

**Probability Distribution of HVDC Capacity and  
Impacts of Two Key Components**

**(Risk, Cost and Feasibility of Extending HVDC life to 2009)**

**Wenyuan Li  
System Performance Assessment  
BCTC**

**May 5, 2004**

**Probability Distribution of HVDC Capacity and Impacts of Two Key Components  
(Risk, Cost and Feasibility of Extending HVDC life to 2009)**

**(Executive Summary)**

**Wenyuan Li  
System Performance Assessment  
BCTC**

This study is a portion of the Vancouver Island Supply Alternative Project [1,2]. HVDC Pole 1 has been retired and Pole 2 will be retired in 2007. BCUC agreed that the planning capacity of HVDC would be zero in 2007. One major alternative for Vancouver Island supply is the addition of the 230 kV AC line. However, the in-service date of the 230 kV AC line project will be in October 2008 as an accelerated plan or in October 2009 as a non-accelerated plan.

Conceptually, the retirement of HVDC does not mean that it can no longer be used in operation. Actually, like human beings, the retired HVDC can continue to serve supply with relatively high unavailability from an operation viewpoint. Also, replacements of some critical components can extend its life. The purpose of the study is to evaluate probability distribution of HVDC capacity and impacts of two key component replacements (Pole 2 reactor and filter capacitor at VIT) on HVDC reliability. The results provide answers to the following questions:

- If we continue to use HVDC as it is (i.e., without any replacement or refurbishment), what is the increased risk or unreliability of HVDC?
- If we replace each of the two key components, how much reliability improvement can be expected and for how long?
- Can HVDC be used as an alternative before the 230 kV line in-service?

The study does not intend to re-address HVDC life extension as a long-term solution to Vancouver Island supply. The previous studies have proved that HVDC life extension is not a competitive alternative for Vancouver Island long-term power supply in terms of economic effectiveness and long time unreliability. HVDC ageing is a basic fact. However, this does not lower the significance of investigating the risk, cost and feasibility of extending HVDC life to fill the gap before the 230 kV AC line in-service.

The following conclusions can be made from the assessment results:

- (1) The evaluated results show that the availability of Pole 1 in 2004 is only 38.9% now and will be further decreased to 20% in 2007. The availability of Pole 2 in 2004 is 84% now, will be decreased to only 73% in 2007 and to 63% in 2009 due to ageing failure probability.
- (2) By combining the poles 1 and 2 together, the availability of the whole HVDC in 2004 is 90.2%, will be 78.4% in 2007 and 66.9% in 2009. The failure event of HVDC can happen any time during the peak or off-peak period with the estimated probabilities in different years. If we can accept the relatively high risk from 2007 to 2009, HVDC without any refurbishment (doing nothing) could be used as an option before the 230 kV line in place in 2008 or 2009.
- (3) The study shows that replacing the Pole 2 reactor at VIT in 2005 will provide HVDC life extension by two years. This means that replacing the Pole 2 reactor at VIT in 2005 will bring the HVDC failure probability in 2009 back to its failure probability level in 2007. Replacing the Pole 2 filter capacitor at VIT in 2005 will provide HVDC life extension by one year. In other words, replacing the Pole 2 filter capacitor at VIT in 2005 will bring the HVDC failure probability in 2008 back to its failure probability level in 2007.
- (4) According to the cost estimate based on the Alstom Life Extension Report completed in June 2001, the Pole 2 reactor costs \$2.0 million and the Pole 2 filter capacitor costs \$1.7 million. If we want to keep the overall HVDC reliability in 2009 at the same level as its reliability status in 2007, replacing the Pole 2 reactor at VIT is an option with \$2.0 million of investment. Replacing the Pole 2 filter capacitor at VIT can be used as an additional measure to get one more year of "reliability advance" with the cost of \$1.7 million.

- (5) It is important to appreciate that the assessment results are based on the probability analysis. The results should be viewed as the expected value of a random variable. Also, the input data always have some uncertainty. The input data used in this study are based on the same source that was used in the reliability evaluation of Vancouver Island in the VIGP project.
- (6) In general, it can be concluded that HVDC can be used as an alternative before the 230 kV AC line in-service. If the 230kV line can be in place in 2008, replacing the Pole 2 filter capacitor at VIT may be a good option if a little bit (about 1%) higher risk is acceptable. If the 230kV line cannot be available until 2009, replacing the Pole 2 reactor at VIT is a potential option. Both of these options provide almost the same HVDC reliability level as that in 2007. The cost paid is \$1.7 or \$2.0 million. Replacing both the Pole 2 reactor and the filter capacitor at VIT can offer further improvement in HVDC reliability with the total cost of \$3.7 million.

## **Probability Distribution of HVDC Capacity and Impacts of Two Key Components (Risk, Cost and Feasibility of Extending HVDC life to 2009)**

**Wenyuan Li**  
**System Performance Assessment**  
**BCTC**

### **1. Introduction**

This study is a portion of the Vancouver Island Supply Alternative Project [1,2]. HVDC Pole 1 has been retired and Pole 2 will be retired in 2007. BCUC agreed that the planning capacity of HVDC would be zero in 2007. One major alternative for Vancouver Island supply is the addition of the 230 kV AC line. However, the in-service date of the 230 kV AC line project will be in October 2008 as an accelerated plan or in October 2009 as a non-accelerated plan.

Conceptually, the retirement of HVDC does not mean that it can no longer be used in operation. Actually, like human beings, the retired HVDC can continue to serve supply with relatively high unavailability from an operation viewpoint. Also, replacements of some critical components can extend its life. The purpose of the study is to evaluate the probability distribution of HVDC capacity and impacts of two key component replacements (Pole 2 reactor and filter capacitor at VIT) on HVDC reliability. The results provide answers to the following questions:

- If we continue to use HVDC as it is (i.e., without any replacement or refurbishment), what is the increased risk or unreliability of HVDC?
- If we replace each of the two key components, how much reliability improvement can be expected and for how long?
- Can the HVDC be used as an alternative before the 230 kV line in-service?

The study does not intend to re-address HVDC life extension as a long-term solution to Vancouver Island supply. The previous studies have proved that HVDC life extension is not a competitive alternative for Vancouver Island long-term power supply in terms of economic effectiveness and long time unreliability. HVDC ageing is a basic fact. However, this does not lower the significance of investigating the risk, cost and feasibility of extending HVDC life to fill the gap before the 230 kV AC line in-service.

### **2. Assumptions and data**

In the study, the following assumptions are considered:

- Both repairable and ageing failure modes of each component of the HVDC system are modelled.
- HVDC has been in the end-of-life stage and ageing failures must be considered. The basic feature of ageing failure is that the failure probability of components increases as the age.
- The time frame is from 2004 to 2010.
- According to the operation logic of HVDC, both poles 1 and 2 have two operation modes. The pole 1 can be operated at the full capacity of 312 MW if all the components are in service and at the half capacity of 156 MW if only one of the components with redundancy fails. The pole 1 has to be shut down if the reactor or filter capacitor at either VIT or ARN fails. The pole 2 can be operated at the full capacity of 476 MW if all the components are available and at the half capacity of 238 MW if only one of the components with redundancy fails. The pole 2 has to be shut down if the reactor or filter capacitor at either VIT or ARN fails.
- It can be judged from the reliability configuration of HVDC that the key components impacting HVDC reliability are the reactor and filter capacitor of Pole 2 at the VIT side. Only the reliability improvement due to replacement of each of the two key components is evaluated.
- The failure data of components are the same as those used in the reliability evaluation study of the VIGP project [3]. The data include the failure frequency and repair time for the repairable failure mode and the mean life and standard deviation of each component. These data are based on the expert's estimation [4].

### 3. Assessment Method

The assessment method includes the following steps:

- (1) The unavailability due to the repairable and ageing failure of each component is calculated using the SPARE program [5].
- (2) The state enumeration technique is used to evaluate the probability of each capacity level of pole 1 or pole 2. This is performed on a spreadsheet.
- (3) The state enumeration technique is used to assess the probability distribution of whole HVDC capacity by combining the state probabilities of poles 1 and 2. This is also conducted on a spreadsheet.
- (4) The above steps are repeated from 2004 to 2010.
- (5) Step (1) to (4) are performed for the three cases: (a) base case (doing nothing); (b) replacement of Pole 2 reactor at VIT; (c) replacement of Pole 2 filter capacitor at VIT.

### 4. Results

#### 4.1 Doing nothing

The unavailability values due to both repairable and ageing failures for all the components from 2004 to 2010, which were obtained from running the SPARE program, are listed in Appendix 1. The calculation process of the probability distributions for the poles 1 and 2 at different capacity levels is also given in Appendix 1.

The separate reliability probability distributions for the poles 1 and 2 are shown respectively in Tables 1 & 2 and Figures 1 & 2. The probability distribution of whole HVDC capacity, which is a combination of probability distributions of the poles 1 and 2, is shown in Table 3 and Figure 3.

Table 1 Reliability probability distribution of Pole 1 (doing nothing)

| Year | Probability at 312 MW only | Probability at 156 MW & above | Failure probability |
|------|----------------------------|-------------------------------|---------------------|
| 2004 | 0.185683187                | 0.389007903                   | 0.610992097         |
| 2005 | 0.143281059                | 0.322473156                   | 0.677526844         |
| 2006 | 0.106243735                | 0.258678238                   | 0.741321762         |
| 2007 | 0.075725132                | 0.200479565                   | 0.799520435         |
| 2008 | 0.051009050                | 0.148315626                   | 0.851684374         |
| 2009 | 0.032753449                | 0.105080105                   | 0.894919895         |
| 2010 | 0.019887959                | 0.070819540                   | 0.929180460         |

Table 2 Reliability probability distribution of Pole 2 (doing nothing)

| Year | Probability at 476 MW only | Probability at 238 MW & above | Failure probability |
|------|----------------------------|-------------------------------|---------------------|
| 2004 | 0.629157259                | 0.840012783                   | 0.159987217         |
| 2005 | 0.593907860                | 0.808170912                   | 0.191829088         |
| 2006 | 0.554333069                | 0.771330493                   | 0.228669507         |
| 2007 | 0.512838492                | 0.730082813                   | 0.269917187         |
| 2008 | 0.463541606                | 0.682057124                   | 0.317942876         |
| 2009 | 0.413689862                | 0.629911569                   | 0.370088431         |
| 2010 | 0.362198344                | 0.573357887                   | 0.426642113         |

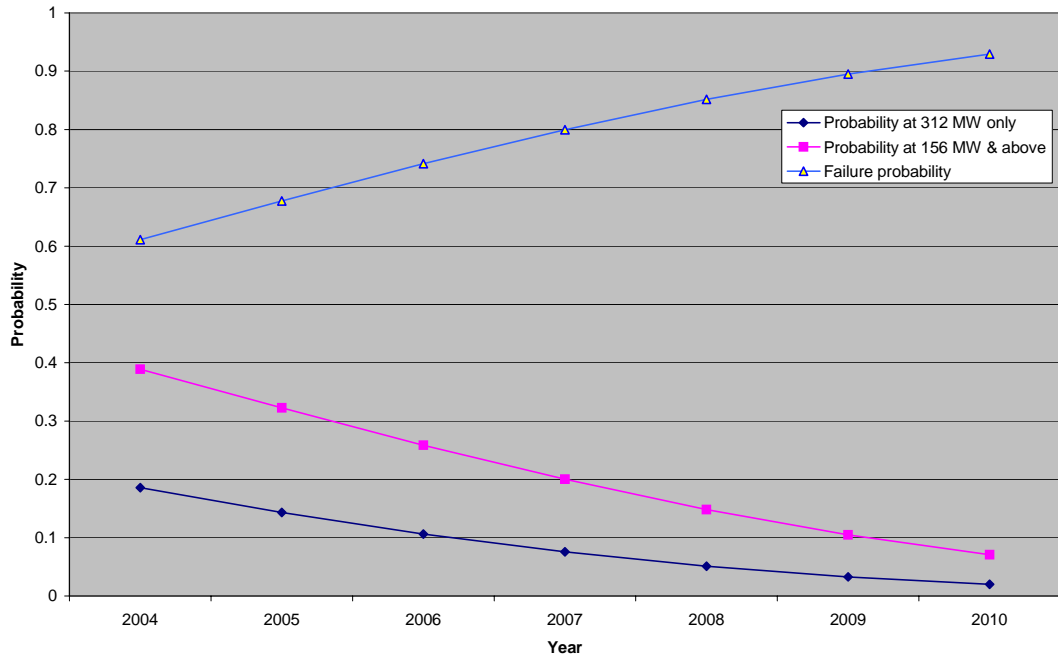


Figure 1 Reliability probability of Pole 1 (doing nothing)

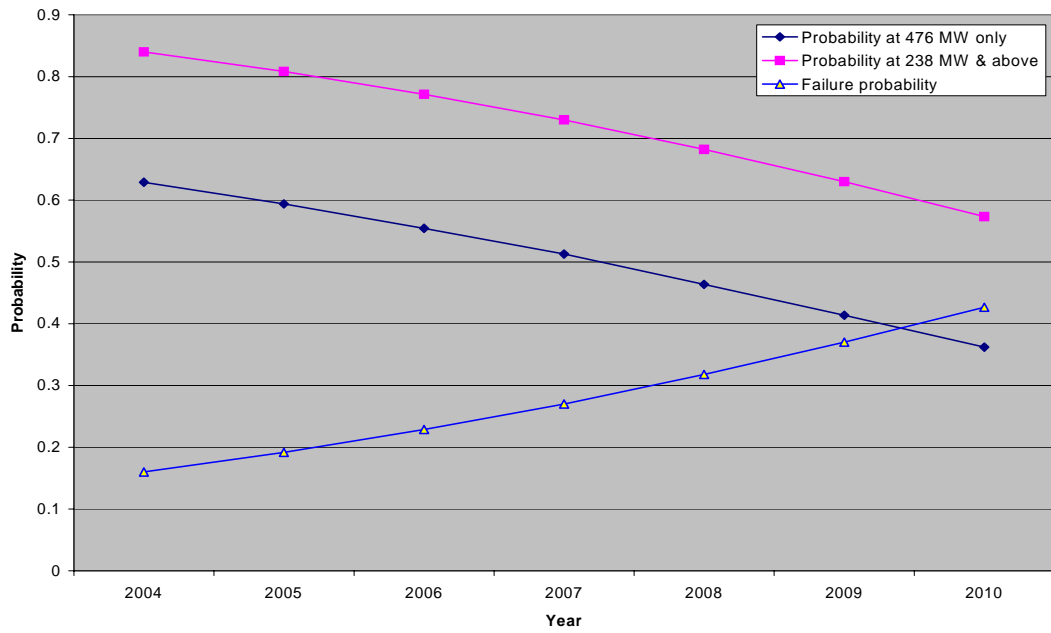


Figure 2 Reliability probability of Pole 2 (doing nothing)

Table 3 Cumulative probability distribution of HVDC capacity (doing nothing)

| Capacity  | 2004        | 2005        | 2006        | 2007        | 2008        | 2009        | 2010        |
|-----------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| 0 MW      | 0.097750925 | 0.129969357 | 0.169517682 | 0.215804307 | 0.270786979 | 0.331199500 | 0.396427514 |
| 156 MW up | 0.902249075 | 0.870030643 | 0.830482318 | 0.784195693 | 0.729213021 | 0.668800500 | 0.603572486 |
| 238 MW up | 0.869719720 | 0.835656386 | 0.795625195 | 0.750522328 | 0.698275088 | 0.642033242 | 0.581842928 |
| 312 MW up | 0.740888660 | 0.690487417 | 0.634760283 | 0.576831053 | 0.512168836 | 0.448532134 | 0.385637607 |
| 394 MW up | 0.711181724 | 0.663001943 | 0.610465580 | 0.556391539 | 0.495950872 | 0.436410461 | 0.377152566 |
| 476 MW up | 0.668309585 | 0.624607697 | 0.577387686 | 0.529289347 | 0.474687875 | 0.420771868 | 0.366397876 |
| 550 MW up | 0.283899472 | 0.222219179 | 0.166448518 | 0.119264493 | 0.079896732 | 0.050552581 | 0.029850253 |
| 632 MW up | 0.244747146 | 0.191519342 | 0.143393901 | 0.102813638 | 0.068750464 | 0.043470574 | 0.025650720 |
| 788 MW    | 0.116823925 | 0.085095747 | 0.058894416 | 0.038834763 | 0.023644817 | 0.013549770 | 0.007203386 |

Note: “up” indicates the capacity and above. For example, “156 MW up” indicates “156 MW & above”.

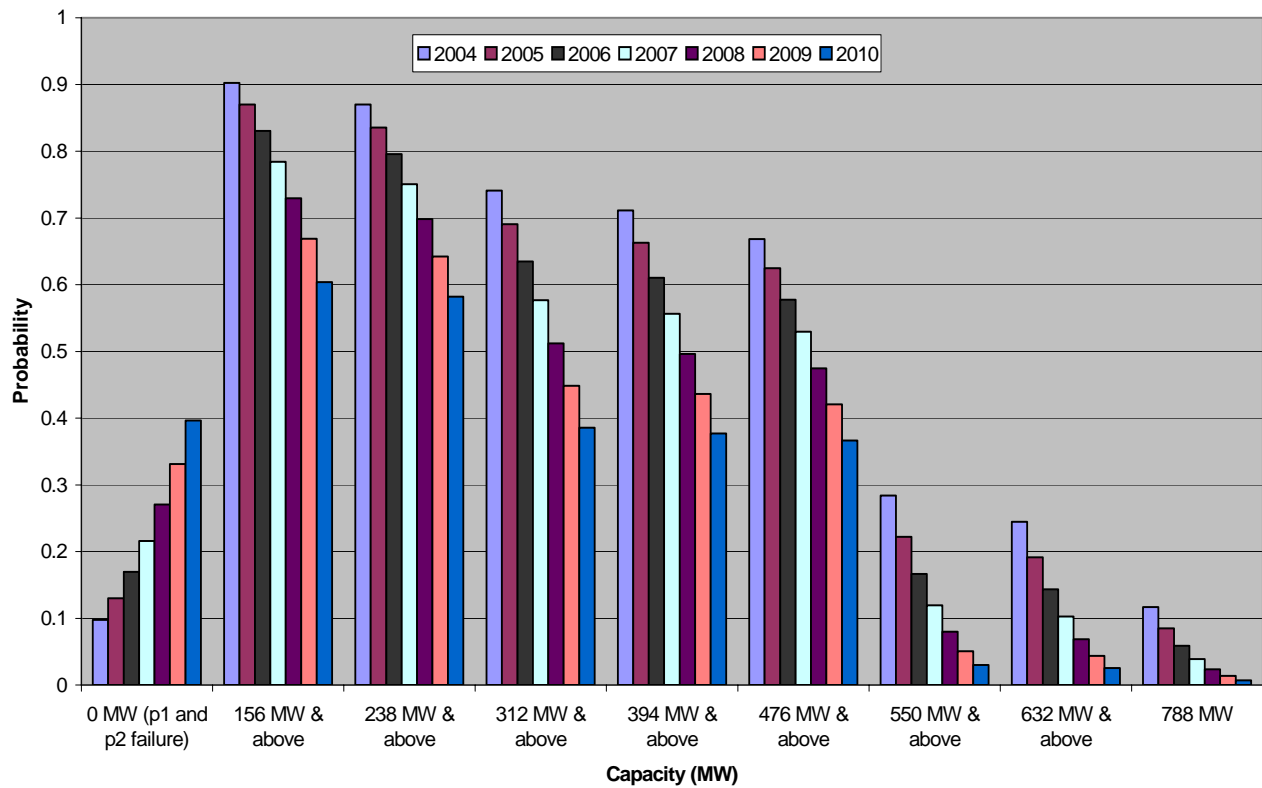


Figure 3 Cumulative probability distribution of HVDC capacity (doing nothing)

The following observations can be made:

- Although the pole 1 has retired, it can be still used as a stand-by source with a very high failure probability. Its unavailability is 61% in 2004 and will be up to 93% in 2010.
- The pole 2 is close to retire. Its unavailability in 2004 is 16% and will be up to 42.7% in 2010. By 2007, the total probability of pole 2 at the half (238 MW) or full (476 MW) capacity will be only about 73%. According to the criterion used in the VIGP project, a dependable source or a firm capacity should have availability of 95% or above. However, like the existing pole 1, the pole 2 will be still used with a relatively high failure probability after 2007 from a viewpoint of operation.
- The full unavailability of the whole HVDC (combined poles 1 and 2) in 2004 is 9.8%, will be increased to 21.6% in 2007 and reach 39.6% in 2010. This equivalently means that the probability that the HVDC has at least 156 MW is 90.2% in 2004, 78.4% in 2007 and 60.4% in 2010.

#### 4.2 Replacement of Pole 2 reactor at VIT

There is no reason to consider any refurbishment on the pole 1 since it has been retired already. For Pole 2, the reactor is a key component due to the fact that it is in series with other components from a viewpoint of HVDC reliability configuration. In other words, once it fails, Pole 2 will fully lose its supply capacity. There is a spare reactor at the ARN side. This spare would have to be transported from ARN to VIT to be installed if the Pole 2 reactor at VIT fails. This results in long recovery time and thus a large negative impact on HVDC reliability. The reactor at VIT has been operated for 28 years while its mean life is estimated to be 30 years [4].

It is assumed that the Pole 2 reactor at VIT is replaced in 2005 and the old one can be used as a spare at VIT. The unavailability data of all the components including a new Pole 2 reactor at VIT from 2004 to 2010 are listed in Appendix 2. The calculation process of the probability distributions for the poles 1 and 2 at different capacity levels is also given in Appendix 2.

The comparison between the reliability probability distributions of Pole 2 with and without the replacement of the reactor at VIT is shown in Table 4 and Figure 4. The cumulative probability distribution of whole HVDC capacity with the replacement of the pole 2 reactor at VIT is shown in Table 5 and Figure 5. The comparison of HVDC reliability between doing nothing and the VIT reactor replacement is shown in Table 6 and Figure 6. In the last comparison, only three capacity levels (0 MW, 238 MW and 476 MW) corresponding to the pole 2 capacities are given.

Table 4 Comparison of Pole 2 reliability between doing nothing and replacement of Pole 2 reactor at VIT

| Year | Doing nothing (Probability) |                |             | Replacement of Pole 2 reactor at VIT (Probability) |                |             | Failure probability reduction |
|------|-----------------------------|----------------|-------------|--|----------------|-------------|-------------------------------|
|      | 476 MW only                 | 238 MW & above | Failure     | 476 MW only  | 238 MW & above | Failure     |                               |
| 2004 | 0.629157259                 | 0.840012783    | 0.159987217 | 0.629157259  | 0.840012783    | 0.159987217 | 0                             |
| 2005 | 0.593907860                 | 0.808170912    | 0.191829088 | 0.634966667  | 0.864042429    | 0.135957571 | 0.055871517                   |
| 2006 | 0.554333069                 | 0.771330493    | 0.228669507 | 0.601807089  | 0.837388539    | 0.162611461 | 0.066058046                   |
| 2007 | 0.512838492                 | 0.730082813    | 0.269917187 | 0.566978784  | 0.807157560    | 0.192842440 | 0.077074747                   |
| 2008 | 0.463541606                 | 0.682057124    | 0.317942876 | 0.523576413  | 0.770392598    | 0.229607402 | 0.088335475                   |
| 2009 | 0.413689862                 | 0.629911569    | 0.370088431 | 0.479127858  | 0.729551795    | 0.270448205 | 0.099640226                   |
| 2010 | 0.362198344                 | 0.573357887    | 0.426642113 | 0.431899224  | 0.683693978    | 0.316306022 | 0.110336091                   |



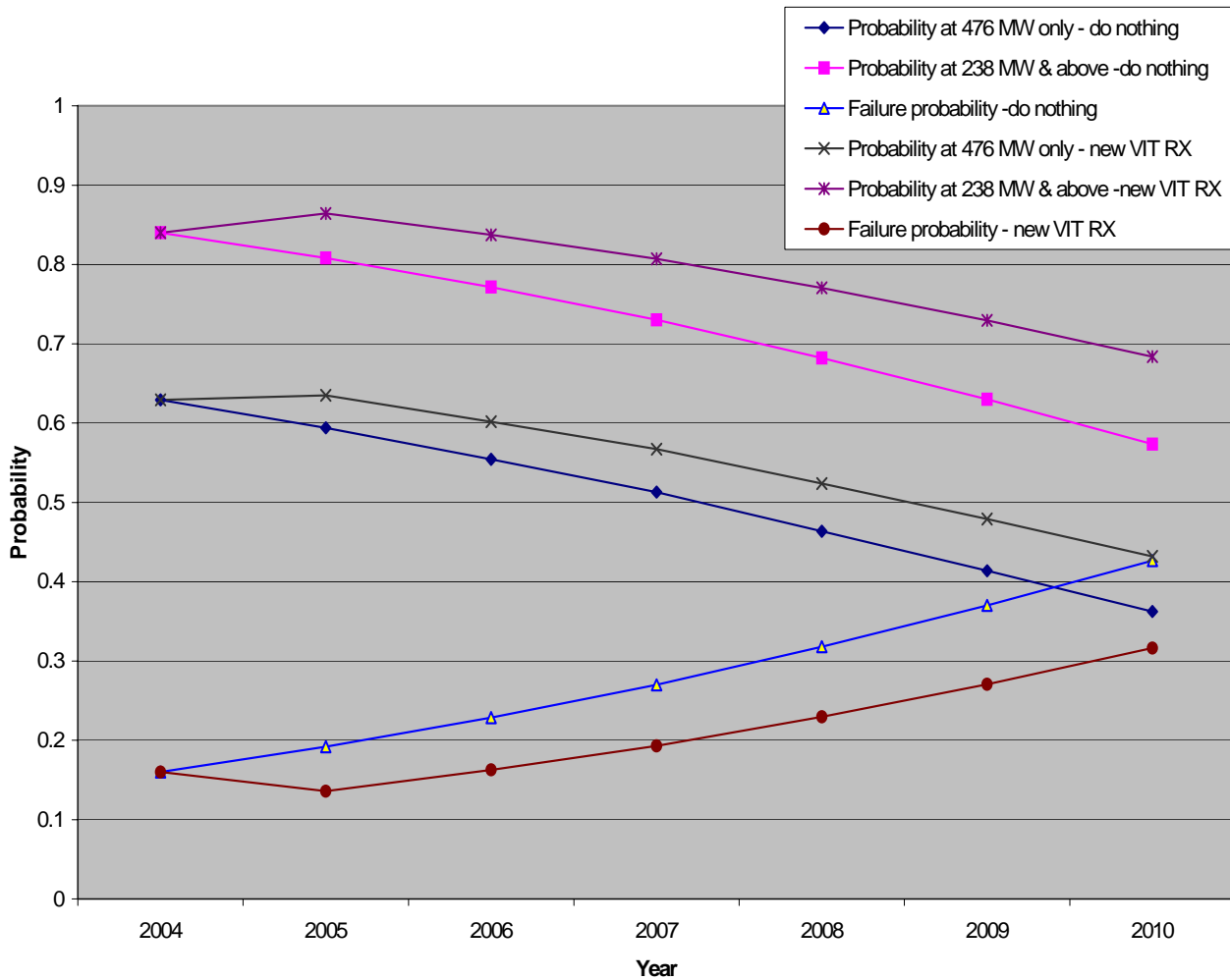


Figure 4 Comparison of Pole 2 reliability between doing nothing and replacement of Pole 2 reactor at VIT

Table 5 Cumulative probability distribution of HVDC capacity (replacement of Pole 2 reactor at VIT)

| Capacity  | 2004        | 2005        | 2006        | 2007        | 2008        | 2009        | 2010        |
|-----------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| 0 MW      | 0.097750925 | 0.092114904 | 0.120547415 | 0.154181472 | 0.195553036 | 0.242029479 | 0.293905375 |
| 156 MW up | 0.902249075 | 0.907885096 | 0.879452585 | 0.845818528 | 0.804446964 | 0.757970521 | 0.706094625 |
| 238 MW up | 0.86971972  | 0.883522574 | 0.854664988 | 0.821760579 | 0.782104654 | 0.738409906 | 0.689984659 |
| 312 MW up | 0.74088866  | 0.728317596 | 0.680023332 | 0.62973274  | 0.571895166 | 0.514300543 | 0.456021894 |
| 394 MW up | 0.711181724 | 0.708837451 | 0.662746883 | 0.615129721 | 0.56018311  | 0.505442432 | 0.449731213 |
| 476 MW up | 0.668309585 | 0.667788885 | 0.626836142 | 0.585166354 | 0.536166272 | 0.487330106 | 0.436906908 |
| 550 MW up | 0.283899472 | 0.237581923 | 0.18070345  | 0.13185523  | 0.090244423 | 0.058549053 | 0.035594588 |
| 632 MW up | 0.244747146 | 0.204759705 | 0.155674397 | 0.11366766  | 0.077654564 | 0.050346806 | 0.030586904 |
| 788 MW    | 0.116823925 | 0.090978696 | 0.063938233 | 0.042934544 | 0.026707135 | 0.01569309  | 0.008589594 |

Note: "up" indicates the capacity and above. For example, "156 MW up" indicates "156 MW & above".

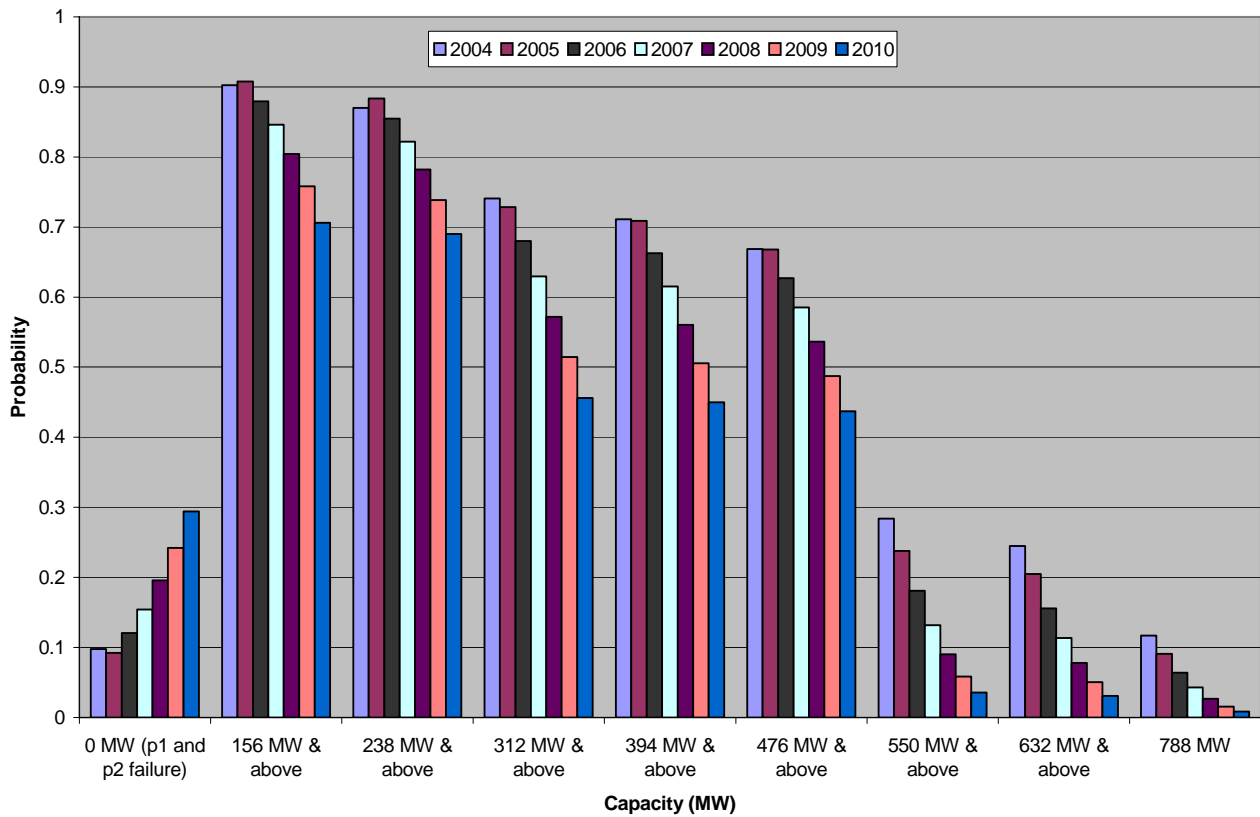


Figure 5 Cumulative probability distribution of HVDC capacity (replacement of Pole 2 reactor at VIT)

Table 6 Comparison of HVDC reliability between doing nothing and replacement of Pole 2 reactor at VIT

| Year | Replacement of Pole 2 reactor at VIT (Probability) |                |                | Doing nothing (Probability) |                |                | Failure (0MW) probability reduction |
|------|--|----------------|----------------|-----------------------------|----------------|----------------|-------------------------------------|
|      | 0 MW   | 238 MW & above | 476 MW & above | 0 MW                        | 238 MW & above | 476 MW & above |                                     |
| 2004 | 0.097750925  | 0.869719720    | 0.668309585    | 0.097750925                 | 0.869719720    | 0.668309585    | 0                                   |
| 2005 | 0.092114904  | 0.883522574    | 0.667788885    | 0.129969357                 | 0.835656386    | 0.624607697    | 0.037854453                         |
| 2006 | 0.120547415  | 0.854664988    | 0.626836142    | 0.169517682                 | 0.795625195    | 0.577387686    | 0.048970267                         |
| 2007 | 0.154181472  | 0.821760579    | 0.585166354    | 0.215804307                 | 0.750522328    | 0.529289347    | 0.061622835                         |
| 2008 | 0.195553036  | 0.782104654    | 0.536166272    | 0.270786979                 | 0.698275088    | 0.474687875    | 0.075233943                         |
| 2009 | 0.242029479  | 0.738409906    | 0.487330106    | 0.331199500                 | 0.642033242    | 0.420771868    | 0.089170020                         |
| 2010 | 0.293905375  | 0.689984659    | 0.436906908    | 0.396427514                 | 0.581842928    | 0.366397876    | 0.102522139                         |

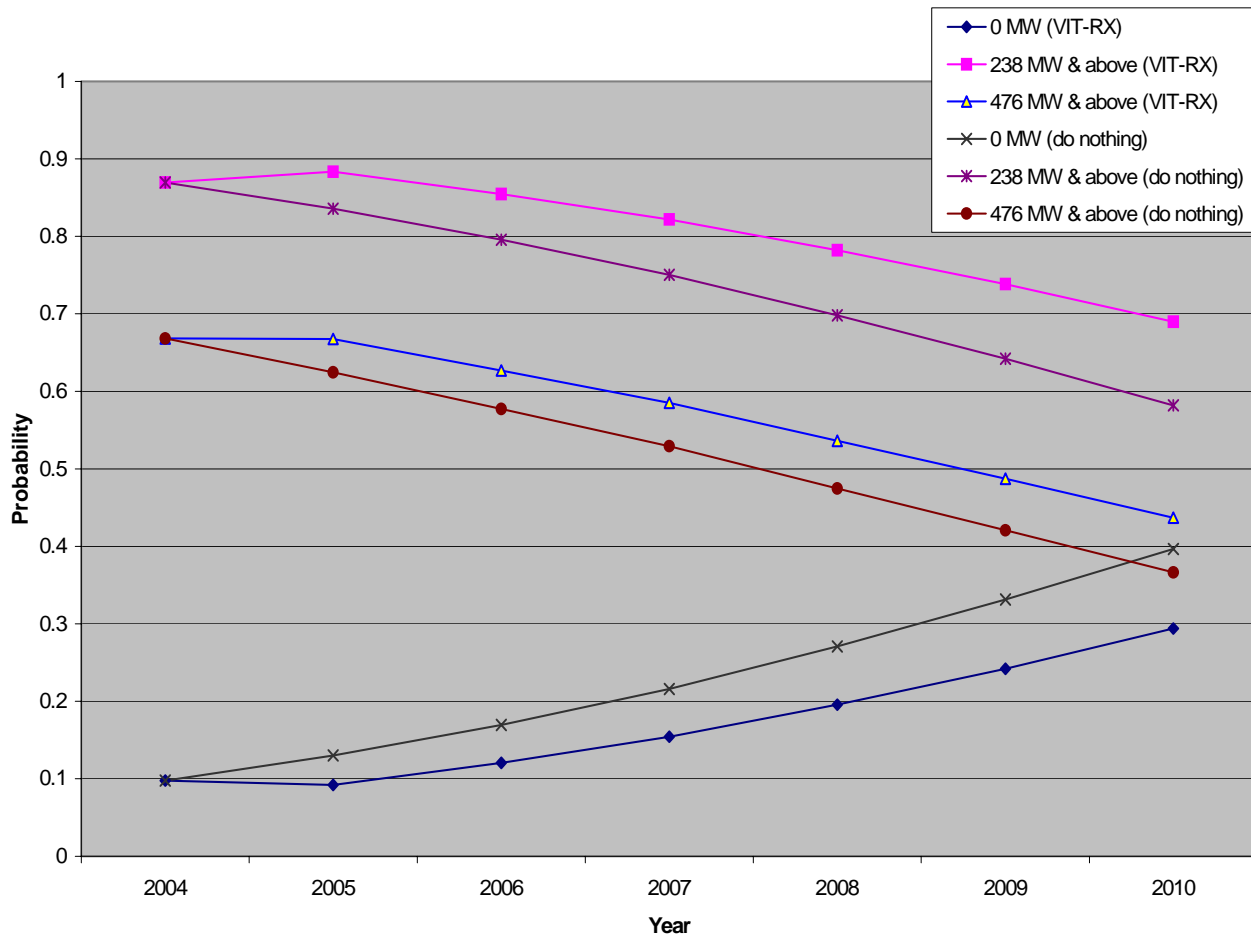


Figure 6 Comparison of HVDC reliability between doing nothing and replacement of Pole 2 reactor at VIT

The following observations can be made:

- With the replacement of Pole 2 reactor at VIT, the failure probability of Pole 2 is reduced by 5.6% in 2005 and by 11% in 2010. This reduction is equivalent to about a life extension of two years for Pole 2. The failure probability of Pole 2 in 2007 if doing nothing is basically the same as its failure probability in 2009 if the reactor at VIT is replaced in 2005.
- With the replacement of Pole 2 reactor at VIT, the failure probability of the whole HVDC is reduced by 3.8% in 2005 and by 10.3% in 2010. This reduction is equivalent to a life extension of 1.5 years for the whole HVDC. The failure probability of the whole HVDC in 2007 if doing nothing is close to its failure probability between 2008 and 2009 if the Pole 2 reactor at VIT is replaced in 2005. The reason why the relative effect of replacing Pole 2 reactor at VIT for the whole HVDC is slightly smaller than that for Pole 2 alone is due to the fact that the Pole 2 reactor does not have any effect on Pole 1. However, incorporation of Pole 1, even with its high unavailability, makes the failure probability of the whole HVDC lower than that of Pole 2 alone for both cases of doing nothing and replacing Pole 2 reactor at VIT.
- The full unavailability of the whole HVDC after replacing Pole 2 reactor at VIT in 2005 is 9.2%, will be increased to 15.4% in 2007 and reach 29.4% in 2010. This equivalently means that the probability that HVDC has at least a 156 MW capacity is 90.8% in 2005, 84.6% in 2007 and 70.6% in 2010.

### 4.3 Replacement of Pole 2 filter capacitor at VIT

Similarly, according to the reliability configuration of HVDC, the filter capacitor of Pole 1 2 is another key component to improve HVDC reliability. The filter capacitor at ARN was replaced in 1996, which is relatively new. The filter capacitor at VIT has been operated for 28 years while its mean life is estimated to be 33 years.

It is assumed that the filter capacitor of Pole 2 is replaced in 2005. The unavailability data of all the components including the new filter capacitor of Pole 2 at VIT from 2004 to 2010 are listed in Appendix 3. The calculation process of the probability distributions for the poles 1 and 2 at different capacity levels is also given in Appendix 3.

The comparison between reliability probability distributions of Pole 2 with and without the replacement of the filter capacitor at VIT is shown in Table 7 and Figure 7. The cumulative probability distribution of whole HVDC capacity with the replacement of the filter capacitor of Pole 2 at VIT is shown in Table 8 and Figure 8. The comparison of HVDC reliability between doing nothing and the VIT filter capacitor replacement is shown in Table 9 and Figure 9. In the last comparison, only three capacity levels (0 MW, 238 MW and 476 MW) corresponding to the pole 2 capacities are given.

Table 7 Comparison of Pole 2 reliability between doing nothing and replacement of Pole 2 filter capacitor at VIT

| Year | Doing nothing (Probability) |                |             | Replacement of Pole 2 filterCP at VIT (Probability) |                |             | Failure probability reduction |
|------|-----------------------------|----------------|-------------|---|----------------|-------------|-------------------------------|
|      | 476 MW only                 | 238 MW & above | Failure     | 476 MW only   | 238 MW & above | Failure     |                               |
| 2004 | 0.629157259                 | 0.840012783    | 0.159987217 | 0.629157259   | 0.840012783    | 0.159987217 | 0                             |
| 2005 | 0.59390786                  | 0.808170912    | 0.191829088 | 0.613541381   | 0.834887581    | 0.165112419 | 0.026716670                   |
| 2006 | 0.554333069                 | 0.771330493    | 0.228669507 | 0.57725614  | 0.803226954    | 0.196773046 | 0.031896461                   |
| 2007 | 0.512838492                 | 0.730082813    | 0.269917187 | 0.539194587   | 0.767603655    | 0.232396345 | 0.037520842                   |
| 2008 | 0.463541606                 | 0.682057124    | 0.317942876 | 0.49297235  | 0.725361647    | 0.274638353 | 0.043304523                   |
| 2009 | 0.413689862                 | 0.629911569    | 0.370088431 | 0.445945416   | 0.679026012    | 0.320973988 | 0.049114443                   |
| 2010 | 0.362198344                 | 0.573357887    | 0.426642113 | 0.396708348   | 0.627987025    | 0.372012975 | 0.054629138                   |

Table 8 Cumulative probability distribution of HVDC capacity (replacement of Pole 2 filter capacitor at VIT)

| Capacity  | 2004        | 2005        | 2006        | 2007        | 2008        | 2009        | 2010        |
|-----------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| 0 MW      | 0.097750925 | 0.111868096 | 0.145872141 | 0.185805627 | 0.233905194 | 0.287246008 | 0.345667187 |
| 156 MW up | 0.902249075 | 0.888131904 | 0.854127859 | 0.814194373 | 0.766094806 | 0.712753992 | 0.654332813 |
| 238 MW up | 0.869719720 | 0.858545064 | 0.824132858 | 0.785201899 | 0.739370688 | 0.689539017 | 0.635385604 |
| 312 MW up | 0.740888660 | 0.708577071 | 0.656615775 | 0.602584181 | 0.541448355 | 0.480950555 | 0.420485977 |
| 394 MW up | 0.711181724 | 0.684919589 | 0.635709872 | 0.584985937 | 0.527439314 | 0.470437550 | 0.413087398 |
| 476 MW up | 0.668309585 | 0.645256099 | 0.601264123 | 0.556490894 | 0.504826307 | 0.453579610 | 0.401308009 |
| 550 MW up | 0.283899472 | 0.229565343 | 0.173331584 | 0.125393803 | 0.084969460 | 0.054494184 | 0.032694364 |
| 632 MW up | 0.244747146 | 0.197850625 | 0.149323601 | 0.108097496 | 0.073115503 | 0.046859991 | 0.028094703 |
| 788 MW    | 0.116823925 | 0.087908858 | 0.061329848 | 0.040830582 | 0.025146051 | 0.014606251 | 0.007889719 |

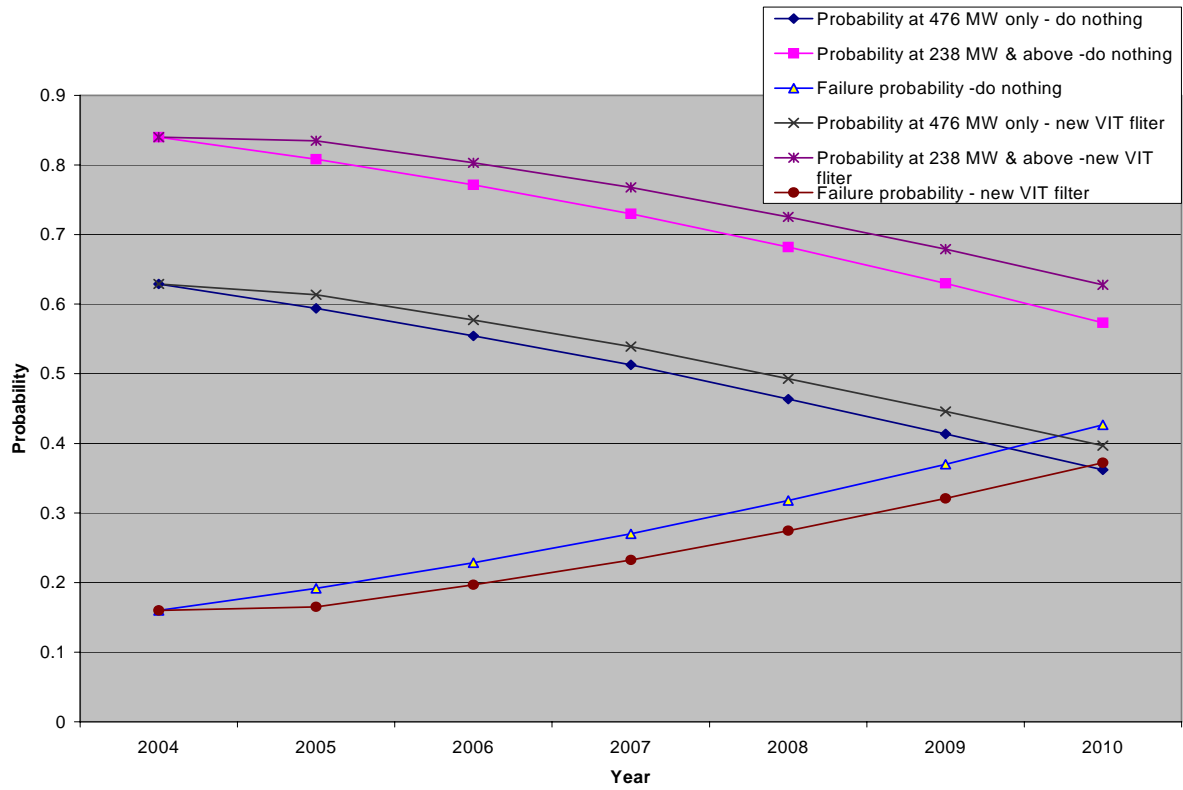


Figure 7 Comparison of Pole 2 reliability between doing nothing and replacement of Pole 2 filter capacitor at VIT

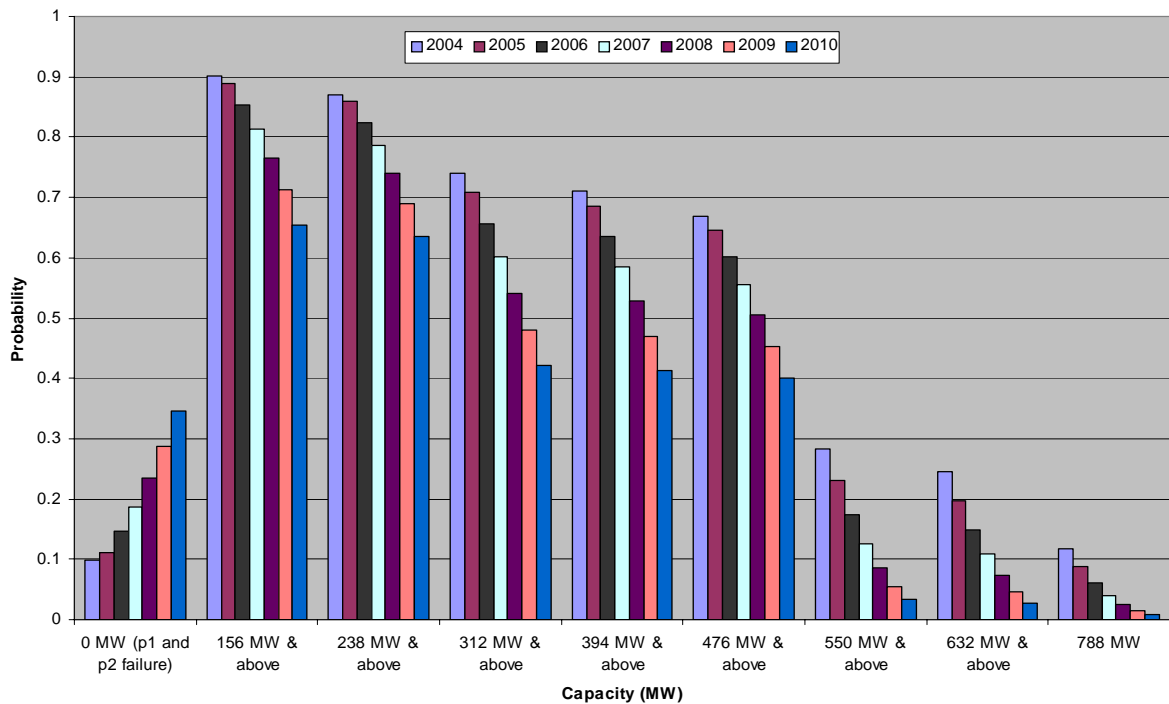


Figure 8 Cumulative probability distribution of HVDC capacity (replacement of Pole 2 filter capacitor at VIT)

Table 9 Comparison of HVDC reliability between doing nothing and replacement of Pole 2 filter capacitor at VIT

| Year | Replacement of Pole 2 filterCp at VIT (Probability) |                |                | Doing nothing (Probability) |                |                | Failure (0MW) probability reduction |
|------|---|----------------|----------------|-----------------------------|----------------|----------------|-------------------------------------|
|      | 0 MW  | 238 MW & above | 476 MW & above | 0 MW                        | 238 MW & above | 476 MW & above |                                     |
| 2004 | 0.097750925   | 0.869719720    | 0.668309585    | 0.097750925                 | 0.86971972     | 0.668309585    | 0                                   |
| 2005 | 0.111868096   | 0.858545064    | 0.645256099    | 0.129969357                 | 0.835656386    | 0.624607697    | 0.018101261                         |
| 2006 | 0.145872141   | 0.824132858    | 0.601264123    | 0.169517682                 | 0.795625195    | 0.577387686    | 0.023645541                         |
| 2007 | 0.185805627   | 0.785201899    | 0.556490894    | 0.215804307                 | 0.750522328    | 0.529289347    | 0.029998680                         |
| 2008 | 0.233905194   | 0.739370688    | 0.504826307    | 0.270786979                 | 0.698275088    | 0.474687875    | 0.036881786                         |
| 2009 | 0.287246008   | 0.689539017    | 0.453579610    | 0.331199500                 | 0.642033242    | 0.420771868    | 0.043953492                         |
| 2010 | 0.345667187   | 0.635385604    | 0.401308009    | 0.396427514                 | 0.581842928    | 0.366397876    | 0.050760327                         |

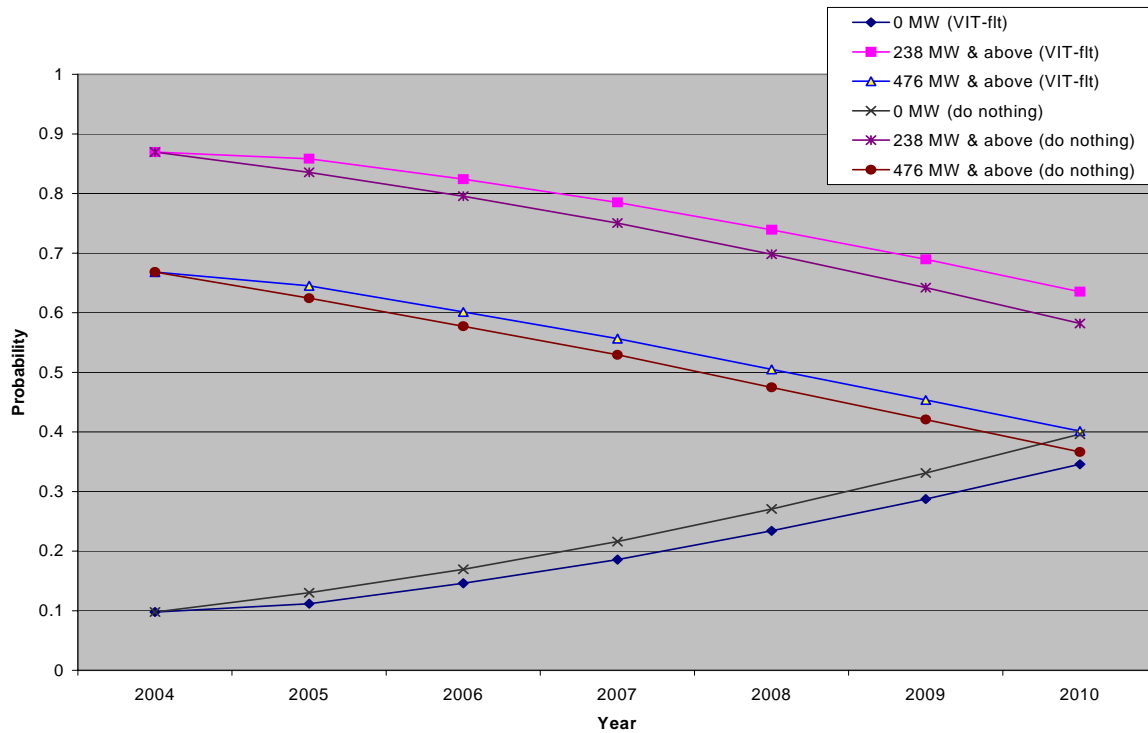


Figure 9 Comparison of HVDC reliability between doing nothing and replacement of Pole 2 filter capacitor at VIT

The following observations can be made:

- With the replacement of Pole 2 filter capacitor at VIT, the failure probability of Pole 2 is reduced by 2.7% in 2005 and by 5.5 in 2010. This reduction is equivalent to a life extension of one year for Pole 2. The failure probability of Pole 2 in 2007 if doing nothing is close to its failure probability in 2008 if the filter capacitor at VIT is replaced in 2005.
- With the replacement of Pole 2 filter capacitor at VIT, the failure probability of the whole HVDC is reduced by 1.8% in 2005 and by 5.1% in 2010. This reduction is equivalent to a life extension of less than one year for the whole HVDC.

- The full unavailability of the whole HVDC after replacing Pole 2 filter capacitor at VIT in 2005 is 11.2%, will be increased to 18.6% in 2007 and reach 34.6% in 2010. This equivalently means that the probability that HVDC has at least a 156 MW capacity is 88.8% in 2005, 81.4% in 2007 and 65.4% in 2010.

## 5. Conclusions

This study assessed the probability distribution of HVDC capacity from 2004 to 2010 and the impacts of two key component replacements (Pole 2 reactor and filter capacitor at VIT) on HVDC reliability. The following conclusions can be made:

- (1) HVDC Pole 1 has been retired and Pole 2 will be retired in 2007. From an operation viewpoint, the retired poles can be still used with relatively high unavailability. The evaluated results show that the availability of Pole 1 in 2004 is only 38.9% and will be further decreased to 20% in 2007. The availability of Pole 2 in 2004 is 84%, will be decreased to only 73% in 2007 and to 63% in 2009 due to ageing failure probability.
- (2) Combining the poles 1 and 2 together, the availability of the whole HVDC in 2004 is 90.2%, will be 78.4% in 2007 and 66.9% in 2009. The failure event of HVDC can happen any time during the peak or off-peak period with the estimated probabilities in different years. If we can accept the relatively high risk from 2007 to 2009, HVDC without any refurbishment (doing nothing) could be used as an option before the 230 kV line in place in 2008 or 2009.
- (3) According to the reliability configuration of the HVDC system, the reactor and filter capacitor of Pole 2 at VIT are two key components to HVDC reliability. Also, both the components are 28 years old with the mean life of 30 years for the reactor and 33 years for the filter capacitor. In other words, they have a high ageing failure probability. The study shows that replacing the Pole 2 reactor at VIT in 2005 will provide HVDC life extension by two years. This means that replacing the Pole 2 reactor at VIT in 2005 will bring the HVDC failure probability in 2009 back to its failure probability level in 2007. Replacing the Pole 2 filter capacitor at VIT in 2005 will provide HVDC life extension by one year. In other words, replacing the Pole 2 filter capacitor at VIT in 2005 will bring the HVDC failure probability in 2008 back to its failure probability level in 2007.
- (4) According to the cost estimate based on the Alstom Life Extension Report completed in June 2001 [6], the Pole 2 reactor costs \$2.0 million and the Pole 2 filter capacitor costs \$1.7 million. If we want to keep the overall HVDC reliability in 2009 at the same level as its reliability status in 2007, replacing the Pole 2 reactor at VIT is an option with \$2.0 million of investment. Replacing the Pole 2 filter capacitor at VIT can be used as an additional measure to get one more year of “reliability advance” with the cost of \$1.7 million.
- (5) It is important to appreciate that the assessment results are based on the probability analysis. The results should be viewed as the expected value of a random variable. Also, the input data always have some uncertainty. The input data used in this study are based on the same source that was used in the reliability evaluation of Vancouver Island in the VIGP project.
- (6) In general, it can be concluded that HVDC can be used as an alternative before the 230 kV AC line in-service. If the 230kV line can be in place in 2008, replacing the Pole 2 filter capacitor at VIT may be a good option if a little bit (about 1%) higher risk is acceptable. If the 230kV line cannot be available until 2009, replacing the Pole 2 reactor at VIT is a potential option. Both of these options provide almost the same HVDC reliability level as that in 2007. The cost paid is \$1.7 or \$2.0 million. Replacing both the Pole 2 reactor and the filter capacitor at VIT can offer further improvement in HVDC reliability with the total cost of \$3.7 million.

## 6. References

- [1] Fred Dennert, “Statement of Objectives – Vancouver Island Supply Solution Strategy”, March 25, 2004
- [2] Fred Dennert, “Vancouver Island Supply Alternatives Project – Task Managers Meeting Notes”, March 19, 2004
- [3] Wenyuan Li, “Reliability Evaluation of Three Scenarios for Vancouver Island Power Supply – An Expected Energy Not Served (EENS) Study”, a study report for the VIGP project, submitted to the BCUC hearing, June 11, 2003
- [4] Terry Treasure, “Estimated Life Expectancy of HVDC Components for the Purpose of Reliability Studies”, March 15, 2002
- [5] Wenyuan Li, SPARE Program User’s Manual, April, 2001
- [6] BCUC Staff IR No.1.20.3 (March 21, 2003), “Vancouver Island Transmission Supply – HVDC Pole 2 Life Extension Alternative 17 October, 2002”

# Appendix 1

| Input data (do-nothing) |         |         |         |         |         |         |         |  |
|-------------------------|---------|---------|---------|---------|---------|---------|---------|--|
| Pole 2                  |         |         |         |         |         |         |         |  |
|                         | 2004    | 2005    | 2006    | 2007    | 2008    | 2009    | 2010    |  |
| filter-VIT              | 0.02557 | 0.03201 | 0.03972 | 0.04889 | 0.05971 | 0.07234 | 0.087   |  |
| filter-ARN              | 0.00002 | 0.00003 | 0.00005 | 0.00008 | 0.00012 | 0.00019 | 0.0003  | (ARN filter replaced in 1996)                |
| Reactor-VIT             | 0.05278 | 0.06485 | 0.07907 | 0.09567 | 0.11484 | 0.13675 | 0.16155 |  |
| Reactor-ARN             | 0.05111 | 0.06321 | 0.07746 | 0.09408 | 0.11328 | 0.13524 | 0.16008 | (spare is located at ARN side)               |
| Common                  | 0.00127 | 0.00149 | 0.00176 | 0.0021  | 0.00252 | 0.00302 | 0.00364 |  |
| T3                      | 0.01303 | 0.01644 | 0.02058 | 0.02557 | 0.03152 | 0.03858 | 0.04689 |  |
| T4                      | 0.01303 | 0.01644 | 0.02058 | 0.02557 | 0.03152 | 0.03858 | 0.04689 |  |
| T7                      | 0.01303 | 0.01644 | 0.02058 | 0.02557 | 0.03152 | 0.03858 | 0.04689 |  |
| T8                      | 0.01303 | 0.01644 | 0.02058 | 0.02557 | 0.03152 | 0.03858 | 0.04689 |  |
| V3                      | 0.01299 | 0.01458 | 0.01641 | 0.01852 | 0.02094 | 0.02369 | 0.02682 |  |
| V4                      | 0.01299 | 0.01458 | 0.01641 | 0.01852 | 0.02094 | 0.02369 | 0.02682 |  |
| V7                      | 0.01299 | 0.01458 | 0.01641 | 0.01852 | 0.02094 | 0.02369 | 0.02682 |  |
| V8                      | 0.01299 | 0.01458 | 0.01641 | 0.01852 | 0.02094 | 0.02369 | 0.02682 |  |
| Auxiliary-V3            | 0.0011  | 0.00132 | 0.00159 | 0.00193 | 0.00234 | 0.00285 | 0.00346 |  |
| Auxiliary-V4            | 0.0011  | 0.00132 | 0.00159 | 0.00193 | 0.00234 | 0.00285 | 0.00346 |  |
| Auxiliary-V7            | 0.0011  | 0.00132 | 0.00159 | 0.00193 | 0.00234 | 0.00285 | 0.00346 |  |
| Auxiliary-V8            | 0.0011  | 0.00132 | 0.00159 | 0.00193 | 0.00234 | 0.00285 | 0.00346 |  |
| Cable 900 amp           | 0.04689 | 0.04842 | 0.05019 | 0.05023 | 0.05456 | 0.05722 | 0.06024 | (MTTR assumed 4 months)                      |
| Cable 900 amp           | 0.04689 | 0.04842 | 0.05019 | 0.05023 | 0.05456 | 0.05722 | 0.06024 | (900 amp cable assumed less life expectancy) |
| Cable 600 amp           | 0.04058 | 0.04082 | 0.04111 | 0.04143 | 0.0418  | 0.04223 | 0.04272 | (MTTR assumed 4 months)                      |
| Cable 600 amp           | 0.04058 | 0.04082 | 0.04111 | 0.04143 | 0.0418  | 0.04223 | 0.04272 |  |
| Cable 600 amp           | 0.04058 | 0.04082 | 0.04111 | 0.04143 | 0.0418  | 0.04223 | 0.04272 |  |
|                         |         |         |         |         |         |         |         |  |
| Pole 1                  |         |         |         |         |         |         |         |  |
|                         | 2004    | 2005    | 2006    | 2007    | 2008    | 2009    | 2010    |  |
| filter-VIT              | 0.10389 | 0.12309 | 0.14478 | 0.16905 | 0.19596 | 0.22549 | 0.25754 |  |
| filter-ARN              | 0.10389 | 0.12309 | 0.14478 | 0.16905 | 0.19596 | 0.22549 | 0.25754 |  |
| Reactor-VIT             | 0.18921 | 0.21992 | 0.2535  | 0.28976 | 0.3284  | 0.36902 | 0.41111 |  |
| Reactor-ARN             | 0.18921 | 0.21992 | 0.2535  | 0.28976 | 0.3284  | 0.36902 | 0.41111 |  |
| T1                      | 0.08277 | 0.09373 | 0.10637 | 0.12082 | 0.13724 | 0.15575 | 0.17644 |  |
| T2                      | 0.08277 | 0.09373 | 0.10637 | 0.12082 | 0.13724 | 0.15575 | 0.17644 |  |
| T5                      | 0.08277 | 0.09373 | 0.10637 | 0.12082 | 0.13724 | 0.15575 | 0.17644 |  |
| T6                      | 0.08277 | 0.09373 | 0.10637 | 0.12082 | 0.13724 | 0.15575 | 0.17644 |  |
| MAV-VIT                 | 0.11284 | 0.13185 | 0.15332 | 0.17735 | 0.20399 | 0.23322 | 0.26496 |  |
| MAV-VIT                 | 0.11284 | 0.13185 | 0.15332 | 0.17735 | 0.20399 | 0.23322 | 0.26496 |  |
| MAV-ARN                 | 0.11284 | 0.13185 | 0.15332 | 0.17735 | 0.20399 | 0.23322 | 0.26496 |  |
| MAV-ARN                 | 0.11284 | 0.13185 | 0.15332 | 0.17735 | 0.20399 | 0.23322 | 0.26496 |  |
| Cable 900 amp           | 0.04689 | 0.04842 | 0.05019 | 0.05023 | 0.05456 | 0.05722 | 0.06024 |  |
| Cable 900 amp           | 0.04689 | 0.04842 | 0.05019 | 0.05023 | 0.05456 | 0.05722 | 0.06024 |  |
| Cable 600 amp           | 0.04058 | 0.04082 | 0.04111 | 0.04143 | 0.0418  | 0.04223 | 0.04272 |  |
| Cable 600 amp           | 0.04058 | 0.04082 | 0.04111 | 0.04143 | 0.0418  | 0.04223 | 0.04272 |  |
| Cable 600 amp           | 0.04058 | 0.04082 | 0.04111 | 0.04143 | 0.0418  | 0.04223 | 0.04272 |  |



| Probability calculations of capacities for Poles 1 and 2 in 2004 (do-nothing) |                    |              |             |             |                   |              |            |
|---|--------------------|--------------|-------------|-------------|-------------------|--------------|------------|
| Pole 2  |                    |              |             |             |                   |              |            |
|   | 2004 failure prob. | success prob | 476 MW prob | 238 MW prob | above 238 MW prob | zero MW prob | average MW |
| filter-VIT  | 0.02557            | 0.97443      |             |             |                   |              |            |
| filter-ARN  | 0.00002            | 0.99998      |             |             |                   |              |            |
| Reactor-VIT   | 0.05278            | 0.94722      |             |             |                   |              |            |
| Reactor-ARN   | 0.05111            | 0.94889      |             |             |                   |              |            |
| Common  | 0.00127            | 0.99873      |             |             |                   |              |            |
| T3  | 0.01303            | 0.98697      |             | 0.008306148 |                   |              |            |
| T4  | 0.01303            | 0.98697      |             | 0.008306148 |                   |              |            |
| T7  | 0.01303            | 0.98697      |             | 0.008306148 |                   |              |            |
| T8  | 0.01303            | 0.98697      |             | 0.008306148 |                   |              |            |
| V3  | 0.01299            | 0.98701      |             | 0.008280314 |                   |              |            |
| V4  | 0.01299            | 0.98701      |             | 0.008280314 |                   |              |            |
| V7  | 0.01299            | 0.98701      |             | 0.008280314 |                   |              |            |
| V8  | 0.01299            | 0.98701      |             | 0.008280314 |                   |              |            |
| Auxiliary-V3  | 0.0011             | 0.9989       |             | 0.000692835 |                   |              |            |
| Auxiliary-V4  | 0.0011             | 0.9989       |             | 0.000692835 |                   |              |            |
| Auxiliary-V7  | 0.0011             | 0.9989       |             | 0.000692835 |                   |              |            |
| Auxiliary-V8  | 0.0011             | 0.9989       |             | 0.000692835 |                   |              |            |
| Cable 900 amp   | 0.04689            | 0.95311      |             | 0.030952549 |                   |              |            |
| Cable 900 amp   | 0.04689            | 0.95311      |             | 0.030952549 |                   |              |            |
| Cable 600 amp   | 0.04058            | 0.95942      |             | 0.026611079 |                   |              |            |
| Cable 600 amp   | 0.04058            | 0.95942      |             | 0.026611079 |                   |              |            |
| Cable 600 amp   | 0.04058            | 0.95942      |             | 0.026611079 |                   |              |            |
|   |                    |              |             |             |                   |              |            |
|   |                    |              | 0.629157259 | 0.210855525 | 0.840012783       | 0.159987217  | 349.66247  |
|   |                    |              |             |             |                   |              |            |
| Pole 1  |                    |              |             |             |                   |              |            |
|   | 2004 failure prob. | success prob | 312 MW prob | 156 MW prob | above 156 MW prob | zero MW prob | average MW |
| filter-VIT  | 0.10389            | 0.89611      |             |             |                   |              |            |
| filter-ARN  | 0.10389            | 0.89611      |             |             |                   |              |            |
| Reactor-VIT   | 0.18921            | 0.81079      |             |             |                   |              |            |
| Reactor-ARN   | 0.18921            | 0.81079      |             |             |                   |              |            |
| T1  | 0.08277            | 0.91723      |             | 0.016755882 |                   |              |            |
| T2  | 0.08277            | 0.91723      |             | 0.016755882 |                   |              |            |
| T5  | 0.08277            | 0.91723      |             | 0.016755882 |                   |              |            |
| T6  | 0.08277            | 0.91723      |             | 0.016755882 |                   |              |            |
| MAV-VIT   | 0.11284            | 0.88716      |             | 0.023617488 |                   |              |            |
| MAV-VIT   | 0.11284            | 0.88716      |             | 0.023617488 |                   |              |            |
| MAV-ARN   | 0.11284            | 0.88716      |             | 0.023617488 |                   |              |            |
| MAV-ARN   | 0.11284            | 0.88716      |             | 0.023617488 |                   |              |            |
| Cable 900 amp   | 0.04689            | 0.95311      |             | 0.009135026 |                   |              |            |
| Cable 900 amp   | 0.04689            | 0.95311      |             | 0.009135026 |                   |              |            |
| Cable 600 amp   | 0.04058            | 0.95942      |             | 0.007853728 |                   |              |            |
| Cable 600 amp   | 0.04058            | 0.95942      |             | 0.007853728 |                   |              |            |
| Cable 600 amp   | 0.04058            | 0.95942      |             | 0.007853728 |                   |              |            |
|   |                    |              |             |             |                   |              |            |
|   |                    |              | 0.185683187 | 0.203324716 | 0.389007903       | 0.610992097  | 89.6518101 |

| Probability calculations of capacities for Poles 1 and 2 in 2005 (do-nothing) |                    |              |             |             |                   |              |             |
|---|--------------------|--------------|-------------|-------------|-------------------|--------------|-------------|
| Pole2   | 2005 failure prob. | success prob | 476 MW prob | 238 MW prob | above 238 MW prob | zero MW prob | average MW  |
| filter-VIT  | 0.03201            | 0.96799      |             |             |                   |              |             |
| filter-ARN  | 0.00003            | 0.99997      |             |             |                   |              |             |
| Reactor-VIT   | 0.06485            | 0.93515      |             |             |                   |              |             |
| Reactor-ARN   | 0.06321            | 0.93679      |             |             |                   |              |             |
| Common  | 0.00149            | 0.99851      |             |             |                   |              |             |
| T3  | 0.01644            | 0.98356      |             | 0.009927046 |                   |              |             |
| T4  | 0.01644            | 0.98356      |             | 0.009927046 |                   |              |             |
| T7  | 0.01644            | 0.98356      |             | 0.009927046 |                   |              |             |
| T8  | 0.01644            | 0.98356      |             | 0.009927046 |                   |              |             |
| V3  | 0.01458            | 0.98542      |             | 0.008787295 |                   |              |             |
| V4  | 0.01458            | 0.98542      |             | 0.008787295 |                   |              |             |
| V7  | 0.01458            | 0.98542      |             | 0.008787295 |                   |              |             |
| V8  | 0.01458            | 0.98542      |             | 0.008787295 |                   |              |             |
| Auxiliary-V3  | 0.00132            | 0.99868      |             | 0.000784995 |                   |              |             |
| Auxiliary-V4  | 0.00132            | 0.99868      |             | 0.000784995 |                   |              |             |
| Auxiliary-V7  | 0.00132            | 0.99868      |             | 0.000784995 |                   |              |             |
| Auxiliary-V8  | 0.00132            | 0.99868      |             | 0.000784995 |                   |              |             |
| Cable 900 amp   | 0.04842            | 0.95158      |             | 0.030220285 |                   |              |             |
| Cable 900 amp   | 0.04842            | 0.95158      |             | 0.030220285 |                   |              |             |
| Cable 600 amp   | 0.04082            | 0.95918      |             | 0.025275046 |                   |              |             |
| Cable 600 amp   | 0.04082            | 0.95918      |             | 0.025275046 |                   |              |             |
| Cable 600 amp   | 0.04082            | 0.95918      |             | 0.025275046 |                   |              |             |
|   |                    |              |             |             |                   |              |             |
|   |                    |              | 0.59390786  | 0.214263051 | 0.808170912       | 0.191829088  | 333.6947477 |
|   |                    |              |             |             |                   |              |             |
| Pole 1  | 2005 failure prob. | success prob | 312 MW prob | 156 MW prob | above 156 MW prob | zero MW prob | average MW  |
| filter-VIT  | 0.12309            | 0.87691      |             |             |                   |              |             |
| filter-ARN  | 0.12309            | 0.87691      |             |             |                   |              |             |
| Reactor-VIT   | 0.21992            | 0.78008      |             |             |                   |              |             |
| Reactor-ARN   | 0.21992            | 0.78008      |             |             |                   |              |             |
| T1  | 0.09373            | 0.90627      |             | 0.014818689 |                   |              |             |
| T2  | 0.09373            | 0.90627      |             | 0.014818689 |                   |              |             |
| T5  | 0.09373            | 0.90627      |             | 0.014818689 |                   |              |             |
| T6  | 0.09373            | 0.90627      |             | 0.014818689 |                   |              |             |
| MAV-VIT   | 0.13185            | 0.86815      |             | 0.021760764 |                   |              |             |
| MAV-VIT   | 0.13185            | 0.86815      |             | 0.021760764 |                   |              |             |
| MAV-ARN   | 0.13185            | 0.86815      |             | 0.021760764 |                   |              |             |
| MAV-ARN   | 0.13185            | 0.86815      |             | 0.021760764 |                   |              |             |
| Cable 900 amp   | 0.04842            | 0.95158      |             | 0.007290684 |                   |              |             |
| Cable 900 amp   | 0.04842            | 0.95158      |             | 0.007290684 |                   |              |             |
| Cable 600 amp   | 0.04082            | 0.95918      |             | 0.006097638 |                   |              |             |
| Cable 600 amp   | 0.04082            | 0.95918      |             | 0.006097638 |                   |              |             |
| Cable 600 amp   | 0.04082            | 0.95918      |             | 0.006097638 |                   |              |             |
|   |                    |              |             |             |                   |              |             |
|   |                    |              | 0.143281059 | 0.179192098 | 0.322473156       | 0.677526844  | 72.65765748 |

| Probability calculations of capacities for Poles 1 and 2 in 2006 (do-nothing) |                    |              |             |             |                   |              |             |
|---|--------------------|--------------|-------------|-------------|-------------------|--------------|-------------|
| Pole 2  |                    |              |             |             |                   |              |             |
|   | 2006 failure prob. | success prob | 476 MW prob | 238 MW prob | above 238 MW prob | zero MW prob | average MW  |
| filter-VIT  | 0.03972            | 0.96028      |             |             |                   |              |             |
| filter-ARN  | 0.00005            | 0.99995      |             |             |                   |              |             |
| Reactor-VIT   | 0.07907            | 0.92093      |             |             |                   |              |             |
| Reactor-ARN   | 0.07746            | 0.92254      |             |             |                   |              |             |
| Common  | 0.00176            | 0.99824      |             |             |                   |              |             |
| T3  | 0.02058            | 0.97942      |             | 0.011647888 |                   |              |             |
| T4  | 0.02058            | 0.97942      |             | 0.011647888 |                   |              |             |
| T7  | 0.02058            | 0.97942      |             | 0.011647888 |                   |              |             |
| T8  | 0.02058            | 0.97942      |             | 0.011647888 |                   |              |             |
| V3  | 0.01641            | 0.98359      |             | 0.009248371 |                   |              |             |
| V4  | 0.01641            | 0.98359      |             | 0.009248371 |                   |              |             |
| V7  | 0.01641            | 0.98359      |             | 0.009248371 |                   |              |             |
| V8  | 0.01641            | 0.98359      |             | 0.009248371 |                   |              |             |
| Auxiliary-V3  | 0.00159            | 0.99841      |             | 0.000882793 |                   |              |             |
| Auxiliary-V4  | 0.00159            | 0.99841      |             | 0.000882793 |                   |              |             |
| Auxiliary-V7  | 0.00159            | 0.99841      |             | 0.000882793 |                   |              |             |
| Auxiliary-V8  | 0.00159            | 0.99841      |             | 0.000882793 |                   |              |             |
| Cable 900 amp   | 0.05019            | 0.94981      |             | 0.02929215  |                   |              |             |
| Cable 900 amp   | 0.05019            | 0.94981      |             | 0.02929215  |                   |              |             |
| Cable 600 amp   | 0.04111            | 0.95889      |             | 0.023765638 |                   |              |             |
| Cable 600 amp   | 0.04111            | 0.95889      |             | 0.023765638 |                   |              |             |
| Cable 600 amp   | 0.04111            | 0.95889      |             | 0.023765638 |                   |              |             |
|   |                    |              | 0.554333069 | 0.216997424 | 0.771330493       | 0.228669507  | 315.5079277 |
| Pole 1  |                    |              |             |             |                   |              |             |
|   | 2006 failure prob. | success prob | 312 MW prob | 156 MW prob | above 156 MW prob | zero MW prob | average MW  |
| filter-VIT  | 0.14478            | 0.85522      |             |             |                   |              |             |
| filter-ARN  | 0.14478            | 0.85522      |             |             |                   |              |             |
| Reactor-VIT   | 0.2535             | 0.7465       |             |             |                   |              |             |
| Reactor-ARN   | 0.2535             | 0.7465       |             |             |                   |              |             |
| T1  | 0.10637            | 0.89363      |             | 0.012646337 |                   |              |             |
| T2  | 0.10637            | 0.89363      |             | 0.012646337 |                   |              |             |
| T5  | 0.10637            | 0.89363      |             | 0.012646337 |                   |              |             |
| T6  | 0.10637            | 0.89363      |             | 0.012646337 |                   |              |             |
| MAV-VIT   | 0.15332            | 0.84668      |             | 0.019239015 |                   |              |             |
| MAV-VIT   | 0.15332            | 0.84668      |             | 0.019239015 |                   |              |             |
| MAV-ARN   | 0.15332            | 0.84668      |             | 0.019239015 |                   |              |             |
| MAV-ARN   | 0.15332            | 0.84668      |             | 0.019239015 |                   |              |             |
| Cable 900 amp   | 0.05019            | 0.94981      |             | 0.005614147 |                   |              |             |
| Cable 900 amp   | 0.05019            | 0.94981      |             | 0.005614147 |                   |              |             |
| Cable 600 amp   | 0.04111            | 0.95889      |             | 0.004554933 |                   |              |             |
| Cable 600 amp   | 0.04111            | 0.95889      |             | 0.004554933 |                   |              |             |
| Cable 600 amp   | 0.04111            | 0.95889      |             | 0.004554933 |                   |              |             |
|   |                    |              | 0.106243735 | 0.152434503 | 0.258678238       | 0.741321762  | 56.92782777 |

| Probability calculations of capacities for Poles 1 and 2 in 2007 (do-nothing) |               |              |             |             |                   |              |            |
|---|---------------|--------------|-------------|-------------|-------------------|--------------|------------|
| Pole 2  |               |              |             |             |                   |              |            |
| 2007  | failure prob. | success prob | 476 MW prob | 238 MW prob | above 238 MW prob | zero MW prob | average MW |
| filter-VIT  | 0.04889       | 0.95111      |             |             |                   |              |            |
| filter-ARN  | 0.00008       | 0.99992      |             |             |                   |              |            |
| Reactor-VIT   | 0.09567       | 0.90433      |             |             |                   |              |            |
| Reactor-ARN   | 0.09408       | 0.90592      |             |             |                   |              |            |
| Common  | 0.0021        | 0.9979       |             |             |                   |              |            |
| T3  | 0.02557       | 0.97443      |             | 0.013457386 |                   |              |            |
| T4  | 0.02557       | 0.97443      |             | 0.013457386 |                   |              |            |
| T7  | 0.02557       | 0.97443      |             | 0.013457386 |                   |              |            |
| T8  | 0.02557       | 0.97443      |             | 0.013457386 |                   |              |            |
| V3  | 0.01852       | 0.98148      |             | 0.009676987 |                   |              |            |
| V4  | 0.01852       | 0.98148      |             | 0.009676987 |                   |              |            |
| V7  | 0.01852       | 0.98148      |             | 0.009676987 |                   |              |            |
| V8  | 0.01852       | 0.98148      |             | 0.009676987 |                   |              |            |
| Auxiliary-V3  | 0.00193       | 0.99807      |             | 0.000991692 |                   |              |            |
| Auxiliary-V4  | 0.00193       | 0.99807      |             | 0.000991692 |                   |              |            |
| Auxiliary-V7  | 0.00193       | 0.99807      |             | 0.000991692 |                   |              |            |
| Auxiliary-V8  | 0.00193       | 0.99807      |             | 0.000991692 |                   |              |            |
| Cable 900 amp   | 0.05023       | 0.94977      |             | 0.027122227 |                   |              |            |
| Cable 900 amp   | 0.05023       | 0.94977      |             | 0.027122227 |                   |              |            |
| Cable 600 amp   | 0.04143       | 0.95857      |             | 0.022165203 |                   |              |            |
| Cable 600 amp   | 0.04143       | 0.95857      |             | 0.022165203 |                   |              |            |
| Cable 600 amp   | 0.04143       | 0.95857      |             | 0.022165203 |                   |              |            |
|   |               |              | 0.512838492 | 0.217244321 | 0.730082813       | 0.269917187  | 295.81527  |
| Pole 1  |               |              |             |             |                   |              |            |
| 2007  | failure prob. | success prob | 312 MW prob | 156 MW prob | above 156 MW prob | zero MW prob | average MW |
| filter-VIT  | 0.16905       | 0.83095      |             |             |                   |              |            |
| filter-ARN  | 0.16905       | 0.83095      |             |             |                   |              |            |
| Reactor-VIT   | 0.28976       | 0.71024      |             |             |                   |              |            |
| Reactor-ARN   | 0.28976       | 0.71024      |             |             |                   |              |            |
| T1  | 0.12082       | 0.87918      |             | 0.010406413 |                   |              |            |
| T2  | 0.12082       | 0.87918      |             | 0.010406413 |                   |              |            |
| T5  | 0.12082       | 0.87918      |             | 0.010406413 |                   |              |            |
| T6  | 0.12082       | 0.87918      |             | 0.010406413 |                   |              |            |
| MAV-VIT   | 0.17735       | 0.82265      |             | 0.016325111 |                   |              |            |
| MAV-VIT   | 0.17735       | 0.82265      |             | 0.016325111 |                   |              |            |
| MAV-ARN   | 0.17735       | 0.82265      |             | 0.016325111 |                   |              |            |
| MAV-ARN   | 0.17735       | 0.82265      |             | 0.016325111 |                   |              |            |
| Cable 900 amp   | 0.05023       | 0.94977      |             | 0.004004836 |                   |              |            |
| Cable 900 amp   | 0.05023       | 0.94977      |             | 0.004004836 |                   |              |            |
| Cable 600 amp   | 0.04143       | 0.95857      |             | 0.003272888 |                   |              |            |
| Cable 600 amp   | 0.04143       | 0.95857      |             | 0.003272888 |                   |              |            |
| Cable 600 amp   | 0.04143       | 0.95857      |             | 0.003272888 |                   |              |            |
|   |               |              | 0.075725132 | 0.124754433 | 0.200479565       | 0.799520435  | 43.0879328 |

| Probability calculations of capacities for Poles 1 and 2 in 2008 (do-nothing) |      |               |              |             |             |                   |              |            |
|---|------|---------------|--------------|-------------|-------------|-------------------|--------------|------------|
| Pole 2  |      |               |              |             |             |                   |              |            |
|   | 2008 | failure prob. | success prob | 476 MW prob | 238 MW prob | above 238 MW prob | zero MW prob | average MW |
| filter-VIT  |      | 0.05971       | 0.94029      |             |             |                   |              |            |
| filter-ARN  |      | 0.00012       | 0.99988      |             |             |                   |              |            |
| Reactor-VIT   |      | 0.11484       | 0.88516      |             |             |                   |              |            |
| Reactor-ARN   |      | 0.11328       | 0.88672      |             |             |                   |              |            |
| Common  |      | 0.00252       | 0.99748      |             |             |                   |              |            |
| T3  |      | 0.03152       | 0.96848      |             | 0.015086353 |                   |              |            |
| T4  |      | 0.03152       | 0.96848      |             | 0.015086353 |                   |              |            |
| T7  |      | 0.03152       | 0.96848      |             | 0.015086353 |                   |              |            |
| T8  |      | 0.03152       | 0.96848      |             | 0.015086353 |                   |              |            |
| V3  |      | 0.02094       | 0.97906      |             | 0.009914164 |                   |              |            |
| V4  |      | 0.02094       | 0.97906      |             | 0.009914164 |                   |              |            |
| V7  |      | 0.02094       | 0.97906      |             | 0.009914164 |                   |              |            |
| V8  |      | 0.02094       | 0.97906      |             | 0.009914164 |                   |              |            |
| Auxiliary-V3  |      | 0.00234       | 0.99766      |             | 0.001087231 |                   |              |            |
| Auxiliary-V4  |      | 0.00234       | 0.99766      |             | 0.001087231 |                   |              |            |
| Auxiliary-V7  |      | 0.00234       | 0.99766      |             | 0.001087231 |                   |              |            |
| Auxiliary-V8  |      | 0.00234       | 0.99766      |             | 0.001087231 |                   |              |            |
| Cable 900 amp   |      | 0.05456       | 0.94544      |             | 0.026750328 |                   |              |            |
| Cable 900 amp   |      | 0.05456       | 0.94544      |             | 0.026750328 |                   |              |            |
| Cable 600 amp   |      | 0.0418        | 0.9582       |             | 0.020221289 |                   |              |            |
| Cable 600 amp   |      | 0.0418        | 0.9582       |             | 0.020221289 |                   |              |            |
| Cable 600 amp   |      | 0.0418        | 0.9582       |             | 0.020221289 |                   |              |            |
|   |      |               |              | 0.463541606 | 0.218515517 | 0.682057124       | 0.317942876  | 272.652498 |
|   |      |               |              |             |             |                   |              |            |
|   |      |               |              |             |             |                   |              |            |
| Pole 1  |      |               |              |             |             |                   |              |            |
|   | 2008 | failure prob. | success prob | 312 MW prob | 156 MW prob | above 156 MW prob | zero MW prob | average MW |
| filter-VIT  |      | 0.19596       | 0.80404      |             |             |                   |              |            |
| filter-ARN  |      | 0.19596       | 0.80404      |             |             |                   |              |            |
| Reactor-VIT   |      | 0.3284        | 0.6716       |             |             |                   |              |            |
| Reactor-ARN   |      | 0.3284        | 0.6716       |             |             |                   |              |            |
| T1  |      | 0.13724       | 0.86276      |             | 0.008114055 |                   |              |            |
| T2  |      | 0.13724       | 0.86276      |             | 0.008114055 |                   |              |            |
| T5  |      | 0.13724       | 0.86276      |             | 0.008114055 |                   |              |            |
| T6  |      | 0.13724       | 0.86276      |             | 0.008114055 |                   |              |            |
| MAV-VIT   |      | 0.20399       | 0.79601      |             | 0.013071866 |                   |              |            |
| MAV-VIT   |      | 0.20399       | 0.79601      |             | 0.013071866 |                   |              |            |
| MAV-ARN   |      | 0.20399       | 0.79601      |             | 0.013071866 |                   |              |            |
| MAV-ARN   |      | 0.20399       | 0.79601      |             | 0.013071866 |                   |              |            |
| Cable 900 amp   |      | 0.05456       | 0.94544      |             | 0.00294366  |                   |              |            |
| Cable 900 amp   |      | 0.05456       | 0.94544      |             | 0.00294366  |                   |              |            |
| Cable 600 amp   |      | 0.0418        | 0.9582       |             | 0.002225191 |                   |              |            |
| Cable 600 amp   |      | 0.0418        | 0.9582       |             | 0.002225191 |                   |              |            |
| Cable 600 amp   |      | 0.0418        | 0.9582       |             | 0.002225191 |                   |              |            |
|   |      |               |              | 0.05100905  | 0.097306577 | 0.148315626       | 0.851684374  | 31.0946494 |

| Probability calculations of capacities for Poles 1 and 2 in 2009 (do-nothing) |                    |              |             |             |                   |              |             |
|---|--------------------|--------------|-------------|-------------|-------------------|--------------|-------------|
| Pole 2  |                    |              |             |             |                   |              |             |
|   | 2009 failure prob. | success prob | 476 MW prob | 238 MW prob | above 238 MW prob | zero MW prob | average MW  |
| filter-VIT  | 0.07234            | 0.92766      |             |             |                   |              |             |
| filter-ARN  | 0.00019            | 0.99981      |             |             |                   |              |             |
| Reactor-VIT   | 0.13675            | 0.86325      |             |             |                   |              |             |
| Reactor-ARN   | 0.13524            | 0.86476      |             |             |                   |              |             |
| Common  | 0.00302            | 0.99698      |             |             |                   |              |             |
| T3  | 0.03858            | 0.96142      |             | 0.016600606 |                   |              |             |
| T4  | 0.03858            | 0.96142      |             | 0.016600606 |                   |              |             |
| T7  | 0.03858            | 0.96142      |             | 0.016600606 |                   |              |             |
| T8  | 0.03858            | 0.96142      |             | 0.016600606 |                   |              |             |
| V3  | 0.02369            | 0.97631      |             | 0.010038116 |                   |              |             |
| V4  | 0.02369            | 0.97631      |             | 0.010038116 |                   |              |             |
| V7  | 0.02369            | 0.97631      |             | 0.010038116 |                   |              |             |
| V8  | 0.02369            | 0.97631      |             | 0.010038116 |                   |              |             |
| Auxiliary-V3  | 0.00285            | 0.99715      |             | 0.001182386 |                   |              |             |
| Auxiliary-V4  | 0.00285            | 0.99715      |             | 0.001182386 |                   |              |             |
| Auxiliary-V7  | 0.00285            | 0.99715      |             | 0.001182386 |                   |              |             |
| Auxiliary-V8  | 0.00285            | 0.99715      |             | 0.001182386 |                   |              |             |
| Cable 900 amp   | 0.05722            | 0.94278      |             | 0.025108014 |                   |              |             |
| Cable 900 amp   | 0.05722            | 0.94278      |             | 0.025108014 |                   |              |             |
| Cable 600 amp   | 0.04223            | 0.95777      |             | 0.018240416 |                   |              |             |
| Cable 600 amp   | 0.04223            | 0.95777      |             | 0.018240416 |                   |              |             |
| Cable 600 amp   | 0.04223            | 0.95777      |             | 0.018240416 |                   |              |             |
|   |                    |              | 0.413689862 | 0.216221708 | 0.629911569       | 0.370088431  | 248.3771406 |
|   |                    |              |             |             |                   |              |             |
|   |                    |              |             |             |                   |              |             |
| Pole 1  |                    |              |             |             |                   |              |             |
|   | 2009 failure prob. | success prob | 312 MW prob | 156 MW prob | above 156 MW prob | zero MW prob | average MW  |
| filter-VIT  | 0.22549            | 0.77451      |             |             |                   |              |             |
| filter-ARN  | 0.22549            | 0.77451      |             |             |                   |              |             |
| Reactor-VIT   | 0.36902            | 0.63098      |             |             |                   |              |             |
| Reactor-ARN   | 0.36902            | 0.63098      |             |             |                   |              |             |
| T1  | 0.15575            | 0.84425      |             | 0.006042463 |                   |              |             |
| T2  | 0.15575            | 0.84425      |             | 0.006042463 |                   |              |             |
| T5  | 0.15575            | 0.84425      |             | 0.006042463 |                   |              |             |
| T6  | 0.15575            | 0.84425      |             | 0.006042463 |                   |              |             |
| MAV-VIT   | 0.23322            | 0.76678      |             | 0.009962127 |                   |              |             |
| MAV-VIT   | 0.23322            | 0.76678      |             | 0.009962127 |                   |              |             |
| MAV-ARN   | 0.23322            | 0.76678      |             | 0.009962127 |                   |              |             |
| MAV-ARN   | 0.23322            | 0.76678      |             | 0.009962127 |                   |              |             |
| Cable 900 amp   | 0.05722            | 0.94278      |             | 0.0019879   |                   |              |             |
| Cable 900 amp   | 0.05722            | 0.94278      |             | 0.0019879   |                   |              |             |
| Cable 600 amp   | 0.04223            | 0.95777      |             | 0.001444165 |                   |              |             |
| Cable 600 amp   | 0.04223            | 0.95777      |             | 0.001444165 |                   |              |             |
| Cable 600 amp   | 0.04223            | 0.95777      |             | 0.001444165 |                   |              |             |
|   |                    |              | 0.032753449 | 0.072326656 | 0.105080105       | 0.894919895  | 21.5020344  |

| Probability calculations of capacities for Poles 1 and 2 in 2010 (do-nothing) |                    |              |             |             |                   |              |             |
|---|--------------------|--------------|-------------|-------------|-------------------|--------------|-------------|
| Pole 2  |                    |              |             |             |                   |              |             |
|   | 2009 failure prob. | success prob | 476 MW prob | 238 MW prob | above 238 MW prob | zero MW prob | average MW  |
| filter-VIT  | 0.087              | 0.913        |             |             |                   |              |             |
| filter-ARN  | 0.0003             | 0.9997       |             |             |                   |              |             |
| Reactor-VIT   | 0.16155            | 0.83845      |             |             |                   |              |             |
| Reactor-ARN   | 0.16008            | 0.83992      |             |             |                   |              |             |
| Common  | 0.00364            | 0.99636      |             |             |                   |              |             |
| T3  | 0.04689            | 0.95311      |             | 0.017819014 |                   |              |             |
| T4  | 0.04689            | 0.95311      |             | 0.017819014 |                   |              |             |
| T7  | 0.04689            | 0.95311      |             | 0.017819014 |                   |              |             |
| T8  | 0.04689            | 0.95311      |             | 0.017819014 |                   |              |             |
| V3  | 0.02682            | 0.97318      |             | 0.009981873 |                   |              |             |
| V4  | 0.02682            | 0.97318      |             | 0.009981873 |                   |              |             |
| V7  | 0.02682            | 0.97318      |             | 0.009981873 |                   |              |             |
| V8  | 0.02682            | 0.97318      |             | 0.009981873 |                   |              |             |
| Auxiliary-V3  | 0.00346            | 0.99654      |             | 0.001257557 |                   |              |             |
| Auxiliary-V4  | 0.00346            | 0.99654      |             | 0.001257557 |                   |              |             |
| Auxiliary-V7  | 0.00346            | 0.99654      |             | 0.001257557 |                   |              |             |
| Auxiliary-V8  | 0.00346            | 0.99654      |             | 0.001257557 |                   |              |             |
| Cable 900 amp   | 0.06024            | 0.93976      |             | 0.023217447 |                   |              |             |
| Cable 900 amp   | 0.06024            | 0.93976      |             | 0.023217447 |                   |              |             |
| Cable 600 amp   | 0.04272            | 0.95728      |             | 0.016163623 |                   |              |             |
| Cable 600 amp   | 0.04272            | 0.95728      |             | 0.016163623 |                   |              |             |
| Cable 600 amp   | 0.04272            | 0.95728      |             | 0.016163623 |                   |              |             |
|   |                    |              | 0.362198344 | 0.211159543 | 0.573357887       | 0.426642113  | 222.662383  |
| Pole 1  |                    |              |             |             |                   |              |             |
|   | 2010 failure prob. | success prob | 312 MW prob | 156 MW prob | above 156 MW prob | zero MW prob | average MW  |
| filter-VIT  | 0.25754            | 0.74246      |             |             |                   |              |             |
| filter-ARN  | 0.25754            | 0.74246      |             |             |                   |              |             |
| Reactor-VIT   | 0.41111            | 0.58889      |             |             |                   |              |             |
| Reactor-ARN   | 0.41111            | 0.58889      |             |             |                   |              |             |
| T1  | 0.17644            | 0.82356      |             | 0.004260809 |                   |              |             |
| T2  | 0.17644            | 0.82356      |             | 0.004260809 |                   |              |             |
| T5  | 0.17644            | 0.82356      |             | 0.004260809 |                   |              |             |
| T6  | 0.17644            | 0.82356      |             | 0.004260809 |                   |              |             |
| MAV-VIT   | 0.26496            | 0.73504      |             | 0.007169016 |                   |              |             |
| MAV-VIT   | 0.26496            | 0.73504      |             | 0.007169016 |                   |              |             |
| MAV-ARN   | 0.26496            | 0.73504      |             | 0.007169016 |                   |              |             |
| MAV-ARN   | 0.26496            | 0.73504      |             | 0.007169016 |                   |              |             |
| Cable 900 amp   | 0.06024            | 0.93976      |             | 0.001274847 |                   |              |             |
| Cable 900 amp   | 0.06024            | 0.93976      |             | 0.001274847 |                   |              |             |
| Cable 600 amp   | 0.04272            | 0.95728      |             | 0.000887529 |                   |              |             |
| Cable 600 amp   | 0.04272            | 0.95728      |             | 0.000887529 |                   |              |             |
| Cable 600 amp   | 0.04272            | 0.95728      |             | 0.000887529 |                   |              |             |
|   |                    |              | 0.019887959 | 0.050931581 | 0.07081954        | 0.92918046   | 14.15036994 |

| Reliability distribution results for Poles 1 and 2 (do-nothing) |                            |                               |                     |
|---|----------------------------|-------------------------------|---------------------|
| Pole 2  |                            |                               |                     |
|   | Probability at 476 MW only | Probability at 238 MW & above | Failure probability |
| 2004  | 0.629157259                | 0.840012783                   | 0.159987217         |
| 2005  | 0.59390786                 | 0.808170912                   | 0.191829088         |
| 2006  | 0.554333069                | 0.771330493                   | 0.228669507         |
| 2007  | 0.512838492                | 0.730082813                   | 0.269917187         |
| 2008  | 0.463541606                | 0.682057124                   | 0.317942876         |
| 2009  | 0.413689862                | 0.629911569                   | 0.370088431         |
| 2010  | 0.362198344                | 0.573357887                   | 0.426642113         |
| Pole 1  |                            |                               |                     |
|   | Probability at 312 MW only | Probability at 156 MW & above | Failure probability |
| 2004  | 0.185683187                | 0.389007903                   | 0.610992097         |
| 2005  | 0.143281059                | 0.322473156                   | 0.677526844         |
| 2006  | 0.106243735                | 0.258678238                   | 0.741321762         |
| 2007  | 0.075725132                | 0.200479565                   | 0.799520435         |
| 2008  | 0.05100905                 | 0.148315626                   | 0.851684374         |
| 2009  | 0.032753449                | 0.105080105                   | 0.894919895         |
| 2010  | 0.019887959                | 0.07081954                    | 0.92918046          |



| Cumulative probability distribution of HVDC capacity (do-nothing) |                          |                            |                           |                               |                          |                           |                          |                          |                          |       |
|---|--------------------------|----------------------------|---------------------------|-------------------------------|--------------------------|---------------------------|--------------------------|--------------------------|--------------------------|-------|
| Pole 2 (doing nothing)  |                          |                            |                           |                               |                          |                           |                          |                          |                          |       |
|   | Failure probability      | Probability at 476 MW only | Probability at 238 MW     | Probability at 238 MW & above |                          |                           |                          |                          |                          |       |
| 2004  | 0.159987217              | 0.629157259                | 0.210855525               | 0.840012783                   |                          |                           |                          |                          |                          |       |
| 2005  | 0.191829088              | 0.59390786                 | 0.214263051               | 0.808170912                   |                          |                           |                          |                          |                          |       |
| 2006  | 0.228669507              | 0.554333069                | 0.216997424               | 0.771330493                   |                          |                           |                          |                          |                          |       |
| 2007  | 0.269917187              | 0.512838492                | 0.217244321               | 0.730082813                   |                          |                           |                          |                          |                          |       |
| 2008  | 0.317942876              | 0.463541606                | 0.218515517               | 0.682057124                   |                          |                           |                          |                          |                          |       |
| 2009  | 0.370088431              | 0.413689862                | 0.216221708               | 0.629911569                   |                          |                           |                          |                          |                          |       |
| 2010  | 0.426642113              | 0.362198344                | 0.211159543               | 0.573357887                   |                          |                           |                          |                          |                          |       |
| Pole 1  |                          |                            |                           |                               |                          |                           |                          |                          |                          |       |
|   | Failure probability      | Probability at 312 MW only | Probability at 156 MW     | Probability at 156 MW & above |                          |                           |                          |                          |                          |       |
| 2004  | 0.610992097              | 0.185683187                | 0.203324716               | 0.389007903                   |                          |                           |                          |                          |                          |       |
| 2005  | 0.677526844              | 0.143281059                | 0.179192098               | 0.322473156                   |                          |                           |                          |                          |                          |       |
| 2006  | 0.741321762              | 0.106243735                | 0.152434503               | 0.258678238                   |                          |                           |                          |                          |                          |       |
| 2007  | 0.799520435              | 0.075725132                | 0.124754433               | 0.200479565                   |                          |                           |                          |                          |                          |       |
| 2008  | 0.851684374              | 0.05100905                 | 0.097306577               | 0.148315626                   |                          |                           |                          |                          |                          |       |
| 2009  | 0.894919895              | 0.032753449                | 0.072326656               | 0.105080105                   |                          |                           |                          |                          |                          |       |
| 2010  | 0.92918046               | 0.019887959                | 0.050931581               | 0.07081954                    |                          |                           |                          |                          |                          |       |
| Pole 1 & 2 density distribution                                   |                          |                            |                           |                               |                          |                           |                          |                          |                          |       |
|   | 0 MW (p1 and p2 failure) | 156 MW (p1-156 & p2 zero)  | 238 MW (p1 zero & p2-238) | 312 MW (p1-312 and p2 zero)   | 394 MW (p1-156 & p2-238) | 476 MW (p1 zero & p2-476) | 550 MW (p1-312 & p2-238) | 632 MW (p1-156 & p2-476) | 788 MW (p1-312 & p2-476) | Total |
| 2004  | 0.097750925              | 0.032529355                | 0.128831059               | 0.029706936                   | 0.04287214               | 0.384410113               | 0.039152326              | 0.127923221              | 0.116823925              | 1     |
| 2005  | 0.129969357              | 0.034374257                | 0.145168969               | 0.027485475                   | 0.038394246              | 0.402388518               | 0.030699837              | 0.106423595              | 0.085095747              | 1     |
| 2006  | 0.169517682              | 0.034857123                | 0.160864913               | 0.024294703                   | 0.033077894              | 0.410939167               | 0.023054617              | 0.084499486              | 0.058894416              | 1     |
| 2007  | 0.215804307              | 0.033673366                | 0.173691274               | 0.020439515                   | 0.027102192              | 0.410024854               | 0.016450855              | 0.063978875              | 0.038834763              | 1     |
| 2008  | 0.270786979              | 0.030937933                | 0.186106252               | 0.016217964                   | 0.021262997              | 0.394791143               | 0.011146269              | 0.045105647              | 0.023644817              | 1     |
| 2009  | 0.3311995                | 0.026767258                | 0.193501108               | 0.012121673                   | 0.015638593              | 0.370219288               | 0.007082007              | 0.029920804              | 0.01354977               | 1     |
| 2010  | 0.396427514              | 0.021729557                | 0.196205322               | 0.008485041                   | 0.010754689              | 0.336547624               | 0.004199532              | 0.018447334              | 0.007203386              | 1     |
| Pole 1 & 2 cumulative distribution                                |                          |                            |                           |                               |                          |                           |                          |                          |                          |       |
|   | 0 MW (p1 and p2 failure) | 156 MW & above             | 238 MW & above            | 312 MW & above                | 394 MW & above           | 476 MW & above            | 550 MW & above           | 632 MW & above           | 788 MW                   |       |
| 2004  | 0.097750925              | 0.902249075                | 0.86971972                | 0.74088866                    | 0.711181724              | 0.668309585               | 0.283899472              | 0.244747146              | 0.116823925              |       |
| 2005  | 0.129969357              | 0.870030643                | 0.835656386               | 0.690487417                   | 0.663001943              | 0.624607697               | 0.222219179              | 0.191519342              | 0.085095747              |       |
| 2006  | 0.169517682              | 0.830482318                | 0.795625195               | 0.634760283                   | 0.61046558               | 0.577387686               | 0.166448518              | 0.143393901              | 0.058894416              |       |
| 2007  | 0.215804307              | 0.784195693                | 0.750522328               | 0.576831053                   | 0.556391539              | 0.529289347               | 0.119264493              | 0.102813638              | 0.038834763              |       |
| 2008  | 0.270786979              | 0.729213021                | 0.698275088               | 0.512168836                   | 0.495950872              | 0.474687875               | 0.079896732              | 0.068750464              | 0.023644817              |       |
| 2009  | 0.3311995                | 0.6688005                  | 0.642033242               | 0.448532134                   | 0.436410461              | 0.420771868               | 0.050552581              | 0.043470574              | 0.01354977               |       |
| 2010  | 0.396427514              | 0.603572486                | 0.581842928               | 0.385637607                   | 0.377152566              | 0.366397876               | 0.029850253              | 0.02565072               | 0.007203386              |       |

## Appendix 2

| Input data (VIT-reactor replacement) |         |         |         |         |         |         |  |
|--------------------------------------|---------|---------|---------|---------|---------|---------|--|
| Pole 2                               |         |         |         |         |         |         |  |
|                                      | 2004    | 2005    | 2006    | 2007    | 2008    | 2009    | 2010   |
| filter-VIT                           | 0.02557 | 0.03201 | 0.03972 | 0.04889 | 0.05971 | 0.07234 | 0.087  |
| filter-ARN                           | 0.00002 | 0.00003 | 0.00005 | 0.00008 | 0.00012 | 0.00019 | 0.0003 (ARN filter replaced in 1996)                 |
| Reactor-VIT                          | 0.05278 | 0.0002  | 0.0002  | 0.0002  | 0.0002  | 0.0002  | 0.0002 (Buy a new reactor in 2005)                   |
| Reactor-ARN                          | 0.05111 | 0.06321 | 0.07746 | 0.09408 | 0.11328 | 0.13524 | 0.16008 (spare is located at ARN side)               |
| Common                               | 0.00127 | 0.00149 | 0.00176 | 0.0021  | 0.00252 | 0.00302 | 0.00364  |
| T3                                   | 0.01303 | 0.01644 | 0.02058 | 0.02557 | 0.03152 | 0.03858 | 0.04689  |
| T4                                   | 0.01303 | 0.01644 | 0.02058 | 0.02557 | 0.03152 | 0.03858 | 0.04689  |
| T7                                   | 0.01303 | 0.01644 | 0.02058 | 0.02557 | 0.03152 | 0.03858 | 0.04689  |
| T8                                   | 0.01303 | 0.01644 | 0.02058 | 0.02557 | 0.03152 | 0.03858 | 0.04689  |
| V3                                   | 0.01299 | 0.01458 | 0.01641 | 0.01852 | 0.02094 | 0.02369 | 0.02682  |
| V4                                   | 0.01299 | 0.01458 | 0.01641 | 0.01852 | 0.02094 | 0.02369 | 0.02682  |
| V7                                   | 0.01299 | 0.01458 | 0.01641 | 0.01852 | 0.02094 | 0.02369 | 0.02682  |
| V8                                   | 0.01299 | 0.01458 | 0.01641 | 0.01852 | 0.02094 | 0.02369 | 0.02682  |
| Auxiliary-V3                         | 0.0011  | 0.00132 | 0.00159 | 0.00193 | 0.00234 | 0.00285 | 0.00346  |
| Auxiliary-V4                         | 0.0011  | 0.00132 | 0.00159 | 0.00193 | 0.00234 | 0.00285 | 0.00346  |
| Auxiliary-V7                         | 0.0011  | 0.00132 | 0.00159 | 0.00193 | 0.00234 | 0.00285 | 0.00346  |
| Auxiliary-V8                         | 0.0011  | 0.00132 | 0.00159 | 0.00193 | 0.00234 | 0.00285 | 0.00346  |
| Cable 900 amp                        | 0.04689 | 0.04842 | 0.05019 | 0.05023 | 0.05456 | 0.05722 | 0.06024 (MTTR assumed 4 months)                      |
| Cable 900 amp                        | 0.04689 | 0.04842 | 0.05019 | 0.05023 | 0.05456 | 0.05722 | 0.06024 (900 amp cable assumed less life expectancy) |
| Cable 600 amp                        | 0.04058 | 0.04082 | 0.04111 | 0.04143 | 0.0418  | 0.04223 | 0.04272 (MTTR assumed 4 months)                      |
| Cable 600 amp                        | 0.04058 | 0.04082 | 0.04111 | 0.04143 | 0.0418  | 0.04223 | 0.04272  |
| Cable 600 amp                        | 0.04058 | 0.04082 | 0.04111 | 0.04143 | 0.0418  | 0.04223 | 0.04272  |
|                                      |         |         |         |         |         |         |  |
| Pole 1                               |         |         |         |         |         |         |  |
|                                      | 2004    | 2005    | 2006    | 2007    | 2008    | 2009    | 2010   |
| filter-VIT                           | 0.10389 | 0.12309 | 0.14478 | 0.16905 | 0.19596 | 0.22549 | 0.25754  |
| filter-ARN                           | 0.10389 | 0.12309 | 0.14478 | 0.16905 | 0.19596 | 0.22549 | 0.25754  |
| Reactor-VIT                          | 0.18921 | 0.21992 | 0.2535  | 0.28976 | 0.3284  | 0.36902 | 0.41111  |
| Reactor-ARN                          | 0.18921 | 0.21992 | 0.2535  | 0.28976 | 0.3284  | 0.36902 | 0.41111  |
| T1                                   | 0.08277 | 0.09373 | 0.10637 | 0.12082 | 0.13724 | 0.15575 | 0.17644  |
| T2                                   | 0.08277 | 0.09373 | 0.10637 | 0.12082 | 0.13724 | 0.15575 | 0.17644  |
| T5                                   | 0.08277 | 0.09373 | 0.10637 | 0.12082 | 0.13724 | 0.15575 | 0.17644  |
| T6                                   | 0.08277 | 0.09373 | 0.10637 | 0.12082 | 0.13724 | 0.15575 | 0.17644  |
| MAV-VIT                              | 0.11284 | 0.13185 | 0.15332 | 0.17735 | 0.20399 | 0.23322 | 0.26496  |
| MAV-VIT                              | 0.11284 | 0.13185 | 0.15332 | 0.17735 | 0.20399 | 0.23322 | 0.26496  |
| MAV-ARN                              | 0.11284 | 0.13185 | 0.15332 | 0.17735 | 0.20399 | 0.23322 | 0.26496  |
| MAV-ARN                              | 0.11284 | 0.13185 | 0.15332 | 0.17735 | 0.20399 | 0.23322 | 0.26496  |
| Cable 900 amp                        | 0.04689 | 0.04842 | 0.05019 | 0.05023 | 0.05456 | 0.05722 | 0.06024  |
| Cable 900 amp                        | 0.04689 | 0.04842 | 0.05019 | 0.05023 | 0.05456 | 0.05722 | 0.06024  |
| Cable 600 amp                        | 0.04058 | 0.04082 | 0.04111 | 0.04143 | 0.0418  | 0.04223 | 0.04272  |
| Cable 600 amp                        | 0.04058 | 0.04082 | 0.04111 | 0.04143 | 0.0418  | 0.04223 | 0.04272  |
| Cable 600 amp                        | 0.04058 | 0.04082 | 0.04111 | 0.04143 | 0.0418  | 0.04223 | 0.04272  |

| Probability calculations of capacities for Poles 1 and 2 in 2004 (VIT reactor replacement) |               |              |             |             |                   |              |            |
|--|---------------|--------------|-------------|-------------|-------------------|--------------|------------|
| Pole 2   |               |              |             |             |                   |              |            |
|  | failure prob. | success prob | 476 MW prob | 238 MW prob | above 238 MW prob | zero MW prob | average MW |
| filter-VIT   | 0.02557       | 0.97443      |             |             |                   |              |            |
| filter-ARN   | 0.00002       | 0.99998      |             |             |                   |              |            |
| Reactor-VIT  | 0.05278       | 0.94722      |             |             |                   |              |            |
| Reactor-ARN  | 0.05111       | 0.94889      |             |             |                   |              |            |
| Common   | 0.00127       | 0.99873      |             |             |                   |              |            |
| T3   | 0.01303       | 0.98697      |             | 0.008306148 |                   |              |            |
| T4   | 0.01303       | 0.98697      |             | 0.008306148 |                   |              |            |
| T7   | 0.01303       | 0.98697      |             | 0.008306148 |                   |              |            |
| T8   | 0.01303       | 0.98697      |             | 0.008306148 |                   |              |            |
| V3   | 0.01299       | 0.98701      |             | 0.008280314 |                   |              |            |
| V4   | 0.01299       | 0.98701      |             | 0.008280314 |                   |              |            |
| V7   | 0.01299       | 0.98701      |             | 0.008280314 |                   |              |            |
| V8   | 0.01299       | 0.98701      |             | 0.008280314 |                   |              |            |
| Auxiliary-V3   | 0.0011        | 0.9989       |             | 0.000692835 |                   |              |            |
| Auxiliary-V4   | 0.0011        | 0.9989       |             | 0.000692835 |                   |              |            |
| Auxiliary-V7   | 0.0011        | 0.9989       |             | 0.000692835 |                   |              |            |
| Auxiliary-V8   | 0.0011        | 0.9989       |             | 0.000692835 |                   |              |            |
| Cable 900 amp  | 0.04689       | 0.95311      |             | 0.030952549 |                   |              |            |
| Cable 900 amp  | 0.04689       | 0.95311      |             | 0.030952549 |                   |              |            |
| Cable 600 amp  | 0.04058       | 0.95942      |             | 0.026611079 |                   |              |            |
| Cable 600 amp  | 0.04058       | 0.95942      |             | 0.026611079 |                   |              |            |
| Cable 600 amp  | 0.04058       | 0.95942      |             | 0.026611079 |                   |              |            |
|  |               |              | 0.629157259 | 0.210855525 | 0.840012783       | 0.159987217  | 349.66247  |
|  |               |              |             |             |                   |              |            |
|  |               |              |             |             |                   |              |            |
| Pole 1   |               |              |             |             |                   |              |            |
|  | failure prob. | success prob | 312 MW prob | 156 MW prob | above 156 MW prob | zero MW prob | average MW |
| filter-VIT   | 0.10389       | 0.89611      |             |             |                   |              |            |
| filter-ARN   | 0.10389       | 0.89611      |             |             |                   |              |            |
| Reactor-VIT  | 0.18921       | 0.81079      |             |             |                   |              |            |
| Reactor-ARN  | 0.18921       | 0.81079      |             |             |                   |              |            |
| T1   | 0.08277       | 0.91723      |             | 0.016755882 |                   |              |            |
| T2   | 0.08277       | 0.91723      |             | 0.016755882 |                   |              |            |
| T5   | 0.08277       | 0.91723      |             | 0.016755882 |                   |              |            |
| T6   | 0.08277       | 0.91723      |             | 0.016755882 |                   |              |            |
| MAV-VIT  | 0.11284       | 0.88716      |             | 0.023617488 |                   |              |            |
| MAV-VIT  | 0.11284       | 0.88716      |             | 0.023617488 |                   |              |            |
| MAV-ARN  | 0.11284       | 0.88716      |             | 0.023617488 |                   |              |            |
| MAV-ARN  | 0.11284       | 0.88716      |             | 0.023617488 |                   |              |            |
| Cable 900 amp  | 0.04689       | 0.95311      |             | 0.009135026 |                   |              |            |
| Cable 900 amp  | 0.04689       | 0.95311      |             | 0.009135026 |                   |              |            |
| Cable 600 amp  | 0.04058       | 0.95942      |             | 0.007853728 |                   |              |            |
| Cable 600 amp  | 0.04058       | 0.95942      |             | 0.007853728 |                   |              |            |
| Cable 600 amp  | 0.04058       | 0.95942      |             | 0.007853728 |                   |              |            |
|  |               |              | 0.185683187 | 0.203324716 | 0.389007903       | 0.610992097  | 89.6518101 |

| Probability calculations of capacities for Poles 1 and 2 in 2005 (VIT reactor replacement) |               |              |             |             |                   |              |             |
|--|---------------|--------------|-------------|-------------|-------------------|--------------|-------------|
| Pole2  | failure prob. | success prob | 476 MW prob | 238 MW prob | above 238 MW prob | zero MW prob | average MW  |
| filter-VIT   | 0.03201       | 0.96799      |             |             |                   |              |             |
| filter-ARN   | 0.00003       | 0.99997      |             |             |                   |              |             |
| Reactor-VIT  | 0.0002        | 0.9998       |             |             |                   |              |             |
| Reactor-ARN  | 0.06321       | 0.93679      |             |             |                   |              |             |
| Common   | 0.00149       | 0.99851      |             |             |                   |              |             |
| T3   | 0.01644       | 0.98356      |             | 0.010613335 |                   |              |             |
| T4   | 0.01644       | 0.98356      |             | 0.010613335 |                   |              |             |
| T7   | 0.01644       | 0.98356      |             | 0.010613335 |                   |              |             |
| T8   | 0.01644       | 0.98356      |             | 0.010613335 |                   |              |             |
| V3   | 0.01458       | 0.98542      |             | 0.00939479  |                   |              |             |
| V4   | 0.01458       | 0.98542      |             | 0.00939479  |                   |              |             |
| V7   | 0.01458       | 0.98542      |             | 0.00939479  |                   |              |             |
| V8   | 0.01458       | 0.98542      |             | 0.00939479  |                   |              |             |
| Auxiliary-V3   | 0.00132       | 0.99868      |             | 0.000839264 |                   |              |             |
| Auxiliary-V4   | 0.00132       | 0.99868      |             | 0.000839264 |                   |              |             |
| Auxiliary-V7   | 0.00132       | 0.99868      |             | 0.000839264 |                   |              |             |
| Auxiliary-V8   | 0.00132       | 0.99868      |             | 0.000839264 |                   |              |             |
| Cable 900 amp  | 0.04842       | 0.95158      |             | 0.032309513 |                   |              |             |
| Cable 900 amp  | 0.04842       | 0.95158      |             | 0.032309513 |                   |              |             |
| Cable 600 amp  | 0.04082       | 0.95918      |             | 0.027022393 |                   |              |             |
| Cable 600 amp  | 0.04082       | 0.95918      |             | 0.027022393 |                   |              |             |
| Cable 600 amp  | 0.04082       | 0.95918      |             | 0.027022393 |                   |              |             |
|  |               |              |             |             |                   |              |             |
|  |               |              | 0.634966667 | 0.229075762 | 0.864042429       | 0.135957571  | 356.7641648 |
|  |               |              |             |             |                   |              |             |
|  |               |              |             |             |                   |              |             |
| Pole 1   | failure prob. | success prob | 312 MW prob | 156 MW prob | above 156 MW prob | zero MW prob | average MW  |
| filter-VIT   | 0.12309       | 0.87691      |             |             |                   |              |             |
| filter-ARN   | 0.12309       | 0.87691      |             |             |                   |              |             |
| Reactor-VIT  | 0.21992       | 0.78008      |             |             |                   |              |             |
| Reactor-ARN  | 0.21992       | 0.78008      |             |             |                   |              |             |
| T1   | 0.09373       | 0.90627      |             | 0.014818689 |                   |              |             |
| T2   | 0.09373       | 0.90627      |             | 0.014818689 |                   |              |             |
| T5   | 0.09373       | 0.90627      |             | 0.014818689 |                   |              |             |
| T6   | 0.09373       | 0.90627      |             | 0.014818689 |                   |              |             |
| MAV-VIT  | 0.13185       | 0.86815      |             | 0.021760764 |                   |              |             |
| MAV-VIT  | 0.13185       | 0.86815      |             | 0.021760764 |                   |              |             |
| MAV-ARN  | 0.13185       | 0.86815      |             | 0.021760764 |                   |              |             |
| MAV-ARN  | 0.13185       | 0.86815      |             | 0.021760764 |                   |              |             |
| Cable 900 amp  | 0.04842       | 0.95158      |             | 0.007290684 |                   |              |             |
| Cable 900 amp  | 0.04842       | 0.95158      |             | 0.007290684 |                   |              |             |
| Cable 600 amp  | 0.04082       | 0.95918      |             | 0.006097638 |                   |              |             |
| Cable 600 amp  | 0.04082       | 0.95918      |             | 0.006097638 |                   |              |             |
| Cable 600 amp  | 0.04082       | 0.95918      |             | 0.006097638 |                   |              |             |
|  |               |              |             |             |                   |              |             |
|  |               |              | 0.143281059 | 0.179192098 | 0.322473156       | 0.677526844  | 72.65765748 |

| Probability calculations of capacities for Poles 1 and 2 in 2006 (VIT reactor replacement) |               |              |             |             |                   |              |             |
|--|---------------|--------------|-------------|-------------|-------------------|--------------|-------------|
| Pole 2   |               |              |             |             |                   |              |             |
|  | failure prob. | success prob | 476 MW prob | 238 MW prob | above 238 MW prob | zero MW prob | average MW  |
| filter-VIT   | 0.03972       | 0.96028      |             |             |                   |              |             |
| filter-ARN   | 0.00005       | 0.99995      |             |             |                   |              |             |
| Reactor-VIT  | 0.0002        | 0.9998       |             |             |                   |              |             |
| Reactor-ARN  | 0.07746       | 0.92254      |             |             |                   |              |             |
| Common   | 0.00176       | 0.99824      |             |             |                   |              |             |
| T3   | 0.02058       | 0.97942      |             | 0.012645433 |                   |              |             |
| T4   | 0.02058       | 0.97942      |             | 0.012645433 |                   |              |             |
| T7   | 0.02058       | 0.97942      |             | 0.012645433 |                   |              |             |
| T8   | 0.02058       | 0.97942      |             | 0.012645433 |                   |              |             |
| V3   | 0.01641       | 0.98359      |             | 0.010040418 |                   |              |             |
| V4   | 0.01641       | 0.98359      |             | 0.010040418 |                   |              |             |
| V7   | 0.01641       | 0.98359      |             | 0.010040418 |                   |              |             |
| V8   | 0.01641       | 0.98359      |             | 0.010040418 |                   |              |             |
| Auxiliary-V3   | 0.00159       | 0.99841      |             | 0.000958397 |                   |              |             |
| Auxiliary-V4   | 0.00159       | 0.99841      |             | 0.000958397 |                   |              |             |
| Auxiliary-V7   | 0.00159       | 0.99841      |             | 0.000958397 |                   |              |             |
| Auxiliary-V8   | 0.00159       | 0.99841      |             | 0.000958397 |                   |              |             |
| Cable 900 amp  | 0.05019       | 0.94981      |             | 0.031800779 |                   |              |             |
| Cable 900 amp  | 0.05019       | 0.94981      |             | 0.031800779 |                   |              |             |
| Cable 600 amp  | 0.04111       | 0.95889      |             | 0.025800967 |                   |              |             |
| Cable 600 amp  | 0.04111       | 0.95889      |             | 0.025800967 |                   |              |             |
| Cable 600 amp  | 0.04111       | 0.95889      |             | 0.025800967 |                   |              |             |
|  |               |              | 0.601807089 | 0.23558145  | 0.837388539       | 0.162611461  | 342.5285593 |
| Pole 1   |               |              |             |             |                   |              |             |
|  | failure prob. | success prob | 312 MW prob | 156 MW prob | above 156 MW prob | zero MW prob | average MW  |
| filter-VIT   | 0.14478       | 0.85522      |             |             |                   |              |             |
| filter-ARN   | 0.14478       | 0.85522      |             |             |                   |              |             |
| Reactor-VIT  | 0.2535        | 0.7465       |             |             |                   |              |             |
| Reactor-ARN  | 0.2535        | 0.7465       |             |             |                   |              |             |
| T1   | 0.10637       | 0.89363      |             | 0.012646337 |                   |              |             |
| T2   | 0.10637       | 0.89363      |             | 0.012646337 |                   |              |             |
| T5   | 0.10637       | 0.89363      |             | 0.012646337 |                   |              |             |
| T6   | 0.10637       | 0.89363      |             | 0.012646337 |                   |              |             |
| MAV-VIT  | 0.15332       | 0.84668      |             | 0.019239015 |                   |              |             |
| MAV-VIT  | 0.15332       | 0.84668      |             | 0.019239015 |                   |              |             |
| MAV-ARN  | 0.15332       | 0.84668      |             | 0.019239015 |                   |              |             |
| MAV-ARN  | 0.15332       | 0.84668      |             | 0.019239015 |                   |              |             |
| Cable 900 amp  | 0.05019       | 0.94981      |             | 0.005614147 |                   |              |             |
| Cable 900 amp  | 0.05019       | 0.94981      |             | 0.005614147 |                   |              |             |
| Cable 600 amp  | 0.04111       | 0.95889      |             | 0.004554933 |                   |              |             |
| Cable 600 amp  | 0.04111       | 0.95889      |             | 0.004554933 |                   |              |             |
| Cable 600 amp  | 0.04111       | 0.95889      |             | 0.004554933 |                   |              |             |
|  |               |              | 0.106243735 | 0.152434503 | 0.258678238       | 0.741321762  | 56.92782777 |

| Probability calculations of capacities for Poles 1 and 2 in 2007 (VIT reactor replacement) |               |              |             |             |                   |              |            |
|--|---------------|--------------|-------------|-------------|-------------------|--------------|------------|
| Pole 2   |               |              |             |             |                   |              |            |
|  | failure prob. | success prob | 476 MW prob | 238 MW prob | above 238 MW prob | zero MW prob | average MW |
| filter-VIT   | 0.04889       | 0.95111      |             |             |                   |              |            |
| filter-ARN   | 0.00008       | 0.99992      |             |             |                   |              |            |
| Reactor-VIT  | 0.0002        | 0.9998       |             |             |                   |              |            |
| Reactor-ARN  | 0.09408       | 0.90592      |             |             |                   |              |            |
| Common   | 0.0021        | 0.9979       |             |             |                   |              |            |
| T3   | 0.02557       | 0.97443      |             | 0.01487808  |                   |              |            |
| T4   | 0.02557       | 0.97443      |             | 0.01487808  |                   |              |            |
| T7   | 0.02557       | 0.97443      |             | 0.01487808  |                   |              |            |
| T8   | 0.02557       | 0.97443      |             | 0.01487808  |                   |              |            |
| V3   | 0.01852       | 0.98148      |             | 0.010698585 |                   |              |            |
| V4   | 0.01852       | 0.98148      |             | 0.010698585 |                   |              |            |
| V7   | 0.01852       | 0.98148      |             | 0.010698585 |                   |              |            |
| V8   | 0.01852       | 0.98148      |             | 0.010698585 |                   |              |            |
| Auxiliary-V3   | 0.00193       | 0.99807      |             | 0.001096385 |                   |              |            |
| Auxiliary-V4   | 0.00193       | 0.99807      |             | 0.001096385 |                   |              |            |
| Auxiliary-V7   | 0.00193       | 0.99807      |             | 0.001096385 |                   |              |            |
| Auxiliary-V8   | 0.00193       | 0.99807      |             | 0.001096385 |                   |              |            |
| Cable 900 amp  | 0.05023       | 0.94977      |             | 0.029985517 |                   |              |            |
| Cable 900 amp  | 0.05023       | 0.94977      |             | 0.029985517 |                   |              |            |
| Cable 600 amp  | 0.04143       | 0.95857      |             | 0.024505181 |                   |              |            |
| Cable 600 amp  | 0.04143       | 0.95857      |             | 0.024505181 |                   |              |            |
| Cable 600 amp  | 0.04143       | 0.95857      |             | 0.024505181 |                   |              |            |
|  |               |              | 0.566978784 | 0.240178776 | 0.80715756        | 0.19284244   | 327.04445  |
| Pole 1   |               |              |             |             |                   |              |            |
|  | failure prob. | success prob | 312 MW prob | 156 MW prob | above 156 MW prob | zero MW prob | average MW |
| filter-VIT   | 0.16905       | 0.83095      |             |             |                   |              |            |
| filter-ARN   | 0.16905       | 0.83095      |             |             |                   |              |            |
| Reactor-VIT  | 0.28976       | 0.71024      |             |             |                   |              |            |
| Reactor-ARN  | 0.28976       | 0.71024      |             |             |                   |              |            |
| T1   | 0.12082       | 0.87918      |             | 0.010406413 |                   |              |            |
| T2   | 0.12082       | 0.87918      |             | 0.010406413 |                   |              |            |
| T5   | 0.12082       | 0.87918      |             | 0.010406413 |                   |              |            |
| T6   | 0.12082       | 0.87918      |             | 0.010406413 |                   |              |            |
| MAV-VIT  | 0.17735       | 0.82265      |             | 0.016325111 |                   |              |            |
| MAV-VIT  | 0.17735       | 0.82265      |             | 0.016325111 |                   |              |            |
| MAV-ARN  | 0.17735       | 0.82265      |             | 0.016325111 |                   |              |            |
| MAV-ARN  | 0.17735       | 0.82265      |             | 0.016325111 |                   |              |            |
| Cable 900 amp  | 0.05023       | 0.94977      |             | 0.004004836 |                   |              |            |
| Cable 900 amp  | 0.05023       | 0.94977      |             | 0.004004836 |                   |              |            |
| Cable 600 amp  | 0.04143       | 0.95857      |             | 0.003272888 |                   |              |            |
| Cable 600 amp  | 0.04143       | 0.95857      |             | 0.003272888 |                   |              |            |
| Cable 600 amp  | 0.04143       | 0.95857      |             | 0.003272888 |                   |              |            |
|  |               |              | 0.075725132 | 0.124754433 | 0.200479565       | 0.799520435  | 43.0879328 |

| Probability calculations of capacities for Poles 1 and 2 in 2008 (VIT reactor replacement) |               |              |             |             |                   |              |            |
|--|---------------|--------------|-------------|-------------|-------------------|--------------|------------|
| Pole 2   |               |              |             |             |                   |              |            |
|  | failure prob. | success prob | 476 MW prob | 238 MW prob | above 238 MW prob | zero MW prob | average MW |
| filter-VIT   | 0.05971       | 0.94029      |             |             |                   |              |            |
| filter-ARN   | 0.00012       | 0.99988      |             |             |                   |              |            |
| Reactor-VIT  | 0.0002        | 0.9998       |             |             |                   |              |            |
| Reactor-ARN  | 0.11328       | 0.88672      |             |             |                   |              |            |
| Common   | 0.00252       | 0.99748      |             |             |                   |              |            |
| T3   | 0.03152       | 0.96848      |             | 0.017040237 |                   |              |            |
| T4   | 0.03152       | 0.96848      |             | 0.017040237 |                   |              |            |
| T7   | 0.03152       | 0.96848      |             | 0.017040237 |                   |              |            |
| T8   | 0.03152       | 0.96848      |             | 0.017040237 |                   |              |            |
| V3   | 0.02094       | 0.97906      |             | 0.01119818  |                   |              |            |
| V4   | 0.02094       | 0.97906      |             | 0.01119818  |                   |              |            |
| V7   | 0.02094       | 0.97906      |             | 0.01119818  |                   |              |            |
| V8   | 0.02094       | 0.97906      |             | 0.01119818  |                   |              |            |
| Auxiliary-V3   | 0.00234       | 0.99766      |             | 0.001228042 |                   |              |            |
| Auxiliary-V4   | 0.00234       | 0.99766      |             | 0.001228042 |                   |              |            |
| Auxiliary-V7   | 0.00234       | 0.99766      |             | 0.001228042 |                   |              |            |
| Auxiliary-V8   | 0.00234       | 0.99766      |             | 0.001228042 |                   |              |            |
| Cable 900 amp  | 0.05456       | 0.94544      |             | 0.030214851 |                   |              |            |
| Cable 900 amp  | 0.05456       | 0.94544      |             | 0.030214851 |                   |              |            |
| Cable 600 amp  | 0.0418        | 0.9582       |             | 0.022840215 |                   |              |            |
| Cable 600 amp  | 0.0418        | 0.9582       |             | 0.022840215 |                   |              |            |
| Cable 600 amp  | 0.0418        | 0.9582       |             | 0.022840215 |                   |              |            |
|  |               |              | 0.523576413 | 0.246816185 | 0.770392598       | 0.229607402  | 307.964625 |
|  |               |              |             |             |                   |              |            |
|  |               |              |             |             |                   |              |            |
| Pole 1   |               |              |             |             |                   |              |            |
|  | failure prob. | success prob | 312 MW prob | 156 MW prob | above 156 MW prob | zero MW prob | average MW |
| filter-VIT   | 0.19596       | 0.80404      |             |             |                   |              |            |
| filter-ARN   | 0.19596       | 0.80404      |             |             |                   |              |            |
| Reactor-VIT  | 0.3284        | 0.6716       |             |             |                   |              |            |
| Reactor-ARN  | 0.3284        | 0.6716       |             |             |                   |              |            |
| T1   | 0.13724       | 0.86276      |             | 0.008114055 |                   |              |            |
| T2   | 0.13724       | 0.86276      |             | 0.008114055 |                   |              |            |
| T5   | 0.13724       | 0.86276      |             | 0.008114055 |                   |              |            |
| T6   | 0.13724       | 0.86276      |             | 0.008114055 |                   |              |            |
| MAV-VIT  | 0.20399       | 0.79601      |             | 0.013071866 |                   |              |            |
| MAV-VIT  | 0.20399       | 0.79601      |             | 0.013071866 |                   |              |            |
| MAV-ARN  | 0.20399       | 0.79601      |             | 0.013071866 |                   |              |            |
| MAV-ARN  | 0.20399       | 0.79601      |             | 0.013071866 |                   |              |            |
| Cable 900 amp  | 0.05456       | 0.94544      |             | 0.00294366  |                   |              |            |
| Cable 900 amp  | 0.05456       | 0.94544      |             | 0.00294366  |                   |              |            |
| Cable 600 amp  | 0.0418        | 0.9582       |             | 0.002225191 |                   |              |            |
| Cable 600 amp  | 0.0418        | 0.9582       |             | 0.002225191 |                   |              |            |
| Cable 600 amp  | 0.0418        | 0.9582       |             | 0.002225191 |                   |              |            |
|  |               |              | 0.05100905  | 0.097306577 | 0.148315626       | 0.851684374  | 31.0946494 |

| Probability calculations of capacities for Poles 1 and 2 in 2009 (VIT reactor replacement) |               |              |             |             |                   |              |             |
|--|---------------|--------------|-------------|-------------|-------------------|--------------|-------------|
| Pole 2   |               |              |             |             |                   |              |             |
|  | failure prob. | success prob | 476 MW prob | 238 MW prob | above 238 MW prob | zero MW prob | average MW  |
| filter-VIT   | 0.07234       | 0.92766      |             |             |                   |              |             |
| filter-ARN   | 0.00019       | 0.99981      |             |             |                   |              |             |
| Reactor-VIT  | 0.0002        | 0.9998       |             |             |                   |              |             |
| Reactor-ARN  | 0.13524       | 0.86476      |             |             |                   |              |             |
| Common   | 0.00302       | 0.99698      |             |             |                   |              |             |
| T3   | 0.03858       | 0.96142      |             | 0.019226512 |                   |              |             |
| T4   | 0.03858       | 0.96142      |             | 0.019226512 |                   |              |             |
| T7   | 0.03858       | 0.96142      |             | 0.019226512 |                   |              |             |
| T8   | 0.03858       | 0.96142      |             | 0.019226512 |                   |              |             |
| V3   | 0.02369       | 0.97631      |             | 0.011625958 |                   |              |             |
| V4   | 0.02369       | 0.97631      |             | 0.011625958 |                   |              |             |
| V7   | 0.02369       | 0.97631      |             | 0.011625958 |                   |              |             |
| V8   | 0.02369       | 0.97631      |             | 0.011625958 |                   |              |             |
| Auxiliary-V3   | 0.00285       | 0.99715      |             | 0.001369417 |                   |              |             |
| Auxiliary-V4   | 0.00285       | 0.99715      |             | 0.001369417 |                   |              |             |
| Auxiliary-V7   | 0.00285       | 0.99715      |             | 0.001369417 |                   |              |             |
| Auxiliary-V8   | 0.00285       | 0.99715      |             | 0.001369417 |                   |              |             |
| Cable 900 amp  | 0.05722       | 0.94278      |             | 0.029079633 |                   |              |             |
| Cable 900 amp  | 0.05722       | 0.94278      |             | 0.029079633 |                   |              |             |
| Cable 600 amp  | 0.04223       | 0.95777      |             | 0.021125708 |                   |              |             |
| Cable 600 amp  | 0.04223       | 0.95777      |             | 0.021125708 |                   |              |             |
| Cable 600 amp  | 0.04223       | 0.95777      |             | 0.021125708 |                   |              |             |
|  |               |              |             |             |                   |              |             |
|  |               |              | 0.479127858 | 0.250423937 | 0.729551795       | 0.270448205  | 287.6657575 |
|  |               |              |             |             |                   |              |             |
|  |               |              |             |             |                   |              |             |
| Pole 1   |               |              |             |             |                   |              |             |
|  | failure prob. | success prob | 312 MW prob | 156 MW prob | above 156 MW prob | zero MW prob | average MW  |
| filter-VIT   | 0.22549       | 0.77451      |             |             |                   |              |             |
| filter-ARN   | 0.22549       | 0.77451      |             |             |                   |              |             |
| Reactor-VIT  | 0.36902       | 0.63098      |             |             |                   |              |             |
| Reactor-ARN  | 0.36902       | 0.63098      |             |             |                   |              |             |
| T1   | 0.15575       | 0.84425      |             | 0.006042463 |                   |              |             |
| T2   | 0.15575       | 0.84425      |             | 0.006042463 |                   |              |             |
| T5   | 0.15575       | 0.84425      |             | 0.006042463 |                   |              |             |
| T6   | 0.15575       | 0.84425      |             | 0.006042463 |                   |              |             |
| MAV-VIT  | 0.23322       | 0.76678      |             | 0.009962127 |                   |              |             |
| MAV-VIT  | 0.23322       | 0.76678      |             | 0.009962127 |                   |              |             |
| MAV-ARN  | 0.23322       | 0.76678      |             | 0.009962127 |                   |              |             |
| MAV-ARN  | 0.23322       | 0.76678      |             | 0.009962127 |                   |              |             |
| Cable 900 amp  | 0.05722       | 0.94278      |             | 0.0019879   |                   |              |             |
| Cable 900 amp  | 0.05722       | 0.94278      |             | 0.0019879   |                   |              |             |
| Cable 600 amp  | 0.04223       | 0.95777      |             | 0.001444165 |                   |              |             |
| Cable 600 amp  | 0.04223       | 0.95777      |             | 0.001444165 |                   |              |             |
| Cable 600 amp  | 0.04223       | 0.95777      |             | 0.001444165 |                   |              |             |
|  |               |              |             |             |                   |              |             |
|  |               |              | 0.032753449 | 0.072326656 | 0.105080105       | 0.894919895  | 21.5020344  |



| Probability calculations of capacities for Poles 1 and 2 in 2010 (VIT reactor replacement) |               |              |             |             |                   |              |             |
|--|---------------|--------------|-------------|-------------|-------------------|--------------|-------------|
| Pole 2   |               |              |             |             |                   |              |             |
|  | failure prob. | success prob | 476 MW prob | 238 MW prob | above 238 MW prob | zero MW prob | average MW  |
| filter-VIT   | 0.087         | 0.913        |             |             |                   |              |             |
| filter-ARN   | 0.0003        | 0.9997       |             |             |                   |              |             |
| Reactor-VIT  | 0.0002        | 0.9998       |             |             |                   |              |             |
| Reactor-ARN  | 0.16008       | 0.83992      |             |             |                   |              |             |
| Common   | 0.00364       | 0.99636      |             |             |                   |              |             |
| T3   | 0.04689       | 0.95311      |             | 0.021248077 |                   |              |             |
| T4   | 0.04689       | 0.95311      |             | 0.021248077 |                   |              |             |
| T7   | 0.04689       | 0.95311      |             | 0.021248077 |                   |              |             |
| T8   | 0.04689       | 0.95311      |             | 0.021248077 |                   |              |             |
| V3   | 0.02682       | 0.97318      |             | 0.011902769 |                   |              |             |
| V4   | 0.02682       | 0.97318      |             | 0.011902769 |                   |              |             |
| V7   | 0.02682       | 0.97318      |             | 0.011902769 |                   |              |             |
| V8   | 0.02682       | 0.97318      |             | 0.011902769 |                   |              |             |
| Auxiliary-V3   | 0.00346       | 0.99654      |             | 0.00149956  |                   |              |             |
| Auxiliary-V4   | 0.00346       | 0.99654      |             | 0.00149956  |                   |              |             |
| Auxiliary-V7   | 0.00346       | 0.99654      |             | 0.00149956  |                   |              |             |
| Auxiliary-V8   | 0.00346       | 0.99654      |             | 0.00149956  |                   |              |             |
| Cable 900 amp  | 0.06024       | 0.93976      |             | 0.027685376 |                   |              |             |
| Cable 900 amp  | 0.06024       | 0.93976      |             | 0.027685376 |                   |              |             |
| Cable 600 amp  | 0.04272       | 0.95728      |             | 0.019274125 |                   |              |             |
| Cable 600 amp  | 0.04272       | 0.95728      |             | 0.019274125 |                   |              |             |
| Cable 600 amp  | 0.04272       | 0.95728      |             | 0.019274125 |                   |              |             |
|  |               |              |             |             |                   |              |             |
|  |               |              | 0.431899224 | 0.251794754 | 0.683693978       | 0.316306022  | 265.511182  |
|  |               |              |             |             |                   |              |             |
|  |               |              |             |             |                   |              |             |
| Pole 1   |               |              |             |             |                   |              |             |
|  | failure prob. | success prob | 312 MW prob | 156 MW prob | above 156 MW prob | zero MW prob | average MW  |
| filter-VIT   | 0.25754       | 0.74246      |             |             |                   |              |             |
| filter-ARN   | 0.25754       | 0.74246      |             |             |                   |              |             |
| Reactor-VIT  | 0.41111       | 0.58889      |             |             |                   |              |             |
| Reactor-ARN  | 0.41111       | 0.58889      |             |             |                   |              |             |
| T1   | 0.17644       | 0.82356      |             | 0.004260809 |                   |              |             |
| T2   | 0.17644       | 0.82356      |             | 0.004260809 |                   |              |             |
| T5   | 0.17644       | 0.82356      |             | 0.004260809 |                   |              |             |
| T6   | 0.17644       | 0.82356      |             | 0.004260809 |                   |              |             |
| MAV-VIT  | 0.26496       | 0.73504      |             | 0.007169016 |                   |              |             |
| MAV-VIT  | 0.26496       | 0.73504      |             | 0.007169016 |                   |              |             |
| MAV-ARN  | 0.26496       | 0.73504      |             | 0.007169016 |                   |              |             |
| MAV-ARN  | 0.26496       | 0.73504      |             | 0.007169016 |                   |              |             |
| Cable 900 amp  | 0.06024       | 0.93976      |             | 0.001274847 |                   |              |             |
| Cable 900 amp  | 0.06024       | 0.93976      |             | 0.001274847 |                   |              |             |
| Cable 600 amp  | 0.04272       | 0.95728      |             | 0.000887529 |                   |              |             |
| Cable 600 amp  | 0.04272       | 0.95728      |             | 0.000887529 |                   |              |             |
| Cable 600 amp  | 0.04272       | 0.95728      |             | 0.000887529 |                   |              |             |
|  |               |              |             |             |                   |              |             |
|  |               |              | 0.019887959 | 0.050931581 | 0.07081954        | 0.92918046   | 14.15036994 |

| Comparison of Pole 2 reliability probability between doing nothing and replacement of Pole 2 reactor at VIT |   |   |                                  |                               |
|---|---|---|----------------------------------|-------------------------------|
|   |   | Doing nothing                             |                                  |                               |
|   | Probability at 476 MW only - do nothing | Probability at 238 MW & above -do nothing | Failure probability -do nothing  |                               |
| 2004  | 0.629157259                             | 0.840012783                               | 0.159987217                      |                               |
| 2005  | 0.59390786                              | 0.808170912                               | 0.191829088                      |                               |
| 2006  | 0.554333069                             | 0.771330493                               | 0.228669507                      |                               |
| 2007  | 0.512838492                             | 0.730082813                               | 0.269917187                      |                               |
| 2008  | 0.463541606                             | 0.682057124                               | 0.317942876                      |                               |
| 2009  | 0.413689862                             | 0.629911569                               | 0.370088431                      |                               |
| 2010  | 0.362198344                             | 0.573357887                               | 0.426642113                      |                               |
|   |   | Reactor at VIT replaced by a new one      |                                  |                               |
|   | Probability at 476 MW only - new VIT RX | Probability at 238 MW & above -new VIT RX | Failure probability - new VIT RX | failure probability reduction |
| 2004  | 0.629157259                             | 0.840012783                               | 0.159987217                      | 0                             |
| 2005  | 0.634966667                             | 0.864042429                               | 0.135957571                      | 0.055871517                   |
| 2006  | 0.601807089                             | 0.837388539                               | 0.162611461                      | 0.066058046                   |
| 2007  | 0.566978784                             | 0.80715756                                | 0.19284244                       | 0.077074747                   |
| 2008  | 0.523576413                             | 0.770392598                               | 0.229607402                      | 0.088335475                   |
| 2009  | 0.479127858                             | 0.729551795                               | 0.270448205                      | 0.099640226                   |
| 2010  | 0.431899224                             | 0.683693978                               | 0.316306022                      | 0.110336091                   |
|   |   | Reactor at VIT replaced by a new one      |                                  |                               |
|   | Probability at 312 MW only              | Probability at 156 MW & above             | Failure probability              |                               |
| 2004  | 0.185683187                             | 0.389007903                               | 0.610992097                      |                               |
| 2005  | 0.143281059                             | 0.322473156                               | 0.677526844                      |                               |
| 2006  | 0.106243735                             | 0.258678238                               | 0.741321762                      |                               |
| 2007  | 0.075725132                             | 0.200479565                               | 0.799520435                      |                               |
| 2008  | 0.05100905                              | 0.148315626                               | 0.851684374                      |                               |
| 2009  | 0.032753449                             | 0.105080105                               | 0.894919895                      |                               |
| 2010  | 0.019887959                             | 0.07081954                                | 0.92918046                       |                               |

| HVDC reliability comparison between doing nothing and VIT reactor replacement |                             |                             |                            |                   |  |
|---|-----------------------------|-----------------------------|----------------------------|-------------------|--|
|   | 0 MW (VIT-RX)               | 238 MW & above (VIT-RX)     | 476 MW & above (VIT-RX)    | 0 MW (do nothing) |  |
| 2004  | 0.097750925                 | 0.86971972                  | 0.668309585                | 0.097750925       |  |
| 2005  | 0.092114904                 | 0.883522574                 | 0.667788885                | 0.129969357       |  |
| 2006  | 0.120547415                 | 0.854664988                 | 0.626836142                | 0.169517682       |  |
| 2007  | 0.154181472                 | 0.821760579                 | 0.585166354                | 0.215804307       |  |
| 2008  | 0.195553036                 | 0.782104654                 | 0.536166272                | 0.270786979       |  |
| 2009  | 0.242029479                 | 0.738409906                 | 0.487330106                | 0.3311995         |  |
| 2010  | 0.293905375                 | 0.689984659                 | 0.436906908                | 0.396427514       |  |
|   |                             |                             |                            |                   |  |
|   | 238 MW & above (do nothing) | 476 MW & above (do nothing) | 0 MW probability reduction |                   |  |
| 2004  | 0.86971972                  | 0.668309585                 | 0                          |                   |  |
| 2005  | 0.835656386                 | 0.624607697                 | 0.037854453                |                   |  |
| 2006  | 0.795625195                 | 0.577387686                 | 0.048970267                |                   |  |
| 2007  | 0.750522328                 | 0.529289347                 | 0.061622835                |                   |  |
| 2008  | 0.698275088                 | 0.474687875                 | 0.075233943                |                   |  |
| 2009  | 0.642033242                 | 0.420771868                 | 0.08917002                 |                   |  |
| 2010  | 0.581842928                 | 0.366397876                 | 0.102522139                |                   |  |

| Cumulative probability distribution of HVDC capacity (VIT reactor replacement) |                          |                            |                           |                               |                          |                           |                          |                          |                          |       |
|--|--------------------------|----------------------------|---------------------------|-------------------------------|--------------------------|---------------------------|--------------------------|--------------------------|--------------------------|-------|
| Pole 2 (New VIT reactor)   |                          |                            |                           |                               |                          |                           |                          |                          |                          |       |
|  | Failure probability      | Probability at 476 MW only | Probability at 238 MW     | Probability at 238 MW & above |                          |                           |                          |                          |                          |       |
| 2004   | 0.159987217              | 0.629157259                | 0.210855525               | 0.840012783                   |                          |                           |                          |                          |                          |       |
| 2005   | 0.135957571              | 0.634966667                | 0.229075762               | 0.864042429                   |                          |                           |                          |                          |                          |       |
| 2006   | 0.162611461              | 0.601807089                | 0.23558145                | 0.837388539                   |                          |                           |                          |                          |                          |       |
| 2007   | 0.19284244               | 0.566978784                | 0.240178776               | 0.80715756                    |                          |                           |                          |                          |                          |       |
| 2008   | 0.229607402              | 0.523576413                | 0.246816185               | 0.770392598                   |                          |                           |                          |                          |                          |       |
| 2009   | 0.270448205              | 0.479127858                | 0.250423937               | 0.729551795                   |                          |                           |                          |                          |                          |       |
| 2010   | 0.316306022              | 0.431899224                | 0.251794754               | 0.683693978                   |                          |                           |                          |                          |                          |       |
| Pole 1   |                          |                            |                           |                               |                          |                           |                          |                          |                          |       |
|  | Failure probability      | Probability at 312 MW only | Probability at 156 MW     | Probability at 156 MW & above |                          |                           |                          |                          |                          |       |
| 2004   | 0.610992097              | 0.185683187                | 0.203324716               | 0.389007903                   |                          |                           |                          |                          |                          |       |
| 2005   | 0.677526844              | 0.143281059                | 0.179192098               | 0.322473156                   |                          |                           |                          |                          |                          |       |
| 2006   | 0.741321762              | 0.106243735                | 0.152434503               | 0.258678238                   |                          |                           |                          |                          |                          |       |
| 2007   | 0.799520435              | 0.075725132                | 0.124754433               | 0.200479565                   |                          |                           |                          |                          |                          |       |
| 2008   | 0.851684374              | 0.05100905                 | 0.097306577               | 0.148315626                   |                          |                           |                          |                          |                          |       |
| 2009   | 0.894919895              | 0.032753449                | 0.072326656               | 0.105080105                   |                          |                           |                          |                          |                          |       |
| 2010   | 0.92918046               | 0.019887959                | 0.050931581               | 0.07081954                    |                          |                           |                          |                          |                          |       |
| Pole 1 & 2 density distribution  |                          |                            |                           |                               |                          |                           |                          |                          |                          |       |
|  | 0 MW (p1 and p2 failure) | 156 MW (p1-156 & p2 zero)  | 238 MW (p1 zero & p2-238) | 312 MW (p1-312 and p2 zero)   | 394 MW (p1-156 & p2-238) | 476 MW (p1 zero & p2-476) | 550 MW (p1-312 & p2-238) | 632 MW (p1-156 & p2-476) | 788 MW (p1-312 & p2-476) | Total |
| 2004   | 0.097750925              | 0.032529355                | 0.128831059               | 0.029706936                   | 0.04287214               | 0.384410113               | 0.039152326              | 0.127923221              | 0.116823925              | 1     |
| 2005   | 0.092114904              | 0.024362522                | 0.155204978               | 0.019480145                   | 0.041048566              | 0.430206962               | 0.032822218              | 0.113781009              | 0.090978696              | 1     |
| 2006   | 0.120547415              | 0.024787597                | 0.174641655               | 0.017276449                   | 0.036910741              | 0.446132692               | 0.025029053              | 0.091736164              | 0.063938233              | 1     |
| 2007   | 0.154181472              | 0.024057949                | 0.192027839               | 0.014603019                   | 0.029963367              | 0.453311124               | 0.01818757               | 0.070733117              | 0.042934544              | 1     |
| 2008   | 0.195553036              | 0.02234231                 | 0.210209488               | 0.011712055                   | 0.024016838              | 0.44592185                | 0.012589659              | 0.050947428              | 0.026707135              | 1     |
| 2009   | 0.242029479              | 0.019560614                | 0.224109363               | 0.008858112                   | 0.018112326              | 0.426781053               | 0.008202248              | 0.034653716              | 0.01569309               | 1     |
| 2010   | 0.293905375              | 0.016109966                | 0.233962765               | 0.006290681                   | 0.012824305              | 0.401312319               | 0.005007684              | 0.02199731               | 0.008589594              | 1     |
| Pole 1 & 2 cumulative distribution   |                          |                            |                           |                               |                          |                           |                          |                          |                          |       |
|  | 0 MW (p1 and p2 failure) | 156 MW & above             | 238 MW & above            | 312 MW & above                | 394 MW & above           | 476 MW & above            | 550 MW & above           | 632 MW & above           | 788 MW                   |       |
| 2004   | 0.097750925              | 0.902249075                | 0.86971972                | 0.74088866                    | 0.711181724              | 0.668309585               | 0.283899472              | 0.244747146              | 0.116823925              |       |
| 2005   | 0.092114904              | 0.907885096                | 0.883522574               | 0.728317596                   | 0.708837451              | 0.667788885               | 0.237581923              | 0.204759705              | 0.090978696              |       |
| 2006   | 0.120547415              | 0.879452585                | 0.854664988               | 0.680023332                   | 0.662746883              | 0.626836142               | 0.18070345               | 0.155674397              | 0.063938233              |       |
| 2007   | 0.154181472              | 0.845818528                | 0.821760579               | 0.62973274                    | 0.615129721              | 0.585166354               | 0.13185523               | 0.11366766               | 0.042934544              |       |
| 2008   | 0.195553036              | 0.804446964                | 0.782104654               | 0.571895166                   | 0.56018311               | 0.536166272               | 0.090244423              | 0.077654564              | 0.026707135              |       |
| 2009   | 0.242029479              | 0.757970521                | 0.738409906               | 0.514300543                   | 0.505442432              | 0.487330106               | 0.058549053              | 0.050346806              | 0.01569309               |       |
| 2010   | 0.293905375              | 0.706094625                | 0.689984659               | 0.456021894                   | 0.449731213              | 0.436906908               | 0.035594588              | 0.030586904              | 0.008589594              |       |

### Appendix 3

| Input data (VIT-filter replacement) |         |         |         |         |         |         |         |  |  |  |  |  |  |  |  |  |
|-------------------------------------|---------|---------|---------|---------|---------|---------|---------|--|--|--|--|--|--|--|--|--|
| Pole 2                              |         |         |         |         |         |         |         |  |  |  |  |  |  |  |  |  |
|                                     | 2004    | 2005    | 2006    | 2007    | 2008    | 2009    | 2010    |  |  |  |  |  |  |  |  |  |
| filter-VIT                          | 0.02557 | 0.00001 | 0.00001 | 0.00001 | 0.00001 | 0.00001 | 0.00001 | (buy a new filter in 2005)                   |  |  |  |  |  |  |  |  |
| filter-ARN                          | 0.00002 | 0.00003 | 0.00005 | 0.00008 | 0.00012 | 0.00019 | 0.0003  | (ARN filter replaced in 1996)                |  |  |  |  |  |  |  |  |
| Reactor-VIT                         | 0.05278 | 0.06485 | 0.07907 | 0.09567 | 0.11484 | 0.13675 | 0.16155 |  |  |  |  |  |  |  |  |  |
| Reactor-ARN                         | 0.05111 | 0.06321 | 0.07746 | 0.09408 | 0.11328 | 0.13524 | 0.16008 | (spare is located at ARN side)               |  |  |  |  |  |  |  |  |
| Common                              | 0.00127 | 0.00149 | 0.00176 | 0.0021  | 0.00252 | 0.00302 | 0.00364 |  |  |  |  |  |  |  |  |  |
| T3                                  | 0.01303 | 0.01644 | 0.02058 | 0.02557 | 0.03152 | 0.03858 | 0.04689 |  |  |  |  |  |  |  |  |  |
| T4                                  | 0.01303 | 0.01644 | 0.02058 | 0.02557 | 0.03152 | 0.03858 | 0.04689 |  |  |  |  |  |  |  |  |  |
| T7                                  | 0.01303 | 0.01644 | 0.02058 | 0.02557 | 0.03152 | 0.03858 | 0.04689 |  |  |  |  |  |  |  |  |  |
| T8                                  | 0.01303 | 0.01644 | 0.02058 | 0.02557 | 0.03152 | 0.03858 | 0.04689 |  |  |  |  |  |  |  |  |  |
| V3                                  | 0.01299 | 0.01458 | 0.01641 | 0.01852 | 0.02094 | 0.02369 | 0.02682 |  |  |  |  |  |  |  |  |  |
| V4                                  | 0.01299 | 0.01458 | 0.01641 | 0.01852 | 0.02094 | 0.02369 | 0.02682 |  |  |  |  |  |  |  |  |  |
| V7                                  | 0.01299 | 0.01458 | 0.01641 | 0.01852 | 0.02094 | 0.02369 | 0.02682 |  |  |  |  |  |  |  |  |  |
| V8                                  | 0.01299 | 0.01458 | 0.01641 | 0.01852 | 0.02094 | 0.02369 | 0.02682 |  |  |  |  |  |  |  |  |  |
| Auxiliary-V3                        | 0.0011  | 0.00132 | 0.00159 | 0.00193 | 0.00234 | 0.00285 | 0.00346 |  |  |  |  |  |  |  |  |  |
| Auxiliary-V4                        | 0.0011  | 0.00132 | 0.00159 | 0.00193 | 0.00234 | 0.00285 | 0.00346 |  |  |  |  |  |  |  |  |  |
| Auxiliary-V7                        | 0.0011  | 0.00132 | 0.00159 | 0.00193 | 0.00234 | 0.00285 | 0.00346 |  |  |  |  |  |  |  |  |  |
| Auxiliary-V8                        | 0.0011  | 0.00132 | 0.00159 | 0.00193 | 0.00234 | 0.00285 | 0.00346 |  |  |  |  |  |  |  |  |  |
| Cable 900 amp                       | 0.04689 | 0.04842 | 0.05019 | 0.05023 | 0.05456 | 0.05722 | 0.06024 | (MTTR assumed 4 months)                      |  |  |  |  |  |  |  |  |
| Cable 900 amp                       | 0.04689 | 0.04842 | 0.05019 | 0.05023 | 0.05456 | 0.05722 | 0.06024 | (900 amp cable assumed less life expectancy) |  |  |  |  |  |  |  |  |
| Cable 600 amp                       | 0.04058 | 0.04082 | 0.04111 | 0.04143 | 0.0418  | 0.04223 | 0.04272 | (MTTR assumed 4 months)                      |  |  |  |  |  |  |  |  |
| Cable 600 amp                       | 0.04058 | 0.04082 | 0.04111 | 0.04143 | 0.0418  | 0.04223 | 0.04272 |  |  |  |  |  |  |  |  |  |
| Cable 600 amp                       | 0.04058 | 0.04082 | 0.04111 | 0.04143 | 0.0418  | 0.04223 | 0.04272 |  |  |  |  |  |  |  |  |  |
|                                     |         |         |         |         |         |         |         |  |  |  |  |  |  |  |  |  |
|                                     |         |         |         |         |         |         |         |  |  |  |  |  |  |  |  |  |
| Pole 1                              |         |         |         |         |         |         |         |  |  |  |  |  |  |  |  |  |
|                                     | 2004    | 2005    | 2006    | 2007    | 2008    | 2009    | 2010    |  |  |  |  |  |  |  |  |  |
| filter-VIT                          | 0.10389 | 0.12309 | 0.14478 | 0.16905 | 0.19596 | 0.22549 | 0.25754 |  |  |  |  |  |  |  |  |  |
| filter-ARN                          | 0.10389 | 0.12309 | 0.14478 | 0.16905 | 0.19596 | 0.22549 | 0.25754 |  |  |  |  |  |  |  |  |  |
| Reactor-VIT                         | 0.18921 | 0.21992 | 0.2535  | 0.28976 | 0.3284  | 0.36902 | 0.41111 |  |  |  |  |  |  |  |  |  |
| Reactor-ARN                         | 0.18921 | 0.21992 | 0.2535  | 0.28976 | 0.3284  | 0.36902 | 0.41111 |  |  |  |  |  |  |  |  |  |
| T1                                  | 0.08277 | 0.09373 | 0.10637 | 0.12082 | 0.13724 | 0.15575 | 0.17644 |  |  |  |  |  |  |  |  |  |
| T2                                  | 0.08277 | 0.09373 | 0.10637 | 0.12082 | 0.13724 | 0.15575 | 0.17644 |  |  |  |  |  |  |  |  |  |
| T5                                  | 0.08277 | 0.09373 | 0.10637 | 0.12082 | 0.13724 | 0.15575 | 0.17644 |  |  |  |  |  |  |  |  |  |
| T6                                  | 0.08277 | 0.09373 | 0.10637 | 0.12082 | 0.13724 | 0.15575 | 0.17644 |  |  |  |  |  |  |  |  |  |
| MAV-VIT                             | 0.11284 | 0.13185 | 0.15332 | 0.17735 | 0.20399 | 0.23322 | 0.26496 |  |  |  |  |  |  |  |  |  |
| MAV-VIT                             | 0.11284 | 0.13185 | 0.15332 | 0.17735 | 0.20399 | 0.23322 | 0.26496 |  |  |  |  |  |  |  |  |  |
| MAV-ARN                             | 0.11284 | 0.13185 | 0.15332 | 0.17735 | 0.20399 | 0.23322 | 0.26496 |  |  |  |  |  |  |  |  |  |
| MAV-ARN                             | 0.11284 | 0.13185 | 0.15332 | 0.17735 | 0.20399 | 0.23322 | 0.26496 |  |  |  |  |  |  |  |  |  |
| Cable 900 amp                       | 0.04689 | 0.04842 | 0.05019 | 0.05023 | 0.05456 | 0.05722 | 0.06024 |  |  |  |  |  |  |  |  |  |
| Cable 900 amp                       | 0.04689 | 0.04842 | 0.05019 | 0.05023 | 0.05456 | 0.05722 | 0.06024 |  |  |  |  |  |  |  |  |  |
| Cable 600 amp                       | 0.04058 | 0.04082 | 0.04111 | 0.04143 | 0.0418  | 0.04223 | 0.04272 |  |  |  |  |  |  |  |  |  |
| Cable 600 amp                       | 0.04058 | 0.04082 | 0.04111 | 0.04143 | 0.0418  | 0.04223 | 0.04272 |  |  |  |  |  |  |  |  |  |
| Cable 600 amp                       | 0.04058 | 0.04082 | 0.04111 | 0.04143 | 0.0418  | 0.04223 | 0.04272 |  |  |  |  |  |  |  |  |  |

| Probability calculations of capacities for Poles 1 and 2 in 2004 (VIT filter replacement) |               |              |             |             |                   |              |            |
|---|---------------|--------------|-------------|-------------|-------------------|--------------|------------|
| Pole 2  |               |              |             |             |                   |              |            |
|   | failure prob. | success prob | 476 MW prob | 238 MW prob | above 238 MW prob | zero MW prob | average MW |
| filter-VIT  | 0.02557       | 0.97443      |             |             |                   |              |            |
| filter-ARN  | 0.00002       | 0.99998      |             |             |                   |              |            |
| Reactor-VIT   | 0.05278       | 0.94722      |             |             |                   |              |            |
| Reactor-ARN   | 0.05111       | 0.94889      |             |             |                   |              |            |
| Common  | 0.00127       | 0.99873      |             |             |                   |              |            |
| T3  | 0.01303       | 0.98697      |             | 0.008306148 |                   |              |            |
| T4  | 0.01303       | 0.98697      |             | 0.008306148 |                   |              |            |
| T7  | 0.01303       | 0.98697      |             | 0.008306148 |                   |              |            |
| T8  | 0.01303       | 0.98697      |             | 0.008306148 |                   |              |            |
| V3  | 0.01299       | 0.98701      |             | 0.008280314 |                   |              |            |
| V4  | 0.01299       | 0.98701      |             | 0.008280314 |                   |              |            |
| V7  | 0.01299       | 0.98701      |             | 0.008280314 |                   |              |            |
| V8  | 0.01299       | 0.98701      |             | 0.008280314 |                   |              |            |
| Auxiliary-V3  | 0.0011        | 0.9989       |             | 0.000692835 |                   |              |            |
| Auxiliary-V4  | 0.0011        | 0.9989       |             | 0.000692835 |                   |              |            |
| Auxiliary-V7  | 0.0011        | 0.9989       |             | 0.000692835 |                   |              |            |
| Auxiliary-V8  | 0.0011        | 0.9989       |             | 0.000692835 |                   |              |            |
| Cable 900 amp   | 0.04689       | 0.95311      |             | 0.030952549 |                   |              |            |
| Cable 900 amp   | 0.04689       | 0.95311      |             | 0.030952549 |                   |              |            |
| Cable 600 amp   | 0.04058       | 0.95942      |             | 0.026611079 |                   |              |            |
| Cable 600 amp   | 0.04058       | 0.95942      |             | 0.026611079 |                   |              |            |
| Cable 600 amp   | 0.04058       | 0.95942      |             | 0.026611079 |                   |              |            |
|   |               |              |             |             |                   |              |            |
|   |               |              | 0.629157259 | 0.210855525 | 0.840012783       | 0.159987217  | 349.66247  |
|   |               |              |             |             |                   |              |            |
| Pole 1  |               |              |             |             |                   |              |            |
|   | failure prob. | success prob | 312 MW prob | 156 MW prob | above 156 MW prob | zero MW prob | average MW |
| filter-VIT  | 0.10389       | 0.89611      |             |             |                   |              |            |
| filter-ARN  | 0.10389       | 0.89611      |             |             |                   |              |            |
| Reactor-VIT   | 0.18921       | 0.81079      |             |             |                   |              |            |
| Reactor-ARN   | 0.18921       | 0.81079      |             |             |                   |              |            |
| T1  | 0.08277       | 0.91723      |             | 0.016755882 |                   |              |            |
| T2  | 0.08277       | 0.91723      |             | 0.016755882 |                   |              |            |
| T5  | 0.08277       | 0.91723      |             | 0.016755882 |                   |              |            |
| T6  | 0.08277       | 0.91723      |             | 0.016755882 |                   |              |            |
| MAV-VIT   | 0.11284       | 0.88716      |             | 0.023617488 |                   |              |            |
| MAV-VIT   | 0.11284       | 0.88716      |             | 0.023617488 |                   |              |            |
| MAV-ARN   | 0.11284       | 0.88716      |             | 0.023617488 |                   |              |            |
| MAV-ARN   | 0.11284       | 0.88716      |             | 0.023617488 |                   |              |            |
| Cable 900 amp   | 0.04689       | 0.95311      |             | 0.009135026 |                   |              |            |
| Cable 900 amp   | 0.04689       | 0.95311      |             | 0.009135026 |                   |              |            |
| Cable 600 amp   | 0.04058       | 0.95942      |             | 0.007853728 |                   |              |            |
| Cable 600 amp   | 0.04058       | 0.95942      |             | 0.007853728 |                   |              |            |
| Cable 600 amp   | 0.04058       | 0.95942      |             | 0.007853728 |                   |              |            |
|   |               |              |             |             |                   |              |            |
|   |               |              | 0.185683187 | 0.203324716 | 0.389007903       | 0.610992097  | 89.6518101 |

| Probability calculations of capacities for Poles 1 and 2 in 2005 (VIT filter replacement) |               |              |             |             |                   |              |             |
|---|---------------|--------------|-------------|-------------|-------------------|--------------|-------------|
| Pole2   | failure prob. | success prob | 476 MW prob | 238 MW prob | above 238 MW prob | zero MW prob | average MW  |
| filter-VIT  | 0.00001       | 0.99999      |             |             |                   |              |             |
| filter-ARN  | 0.00003       | 0.99997      |             |             |                   |              |             |
| Reactor-VIT   | 0.06485       | 0.93515      |             |             |                   |              |             |
| Reactor-ARN   | 0.06321       | 0.93679      |             |             |                   |              |             |
| Common  | 0.00149       | 0.99851      |             |             |                   |              |             |
| T3  | 0.01644       | 0.98356      |             | 0.010255216 |                   |              |             |
| T4  | 0.01644       | 0.98356      |             | 0.010255216 |                   |              |             |
| T7  | 0.01644       | 0.98356      |             | 0.010255216 |                   |              |             |
| T8  | 0.01644       | 0.98356      |             | 0.010255216 |                   |              |             |
| V3  | 0.01458       | 0.98542      |             | 0.009077787 |                   |              |             |
| V4  | 0.01458       | 0.98542      |             | 0.009077787 |                   |              |             |
| V7  | 0.01458       | 0.98542      |             | 0.009077787 |                   |              |             |
| V8  | 0.01458       | 0.98542      |             | 0.009077787 |                   |              |             |
| Auxiliary-V3  | 0.00132       | 0.99868      |             | 0.000810945 |                   |              |             |
| Auxiliary-V4  | 0.00132       | 0.99868      |             | 0.000810945 |                   |              |             |
| Auxiliary-V7  | 0.00132       | 0.99868      |             | 0.000810945 |                   |              |             |
| Auxiliary-V8  | 0.00132       | 0.99868      |             | 0.000810945 |                   |              |             |
| Cable 900 amp   | 0.04842       | 0.95158      |             | 0.031219313 |                   |              |             |
| Cable 900 amp   | 0.04842       | 0.95158      |             | 0.031219313 |                   |              |             |
| Cable 600 amp   | 0.04082       | 0.95918      |             | 0.026110594 |                   |              |             |
| Cable 600 amp   | 0.04082       | 0.95918      |             | 0.026110594 |                   |              |             |
| Cable 600 amp   | 0.04082       | 0.95918      |             | 0.026110594 |                   |              |             |
|   |               |              | 0.613541381 | 0.221346201 | 0.834887581       | 0.165112419  | 344.726093  |
|   |               |              |             |             |                   |              |             |
| Pole 1  |               |              |             |             |                   |              |             |
|   | failure prob. | success prob | 312 MW prob | 156 MW prob | above 156 MW prob | zero MW prob | average MW  |
| filter-VIT  | 0.12309       | 0.87691      |             |             |                   |              |             |
| filter-ARN  | 0.12309       | 0.87691      |             |             |                   |              |             |
| Reactor-VIT   | 0.21992       | 0.78008      |             |             |                   |              |             |
| Reactor-ARN   | 0.21992       | 0.78008      |             |             |                   |              |             |
| T1  | 0.09373       | 0.90627      |             | 0.014818689 |                   |              |             |
| T2  | 0.09373       | 0.90627      |             | 0.014818689 |                   |              |             |
| T5  | 0.09373       | 0.90627      |             | 0.014818689 |                   |              |             |
| T6  | 0.09373       | 0.90627      |             | 0.014818689 |                   |              |             |
| MAV-VIT   | 0.13185       | 0.86815      |             | 0.021760764 |                   |              |             |
| MAV-VIT   | 0.13185       | 0.86815      |             | 0.021760764 |                   |              |             |
| MAV-ARN   | 0.13185       | 0.86815      |             | 0.021760764 |                   |              |             |
| MAV-ARN   | 0.13185       | 0.86815      |             | 0.021760764 |                   |              |             |
| Cable 900 amp   | 0.04842       | 0.95158      |             | 0.007290684 |                   |              |             |
| Cable 900 amp   | 0.04842       | 0.95158      |             | 0.007290684 |                   |              |             |
| Cable 600 amp   | 0.04082       | 0.95918      |             | 0.006097638 |                   |              |             |
| Cable 600 amp   | 0.04082       | 0.95918      |             | 0.006097638 |                   |              |             |
| Cable 600 amp   | 0.04082       | 0.95918      |             | 0.006097638 |                   |              |             |
|   |               |              | 0.143281059 | 0.179192098 | 0.322473156       | 0.677526844  | 72.65765748 |

| Probability calculations of capacities for Poles 1 and 2 in 2006 (VIT filter replacement) |               |              |             |             |                   |              |             |
|---|---------------|--------------|-------------|-------------|-------------------|--------------|-------------|
| Pole 2  |               |              |             |             |                   |              |             |
|   | failure prob. | success prob | 476 MW prob | 238 MW prob | above 238 MW prob | zero MW prob | average MW  |
| filter-VIT  | 0.00001       | 0.99999      |             |             |                   |              |             |
| filter-ARN  | 0.00005       | 0.99995      |             |             |                   |              |             |
| Reactor-VIT   | 0.07907       | 0.92093      |             |             |                   |              |             |
| Reactor-ARN   | 0.07746       | 0.92254      |             |             |                   |              |             |
| Common  | 0.00176       | 0.99824      |             |             |                   |              |             |
| T3  | 0.02058       | 0.97942      |             | 0.012129558 |                   |              |             |
| T4  | 0.02058       | 0.97942      |             | 0.012129558 |                   |              |             |
| T7  | 0.02058       | 0.97942      |             | 0.012129558 |                   |              |             |
| T8  | 0.02058       | 0.97942      |             | 0.012129558 |                   |              |             |
| V3  | 0.01641       | 0.98359      |             | 0.009630815 |                   |              |             |
| V4  | 0.01641       | 0.98359      |             | 0.009630815 |                   |              |             |
| V7  | 0.01641       | 0.98359      |             | 0.009630815 |                   |              |             |
| V8  | 0.01641       | 0.98359      |             | 0.009630815 |                   |              |             |
| Auxiliary-V3  | 0.00159       | 0.99841      |             | 0.000919299 |                   |              |             |
| Auxiliary-V4  | 0.00159       | 0.99841      |             | 0.000919299 |                   |              |             |
| Auxiliary-V7  | 0.00159       | 0.99841      |             | 0.000919299 |                   |              |             |
| Auxiliary-V8  | 0.00159       | 0.99841      |             | 0.000919299 |                   |              |             |
| Cable 900 amp   | 0.05019       | 0.94981      |             | 0.030503454 |                   |              |             |
| Cable 900 amp   | 0.05019       | 0.94981      |             | 0.030503454 |                   |              |             |
| Cable 600 amp   | 0.04111       | 0.95889      |             | 0.024748407 |                   |              |             |
| Cable 600 amp   | 0.04111       | 0.95889      |             | 0.024748407 |                   |              |             |
| Cable 600 amp   | 0.04111       | 0.95889      |             | 0.024748407 |                   |              |             |
|   |               |              | 0.57725614  | 0.225970815 | 0.803226954       | 0.196773046  | 328.5549763 |
| Pole 1  |               |              |             |             |                   |              |             |
|   | failure prob. | success prob | 312 MW prob | 156 MW prob | above 156 MW prob | zero MW prob | average MW  |
| filter-VIT  | 0.14478       | 0.85522      |             |             |                   |              |             |
| filter-ARN  | 0.14478       | 0.85522      |             |             |                   |              |             |
| Reactor-VIT   | 0.2535        | 0.7465       |             |             |                   |              |             |
| Reactor-ARN   | 0.2535        | 0.7465       |             |             |                   |              |             |
| T1  | 0.10637       | 0.89363      |             | 0.012646337 |                   |              |             |
| T2  | 0.10637       | 0.89363      |             | 0.012646337 |                   |              |             |
| T5  | 0.10637       | 0.89363      |             | 0.012646337 |                   |              |             |
| T6  | 0.10637       | 0.89363      |             | 0.012646337 |                   |              |             |
| MAV-VIT   | 0.15332       | 0.84668      |             | 0.019239015 |                   |              |             |
| MAV-VIT   | 0.15332       | 0.84668      |             | 0.019239015 |                   |              |             |
| MAV-ARN   | 0.15332       | 0.84668      |             | 0.019239015 |                   |              |             |
| MAV-ARN   | 0.15332       | 0.84668      |             | 0.019239015 |                   |              |             |
| Cable 900 amp   | 0.05019       | 0.94981      |             | 0.005614147 |                   |              |             |
| Cable 900 amp   | 0.05019       | 0.94981      |             | 0.005614147 |                   |              |             |
| Cable 600 amp   | 0.04111       | 0.95889      |             | 0.004554933 |                   |              |             |
| Cable 600 amp   | 0.04111       | 0.95889      |             | 0.004554933 |                   |              |             |
| Cable 600 amp   | 0.04111       | 0.95889      |             | 0.004554933 |                   |              |             |
|   |               |              | 0.106243735 | 0.152434503 | 0.258678238       | 0.741321762  | 56.92782777 |



| Probability calculations of capacities for Poles 1 and 2 in 2007 (VIT filter replacement) |               |              |             |             |                   |              |            |
|---|---------------|--------------|-------------|-------------|-------------------|--------------|------------|
| Pole 2  |               |              |             |             |                   |              |            |
|   | failure prob. | success prob | 476 MW prob | 238 MW prob | above 238 MW prob | zero MW prob | average MW |
| filter-VIT  | 0.00001       | 0.99999      |             |             |                   |              |            |
| filter-ARN  | 0.00008       | 0.99992      |             |             |                   |              |            |
| Reactor-VIT   | 0.09567       | 0.90433      |             |             |                   |              |            |
| Reactor-ARN   | 0.09408       | 0.90592      |             |             |                   |              |            |
| Common  | 0.0021        | 0.9979       |             |             |                   |              |            |
| T3  | 0.02557       | 0.97443      |             | 0.014148995 |                   |              |            |
| T4  | 0.02557       | 0.97443      |             | 0.014148995 |                   |              |            |
| T7  | 0.02557       | 0.97443      |             | 0.014148995 |                   |              |            |
| T8  | 0.02557       | 0.97443      |             | 0.014148995 |                   |              |            |
| V3  | 0.01852       | 0.98148      |             | 0.010174312 |                   |              |            |
| V4  | 0.01852       | 0.98148      |             | 0.010174312 |                   |              |            |
| V7  | 0.01852       | 0.98148      |             | 0.010174312 |                   |              |            |
| V8  | 0.01852       | 0.98148      |             | 0.010174312 |                   |              |            |
| Auxiliary-V3  | 0.00193       | 0.99807      |             | 0.001042658 |                   |              |            |
| Auxiliary-V4  | 0.00193       | 0.99807      |             | 0.001042658 |                   |              |            |
| Auxiliary-V7  | 0.00193       | 0.99807      |             | 0.001042658 |                   |              |            |
| Auxiliary-V8  | 0.00193       | 0.99807      |             | 0.001042658 |                   |              |            |
| Cable 900 amp   | 0.05023       | 0.94977      |             | 0.028516108 |                   |              |            |
| Cable 900 amp   | 0.05023       | 0.94977      |             | 0.028516108 |                   |              |            |
| Cable 600 amp   | 0.04143       | 0.95857      |             | 0.02330433  |                   |              |            |
| Cable 600 amp   | 0.04143       | 0.95857      |             | 0.02330433  |                   |              |            |
| Cable 600 amp   | 0.04143       | 0.95857      |             | 0.02330433  |                   |              |            |
|   |               |              | 0.539194587 | 0.228409068 | 0.767603655       | 0.232396345  | 311.017981 |
|   |               |              |             |             |                   |              |            |
|   |               |              |             |             |                   |              |            |
| Pole 1  |               |              |             |             |                   |              |            |
|   | failure prob. | success prob | 312 MW prob | 156 MW prob | above 156 MW prob | zero MW prob | average MW |
| filter-VIT  | 0.16905       | 0.83095      |             |             |                   |              |            |
| filter-ARN  | 0.16905       | 0.83095      |             |             |                   |              |            |
| Reactor-VIT   | 0.28976       | 0.71024      |             |             |                   |              |            |
| Reactor-ARN   | 0.28976       | 0.71024      |             |             |                   |              |            |
| T1  | 0.12082       | 0.87918      |             | 0.010406413 |                   |              |            |
| T2  | 0.12082       | 0.87918      |             | 0.010406413 |                   |              |            |
| T5  | 0.12082       | 0.87918      |             | 0.010406413 |                   |              |            |
| T6  | 0.12082       | 0.87918      |             | 0.010406413 |                   |              |            |
| MAV-VIT   | 0.17735       | 0.82265      |             | 0.016325111 |                   |              |            |
| MAV-VIT   | 0.17735       | 0.82265      |             | 0.016325111 |                   |              |            |
| MAV-ARN   | 0.17735       | 0.82265      |             | 0.016325111 |                   |              |            |
| MAV-ARN   | 0.17735       | 0.82265      |             | 0.016325111 |                   |              |            |
| Cable 900 amp   | 0.05023       | 0.94977      |             | 0.004004836 |                   |              |            |
| Cable 900 amp   | 0.05023       | 0.94977      |             | 0.004004836 |                   |              |            |
| Cable 600 amp   | 0.04143       | 0.95857      |             | 0.003272888 |                   |              |            |
| Cable 600 amp   | 0.04143       | 0.95857      |             | 0.003272888 |                   |              |            |
| Cable 600 amp   | 0.04143       | 0.95857      |             | 0.003272888 |                   |              |            |
|   |               |              | 0.075725132 | 0.124754433 | 0.200479565       | 0.799520435  | 43.0879328 |

| Probability calculations of capacities for Poles 1 and 2 in 2008 (VIT filter replacement) |               |              |             |             |                   |              |            |
|---|---------------|--------------|-------------|-------------|-------------------|--------------|------------|
| Pole 2  |               |              |             |             |                   |              |            |
|   | failure prob. | success prob | 476 MW prob | 238 MW prob | above 238 MW prob | zero MW prob | average MW |
| filter-VIT  | 0.00001       | 0.99999      |             |             |                   |              |            |
| filter-ARN  | 0.00012       | 0.99988      |             |             |                   |              |            |
| Reactor-VIT   | 0.11484       | 0.88516      |             |             |                   |              |            |
| Reactor-ARN   | 0.11328       | 0.88672      |             |             |                   |              |            |
| Common  | 0.00252       | 0.99748      |             |             |                   |              |            |
| T3  | 0.03152       | 0.96848      |             | 0.016044202 |                   |              |            |
| T4  | 0.03152       | 0.96848      |             | 0.016044202 |                   |              |            |
| T7  | 0.03152       | 0.96848      |             | 0.016044202 |                   |              |            |
| T8  | 0.03152       | 0.96848      |             | 0.016044202 |                   |              |            |
| V3  | 0.02094       | 0.97906      |             | 0.010543625 |                   |              |            |
| V4  | 0.02094       | 0.97906      |             | 0.010543625 |                   |              |            |
| V7  | 0.02094       | 0.97906      |             | 0.010543625 |                   |              |            |
| V8  | 0.02094       | 0.97906      |             | 0.010543625 |                   |              |            |
| Auxiliary-V3  | 0.00234       | 0.99766      |             | 0.001156261 |                   |              |            |
| Auxiliary-V4  | 0.00234       | 0.99766      |             | 0.001156261 |                   |              |            |
| Auxiliary-V7  | 0.00234       | 0.99766      |             | 0.001156261 |                   |              |            |
| Auxiliary-V8  | 0.00234       | 0.99766      |             | 0.001156261 |                   |              |            |
| Cable 900 amp   | 0.05456       | 0.94544      |             | 0.028448734 |                   |              |            |
| Cable 900 amp   | 0.05456       | 0.94544      |             | 0.028448734 |                   |              |            |
| Cable 600 amp   | 0.0418        | 0.9582       |             | 0.02150516  |                   |              |            |
| Cable 600 amp   | 0.0418        | 0.9582       |             | 0.02150516  |                   |              |            |
| Cable 600 amp   | 0.0418        | 0.9582       |             | 0.02150516  |                   |              |            |
|   |               |              | 0.49297235  | 0.232389297 | 0.725361647       | 0.274638353  | 289.963491 |
|   |               |              |             |             |                   |              |            |
|   |               |              |             |             |                   |              |            |
| Pole 1  |               |              |             |             |                   |              |            |
|   | failure prob. | success prob | 312 MW prob | 156 MW prob | above 156 MW prob | zero MW prob | average MW |
| filter-VIT  | 0.19596       | 0.80404      |             |             |                   |              |            |
| filter-ARN  | 0.19596       | 0.80404      |             |             |                   |              |            |
| Reactor-VIT   | 0.3284        | 0.6716       |             |             |                   |              |            |
| Reactor-ARN   | 0.3284        | 0.6716       |             |             |                   |              |            |
| T1  | 0.13724       | 0.86276      |             | 0.008114055 |                   |              |            |
| T2  | 0.13724       | 0.86276      |             | 0.008114055 |                   |              |            |
| T5  | 0.13724       | 0.86276      |             | 0.008114055 |                   |              |            |
| T6  | 0.13724       | 0.86276      |             | 0.008114055 |                   |              |            |
| MAV-VIT   | 0.20399       | 0.79601      |             | 0.013071866 |                   |              |            |
| MAV-VIT   | 0.20399       | 0.79601      |             | 0.013071866 |                   |              |            |
| MAV-ARN   | 0.20399       | 0.79601      |             | 0.013071866 |                   |              |            |
| MAV-ARN   | 0.20399       | 0.79601      |             | 0.013071866 |                   |              |            |
| Cable 900 amp   | 0.05456       | 0.94544      |             | 0.00294366  |                   |              |            |
| Cable 900 amp   | 0.05456       | 0.94544      |             | 0.00294366  |                   |              |            |
| Cable 600 amp   | 0.0418        | 0.9582       |             | 0.002225191 |                   |              |            |
| Cable 600 amp   | 0.0418        | 0.9582       |             | 0.002225191 |                   |              |            |
| Cable 600 amp   | 0.0418        | 0.9582       |             | 0.002225191 |                   |              |            |
|   |               |              | 0.05100905  | 0.097306577 | 0.148315626       | 0.851684374  | 31.0946494 |

| Probability calculations of capacities for Poles 1 and 2 in 2009 (VIT filter replacement) |               |              |             |             |                   |              |             |
|---|---------------|--------------|-------------|-------------|-------------------|--------------|-------------|
| Pole 2  |               |              |             |             |                   |              |             |
|   | failure prob. | success prob | 476 MW prob | 238 MW prob | above 238 MW prob | zero MW prob | average MW  |
| filter-VIT  | 0.00001       | 0.99999      |             |             |                   |              |             |
| filter-ARN  | 0.00019       | 0.99981      |             |             |                   |              |             |
| Reactor-VIT   | 0.13675       | 0.86325      |             |             |                   |              |             |
| Reactor-ARN   | 0.13524       | 0.86476      |             |             |                   |              |             |
| Common  | 0.00302       | 0.99698      |             |             |                   |              |             |
| T3  | 0.03858       | 0.96142      |             | 0.017894962 |                   |              |             |
| T4  | 0.03858       | 0.96142      |             | 0.017894962 |                   |              |             |
| T7  | 0.03858       | 0.96142      |             | 0.017894962 |                   |              |             |
| T8  | 0.03858       | 0.96142      |             | 0.017894962 |                   |              |             |
| V3  | 0.02369       | 0.97631      |             | 0.010820791 |                   |              |             |
| V4  | 0.02369       | 0.97631      |             | 0.010820791 |                   |              |             |
| V7  | 0.02369       | 0.97631      |             | 0.010820791 |                   |              |             |
| V8  | 0.02369       | 0.97631      |             | 0.010820791 |                   |              |             |
| Auxiliary-V3  | 0.00285       | 0.99715      |             | 0.001274577 |                   |              |             |
| Auxiliary-V4  | 0.00285       | 0.99715      |             | 0.001274577 |                   |              |             |
| Auxiliary-V7  | 0.00285       | 0.99715      |             | 0.001274577 |                   |              |             |
| Auxiliary-V8  | 0.00285       | 0.99715      |             | 0.001274577 |                   |              |             |
| Cable 900 amp   | 0.05722       | 0.94278      |             | 0.027065696 |                   |              |             |
| Cable 900 amp   | 0.05722       | 0.94278      |             | 0.027065696 |                   |              |             |
| Cable 600 amp   | 0.04223       | 0.95777      |             | 0.019662628 |                   |              |             |
| Cable 600 amp   | 0.04223       | 0.95777      |             | 0.019662628 |                   |              |             |
| Cable 600 amp   | 0.04223       | 0.95777      |             | 0.019662628 |                   |              |             |
|   |               |              | 0.445945416 | 0.233080596 | 0.679026012       | 0.320973988  | 267.7431999 |
|   |               |              |             |             |                   |              |             |
|   |               |              |             |             |                   |              |             |
| Pole 1  |               |              |             |             |                   |              |             |
|   | failure prob. | success prob | 312 MW prob | 156 MW prob | above 156 MW prob | zero MW prob | average MW  |
| filter-VIT  | 0.22549       | 0.77451      |             |             |                   |              |             |
| filter-ARN  | 0.22549       | 0.77451      |             |             |                   |              |             |
| Reactor-VIT   | 0.36902       | 0.63098      |             |             |                   |              |             |
| Reactor-ARN   | 0.36902       | 0.63098      |             |             |                   |              |             |
| T1  | 0.15575       | 0.84425      |             | 0.006042463 |                   |              |             |
| T2  | 0.15575       | 0.84425      |             | 0.006042463 |                   |              |             |
| T5  | 0.15575       | 0.84425      |             | 0.006042463 |                   |              |             |
| T6  | 0.15575       | 0.84425      |             | 0.006042463 |                   |              |             |
| MAV-VIT   | 0.23322       | 0.76678      |             | 0.009962127 |                   |              |             |
| MAV-VIT   | 0.23322       | 0.76678      |             | 0.009962127 |                   |              |             |
| MAV-ARN   | 0.23322       | 0.76678      |             | 0.009962127 |                   |              |             |
| MAV-ARN   | 0.23322       | 0.76678      |             | 0.009962127 |                   |              |             |
| Cable 900 amp   | 0.05722       | 0.94278      |             | 0.0019879   |                   |              |             |
| Cable 900 amp   | 0.05722       | 0.94278      |             | 0.0019879   |                   |              |             |
| Cable 600 amp   | 0.04223       | 0.95777      |             | 0.001444165 |                   |              |             |
| Cable 600 amp   | 0.04223       | 0.95777      |             | 0.001444165 |                   |              |             |
| Cable 600 amp   | 0.04223       | 0.95777      |             | 0.001444165 |                   |              |             |
|   |               |              | 0.032753449 | 0.072326656 | 0.105080105       | 0.894919895  | 21.5020344  |

| Probability calculations of capacities for Poles 1 and 2 in 2010 (VIT filter replacement) |               |              |             |             |                   |              |             |
|---|---------------|--------------|-------------|-------------|-------------------|--------------|-------------|
| Pole 2  |               |              |             |             |                   |              |             |
|   | failure prob. | success prob | 476 MW prob | 238 MW prob | above 238 MW prob | zero MW prob | average MW  |
| filter-VIT  | 0.00001       | 0.99999      |             |             |                   |              |             |
| filter-ARN  | 0.0003        | 0.9997       |             |             |                   |              |             |
| Reactor-VIT   | 0.16155       | 0.83845      |             |             |                   |              |             |
| Reactor-ARN   | 0.16008       | 0.83992      |             |             |                   |              |             |
| Common  | 0.00364       | 0.99636      |             |             |                   |              |             |
| T3  | 0.04689       | 0.95311      |             | 0.019516797 |                   |              |             |
| T4  | 0.04689       | 0.95311      |             | 0.019516797 |                   |              |             |
| T7  | 0.04689       | 0.95311      |             | 0.019516797 |                   |              |             |
| T8  | 0.04689       | 0.95311      |             | 0.019516797 |                   |              |             |
| V3  | 0.02682       | 0.97318      |             | 0.010932939 |                   |              |             |
| V4  | 0.02682       | 0.97318      |             | 0.010932939 |                   |              |             |
| V7  | 0.02682       | 0.97318      |             | 0.010932939 |                   |              |             |
| V8  | 0.02682       | 0.97318      |             | 0.010932939 |                   |              |             |
| Auxiliary-V3  | 0.00346       | 0.99654      |             | 0.001377377 |                   |              |             |
| Auxiliary-V4  | 0.00346       | 0.99654      |             | 0.001377377 |                   |              |             |
| Auxiliary-V7  | 0.00346       | 0.99654      |             | 0.001377377 |                   |              |             |
| Auxiliary-V8  | 0.00346       | 0.99654      |             | 0.001377377 |                   |              |             |
| Cable 900 amp   | 0.06024       | 0.93976      |             | 0.025429589 |                   |              |             |
| Cable 900 amp   | 0.06024       | 0.93976      |             | 0.025429589 |                   |              |             |
| Cable 600 amp   | 0.04272       | 0.95728      |             | 0.017703682 |                   |              |             |
| Cable 600 amp   | 0.04272       | 0.95728      |             | 0.017703682 |                   |              |             |
| Cable 600 amp   | 0.04272       | 0.95728      |             | 0.017703682 |                   |              |             |
|   |               |              | 0.396708348 | 0.231278677 | 0.627987025       | 0.372012975  | 243.8774988 |
|   |               |              |             |             |                   |              |             |
|   |               |              |             |             |                   |              |             |
| Pole 1  |               |              |             |             |                   |              |             |
|   | failure prob. | success prob | 312 MW prob | 156 MW prob | above 156 MW prob | zero MW prob | average MW  |
| filter-VIT  | 0.25754       | 0.74246      |             |             |                   |              |             |
| filter-ARN  | 0.25754       | 0.74246      |             |             |                   |              |             |
| Reactor-VIT   | 0.41111       | 0.58889      |             |             |                   |              |             |
| Reactor-ARN   | 0.41111       | 0.58889      |             |             |                   |              |             |
| T1  | 0.17644       | 0.82356      |             | 0.004260809 |                   |              |             |
| T2  | 0.17644       | 0.82356      |             | 0.004260809 |                   |              |             |
| T5  | 0.17644       | 0.82356      |             | 0.004260809 |                   |              |             |
| T6  | 0.17644       | 0.82356      |             | 0.004260809 |                   |              |             |
| MAV-VIT   | 0.26496       | 0.73504      |             | 0.007169016 |                   |              |             |
| MAV-VIT   | 0.26496       | 0.73504      |             | 0.007169016 |                   |              |             |
| MAV-ARN   | 0.26496       | 0.73504      |             | 0.007169016 |                   |              |             |
| MAV-ARN   | 0.26496       | 0.73504      |             | 0.007169016 |                   |              |             |
| Cable 900 amp   | 0.06024       | 0.93976      |             | 0.001274847 |                   |              |             |
| Cable 900 amp   | 0.06024       | 0.93976      |             | 0.001274847 |                   |              |             |
| Cable 600 amp   | 0.04272       | 0.95728      |             | 0.000887529 |                   |              |             |
| Cable 600 amp   | 0.04272       | 0.95728      |             | 0.000887529 |                   |              |             |
| Cable 600 amp   | 0.04272       | 0.95728      |             | 0.000887529 |                   |              |             |
|   |               |              | 0.019887959 | 0.050931581 | 0.07081954        | 0.92918046   | 14.15036994 |

| Reliability distribution results for Poles 1 and 2 (VIT filter replacement) |                            |   |                                      |                               |
|---|----------------------------|---|--------------------------------------|-------------------------------|
| Doing nothing   |                            |   |                                      |                               |
|   | Probability at 476 MW only | Probability at 238 MW & above -do nothing     | Failure probability -do nothing      |                               |
| 2004  | 0.629157259                | 0.840012783                                   | 0.159987217                          |                               |
| 2005  | 0.59390786                 | 0.808170912                                   | 0.191829088                          |                               |
| 2006  | 0.554333069                | 0.771330493                                   | 0.228669507                          |                               |
| 2007  | 0.512838492                | 0.730082813                                   | 0.269917187                          |                               |
| 2008  | 0.463541606                | 0.682057124                                   | 0.317942876                          |                               |
| 2009  | 0.413689862                | 0.629911569                                   | 0.370088431                          |                               |
| 2010  | 0.362198344                | 0.573357887                                   | 0.426642113                          |                               |
| Filter at VIT replaced by a new one   |                            |   |                                      |                               |
|   | Probability at 476 MW only | Probability at 238 MW & above -new VIT filter | Failure probability - new VIT filter | failure probability reduction |
| 2004  | 0.629157259                | 0.840012783                                   | 0.159987217                          | 0                             |
| 2005  | 0.613541381                | 0.834887581                                   | 0.165112419                          | 0.02671667                    |
| 2006  | 0.57725614                 | 0.803226954                                   | 0.196773046                          | 0.031896461                   |
| 2007  | 0.539194587                | 0.767603655                                   | 0.232396345                          | 0.037520842                   |
| 2008  | 0.49297235                 | 0.725361647                                   | 0.274638353                          | 0.043304523                   |
| 2009  | 0.445945416                | 0.679026012                                   | 0.320973988                          | 0.049114443                   |
| 2010  | 0.396708348                | 0.627987025                                   | 0.372012975                          | 0.054629138                   |
|   | Probability at 312 MW only | Probability at 156 MW & above                 | Failure probability                  |                               |
| 2004  | 0.185683187                | 0.389007903                                   | 0.610992097                          |                               |
| 2005  | 0.143281059                | 0.322473156                                   | 0.677526844                          |                               |
| 2006  | 0.106243735                | 0.258678238                                   | 0.741321762                          |                               |
| 2007  | 0.075725132                | 0.200479565                                   | 0.799520435                          |                               |
| 2008  | 0.05100905                 | 0.148315626                                   | 0.851684374                          |                               |
| 2009  | 0.032753449                | 0.105080105                                   | 0.894919895                          |                               |
| 2010  | 0.019887959                | 0.07081954                                    | 0.92918046                           |                               |

| HVDC reliability distribution (VIT filter replacement) |                |                             |                           |                   |
|--|----------------|-----------------------------|---------------------------|-------------------|
|  | 0 MW (VIT-flt) | 238 MW & above (VIT-flt)    | 476 MW & above (VIT-flt)  | 0 MW (do nothing) |
| 2004   | 0.097750925    | 0.86971972                  | 0.668309585               | 0.097750925       |
| 2005   | 0.111868096    | 0.858545064                 | 0.645256099               | 0.129969357       |
| 2006   | 0.145872141    | 0.824132858                 | 0.601264123               | 0.169517682       |
| 2007   | 0.185805627    | 0.785201899                 | 0.556490894               | 0.215804307       |
| 2008   | 0.233905194    | 0.739370688                 | 0.504826307               | 0.270786979       |
| 2009   | 0.287246008    | 0.689539017                 | 0.45357961                | 0.3311995         |
| 2010   | 0.345667187    | 0.635385604                 | 0.401308009               | 0.396427514       |
|  |                |                             |                           |                   |
|  | 238 MW & above | 476 MW & above (do nothing) | 0MW probability reduction |                   |
| 2004   | 0.86971972     | 0.668309585                 | 0                         |                   |
| 2005   | 0.835666386    | 0.624607697                 | 0.018101261               |                   |
| 2006   | 0.795625195    | 0.577387686                 | 0.023645541               |                   |
| 2007   | 0.750522328    | 0.529289347                 | 0.02999868                |                   |
| 2008   | 0.698275088    | 0.474687875                 | 0.036881786               |                   |
| 2009   | 0.642033242    | 0.420771868                 | 0.043953492               |                   |
| 2010   | 0.581842928    | 0.366397876                 | 0.050760327               |                   |

| Cumulative probability distribution to HVDC capacity (VIT filter replacement) |                          |                            |                           |                               |                          |                           |                          |                          |                          |       |
|---|--------------------------|----------------------------|---------------------------|-------------------------------|--------------------------|---------------------------|--------------------------|--------------------------|--------------------------|-------|
| Pole 2 (New VIT filter)   |                          |                            |                           |                               |                          |                           |                          |                          |                          |       |
|   | Failure probability      | Probability at 476 MW only | Probability at 238 MW     | Probability at 238 MW & above |                          |                           |                          |                          |                          |       |
| 2004  | 0.159987217              | 0.629157259                | 0.210855525               | 0.840012783                   |                          |                           |                          |                          |                          |       |
| 2005  | 0.165112419              | 0.613541381                | 0.221346201               | 0.834887581                   |                          |                           |                          |                          |                          |       |
| 2006  | 0.196773046              | 0.57725614                 | 0.225970815               | 0.803226954                   |                          |                           |                          |                          |                          |       |
| 2007  | 0.232396345              | 0.539194587                | 0.228409068               | 0.767603655                   |                          |                           |                          |                          |                          |       |
| 2008  | 0.274638353              | 0.49297235                 | 0.232389297               | 0.725361647                   |                          |                           |                          |                          |                          |       |
| 2009  | 0.320973988              | 0.445945416                | 0.233080596               | 0.679026012                   |                          |                           |                          |                          |                          |       |
| 2010  | 0.372012975              | 0.396708348                | 0.231278677               | 0.627987025                   |                          |                           |                          |                          |                          |       |
| Pole 1  |                          |                            |                           |                               |                          |                           |                          |                          |                          |       |
|   | Failure probability      | Probability at 312 MW only | Probability at 156 MW     | Probability at 156 MW & above |                          |                           |                          |                          |                          |       |
| 2004  | 0.610992097              | 0.185683187                | 0.203324716               | 0.389007903                   |                          |                           |                          |                          |                          |       |
| 2005  | 0.677526844              | 0.143281059                | 0.179192098               | 0.322473156                   |                          |                           |                          |                          |                          |       |
| 2006  | 0.741321762              | 0.106243735                | 0.152434503               | 0.258678238                   |                          |                           |                          |                          |                          |       |
| 2007  | 0.799520435              | 0.075725132                | 0.124754433               | 0.200479565                   |                          |                           |                          |                          |                          |       |
| 2008  | 0.851684374              | 0.05100905                 | 0.097306577               | 0.148315626                   |                          |                           |                          |                          |                          |       |
| 2009  | 0.894919895              | 0.032753449                | 0.072326656               | 0.105080105                   |                          |                           |                          |                          |                          |       |
| 2010  | 0.92918046               | 0.019887959                | 0.050931581               | 0.07081954                    |                          |                           |                          |                          |                          |       |
| Pole 1 & 2 density distribution   |                          |                            |                           |                               |                          |                           |                          |                          |                          |       |
|   | 0 MW (p1 and p2 failure) | 156 MW (p1-156 & p2 zero)  | 238 MW (p1 zero & p2-238) | 312 MW (p1-312 and p2 zero)   | 394 MW (p1-156 & p2-238) | 476 MW (p1 zero & p2-476) | 550 MW (p1-312 & p2-238) | 632 MW (p1-156 & p2-476) | 788 MW (p1-312 & p2-476) | Total |
| 2004  | 0.097750925              | 0.032529355                | 0.128831059               | 0.029706936                   | 0.04287214               | 0.384410113               | 0.039152326              | 0.127923221              | 0.116823925              | 1     |
| 2005  | 0.111868096              | 0.029586841                | 0.149967993               | 0.023657482                   | 0.03966349               | 0.415690755               | 0.031714718              | 0.109941767              | 0.087908858              | 1     |
| 2006  | 0.145872141              | 0.029995001                | 0.167517083               | 0.020905903                   | 0.034445749              | 0.427932539               | 0.024007983              | 0.087993753              | 0.061329848              | 1     |
| 2007  | 0.185805627              | 0.028992474                | 0.182617717               | 0.017598244                   | 0.028495044              | 0.431097091               | 0.017296307              | 0.067266915              | 0.040830582              | 1     |
| 2008  | 0.233905194              | 0.026724118                | 0.197922333               | 0.014009041                   | 0.022613007              | 0.419856847               | 0.011853957              | 0.047969452              | 0.025146051              | 1     |
| 2009  | 0.287246008              | 0.023214975                | 0.208588462               | 0.010513005                   | 0.01685794               | 0.399085425               | 0.007634193              | 0.032253741              | 0.014606251              | 1     |
| 2010  | 0.345667187              | 0.018947209                | 0.214899627               | 0.007398579                   | 0.011779389              | 0.368613645               | 0.004599661              | 0.020204983              | 0.007889719              | 1     |
| Pole 1 & 2 cumulative distribution  |                          |                            |                           |                               |                          |                           |                          |                          |                          |       |
|   | 0 MW (p1 and p2 failure) | 156 MW & above             | 238 MW & above            | 312 MW & above                | 394 MW & above           | 476 MW & above            | 550 MW & above           | 632 MW & above           | 788 MW                   |       |
| 2004  | 0.097750925              | 0.902249075                | 0.86971972                | 0.74088866                    | 0.711181724              | 0.668309585               | 0.283899472              | 0.244747146              | 0.116823925              |       |
| 2005  | 0.111868096              | 0.888131904                | 0.858545064               | 0.708577071                   | 0.684919589              | 0.645256099               | 0.229565343              | 0.197850625              | 0.087908858              |       |
| 2006  | 0.145872141              | 0.854127859                | 0.824132958               | 0.656615775                   | 0.635709872              | 0.601264123               | 0.173331584              | 0.149323601              | 0.061329848              |       |
| 2007  | 0.185805627              | 0.814194373                | 0.785201899               | 0.602584181                   | 0.584985937              | 0.556490894               | 0.125393803              | 0.108097496              | 0.040830582              |       |
| 2008  | 0.233905194              | 0.766094806                | 0.739370688               | 0.541448355                   | 0.527439314              | 0.504826307               | 0.08496946               | 0.073115503              | 0.025146051              |       |
| 2009  | 0.287246008              | 0.712753992                | 0.689539017               | 0.480950555                   | 0.47043755               | 0.45357961                | 0.054494184              | 0.046859991              | 0.014606251              |       |
| 2010  | 0.345667187              | 0.654332813                | 0.635385604               | 0.420465977                   | 0.4130807398             | 0.401308009               | 0.032694364              | 0.020094703              | 0.007889719              |       |