APPENDIX A - CALCULATION OF RESERVE RESPONSIBILITY SHARES

A.1 PURPOSE

A.1.1 This Appendix describes the procedure that the *EMC* shall use to determine *reserve responsibility shares* (RRSs) for the purpose of allocating the costs of *reserves* among *GRFs* in each *settlement interval* as contemplated in section 2.2.4 of this Chapter. Unless otherwise indicated, each procedure described in this Appendix shall be applied for each *settlement interval*.

A.1.2 All references in this Appendix to a *GRF* (including in section A.1.1) shall also include references to an *IRF*.

A.2 DEFINITIONS

A.2.1 In this Appendix:

A.2.1.1 a reference to the "size" of a *GRF* in the *settlement interval* corresponding to a *dispatch period* shall be designated by SZ, where, subject to section 10.3.3 of Chapter 6:

SZ = (½-hour) x *energy* scheduled (in MW) from the *real-time dispatch schedule* for that *GRF* in that *dispatch period*

A.2.1.2 "*secondary contingency unit*" or *SCU* means a *GRF* that is expected to *disconnect automatically* from the *transmission system* if the frequency of the *transmission system* falls due to failure of the largest *GRF*, and "*SCU* m" refers to the *SCU* at *MNN* m;

A.2.1.3 "*cut-off size*" or *CSZ* (in MWh) means the size below which a *GRF* that is not a *secondary contingency unit* will not pay a share of the cost of *reserve* but will pay for *regulation*. *CSZ* is 5 MWh;

A.2.1.4 "*primary contingency unit*" or *PCU* means a *GRF* whose size is greater than *CSZ* and that is not a *secondary contingency unit*, and:

a. "*PCU* m" refers to the *PCU* at *MNN* m; and

b. "*PCU* z" refers to the *PCU* with size index z; and

A.2.1.5 "*probability of failure*", in respect of a *GRF*, means the probability that that *GRF* will, after being *dispatched* by the *PSO* for a *dispatch period*, cease operating, *disconnect* from the *transmission system*, or both in that *dispatch period* even if no other *GRF* fails.

Explanatory Note: System reserve requirements are determined by the largest contingency, defined as the loss of the largest PCU with the consequent loss of all SCUs, so the total reserve requirement (TRQ) is the size of the largest PCU plus the sizes of all SCUs. The RRS for each SCU is that unit's size as a fraction of the TRQ, which means that each SCU pays the full cost of the reserve necessary to protect the system against its own outage, whether from primary or secondary causes, and hence need not contribute again as a primary contingency.

All PCUs share the remaining reserve costs – which pays for enough reserve to cover the loss of the largest unit – according to a "modified runway" formula. The basic concept behind this formula is that no unit should pay for reserves that are necessary only to protect against loss of a unit larger than itself, but each unit should pay a share of the costs of each "tier" of the reserve requirement that is protecting against loss of units its size or smaller. The RRS for each PCU is determined as follows:

- **The first tier of the total reserve requirement (in MWh) is defined as the difference between the sizes of the largest and the second-largest PCUs. The largest PCU is allocated all of this first tier of reserves, on the grounds that this tier is necessary only because the largest unit is producing more than the second-largest unit.**

- **The second tier of reserves is defined as the difference between the sizes of the second- and the third-largest units. The largest two units share the costs of this tier on the grounds that this tier of reserves is necessary only because these two units are larger than the third-largest unit. The sharing of costs is in proportion to failure probabilities on the grounds that a less reliable unit should pay more than a more reliable unit.**

The "nth" tier of reserves is defined as the difference between the sizes of the nth- and the (n+1)th-largest unit. The first nth-largest units share the cost of this tier in proportion to their individual failure probabilities.

This process is repeated until all PCUs are allocated a share of the total cost of reserves. The shares of all SCUs and all PCUs add up to 1.0.

Units that are not SCUs and with size less than CSZ do not pay for operating reserves, but all units pay for regulation (at the same $/MWh charge paid by loads) in proportion to their IEQ up to CSZ.

A.3 IDENTIFICATION OF SECONDARY CONTINGENCY UNITS

A.3.1 The *EMC* shall, in consultation with the *PSO*, establish criteria for identifying *SCUs*, and shall, from time to time but not for each *settlement interval*, use such criteria to identify the *GRFs* designated as *SCUs*.

A.3.2 The *EMC* shall maintain and update as required a register indicating which *GRFs* are designated as *SCUs*.

A.3.3 If *GRF* n has been designated as an *SCU*, it may be referred to as "*SCU* n".

A.4 IDENTIFICATION AND ORDERING OF PRIMARY CONTINGENCY UNITS

A.4.1 If the size of a *GRF* is greater than *CSZ* and the *GRF* is not designated as an *SCU* pursuant to section A.3.1, the *GRF* shall be designated as a *PCU*.

A.4.2 The *EMC* shall order all *PCUs* by decreasing size to determine a size-index (z(m)) and the ordered size function (OSZ(z)), such that:

z(m)	=	integer size-index for PCU m
m(z)	=	the *MNN* m for the PCU with size-index z(m)
OSZ(z)	=	SZ(m(z))
OSZ(z)	≥	OSZ(z+1)
Z	=	Largest value of z such that OSZ(z) ≥ *CSZ*

A.4.3 If *GRF* m has been designated as a *PCU*, *GRF* m may be referred to equivalently as "*PCU* m" or "*PCU* z", where z = z(m) and m = m(z).

A.5 RESERVE REQUIREMENTS

A.5.1 The primary *reserve* requirement or PRQ (in MWh) shall be defined as follows:

PRQ = SZ(m(1)) = OSZ(1) = size of largest PCU

A.5.2 The secondary *reserve* requirement or SRQ (in MWh) shall be defined as follows:

SRQ = $\sum_s$ SZ(s), where s = all *MNNs* corresponding to *SCU*s having SZ(s)>0

A.5.3 The total *reserve* requirement (TRQ, in MWh) shall be defined as follows:

TRQ = SRQ + PRQ

A.6 RESERVE TIERS AND RESERVE TIER SHARES

A.6.1 That amount of the primary *reserve* requirement referred to in section A.5.1 which is in excess of *CSZ* shall be divided into "tiers" defined by the sizes of the *PCU*s. The term "*reserve* tier z" shall mean the portion of the primary *reserve* requirement between the size of *PCU* z+1 and the size of *PCU* z.

A.6.2 The *reserve* tier quantity for *reserve* tier z or RTQ(z) shall be defined as follows:

$$RTQ(z) = OSZ(z) - OSZ(z+1), \text{ with } OSZ(Z+1) \equiv CSZ$$

A.6.3 The *reserve* tier share for *reserve* tier z or RTS(z) shall be defined as follows:

$$RTS(z) = RTQ(z) / (PRQ - CSZ)$$

A.7 FAILURE PROBABILITIES AND WEIGHTS

A.7.1 The *EMC* shall, in consultation with the *PSO*, establish procedures for determining and updating from time to time, but not for each *settlement interval,* the *probability of failure* of each *GRF* based on operating experience with that *GRF* and similar *GRFs*.

A.7.2 The *EMC* shall maintain and update as required a register indicating the standing *probability of failure* of each *GRF*, with:

SPF(m) = Standing probability of failure of *GRF* m

A.7.3 For each *settlement interval*, the *EMC* shall use the data in the *probability of failure* register referred to in section A.7.2 and the size-ordering of *PCUs* for that *settlement interval* determined in accordance with section A.4 to determine the interval *probabilities of failure* or IPF(z) and interval probability weights or IPW(z) for each *PCU* as follows:

IPF(z) = SPF(m(z))

where:

z = *PCU* z

IPW(z) = $\sum_{i=1 \text{ to } z}$ IPF(i)

where:

z = *PCU* z

A.7.4 The *EMC* shall provide the standing *probability of failure* of each *GRF* to all *market participants* and the *MSSL*.

A.8 RRSs FOR SECONDARY CONTINGENCY UNITS

A.8.1 The *EMC* shall determine the *reserve responsibility share* (RRS) for an *SCU* in a *settlement interval* in accordance with the following formula:

$RRS_{R,h}^{m}$ = 0 in cases where SZ(m)≤ 0; and SZ(m)/TRQ, otherwise,

where:

m = *SCU* m

h = *settlement interval* h

SZ(m) is determined for *SCU* m in accordance with in this Appendix for *settlement interval* h.

A.9 RRSs FOR PRIMARY CONTINGENCY UNITS

A.9.1 The ordered *reserve* share for a *PCU* or ORS(z) shall be defined as follows:

$$ORS(z) = [PRQ/TRQ] \times IPF(z) \times \sum_{j=z \text{ to } Z} RTS(j)/IPW(j)$$

where:

z = *PCU* z

A.9.2 The *EMC* shall determine the *reserve responsibility share* (RRS) for a *PCU* in a *settlement interval* in accordance with the following formula:

$$RRS_{R,h}^{m} = ORS(z(m)),$$

where:

m = *PCU* m

h = *settlement interval* h

z(m) is the size-index of PCU m

ORS(z(m)) is determined for PCU z(m) in accordance with this Appendix for *settlement interval* h.