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Press Release
15 May 2023

HK Electric Submits Investigation Report on Power Interruption Incident

HK Electric today (15 May 2023) submitted to the Government an incident investigation report on the 275-kV fault in its power system which occurred on 19 April 2023. Investigations revealed that the incident was caused by a number of factors and a series of events. Improvement measures have been formulated to prevent similar incidents from happening in the future.

At the time of the incident, a spare cable circuit at the Cyberport 275-kV Switching Station (CPX) was inadvertently energised. It led to a severe voltage dip of the power system and affected generating units at Lamma Power Station (LPS), necessitating a shutdown of two of the units and resulting in insufficient power generation to meet the load demand, and eventually power interruption to some customers.

About 44,000 customers in HK Electric's supply areas were affected, representing about 4% of the total loading at the time of the incident. The power interruption began at 00:49 hours, and restoration of power supply was initiated 33 minutes later at 01:22 hours. The longest duration of power interruption was 48 minutes and by 01:37 hours, the power supply to all affected customers was fully resumed.

Describing the incident as very rare, HK Electric's Operations Director, Mr. Francis Cheng, noted that it was the first major power interruption in HK Electric's system in almost 30 years. "The incident is most regrettable, and we apologise again for the inconvenience caused to our customers. We will learn from this lesson and enhance our operations to sustain our commitment to delivering a reliable electricity supply to our customers," he added.

Power System Fault

CPX at which the incident started is a core part of HK Electric's transmission system to receive electricity from LPS. At the time of the incident, engineers were commissioning some refurbished 275-kV Gas Insulated Switchgear (GIS) at CPX as scheduled.

At 00:45 hours on 19 April 2023, as per confirmation of the engineer in charge at site, an engineer at System Control Centre energised the GIS whereby a 275-kV "three-

phase fault” occurred and relevant circuit breakers tripped correctly by protection system to isolate the fault.

Subsequent investigations concluded that the GIS was connected to a spare cable circuit which was not indicated in the circuit diagrams of the Energy Management System (EMS). Besides, the generic “spare” labels attached at site did not indicate the crucial fact that the spare GIS was connected to a spare cable circuit.

Shutdown of Generating Units

It was the first “three-phase fault” ever happened in HK Electric’s 275-kV transmission system, which instantly led to a very severe power disturbance. The system voltage collapsed to nearly zero for about half a second, causing automatic disconnection of all three interconnector circuits between HK Electric and CLP Power’s power systems. All the generating units at LPS and their auxiliary equipment were also seriously affected by this unprecedented power disturbance.

The LPS was operating with five generating units running prior to the incident. Amongst those, one coal-fired and one gas-fired units were seriously affected by the severe power disturbance and had to be shut down manually. The total power generation of HK Electric was insufficient to meet the load demand. It in turn led to a rapid drop in system frequency and triggered the operation of the “Under-frequency Load-shedding Scheme”. There is a device installed in all zone substations to disconnect a pre-defined amount of load automatically when the system frequency drops to a particular value in order to prevent a further decrease in system frequency, which would result in a system blackout if not arrested.

After restoring the interconnector circuits with CLP Power, engineers at the System Control Centre began to restore electricity supply to the customers. The entire power restoration process took 15 minutes to complete at 01:37 hours.

Causes of the Power Interruption

The report identified the causes of the incident as follows:

1. EMS circuit diagrams did not record the spare cable circuit
 - Since spare cable circuits are not designed for use in the daily operation of the power network, the connection of spare cable circuits was not specifically marked in the EMS circuit diagrams which were commonly used by our engineers for GIS refurbishment work.

2. On-site labels were insufficient to indicate whether a spare cable circuit was connected to the switchgear
 - Generic “spare” labels without any other details were displayed on the switchgear concerned as per past common practices. These labels were designed to indicate the function of the switchgear, but could not sufficiently indicate or differentiate between a switchgear with or without spare cable circuit connected.
3. Engineer in charge was unable to identify the presence of the spare cable circuit
 - During the course of GIS refurbishment, the engineer performed a number of visual inspections at site. However, the bottom of each cable connection tank is fully concealed by a fire-rated steel enclosure and a corrugated pipe, the engineer could not clearly see any cable connected to the GIS. Hence, he concluded that the GIS was not connected to any cable circuit.
4. No compulsory counter-check requirements for commissioning of GIS after refurbishment
 - HK Electric has adopted counter-check requirements for high-risk or critical tasks involving GIS. However, as the GIS refurbishment did not involve replacement of insulation parts, the commissioning procedure was not counter-checked by another qualified engineer at site.
5. Generating Units affected by severe voltage dip
 - The “three-phase fault” affected the generating units, causing some of them to shut down and there was insufficient generation to meet customers’ demand.

Recommendations and Improvement Measures

To address public concerns and to prevent similar incidents from happening in the future, HK Electric has formulated a series of improvement measures. Some of these measures have been implemented:

- All relevant transmission refurbishment works have been suspended until new commissioning guidelines are formulated.
- Four spare cable circuits (including the one in this incident) in our transmission system were identified and all disconnected from the corresponding GIS.
- Site labels showing details of the spare cable circuits were added at sites and update of EMS circuit diagrams was completed.
- Additional resources have been deployed to check critical infrastructure, on-site labelling and circuit diagrams in transmission network to ensure the reliability and stability of supply.
- Counter-check requirements have been adopted for commissioning of all GIS.

HK Electric will follow up on the recommendations in seven areas outlined in the Investigation Report. They include:

1. Site Labels and Circuit Diagrams

- Instructions and guidelines for updating site identification labels, detailed transmission schematic drawings and EMS circuit diagrams will be established by end June 2023.

2. Site Arrangement of Spare Cable Circuits

- Complete segregation of spare cable circuits from our GIS will be completed by July 2023.
- Guidelines to detail the physical connection arrangement and labelling format of spare GIS bays will be established by June 2023.
- The site labelling, switchgear arrangement and relevant drawings of distribution spare cable circuits will be checked and the requirements will be aligned with that of spare transmission cable circuits as much as possible, and guidelines on handling spare distribution cable circuits will be established by Q3 2023.

3. Training of Engineers

- The engineer in charge concerned has been suspended for all work-related authorisation in our Transmission and Distribution network and re-deployed to a support unit until he has regained confidence and passed relevant assessments.
- Coaching and site training of engineers, in particular, in handling new and refurbished transmission apparatuses/configurations will be enhanced, and guidelines on the limitations and purposes of each type of transmission diagram will also be established. Preparation of the guidelines and the training will be implemented by Q3 2023.

4. Risk Assessment and Enhanced Procedures for Transmission Equipment Commissioning

- The commissioning procedures of transmission equipment after various types of works, including the checking and approval process as well as the selection criteria of dedicated commissioning circuit will be further enhanced.
- The settings of protection system(s) to provide faster protection during commissioning will be formulated to cater for unforeseeable circumstances. The study and implementation of the study results will be completed by Q3 2023.
- The critical steps in transmission system works which require counter-checks will be holistically reviewed and confirmation of the presence or

otherwise of spare cable circuits will be included. The review will be completed and relevant instructions issued by June 2023.

5. Fault Ride-through Capability of Generation Units

- Arrange dual-firing operation of coal-fired units, i.e., putting fuel oil burners in service in addition to the coal mills being operated, in the future when there is any critical switching operation in 275-kV system with similar risk as that of the incident, in order to stabilize the operation of the units when required.
- Request the Original Equipment Manufacturers of the generating units to investigate the differences in responses between the units during the incident, and seek their recommendations to improve ability of the generating units to ride through similar severe fluctuations of system voltage.

6. Customer Emergency Services Centre

- Review comprehensively the manpower arrangement, equipment and workflow of the Customer Emergency Services Centre and explore other possible means to effectively disseminate information on major power abnormalities to customers by Q3 2023.

7. Advisory Service

- Engage an advisory service by June 2023 to review the incident and propose improvements of various management systems.