Generator Testing

Background and Calculation of Commissioning Charges

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1.0 Introduction

It is anticipated that two large generators will commence commissioning procedures during 2002. These commissioning procedures are required to test new generation plant in advance of that plant becoming fully operational. During these commissioning tests the generator commonly requires that it be run at certain levels of output or profiled outputs. During this phase the generator cannot accurately predict the actual level of output the commissioning unit will achieve at any specific time and will be at a significantly higher risk of fault than a fully commissioned generator. The unit is not available to the Transmission System Operator (TSO) for conventional dispatch (although the unit is issued with dispatch instructions) when it is in this phase of operation.

This leads to increased operating costs for the TSO for several reasons. The TSO will not be able to predict the output of the unit in advance with any degree of confidence, as it is common for tests to be cancelled at short notice or to vary significantly from their nominated level of output. To match supply and demand, the TSO will generally have to commit extra units to ensure a rapid response to changes from the commissioning unit's scheduled output and to ensure that the system would remain within normal security standards following the loss of the commissioning unit. As the commissioning unit is at a significantly higher risk of tripping, the TSO will carry additional operating reserve to ensure that security of supply is not compromised. This leads to additional constraint costs through the trading and settlement rules and increased reserve premium payments.

These costs are a component of the overall costs of installing a new generator and are required to bring a new generator to the market. As they represent part of the costs of a new generator, it is appropriate that these costs should be paid by the generator and recovered over the lifetime of the plant through the energy market. However, the actual costs caused by the commissioning of an individual generator are highly volatile and dependent on many factors outside the generator's control. There is little benefit to the market in exposing the generator to this risk, as the generator will not be in a position to manage the risk and reduce costs. Further, the variation in costs may appear insignificant to a generator in comparison to the costs of commissioning or delays in commissioning. Hence it is proposed that generators will pay for the costs of commissioning based on an ex-ante published schedule of charges for commissioning tests. The TSO will manage the volatility and magnitude of actual costs while ensuring system security on a daily basis.

The actual level of costs will depend on the specific operational policy used during the commissioning stage. The TSO has determined the operating policy that it intends to apply during commissioning and this is detailed in Section 2. The application of this policy will result in increases in several individual cost components as described above. These components are identified and described in Section 3. The modelling assumptions used to determine the level of these costs are described in Section 4. Section 5 presents and analyses the study results, a detailed schedule of charges is presented in Section 6. Finally some conclusions are presented in Section 7.

2.0 Operational Policy

In order that costs to generators are minimised, three distinct phases of commissioning have been identified. Phase 1 will cover the initial period where the unit is highly unreliable and presents a large risk to the system. As the unit progresses through commissioning it enters phases two and three as it passes key commissioning milestones. As the unit is deemed to have completed each phase, it is considered more secure, and hence different operational policies will apply. As each policy will result in different costs a different schedule of charges will apply to each phase of the commissioning programme.

During phases one and two of testing it will be necessary to carry additional spinning reserve.

Phase 1

In this phase, the unit is considered to be highly unreliable and it is necessary to have sufficient primary reserve on line to cover 100% of the MW produced by the generator under test. Interruptible loads will not be part of the primary reserve for this phase as these loads are only available for a limited number of interruptions per year and it would be imprudent to over utilise this resource during an unreliable operational phase. To complete this phase the generator under test will have to complete a minimum:

- 10 hours running (in two blocks of 5 hours continuous running) @ loads in range 0-25% registered capacity
- 10 hours running (in two blocks of 5 hours continuous running) @ loads in range 25% - 50% registered capacity
- 20 hours running (in four blocks of 5 hours continuous running) @ loads in range 50% - 75% registered capacity
- 20 hours running (in four blocks of 5 hours continuous running) @ loads in range 75% - 100% registered capacity

For a combined cycle module commissioning different units[1] in sequential stages the deemed capacity (for the purposes of commissioning only) for each stage shall be the capacity of the unit, following the completion of that stage in its commissioning programme, as determined by ESBNG. Any unreliable behaviour or known reliability problems occurring during any of these four sub-phases may require a repeat of that particular sub-phase.

Phase 2

The unit is assumed to be more reliable than in Phase1 but not as reliable as a unit in normal operation. Hence the overall reserve requirement is the same as in Phase 1, however, the unit is deemed to be sufficiently reliable to allow Interruptible loads to contribute towards the reserve requirement. Sufficient primary reserve to cover 100% of the MW produced by the generator under test will be maintained.

[1] A module may consist of several distinct units e.g. a CCGT module will typically comprise a number of gas turbine and steam turbine units.

To complete this phase the generator under test will have to complete a minimum of:

?? 72 hours continuous running at loads greater than 90% registered capacity including 24 hours at 100% registered capacity as part of the full-load reliability run.

As with Phase 1, any tripping during the 72 hours will require a repeat of this phase. Any unreliable behaviour or known reliability problems occurring during this phase may require that Phase 1 operating conditions be restored.

Phase 3

At this stage of the commissioning programme the unit is deemed to be reasonably reliable and normal primary reserve rules will apply for remainder of reliability run

Any tripping or unreliable behaviour or known reliability problems occurring during the reliability run may require a restart of Phase 2 with the appropriate operating conditions being restored.

3.0 Elements of cost

The extra costs incurred by the TSO can be broken into three components

3.1 Increased constraint costs where extra reserve is being provided

A generator provides spinning reserve when it is operating at levels below its maximum output. In general, an amount of reserve is available from generating sources based on their nominated outputs. However, it is normally necessary to redispatch several units away from their nominated output to ensure the provision of sufficient reserve. This results in instructed imbalance payments being made to the generators by the TSO. When the level of reserve required is increased (for example to facilitate the commissioning of a new unit) the level of these costs increases.

3.2 Increased costs of Reserve Premiums

ESBNG pays providers of reserve a Reserve Premium for the actual reserve level provided. This is separate from payments for out of merit generation under the trading and settlement code described above. When the TSO is carrying additional reserve to facilitate the commissioning of a new unit additional payments will be made. Additional interruptible load costs that may be incurred by the TSO during phase 2 operation are not considered in this paper. It is also assumed that it is only necessary to carry additional Primary and Secondary Reserve.

3.3 Increased run hours as commitment will assume unit does not exist

As described above, units may be highly unreliable during Phase 1. It is common for scheduled tests to be postponed, cancelled or completed early at short notice. If no mitigating action was taken, these situations could leave the system with insufficient committed plant. To reduce the risk to the system in these events, the TSO will commit the same plant, as it would otherwise have done if the commissioning unit were not present on the system. This will, however, appear as an instructed imbalance in the Settlement System and the TSO will incur additional constraint costs under the Trading and Settlement Code.

There is an element of overlap between the cost drivers identified in 1 and 3 above. Some units may be constrained on under each criterion individually. The methodology employed by the TSO to quantify constraint costs recognises this and eliminates any “double counting” of constraint costs.

4.0 Studies

ESB National Grid has performed detailed analysis to evaluate the magnitude of these costs.

In order to capture the additional costs associated with these generation unit tests, system production costs have been evaluated under a number of scenarios. These scenarios have been chosen to represent the situation when a new unit is under test during 2002. Different output levels and corresponding reserve requirements have been modelled. Promod IV? has been used for this purpose. Each study evaluates the impact of a commissioning unit over a full year, hence a wide range of scenarios is modelled and highly representative results are obtained.

Reasonable assumptions have been made about fuel costs, plant mix, dispatch, interconnector flows etc. Studies were performed to evaluate the cost of commissioning at five different output levels in each phase of commissioning. Transmission constraints have not been considered.

4.2 Methodology

Total costs, on a unit by unit and system basis, have been calculated under the different reserve carrying and test unit output scenarios. Generating unit run hours are also determined.

For these studies, only the primary reserve constraint was modelled. This would, if anything, underestimate the additional costs. However, experience on the Irish system indicates that this approach, in general, yields accurate results for the constraint costs of reserve.

5.0 Results

5.1 Constraint Costs due to increased reserve requirement

The studies above have evaluated the reserve constraint costs under a number of assumptions. By comparing these figures the increased constraint cost due to the commissioning of a new unit may be determined.

A base case study of the situation that would pertain if the commissioning unit were reliable was performed. By comparing the costs of the various other cases with the base case the additional costs of constraints may be determined. This result is the total additional cost that would be incurred by the TSO if the commissioning unit was testing under the stated assumptions and operational policies for a full year. Hence, the cost found is an accurate representation of the costs incurred under many different system conditions. The costs found are then divided by the number of hours in a year to yield the average hourly cost of the constraints over the period. This figure is then divided by the output of the commissioning unit to yield the costs per MWhr for commissioning units set out below.

Cost per MWhr of commissioning running	
	€
Phase 1 300	3.24
Phase 1 350	4.38
Phase 1 400	4.39
Phase 2 300	1.54
Phase 2 350	1.74
Phase 2 400	2.48

Table 2: Constraint Costs

Note that for units commissioning at loads of 100 or 200MW no additional reserve is required as sufficient reserve (excluding interruptible load) is carried by ESBNG and the Northern Ireland TSO (SONI) under normal operational conditions.

5.2 Reserve Costs

It is possible to accurately determine the additional reserve cost for every hour of commissioning in every phase based on the operational figures determined above. 2002 rates for reserve premium payments have been used. The costs below are the costs incurred per MWhr of running for the commissioning unit.

Cost per MWhr of commissioning running	
	€
Phase 1 300	0.62
Phase 1 350	0.62
Phase 1 400	0.93
Phase 2 300	0.31
Phase 2 350	0.27*
Phase 2 400	0.62

Table 3: Reserve Premium Costs

* The cost is proportionally less in the 350MW cases than in the 300MW cases as there is proportionally less additional reserve required in the 350MW case than in the 300MW case and the total extra cost is recovered over more MWhrs.

5.3 Constraints Costs due to additional run hours

The number of hours each unit would be expected to run in a one year period was determined for each of the cases described above. By comparing the number of hours a unit would be expected to run in the base case (the case with no commissioning unit) with the number of hours it is expected to run in specific commissioning cases, the additional run hours in the base case may be determined. The cost of these additional run hours are assumed to be represented by the number of hours multiplied by the units assumed idling cost. To prudently manage this cost it represents good operational practice not to retain all the marginal units that can start at short notice on-line at all times a unit is commissioning. It has been assumed for the purposes of this study that units that can start in under 30 minutes will be kept on-line 50% of the additional time they are deemed to be required in the base case and not in the commissioning case. This yields the cost of the additional run hours over a one year period. From this the following hourly costs per MWhr of commissioning running have been determined.

Phase 1 Costs per MWhr	
Case	Cost €
Phase 1 100MW	1.36
Phase 1 200MW	2.77
Phase 1 300MW	1.25
Phase 1 350MW	0.97
Phase 1 400MW	1.07

Table 4: Additional run hour costs

These figures are significant for the 100 and 200MW cases as no additional reserve is being scheduled in these cases. However, for the 300MW and 400MW cases substantial amounts of additional reserve will be required and hence many units will be constrained on to provide this reserve. Hence, it is to be expected that the difference in run hours would diminish significantly as seen.

5.4 Summary of Results

Combining the costs determined above provides the overall costs for generators commissioning as set out below. All figures are in €/MWh.

Phase 1

	Phase 1 100MW	Phase 1 200MW	Phase 1 300MW	Phase 1 350MW	Phase 1 400MW
	€	€	€	€	€
Constraints			3.24	4.38	4.39
Additional Run Hours	1.36	2.77	1.25	0.97	1.07
Premium Costs			0.62	0.62	0.93
Total Charge	1.36	2.77	5.10	5.97	6.40

Table 5: Phase 1 Costs

Phase 2

	Phase 2 300MW	Phase 2 350MW	Phase 2 400MW
	€	€	€
Constraints	1.54	1.74	2.48
Additional Run Hours			
Premium Costs	0.31	0.27	0.62
Total Charge	1.85	2.01	3.10

Table 6: Phase 2 Costs

6.0 Schedule of Charges

The following schedule of charges has been developed based on the results above. Charges will be per MWhr and charges are specified for different unit outputs and operational phases.

Generator Output (MW)	Charge (€/MWh)
0-50	0.00
51-100	1.02
101-150	1.71
151-200	2.42
201-250	3.35
251-300	4.52
301-350	5.54
351-400	6.18

Phase 1 Charges

Generator Output (MW)	Charge (€/MWh)
0-250	0.00
251-300	0.92
301-350	1.93
351-400	2.56

Phase 2 Charges

No commissioning charges will be made in respect of a generator in phase 3 of its commissioning programme.

6.1 TUoS Charges

It is not intended to charge generators for fast wind-downs or trips while they are in phases 1 or 2 of their commissioning programme. It is considered that the commissioning charges as determined provide for these costs. As generators in phase 3 of their commissioning programme do not pay explicit commissioning charges they will be subject to charges for fast wind-downs and trips.

Generators will be charged transmission tariffs during their commissioning programme, these charges will be based on a "non-firm" tariff currently under development by ESBNG.

7.0 Conclusions

This paper has developed a schedule of charges for generator commissioning. In Phase 2 commissioning there will be no charge for generators commissioning at outputs less than 250MW.

Charges will be made on a trading period basis and be based on the units metered output as used in the TESS settlement system.