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QUALITY CONTROL		
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## 1. Expert Meeting 27.11.2014

*TenneT requested if a number of J-tubes could be provided for a 33kV and a 66kV connection philosophy.*

## 2. Expert Meeting 29.01.2015

*A choice for six J-tubes as absolute minimum is suggested. However, some raise the issue for adding extra redundancy by creating loops and therefore might need more J-tubes. Comments were given that the parties would like to have TenneT show different OWF layouts. To substantiate the choices, TenneT is making in a broader context.*

## 3. Expert Meeting 18.03.2015

### Summary of concerns based on feedback during the Expert Meeting

- More than one spare considered desirable to cope with repair actions.
- Is there enough room to incorporate infield redundancy schemes that require more J-Tubes?
- Designing the system on 630 A is using the upper level as base case.

### Feedback from the meeting attendees:

*From experience it is better to have more J-tubes. The concept presented is the lowest possible amount of J-tubes. 12 strings with 5 wind turbines per string which gives optimum flexibility. In case switch gear fails then you can still power the wind turbines. Costs will be decreased. Smaller cables decrease costs more than adding J-tubes.*

*Suggestion to make a specific site layout for Borssele since you might need an additional J-tube when the layout doesn't allow specific connection at certain points of the platform – due to pipelines and cabling etc. Reserve one specific J-tube that can be used for quick repair of strings that could fail (including switch gear etc). Specific reservation for that wind farm for cable repair.*

*What is the overload capability: upper side of what is currently available. This is the upper side/the maximum possible?*

*What happens in the case of co-location. With other words: will this be connected to the spare J-tube? This would mean that in case of colocation there's no spare J-tube available anymore.*

## 4. Expert Meeting 15&16.04.2015

### Summary of concerns based on feedback during the Expert Meeting

- Overall there are no objections to the amount of 8 j-tubes except for one developer which would like

to extent this amount to 12 based on its development philosophy.

### **Feedback from the meeting attendees:**

*We are talking about three parties: TenneT, developers with ring system, developers radial system. If the amount of J-tubes is fixed at a low amount than the lay out is mostly fixed (radial system). Why not add J-tubes (12 strings for 66kV) in order to keep availabilities open and therefore reducing risks?*

*If the number of 12 j-tubes is applied other elements will also increase, space on platform, circuit breakers etc. a lot of equipment could be installed which might not used in the end.*

*We started this discussion with 6 J-tubes and are now at the number of 8. Is this enough and does this decrease the risk sufficiently? How far can we stretch this amount?*

*8 is sufficient for how we now develop a WF but to lock this in for the future is quite stressing. How can we say that 8 j-tubes is still the best in the future (taking into account changes in costs etc). How fixed is this?*

*Is it a big challenge to have this many J-tubes on the platform? Suggestion would be to choose an amount that could be divided by 4. We can agree with 8 j-tubes. Is the spare tube necessary? If this is on the opposite site of the j-tube failure it could be possible that for connection to the spare j tube cables need to be crossed.*

*The testing roll out should be known before opening of the tender.*

### **5. Expert Meeting 12&13.05.2015**

*Based on 66 kV inter-array cables and 64 MW per cable - a standard platform shall be equipped with 18 J-tubes for the inter array system:*

- *2x 8 J-tubes for offshore PPM*
- *1 J-tube installed for possible test purposes*
- *1 J-tube installed for the connection to the neighbouring platform.*

### **Feedback from the meeting attendees**

*No comments*

## 6. TenneT stakeholder consultation website March

*The advice for this topic is to first make a specific site layout and determine, based on that site specific layout, how many J-tubes are needed. Then added to that number there should be two redundant J-tube available, for design flexibility and a spare exclusively reserved for the wind farm in the event of an inter array cable fault. This J-tube plus equipment should be capable to reconnect every particular string.*

*We call for more flexibility in the number of J-tubes per wind farm of 350 MW wind farm. Each wind farm should at least have access to one spare J-tube. This way different designs and layouts can be taken into account and gives room for "overplanting" up to 380 MW. On the one hand this leads to an increase in costs due to the higher number of J-tubes but on the other hand this also leads to a cost decrease since more yield can be expected from the wind farm.*

*As general feed-back we agree with TenneT assessment on number of J-tubes.*

*Re: "For dimensioning of the J-tubes, the diameter of the 66 kV cable is estimated to be 160 mm. The inner diameter of the J-tube shall be at least 2,5 times the diameter of the cable, resulting in at least 400 mm."*

**For 33kV** we might see 630mm<sup>2</sup> cables with an outer diameter of 155mm + up to 6mm tolerance.

*J-tube inner dimensions should be minimum 2.5 x cable OD => ID ≤ 2.5 x (155+6) => ID ≤ 402.5mm*

*On top of that we might end up using 800mm<sup>2</sup>, so I would advise that the 33kV j-tubes should have a minimum inner clearance of 402.5mm.*

**For 66kV** we do not have an overview of cable sizes from a broad range of suppliers.

*We are however in correspondence with a likely supplier that offer a 800mm<sup>2</sup> with an outer diameter of 171mm + up to 3.5mm tolerance.*

*J-tube inner dimensions should be minimum 2.5 x cable OD => ID ≤ 2.5 x (171+3.5) => ID ≤ 436.25mm*

*On top of that we might end up using 800mm<sup>2</sup>, so I would advise that the 66kV j-tubes should have a minimum inner clearance of 436.25mm.*

*Clearly the number of J-tubes in any case (33kV/66kV) should be sufficient and allow some freedom in design of the wind farm layout.*

*A spare J-tube is required for repairs or maintenance, as suggested by TenneT.*

*With regards to the Borssele Substation Design we believe that it makes sense to provide 12 J-tubes per site. The scenario with 6 J-Tubes is under the possible solutions a design*

*a) with a very low flexibility in all phases (Eng./Installation/Commissioning and Operation) of the project and*

*b) has the highest risk profile.*

## **7. TenneT stakeholder consultation website April**

*TenneT foresees 8 J-tubes per WF (2 x 8 per platform) in case of 66kV. 16 J-tubes (2 x 16) in case of 33kV would provide sufficient flexibility, but needs to be checked with park & IAC lay-out.*

## **8. Bi-lateral meetings**

## **9. Other**