*			38	20A/1P	0		SPARE
SPARE		0	20A/1P	39		*		40	20A/1P	0		SPARE
SPARE		0	20A/1P	41			*	42	20A/1P	0		SPARE

CONNECTED LOAD (KW) - A	22.35	TOTAL DESIGN LOAD (KW)	90.58
CONNECTED LOAD (KW) - B	19.11	POWER FACTOR	0.99
CONNECTED LOAD (KW) - C	20.39	TOTAL DESIGN LOAD (AMPS)	110

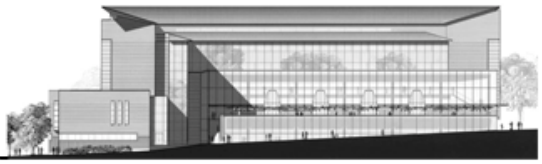


Figure 2.14 –Existing Panelboard Schedule PCB-NEB1-N04

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 225A
SIZE/TYPE MAIN: 225A/3P C/B

PANEL TAG: PCB-NEB1-N04
PANEL LOCATION: ELEC. RM NE LEVEL B1
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 42K
OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
LIGHTING	SE OFFICES	3420	20A/1P	1	*			2	20A/1P	2945	S & SE WALL	LIGHTING
LIGHTING	ALCOVE	950	20A/1P	3		*		4	20A/1P	2755	STACKS	LIGHTING
LIGHTING	LIBR. RDG	2185	20A/1P	5			*	6	20A/1P	2850	STACKS	LIGHTING
LIGHTING	LIBR. RDG	1235	20A/1P	7	*			8	20A/1P	3230	STACKS	LIGHTING
LIGHTING	LIBR. RDG	1710	20A/1P	9		*		10	20A/1P	2755	STACKS	LIGHTING
LIGHTING	LIBR. RDG	1710	20A/1P	11			*	12	20A/1P	2470	STACKS	LIGHTING
LIGHTING	LIBR. RDG	1710	20A/1P	13	*			14	20A/1P	2850	STACKS	LIGHTING
LIGHTING	LIBR. RDG	1710	20A/1P	15		*		16	20A/1P	2470	NE ROOMS	LIGHTING
LIGHTING	LIBR. RDG	1710	20A/1P	17			*	18	20A/1P	500	ELEC. RM	ALC-L1B
LIGHTING	LIBR. RDG	1710	20A/1P	19	*			20	20A/1P	0		SPARE
LIGHTING	LIBR. RDG	2185	20A/1P	21		*		22	20A/1P	0		SPARE
SPARE		0	20A/1P	23			*	24	20A/1P	0		SPARE
SPARE		0	60A/3P	25	*			26	20A/1P	0		SPARE
--		0	--	27		*		28	20A/1P	0		SPARE
--		0	--	29			*	30	20A/1P	0		SPARE
SPARE		0	20A/1P	31	*			32	20A/1P	0		SPARE
SPARE		0	20A/1P	33		*		34	20A/1P	0		SPARE
SPARE		0	20A/1P	35			*	36	20A/1P	0		SPARE
MECH FTU	EAST	6500	60A/3P	37	*			38	20A/1P	0		SPARE
--	EAST	4900	--	39		*		40	20A/1P	0		SPARE
--	EAST	4200	--	41			*	42	20A/1P	0		SPARE

CONNECTED LOAD (KW) - A	23.60	TOTAL DESIGN LOAD (KW)	91.50
CONNECTED LOAD (KW) - B	19.44	POWER FACTOR	0.96
CONNECTED LOAD (KW) - C	15.63	TOTAL DESIGN LOAD (AMPS)	114

Figure 2.15 – Revised Panelboard Schedule PCB- NEB1-N04

PANELBOARD SCHEDULE

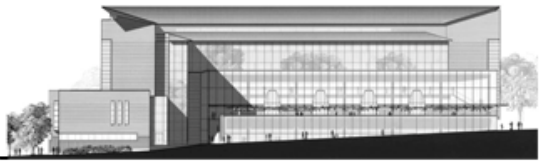
VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 150A
SIZE/TYPE MAIN: 150A/3P C/B

PANEL TAG: PCB-NEB1-N04
PANEL LOCATION: ELEC. RM NE LEVEL B1
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 14K
OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
LIGHTING	SE OFFICES	3420	20A/1P	1	*			2	20A/1P	2945	S & SE WALL	LIGHTING
LIGHTING	ALCOVE	950	20A/1P	3		*		4	20A/1P	2755	STACKS	LIGHTING
LIGHTING	LIBR. RDG	1093	20A/1P	5			*	6	20A/1P	2850	STACKS	LIGHTING
LIGHTING	LIBR. RDG	1235	20A/1P	7	*			8	20A/1P	3230	STACKS	LIGHTING
LIGHTING	LIBR. RDG	1710	20A/1P	9		*		10	20A/1P	2755	STACKS	LIGHTING
LIGHTING	LIBR. RDG	1710	20A/1P	11			*	12	20A/1P	2470	STACKS	LIGHTING
LIGHTING	LIBR. RDG	1710	20A/1P	13	*			14	20A/1P	2850	STACKS	LIGHTING
LIGHTING	LIBR. RDG	1710	20A/1P	15		*		16	20A/1P	2470	NE ROOMS	LIGHTING
LIGHTING	LIBR. RDG	1710	20A/1P	17			*	18	20A/1P	500	ELEC. RM	ALC-L1B
LIGHTING	LIBR. RDG	1710	20A/1P	19	*			20	20A/1P	0		SPARE
LIGHTING	LIBR. RDG	1093	20A/1P	21		*		22	20A/1P	0		SPARE
SPARE		0	20A/1P	23			*	24	20A/1P	0		SPARE
SPARE		0	60A/3P	25	*			26	20A/1P	0		SPARE
--		0	--	27		*		28	20A/1P	0		SPARE
--		0	--	29			*	30	20A/1P	0		SPARE
SPARE		0	20A/1P	31	*			32	20A/1P	0		SPARE
SPARE		0	20A/1P	33		*		34	20A/1P	0		SPARE
SPARE		0	20A/1P	35			*	36	20A/1P	0		SPARE
MECH FTU	EAST	6500	60A/3P	37	*			38	20A/1P	0		SPARE
--	EAST	4900	--	39		*		40	20A/1P	0		SPARE
--	EAST	4200	--	41			*	42	20A/1P	0		SPARE

CONNECTED LOAD (KW) - A	23.60	TOTAL DESIGN LOAD (KW)	88.09
CONNECTED LOAD (KW) - B	18.34	POWER FACTOR	0.96
CONNECTED LOAD (KW) - C	14.53	TOTAL DESIGN LOAD (AMPS)	110



Senator Warren G. Magnuson & Senator Henry Jackson Trial Courtroom

The lighting loads in the Trial Courtroom are controlled and powered by a preset scene dimming system and dimming panel. The existing lighting designing in this space is fed from a 208Y/120V, 3PH, 4W dimmer rack panel with 16 circuits. This panel is served from distribution panel PCD-SW01-N05. This dimmer rack panel will be replaced with a 480/277V, 3PH, 4W dimmer rack with 8 circuits, which will be fed from panel PCB-NWB2-N03(2). All existing feeders feeding to the existing dimmer rack will be removed and new feeders will be fed to the new dimming panel in the first floor southwest electrical room.

A Lutron GP Dimming Panel, model GP12-2774M60-20 will be utilized for control of this space. Please refer to the 'Controls' section of Appendix A for more information regarding the power requirements of this dimming panel.

As outlined in the Lighting Depth, the luminaires in the Trial Courtroom are divided into eight separate zones. Each of these zones characterizes a single circuit to the dimming panel.

Please refer to the following Lighting Power Plan, Dimmer Rack Schedules, Panelboard/Distribution Panel Schedules and One-Line Diagrams for further information on the lighting power requirements. On the existing one-line diagram, the dimmer rack and associated feeder to be removed is noted it red. Likewise, on the revised one-line diagram the proposed new dimming rack and feeders are shown in blue.

The following table outlines feeder and conduit sizes for each of the revised panelboards in the courtroom.

Table 2.3 – Courtroom Panelboard Feeder & Conduit Sizes

PANELBOARD	OVERCURRENT PROTECTION	FEEDER SIZE				CONDUIT SIZE
		NO. SETS	PHASE	NEUTRAL	GROUND	
PCD-SW01-N05	225A 3P C/B	1	3#4/0	1#4/0	1#4	2 1/2"
PCB-NWB2-N03(2)	400A 3P C/B	2	3#3/0	1#3/0	1#2	2"
DIMMER RACK 1	60A 3P C/B	1	3#6	1#6	1#10	1"

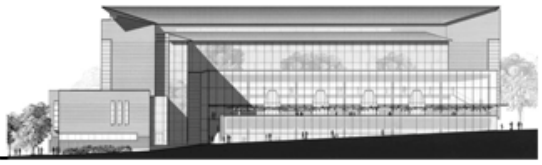
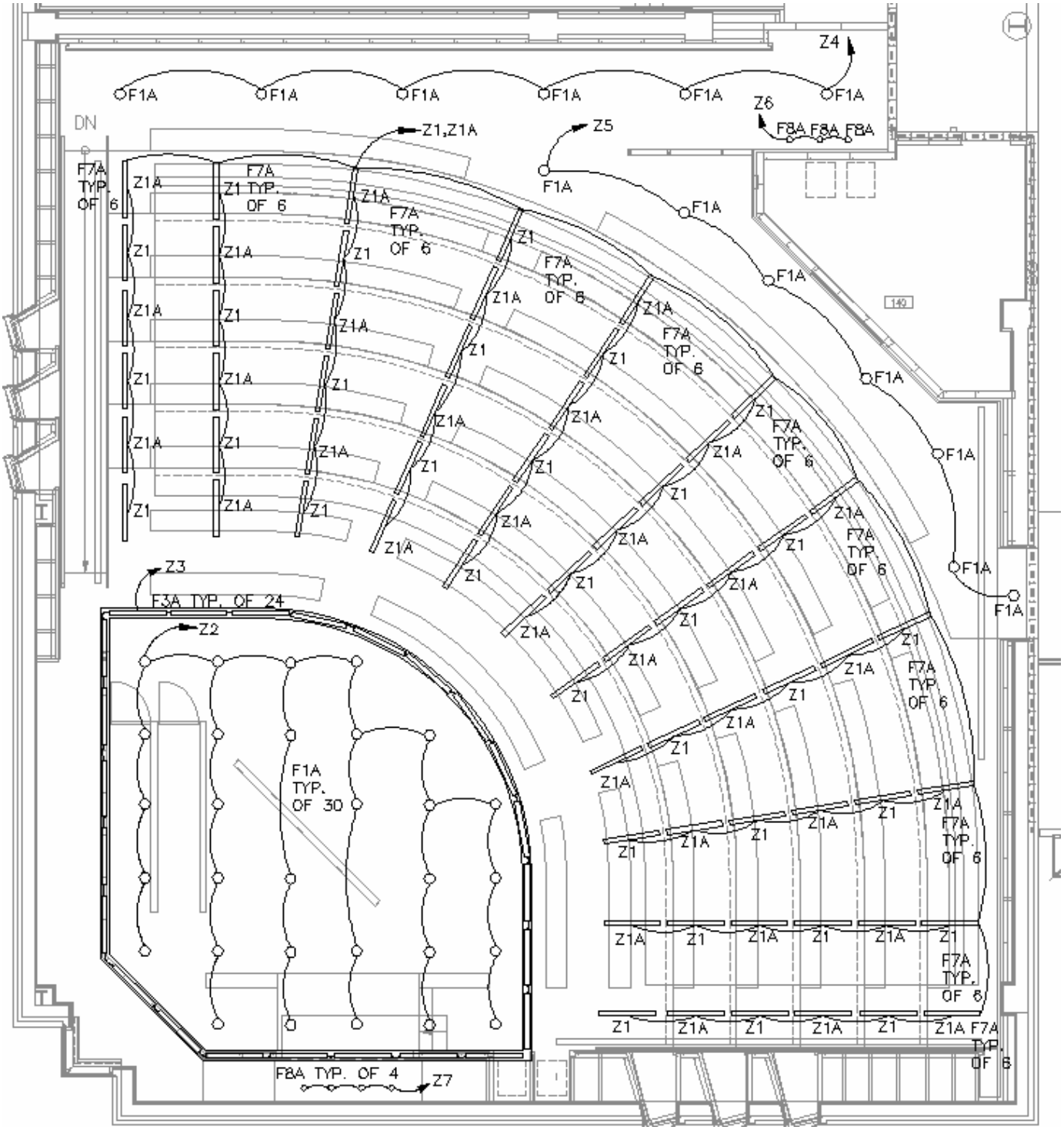


Figure 2.16 – Trial Courtroom Lighting Power Plan



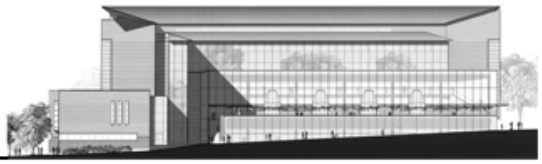


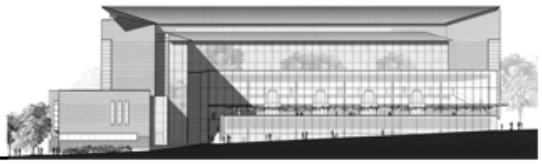
Figure 2.17 – Existing Dimmer Rack 1 Schedule

Dimmer Rack 1 Schedule							
Voltage: 208Y/120V, 3PH, 4W				**Size/Type Bus: 100A**			
				Size/Type Main: 100A MCB			
Dimmer Circuit No.	**Zone No.**	**Source Type**	**Fixture Quantity**	**Unit Watts**	**Total Watts**	**Dim. Capacity**	**C/B Size**
1	Z1	FL	14	66	924	1900	20A/1P
2	Z1A	FL	15	66	990	1900	20A/1P
3	Z1B	FL	6	66	396	1900	20A/1P
4	Z3	FL	7	66	462	1900	20A/1P
5	Z4	FL	7	66	462	1900	20A/1P
6	Z5	FL	10	44	440	1900	20A/1P
7	Z6	FL	11	66	726	1900	20A/1P
8	Z7	FL	4	66	264	1900	20A/1P
9	Z8	FL	8	32	256	1900	20A/1P
10	Z9	FL	13	32	416	1900	20A/1P
11	Z10	FL	4	64	256	1900	20A/1P
12	Z11	FL	24	32	768	1900	20A/1P
13	Z11	FL	2	27	54	1900	20A/1P
14	Z11	FL	2	19	38	1900	20A/1P
15	Z13	FL	4	33	132	1900	20A/1P
16	Z16	FL	10	66	660	1900	20A/1P

Figure 2.18 – Existing Dimmer Rack 1 Schedule

Dimmer Rack 1 Schedule							
Voltage: 480Y/277V, 3PH, 4W				**Size/Type Bus: 60A**			
				Size/Type Main: 60A MCB			
Dimmer Circuit No.	**Zone No.**	**Source Type**	**Fixture Quantity**	**Unit Watts**	**Total Watts**	**Dim. Capacity**	**C/B Size**
1	Z1	FL	33	30	990	4500	20A/1P
2	Z1A	FL	33	30	990	4500	20A/1P
3	Z2	FL	30	34	1020	4500	20A/1P
4	Z3	FL	24	30	720	4500	20A/1P
5	Z4	FL	6	34	204	4500	20A/1P
6	Z5	FL	7	34	238	4500	20A/1P
7	Z6	FL	3	20	60	4500	20A/1P
8	Z7	FL	4	20	80	4500	20A/1P

Figure 2.19 – Existing Distribution Panel Schedule PCD-SW01-N05



PANELBOARD SCHEDULE

VOLTAGE: 208Y/120V,3PH,4W	PANEL TAG: PCD-SW01-N05	MIN. C/B AIC: 22K
SIZE/TYPE BUS: 400A	PANEL LOCATION: LEVEL 01	OPTIONS:
SIZE/TYPE MAIN: 400A MLO	PANEL MOUNTING: SURFACE	

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
LIGHTING	DIM. RACK 1	12730	20A/1P	1	*			2	20A/1P	9975	DIM. RACK 2	LIGHTING
LIGHTING	FUTURE DIM.	0	20A/1P	3		*		4	20A/1P	0	0	SPARE
CONNECTED LOAD (KW) - A		22.71								TOTAL DESIGN LOAD (KW)		35.48
CONNECTED LOAD (KW) - B		0.00								POWER FACTOR		0.95
CONNECTED LOAD (KW) - C		0.00								TOTAL DESIGN LOAD (AMPS)		104

Figure 2.20 – Revised Distribution Panel Schedule PCD-SW01-N05

PANELBOARD SCHEDULE

VOLTAGE: 208Y/120V,3PH,4W	PANEL TAG: PCD-SW01-N05	MIN. C/B AIC: 22K
SIZE/TYPE BUS: 225A	PANEL LOCATION: LEVEL 01	OPTIONS:
SIZE/TYPE MAIN: 225A MLO	PANEL MOUNTING: SURFACE	

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
SPARE	0	0	20A/1P	1	*			2	20A/1P	9975	DIM. RACK 2	LIGHTING
LIGHTING	FUTURE DIM.	0	20A/1P	3		*		4	20A/1P	0	0	SPARE
CONNECTED LOAD (KW) - A		9.98								TOTAL DESIGN LOAD (KW)		15.59
CONNECTED LOAD (KW) - B		0.00								POWER FACTOR		0.95
CONNECTED LOAD (KW) - C		0.00								TOTAL DESIGN LOAD (AMPS)		47

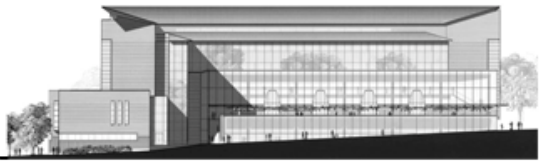


Figure 2.21 – Existing Panelboard Schedule PCB-NWB2-N03(2)

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 600A
SIZE/TYPE MAIN: 600A/3P C/B

PANEL TAG: PCB-NWB2-N03(2)
PANEL LOCATION: PUMP ROOM
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 65K
OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
MECH FC-11	B2	800	20A/3P	1	*			2	60A/3P	0		SPARE
--	B2	800	--	3		*		4	--	0		--
--	B2	800	--	5			*	6	--	0		--
MECH FC-12	B2	800	20A/3P	7	*			8	60A/3P	0		SPARE
--	B2	800	--	9		*		10	--	0		--
--	B2	800	--	11			*	12	--	0		--
SPARE		0	60A/3P	13	*			14	60A/3P	0		SPACE
--		0	--	15		*		16	--	0		--
--		0	--	17			*	18	--	0		--
SPARE		0	60A/3P	19	*			20	60A/3P	0		SPACE
--		0	--	21		*		22	--	0		--
--		0	--	23			*	24	--	0		--
SPACE		0	60A/3P	25	*			26	60A/3P	0		SPACE
--		0	--	27		*		28	--	0		--
--		0	--	29			*	30	--	0		--
SPACE		0	60A/3P	31	*			32	60A/3P	0		SPACE
--		0	--	33		*		34	--	0		--
--		0	--	35			*	36	--	0		--
SPACE		0	60A/3P	37	*			38	60A/3P	0		SPACE
--		0	--	39		*		40	--	0		--
--		0	--	41			*	42	--	0		--

CONNECTED LOAD (KW) - A	1.60	TOTAL DESIGN LOAD (KW)	6.75
CONNECTED LOAD (KW) - B	1.60	POWER FACTOR	1.00
CONNECTED LOAD (KW) - C	1.60	TOTAL DESIGN LOAD (AMPS)	8

Figure 2.22 – Revised Panelboard Schedule PCB-NWB2-N03(2)

PANELBOARD SCHEDULE

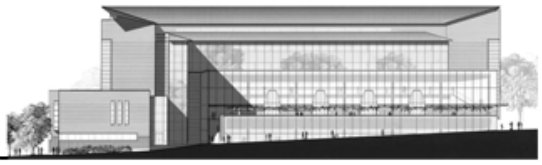
VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 400A
SIZE/TYPE MAIN: 400A/3P C/B

PANEL TAG: PCB-NWB2-N03(2)
PANEL LOCATION: PUMP ROOM
PANEL MOUNTING: SURFACE

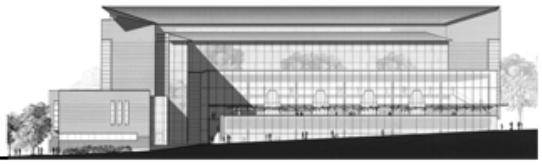
MIN. C/B AIC: 14K
OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
MECH FC-11	B2	800	20A/3P	1	*			2	60A/3P	1430	LEVEL 01	DIMMER RACK 1
--	B2	800	--	3		*		4	--	1430		--
--	B2	800	--	5			*	6	--	1430		--
MECH FC-12	B2	800	20A/3P	7	*			8	60A/3P	0		SPARE
--	B2	800	--	9		*		10	--	0		--
--	B2	800	--	11			*	12	--	0		--
SPARE		0	60A/3P	13	*			14	60A/3P	0		SPACE
--		0	--	15		*		16	--	0		--
--		0	--	17			*	18	--	0		--
SPARE		0	60A/3P	19	*			20	60A/3P	0		SPACE
--		0	--	21		*		22	--	0		--
--		0	--	23			*	24	--	0		--
SPACE		0	60A/3P	25	*			26	60A/3P	0		SPACE
--		0	--	27		*		28	--	0		--
--		0	--	29			*	30	--	0		--
SPACE		0	60A/3P	31	*			32	60A/3P	0		SPACE
--		0	--	33		*		34	--	0		--
--		0	--	35			*	36	--	0		--
SPACE		0	60A/3P	37	*			38	60A/3P	0		SPACE
--		0	--	39		*		40	--	0		--
--		0	--	41			*	42	--	0		--

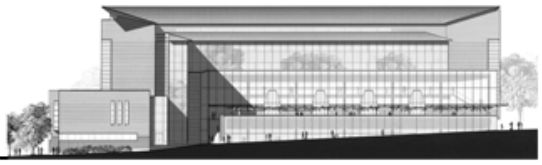
CONNECTED LOAD (KW) - A	3.03	TOTAL DESIGN LOAD (KW)	13.45
CONNECTED LOAD (KW) - B	3.03	POWER FACTOR	0.97
CONNECTED LOAD (KW) - C	3.03	TOTAL DESIGN LOAD (AMPS)	17



INSERT FIGURE 2.23 in elec folder



INSERT FIGURE 2.24 in elec folder



Marion Gould Gallagher Law Library – Reading Room

The existing lighting design of the two-story library reading area utilizes circuits on four separate panelboards: one lighting panel and one emergency panel for each of the two floors. These panels include panels PCB-NWB1-N04 and PCB-NWB1-E02, which serve loads for the upper level of the library (Level L1), and panels PCB-NWB2-N08 and PCB-NWB2-E04, which serve lighting loads for the library's lower level (Level L2). Each of these panels will be used for the circuiting of the proposed lighting design in the library, however, several of the existing circuits on panelboard NWB1-N04 will not be reused and will become spare circuits.

The two levels of the library will be circuited independently to their respective panels. Lighting loads for general lighting on Level L1 will utilize two circuits on panel NEB1-N04. On the lower level of the library, two circuits on panel NWB2-N08 will be utilized; one circuit for the general lighting in this area and another circuit for the stack lighting in this space. Throughout the upper and lower levels of the library there are several table lamps which are locally switched. Each lamp is fed from a floor box receptacle located beneath each table. Table lamps are fed from general purpose receptacle circuits on panels SWB1-N02 and SWB1-N04 on the lower level and panelboards SWB1-N04 and SEB1-N02 on the upper level.

Throughout the both levels of the library, several luminaires will be integrated into the existing emergency circuit serving the space to meet emergency lighting requirements. The existing emergency loads in the library will be taken off of the circuits from panels PCB-NWB1-E02 and PCB-NWB2-E04, and replaced with the emergency loads from the proposed lighting design.

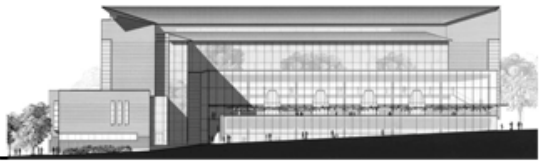
As outlined in the Lighting Depth, each of the circuits serving the library will be controlled via an automated relay system, with the exception of the emergency lighting circuit.

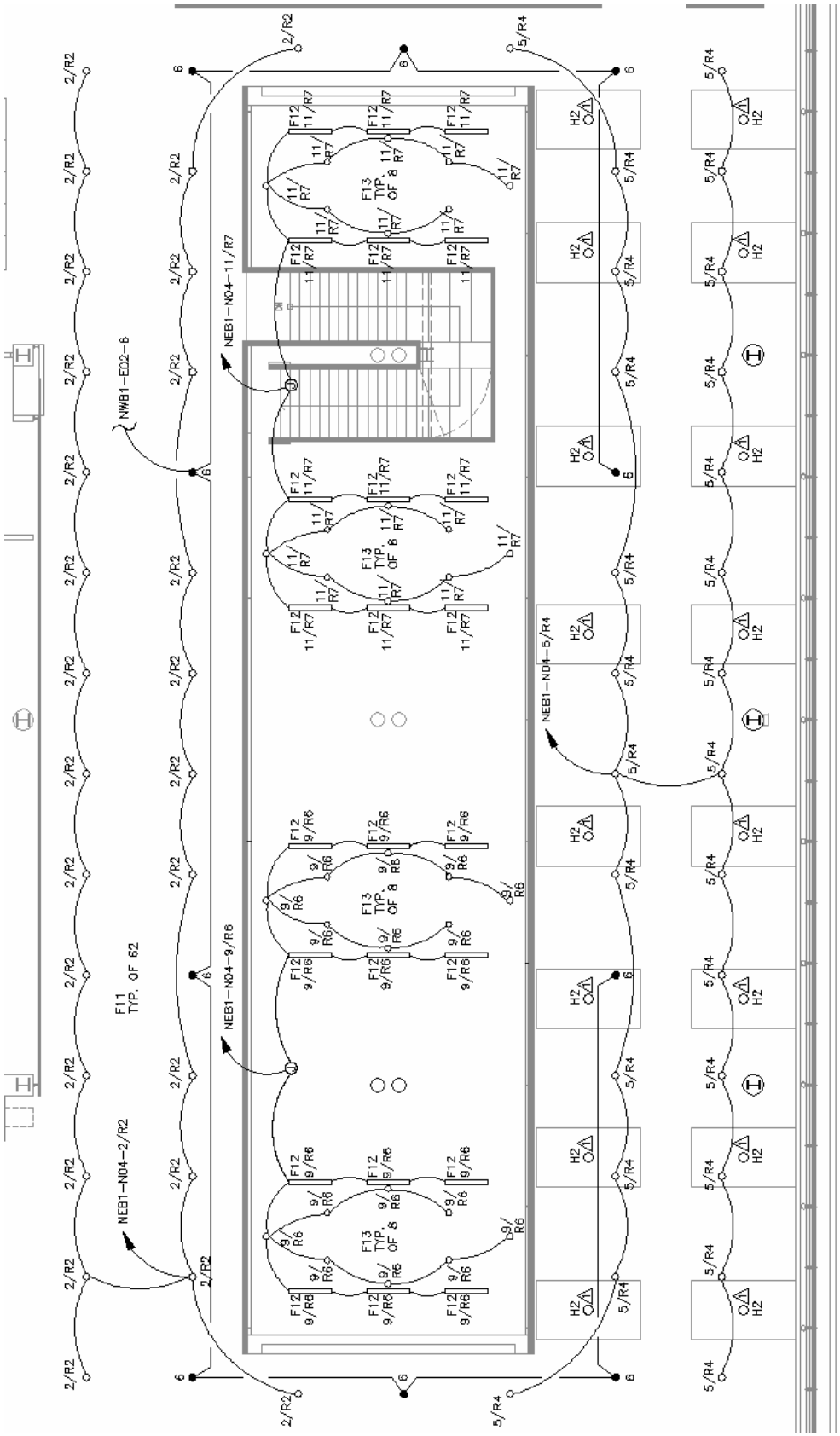
Please refer to the following Lighting Power Plan and Panelboard Schedules for further information on lighting circuitry and corresponding loads.

The following table outlines feeder and conduit sizes for each of the revised panelboards in the library.

Table 2.4 – Library Panelboard Feeder & Conduit Sizes

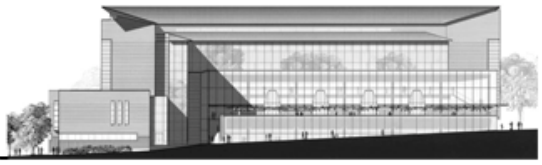
PANELBOARD	OVERCURRENT PROTECTION	FEEDER SIZE				CONDUIT SIZE
		NO. SETS	PHASE	NEUTRAL	GROUND	
PCB-NEB1-N04	150A 3P C/B	1	3#1/0	1#1/0	1#6	1 1/2"
PCB-NWB1-E02	150A 3P C/B	1	3#1/0	1#1/0	1#6	1 1/2"
PCB-NWB2-N08	150A 3P C/B	1	3#1/0	1#1/0	1#6	1 1/2"
PCB-NWB2-E04	150A 3P C/B	1	3#1/0	1#1/0	1#6	1 1/2"





NOTE: △ All table lamps are controlled by a local switch and are incorporated into the existing floor box receptacles

Figure 2.23 – Library Level L1 Lighting Power Plan



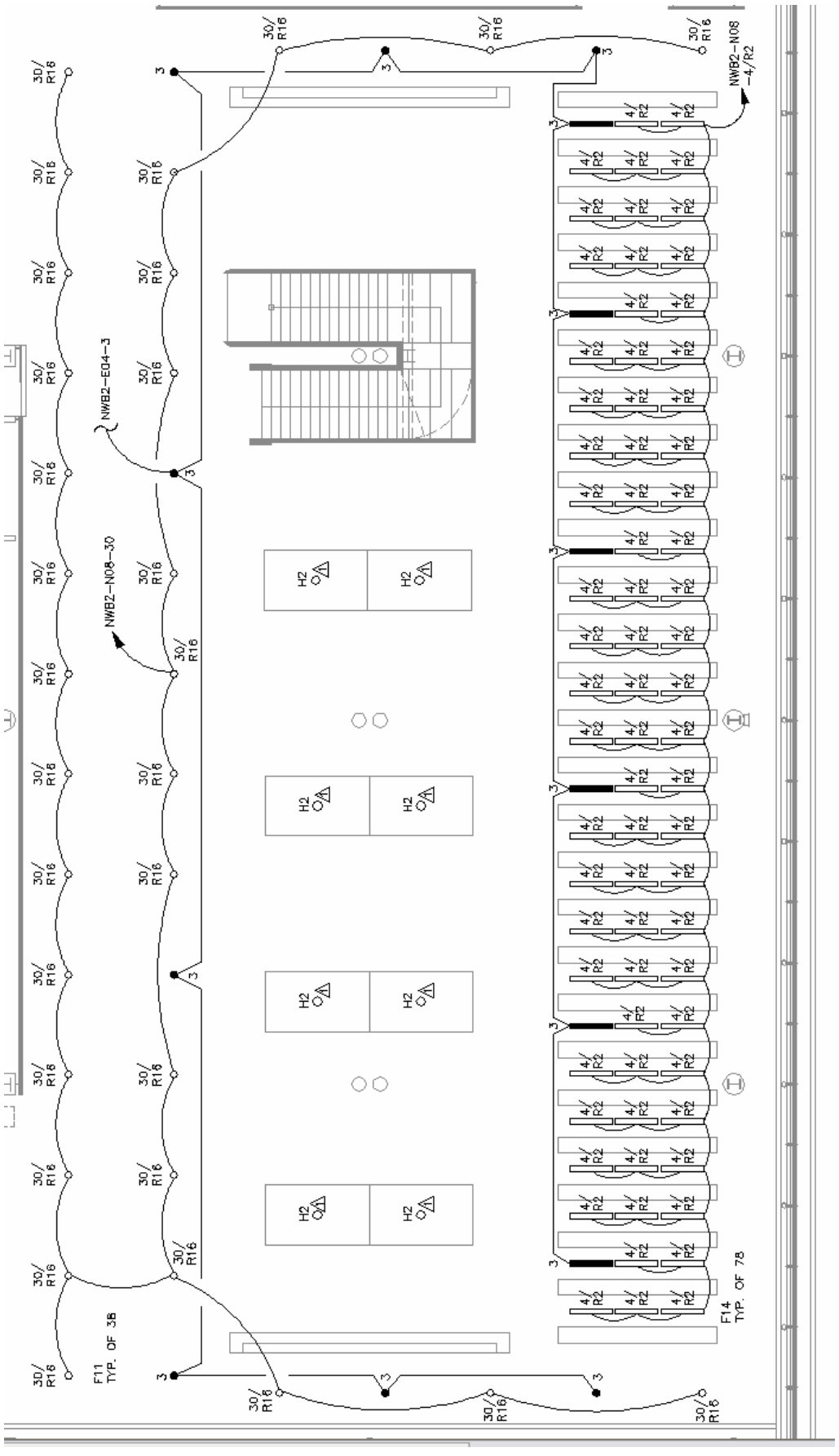


Figure 2.24 – Library Level L2 Lighting Power Plan

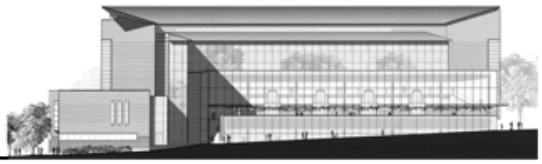


Figure 2.25 – Existing Panelboard Schedule PCB-NEB1-N04

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 225A
SIZE/TYPE MAIN: 225A/3P C/B

PANEL TAG: PCB-NEB1-N04
PANEL LOCATION: ELEC. RM NE LEVEL B1
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 42K
OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
LIGHTING	SE OFFICES	3420	20A/1P	1	*			2	20A/1P	2945	S & SE WALL	LIGHTING
LIGHTING	ALCOVE	950	20A/1P	3		*		4	20A/1P	2755	STACKS	LIGHTING
LIGHTING	LIBR. RDG	1093	20A/1P	5			*	6	20A/1P	2850	STACKS	LIGHTING
LIGHTING	LIBR. RDG	1235	20A/1P	7	*			8	20A/1P	3230	STACKS	LIGHTING
LIGHTING	LIBR. RDG	1710	20A/1P	9		*		10	20A/1P	2755	STACKS	LIGHTING
LIGHTING	LIBR. RDG	1710	20A/1P	11			*	12	20A/1P	2470	STACKS	LIGHTING
LIGHTING	LIBR. RDG	1710	20A/1P	13	*			14	20A/1P	2850	STACKS	LIGHTING
LIGHTING	LIBR. RDG	1710	20A/1P	15		*		16	20A/1P	2470	NE ROOMS	LIGHTING
LIGHTING	LIBR. RDG	1710	20A/1P	17			*	18	20A/1P	500	ELEC. RM	ALC-L1B
LIGHTING	LIBR. RDG	1710	20A/1P	19	*			20	20A/1P	0		SPARE
LIGHTING	LIBR. RDG	1093	20A/1P	21		*		22	20A/1P	0		SPARE
SPARE		0	20A/1P	23			*	24	20A/1P	0		SPARE
SPARE		0	60A/3P	25	*			26	20A/1P	0		SPARE
--		0	--	27		*		28	20A/1P	0		SPARE
--		0	--	29			*	30	20A/1P	0		SPARE
SPARE		0	20A/1P	31	*			32	20A/1P	0		SPARE
SPARE		0	20A/1P	33		*		34	20A/1P	0		SPARE
SPARE		0	20A/1P	35			*	36	20A/1P	0		SPARE
MECH FTU	EAST	6500	60A/3P	37	*			38	20A/1P	0		SPARE
--	EAST	4900	--	39		*		40	20A/1P	0		SPARE
--	EAST	4200	--	41			*	42	20A/1P	0		SPARE

CONNECTED LOAD (KW) - A	23.60	TOTAL DESIGN LOAD (KW)	88.09
CONNECTED LOAD (KW) - B	18.34	POWER FACTOR	0.96
CONNECTED LOAD (KW) - C	14.53	TOTAL DESIGN LOAD (AMPS)	110

Figure 2.26 – Revised Panelboard Schedule PCB-NEB1-N04

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 150A
SIZE/TYPE MAIN: 150A/3P C/B

PANEL TAG: PCB-NEB1-N04
PANEL LOCATION: ELEC. RM NE LEVEL B1
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 14K
OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
LIGHTING	SE OFFICES	3420	20A/1P	1	*			2	20A/1P	1196	LIBRARY	LIGHTING
LIGHTING	ALCOVE	950	20A/1P	3		*		4	20A/1P	2755	STACKS	LIGHTING
LIGHTING	LIBRARY	1196	20A/1P	5			*	6	20A/1P	2850	STACKS	LIGHTING
LIGHTING	LIBR. RDG	1235	20A/1P	7	*			8	20A/1P	3230	STACKS	LIGHTING
LIGHTING	LIBR. RDG	1752	20A/1P	9		*		10	20A/1P	2755	STACKS	LIGHTING
LIGHTING	LIBR. RDG	1752	20A/1P	11			*	12	20A/1P	2470	STACKS	LIGHTING
SPARE	0	0	20A/1P	13	*			14	20A/1P	2850	STACKS	LIGHTING
SPARE	0	0	20A/1P	15		*		16	20A/1P	2470	NE ROOMS	LIGHTING
SPARE	0	0	20A/1P	17			*	18	20A/1P	500	ELEC. RM	ALC-L1B
SPARE	0	0	20A/1P	19	*			20	20A/1P	0		SPARE
SPARE	0	0	20A/1P	21		*		22	20A/1P	0		SPARE
SPARE		0	20A/1P	23			*	24	20A/1P	0		SPARE
SPARE		0	60A/3P	25	*			26	20A/1P	0		SPARE
--		0	--	27		*		28	20A/1P	0		SPARE
--		0	--	29			*	30	20A/1P	0		SPARE
SPARE		0	20A/1P	31	*			32	20A/1P	0		SPARE
SPARE		0	20A/1P	33		*		34	20A/1P	0		SPARE
SPARE		0	20A/1P	35			*	36	20A/1P	0		SPARE
MECH FTU	EAST	6500	60A/3P	37	*			38	20A/1P	0		SPARE
--	EAST	4900	--	39		*		40	20A/1P	0		SPARE
--	EAST	4200	--	41			*	42	20A/1P	0		SPARE

CONNECTED LOAD (KW) - A	18.43	TOTAL DESIGN LOAD (KW)	73.25
CONNECTED LOAD (KW) - B	15.58	POWER FACTOR	0.97
CONNECTED LOAD (KW) - C	12.97	TOTAL DESIGN LOAD (AMPS)	91

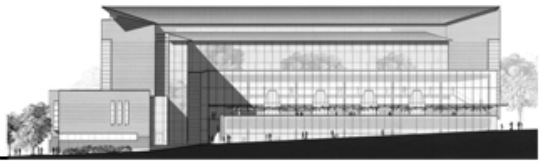


Figure 2.27 – Existing Panelboard Schedule PCB-NWB1-E02

PANELBOARD SCHEDULE

VOLTAGE: 208Y/120V,3PH,4W
SIZE/TYPE BUS: 225A
SIZE/TYPE MAIN: 225A/3P C/B

PANEL TAG: PCB-NWB1-E02
PANEL LOCATION: ELEC. RM NW - LEVEL B1
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 10K
OPTIONS: PROVIDE FEED THROUGH LUGS FOR PANELBOARD 1L1B

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
LIGHTING	EXIT SIGNS	95	20A/1P	1	*			2	20A/1P	380	STAIR 1	LIGHTING
LIGHTING	EGRESS	3135	20A/1P	3		*		4	20A/1P	190	STAIR 4	LIGHTING
LIGHTING	MECH/ELEC	380	20A/1P	5			*	6	20A/1P	1425	L107	LIGHTING
LIGHTING	EXIT SIGNS	95	20A/1P	7	*			8	20A/1P	0		SPARE
LIGHTING	EGRESS L-01	1235	20A/1P	9		*		10	20A/1P	0		SPARE
LIGHTING	MECH/ELEC	380	20A/1P	11			*	12	20A/1P	0		SPARE
SPARE		0	20A/1P	13	*			14	20A/1P	0		SPARE
SPARE		0	20A/1P	15		*		16	20A/1P	0		SPARE
SPARE		0	20A/1P	17			*	18	20A/1P	0		SPARE
SPARE		0	20A/1P	19	*			20	20A/1P	0		SPARE
SPARE		0	20A/1P	21		*		22	20A/1P	0		SPARE
SPARE		0	20A/1P	23			*	24	20A/1P	0		SPARE
SPARE		0	20A/1P	25	*			26	20A/1P	0		SPARE
SPARE		0	20A/1P	27		*		28	20A/1P	0		SPARE
SPARE		0	20A/1P	29			*	30	20A/1P	0		SPARE
SPARE		0	20A/1P	31	*			32	40A/3P	0		SPARE
SPARE		0	20A/1P	33		*		34	--	0		--
SPARE		0	20A/1P	35			*	36	--	0		--
SPARE		0	20A/1P	37	*			38	40A/3P	0		SPARE
SPARE		0	20A/1P	39		*		40	--	0		--
SPARE		0	20A/1P	41			*	42	--	0		--

CONNECTED LOAD (KW) - A	0.57	TOTAL DESIGN LOAD (KW)	11.43
CONNECTED LOAD (KW) - B	4.56	POWER FACTOR	0.95
CONNECTED LOAD (KW) - C	2.19	TOTAL DESIGN LOAD (AMPS)	14

Figure 2.28 – Revised Panelboard Schedule PCB-NWB1-E02

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 150A
SIZE/TYPE MAIN: 150A/3P C/B

PANEL TAG: PCB-NWB1-E02
PANEL LOCATION: ELEC. RM NW - LEVEL B1
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 14
OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
LIGHTING	EXIT SIGNS	95	20A/1P	1	*			2	20A/1P	380	STAIR 1	LIGHTING
LIGHTING	EGRESS	3135	20A/1P	3		*		4	20A/1P	190	STAIR 4	LIGHTING
LIGHTING	MECH/ELEC	380	20A/1P	5			*	6	20A/1P	460	LIBRARY	LIGHTING
LIGHTING	EXIT SIGNS	95	20A/1P	7	*			8	20A/1P	0		SPARE
LIGHTING	EGRESS L-01	1116	20A/1P	9		*		10	20A/1P	0		SPARE
LIGHTING	MECH/ELEC	380	20A/1P	11			*	12	20A/1P	0		SPARE
SPARE		0	20A/1P	13	*			14	20A/1P	0		SPARE
SPARE		0	20A/1P	15		*		16	20A/1P	0		SPARE
SPARE		0	20A/1P	17			*	18	20A/1P	0		SPARE
SPARE		0	20A/1P	19	*			20	20A/1P	0		SPARE
SPARE		0	20A/1P	21		*		22	20A/1P	0		SPARE
SPARE		0	20A/1P	23			*	24	20A/1P	0		SPARE
SPARE		0	20A/1P	25	*			26	20A/1P	0		SPARE
SPARE		0	20A/1P	27		*		28	20A/1P	0		SPARE
SPARE		0	20A/1P	29			*	30	20A/1P	0		SPARE
SPARE		0	20A/1P	31	*			32	20A/1P	0		SPARE
SPARE		0	20A/1P	33		*		34	20A/1P	0		SPARE
SPARE		0	20A/1P	35			*	36	20A/1P	0		SPARE
SPARE		0	20A/1P	37	*			38	20A/1P	0		SPARE
SPARE		0	20A/1P	39		*		40	20A/1P	0		SPARE
SPARE		0	20A/1P	41			*	42	20A/1P	0		SPARE

CONNECTED LOAD (KW) - A	0.57	TOTAL DESIGN LOAD (KW)	13.63
CONNECTED LOAD (KW) - B	4.44	POWER FACTOR	0.95
CONNECTED LOAD (KW) - C	1.22	TOTAL DESIGN LOAD (AMPS)	17

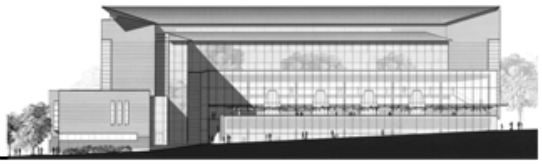


Figure 2.29 – Existing Panelboard Schedule PCB-NWB2-N08

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 400A
SIZE/TYPE MAIN: 400A/3P C/B

PANEL TAG: PCB-NWB2-N08
PANEL LOCATION: ELEC. RM - LEVEL B2
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 100K
OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
SPARE		0	20A/1P	1	*			2	20A/1P	1710	SW STORAGE	LIGHTING
SPARE		0	20A/1P	3		*		4	20A/1P	3325	S. STACKS	LIGHTING
SPARE		0	20A/1P	5			*	6	20A/1P	1900	SE. OFFICES	LIGHTING
SPARE		0	20A/1P	7	*			8	20A/1P	3230	STACKS	LIGHTING
SPARE		0	20A/1P	9		*		10	20A/1P	3135	STACKS	LIGHTING
SPARE		0	20A/1P	11			*	12	20A/1P	3135	STACKS	LIGHTING
SPARE		0	20A/1P	13	*			14	20A/1P	2755	STACKS	LIGHTING
SPARE		0	20A/1P	15		*		16	20A/1P	1900	STACKS	LIGHTING
SPARE		0	20A/1P	17			*	18	20A/1P	2565	STACKS	LIGHTING
SPARE		0	20A/1P	19	*			20	20A/1P	3420	CORRIDOR	LIGHTING
SPARE		0	20A/1P	21		*		22	20A/1P	3325	N. ROOMS	LIGHTING
SPARE		0	20A/1P	23			*	24	20A/1P	1900	L201, L202	LIGHTING
SPARE		0	20A/1P	25	*			26	20A/1P	500	ELEC. RM	ALC-L2A
SPARE		0	20A/1P	27		*		28	20A/1P	500	ELEC. RM	ALC-L2B
SPARE		0	20A/1P	29			*	30	20A/1P	0		SPARE
SPARE		0	20A/1P	31	*			32	20A/1P	0		SPARE
SPARE		0	20A/1P	33		*		34	20A/1P	0		SPARE
SPARE		0	20A/1P	35			*	36	20A/1P	0		SPARE
SPARE		0	20A/1P	37	*			38	20A/1P	0		SPARE
SPARE		0	20A/1P	39		*		40	20A/1P	0		SPARE
SPARE		0	20A/1P	41			*	42	20A/1P	0		SPARE

CONNECTED LOAD (KW) - A	11.62	TOTAL DESIGN LOAD (KW)	51.72
CONNECTED LOAD (KW) - B	12.19	POWER FACTOR	0.95
CONNECTED LOAD (KW) - C	9.50	TOTAL DESIGN LOAD (AMPS)	65

Figure 2.30 – Revised Panelboard Schedule PCB-NWB2-N08

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 150A
SIZE/TYPE MAIN: 150A/3P C/B

PANEL TAG: PCB-NWB2-N08
PANEL LOCATION: ELEC. RM - LEVEL B2
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 14K
OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
SPARE		0	20A/1P	1	*			2	20A/1P	1710	SW STORAGE	LIGHTING
SPARE		0	20A/1P	3		*		4	20A/1P	2160	S. STACKS	LIGHTING
SPARE		0	20A/1P	5			*	6	20A/1P	1900	SE. OFFICES	LIGHTING
SPARE		0	20A/1P	7	*			8	20A/1P	3230	STACKS	LIGHTING
SPARE		0	20A/1P	9		*		10	20A/1P	3135	STACKS	LIGHTING
SPARE		0	20A/1P	11			*	12	20A/1P	3135	STACKS	LIGHTING
SPARE		0	20A/1P	13	*			14	20A/1P	2755	STACKS	LIGHTING
SPARE		0	20A/1P	15		*		16	20A/1P	1900	STACKS	LIGHTING
SPARE		0	20A/1P	17			*	18	20A/1P	2565	STACKS	LIGHTING
SPARE		0	20A/1P	19	*			20	20A/1P	1900	CORRIDOR	LIGHTING
SPARE		0	20A/1P	21		*		22	20A/1P	3325	N. ROOMS	LIGHTING
SPARE		0	20A/1P	23			*	24	20A/1P	1900	L201, L202	LIGHTING
SPARE		0	20A/1P	25	*			26	20A/1P	500	ELEC. RM	ALC-L2A
SPARE		0	20A/1P	27		*		28	20A/1P	500	ELEC. RM	ALC-L2B
SPARE		0	20A/1P	29			*	30	20A/1P	1380	LIBR. RDG	LIGHTING
SPARE		0	20A/1P	31	*			32	20A/1P	0		SPARE
SPARE		0	20A/1P	33		*		34	20A/1P	0		SPARE
SPARE		0	20A/1P	35			*	36	20A/1P	0		SPARE
SPARE		0	20A/1P	37	*			38	20A/1P	0		SPARE
SPARE		0	20A/1P	39		*		40	20A/1P	0		SPARE
SPARE		0	20A/1P	41			*	42	20A/1P	0		SPARE

CONNECTED LOAD (KW) - A	10.10	TOTAL DESIGN LOAD (KW)	59.62
CONNECTED LOAD (KW) - B	11.02	POWER FACTOR	0.95
CONNECTED LOAD (KW) - C	10.88	TOTAL DESIGN LOAD (AMPS)	75

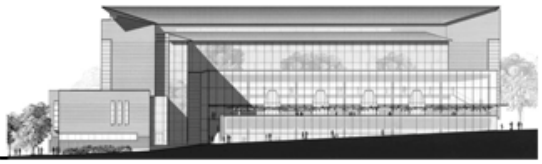


Figure 2.31 – Existing Panelboard Schedule PCB-NWB2-E04

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 225A
SIZE/TYPE MAIN: 225A/3P C/B

PANEL TAG: PCB-NWB2-E04
PANEL LOCATION: MAIN ELEC. RM - LEVEL B2
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 65K
OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
LIGHTING	EXIT SIGNS	95	20A/1P	1	*			2	20A/1P	760	STAIR 2	LIGHTING
LIGHTING	EGRESS	1710	20A/1P	3		*		4	20A/1P	570	STAIR 3	LIGHTING
LIGHTING	MECH/ELEC	1330	20A/1P	5			*	6	20A/1P	0		SPARE
SPARE		0	20A/1P	7	*			8	20A/1P	0		SPARE
SPARE		0	20A/1P	9		*		10	20A/1P	0		SPARE
SPARE		0	20A/1P	11			*	12	20A/1P	0		SPARE
SPARE		0	20A/1P	13	*			14	20A/1P	0		SPARE
SPARE		0	20A/1P	15		*		16	20A/1P	0		SPARE
SPARE		0	20A/1P	17			*	18	20A/1P	0		SPARE
SPARE		0	20A/1P	19	*			20	20A/1P	0		SPARE
SPARE		0	20A/1P	21		*		22	20A/1P	0		SPARE
SPARE		0	20A/1P	23			*	24	20A/1P	0		SPARE
SPARE		0	20A/1P	25	*			26	20A/1P	0		SPARE
SPARE		0	20A/1P	27		*		28	20A/1P	0		SPARE
SPARE		0	20A/1P	29			*	30	20A/1P	0		SPARE
SPARE		0	20A/1P	31	*			32	20A/1P	0		SPARE
SPARE		0	20A/1P	33		*		34	20A/1P	0		SPARE
SPARE		0	20A/1P	35			*	36	20A/1P	0		SPARE
SPARE		0	20A/1P	37	*			38	20A/1P	0		SPARE
SPARE		0	20A/1P	39		*		40	20A/1P	0		SPARE
SPARE		0	20A/1P	41			*	42	20A/1P	0		SPARE

CONNECTED LOAD (KW) - A	0.86	TOTAL DESIGN LOAD (KW)	6.98
CONNECTED LOAD (KW) - B	2.28	POWER FACTOR	0.95
CONNECTED LOAD (KW) - C	1.33	TOTAL DESIGN LOAD (AMPS)	9

Figure 2.32 – Revised Panelboard Schedule PCB-NWB2-E04

PANELBOARD SCHEDULE

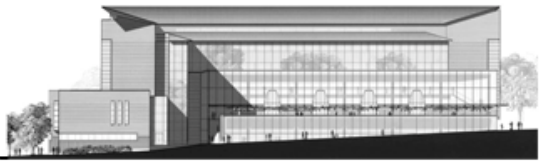
VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 150A
SIZE/TYPE MAIN: 150A/3P C/B

PANEL TAG: PCB-NWB2-E04
PANEL LOCATION: MAIN ELEC. RM - LEVEL B2
PANEL MOUNTING: SURFACE

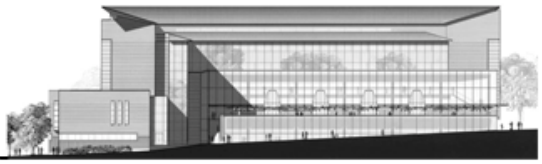
MIN. C/B AIC: 14K
OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
LIGHTING	EXIT SIGNS	95	20A/1P	1	*			2	20A/1P	760	STAIR 2	LIGHTING
LIGHTING	EGRESS	1805	20A/1P	3		*		4	20A/1P	570	STAIR 3	LIGHTING
LIGHTING	MECH/ELEC	1330	20A/1P	5			*	6	20A/1P	0		SPARE
SPARE		0	20A/1P	7	*			8	20A/1P	0		SPARE
SPARE		0	20A/1P	9		*		10	20A/1P	0		SPARE
SPARE		0	20A/1P	11			*	12	20A/1P	0		SPARE
SPARE		0	20A/1P	13	*			14	20A/1P	0		SPARE
SPARE		0	20A/1P	15		*		16	20A/1P	0		SPARE
SPARE		0	20A/1P	17			*	18	20A/1P	0		SPARE
SPARE		0	20A/1P	19	*			20	20A/1P	0		SPARE
SPARE		0	20A/1P	21		*		22	20A/1P	0		SPARE
SPARE		0	20A/1P	23			*	24	20A/1P	0		SPARE
SPARE		0	20A/1P	25	*			26	20A/1P	0		SPARE
SPARE		0	20A/1P	27		*		28	20A/1P	0		SPARE
SPARE		0	20A/1P	29			*	30	20A/1P	0		SPARE
SPARE		0	20A/1P	31	*			32	20A/1P	0		SPARE
SPARE		0	20A/1P	33		*		34	20A/1P	0		SPARE
SPARE		0	20A/1P	35			*	36	20A/1P	0		SPARE
SPARE		0	20A/1P	37	*			38	20A/1P	0		SPARE
SPARE		0	20A/1P	39		*		40	20A/1P	0		SPARE
SPARE		0	20A/1P	41			*	42	20A/1P	0		SPARE

CONNECTED LOAD (KW) - A	0.86	TOTAL DESIGN LOAD (KW)	8.55
CONNECTED LOAD (KW) - B	2.38	POWER FACTOR	0.95
CONNECTED LOAD (KW) - C	1.33	TOTAL DESIGN LOAD (AMPS)	11



Transformer Analysis
Central vs. Distributed Transformers



Introduction

The following portion of the Electrical Depth looks to redesign William H. Gates Hall's electrical distribution system incorporating the use of the distributed transformers. The building's existing distribution system utilizes four central step-down transformers. The Transformer Analysis will redesign the feeders and loads fed by these central transformers up the building electrical riser stack. Additionally, a cost analysis comparison will explore the cost implications of the two design options in order to help best determine the ideal transformer system for William H. Gates Hall

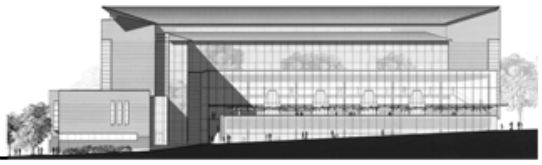
Existing System

The electrical design William H. Gates Hall utilizes a radial distribution system, in which the service is brought to the building through two 13.8 kV primary feeders tapped from the main campus distribution system. These two feeders enter the building in the Main Electric Room on level L2 and are connected to the three-bay primary switchgear. This then feeds a single-ended interior substation and the primary switch, rated at 15KV, 600 amperes, serving a 2500/3333 KVA fan cooled, dry type transformer. The secondary serving voltage for the building is a 480Y/277 volts, 3 phase, 4 wire grounded Wye system. The majority of the building's mechanical system and lighting loads are served at these voltages, and 208/120 volt loads are served through additional step-down transformers.

The current design of the electrical distribution system in William H. Gates Hall utilizes central step-down transformers located in the Main Electrical Room on Level L1. Four primary transformers are fed from the building switchgear and provide 208/120V power throughout the building. These four transformers include: TR-NWB2-N02, TR-NWB2-N03, TR-NWB2-N04 and TR-NWB2-N05. The following transformer schedule, Table 3.1, outlines all of the building's transformers. Additionally, please refer to Appendix C for information regarding the building existing electrical distribution system, the existing one-line diagram and a feeder schedule.

Table 3.1 – Existing Transformer Schedule

TRANSFORMER SCHEDULE							
TAG	PRIMARY VOLTAGE	SECONDARY VOLTAGE	SIZE	TYPE	TEMP. RISE	MOUNTING	REMARKS
TR-NWB2-N01	13.8 KV,3PH,3W	480Y/277V,3PH,4W	2500	DRY TYPE	150 DEGREE C	PAD MOUNTED ON FLOOR	K-4 RATED
TR-NWB2-N02	480V,3PH,3W.	208Y/120V,3PH,4W	500	DRY TYPE	150 DEGREE C	PAD MOUNTED ON FLOOR	K-13 RATED
TR-NWB2-N03	480V,3PH,3W.	208Y/120V,3PH,4W	500	DRY TYPE	150 DEGREE C	PAD MOUNTED ON FLOOR	K-13 RATED
TR-NWB2-N04	480V,3PH,3W.	208Y/120V,3PH,4W	225	DRY TYPE	150 DEGREE C	PAD MOUNTED ON FLOOR	K-13 RATED
TR-NWB2-N05	480V,3PH,3W.	208Y/120V,3PH,4W	225	DRY TYPE	150 DEGREE C	PAD MOUNTED ON FLOOR	K-13 RATED
TR-NWB2-N06	480V,3PH,3W.	208Y/120V,3PH,4W	45	DRY TYPE	150 DEGREE C	PAD MOUNTED ON FLOOR	K-13 RATED
TR-SW01-N01	480V,3PH,3W.	208Y/120V,3PH,4W	112.5	DRY TYPE	150 DEGREE C	PAD MOUNTED ON FLOOR	K-13 RATED
TR-NE04-N06	480V,3PH,3W.	208Y/120V,3PH,4W	75	DRY TYPE	150 DEGREE C	PAD MOUNTED ON FLOOR	K-13 RATED



Transformer Design Considerations

While there are no current design issues or concerns with the existing building distribution system and transformer design, there are several points to consider when designing the building transformer distribution. The current system of utilizing four larger central transformers to provide the building with 208/120 volt power allows for minimal equipment to be used and for the equipment to be centrally located. This allows for 208/120V to be fed up the electrical riser stack and directly to the required panels. While this type of power transformation requires less equipment, it also commonly increases wire sizes and cost throughout the building due to the decreased voltage.

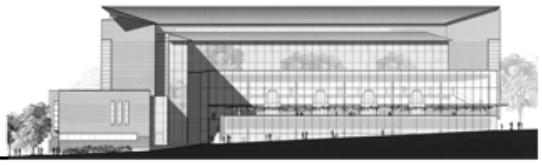
An electrical distribution system that utilizes distributed transformers posses another set of design considerations. The use of smaller, distributed transformers on each floor requires for larger quantities of equipment to be purchased and installed. However, by locally stepping down the voltage to 208/120V, the main feeders running through the building riser are often able to be sized much smaller, and thus provide potential significant savings on wire. This is a very important consideration given the high cost of copper wire. In addition to the quantity and cost of equipment and materials required for each system, electrical room/closest space considerations must not be overlooked. There needs to be adequate space in many of the floors electrical closets for one or more transformers. These electrical closets are often small and overcrowded with equipment.

Additionally, the heat discharge of the transformers is an important issue that should be considered in designing building transformers. This is especially important with the use of distributed transformers that are often located in smaller electrical closets. The small spaces filled with different equipment, which often is generating heat, must have proper ventilation for these spaces. For the purpose of this report, it is assumed that each of the electrical closets allows for proper ventilation and the heat discharge of the transformers is not an issue.

Distributed Transformer Design

The redesign of the electrical distribution system using distributed transformers will look at four feeders that run the height of the building feeding the same 208/120V panelboards respective to each floor. The central transformers that steps down each of these feeders will be removed or resized depending on the components along the run of each individual feeder. For each of these vertical runs, all feeders and associated equipment, such as protection, panelboards, distribution panelboards and circuit breakers will be resized according to the changes made and transformers added to the system.

Transformers TR-NWB2-N02 and TR-NWB2-N03, whose secondary side directly feeds distribution panels, will not be removed from the new design; rather, they will be resized according to the distribution panels' design loads after the 208/120V feeders have been



removed. Due to the uncertainty of the original design criteria the panelboards and loads fed directly from these distribution panels will remain connected in these locations.

Figure 3.1 highlights in red each of the feeders and the associated components on the existing one line diagram that will be considered in the redesign of the transformers.

In determining the locations and quantity of new transformers, the general rule of thumb of two panelboards per transformer was applied. In the case that only one panelboard from a specific feeder is located on each floor, an exception was made and three panelboards were fed from a transformer. This allows for transformers to be placed on one floor and feed panelboards on adjacent floors, directly above and/or below. Figure 3.2 shows the panelboard grouping used in adding distributed transformers.

Additionally, refer to Appendix C for manufacturer information on the transformers used in this redesign.

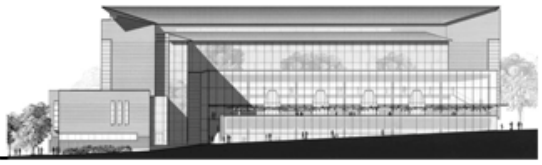


FIGURE 3.1 FEEDERS TO BE REDESIGNED – in elec folder

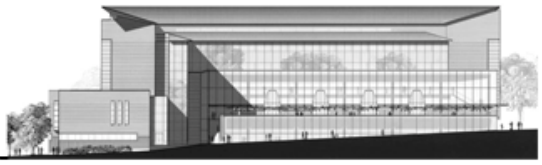
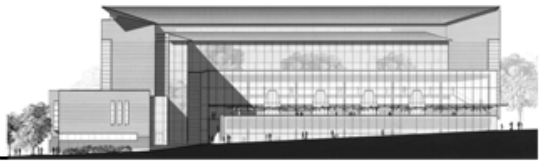


Figure 3.2 Panelboard grouping – elec folder



Transformer Sizing

The following tables outline all pertinent information in sizing the transformers, transformer protection and feeders.

To size transformers the following equation is used:

*Calculated KVA = Total Design Load * 208 * √3*

Primary protection is sized for each panel using the following equations:

Primary & Secondary Protection

*Primary Protection = ((Transformer KVA * 1000) / (480 * √3)) * 250%*

Primary Protection Only

*Primary Protection = ((Transformer KVA * 1000) / (480 * √3)) * 125%*

When secondary protection is required, protection was sized using the following equation:

*Secondary Protection = Total Design Load * 125%*

Table 3.2 – Transformer Sizing

TR-NEB1-N05	
Design Load	
PCB-NWB2-N05	48.65
PCB-NEB1-N05	40
PCB-NE01-N05	40
Total Design Load	**128.65**
Transformer Size	
Calc. KVA	46.314
Transformer Size	**45 KVA**
Transformer Protection	
Primary	
Rating (Amps)	60.14
X 250%	150.36
Breaker Size	**225 A**
Secondary	
Rating (Amps)	148.65
X 125%	185.8125
Breaker Size	**225A**
Feeders	
Primary	
Phase Wire	3#4/0
Neutral	1#4/0
Ground	1#4
Conduit	2 1/2"
Secondary (To Each Panel)	
Phase Wire	3#4/0
Neutral	1#4/0
Ground	1#4
Conduit	2 1/2"

TR-NE03-N05	
Design Load	
PCB-NE02-N05	73
PCB-NE03-N05	26.25
PCB-NE04-N05	18
Total Design Load	**117.25**
Transformer Size	
Calc. KVA	42.21
Transformer Size	**45 KVA**
Transformer Protection	
Primary	
Rating (Amps)	60.14
X 250%	150.36
Breaker Size	**225 A**
Secondary	
Rating (Amps)	117.25
X 125%	146.5625
Breaker Size	**225 A**
Feeders	
Primary	
Phase Wire	3#4/0
Neutral	1#4/0
Ground	1#4
Conduit	2 1/2"
Secondary (To Each Panel)	
Phase Wire	3#4/0
Neutral	1#4/0
Ground	1#4
Conduit	2 1/2"

TR-NWB2-N03	
Design Load	
PCD-NWB2-N04	127.2
Total Design Load	**127.2**
Transformer Size	
Calc. KVA	45.792
Transformer Size	**45 KVA**
Transformer Protection	
Primary	
Rating (Amps)	60.14
X 125%	75.18
Breaker Size	**100 A**
Secondary	
Rating (Amps)	NA
X 125%	NA
Breaker Size	NA
Feeders	
Primary	
Phase Wire	3#3
Neutral	1#3
Ground	1#8
Conduit	1 1/4"
Secondary	
Phase Wire	SEE ONE-LINE
Neutral	SEE ONE-LINE
Ground	SEE ONE-LINE
Conduit	SEE ONE-LINE

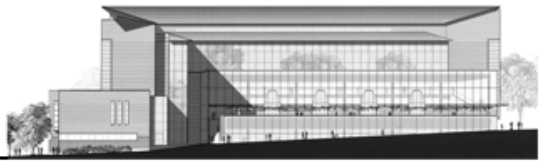


Table 3.2 – Transformer Sizing (cont'd)

TR-NEB1-N01	
Design Load	
PCB-NEB1-N03	54.9
PCB-NEB1-N01	138.2
PCB-SEB1-N02	82.1
Total Design Load	**275.2**
Transformer Size	
Calc. KVA	99.072
Transformer Size	**112.5 KVA**
Transformer Protection	
Primary	
Rating (Amps)	135.32
X 125%	169.15
Breaker Size	**225A**
Secondary	
Rating (Amps)	NA
X 125%	NA
Breaker Size	NA
Feeders	
Primary	
Phase Wire	3#4/0
Neutral	1#4/0
Ground	1#4
Conduit	2 1/2"
Secondary	
Phase Wire	SEE ONE-LINE
Neutral	SEE ONE-LINE
Ground	SEE ONE-LINE
Conduit	SEE ONE-LINE

TR-NE01-N01	
Design Load	
PCB-NE01-N03	87.63
PCB-NE01-N01	119
Total Design Load	**206.63**
Transformer Size	
Calc. KVA	74.3868
Transformer Size	**75 KVA**
Transformer Protection	
Primary	
Rating (Amps)	90.21
X 125%	112.77
Breaker Size	**225**
Secondary	
Rating (Amps)	NA
X 125%	NA
Breaker Size	NA
Feeders	
Primary	
Phase Wire	3#4/0
Neutral	1#4/0
Ground	1#4
Conduit	2 1/2"
Secondary	
Phase Wire	SEE ONE-LINE
Neutral	SEE ONE-LINE
Ground	SEE ONE-LINE
Conduit	SEE ONE-LINE

TR-NE03-N01	
Design Load	
PCB-NE02-N01	128.9
PCB-NE03-N01	70.75
PCB-NE04-N01	53.63
Total Design Load	**253.28**
Transformer Size	
Calc. KVA	91.1808
Transformer Size	**112.5 KVA**
Transformer Protection	
Primary	
Rating (Amps)	135.32
X 250%	338.30
Breaker Size	**400A**
Secondary	
Rating (Amps)	253.28
X 125%	316.6
Breaker Size	**400A**
Feeders	
Primary (2 Sets)	
Phase Wire	3#3/0
Neutral	1#3/0
Ground	1#6
Conduit	2"
Secondary (2 Sets)	
Phase Wire	3#3/0
Neutral	1#3/0
Ground	1#6
Conduit	2"

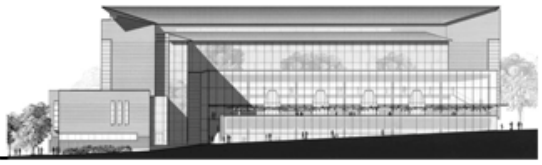


Table 3.2 – Transformer Sizing (cont'd)

TR-NWB2-N02	
Design Load	
PCD-NWB2-N03	346.3
Total Design Load	**346.3**
Transformer Size	
Calc. KVA	124.668
Transformer Size	**150 KVA**
Transformer Protection	
Primary	
Rating (Amps)	180.43
X 125%	225.53
Breaker Size	**225A**
Secondary	
Rating (Amps)	NA
X 125%	NA
Breaker Size	NA
Feeders	
Primary	
Phase Wire	3#4/0
Neutral	1#4/0
Ground	1#4
Conduit	2 1/2"
Secondary	
Phase Wire	SEE ONE LINE
Neutral	SEE ONE LINE
Ground	SEE ONE LINE
Conduit	SEE ONE LINE

TR-NWB1-N03	
Design Load	
PCB-NWB1-N03	135.5
PCB-NWB1-N05	94.7
Total Design Load	**230.2**
Transformer Size	
Calc. KVA	82.872
Transformer Size	**112.5 KVA**
Transformer Protection	
Primary	
Rating (Amps)	135.32
X 125%	169.15
Breaker Size	**225A**
Secondary	
Rating (Amps)	NA
X 125%	NA
Breaker Size	NA
Feeders	
Primary	
Phase Wire	3#4/0
Neutral	1#4/0
Ground	1#4
Conduit	2 1/2"
Secondary	
Phase Wire	SEE ONE LINE
Neutral	SEE ONE LINE
Ground	SEE ONE LINE
Conduit	SEE ONE LINE

TR-NW01-N03	
Design Load	
PCB-NW01-N03	235.25
PCB-NW01-N05	180.25
Total Design Load	**415.5**
Transformer Size	
Calc. KVA	149.58
Transformer Size	**150 KVA**
Transformer Protection	
Primary	
Rating (Amps)	180.43
X 125%	225.53
Breaker Size	**225A**
Secondary	
Rating (Amps)	NA
X 125%	NA
Breaker Size	NA
Feeders	
Primary	
Phase Wire	3#4/0
Neutral	1#4/0
Ground	1#4
Conduit	2 1/2"
Secondary	
Phase Wire	SEE ONE LINE
Neutral	SEE ONE LINE
Ground	SEE ONE LINE
Conduit	SEE ONE LINE

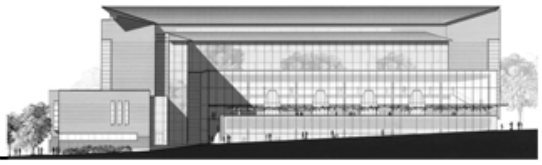


Table 3.2 – Transformer Sizing (cont'd)

TR-NW02-N03	
Design Load	
PCB-NW02-N03	84.5
PCB-NW02-N05	95.1
Total Design Load	**179.6**
Transformer Size	
Calc. KVA	64.656
Transformer Size	**75 KVA**
Transformer Protection	
Primary	
Rating (Amps)	90.21
X 125%	112.77
Breaker Size	**225A**
Secondary	
Rating (Amps)	NA
X 125%	NA
Breaker Size	NA
Feeders	
Primary	
Phase Wire	3#4/0
Neutral	1#4/0
Ground	1#4
Conduit	2 1/2"
Secondary	
Phase Wire	SEE ONE LINE
Neutral	SEE ONE LINE
Ground	SEE ONE LINE
Conduit	SEE ONE LINE

TR-NW03-N03	
Design Load	
PCB-NW03-N03	70.1
PCB-NW03-N05	96.5
Total Design Load	**166.6**
Transformer Size	
Calc. KVA	59.976
Transformer Size	**75 KVA**
Transformer Protection	
Primary	
Rating (Amps)	90.21
X 125%	112.77
Breaker Size	**225A**
Secondary	
Rating (Amps)	NA
X 125%	NA
Breaker Size	NA
Feeders	
Primary	
Phase Wire	3#4/0
Neutral	1#4/0
Ground	1#4
Conduit	2 1/2"
Secondary	
Phase Wire	SEE ONE LINE
Neutral	SEE ONE LINE
Ground	SEE ONE LINE
Conduit	SEE ONE LINE

TR-NW04-N03	
Design Load	
PCB-NW04-N03	40.46
PCB-NW04-N05	110.5
Total Design Load	**150.96**
Transformer Size	
Calc. KVA	54.3456
Transformer Size	**75 KVA**
Transformer Protection	
Primary	
Rating (Amps)	90.21
X 125%	112.77
Breaker Size	**225A**
Secondary	
Rating (Amps)	NA
X 125%	NA
Breaker Size	NA
Feeders	
Primary	
Phase Wire	3#4/0
Neutral	1#4/0
Ground	1#4
Conduit	2 1/2"
Secondary	
Phase Wire	SEE ONE LINE
Neutral	SEE ONE LINE
Ground	SEE ONE LINE
Conduit	SEE ONE LINE

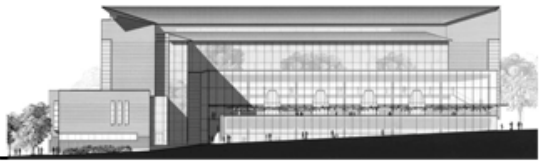


Table 3.2 – Transformer Sizing (cont'd)

TR-NWB1-N01	
Design Load	
PCB-NWB1-N01	105.1
PCB-NW01-N01	142.75
Total Design Load	**247.85**
Transformer Size	
Calc. KVA	89.226
Transformer Size	**112.5 KVA**
Transformer Protection	
Primary	
Rating (Amps)	135.32
X 250%	338.30
Breaker Size	**400A**
Secondary	
Rating (Amps)	247.85
X 125%	309.8125
Breaker Size	**400A**
Feeders	
Primary (2 Sets)	
Phase Wire	3#3/0
Neutral	1#3/0
Ground	1#6
Conduit	2"
Secondary (2 Sets)	
Phase Wire	3#3/0
Neutral	1#3/0
Ground	1#6
Conduit	2"

TR-NW03-N01	
Design Load	
PCB-NW02-N01	113.1
PCB-NW03-N01	68.2
PCB-NW04-N01	87.78
Total Design Load	**269.08**
Transformer Size	
Calc. KVA	96.8688
Transformer Size	**112.5 KVA**
Transformer Protection	
Primary	
Rating (Amps)	135.32
X 250%	338.30
Breaker Size	**400A**
Secondary	
Rating (Amps)	269.08
X 125%	336.35
Breaker Size	**400A**
Feeders	
Primary (2 Sets)	
Phase Wire	3#3/0
Neutral	1#3/0
Ground	1#6
Conduit	2"
Secondary (2 Sets)	
Phase Wire	3#3/0
Neutral	1#3/0
Ground	1#6
Conduit	2"

Transformer Schedules & One-Line Diagrams

The following transformer schedule, Table 3.3, outlines all new transformers, in addition to existing transformers. All new and existing transformers are K-13 rated, per the building design specifications. Additionally, please refer to Figure 3.3 – Proposed One Line Diagram, for more information regarding the proposed transformer system and distribution. For feeder sizes and information, please refer to Appendix C for a feeder schedule.

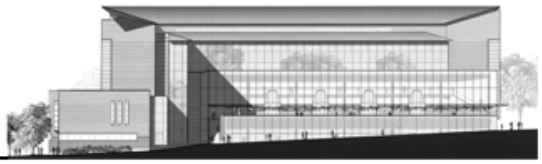


Table 3.3 – Transformer Schedule

TRANSFORMER SCHEDULE							
TAG	**PRIMARY VOLTAGE**	**SECONDARY VOLTAGE**	**SIZE**	**TYPE**	**TEMP. RISE**	**MOUNTING**	**REMARKS**
TR-NWB2-N01	*13.8 KV,3PH,3W*	*480Y/277V,3PH,4W*	*2500*	*DRY TYPE*	*150 DEGREE C*	*PAD MOUNTED ON FLOOR*	*K-4 RATED*
TR-NWB2-N02	480V,3PH,3W	208Y/120V,3PH,4W	150	DRY TYPE	150 DEGREE C	PAD MOUNTED ON FLOOR	K-13 RATED
TR-NWB2-N03	480V,3PH,3W	208Y/120V,3PH,4W	50	DRY TYPE	150 DEGREE C	PAD MOUNTED ON FLOOR	K-13 RATED
TR-NWB2-N05	*480V,3PH,3W*	*208Y/120V,3PH,4W*	*45*	*DRY TYPE*	*150 DEGREE C*	*PAD MOUNTED ON FLOOR*	K-13 RATED
TR-NWB1-N01	480V,3PH,3W	208Y/120V,3PH,4W	112.5	DRY TYPE	150 DEGREE C	PAD MOUNTED ON FLOOR	K-13 RATED
TR-NWB1-N03	480V,3PH,3W	208Y/120V,3PH,4W	112.5	DRY TYPE	150 DEGREE C	PAD MOUNTED ON FLOOR	K-13 RATED
TR-NW01-N03	480V,3PH,3W	208Y/120V,3PH,4W	150	DRY TYPE	150 DEGREE C	PAD MOUNTED ON FLOOR	K-13 RATED
TR-NW02-N03	480V,3PH,3W	208Y/120V,3PH,4W	75	DRY TYPE	150 DEGREE C	PAD MOUNTED ON FLOOR	K-13 RATED
TR-NW03-N01	480V,3PH,3W	208Y/120V,3PH,4W	112.5	DRY TYPE	150 DEGREE C	PAD MOUNTED ON FLOOR	K-13 RATED
TR-NW03-N03	480V,3PH,3W	208Y/120V,3PH,4W	75	DRY TYPE	150 DEGREE C	PAD MOUNTED ON FLOOR	K-13 RATED
TR-NW04-N03	480V,3PH,3W	208Y/120V,3PH,4W	75	DRY TYPE	150 DEGREE C	PAD MOUNTED ON FLOOR	K-13 RATED
TR-NEB1-N01	480V,3PH,3W	208Y/120V,3PH,4W	112.5	DRY TYPE	150 DEGREE C	PAD MOUNTED ON FLOOR	K-13 RATED
TR-NEB1-N05	480V,3PH,3W	208Y/120V,3PH,4W	50	DRY TYPE	150 DEGREE C	PAD MOUNTED ON FLOOR	K-13 RATED
TR-NE01-N01	480V,3PH,3W	208Y/120V,3PH,4W	75	DRY TYPE	150 DEGREE C	PAD MOUNTED ON FLOOR	K-13 RATED
TR-NE03-N01	480V,3PH,3W	208Y/120V,3PH,4W	112.5	DRY TYPE	150 DEGREE C	PAD MOUNTED ON FLOOR	K-13 RATED
TR-NE03-N05	480V,3PH,3W	208Y/120V,3PH,4W	50	DRY TYPE	150 DEGREE C	PAD MOUNTED ON FLOOR	K-13 RATED
TR-NE04-N06	*480V,3PH,3W*	*208Y/120V,3PH,4W*	*75*	*DRY TYPE*	*150 DEGREE C*	*PAD MOUNTED ON FLOOR*	K-13 RATED
TR-SW01-N01	*480V,3PH,3W*	*208Y/120V,3PH,4W*	*112.5*	*DRY TYPE*	*150 DEGREE C*	*PAD MOUNTED ON FLOOR*	K-13 RATED

ITALICIZED ENTRIES ARE EXISTING TO REMAIN

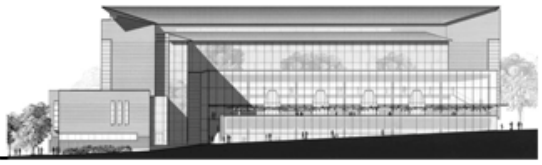
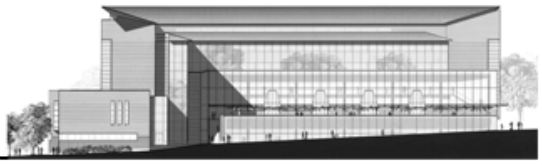


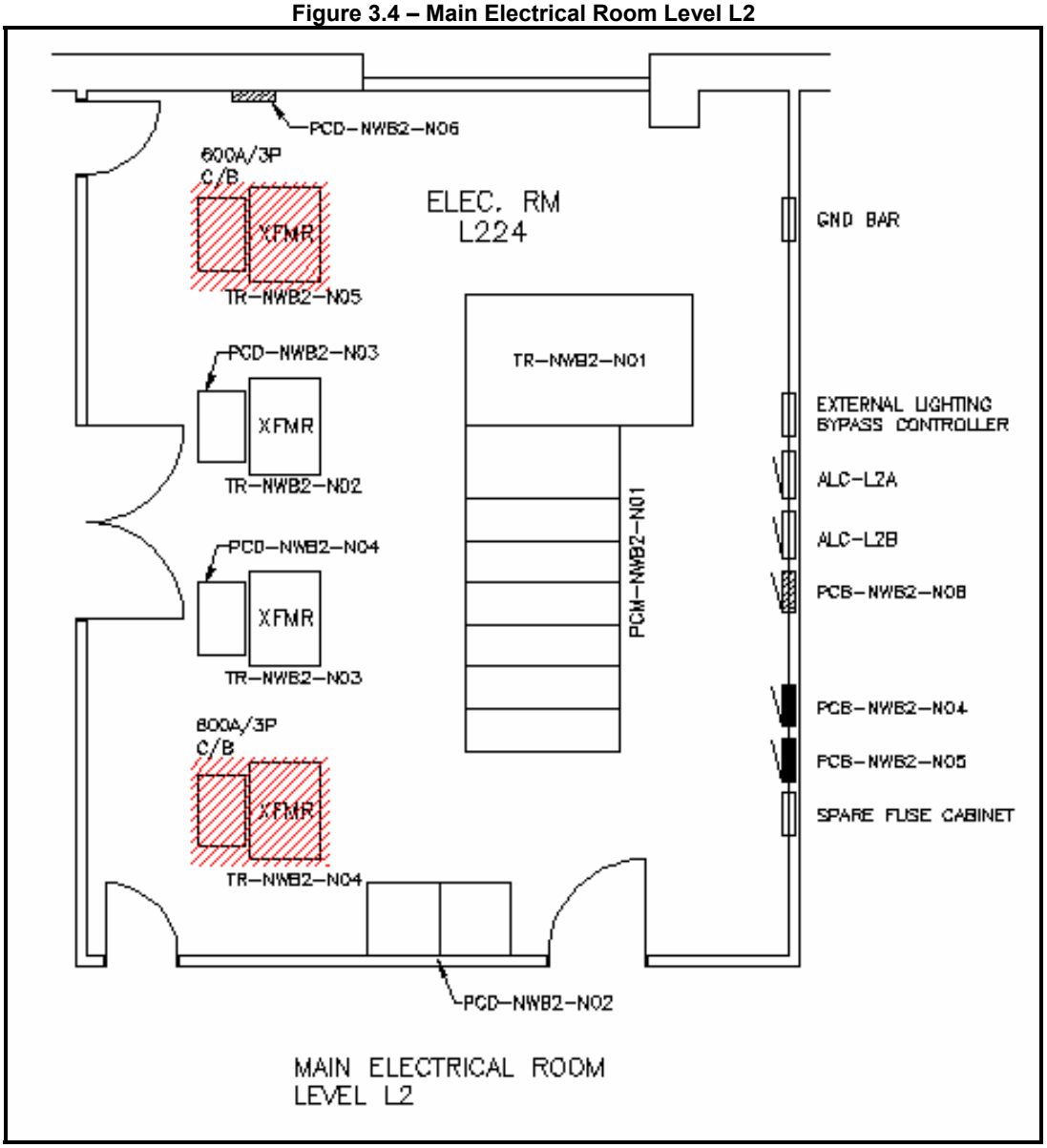
Figure 3.3 – Proposed One Line Diagram

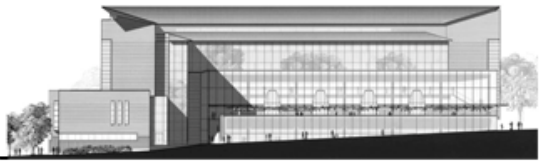


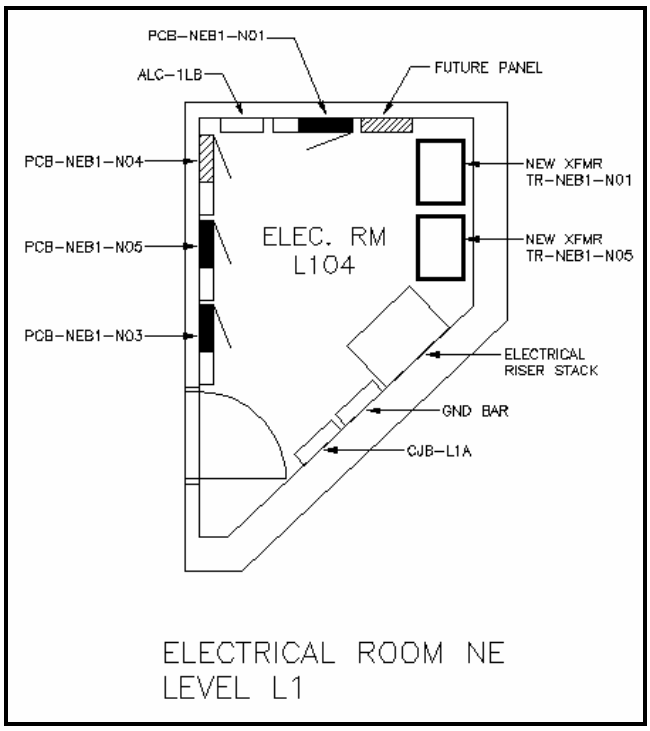
Electrical Room Layouts

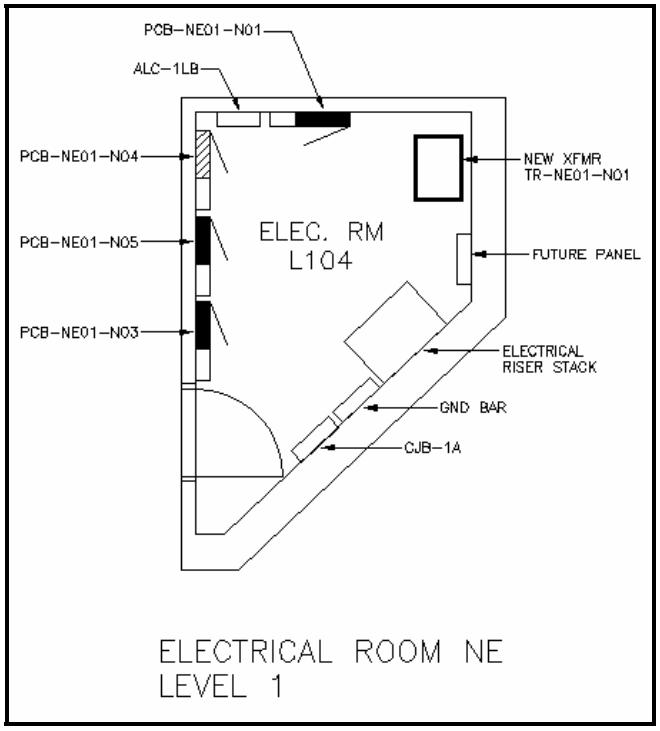
The following electrical room layouts show the proposed locations for each of the new transformers. Transformers are being located in the northeast and northwest electrical closest on all levels of the building. Transformers that are fed from the same feeder are placed in the same location in each electrical closet for the respective floors. Note that the transformers in the Main Electrical Room hatched in red are existing transformers that are to be removed.

Figure 3.4 – Main Electrical Room Level L2









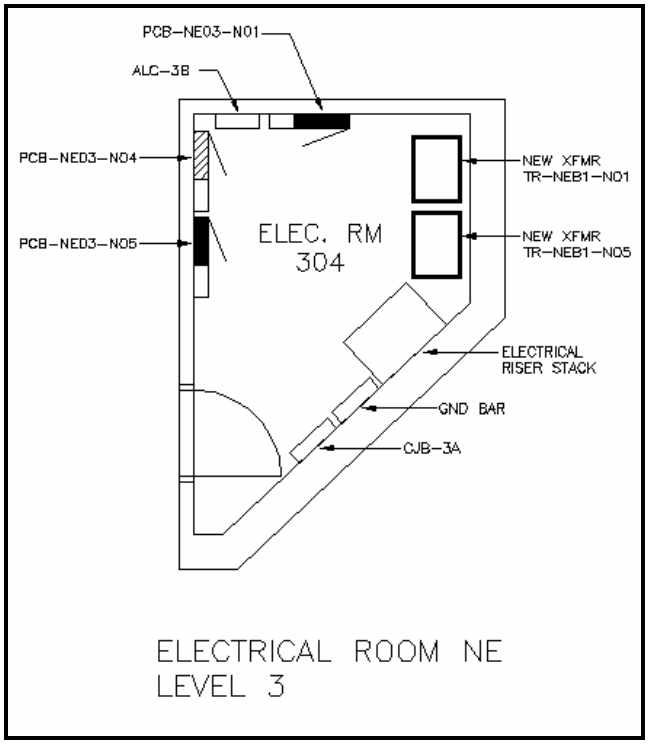


Figure 3.5 (Top Left) – Electrical Room NE Level L1
Figure 3.6 (Top Right) – Electrical Room NE Level 1
Figure 3.7 (Bottom Left) – Electrical Room NE Level 3

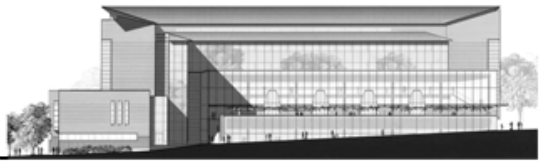


Figure 3.8 – Electrical Room NW Level L1

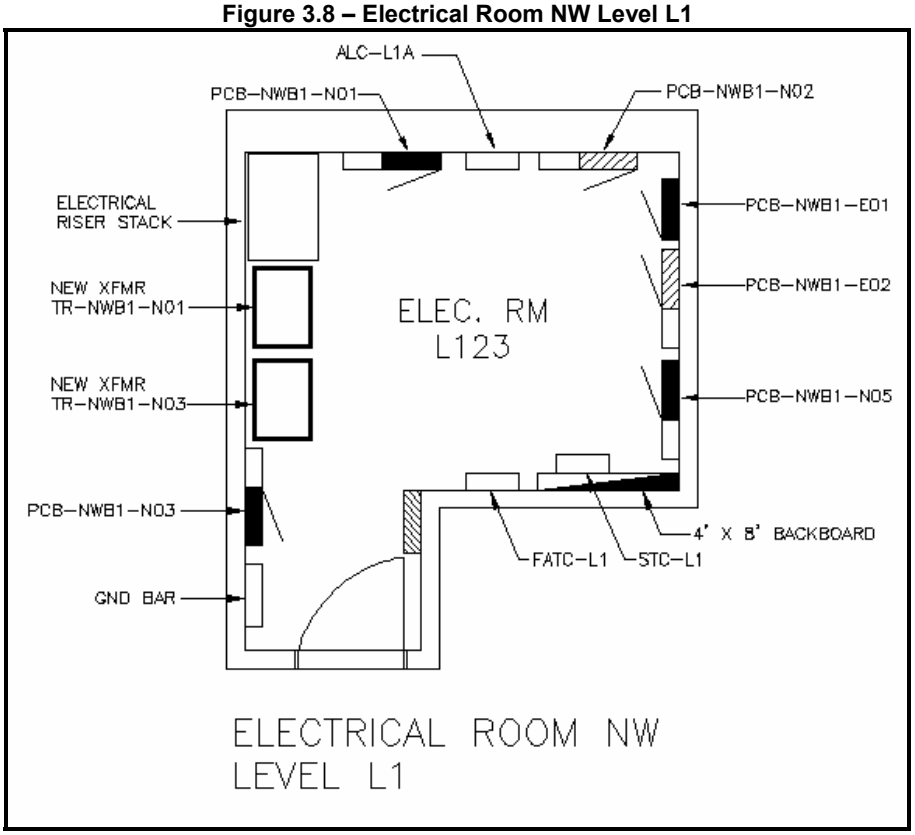
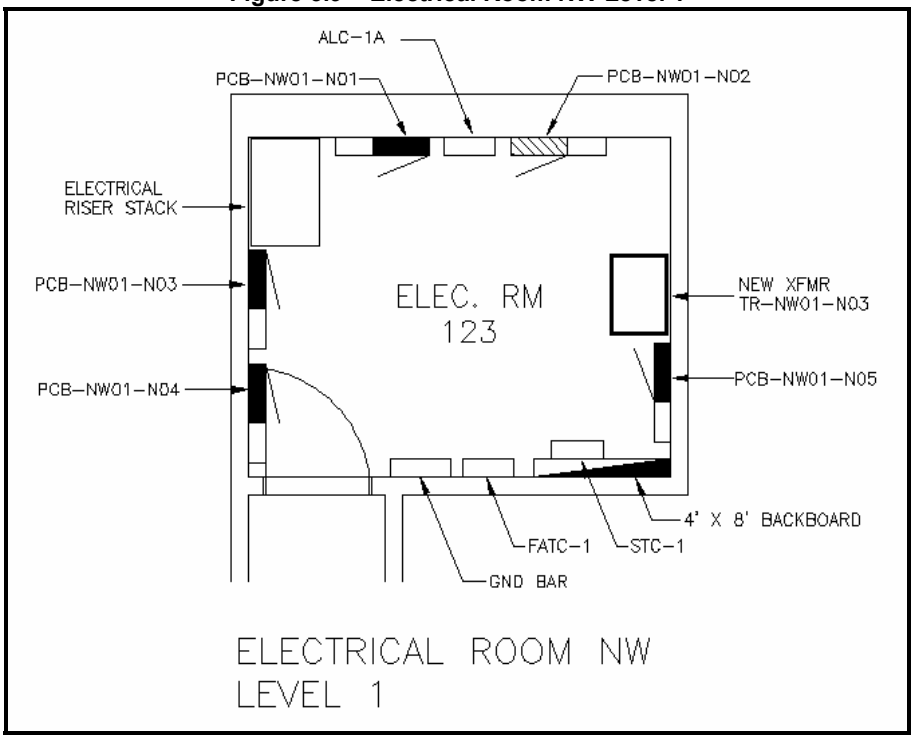


Figure 3.9 – Electrical Room NW Level 1



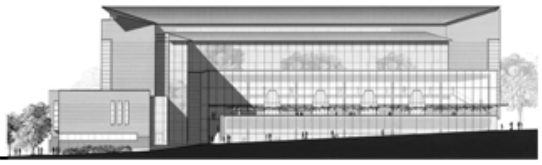


Figure 3.10 – Electrical Room NW Level 2

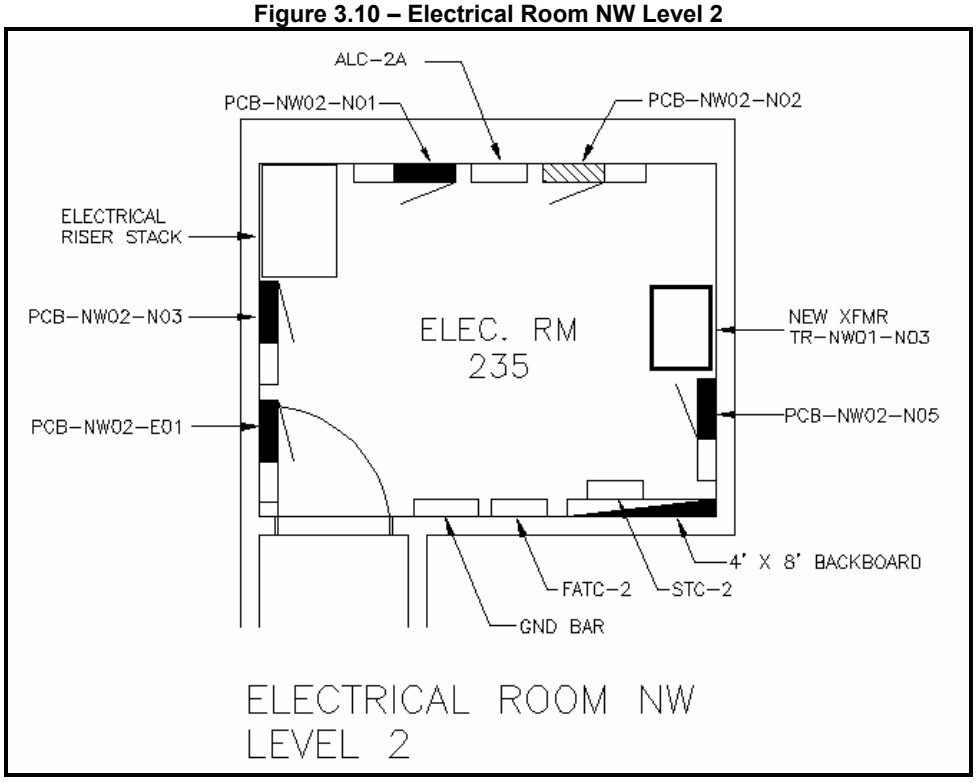
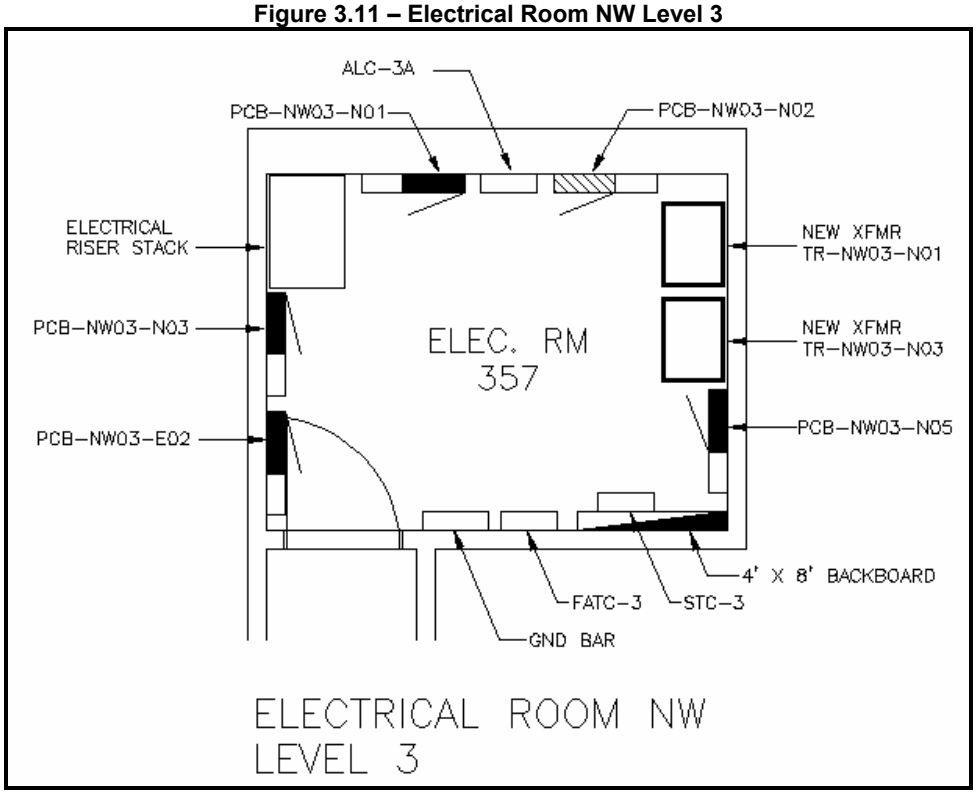


Figure 3.11 – Electrical Room NW Level 3



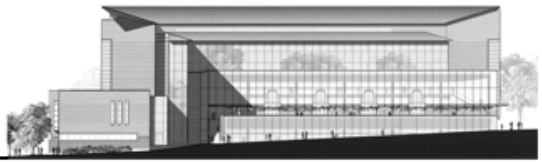
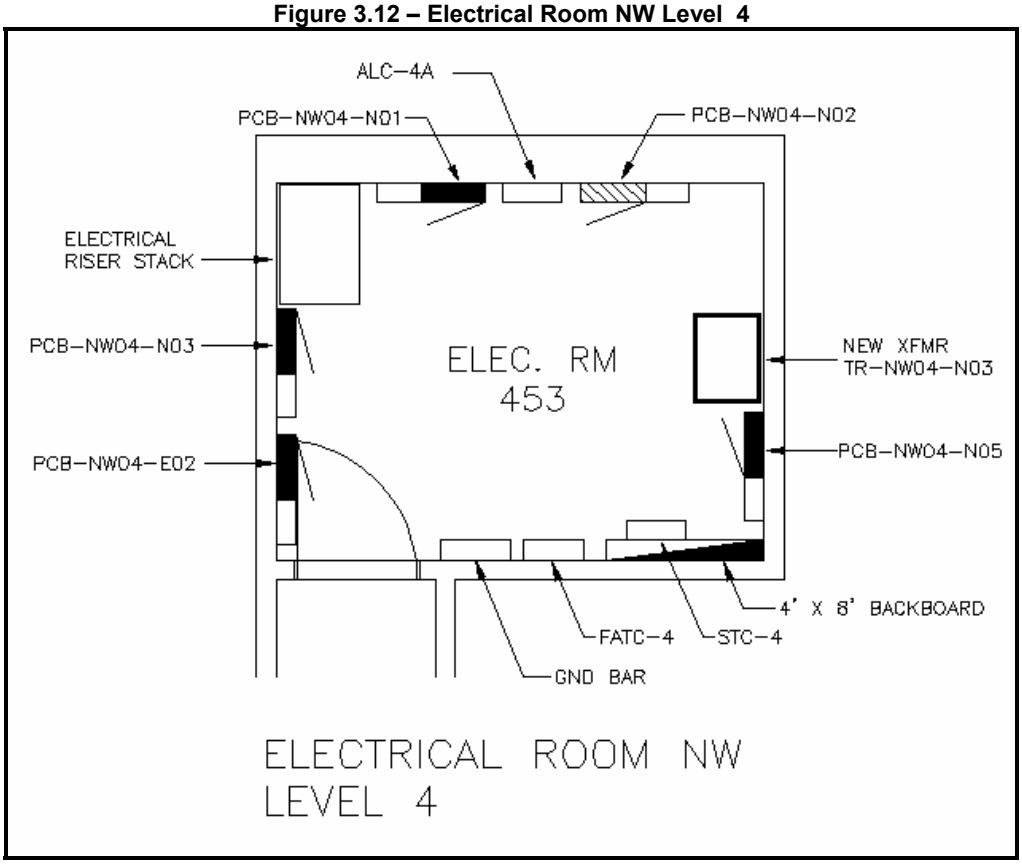


Figure 3.12 – Electrical Room NW Level 4



Cost Analysis

The following cost analysis looks at the cost associated with the existing central transformer system and the proposed distributed transformer system. The cost comparison accounts for all components on the feeders that were redesigned. This includes transformers, transformer protection, feeder protection, feeders, panelboards, distribution panels and circuit breakers.

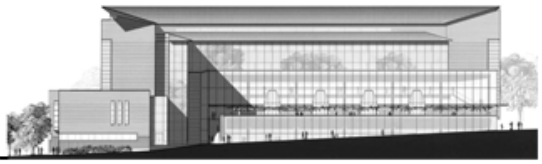


Table 3.4 – Existing System Cost

EXISTING SYSTEM								
TRANSFORMERS								
480-208/120V, 3 PH, 4W - K-13 RATED, VENTILATED								
SIZE	**COST (INCL. O&P)**	**UNITS**		**QUANTITY**			**TOTAL COST**	
225 KVA	$18,100	EA.		2			$36,200	
500 KVA	$37,200	EA.		2			$74,400	
				SUBTOTAL			**$110,600**	
TRANSFORMER PROTECTION								
ENCLOSED CIRCIT BREAKERS, NEMA 1								
SIZE	**COST (INCL. O&P)**	**UNITS**		**QUANTITY**			**TOTAL COST**	
600A	$3,900	EA.		2			$7,800	
				SUBTOTAL			**$7,800**	
SWITCHGEAR BREAKERS								
SIZE	**COST (INCL. O&P)**	**UNITS**		**QUANTITY**			**TOTAL COST**	
400A	$3,775	EA.		2			$7,550	
800A	$5,900	EA.		2			$11,800	
				SUBTOTAL			**$19,350**	
MOLDED CASE CIRCUIT BREAKERS								
SIZE	**COST (INCL. O&P)**	**UNITS**		**QUANTITY**			**TOTAL COST**	
400A	$3,775	EA.		1			$3,775	
600A	$4,650	EA.		5			$23,250	
				SUBTOTAL			**$27,025**	
DISTRIBUTION PANEL								
SIZE	**COST (INCL. O&P)**	**UNITS**		**QUANTITY**			**TOTAL COST**	
1600A	$4,850	EA.		2			$9,700	
				SUBTOTAL			**$9,700**	
PANELBOARDS								
SIZE	**COST (INCL. O&P)**	**UNITS**		**QUANTITY**			**TOTAL COST**	
225A	$2,025	EA.		23			$46,575	
400A	$3,025	EA.		9			$27,225	
				SUBTOTAL			**$73,800**	
FEEDER & CONDUIT								
FEEDER DESIG.	**WIRE**	**NO. SETS**	**QUANTITY**	**SIZE**	**COST (INCL. O&P)**	**UNITS**	**LENGTH (L.F.)**	**TOTAL COST**
225Y	PHASE	1	3	4/0	$420.00	C.L.F.	595	$7,497.00
	NEUTRAL		1	4/0	$420.00	C.L.F.	595	$2,499.00
	GROUND		1	4	$136.00	C.L.F.	595	$809.20
	CONDUIT		1	2-1/2"	$17.60	L.F.	595	$10,472.00
350Y	PHASE	1	3	500 KCMIL	$765.00	C.L.F.	20	$459.00
	NEUTRAL		1	500 KCMIL	$765.00	C.L.F.	20	$153.00
	GROUND		1	2	$178.00	C.L.F.	20	$35.60
	CONDUIT		1	3"	$22.50	L.F.	20	$450.00
400Y	PHASE	2	3	3/0	$355.00	C.L.F.	324	$6,901.20
	NEUTRAL		1	3/0	$355.00	C.L.F.	324	$2,300.40
	GROUND		1	2	$178.00	C.L.F.	324	$1,153.44
	CONDUIT		1	2-1/2"	$17.60	L.F.	324	$5,702.40
600Y	PHASE	2	3	350 KCMIL	$595.00	C.L.F.	980	$34,986.00
	NEUTRAL		1	350 KCMIL	$595.00	C.L.F.	980	$11,662.00
	GROUND		1	1	$209.00	C.L.F.	980	$4,096.40
	CONDUIT		1	3"	$22.50	L.F.	980	$22,050.00
800Y	PHASE	3	3	300 KCMIL	$535.00	C.L.F.	20	$963.00
	NEUTRAL		1	300 KCMIL	$535.00	C.L.F.	20	$321.00
	GROUND		1	1/0	$250.00	C.L.F.	20	$150.00
	CONDUIT		1	3"	$22.50	L.F.	20	$450.00
1600Y	PHASE	5	3	500 KCMIL	$765.00	C.L.F.	10	$1,147.50
	NEUTRAL		1	500 KCMIL	$765.00	C.L.F.	10	$382.50
	GROUND		1	4/0	$420.00	C.L.F.	10	$210.00
	CONDUIT		1	3-1/2"	$27.50	L.F.	10	$275.00
					SUBTOTAL		**$115,125.64**	
EXISTING SYSTEM TOTAL							**$363,400.64**	

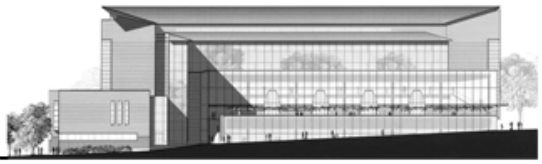


Table 3.5 – Proposed System Cost

PROPOSED SYSTEM								
TRANSFORMERS								
480-208/120V, 3 PH, 4W - K-13 RATED, VENTILATED								
SIZE	**COST (INCL. O&P)**	**UNITS**			**QUANTITY**		**TOTAL COST**	
45 KVA	$4,300	EA.			3		$12,900	
75 KVA	$5,750	EA.			4		$23,000	
112.5 KVA	$10,500	EA.			5		$52,500	
150 KVA	$12,500	EA.			2		$25,000	
					SUBTOTAL		**$113,400**	
TRANSFORMER PROTECTION								
ENCLOSED CIRCIT BREAKERS, NEMA 1								
SIZE	**COST (INCL. O&P)**	**UNITS**			**QUANTITY**		**TOTAL COST**	
100A	$755	EA.			1		$755	
225A	$1,575	EA.			12		$18,900	
400A	$2,750	EA.			6		$16,500	
					SUBTOTAL		**$36,155**	
SWITCHGEAR BREAKERS								
SIZE	**COST (INCL. O&P)**	**UNITS**			**QUANTITY**		**TOTAL COST**	
225A	2850	EA.			1		$2,850	
400A	$3,775	EA.			1		$3,775	
600A	$4,650	EA.			1		$4,650	
800A	$5,900	EA.			1		$5,900	
					SUBTOTAL		**$17,175**	
MOLDED CASE CIRCUIT BREAKERS								
SIZE	**COST (INCL. O&P)**	**UNITS**			**QUANTITY**		**TOTAL COST**	
400A	$3,775	EA.			2		$7,550	
					SUBTOTAL		**$7,550**	
DISTRIBUTION PANEL								
SIZE	**COST (INCL. O&P)**	**UNITS**			**QUANTITY**		**TOTAL COST**	
400A	$2,550	EA.			2		$5,100	
					SUBTOTAL		**$5,100**	
PANELBOARDS								
SIZE	**COST (INCL. O&P)**	**UNITS**			**QUANTITY**		**TOTAL COST**	
225A	$2,025	EA.			23		$46,575	
400A	$3,025	EA.			9		$27,225	
					SUBTOTAL		**$73,800**	
FEEDER & CONDUIT								
FEEDER DESIG.	**WIRE**	**NO. SETS**	**QUANTITY**	**SIZE**	**COST (INCL. O&P)**	**UNITS**	**LENGTH (L.F.)**	**TOTAL COST**
100Y	PHASE	1	3	1	$209.00	C.L.F.	10	$62.70
	NEUTRAL		1	1	$209.00	C.L.F.	10	$20.90
	GROUND		1	8	$78.00	C.L.F.	10	$7.80
	CONDUIT		1	2"	$11.15	L.F.	10	$111.50
225Y	PHASE	1	3	4/0	$420.00	C.L.F.	892	$11,239.20
	NEUTRAL		1	4/0	$420.00	C.L.F.	892	$3,746.40
	GROUND		1	4	$136.00	C.L.F.	892	$1,213.12
	CONDUIT		1	2-1/2"	$17.60	L.F.	892	$15,699.20
400Y	PHASE	2	3	3/0	$355.00	C.L.F.	404	$8,605.20
	NEUTRAL		1	3/0	$355.00	C.L.F.	404	$2,868.40
	GROUND		1	2	$178.00	C.L.F.	404	$1,438.24
	CONDUIT		1	2-1/2"	$17.60	L.F.	404	$7,110.40
600Y	PHASE	2	3	350 KCMIL	$595.00	C.L.F.	206	$7,354.20
	NEUTRAL		1	350 KCMIL	$595.00	C.L.F.	206	$2,451.40
	GROUND		1	1	$209.00	C.L.F.	206	$861.08
	CONDUIT		1	3"	$22.50	L.F.	206	$4,635.00
800Y	PHASE	3	3	300 KCMIL	$535.00	C.L.F.	180	$8,667.00
	NEUTRAL		1	300 KCMIL	$535.00	C.L.F.	180	$2,889.00
	GROUND		1	1/0	$250.00	C.L.F.	180	$1,350.00
	CONDUIT		1	3"	$22.50	L.F.	180	$4,050.00
					SUBTOTAL		**$84,177.84**	
PROPOSED SYSTEM TOTAL							**$337,357.84**	

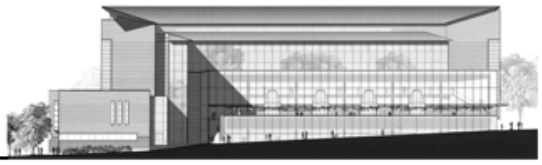


Table 3.6 – Cost Comparison

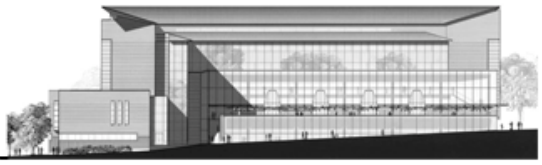
COST COMPARISON	
EXISTING SYSTEM COST	$363,400.64
PROPOSED SYSTEM COST	$337,357.84
SAVINGS	**$26,042.80**

This cost analysis compared to cost for the building's existing transformer design, which utilizes central transformers and the proposed transformer design, which uses distributed transformers. The proposed distributed transformer system allows for a savings of approximately $26,042. Equipment and material prices for this analysis were obtained from R.S. Means. Methods by which material and equipment totals were obtained was kept consistent for both system take-offs to maintain consistency in the values obtained.

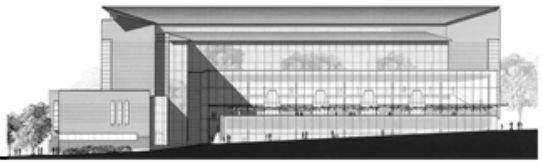
When comparing to cost of the two transformer systems, the prime area of cost savings of the proposed distributed transformer design is in feeders and conduits. While overall equipment cost for the proposed system is higher than the existing system, a lower system cost is achieved by using smaller feeders throughout the building due to the high price of copper wiring.

Conclusions

While there are several concerns surrounding the use of distributed transformers, such as an increased number of transformers required and space requirements in electrical closets, it does prove to be an effective design solution. By using distributed transformers throughout the building, feeder sizes running vertically through the building can be reduced, and thus, the high cost associated with copper feeders can be decreased significantly. While the number of step-down transformers in the buildings is increased from seven to seventeen, other equipment is able to be de-rated, feeders are sized smaller and the total cost of the system is decreased by approximately $26,000. In the case of the electrical system for William H. Gates Hall, distributed transformers are a good alternative to the existing central transformers and would be recommended for this building.



Motor Control Center Design



Introduction

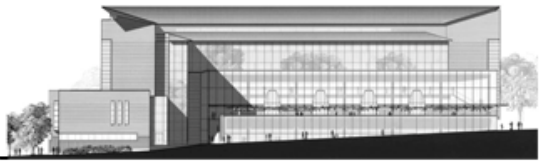
The Motor Control Center Design potion of the Electrical Depth looks to design a motor control center to control the motor starters for all nine of the air handling units, which are located in the fourth floor mechanical room of William H. Gates Hall. The design of the motor control center includes a system layout, equipment sizing and selection, and sizing of all required feeders and protection. Additionally, the space requirements in the fourth floor mechanical room are considered in order to ensure space for the motor control center.

Motor Control Center Loads

William H. Gates Hall's heating and cooling system is operated with the use of nine variable air volume air handling units. Each of these units is located in the fourth floor mechanical room, and range from 10,000 cfm to 29,940 cfm. A separate motor is used for the supply and return fans for each air handling unit. Motor sizes range from 20hp to 50hp for the supply fans motors and from 7.5hp to 15 hp for the return fan motors. Each of these motors is incorporated into the design of the motor control center. Additional information on each of the air handling units and their respective motors can be found in Table 4.1.

Table 4.1 – Air Handling Units

AIR HANDLING UNITS								
Designation	**Equipment Type**	**Phase (Φ)**	**Voltage**	**Motor**	**FLA**	**Power Factor**	**Controls**	**Load (KVA)**
AHU-1	SUPPLY FAN MOTOR	3	480	40 HP	52	0.95	100W	52.23
	RETURN FAN MOTOR			10 HP	14	0.95		
AHU-2	SUPPLY FAN MOTOR	3	480	40 HP	52	0.95	100W	52.23
	RETURN FAN MOTOR			10 HP	14	0.95		
AHU-3	SUPPLY FAN MOTOR	3	480	40 HP	52	0.95	100W	57.76
	RETURN FAN MOTOR			15 HP	21	0.95		
AHU-4	SUPPLY FAN MOTOR	3	480	20 HP	27	0.95	100W	30.11
	RETURN FAN MOTOR			7.5 HP	11	0.95		
AHU-5	SUPPLY FAN MOTOR	3	480	30 HP	40	0.95	100W	42.75
	RETURN FAN MOTOR			10 HP	14	0.95		
AHU-6	SUPPLY FAN MOTOR	3	480	50 HP	65	0.95	100W	68.02
	RETURN FAN MOTOR			15 HP	21	0.95		
AHU-7	SUPPLY FAN MOTOR	3	480	50 HP	65	0.95	100W	68.02
	RETURN FAN MOTOR			15 HP	21	0.95		
AHU-8	SUPPLY FAN MOTOR	3	480	40 HP	52	0.95	100W	57.76
	RETURN FAN MOTOR			15 HP	21	0.95		
AHU-9	SUPPLY FAN MOTOR	3	480	30 HP	40	0.95	100W	42.75
	RETURN FAN MOTOR			10 HP	14	0.95		



Motor Starters

Eighteen motors total are incorporated into the motor control center, two motors for each air handling unit. According to the specifications, all motor starters shall be full voltage non-reversing for NEMA size 3 and under. Starters that are larger than NEMA size 3 shall be autotransformer type. The following table outlines each motor's NEMA sizing and motor starter type.

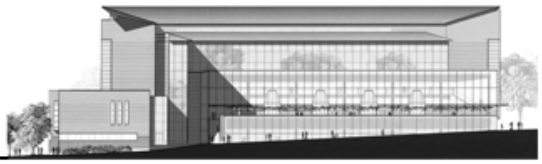
Table 4.2 – Motor Starter Type & Size

MOTOR STARTERS				
Designation	**Equipment Type**	**Motor**	**NEMA Starter Size**	**Motor Starter Type**
AHU-1	SUPPLY FAN MOTOR	40 HP	3	FVNR
	RETURN FAN MOTOR	10 HP	1	FVNR
AHU-2	SUPPLY FAN MOTOR	40 HP	3	FVNR
	RETURN FAN MOTOR	10 HP	1	FVNR
AHU-3	SUPPLY FAN MOTOR	40 HP	3	FVNR
	RETURN FAN MOTOR	15 HP	2	FVNR
AHU-4	SUPPLY FAN MOTOR	20 HP	2	FVNR
	RETURN FAN MOTOR	7.5 HP	1	FVNR
AHU-5	SUPPLY FAN MOTOR	30 HP	3	FVNR
	RETURN FAN MOTOR	10 HP	1	FVNR
AHU-6	SUPPLY FAN MOTOR	50 HP	3	FVNR
	RETURN FAN MOTOR	15 HP	2	FVNR
AHU-7	SUPPLY FAN MOTOR	50 HP	3	FVNR
	RETURN FAN MOTOR	15 HP	2	FVNR
AHU-8	SUPPLY FAN MOTOR	40 HP	3	FVNR
	RETURN FAN MOTOR	15 HP	2	FVNR
AHU-9	SUPPLY FAN MOTOR	30 HP	3	FVNR
	RETURN FAN MOTOR	10 HP	1	FVNR

FVNR - Full Voltage Non-Reversing

Motor Control Center Sizing

In order size the motor control center, the number of spaces required for each motor is established in order to properly configure the motor control center. In addition, the motor control center minimum ampacity is determined and the control center is sized.



Control Center Ampacity

In order to determine the ampacity of the motor control center's main bus, the minimum ampacity of the connected motor loads is determined. This value is determined using the full load ampacity based on the motor horsepower. Full-load currents were determined using NEC Table 430.250 –Full-Load Current, Three-Phase Alternating-Current Motors. Demand factors of 125% for the largest motor and 100% of the remaining motors are applied to these loads. The minimum ampacity is determined according to motor size in Table 4.3.

Table 4.3 – Motor Control Center Main Bus Ampacity

Motor Horsepower	Quantity	FLMA	Demand Factor	Amps
50	2	65	125% of Largest	146.25
40	4	52	100% of Remaining	208
30	2	40		80
20	1	27		27
15	4	21		84
10	4	14		56
7.5	1	11		11
			Minimum Ampacity	**612.25**

The minimum ampacity of all connected loads on the motor control center is 612.25 amps. Therefore, the main bus of the motor control center will be size at 800A in order to feed all of these loads.

Space Factors

Each of the motors controlled by the motor control center requires a certain number spaces within the control center, referred to as X-spaces. Space factors are determined according to motor starter type and the starter NEMA size. Spaces factors are then used in determining the layout and overall size of the motor control center. The control center will be composed of 20 inch wide sections that are 72 inches high. For each space factor, 6 vertical inches will be allotted for each motor. This allows for a total of twelve space factors per vertical section of the motor control center.

Table 4.4 shows the number of space factors required for each motor and the starter NEMA size, using full voltage non-reversing combination starters from Cutler Hammer's *Intelligent Technologies (IT)* Motor Control Centers. The number of spaces is determined by the motor's horsepower rating and NEMA size. Additional space in the motor control center must be considered for the main feeder and protection section of the center. The total number of space factors needed is used to determine the layout and size (according to number of vertical sections) of the motor control center. Refer to Appendix D for manufacturer information that was used in determining the required number of spaces factors.

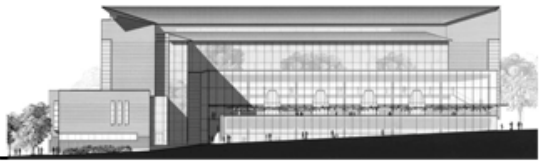


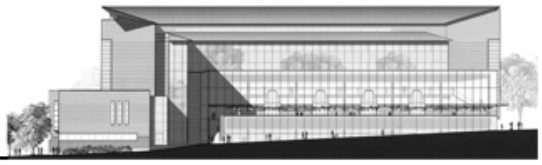
Table 4.4 – Motor Control Center Required Space Factors

REQUIRED SPACE FACTORS				
MOTORS STARTERS				
Designation	**Equipment Type**	**Motor Starter Type**	**NEMA Starter Size**	**X-Spaces**
AHU-1	SUPPLY FAN MOTOR	FVNR	3	2
	RETURN FAN MOTOR	FVNR	1	1
AHU-2	SUPPLY FAN MOTOR	FVNR	3	2
	RETURN FAN MOTOR	FVNR	1	1
AHU-3	SUPPLY FAN MOTOR	FVNR	3	2
	RETURN FAN MOTOR	FVNR	2	1
AHU-4	SUPPLY FAN MOTOR	FVNR	2	1
	RETURN FAN MOTOR	FVNR	1	1
AHU-5	SUPPLY FAN MOTOR	FVNR	3	2
	RETURN FAN MOTOR	FVNR	1	1
AHU-6	SUPPLY FAN MOTOR	FVNR	3	2
	RETURN FAN MOTOR	FVNR	2	1
AHU-7	SUPPLY FAN MOTOR	FVNR	3	2
	RETURN FAN MOTOR	FVNR	2	1
AHU-8	SUPPLY FAN MOTOR	FVNR	3	2
	RETURN FAN MOTOR	FVNR	2	1
AHU-9	SUPPLY FAN MOTOR	FVNR	3	2
	RETURN FAN MOTOR	FVNR	1	1
			Subtotal	**26**
FEEDER				
Feeder	**Feeder Size Rating**	**Frame**	**Frame Rating**	**X-Spaces**
1	800A	HND	800	7
			Subtotal	**7**
TOTAL REQUIRED SPACE FACTORS				**33**

The total number of space factors needed for all of the motors in the control center is 33. From this number, the number of vertical sections and the layout of the motor control center is determined.

Maximum possible space factors per vertical section = 12
Minimum number of vertical sections = 33/12 = 2.75 → 3
*Total number of space factors = 3 * 12 = 36*
Number of space factors used = 33
Number of spare space factors = 3

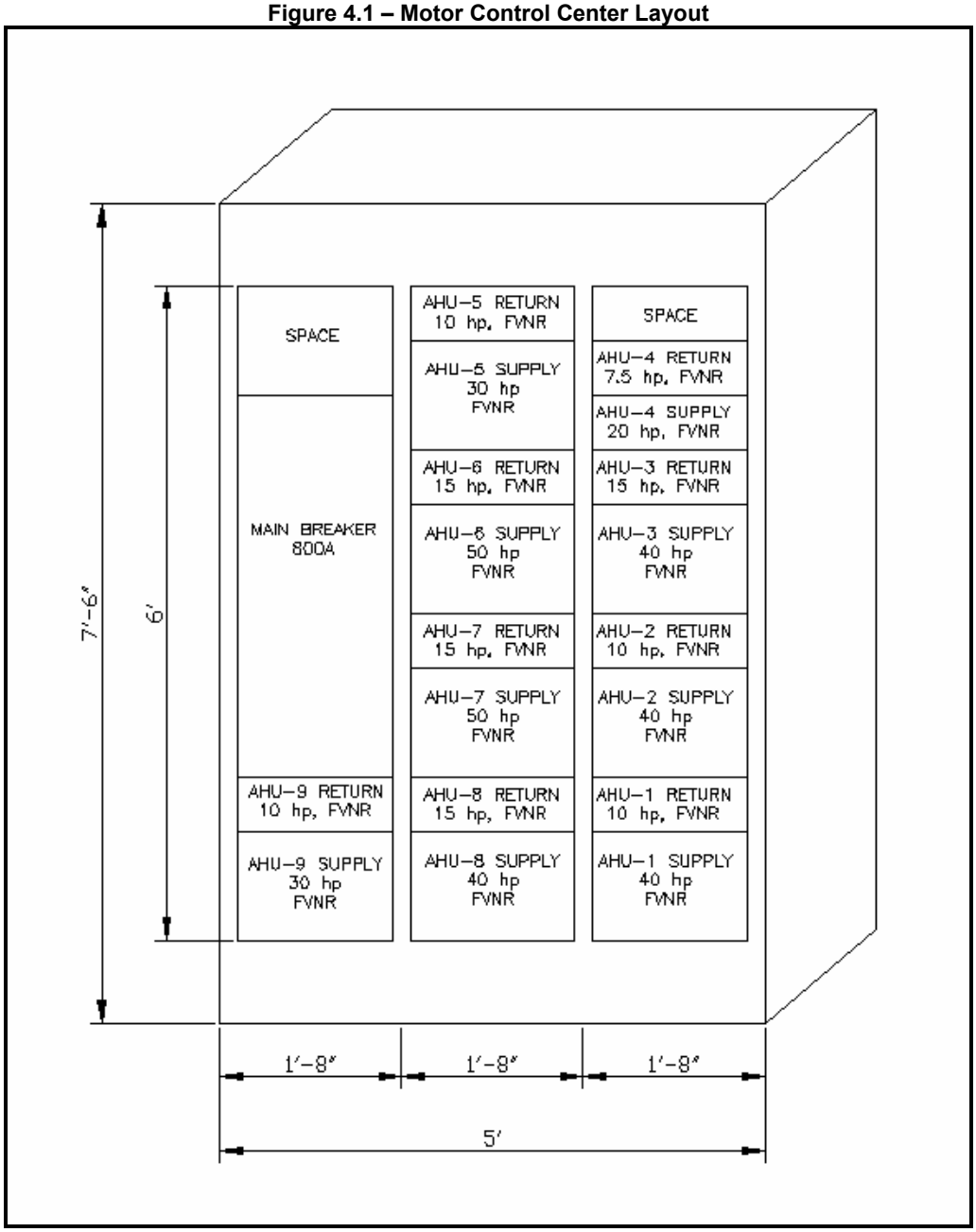
The motor control center will contain 3 vertical sections, with 3 spare space factors.

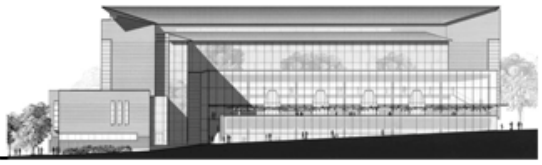


Motor Control System Layout

In designing the motor control center, an *Intelligent Technologies (IT)* Motor Control Center from Cutler Hammer will be used. Refer to Appendix D for product information. The motor control center is laid out according to the space factors previously determined. In each vertical section, the maximum amount of vertical space is utilized. The overall dimensions of the control center with three vertical sections are 90" high, 60" wide, and 16" deep. The layout of each motor starter section within the vertical columns is shown below in Figure 4.1.

Figure 4.1 – Motor Control Center Layout

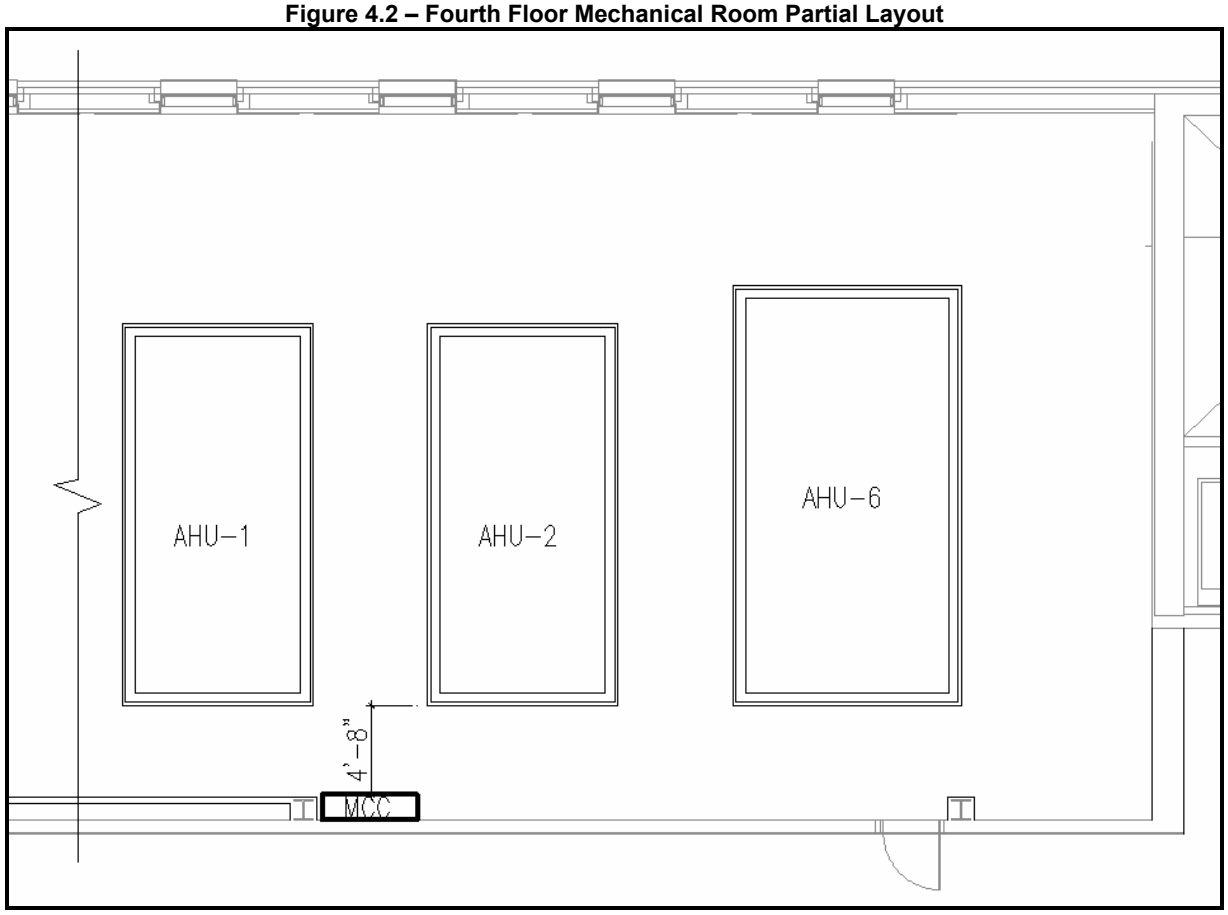




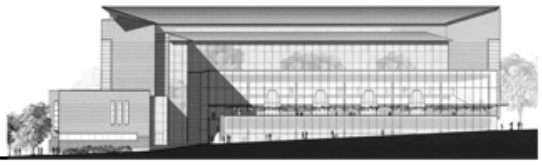
Motor Control Center Location

The motor control center will be located in the fourth floor mechanical room in order to allow for motor control as close as possible to the air handling units. The control center will be located along the south wall of the mechanical room next to the east entrance. Figure 4.2 shows the proposed location of the motor control center.

Figure 4.2 – Fourth Floor Mechanical Room Partial Layout



There is ample space in the mechanical room for the motor control center. For a motor control center operating at 480 volts, there must be a minimum clearance of 3 ½ feet from the front face of the unit to the nearest grounded surface. The location of the control center easily meets this requirement with 4 feet 8 inches of clearance between the unit and the closest air handling unit.



Motor Control Center Loads, Feeders and Protection

Main Feeder

In order to size the main feeder, the minimum ampacity calculation, performed previously in the Control Center Ampacity section of this Depth, is used to determine the appropriate feeder size. The minimum ampacity of all connected loads on the motor control center is 612.25 amps, and the motor control center main bus is rated at 800 amps. Using NEC table 310.16, the main feeder for this motor control center is sized to be 3 sets of (3) 300 kcmil in 2 ½" EMT conduit. The overcurrent protection for this unit rated at 800A.

The motor control center will be fed from an 800A spare in the main distribution panel and the feeder will run to the unit in fourth floor mechanical room. Refer to Appendix D for the one-line diagram.

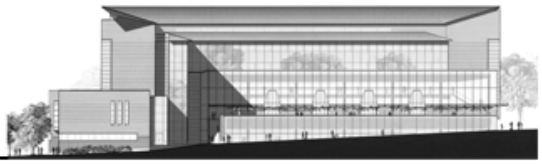
Branch Circuits

Each motor connected to the motor control center will require branch feeders and protection. Feeders for each of the motor starters are determined from the motor load. Table 4.5 outlines each of the connected equipments loads.

Table 4.5 – Motor Control Center Branch Circuit Loads

MOTOR CONTROL CENTER LOADS							
Designation	**Equipment Type**	**Phase (Φ)**	**Voltage**	**Motor**	**FLA**	**Power Factor**	**Load (KW)**
AHU-1	SUPPLY FAN MOTOR	3	480	40 HP	52	0.95	41.07
	RETURN FAN MOTOR	3	480	10 HP	14	0.95	11.06
AHU-2	SUPPLY FAN MOTOR	3	480	40 HP	52	0.95	41.07
	RETURN FAN MOTOR	3	480	10 HP	14	0.95	11.06
AHU-3	SUPPLY FAN MOTOR	3	480	40 HP	52	0.95	41.07
	RETURN FAN MOTOR	3	480	15 HP	21	0.95	16.59
AHU-4	SUPPLY FAN MOTOR	3	480	20 HP	27	0.95	21.33
	RETURN FAN MOTOR	3	480	7.5 HP	11	0.95	8.69
AHU-5	SUPPLY FAN MOTOR	3	480	30 HP	40	0.95	31.59
	RETURN FAN MOTOR	3	480	10 HP	14	0.95	11.06
AHU-6	SUPPLY FAN MOTOR	3	480	50 HP	65	0.95	51.34
	RETURN FAN MOTOR	3	480	15 HP	21	0.95	16.59
AHU-7	SUPPLY FAN MOTOR	3	480	50 HP	65	0.95	51.34
	RETURN FAN MOTOR	3	480	15 HP	21	0.95	16.59
AHU-8	SUPPLY FAN MOTOR	3	480	40 HP	52	0.95	41.07
	RETURN FAN MOTOR	3	480	15 HP	21	0.95	16.59
AHU-9	SUPPLY FAN MOTOR	3	480	30 HP	40	0.95	31.59
	RETURN FAN MOTOR	3	480	10 HP	14	0.95	11.06

Feeders and circuit protection are determined from the loads outlined above. For each motor the conductors, branch circuit protection, and motor overcurrent protection are sized. The convention used for sizing each of these elements is noted below.



Branch Circuit Protection:
Branch Circuit Protection for each motor is provided by inverse time delay molded-case circuit breakers. The maximum rating of the motor branch circuit protection for inverse time delay circuit breakers is 250%, per NEC table 430.52

*Maximum Breaker Size = 250% * FLA*

The next highest standard trip rating and a frame size is chosen according to this calculated value.

Branch Circuit Conductors:
Branch circuit conductors are sized according to 125% of a motor's full load current.

*Minimum Ampacity = 125% * FLA*

The feeder for each motor branch circuit is sized according to NEC Table 310.16. The conduits for these feeders are sized using the conduit sizing worksheet.

Motor Disconnect:
A means of motor disconnect is required for all motors, within sight, or 50 feet, from the motor and its driven equipment. The location of the motor control center within the mechanical rooms is within this 50 foot line of sight to several air handling units – AHU-1, AHU-2, AHU-6, AHU-8, and AHU-9. These air handling units, therefore, do not require a means of disconnect at the motor location. The remainder of the air handling units, AHU-3, AHU-4, AHU-5, and AHU-7, do require for a local disconnect. For the purpose of this design, disconnects for all air handling units are sized. Unfused disconnect switches are used for all air handlers. The three-pole motor switches are size according to the following rating standards shown in Table 4.6.

Table 4.6 – Standard Ratings of Three-Pole Motor Circuit Switches

	MAXMUM HORSEPOWER RATING
AMPERE RATING	UNFUSED
	480 VAC
30	15
60	30
100	60
200	100

The following table, Table 4.7, shows the sizing for all of branch circuit conductors, branch circuit protection devices, and motor disconnect switches.

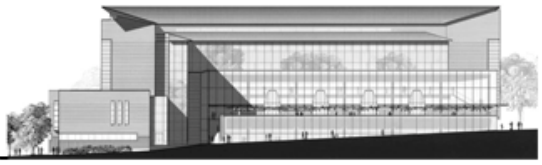
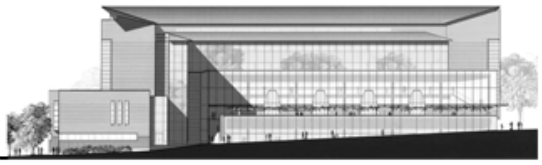


Table 4.7 – Motor Protection and Conductor Sizing

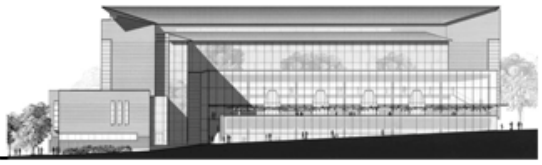
MOTOR	BRANCH CIRCUIT PROTECTION	BRANCH CIRCUIT CONDUCTORS			MOTOR DISCONNECT
		SETS	WIRE SIZE	CONDUIT SIZE	
AHU1 - SUPPLY	225AF/150AT	1	(3) #6	3/4"	100A
AHU1 - RETURN	150AF/40AT	1	(3) #12	3/4"	30A
AHU2 - SUPPLY	150AF/150AT	1	(3) #6	3/4"	100A
AHU2 - RETURN	100AF/40AT	1	(3) #12	3/4"	30A
AHU3 - SUPPLY	150AF/150AT	1	(3) #6	3/4"	100A
AHU3 - RETURN	100AF/60AT	1	(3) #10	3/4"	30A
AHU4 - SUPPLY	100AF/70AT	1	(3) #10	3/4"	60A
AHU4 - RETURN	100AF/40AT	1	(3) #12	3/4"	30A
AHU5 - SUPPLY	100AF/100AT	1	(3) #8	3/4"	60A
AHU5 - RETURN	100AF/40AT	1	(3) #12	3/4"	30A
AHU6 - SUPPLY	225AF/175AT	1	(3) #4	1"	100A
AHU6 - RETURN	100AF/60AT	1	(3) #10	3/4"	30A
AHU7 - SUPPLY	225AF/175AT	1	(3) #4	1"	100A
AHU7 - RETURN	100AF/60AT	1	(3) #10	3/4"	30A
AHU8 - SUPPLY	150AF/150AT	1	(3) #6	3/4"	100A
AHU8 - RETURN	100AF/60AT	1	(3) #10	3/4"	30A
AHU9 - SUPPLY	100AF/100AT	1	(3) #8	3/4"	60A
AHU9 - RETURN	100AF/40AT	1	(3) #12	3/4"	30A

Conclusion

The motor control center design includes motor starters for all nine of the air handling units located in the fourth floor mechanical room. From analyzing the motor loads, it was determined an 800A bus bar would be needed to feed all of the loads, and the motor control center will be fed from a spare 800A breaker in the main distribution panel. It was determined that the motor control center would need to contain three 20 inch vertical sections in order to house all of the motor starters, and incoming feed main circuit breaker. Additionally, there is ample space and clearance in the mechanical room for the control center at its determined size.



Protective Device Coordination Study



Introduction

The Protective Device Coordination Study looks at the coordination of protective devices along a single path through the distribution. This includes protection for a lighting/equipment panel, protection of the distribution panel feeding the lighting panel, and the protection of the distribution panel's respective feeder in the switchgear.

Protective Device Coordination

The three devices that are analyzed for this protective coordination study are: the 150 amp main circuit breaker of lighting panel PCB-NWB1-N02, the 400 amp lighting panel feeder protection in distribution panel PCD-NWB2-N02, and the 800 amp protection of the distribution panel, located in the main switchgear.

The time/current trip curves for each of these protection devices are overlaid to determine the coordination of these devices. Refer to Appendix E for protection device time/current trip curves.

Figure 5.1, on the following page, illustrates the overlay and coordination of these three devices. According to this overlay, the branch panel protection device and distribution panel are coordinated, as the branch panel protection curve is located to the left of the distribution panel protection curve (although, only slightly). However, the protection device located in the main switchgear is not coordinated with either other protection devices. The switchgear circuit breaker time/current curve is located to the left of both other curves.

Short Circuit Current Calculations

Short circuit current calculations on the transformer secondary side and the switch board cannot be completed at this time due to the inability to obtain information on the utility/campus electrical distribution short circuit current.

Conclusion

The protective device coordination study shows that the protection devices studied are not coordinated. The overlay of the protection time/current trip curves shows that the protective device on the main switchgear will trip before either the distribution panel or the branch circuit lighting and equipment panelboard.

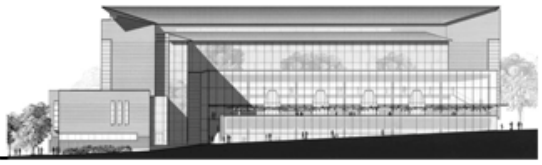


Figure 5.1 – Overlay of Time/Current Trip Curves