Abstract

Résumé:
A substation maintenance center is the base of the squads responsible for the inspection and maintenance of the substations under the management, as well as on-site operations and the fault handling of the substations. A substation maintenance center needs space for operation tools and substation consumables. It also provides the office area for the 24-hour-on-duty squads. Due to lack of land resource, it is getting difficult to build new substation maintenance centers in some places. This paper investigated the setting standard and construction demands of substation maintenance centers in highly built-up areas. The typical situation of Shenzhen, which ranks the third in GDP in China, with the land area of only 1997 square kilometers, is studied to give power supply companies and land utilization departments some inspirations. According to the study, service radius of the substation maintenance center should not exceed 9 kilometers to guarantee timeliness. The upper limit number of substations under the management is twenty-five. In places with land shortage problems, the site area for a new substation maintenance center could be limited in 500 square meters, and the floor area in 2300 square meters.
Nanchen Zheng

MATPOST 2019 Study of substation maintenance center setting standard in highly built-up areas

Wei Yang

MATPOST 2019 Study of substation maintenance center setting standard in highly built-up areas

Yuxiao Yan

MATPOST 2019 Study of substation maintenance center setting standard in highly built-up areas

Xiaodong Fu

MATPOST 2019 Study of substation maintenance center setting standard in highly built-up areas

Jie Wei

MATPOST 2019 Study of substation maintenance center setting standard in highly built-up areas

Metrics

Downloaded: 0
Viewed: 0
Size: 453.37 KB
Type: application/pdf
URI: bitcache://6b4627bea65637330c32d3ad89e25644ab9e196a

License

Licence: 

La SEE (Société de l'Electricité, de l'Electronique et des Technologies de l'Information et de la Communication – Association reconnue d’utilité publique, régie par la loi du 1er juillet 1901) met à la disposition de ses adhérents et des abonnés à ses publications, un ensemble de documents numériques accessibles à partir de son portail des publications. Ces documents incluent notamment les articles des revues REE, 3 El et e-STA disponibles sous forme numérique ainsi que des publications additionnelles regroupées dans l’espace eREE. Les présentes conditions précisent les conditions de diffusion et d’utilisation de ces documents et des informations qu’ils contiennent. L’accès à ces documents, qu’il se fasse de façon gratuite ou dans le cadre d’abonnements ou d’achats faits à titre onéreux, implique l’acceptation sans restriction de ces dispositions.

Droits de propriété et de diffusion des contenus téléchargés sur le portail des
publications

Les contenus rendus accessibles sur le portail des publications sont, en règle générale, protégés par le droit d'auteur. En tant que producteur, et le cas échéant d'auteur, des informations rassemblées dans les contenus accessibles par ce portail, SEE se réserve l'exclusivité des droits de copie et de diffusion de tout ou partie de ces contenus.

Les contenus sont rendus accessibles à titre individuel, pour les besoins de la personne en détenant des droits d'accès en cours de validité. Aussi, la modification, la reproduction et/ou la diffusion via Internet ou le Web, intranet, extranet ou toute autre forme numérique ou imprimée, de tout ou partie des contenus téléchargés sont interdites. Une tolérance est consentie quant à la reproduction d'extraits limités de ces contenus, dans le cadre de travaux ou d'activités auxquels ils sont utiles, à la condition que l'origine de ces reproductions partielles soit mentionnée de façon lisible et sans ambiguïté. Figureront en particulier : la REE (ou toute autre revue accessible sur le portail) en tant que la source, la référence de la publication et le nom de l'auteur (s'il figure dans la revue).

Ces dispositions s'appliquent également aux figures, illustrations, logos ou images.

Publication externe des contenus du portail des publications

Tout extrait des contenus du portail destiné à être utilisé dans des publicités, des communiqués de presse ou du matériel de promotion nécessite un accord préalable écrit de la SEE. Une version préliminaire du document proposé contenant ces extraits doit accompagner chacune de ces demandes. SEE se réserve le droit de refuser un tel usage externe pour quelque raison que ce soit.

Responsabilités

La SEE apporte tout le soin possible à la préparation des informations délivrées dans les contenus produits. Cependant elle ne peut être tenue pour responsable d'aucune perte ou frais qui pourrait résulter d'imprécisions, d'inexactitudes, d'erreurs ou de possibles omissions portant sur des informations publiées, ni des résultats obtenus par l'utilisation et la pratique des informations délivrées.

Utilisation des informations recueillies lors du téléchargement de contenu

Le portail des publications est susceptible d'utiliser des « cookies » afin notamment de permettre l'utilisation de paniers d'achat et de personnaliser les parcours sur le site. SEE se réserve la possibilité d'utiliser les informations recueillies lors des téléchargements pour ses besoins internes et notamment pour l'amélioration de ses services, sans qu'elles puissent être cédées à des partenaires commerciaux. Conformément à la loi "informatique et libertés" du 6 janvier 1978, chaque utilisateur du portail dispose d'un droit d'accès et de rectification aux informations qui le concernent. Pour exercer ce droit, les utilisateurs doivent s'adresser à SEE – 17 rue de l’amiral Hamelin – 75783 Paris Cedex 16, par simple lettre ou en utilisant le formulaire de contact disponible sur son site.

Paris, le 28 avril 2013

Sponsors
Study of substation maintenance center setting standard in highly built-up areas Nanchen Zheng, Wei Yang, Yuxiao Yan, Xiaodong Fu, Jie Wei Department of Municipal Planning Shenzhen Urban Planning and Land Resource Research Center Shenzhen, China Abstract—A substation maintenance center is the base of the squads responsible for the inspection and maintenance of the substations under the management, as well as on-site operations and the fault handling of the substations. A substation maintenance center needs space for operation tools and substation consumables. It also provides the office area for the 24-hour-on-duty squads. Due to lack of land resource, it is getting difficult to build new substation maintenance centers in some places. This paper investigated the setting standard and construction demands of substation maintenance centers in highly built-up areas. The typical situation of Shenzhen, which ranks the third in GDP in China, with the land area of only 1997 square kilometers, is studied to give power supply companies and land utilization departments some inspirations. According to the study, service radius of the substation maintenance center should not exceed 9 kilometers to guarantee timeliness. The upper limit number of substations under the management is twenty-five. In places with land shortage problems, the site area for a new substation maintenance center could be limited in 500 square meters, and the floor area in 2300 square meters. Keywords—substation maintenance center; setting standard; construction scale I. INTRODUCTION As an important supporting facility to ensure the safety of power production, a substation maintenance center not only provides space for operation tools and substation consumables, but also provides the office area for the 24-hour-on-duty squads who are responsible for the substation operation management, including substation monitoring, equipment maintenance and periodic test, electrical switching operation, and fault handling. Most of the substations built in the early years were manned substations. The substations have large land areas. The function of maintenance center is attached inside the substation. Recently, in highly built-up areas, there is less available land for urban infrastructures. Municipal infrastructures tend to take the advantage of intensive design for full function on smaller size of land, results in lack of land for substation maintenance center. To give power supply company and land utilization department better advice on planning and construction, this study concentrated on the setting standard of substation maintenance centers in highly built-up areas. The land area and floor area needed for intensive design of substation maintenance center was also studied. Shenzhen, a southern coastal city in China, was studied as an example in this paper. Shenzhen was the gateway of the reform and opening-up of China. It took only 40 years to transform from a small fishing village to an emerging city of which the GDP ranked the third in China in 2017. The land area of Shenzhen is 1997 square kilometers, and the resident population is 130 million. Load density was high compared to other advanced cities in China, resulted in dense substations distribution in built-up areas. TABLE I. URBAN DEVELOPMENT SCALE AND PEAK LOAD OF TOP THREE CITIES IN GDP IN CHINA City Land Area (Thousand Square Kilometers) Population (Million) Peak Load (Million Kilovolt) Beijing 16.41 21.7 22.5 Shanghai 6.34 24.2 32.7 Shenzhen 2.00 12.5 17.5 a. Data are from the year of 2017 For now, only China Southern Power Grid Company (CSG) has set guidelines for the maintenance center setting requirements and construction requirements. CSG serves five provinces in south China, but different from other places, Shenzhen is the only highly built-up city short for unused land under the service of CSG. The guidelines could not meet the circumstance Shenzhen was facing. Moreover, there were no relevant contents of maintenance center in the urban planning standards or guidelines. Thus, this study was carried out in order to meet the basic need of maintenance center,
guarantee the power supply safety, while obeying the requirement of intensive land use to improve the efficiency of land resource. The study also helps the urban planning and land resource commission exam and approve the apply for a new substation. Based on the requirements for safe operation and production from the power supply company, by quantitative analysis and referring to relevant norms, the setting guidelines and construction standards of the maintenance center were proposed. The results were adopted by the Urban Planning and Land Resources Commission of Shenzhen Municipality, as standards for planning approval. II. METHOD By meeting with the power supply company, communicating with maintenance squads, and field research, the requirements of the production department were acquired. This study conduct a detailed analysis of the setting standard of substation maintenance center based on the internal guideline of CSG. Service radius was given instead of time by calculating travelling time and conservative speed. To ensure the safety of power supply while achieving the goal of intensive land use, personnel need and functional need were analysed. According to relevant domestic standards and guidelines, referring to typical cases, the construction scale requirements of the maintenance center were proposed. III. THE DEVELOPMENT OF SUBSTATION MAINTENANCE CENTER IN SHENZHEN There are fifteen substation maintenance centers which were in charge of the maintenance for 230 substations in Shenzhen. The average site area is 1320 square meters, and the average number of staff is twenty-five. Besides, there is a substation maintenance center under construction, and the area is 460 square meters. Fig. 1. Distribution of substation maintenance centers of Shenzhen The substations built in Shenzhen in the early years have large areas. The maintenance centers are built within the boundary line of the substations. For example, the 220kV Xixiang substation (3× 150 MVA +1× 180MVA) are built in the late 1980s and covers an area of 3.9 hectares, including a maintenance center. However, with the development of the intensive construction requirement for new substations, the site areas of the substations have been greatly reduced. For another example, the 220kV Mintian substation (built in 2012, with the capacity of 4× 180MVA) covers an area of only 6565 square meters. It is unlikely to build a maintenance center within the boundary line of Mintian substation. According to CSG operation guideline, to guarantee timeliness, the travel time from the maintenance center to each substation under the management should not exceed forty minutes. The number of substations under management should not exceed fifteen preferably. Because each squad needs to be on duty for forty-eight hours consecutively, the maintenance should meet living needs. IV. STUDY OF SETTING STANDARDS OF THE SUBSTATION MAINTENANCE CENTER The maintenance center is an important facility for power supply safety. To guarantee the response time of the maintenance center, also help the urban planning commission make decision whether and where a maintenance center should be set, this paragraph studies the setting standards of the maintenance center. A. Distance to Substations under the Management According to CSG operation guideline, to guarantee timeliness, the travel time from the maintenance center to each substation under the management should not exceed forty minutes. For planning applications, distance is a better mean than time to decrease uncertainty. Service radius was used to take place of travelling time. According to the data released by Transport Commission of Shenzhen, the average speeds of highway, urban expressway, primary road and branch road was 74.5, 46, 31, 20km/h respectively during rush hours. In a conservative analysis, the travelling distance is 13.3 kilometers in 40 minutes if the speed is 20km/h. If the non-linear coefficient is 1.5 (normally below 1.4), the distance in a straight line is about 9 kilometers. To guarantee emergency respond time, the service radius of the substation maintenance center should not exceed 9 kilometers. B. Number of Substations under the Management According to CSG operation guideline, the number of substations under management should not exceed fifteen preferably. In current situation of Shenzhen, the number of substations under the management of each maintenance center is different. The average number of substations under the management is fifteen, but varies enormously among maintenance centers. Two centers are in charge of twenty-four substations respectively, and one has taken charge of twenty- seven substations in the past. The power load density is very high in build-up areas, results in densely distribution of substations. Considering the advanced management ability of the power supply company, the substation number under management of new maintenance center could be appropriately increased. However, due to the different operation modes of different substations, more substations under the management means more complexity for operators and technicians. The number of substations under management should not be excessive. The current average number of substations under management is fifteen. For some maintenance centers the number goes up to twenty-four substations. Considering the high density of substation distribution in Shenzhen and the improvement of management capacity, the recommended upper limit number of substations under management is twenty-five. In relatively remote areas where the substation distributes sparsely, the substations under the management could be less, but should not below fifteen. V. STUDY OF CONSTRUCTION SCALE OF THE SUBSTATION MAINTENANCE CENTER The power supply company put forward requirements according to their production management. This study compared the demands with relevant standards and guidelines to analyze the building scale of the substation maintenance center. For reasonable production space, power supply company demands were met. For auxiliary functions, relevant domestic standards were followed. A. Number of Staff in the Maintenance Center The number of staff is a calculation base when analyzing the scale of office space and living space. Considering the basic need for normal functioning, there is usually 36 employees in a maintenance center, including a head of the center, two deputy head of the center, four technical squads made up of 28 technicians, and about five new employees attending basic training. One technical squad has to stay on duty for 48 hours consecutively. Three squads rotate for uninterrupted duty of the substations under the management, while the rest squad performs normal 8 hours working for daily administration. B. Parking Spaces The vehicles of the maintenance centers are mainly pickup trunks used for substation maintenance. The power supply company proposed the basic demand. According to the routine work, each maintenance center needed to deal with about 3 accidents every day and at least one vehicle should be dispatched for each accident. One pickup was used for routine maintenance of the substations. Thus four parking spaces were essential. Besides, two more parking spaces was planned for emergency use. So a maintenance center should equiped with six parking places. The size of such pickup is generally 1.8
meters wide and 5.5 meters long. The parking spaces could be set on the first floor of the building. Thus the ground parking plot for extra land could be saved. The suggested size of each parking space is 3 meters wide and 8 meters long. The total parking area would be 144 square meters. C. The Floor Area The necessary rooms of the maintenance center are operation tool rooms, spare parts rooms, staff quarters, office area, and auxiliary facilities. 1) Operation tool rooms and spare parts rooms: Operation tool rooms include common tool room, safety equipment room, firefighting equipment room, flood-and-typhoon-protection equipment room. Spare parts rooms include emergency spare parts room, safety operation tool room, flood-and-storm-protection tool room, production supply spare parts room, repair material spare parts room, relay protection spare parts room. Operation tool rooms and spare parts rooms are space for production that have to be guaranteed. According to the demand proposed by the power supply company, the suggested usable floor area of operation rooms is 98 square meters and the spare parts room is 180 square meters. 2) Staff quarters: A rotating squad should be on duty for 48 hours consecutively, the center should provide basic living space. Staff quarters for staff when standing by for orders are necessary. According to corresponding guideline on dormitory building design from the Ministry of Housing and Urban-Rural Development (MOHURD), the usable floor area per capita should not below 8 square meters. There is staff of thirty-six working in a maintenance center. Twenty twin bed rooms of twenty-four square meters would fulfill the need. Then the total usable floor area of the staff quarters would be 480 square meters. 3) Office area: Office area contains office room and service room. According to the “Construction Standard for Governmental Office”, set by MOHURD together with National Development and Reform Commission of the People's Republic of China (NDRC), the usable area of office rooms should not exceed 9 square meters per capita, while the service rooms (including meeting room, archive room, etc.) should not exceed 8 square per capita. The usable floor area should not exceed 667 square meters if there were 36 technicians. However, the CSG guideline suggested the usable office area below 350 square meters. Because there are two squads in the office area most of the time, and the building scale of office area would not affect the main function of the maintenance work, the more intensive CSG guideline was adopted. 4) Auxiliary facilities: Auxiliary facilities include device room, security room, switching room, canteen, and so on. The CSG guideline suggested 332 square meters of floor area, while the MOHURD provided no more than 310 square meters. The more intensive standard was adopted. TABLE II. DETAILS OF THE BUILDING AREA OF THE MAINTENANCE CENTER Functional Module Usable Area (Square meter) Floor Area (Square meter) Source Operation tool rooms 98 Power supply company Spare parts rooms 180 Power supply company Staff quarters 480 MOHURD Office area 350 CSG Auxiliary facilities 310 NDRC and MOHURD Parking spaces 144 Power supply company The lowest floor-area-to-usable-area coefficient is 65% as suggested by MOHURD. To summarize, the total floor area should not exceed 2236 square meters. D. The Site Area There are few standard on the site area of the maintenance center. All existing maintenance centers are not intensively designed. Some of them consist of more than one building. Some are not specially built for maintenance center, combined with other functions. Referring to current cases, the site area ranges from 620-1597 square meters. There is a new maintenance center under construction, within the boundary line of a substation, but independently constructed from other buildings. The site area of the center is 460 square meters, which is the least among all. However, Due to the limited floor space of the new maintenance center, it is difficult to set up an underground parking lot. The maintenance center has ground parking spaces for engineer vehicles outside the building. The parking spaces could be set on the first floor of the building. Thus it is not necessary to set ground parking plot. Fig. 2. Ground plan of Dengfeng Substation VI. CONCLUSION To guarantee timeliness, the service radius of the substation maintenance center should not exceed nine kilometers. In built-up area, the upper number of substations under the management of a substation maintenance center is twenty-five. In relatively remote areas where the substation are less distributes, the substations under the management could be less, but should not below fifteen. The floor area of a substation maintenance center should not exceed 2300 square meters (including six parking spaces), while the site area should not exceed 500 square meters. REFERENCES [1]. X. Shao, Q. Liu, Y. Zhang, “Advances and expectations of intensive land use researches,” Progress in Geography, 2006, 25(2):85-95. [2]. S. Xing, Z. Wang, M. Niu, et al. “Discussion on safety hidden trouble and its solution of substation operations,” Application of Electronic Technique, 2015, [3]. P. Yan, S. Dai, “Integration of infrastructure facilities under the background of intensive land use,” Urban Planning Forum, 2010. [4]. S. S. Y Lau, R. Giridharan, S. Ganesan, “Multiple and intensive land use: Case studies in Hong Kong.” Habitat International,” 2005, 29(3):527-546. [5]. H. Chen, B. Jia, S. S. Y Lau, “Sustainable urban form for Chinese compact cities: Challenges of a rapid urbanized economy,” Habitat International, 2008, 32(1):28-40. [6]. China Southern Power Grid Company, “Code for substation operation management in 110kV and above voltage (in Chinese)”, 2015 [7]. Ministry of Housing and Urban-Rural Development of the People's Republic of China, “Code for design of dormitory building,” Chemical Industry Press, 2016, [8]. W. Ying, W. Zhe, “Discussion on the design method of dormitory building,” Industrial Construction, 2014. [9]. F. Shi, “Comparison Study of Construction Standards of Governmental Office Building among China, Canada and Germany,” Construction Economy, 2011. [10]. National Development and Reform Commission of the People's Republic of China, Ministry of Housing and Urban-Rural Development of the People's Republic of China, “Construction Standard for Governmental Office (in Chinese)”, 2014 [11]. United States GSA Office of Governmentwide Policy, “Workspace Utilization and Allocation Benchmark,” 2012

https://www.see.asso.fr/en/node/94520/landing