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15. IMPACTS FROM ELECTRIC AND MAGNETIC FIELDS

15.1 Introduction

15.1.1.1 This section identifies and assesses the potential impacts from exposure to electric and magnetic fields (EMF) generated from the proposed 132 kV Electricity Substation (ESS) at the proposed development at TKO 137, and the proposed 400 kV Electricity Facilities (EFs) at TKO 132, which has been conducted in accordance with the requirements stated in Clause 3.4.16 of the EIA Study Brief (ESB-360/2023). The cumulative impact due to the power cables associated with the proposed EFs and the proposed ESSs have also been evaluated.

15.2 Environmental Legislation, Standards and Guidelines

15.2.1 International Commission on Non-ionizing Radiation Protection (ICNIRP)

15.2.1.1 With reference to Clause 3.4.16.1 of the EIA Study Brief, guidelines on limits of exposure to EMF issued by the International Commission on Non-ionizing Radiation Protection (ICNIRP) in Year 1998 should be followed. The ICNIRP guidelines were recognized by the World Health Organization (WHO). EMF generated from the proposed EFs and the proposed ESSs shall comply with the guidelines stated in **Table 15.1**.

Table 15.1 Guidelines on Limits of Exposure to 50Hz Power Frequency Electric and Magnetic Fields Issued by ICNIRP

Exposure Characteristics	Electric Field Strength, V/m [a]	Magnetic Flux Density, μT [a]
General Public Continuous	5,000 [b]	100 [b]
Occupational Continuous	10,000 [b]	500 [b]

Remarks
[a] Unperturbed root-mean-square (rms) values.
[b] The standards stipulated in Guidelines following the ICNIRP (1998) limits for 50 Hz EMF.

15.2.2 Hong Kong Planning Standards and Guidelines

15.2.2.1 As stated in Section 2.3.10 of Chapter 7 of the Hong Kong Planning Standards and Guidelines (HKPSG), the EMF exposure limits promulgated in the guidelines issued by ICNIRP in 1998 are adopted. The relevant standards are presented in **Table 15.1**.

15.3 Identification of Potential Sources of Impact and Sensitive Receivers

15.3.1 Potential Sources of Electric and Magnetic Field Impact

15.3.1.1 EMF are present everywhere in our environment. Electric field is generated by difference in voltage. The higher the voltage, the stronger will be the resultant electric field. Magnetic fields are created by electric current. The greater the current, the stronger the magnetic field. EMF are produced by virtually all electrical consumer appliances, computer terminals, wiring in homes, offices, electrical facilities and power cables / transmission lines. Potential EMF impacts from the project would be expected from the operation of the proposed EFs at TKO 132 and the operation of the proposed ESSs at TKO 137. The locations of the proposed EFs and the proposed ESSs are presented in Figure 2.4 and Figure 2.5.

15.3.1.2 Potential cumulative EMF impacts from the concurrent projects, i.e. planned power cables connected to the EFs at TKO 132 and the planned power cables connected to the proposed ESSs at TKO 137 would also be expected.

15.3.2 Identification of Representative Electric and Magnetic Field Sensitive Receivers

15.3.2.1 Representative EMF sensitive receivers nearby the EFs and ESSs are identified and listed in below **Table 15.2**. Locations of the representative EMF sensitive receivers are shown in **Figure 2.4** and **Figure 2.5**.

Table 15.2 Identified Representative Electric and Magnetic Field Sensitive Receivers

EMF Source	Sensitive Receivers	Land Use	Approximate Distance between the Boundary of Sites of the Proposed EMF Source and Sensitive Receiver, m
Electricity Facilities (EFs) at Site OU1 at TKO 132	On Luen Village	Green Belt[2]	140
	Proposed Construction Waste Handling Facilities (CWHF)	Other Use (Construction Waste Handling Facility)	0 [1]
ESS at Site OU1 at TKO 137	Proposed Residential Site PU1&2	Residential	30
	Proposed Open Space O1	Open Space	0 [1]
ESS at Site OU2 at TKO 137	Proposed Open Space O8	Open Space	0 [1]
	Proposed Green Filling Station	Other Use	0 [1]
	Proposed Residential Site (PU6)	Residential	25
	Proposed Secondary School (E5)	Educational	30

Remarks:
[1] The site of the proposed sensitive receiver would be located immediately adjacent to the site of the proposed EMF source.
[2] On Luen Village are residential uses on area zoned as Green Belt.

15.4 Evaluation of Potential Impact

15.4.1 Electric and Magnetic Field due to the Project

15.4.1.1 In TKO 137, there would be two proposed 132 kV ESSs located at proposed Sites OU1 and OU2, respectively, as shown in **Figure 2.4**. Their design would follow the requirements stated in Section 2 of Chapter 7 of *Hong Kong Planning Standards and Guidelines*. The two proposed 132 kV ESSs would be of the same nature, the same operation voltage, the same major plants, similar design of housing major plants inside similar structure of reinforced concrete as an existing 132 kV ESS. Therefore, it is expected that the EMF from the two proposed ESSs would be similar to that of an existing 132 kV ESS. With reference to the project profile of the approved direct application of environmental permit for *Extension Project for the Existing Tseung Kwan O 400 kV Substation* (PP-072/1999), EMF measurement was conducted inside Tuen Mun 132 kV Substation (i.e. 0m away from the source). The measured electric field strength was 10 V/m (as 0.01 kV/m in PP-072/1999) and the measured magnetic flux density was 4.7 μT (as 0.047 mT in PP-072/1999), complying with the limits in **Table 15.1** by well below of the limits over 99% and over 95%, respectively. Similar electric field strength and magnetic flux density would be expected inside the proposed ESSs at TKO 137. Since EMF would decrease rapidly with increasing distance, EMF outside the proposed ESSs would be lower than that inside the ESSs. Therefore, it is expected that EMF at the sensitive receivers located outside the proposed

ESSs listed in **Table 15.2** would comply with the limits in **Table 15.1**. No adverse impact from the exposures of EMF generated from the proposed ESSs at TKO 137 would be anticipated.

15.4.1.2 Design of the EFs at TKO 132 would also follow the requirements stated in Section 2 of Chapter 7 of *Hong Kong Planning Standards and Guidelines*. Based on the latest available information, the proposed EFs would consist of High-Voltage Direct Current (HVDC) and High-Voltage Alternating Current (HVAC) Converter Blocks, which are reinforced concrete structure housing major plants, including transformer, a series of reactor, shunt reactor and cooling fans, etc. As confirmed by respective proponent of the EFs, the EFs would house equipment of up to 400 kV. Hece, it is considered that the EFs would be similar to that of existing 400 kV ESSs. Therefore, it is expected that the EMF from the proposed EFs would be similar to that of existing 400 kV ESSs. With reference to PP-072/1999, EMF measurement was conducted inside Tsz Wan Shan 400 kV ESS (i.e. 0m away from the source) and the measured electric field strength was 10 V/m (as 0.01 kV/m in PP-072/1999) and the measured magnetic flux density was 59 μT (as 0.059 mT in PP-072/1999), complying with the limits in **Table 15.1** by huge margin of over 99% and over 40%, respectively. With reference to PP-072/1999, EMF measurement was also conducted at 6 m to 18 m from the reinforced concrete structure of the Shatin 400 kV Substation, and the measured electric field strength ranged from 3 V/m to 7 V/m and the measured magnetic flux density ranged from 0.89 μT (as 8.9 mG in PP-072/1999) to 6.52 μT (as 65.2 mG in PP-072/1999), complying with the limits in **Table 15.1** by huge margin of over 99% and over 90%, respectively. Based on the above, it is expected the EMF outside the proposed EFs would comply with the limits in **Table 15.1**, and the EMF at the sensitive receivers located outside the proposed EFs listed in **Table 15.2** would comply with the limits in **Table 15.1**. Based on the latest available information at this stage, no adverse impact from the exposure of EMF generated from the proposed EFs at TKO 132 would be anticipated.

15.4.1.3 As identified as DP6 in **Table 1.1**, the EFs requires an Environmental Permit (EP) to construct and operate under the EIAO. As the detailed design information is not yet available at the time of the preparation of the Report, an Environmental Permit (EP) would be applied separately by the proponent of the EFs, with a EIA study as necessary, following the EIAO mechanism to ensure that no adverse impact from the exposure of EMF generated from the proposed EFs would be anticipated.

15.5 Mitigation Measures

15.5.1.1 Based on the latest available information at this stage, no adverse impact due to exposure to EMF would be anticipated from the proposed EFs and ESSs. No mitigation measures would be required, given that the design of the proposed ESSs would be similar to that of existing 132 kV ESSs, while the design of the proposed EFs would be similar to that of existing 400 kV ESSs.

15.5.1.2 Nevertheless, the design of the EFs would be subject to further review by the proponent of the EFs. Therefore, in view of the uncertainty, the proponent of the EFs would apply for an Environmental Permit (EP) separately when the design information is available, following the EIAO mechanism for the construction and operation of the proposed EFs to ensure that no adverse impact from the exposure of EMF generated from the proposed EFs would be anticipated.

15.5.1.3 During the application of the EP for the EFs, should any changes, including but not limited to update of criteria and design information, lead to the need of mitigation measures, the proponent of the EFs should implement as necessary to ensure compliance to the criteria at the time of the EP application.

15.6 Cumulative Impact due to Concurrent Project

15.6.1.1 Based on latest available information, no overhead power cables would be proposed/planned within the Project site or in the vicinity of the Project site. EMF impacts due to overhead power transmission line to the Project site and the vicinity of the Project site would not be anticipated.

15.6.1.2 The submarine power cables and the underground power cables would be constructed and operated under separate project(s). Based on latest available information, submarine power cables would be used to deliver electrical power to the EFs, which provide electrical power to users via underground power cables. Underground power cables would be used to deliver electrical power to and from the proposed ESSs at TKO 137. The potential cumulative impact due to the submarine and underground power cables would be assessed below.

15.6.1.3 Underground and submarine power cables are normally well-insulated to avoid electrical current loss. Therefore, it is expected that the EMF from the underground and submarine power cables would be largely confined by the insulation layer.

15.6.1.4 With reference to the EMF measurement result in the project profile (PP-005/1998) of the approved EIA for *132kV Overhead Line From Tsuen Wan to Sham Tseng* (AEIAR-023/1999), EMF measurements were conducted at 1 m above ground for existing 400 kV and 132 kV underground power cables that located 1 m below ground. The distance between measurement location and existing 400 kV and 132 kV underground cables is 2m in total. The measured electric field strength was less than 10 V/m (as <0.01 kV/m in PP-005/1998) for both 400 kV and 132 kV underground power cables, while the measured magnetic flux density was 5.2 μT (as 0.0052 mT in PP-005/1998) for 400 kV underground power cables and 0.3 μT (as 0.0003 mT in PP-005/1998) for 132 kV underground power cables, all complying with the limits in **Table 15.1** by huge margin of over 99% and over 90%, respectively. It would be expected that the proposed underground power cables would adopt similar design as existing underground power cables, such that the EMF due to the underground power cables would comply with the limits in **Table 15.1**. Due to the minimal EMF from underground power cables, no adverse cumulative impact from underground power cables would be expected.

15.6.1.5 For submarine cables, with reference to literature[1], electric field is generally contained by the cable as an industrial standard. No adverse cumulative electric field impact would be anticipated from submarine cable. Magnetic flux density were measured at 0 m to 2 m from various submarine cables of 11 kV to 500 kV voltage in the European area to be in the range of 0.004 μT to 72 μT, which comply with the limits in **Table 15.1** by over 25% margin. Sensitive receivers would be expected to be located on land which are well beyond 2 m separation from a submarine power cable, and EMF would decrease rapidly with increasing distance, the EMF due to a submarine cable at any sensitive receivers on land would be expected much lower than that under water within 2m from a submarine cable. EMF compliance to ICNIRP limit at the sensitive receivers would be expected. Hence, it is expected that no adverse EMF impact to sensitive receivers from submarine power cables.

15.6.1.6 As mentioned above, the EMF impacts arose from the power cables for the EFs and ESSs would be anticipated well below the limits in **Table 15.1**. Therefore, it is anticipated that the cumulative EMF would comply with the limits. No adverse cumulative electric and magnetic fields impacts would be expected from the Project and concurrent projects.

[1] Hermans A. et al., 2024. 'Do electromagnetic fields from subsea power cables effect benthic elasmobranch behaviour? A risk-based approach for the Dutch Continental Shelf', 346 Environmental Pollution. https://doi.org/10.1016/j.envpol.2024.123570

15.7 Evaluation of Residual Impacts

15.7.1.1 Based on above **Section 15.4**, no adverse EMF impact would be anticipated from the Project.

15.7.1.2 Based on above **Section 15.6**, no adverse cumulative EMF impact would be anticipated from concurrent projects of power cables connecting to the ESSs and EFs.

15.7.1.3 Nevertheless, the design of the EFs would be subject to further review by the proponent of the EFs. Therefore, in view of the uncertainty, the proponent of the EFs would apply for an Environmental Permit (EP) separately when the design information is available, following the EIAO mechanism for the construction and operation of the proposed EFs to ensure that no adverse impact from the exposure of electric and magnetic fields generated from the proposed EFs would be anticipated.

15.8 Environmental Monitoring and Audit

15.8.1.1 Based on the above assessment in **Section 15.4** and **Section 15.6**, no adverse impact due to exposure to EMF is anticipated for the two ESSs and their associated power cables in TKO 137. Environmental monitoring and audit is therefore deemed not necessary for TKO 137.

15.8.1.2 Based on the above assessment in **Section 15.4** and **Section 15.6**, no adverse impact due to exposure to EMF is anticipated for EFs and their associated power cables in TKO 132. In view of the uncertainty, the proponent of the EFs would apply for an EP separately when the design information is available, following the EIAO mechanism for the construction and operation of the proposed EFs to ensure that no adverse impact from the exposure of EMF generated from the proposed EFs would be anticipated. If found necessary, environmental monitoring and audit requirements would be determined in the separate EP application.

15.9 Conclusion

15.9.1.1 Electric and magnetic field impact assessment has been conducted in accordance with the requirements stated in Clause 3.4.16 of the EIA Study Brief.

15.9.1.2 The proposed 132 kV ESSs at TKO 137 would be of the similar nature and design as existing 132 kV substations. The EMF due to the proposed ESSs would be expected similar to existing 132 kV substations. With reference to EMF measurement inside the existing Tuen Mun 132 kV Substation, the electric field strength and the magnetic flux density were respectively measured at 10 V/m and 4.7 μT, which complied with the ICNIRP limit by huge margin of over 99% and over 95%, respectively. EMF outside the proposed ESSs would be lower than that inside the ESSs, since EMF would decrease rapidly with increasing distance. Hence, it is expected that the EMF from the proposed ESSs at sensitive receivers would comply to the ICNIRP limit. No adverse EMF impact would be anticipated from the proposed ESSs.

15.9.1.3 The proposed 400 kV EFs at TKO 132 would be of the similar nature and design of existing 400 kV substations. The EMF due to the proposed EFs would be expected similar to existing 400 kV substations. With reference to EMF measurement inside the existing Tsz Wan Shan 400 kV Substation, the electric field strength and the magnetic flux density were respectively measured at 10 V/m and 59 μT, which complied with the ICNIRP limit by large margin of over 99% and over 40%, respectively. With reference to EMF measurement in the vicinity of the existing Shatin 400 kV Substation, the electric field strength and the

magnetic flux density were respectively measured up to 7 V/m and 6.52 μT, which complied with the ICNIRP limit by huge margin of over 99% and over 90%, respectively. Hence, it is expected that the EMF from the proposed EFs at sensitive receivers would comply to the ICNIRP limit. No adverse EMF impact would be anticipated from the proposed EFs, based on latest available information.

15.9.1.4 Cumulative EMF impact would be expected from concurrent projects, i.e. underground and submarine power cables connecting to the proposed EFs and the proposed ESSs. With reference to previous EMF measurement result at existing underground power cables, measured electric field strength and magnetic flux complied with the ICNIRP limit by huge margin of over 99% and over 90%, respectively. For submarine power cables, referenced literature indicated electric field should be well contained within the submarine power cable as an industrial standard, while magnetic field generated from a submarine power cable at 2 m from the cable could be up to 72 μT, which complied with the ICNIRP limit by large margin of over 25%. Sensitive receivers would be expected to be located on land which are well beyond 2 m separation from a submarine power cable, and EMF would decrease rapidly with increasing distance, the EMF due to a submarine cable at any sensitive receivers on land would be expected much lower than that under water within 2m from a submarine cable. EMF compliance to ICNIRP limit at the sensitive receivers would be expected. Hence, it is expected that no adverse EMF impact to sensitive receivers from submarine power cables.

15.9.1.5 Nevertheless, the design of the EFs would be subject to further review by the proponent of the EFs. Therefore, in view of the uncertainty, the proponent of the EFs would apply for an EP separately when the design information is available, following the EIAO mechanism for the construction and operation of the proposed EFs to ensure that no adverse impact from the exposure of EMF generated from the proposed EFs would be anticipated.