And now we'll hear on the third issue from Dr. Venkat Banunarayanan, an electrical engineer with ICF International.

Thank you, Robert and good afternoon everyone. I am going to describe a study that we did at ICF regarding line separation distances. There were two goals for the study, the first was to develop a universal framework that's applicable in all situations for determining separation distances between transmission lines, and the second goal was to apply this framework to transmission lines in Wyoming to determine a minimum range of acceptable line separation distances.

The study first performed a detailed literature survey to understand the various issues involved in line separation distances. It develops a robust and universally applicable framework that can be used to determine line separation distances in any region, and it applies the framework to the state of Wyoming. However, it is important to note that the study does not replace WECC approval process for transmission lines. The study also does not perform environmental impact or any other analysis that is required for transmission lines.

As Brian had mentioned in detail about the WRS 1.1 carrier criteria for common corridors, here I just want to show different ways in which we can meet that criteria. Of course, all of these ways are based on approval from WECC. Some of the ways are forced to ensure adequate line separation is kept to prevent

common corridor outages. You could also implement mitigation measures such as remedial action schemes for a common corridor outage. You could also meet the criteria by demonstrating that the mean time between failures, MTBF, for a common corridor outage is more than 30 years, or you could consider probable common corridor outages during the analyses, the type of path rating analysis that again Brian mentioned, and accept the granted path rating for the proposed project.

This chart shows various factors that influence either a reduction or an increase in line separation distances. There are really a lot of factors as shown in this chart, for example, if there are two lines closer to each other, environmental permitting delays could be reduced because there is less footprint of land being used. It will also reduce installation or maintenance costs because the same maintenance trip could serve to maintain both the lines because they are close to each other. However, again as Robert had mentioned earlier, electrical reliability concerns could necessitate spacing lines farther apart. So there are factors completing with each other, or that influence reduction or increase in separation distances. This chart also shows that there is no single value for line separation distance because there are a lot of factors involved, and therefore there is a range of acceptable separation distances that are based on various factors.

Now from the literature surveys that we did as part of the study, the first thing we observed was there was no universal framework for determination of line

separation distances and the line separation distances was determined historically on a case-by-case basis.

We also observed that the determinants of line separation distances factor that influence them could be grouped in three main categories. One is the absolute, second is the CASE specific, and the third is the region specific. Therefore, we developed a framework in which the total line separation distance is split into three components, and these three components are shown in this figure, the AB-MIN, the CASE-MIN and the REG-MIN component.

Now all of these three components depend on different factors and these factors are shown in this chart. The AB-MIN component or the absolute minimum depends on industry standard rules such as the National Electricity Safety Code and OSHA rules. It also considers transmission tower height and the sag length of a conductor between two transmission towers.

Now the CASE-MIN is a project-specific component and it is important to note that it could be either positive or negative. One of the examples in which it could be negative would be that a project passes through a narrow valley which could force two lines to be closer, and therefore the separation distance could be less than AB-MIN.

Now REG-MIN, which is a regional minimum component is based on regionally varying factors such as the weather and as will be shown later, would need more detailed analysis to determine the separation distance.

So based on these three components, the process to determine the range of separation distance is first to determine the AB-MIN or the absolute minimum, next to determine the CASE-MIN, which is project specific, and the third to determine the REG-MIN, which is regional specific. And as mentioned before, as was shown in the chart earlier it is not possible to derive an exact number for the line separation distance since it is a range based on a number of factors, and therefore the range of minimum line separation distance could be from AB-MIN, which is at minimum value, and then the maximum would be the sum of the three components, the AB-MIN and the CASE-MIN and the REG-MIN.

So based on this framework, we applied this to the state of Wyoming and we considered counties in the southern part and the eastern part of Wyoming. The reason we considered only those counties is most of the proposed transmission lines in Wyoming pass through one or more of these counties, and this figure shows those counties, with the rest of them being shaded.

Again, based on the various factors that influence the three components, we determine that the AB-MIN, the absolute minimum was 260 feet between two transmission lines in Wyoming. Now this value is based on certain key

assumptions. The first one is, this value is based on a typical 500 kV line and tower characteristics, and any applicable NESC and OSHA regulations. In this case, the CASE-MIN we assumed it to be 0 feet since we are looking at region and not necessarily at a single transmission line or a project.

The regional component or the REG-MIN is the incremental line separation needed to account for all factors regional to Wyoming. In our literature survey and also in the analysis of the causes for historical transmission outages in Wyoming, we found that weather to be the most significant factor, different weather conditions to be the most significant factor for transmission line outages, and we also found that five types of weather caused most of the transmission line outages, they are wind, storms, fire, tornadoes and lightning. So divided the REG-MIN component into those contributed by the five incremental components, which is REG-MIN wind, REG-MIN storm, REG-MIN due to fire, and REG-MIN due to tornadoes and REG-MIN due to lightning. So the maximum value among these five components would mitigate for the other four, and therefore that would be the value for REG-MIN.

Based on these definitions, now the minimum range for line separation distances was determined as follows. First the AB-MIN was a value of 260 feet, CASE-MIN was 0 feet since we were not looking at any specific transmission lines, and to derive the REG-MIN we made three important assumptions. The first one is that the transmission line mitigates the risk of fire-related outages by installing fire

breaks and/or early detection system and operation guidance. The second assumption is the outages due to high winds and tornadoes are mitigated by designing transmission lines to withstand 101 miles per hour wind speeds, and at least F0 class tornadoes. The reason we chose F0 was that, based on historical data, F0 class tornadoes are the most common in Wyoming. And a third assumption is that the risk of lightning-related outages are mitigated by installing shield wires or transmission line arresters. If these three assumptions are fulfilled, then the REG-MIN component is 1240 feet. Therefore, based on the earlier chart, the minimum separation distance ranges from AB-MIN, which is 260 feet, to the sum of the three components, which is 260 + 0 + 1240, which is 1500 feet and therefore the separation distance is between 260 and 1500 feet for lines in Wyoming. Therefore, the minimum separation distance in Wyoming is 1500 feet, which is made up of these three components as explained earlier.

This concludes my part of the presentation. Back to you, Robert.