Okay, thanks John. Let's see, not too much time left. I'm gonna try to buzz through electron calcs quickly. Oops, wrong one. Okay, no. This one? Okay. Back to nomenclature. Some of the independent variables that we're gonna deal with with electron calculations are as follows. Applicator, field size, most accelerators would say have five applicators that you can use to collimate the beam. Effective field size akin to a phantom scatter factor so it's the field size on the patient surface after further collimation. G is a variable that's basically a gap factor. It's the distant between the treatment SSD and your normalization SSD, which for our purposes here we'll call 100 cm. So if you have to go to an extended SSD, you're gonna get a gap. Effective SSD, the very bottom one, is an effective source of surface distant and I'll talk about how we use that in just a second. A couple of dependent variables, there's an air gap correction factor, which

is used in a different method to calculate modern units of extended SSD's, I'll talk about that in a second as well. And then over all, the electron output factor, which most of you are familiar with in calculating electron modern units and it's sort of an all encompassing output factor. Okay. So the general equation that we use for this is the familiar equation that most of you are familiar with and that's the dose of prescription, and I'm not gonna consider the case here where you're prescribing to a percentage depth dose, I'm talking about D-max here alone, divided by the output of the modern units, centigrade per modern units and then also that output factor we talked about just a minute ago as a function of the applicator and the let's call it the effective field size here or the collimated field size. For extended SSD's, for example, posterior neck electrons where you perhaps can't get your 100 SSD at the patient surface, there's two different methods

that TG71 is gonna recommend akin to what TG25 did. In this case, you see the familiar factors here, but then there's this essentially inverse square factor down here, which has effective SSD's plus depth and in this case effective SSD plus depth plus the gap that you had to use to treat the patient and then a square term on the bottom there. The second technique from M.D. Anderson uses slightly differently than TG71 the nominal SSD. So 100 SSD, whereas in TG25 that was a virtual SSD, but for our purposes here we're gonna use the nominal SSD plus depth and the gap. And then sort of a fudge factor here, which is the difference between the straight inverse square attenuation and what the actual dosimetry shows. Okay. So, as usual for square fields we're gonna measure the output factor during commissioning and if you have some extra time you could even measure those at different SSD's. But assuming you only do them at 100 SSD, that

would be the standard data set that you'd get with an accelerator. For rectangular fields, we're gonna recommend that you use the square root method from Mills, et al. Basically says that the output factor for a applicator field size and a rectangular field, a length and a width, is basically the square root of the product of the output factors of squares of those two sides. And many irregular fields can also be approximated by rectangular fields, there's a couple examples here. Posterior neck electrons, it's essentially a rectangle here so you can make that into a rectangle and just assume the dosimetry is the same. Some of these are a little more complicated, for example, with a little wing out here, we suggest you treat more as a rectangle that way assuming that a lot of the scatter from out here is not making to the prescription point anyway. Okay. So, if the fields are very small, however, you have to make some special considerations and what we consider a very small field is an effective field size or let's say a phantom field size that is smaller than the energy over two and a half. So, for example, for a 6MEv field, if your effective field size on the order of two or two and a half centimeters then there's some special dosimetry that you have to consider because you're not getting equilibrium, for example on that field. For bigger or for higher energy, such as 20MEv, now you're starting to talk about a ten by ten field, but if you have an eight by eight field, for example, and 20MEv you still have these problems with lateral scatter equilibrium. And so, under these conditions you can determine your output factor by a couple of different ways. One is just the standard special dosimetry, go out to your machine compare the output of this particular setup, this particular clinical setup to a setup that

you know the answer to, standard. And then also, you can use the method of lateral buildup ratio by Cahn that I am gonna talk about perhaps just a touch here, but we are running low on time. The point is that the smaller the field, the more different the percent depth doses are. So, in these cases for a 6Mv, 12Mv and 20MEv electron field, you can see what the percent depth doses look like for fields from small to large. And this large is approaching lateral scatter equilibrium. So, not only do you have different depths of the 90%, for example, but also you have different depths of D-max. So under these circumstances lots of things change, not just the output, but also the depth of D-max, the depth of D90, the profile, so all these things need to be relayed to your physician so they know what they're treating under those conditions. Okay, just very quickly in this lateral buildup ratio, it's the same thing that we do normally with an output except

for the fact that you now have this thing called a lateral buildup ratio and then a couple of factors that compare the fluence of a applicator to the fluence of a reference applicator. Also, the fluence of an insert so you're cut out actually in this case to a reference insert, let's say. And I refer you to his paper published I think, two or three years ago now to see what some of these actually come out to be. The lateral buildup ratio itself, however, as you can see down here, is the ratio of the central axis depth dose in a given circular field to the central axis depth dose in a broad field. So, in other words, with lateral scatter equilibrium for the same incident fluence. So basically you normalize at the surface and you can measure these data. You can take very, very small fields, you know, a radio field of one centimeter, two centimeters, three centimeters, essentially getting all the LBR's at commissioning time so you can determine your MU's down

the road. So for extended SSD's, again, there's two different ways we can do these. Their required, as you know and a lot of different cases, for example, posterior neck electrons, perineum, those kinds of things where you just can't get 100 SSD in the patient so you need to account for that. In using the air gap technique, you can determine this air gap factor by using just a straight inverse square correction with this virtual SSD and making up for the difference in the output you see as this air gap factor or again, now we're not using virtual SSD anymore, we're using actual SSD, 100 SSD. Or you can use a straight inverse square correction with no other term by determining what the effective SSD is and this is from a very old paper by Cahn, but it shows you that if you measure at different SSD's what the output is versus what the output is at 100 SSD and you plot the square root of the inverted ratio of those two measurements

versus the gap itself, you get a line and the best fit line and the slope of the best fit line, the inverse of the slope of the best fit line minus the reference depth gives you this thing called an effective SSD. And if you look at a table of these effective SSD's, which perhaps you can't see, what happens is once you get to broad field, so anything over ten by ten, for energy, for field size it doesn't really make a difference. The effective SSD is pretty much the same. As you get to lower energies and smaller field sizes, the effective SSD can change dramatically even over four by four to a six by six field, to the point where you have extreme SSD, effective SSD's. Okay, let's move on from there. Talk briefly about quality assurance, monitoring quality assurance. We're gonna strongly recommend some independent verification of the modern units that come out of, say, you're treatment planning system. For example, if you have a treatment planning

system that gives you MU's, you can use an independent treatment planning system to confirm those modern units, you can have a stand alone program, either one that's commercially available or one that's sort of a home built program, or the old standard you can look all the factors up in tables to make sure that your modern units make some sense. We're gonna recommend that you follow task group 53's report on treatment planning systems, such that you confirm that the input is the same, that the treatment planning system is getting the appropriate input, that the algorithm makes sense for calculating MU's and that it handles heterogeneity appropriately for MU's. For example, you get the appropriate depths if you're going through lung. Some of the vendors these days, calculate modern units in ways that we can't independently verify with the parameters they use. So, it's important that we demand as users, the appropriate data. For example, an effective

depth or an effective field size such that we can do an independent calculation. And that's also appropriate for us to set appropriate criteria, what is good enough agreement for our hand calculation, say, to what the treatment planning system says. For example, a straight on spinal field should agree probably much more accurately, for example, a tangential photon field on a breast patient. We're gonna also recommend that quality audits occur. The standard quality audit is the RPC sending you TLD's. Again, that's only about as standard a condition as you can get to irradiate a TLD with 300 centigrade with no other associated parameters. You can also, however, get a thorough test set of different types of setups to make sure that your MU's are okay or you could hire an independent physicist to come in and look at your whole setup and make sure systematically that your MU's are correct. And finally, here's our conclusions. Task group

71 of the radiation therapy committee was formed to create a consistent nomenclature and formalism for MU calculations. For photons, we're gonna recommend a normalization depth of 10 centimeters, although the formalism is valid for the maximum depth of maximum dose. So, if you choose not to go to ten centimeters, this formalism will still work. And for electron beams, we're going to allow for both effective SSD or air gap correction methods for extended SSD calculations. Thank you very much.