Department of Energy

Bonneville Power Administration
P.O. Box 3621
Portland, Oregon 97208-3621

PUBLIC AFFAIRS

February 2, 2012

In reply refer to: DK-7

Francisco Carvalho
Ex 6

FOIA #BPA-2012-00676-F

Dear Mr. Carvalho:

Thank you for your request for records that you made to the Bonneville Power Administration (BPA), under the Freedom of Information Act (FOIA), 5 U.S.C. 552. Your request was received in this office on Wednesday, February 1, 2012, and has been assigned a control number, BPA-2012-00656-F. Please use this number in any correspondence with the Agency about your request.

You have requested the following:
Copy of BPA Substation Design Standards - specifically related to "direct stroke lightning shielding of substations".

Your request addresses all of the criteria of a proper request under the FOIA, DOE, and BPA regulation that implements the FOIA at Title 10, Code of Federal Regulations, Part 1004.

We have been able to process it quickly. You will find a CD with the requested documents, in their entirety, enclosed.

There are no fees associated with this request.

Pursuant to 10 CFR 1004.8, if you are dissatisfied with this determination, or the adequacy of the search, you may appeal in writing within 30 calendar days of receipt of a final response letter. The appeal should be made to the Director, Office of Hearings and Appeals, HG-1, Department of Energy, 1000 Independence Avenue, SW, Washington, DC 20585-1615. The written appeal, including the envelope, must clearly indicate that a FOIA Appeal is being made.

Thank you for your interest in Bonneville Power Administration. Please contact Kim Winn, Communications Specialist at 503-230-7305 with any questions about this letter.

Sincerely,

/s/ Christina J. Munro
Christina J. Munro
Freedom of Information Act/Privacy Act Officer

Enclosed: CD

From: Perkins,Sam C (BPA) - TESD-CSB-2
Sent: Thursday, February 02, 2012 12:36 PM
To: Winn,Kim S (BPA) - DK-7
Subject: RE: New FOIA request BPA-2012-000676-F

Attachments: D1LIGPRO.doc

Kim,

I have attached BPA's most recent published version of the substation lightning protection standard.

Please note that we are in the process of revising it this year, and I would be happy to forward a copy to Mr. Carvalho when it is finished. I expect it to be ready before September of 2012.

In the meantime, I would like Mr. Carvalho to know that the amount of lightning that occurs in the BPA service area is relatively small. (In fact we do not have continuous shield wire on our transmission lines below 500 kV.) Therefore I will be proposing that we continue to use the 150-foot radius sphere method for substation lighting protection, rather than the more conservative IEEE 998 'EGM' method, which recommends sphere diameters based on the Basic Impulse Insulation Level (BIL) for each voltage class. There are others here at BPA who feel that even the 'fixed angle' method should be sufficient, considering the relatively low amount of lightning we experience. I agree, but suggest that at substations east of the western Idaho border, we only use the 150-foot sphere method, just to be a little more conservative. According to the isokeraunic maps, there is more lightning in Idaho, Montana and Wyoming than in Oregon, Washington and Northern California. Probability equations in IEEE 998 indicate that we should achieve around 95% protection by using the 150-foot sphere method. Perhaps at sites with a history of lightning strikes we could consider applying the IEEE 998 'EGM' method.

If Mr. Carvalho has any recommendations he would be willing to share with us regarding lightning protection in general, or on our standard, we would be most grateful.

Sam

D1LIGPRO.doc (75 KB)

From: Winn,Kim S (BPA) - DK-7
Sent: Thursday, February 02, 2012 11:29 AM
To: Perkins,Sam C (BPA) - TESD-CSB-2
Subject: New FOIA request BPA-2012-000676-F

Good morning Sam,

You have been designated as the Authorizing Official (AO) for the attached incoming FOIA request from Mr. Francisco Carvalho.
<< File: BPA-2012-00676-FRequest.pdf >> << File: Employee Training PP.ppt >>

All information needs to be delivered to me no later than Friday, February 24, 2012, to meet our target response date of Thursday, March 1, 2012.

If you have questions, please feel free to give me a call.

Thank you for your assistance!

Kim Winn
Communications Specialist
x5273

----------Legacy Standard – Not Verified----------

INTENT

- To provide a fundamental overview of lightning and surge protection as used on the BPA system.

Major studies have been performed based on both practical and theoretical analysis, including performance-measurements over a nine year period-at 4600 locations on 433 miles of overhead power lines. A statistical analysis of the performance of the lines and their conductor configurations was the basis of their results and recommendations. The studies were published in several IEEE papers and the results were included in the NFPA #78 standard.

During the last several centuries, many different shield angles have been proposed as adequate or optimum for lightning protection. As recently as 20 years ago, 45 degrees was considered the standard for BPA substations. More recently, 30 degrees (measured from vertical) outside the shield wire or mast and 60 degrees between parallel, closely spaced wires or masts became the new standard. In the 1980's, the 150-foot radius sphere concept, which was based on extensive tests and studies, was introduced as the best available design and was proven to produce 99.5% lightning protection.

RELATED TOPICS

Surge Arresters

APPLICATION

RELIABILITY CRITERIA

All facilities rated 15-kV and above and all transformer and reactors shall be provided with surge protection. Surge protection includes surge arresters, protective rod gaps, shield wire on incoming lines, and substation shielding. Arresters and rod gaps will be rated to coordinate with the insulation level of the equipment being protected and with the degree of shielding at the facility.

Refer to the Reliability Criteria for Transmission Lines (Section I-E) for shielding of incoming transmission lines.

Normally, substations shall be effectively shielded to prevent direct lightning strikes to energized equipment. As discussed in paragraph 10.4, customer feeder stations may not be shielded.

Customer feeder substations 23O-kV and below may have alternative surge protection requirements depending on size of transformer, use of high side load switching devices, and length of entering transmission line. If the substation transformation is 25 MVA (forced-cooled rated) or less and no high side load switching devices are either installed or planned, no rod gaps or arresters are required on the incoming lines and the station

does not require effective shielding.

For customer feeder substations with transformation greater than 25 MVA , or when high side load switching devices are installed or planned, and when the minimum acceptable transmission line shielding criteria is met, rod gaps shall be installed at the station entrance of the incoming lines and the station shall be effectively shielded.

For customer feeder substations where the transformation is greater than 25 MVA or high side load switching devices are installed or planned and it is not economic to meet the minimum incoming transmission line shielding criteria, gapless metal oxide surge arresters shall be installed at the station entrance of incoming lines and the station shall be effectively shielded.

For older BPA designs using a single overhead shield wire with the 45-degree angle zone of protection :

- For 69-kV and 115-kV installations, the 45-degree zone provides good, conservative protection. However, the sphere zone shows that a given wire provides appreciably more protection beyond the 45-degree zone, especially at and below the high-bus level.

- For 230-kV installations, the 45-degree zone provides roughly the same amount of protection as the sphere zone, with slightly more useful protection below the high-bus level, but slightly less protection at and above the high-bus level. There normally is little or no equipment above high-bus level, except perhaps open disconnect switch blades, which would require protection.

- For 500-kV installations, the 45-degree zone permits an excessively large area of unprotected equipment, both above and below the high-bus level, when compared to the sphere zone.

For older BPA designs having equipment located between parallel shield wires and which used the 45-degree zone of protection:

- For 69-kV installations, the 45-degree zone with overhead shield wire spacings up to 50 feet provides good protection for equipment at and below high-bus level. The larger sphere zone shows good protection by wires spaced up to 170 feet.

- For 115-kV installations, the 45-degree zone with overhead shield wire spacings up to 60 feet provides good protection for equipment at and below high-bus level. The larger sphere zone shows good protection by wires spaced up to 180 feet.

- For 230-kV installations, the-45 degree zone with overhead shield wire spacings up to 90 feet provides good protection for equipment at and below high-bus level. The sphere zone shows good protection by wires spaced up to 220 feet.

  For 500-kV installations, the 45-degree zone with overhead shield wire spacings up to 140 feet provides good, protection for equipment at and below high-bus level. The sphere zone shows good protection by wires spaced up to 250 feet.

For more recent BPA designs using a single overhead shield wire with the 30- degree angle zone of protection:

- For 69-kV and 115-kV installations, the 30-degree zone provides good, but ultraconservative, protection when compared with the sphere zone. The sphere zone shows much more protection beyond the 30-degree zone for equipment above and below the high-bus level.

- For 230-kV installations, the 30-degree zone provides good protection, but the zone is much smaller than necessary. The sphere zone shows a larger zone of protection for equipment above the high-bus level, and a much larger zone of protection for equipment at and below the high-bus level;

- For 500-kV installations, the 30-degree zone provides good protection for equipment at and below the high-bus level. The sphere zone shows more protection for equipment below the high-bus level.

For more recent BPA designs with equipment located between parallel shield wires, the designs with the 60-degree angle zone shows mixed results:

- For 69-kV installations, the 60-degree zone with overhead shield wires spaced up to 90 feet provides good protection for equipment at and below high-bus level. The sphere zone shows good protection by wires spaced up to 170 feet.

- For 115-kV installations, the 60-degree zone with overhead shield wires spaced up to 110 feet provides good protection for equipment at and below high-bus level. The sphere zone shows good protection by wires spaced up to 180 feet.

- For 230-kV installations, the 60-degree zone with overhead shield wires spaced up to 160 feet provides good protection for equipment at and below high-bus level. The sphere zone shows good protection by wires spaced up to 220 feet.

- For 500-kV installations, the 60-degree zone with overhead shield wires spaced up to 240 feet provides good protection for equipment at and below high-bus level. The sphere zone shows good protection by wires spaced up to 250 feet. Equipment located above high-bus level may not be protected unless wire spacing is reduced to a range of 150 to 200 feet.

SPECIAL CONSIDERATIONS

The dimensions used above for overhead shield wire spacings should be considered the maximum, applicable only to the termination elevations of overhead shield wires on multiple dead end towers. The spacings need to be reduced according to the amount of sag in the wires toward the center of the spans.

The term "Parallel", as used above, should be interpreted broadly, as most shield wires are only approximately parallel, and may diverge at various horizontal and vertical angles. Protection coverage varies accordingly.

For wires on structures for other voltages, for ground masts, and for grounded metal buildings of different heights, the spacings and zones of protection should also be determined using the sphere zone analysis.

The high-bus level was selected as a reference because little or no equipment in a standard terminal bay is higher, except for open disconnect switch blades for voltages up to 230 kV.

RESULTS

Designs using the 45- or 30/60-degree protection zones show mixed results when compared to the sphere protection zone, with some switchyards apparently overprotected and others underprotected. Both conditions can exist in the same substation and even in the same-kV yard.

With overprotection, some of the extra costs are probably unjustified. Several recent projects would have required additional overhead shield wires if the 30/60-degree zone criteria had been applied. Because the sphere zone was used, additional wires were found unnecessary, which illustrates cost savings.

With underprotection, the system equipment theoretically is subjected to higher incidences of lightning strokes, with more frequent stress and operations of protection devices, and possibly higher rates of failures.