

Electrical Design Review Method Based on BIM-MEP Model

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1. Introduction

Taiwan Power Company (Taipower) processes a large volume of user electricity facility drawing review cases annually. Given the complexity and numerous detailed clauses in power system regulations, manual review of these cases is time-consuming and labor-intensive. This study investigates the feasibility of digitizing the drawing review process through Building Information Modeling (BIM). It explores how this approach can accelerate the overall workflow, enhance Taipower's collection and use of related data, reduce manual review errors, and establish standardized BIM data for power equipment to serve as the basis for Taipower's future promotion of electronic drawing review.

The Associated General Contractors of America (AGC) introduced Building Information Modeling (BIM) in 2005. BIM represents a facility model in a digital format, assisting in analysis from a visual perspective [1]. BIM utilizes n-dimensional (n-D) models to simulate planning, design, construction, and operation, helping users observe the building being constructed in a simulated environment and identify potential issues [2].

Based on the premise of performing electrical configuration design using the BIM architectural model, this study proposes a BIM-based electrical design review mechanism for Mechanical, Electrical, and Plumbing (MEP). This mechanism attempts to transform the traditional 2D electrical design review method into a 3D assessment to reduce the required review manpower and

improve accuracy and timeliness. Simultaneously, it can instantly determine whether the designs of cables, devices, equipment, and components comply with relevant regulations. The BIM model for this review method is constructed based on Autodesk Revit. It integrates regulatory modeling, including the determination and calculation of wiring distances, short-circuit current, and voltage drop, and allows comparison and review against established regulatory data.

2. Methods

Figure 1 illustrates the electrical design review process model based on BIM-MEP. This study focuses its case example on residential MEP and conducts testing according to the Figure 1 process and Taipower's review specifications.

(1) Importing IFC/RVT files

Revit's Industrial Foundation Class (IFC) files serve as the standard format for compiling all electrical design information. The review platform developed in this study operates in standalone mode (using the Dynamo plugin within Revit) to receive Revit (or other BIM software) files uploaded via the web and convert them into IFC format. This research focuses on BIM review for load analysis tables and short-circuit current analysis. Consequently, relevant electrical information—including distribution panels, transformers, and load equipment—constitutes the required review data. Electrical engineers first import design data as a basis for

subsequent review.

(2) Switchboards Distance Calculation

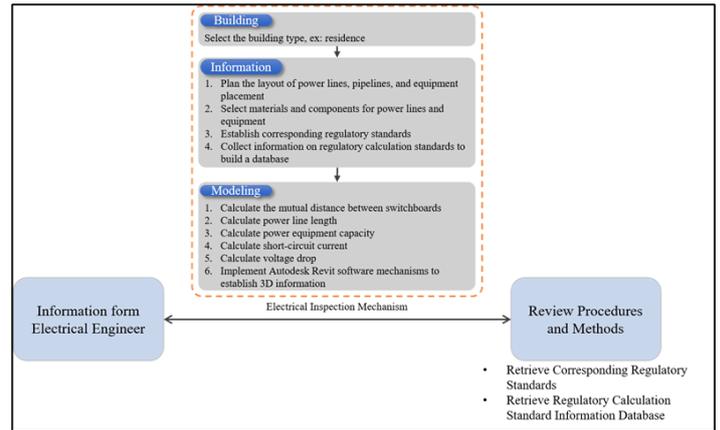
Figure 2 shows the model used to calculate the distance between distribution panels in BIM software. The calculation formula is as follows:

$$d = \Delta X_1 + \Delta Y_1 + \Delta H_1 + \Delta X_2 + \Delta Y_2 + \Delta H_2 + \Delta H$$

(3) Key Points for BIM Review

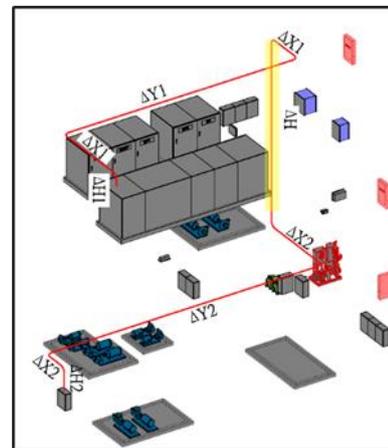
Based on the data required in Appendix 3’s “Self-Checklist for Design Data Submission” of the Taiwan Power Company’s “Operational Standards for Reviewing Design Data of Electrical Equipment Below High Voltage,” this study employs BIM review for the following items: 3- Power Line Connections, 4-Single-Line Diagram System, 8-Transformer Equipment and High-Voltage Equipment, 10-Short-Circuit Current, and 15-Voltage Drop Calculation.

The electrical engineer’s cable dimensions and parallel group counts were imported into the BIM model. Based on the “Rules for Installation of User Electrical Equipment” [3], the AT (trip current) value of circuit breakers can be calculated and analyzed to verify compliance. Using the cable or busbar parameter data from the BIM model, combined with the length calculated in ii, voltage drop and short-circuit current can be computed to assist in confirming whether the data meets requirements.



Source: Self-drawn

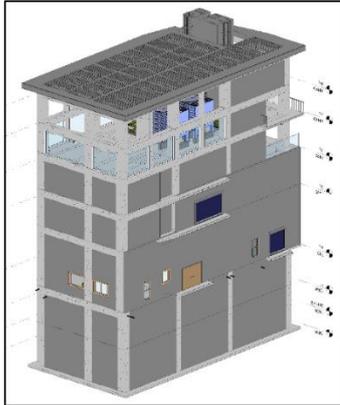
Figure 1. Modeling Based on the BIM-MEP Electrical Design Review Process



Source: Self-drawn

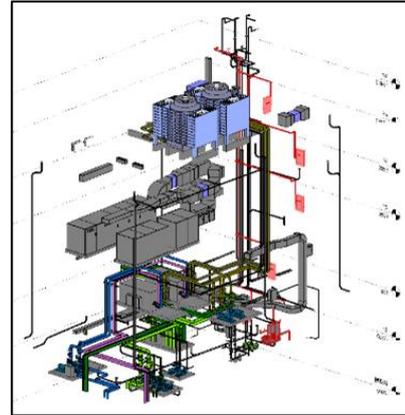
Figure 2. Computational model

Figure 3 depicts a single-unit mechanical and electrical equipment room designed using a 3D BIM. Figure 3(a) shows the three-dimensional BIM model of the single-unit mechanical and electrical room. Figure 3(b) presents the BIM model of the mechanical and electrical equipment within the room. Based on the aforementioned calculations, the short-circuit table (excerpt) is shown in Figure 4(b). Should any discrepancies arise between the review specifications and the data, the system generates an alert document for user reference.



Source: Self-drawn

Figure 3 (a). Three-Dimensional BIM Model of a Single-Family House



Source: Self-drawn

Figure 3 (b). BIM Model for Electrical and Mechanical Equipment in the Machine Room

說明		1		2				3		4		5		6		7		8	
		上游		變壓器或饋線資料				合計		K		Z		Is		Ias		備註	
回路編號	由 X/R 至	R (PU)	X (PU)	線路/容量 (M)	長度或Z (km)	R(PU)	X(PU)	R (PU)	X (PU)	R (PU)	X (PU)	R (PU)	X (PU)	Z (PU)	Is (KA)	Ias (KA)			
MOF	DC	22800	0.0008	0.002	150	5	0.00029	0.00017	0	0	0.00008	0.002	1.332	0.002	12.65	16.84			
DC	YCB	22800	0.0008	0.002	150	4.8	0.00029	0.00017	0	0	0.00008	0.002	1.332	0.002	12.65	16.85			
YCB	TRA	22800	0.0008	0.002	150	5.4	0.00029	0.00017	0	0	0.00008	0.002	1.332	0.002	12.65	16.84			
TRA	871 TRA	380	0.0008	0.002	1000	0.96	0.00685	0.00961	0.00685	0.00961	0.00685	0.00961	1.222	0.062	23.51	29.95			
TRA	ACB	380	0.0093	0.06161	500	5.4	0.7964	0.44598	0.0043	0.00241	0.01123	0.06402	1.154	0.065	23.38	26.98	TRA		
Motor	620.55 Motor	380	0.01123	0.06402	0	0.25	0	0	0.06714	0.40287	0.00962	0.05524	1.155	0.061	27.1	31.3			
ACB	ACM	380	0.00962	0.05524	200	10.3	0.7964	0.44598	0.0082	0.00459	0.01782	0.05983	1.074	0.0624	24.34	26.14	ACB		
ACB	107.269 MP1	380	0.00962	0.05524	150	12.7	1.01801	0.44321	0.01293	0.00563	0.02255	0.06087	1.048	0.0649	23.41	25.17	ACB		
ACM	221.182 MACP	380	0.01782	0.05983	200	4.8	0.7964	0.44598	0.00382	0.00214	0.02164	0.06197	1.054	0.0656	23.15	25.75	ACM		
MP1	BP	380	0.02255	0.06087	5.5	21.99	44.68144	0.49584	0.98254	0.0189	1.00309	0.07177	1	1.0077	1.51	1.51	MP1		
MP1	EL-1	380	0.02255	0.06087	5.5	28.24	44.68144	0.49584	1.2618	0.014	1.28435	0.07487	1	1.2865	1.18	1.18	MP1		
MP1	R1	380	0.02255	0.06087	5.5	27.64	44.68144	0.49584	1.235	0.01371	1.25755	0.07458	1	1.2598	1.21	1.21	MP1		
MP1	LB1	380	0.02255	0.06087	5.5	27.74	44.68144	0.49584	1.01606	0.01128	1.03861	0.07215	1	1.0411	1.46	1.46	MP1		
MP1	2.67 WF	380	0.02255	0.06087	5.5	38.29	44.68144	0.49584	1.71085	0.01899	1.7334	0.07986	1	1.7352	0.88	0.89	MP1		
MP1	28.502 CAF	380	0.02255	0.06087	22	12.97	7.07064	0.4723	0.09171	0.00613	0.11426	0.067	1	0.1324	11.47	11.64	MP1		
MP1	32.352 MP2	380	0.02255	0.06087	20	5.6	5.45706	0.46468	0.03056	0.0026	0.05311	0.06347	1.003	0.0828	18.36	18.6	MP1		

Source: Self-drawn

Figure 4 (a). Load Table (Excerpt)

盤名(Panel)	MACP	往上連接盤名(Uplink Panel) ACM											
回路編號	說明	連接負載 (Load) (VA)			斷路器 (MOCB or ELCB)	I.C.	電流	功率因數	線徑(線別, 導線, 地線) Wire_Size, Earth	管徑 Conduit Dia. (mmφ)	長度 L (m)	壓降 Vd (%)	
CKT No.	Load Description	合計 Total	A	B	C	P-AF-AT	(kA)	(A)	PF	(mm²)	(m)	(%)	
1	R-1	77344	25781	25781	25782	3-225-200	18	117.51	0.8	X1R100x3.22E	F54	43.94	0.62
2	R-2	77344	25781	25781	25782	3-225-200	18	117.51	0.8	X1R100x3.22E	F54	43.34	0.61
3	CT	31412	10470	10471	10471	3-100-75	18	47.73	0.8	X1R22x3.8E	F28	12.94	0.26
4	CP	18676	6225	6225	6226	3-100-50	18	28.38	0.8	X1R14x3.55E	F28	22.26	0.41
5	CWP	16404	5468	5468	5468	3-100-50	18	24.92	0.8	X1R14x3.55E	F28	42.58	0.68
主開關(Main Breaker)		221182	73727	73727	73728	3-600-500	18	336.05	0.8	X1C200x6.38E	C	4.8	0.11

Source: Self-drawn

Figure 4 (b). Short Circuit Table (Excerpt)

3. Result and Conclusion

This study employs BIM as the foundation for electrical design review, utilizing Autodesk Revit software as the implementation tool. It focuses on key items within electrical review load schedules—including

line voltage, short-circuit current, and electrical equipment capacity—to conduct BIM-based electrical review research and establish calculation and measurement specifications. Review test results confirm that the time required for voltage drop calculations and

short-circuit current calculations has been reduced from 4 to 16 hours to under 2 hours. This approach also enhances review accuracy and improves the rationality of cable calculations.

4. Reference

[1] Associated General Contractors of America, *The Contractor's Guide to BIM*, 1st ed. Las Vegas, NV: AGC, 2005.

[2] S. Azhar, M. Khalfan, and T. Maqsood, "Building information modeling (BIM): Now and beyond," *Australasian J. Construction Econ. Build.*, vol. 12, no. 4, pp. 15–28, 2012.

[3] 經濟部，「用戶用電設備裝置規則」，2021 年。