

DOCUMENT TITLE AND APPROVAL PAGE

DOCUMENT NUMBER: Ele 2006/05

1. DOCUMENT TITLE:

Directive (Ele 2006/05) issued to Jamaica Public Service Company Limited pursuant to Section 4 of the Office of Utilities Regulation Act requiring remedial actions following the island-wide system shutdown of July 15, 2006

2. PURPOSE OF DOCUMENT

To direct Jamaica Public Service Company Limited to carry out specific studies, undertake prescribed remedial and other actions to remedy identified system deficiencies and improve the reliability of electricity supplies.

3. RECORD OF REVISION

This Directive is approved by the Office of Utilities Regulation and becomes effective on November 30, 2006.

By Order of the Office:

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J. Paul Morgan
Director General

November 30, 2006
Date

WHEREAS a “*Preliminary Technical Report*” on the system shutdown prepared by JPS, dated July 27, 2006 was subsequently submitted to the Office of Utilities Regulation (“the Office”) and constitutes an integral part of this Directive. **AND**

WHEREAS the Office conducted an initial investigation into the outage and submitted its “*Preliminary Findings*” in an initial report dated August 11, 2006 (OUR Document No. Ele 2006/04), which constitutes an integral part of this Directive in which it made a number of observations, comments and posed some eighteen (18) questions to which the JPS was required to submit a response and in addition made several interim recommendations following the work of the preliminary enquiry. **AND**

WHEREAS JPS subsequently followed up its initial report with a “*JPS Final Report*” comprising a number of detailed technical reports, together with other attachments and documentations dated August 17, 2006, which constitutes an integral part of this Directive, all of which were submitted to the Office. **AND**

WHEREAS in its final report JPS states and represents inter alia that:

- (i) it carried out computerized simulation of the system collapse addressing the issue of short term stability, frequency, voltages as well as fault current levels at various points of the island-wide electric grid and in particular in its report, JPS indicated that of the total installed system generating capacity of 817 MW, only some 613 MW was available due to a number of units being out of service on forced and planned maintenance. Capacity on line at the time was 497.3 MW supplying a load demand of 465.6 MW and providing a spinning reserve of 31.7 MW. The recorded system frequency was 50 Hz and system bus bar voltages were within the normal operating limit of ± 5 percent.
- (ii) the transmission system was largely intact except for planned maintenance on 3 transmission lines and a distribution substation in the Corporate Area and eastern side of the island. The National Weather Service reported rain and lightning in the northern areas of the island.
- (iii) Forty Seven (47) substations are monitored and remotely controlled by the Company’s SCADA system; however, at the time of the shutdown 14 were not under SCADA supervision due to communication problems. Between 2003 and 2006 1586 interruptions took place on the transmission system. There was a 97% correct clearance by the relay protection system and no incident of a system-wide collapse of the grid. In respect of the Duncans/Bogue 138 kV transmission line, 16 outages took place since 2002, all of which were correctly cleared without disturbance of the system’s integrity.
- (iv) a three-phase transient fault on the Duncans/Bogue 138 kV transmission line that was caused by a lightning strike at Tower #75, initiated the occurrence that led to the system shutdown. Primary protective relays located at the Bogue substation side of the line tripped and isolated the fault.

However, the corresponding primary protection relays at the Duncans substation end of the line did not clear the fault as designed thereby initiating the system collapse. In addition, the back up protection scheme at that location and those located remotely at Bellevue and Kendal substations did not operate.

- (v) failure of the primary, as well as, the backup protection to operate was due to the absence of a DC voltage supply because a breaker had previously tripped taking both circuits out of service. Remote status alarms which would have alerted system controllers to the situation were not in place. **AND**

WHEREAS despite the transient nature of the fault, the system went into unrecoverable instability and started cascading because the critical clearance time for the system (approximately 0.54 seconds) was exceeded and took place before system backup relays (set to operate within 0.8 second) could operate to isolate the fault. The system shutdown occurred approximately 10 seconds after the fault occurred. **AND**

WHEREAS the Office pursuant to its finding concludes that:

- a) The system shutdown was initiated by lightning striking steel tower #75 or the adjacent lines on the Duncans/Bogue 138 kV transmission link, precipitating a three-phase ground fault.
- b) The subsequent system collapse occurred for the reason that protective relays at the Duncans substation side of the line did not operate to clear the fault. This was as a result of the absence of DC voltage supply to the relay circuits. The system controllers were not aware of the situation because the remote alarm system was not in place.
- c) The system subsequently became unstable because the critical clearing time for system stability was exceeded, due to of non-clearance of the fault.
- d) Remote relay backup systems did not operate, possibly due to relay coordination problems or early dissipation of the fault, which could have been transient in nature.
- e) Several generators, inclusive of some at JEP, JPPC and JPS Old Harbour and Bogue plants, were affected by the instability particularly the very low bus bar voltages and disengaged from the system incorrectly. JEP Barge #2 had a problem with relays which mal-operated, while the other generators seem to have been negatively impacted by the low voltage situation.
- f) The non-functioning of a number of important SCADA and communication circuits at the time of the shutdown affected the early analysis of the problem and therefore delayed restoration activities.

WHEREAS interim recommendations were made following the OUR's preliminary investigation and where those recommendations that were not changed after completion of the

Enquiry were repeated and added in the Office's *Final Report* of September 19, 2006 (OUR Document No. 2006/04.1), which constitutes an integral part of this Directive. **AND**

WHEREAS (i) Section 4 of the Act prescribes the functions of the Office and in particular provides at Section 4 (1) (e) as follows:

“(e) subject to section 8A, carry out, on its own initiative or at the request of any person, such investigations in relation to the provision of prescribed utility services as will enable it to determine whether the interests of consumers are adequately protected”.

(ii) Section 4 (2) provides that:

“(2) The Office may, where it considers necessary, give directions to any licensee or specified organization with a view to ensuring that—

(a) the needs of the consumers of the services provided by the licensee or specified organization are met; and

(b) the prescribed utility service operates efficiently and in a manner designed to-...

(i) protect the health and well being of users of the service and such elements of the public as would normally be expected to be affected by its operation; and

(ii) protect and preserve the environment; and

*(iii) afford to its consumers economical and reliable service.” **AND***

WHEREAS pursuant to **Section 8** and **8A** of the Act, it is provided:

“8. Power to hold an enquiry.

8. (1) The Office may, upon its own motion or upon complaint by any persons, hold an enquiry into the operations of the provision of any prescribed utility services by a licensee or specified organization.

(2) The provisions of the Third Schedule shall apply to every enquiry conducted by the Office pursuant to this section.

8A. Discretion to under take or continue investigation.

*8A. (1) The Office may, determine whether to undertake or continue an investigation under this Act” **AND***

WHEREAS JPS is bound by **Condition 8,"Information Access and Audit Rights for the Office" paragraphs 5 & 7** of the Licence which provides:

5. *"The Licensee shall provide such other reports to the Office as may be reasonably specified from time to time."*
7. *The Office and its agents shall be entitled during the normal business hours and without notice to attend at any premises from time to time owned or occupied by or in the possession of the Licensee for the purpose of inspecting any books, records and accounts of the Licensee to which this Licence relates and the Licensee shall fully co-operate and assist the Office for such purposes. Notwithstanding this obligation, the Licensee shall not be compelled to provide information which it could not be required to reveal in a civil action. The Licensee shall at the request of the Office furnish the Office, at the Licensee's expense, with a copy (in such format as the Office may specify) of any book, record or accounts as the Office may reasonably require". AND*

WHEREAS pursuant to Section 9 of the Office of Utilities Regulation Act (the Act), the Office may require measures to be taken, as set out below:

"9. Power to require measures to be taken.

9. (1) Where it appears to the Office that a licensee or specified organization, as the case may be, is not fulfilling its obligations under its licence or enabling instrument, as the case may be, the Office may, by memorandum in writing to the licensee or specified organization, require the licensee or specified organization, within the time specified in that memorandum, to take such remedial measures as may be so specified.

(2) Any licensee or specified organization which fails to comply with the requirements of a memorandum issued by the Office under this section shall be guilty of an offence and liable on summary conviction before a Resident Magistrate to a fine not exceeding two million dollars..."

THE OFFICE HEREBY DIRECTS JPS, pursuant to Section 4 (2) and in accordance with its Final Report of September 19, 2006 to carry out actions as follows:

Item	ACTION	Completion Date
1	Engage appropriate experts to review the existing system relay coordination scheme. Particular attention should be paid to the early clearance of generators and the probability of low fault currents occurring on the transmission infrastructure in specific contingency situations.	September 30, 2007
2	Review the linkage of the 138 kV grid to the northwest transmission system. Determine the feasibility of establishing such a link between Kendal/Spur Tree and Bogue substations and take the necessary action as appropriate to include the desired solution	March 31, 2007

Item	ACTION	Completion Date
	in the company's investment programme. JPS shall advise the Office of the outcome of this review indicating the amount set aside for resolving this matter and the proposed date of commencement of the work.	
3	Examine the non-operation of under-frequency relays during a system stability crisis and conduct investigations to determine the technical feasibility and desirability of implementing the JPS recommendations that a voltage load shedding scheme be incorporated to enhance system stability. Recommendations shall be forwarded to the Office.	June 30, 2007
4	<p>Correct or ensure that the Independent Power Producers (IPPs), JEP and JPPC correct the early and/or incorrect tripping of generators at Old Harbour, Bogue and Rockfort plants and submit a report to the Office advising of the actions taken.</p> <p>JEP: Mal-operation of relays on Barge #2 to be remedied and UPS to be installed on Barge #1. JPPC: Generator trip-out on low bus bar voltage or low load to be investigated. JPS Old Harbour: Measures to prevent low bus bar voltage tripping of generators to be investigated. Bogue: Problems with ST14 Unit governor controls to be remedied.</p>	March 31, 2007
5	Review the Company's spinning reserve and under-frequency load shedding policies to ensure dynamic stability of the generating system under normal operating conditions and probable contingency scenarios. This activity to be done in conjunction with the OUR. A report advising of the action taken and copies of the proposed new policy shall be submitted to the Office.	April 30, 2007
6	<p>Assess the non-functioning of all highly important communication links and SCADA monitoring systems and implement such remedial measures as will restore the system to acceptable operating status. JPS must submit a report advising of the actions taken to facilitate the acceptable functioning of the remote control operations, which is vital.</p> <p>The maintenance of this system must be accorded immediate and first priority in order to effect full operating status at all times. In addition JPS shall prescribe a maintenance programme for this system and shall lodge with the Office a copy of this programme.</p>	February 28, 2007
7	Implement backup systems for the communication network where not now existing. JPS shall lodge with the Office a report on	September 30, 2007

Item	ACTION	Completion Date
	actions taken.	
8	Extensively review the primary relaying system for the 138kV and 69kV transmission grid and implement remedial measures to ensure the system's proper functioning consistent with its design standards. The appropriateness of existing relay maintenance policies and procedures should be re-examined. JPS shall submit a report to the Office indicating the actions taken.	April 30, 2007
9	Ensure that all JPS generating stations, IPP plants and JPS System Control Centre are time-synchronized and fully operational. JPS shall lodge with the Office a report of the actions taken.	June 30, 2007
10	Ensure that the sequence-of-events recorders for all power stations and generators are made fully functional and kept in a state of serviceability. JPS shall lodge with the Office a report of actions taken.	March 31, 2007

In addition, the OFFICE FURTHER **DIRECTS** that **JPS** carry out the following actions arising from its own investigation and recommendations connected with the July 15, 2006 system shutdown, in order to remedy or improve the reliability of electricity supply:

Item	ACTION	Completion Date
1	Replace failed back-up distance relay (type REL512) on Duncans/Bogue 138 kV line at Duncans Substation and re-commission associated remote monitoring point. Replace similar type REL relays at substations island-wide with type SEL.	November 30, 2006 March 31, 2007
2	Carry out separation of DC supply to primary and back-up protective relays on Duncans/Bogue 138 kV line at Duncans Substation. Carry out inspection of major substations island-wide and perform similar separation of DC supply to primary and back-up line relays.	Completed March 31, 2007
3	Investigate and revise relay settings for JEP Power Barge #2 to remove problem with incorrect tripping of 51N relay during remote system disturbances. Also, ensure correction of susceptibility of Barge #2 to low voltage conditions on 380V bus bars.	Completed March 31, 2007

4	Review generation dispatch philosophy, considering system stability and security constraints at varying load conditions.	August 31, 2007
5	Conduct system studies to determine critical fault-clearing times on various transmission lines island-wide.	September 30, 2007
6	Review relay settings on critical transmission lines based on the outcome of item 5 and other relevant attendant parameters.	December 31, 2007
7	Implement a differential protection scheme for the Bogue/Duncans 138kV transmission link.	December 31, 2007
8	Review the existing under-frequency load-shedding scheme to determine adequacy to maintain system stability during disturbances, giving consideration to changes in system configurations and load growth patterns.	June 30, 2007
9	Examine and determine the appropriateness of implementing a voltage load-shedding scheme to ensure system stability. Install such relays if determined to be needed.	June 30, 2007
10	Restore Hunts Bay Gas Turbine 5 black-start capability.	March 31, 2007

JPS shall submit to the Office a **Monthly Report effective to the end of each month**, setting out the status of each of the activities listed above and identifying the reason if any, for any anticipated delay in implementing whichever of the Action, by the Completion Date indicated. The first report shall be effective to **November 30, 2006**

This **DIRECTIVE** becomes effective on the _____ of _____, 2006.

BY ORDER OF THE OFFICE:

SIGNED THIS _____ DAY OF _____, 2006

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J. PAUL MORGAN
DIRECTOR GENERAL