Thanks, Mike. Actually, I should say that the vast majority of this talk was put together by Cynthia McCullough, and she was not able to be here and she, actually, was the Chair of the…of the physics portion of the accreditation process of the ACR. The time line on this was, this was approved by the ACR Council in '97 and then we got started and had our first meeting in '98, did lots of work, and then piloted this thing in the summer of 2001, program went active in 2002, and, to date, there are 615 total sites have applied, 337 have been accredited as of this last week. Of those sites, there are…some are multiple CT unit sites, so it…there are 779 total units in pr…that have applied and 411 units accredited. Pass rate is, in 2003, it was 64% for the first time, 92% for the second time, and, so far, in 2004 it's running about 70%. And, unfortunately, I can't…I can't tell you exactly the breakdown of, you know, what are some of the problems, but

as we go through, I've done…I, personally, have done about ten CT sites and I can tell you the problems I had, so…What I'm going to do…this talk is, I know I downloaded or uploaded, or whatever you want to call it, to the APM website, so I think every slide that you're going to see is viewable on the APM website, so it's up to you, but I…so I'm going to move kind of quickly on some of this stuff and then we might slow down on some things that I know give people problems when they're doing the CT physics accreditation test. Okay, just as one of our illustrious people, Mike and Cynthia really get the yeomen's…they did most of the work and some of us just…Tom and Tom…we just sort of hung on. And Dr. Brink was very helpful in working with us and getting some of the things done. And then, of course, on the ACR, Pam, Penny, Crista did a yeomen's job and Chris. Okay, some of you know that the program is a

combination of looking at personnel, looking at clinical images, looking at equipment performance, and then, actually, doing…setting up a quality control program, and then measuring some dose. We're just going to look today at equipment performance and some dose issues. And, I'll just go through…this is standard stuff in terms of applying, getting application, filling it out, etc. I'm not going to dwell much…there are qualifications to be a qualified physicist and you need to provide a documentation, and I think now Penny…we will be checking this pretty closely, what within, no comment. Just a form…this is a typical form that going to be filled out by the medical physicist and, continuing, you can have assistance…I would…I would…well, I would really encourage you to take over, and, in fact, I started to…it got easier for me once you start doing these, you can probably do them faster than…than trying to get

assistance from the CT techs, so I had the CT techs teach me how to run the CT scanner and then I sort of took over. So that's kind of…I think you'll find that might be more satisfactory, and you, then, become a responsible party and make sure that everything get done correctly. Now, I'll say it again and I'll say it now that, really, the…I also, as Mike and there are about 30 or so reviewers, I have not passed a few sites and I'd have to say, really, it's usually not the CT equipment, it's just the person doing the test didn't follow the directions. And, so if you pay close attention to what is requested and make sure the images get processed correctly and submitted correctly, you should pass and you should be…if you have questions you can probably find a colleague or somebody nearby that you could bounce some things off of, but when I have not passed somebody, it's usually because the data was not acquired correctly. Then

responsibilities of the physicist, you should, in addition to just coming in to do the tests once a year, you should be available, and you should I have been starting to get more involved in looking more critically at the CT protocols, the scan protocols, and particularly the head protocols. I think some of you who do this stuff are going to probably have the same experience, and, that is, a lot of the head studies that are out there, protocols, I should say, loaded into the machines are probably…the techniques are probably too high. Typically, you look at the mA on some systems and the mAs, in other words, two seconds may be 200, 400 mA, and you kind of go, Hum, and you look at the CTDI volume dose, or the CTDIw dose, and you start to see that up around seven, eight. In some cases, I've seen some places that are up around 10-12 rads per study, and you kind of go, I don't think we need to do that any more…so, pay attention to that. Okay, there is a phantom and then in the annual performance you're going to be looking at the

alignment, that's very, very critical, and especially when you submit for the ACR, the alignment test is going to be the one that makes or breaks most people, and the alignment of table to gantry, gantry tilt, and then you go on through slice localization, slice thicknesses, table increment accuracy, that's not really tested, per se, on the material you submit to the ACR, but you should be looking at it yourself critically…slice thickness, of course, and then image quality. The phantom has some high contrast bars, has some low contrast pins, there's a section that's uniform and so you're looking at any kind of artifacts, etc. There is…in the uniformity section, you do look, based on the technique you're using, you look at the noise and you sort of look for that particular technique--is that a reasonable value—and then just check…look for artifact streaks, what not, and then there's a…on your guidance on some of the studies to look at the CT

unit numbers and their constancy. Okay, the…also you'll be looking at display devices. We do request that there be a SMPTE**,** or something analogous to a SMPTE**,** so that's on each film that gets submitted. Typically, there's two films and the SMPTE pattern's in the upper left-hand corner of each one. Dosimetry, you'll need to have a CTDI at one of these pencil chambers and have it calibrated and then, basically, the only tough thing in…it's pretty well set up. Mike did a great job of getting it formatted and calculation in a spreadsheet format. The only hooker on all this is, when you…on these multi-detector systems, these so-called multi-slice systems, it's trying to figure out, sometimes it's obvious, sometimes it's not so obvious, is how much…what kind of beam are you using? Do you have a 5 mm beam, a 10 mm beam, a 15, a 20, you know, and what? And so, actually, at that point you could actually become a real physicist. You know, I

shutter. I realize it's tough, but you could actually, you know, you don't have to trust the verbiage and stuff, you could actually take a piece of film, or even a screen if you have one, and you could just sort of stick in the beam and you can see, you know, you think it this big and now you can verify if it really is. So, that's…and that usually turns out to be one of the places that people get totally whacked on the dose values that they come up with and then just knowing how to use their equipment, knowing how it's calibrated, and knowing your _____, and so forth. Okay, then your equipment, of course, must meet, in addition to the ACR part, there are a lot of the states now, of course, have a state requirements for CT scanners and there are, of course, some federal requirements. So, that's something that you put…build into your, as a consultant, into your annual evaluation. Just for completeness, in addition to the physics part of the ACR

accreditation, there is a clinical part, so your clinical colleagues are selecting representative cases and sending those in as well for evaluation, and I'm not really going to comment on…I'm not too familiar with that part of the process. Okay, so what do we have to do? So, now let's just look at doing the physics part. You're going to take the phantom and you're going to get a set of images, and you're going to put them on two films. So, and, it's pretty well laid out as to how to go about setting this up, what image goes in what, and how to format your multi-format laser printer. And then there are data sheets that you need to complete and you'll calculate using the spreadsheet, the CTDI values and CTDI volume and dose limit…linear product and exposure. And, of course, the other thing, sometimes it is a little tricky. You're going to have to put down for routine head, abdomen, pediatric, the techniques, and you would think it'd be easy, but on

some scanners pitch is not so…is pretty easy; on other scanners, it's not so easy. So, again, you're going to have to become a physicist and try and figure out, you know, what area's being covered and how the CT scanner's configured to sometimes come up with pitch. And, of course, there's a…and you all know, there's been this big confusion the vendors have had crazy pitches, you know, 3 and 6…it's not really 3 and it's not really 6, so, you know, the pitch is going to be…there's…you can underscan or overscan, you can have pitches of .75 and sometimes we kind of question why when people do that, but, nonetheless, it's done. And, more typically, though, you see pitches of like 1.5, 1.25, and things like that, so you're covering a little more area than the actual beam size. For the accreditation, the cycle, there will be a peer review so the physics part is sent to physics reviewers; the accreditation is a three-year period…time period,

and there's potential for a, I think the ACR will come around and do some site visits and some film checks, as necessary. And, then, if you do add…if you do make changes in your scanners, each scanner, of course, is a unique part of the accreditation, so if you change it, you have to reevaluate it; and if you get more scanners, you have to get those evaluated. So, here's the crew. Mike you've met, and there's Tom, Crista, and Cynthia, the leader. And we…we did modify some existing phantoms. I've been in the phantom business now…it hard…there's a few of you in the audience that are older than I am, but I'm getting up there…but I designed phantoms. I was on the original AAPM Committee back in '74-'75, and then there was a…I worked with some companies and came up with different kinds of phantoms using solid water, and so it kind of took that…there's the econo-phantom, some of you maybe are familiar with that, and we took

some of those ideas, some other ideas, and we decided to make a phantom out of solid water so we don't have problems with real water, and, likewise, we did increase its size—it's diameter is 20 cm, so a lot of the phantoms out there were 16 cm, some maybe a little bit bigger, so we did…we decided on 20, it was big enough to at least be fairly robust for…to represent a good head, of course, and represent, maybe, a small infant. And then we had four sections. We have sections in there to look at Hounsfield numbers, we have a section for low contrast, a uniformity section, and then a high-contrast spatial detectability section, so…and then each section's indicated, and so forth. So it's a…it's a fairly good phantom. I have to…I have to be proud of some of the stuff we did. The things you will do with this phantom, you will…it's very accurate in coming up with positioning. In fact, it's so accurate that this is where a lot of people don't take

the time to make sure they get a position correctly and this is probably the most common source of failure. There are pins of different materials—plexiglas, acrylic, agnea acrylic, polyethylene, air, and a bone-equivalent material. So you can look at CT numbers, and CT numbers generally are going to be okay, except I'm finding people…not people…the systems go out of CT-number tolerance at different kV's**.** Typically, if you run scanners at 140 kV, you might not be able, in all cases, meet the recommended tolerance levels, and I don't know…Mike may be…maybe at this point…have you seen that at all or has it been a problem for you? Okay. I have seen a few, so typically at higher kV's and usually we don't look at Hounsfield numbers at the lower kV's, like 80, that's pretty unusual, even though you might use them a little bit for pediatric studies. The most typical, obviously, Hounsfield numbers are pretty much right on. If you're imaging at 120 kV or even 130 kV, I have not seen a problem. I have seen problems at 140. Slice width, pretty straightforward. The phantom actually consists of two ramps. There are ramps with little fibrils

and then, of course, you're looking at them sideways and so you need to, kind of, be concerned that, is the phantom perpendicular to the scan plane; is the scan plane, of course, perpendicular to the world; and then, of course, just make sure that you…that you have the symmetry top to bottom, and then you can go about doing your slice width. There's a low-contrast section. They actually are able to develop a resin that they inject into some holes and they are able…the company that makes these is able to change the density of the resin by about .05% or 5 Hounsfields. So the chemical composition is virtually identical and it is a mass-density change, so it's a pretty good test, and it is…we've tested it. It is kVp independent, so you will see it's basically a density-type phantom. Then there are some bar sections, line pairs per centimeter, and then a uniform section, artifact section. Okay, here's just a layout of the phantom and we have a

foot in, so, again, make sure the phantom goes in correctly, and the…it's…each section is 4 cm or 40 mm apart, but the objects inside don't necessarily go the entire duration. We tried…I think in most cases, certainly the pins do, but some of the objects are at least 20 mm long and centered underneath the lines. So, the center of these lines represent where you're supposed to be scanning. It's not shown here, but like this position and like 40…set this at zero, 40, 80, 120, is the typical way of going about setting it up. Here's a picture of it set up in our machine. Most of you have probably seen that. It's pretty…this is…this, I would definitely…a couple of comments. First of all, this one I wouldn't…first these little rollers here, I would get to either ends, so this is a good example of how not to scan. You can see this one roller's probably underneath the line, so push those to either end and then you won't see them on your pictures

'cause they can create some artifacts. And then, secondly, I usually…what is not shown here, is I just get a little level from the hardware store and the first thing I do is I put my level up here, and before…and I get the phantom fairly close to the scan plane, but not all the way inside the gantry, and I put my little level on there and I then start changing the thumb crank here to level the phantom. So I'm leveling the phantom and then I'm…you know, you set the gantry to zero. Now you and I know that…if you talk to service guys, they just sort of look at these things and they say, that looks like zero, and so then they go in there and make the digital readouts say zero. So zero isn't necessarily zero, but, hey, it's as good as any, so you kind of look at the thing yourself and say, well it looks pretty close. So, that's that. And then you get this so that this is level and then you start and in a minute I'll make some more comments about setting this thing

up, and away we go. But that…that's the best thing to do, and then, of course, until otherwise…until you've been…until otherwise told, believe the laser lights. I still am pretty good…most of the time, the laser light are right, so I wouldn't get too excited if…I would sort of make sure that the laser lights conform to these little lines. And there's instructional manual with detailed steps, I'm not going to do that. And…oh and one comment, before you get going…I've tried to cut corners. I'm good at that. I'm trying to keep it moving, but one place where I don't…I wouldn't recommend is, I would go through and even though you may get the scanner they've been doing clinical patients, I would go back and I would do an air cal, 'cause it's kind of a mess if you get part way through these tests and all of a sudden you go hum? Your Hounsfield numbers for the different, aren't coming up right, the water is not zero or, you know,

zero+/- a few Hounsfields, and at that point now you've got to move the phantom out, do the air cal, and you're just going to waist a lot of time, so I think just, probably, it's better off just to, you know, do the air cal right up front, then you know you've done what you're supposed to do for setting up the scanner to be operating properly. So, it is recommended, if you want to, it's recommended, I don't usually do it, but it's recommended that you scan their own water phantom, so you can always scan the site phantom, make sure it's okay and then that's a little bit further assurance that the system is actually in calibration. And, then you're going to have to do a SMPTE or something like a SMPTE and get that image onto the film that you're going to use to submit for your evaluation. Then, you go through…you'll have to…usually they have some sort of protocol, icon, or whatnot, and you'll pick out the adult head, high-resolution chest, adult

abdomen, pediatric abdomen. Here it's also helpful to…usually they're imbedded in the software of the machine, but also you probably should double check. Sometimes the pediatric techniques are not imbedded. You might want to ask one of the CT supervisors or main techs exactly what they do when they have a pediatric patient. And there are…and you can…some sites decide not to be accredited for pediatric; they just don't do children, so that's fine, too. You can just have an adult accreditation, and so forget that. And this is just a form that you use to fill out these typical applications. Now, I'll say, as a reviewer, I'm pretty sure Mike and anybody else who is a reviewer, I pretty much hold the sites to this…if they say this is what they do, later on as we're doing out checks, we…there are questions that come up to us as reviewers, did they use an abdomen protocol? And, we're big boys, we're big people now, and so if here the mA is

supposed to be 200 mA, then I expect to see 200 mA on the scan, and it makes big difference, obviously, as you could imagine, when you're doing low-contrast detectability. I mean, if somebody inadvertently, or whatever, selects a higher mA or even a lower mA, that's not…not cricket. So, pay close attention. First of all, make sure you get these correct, and second, as you're going through doing the phantom scans, make sure where it says to use head or abdomen or high resolution check, make sure you really do do that and not just use some default protocol. So, and this is where I found people have not passed. Okay. This is just some terminology that you should be familiar with, so I'm not going to go into that. There are problems, as you well know. Often times we don't really know the collimation, the beam collimation. Some manufacturers just tell us, some really don't; and sometimes we don't necessarily know all of

the…so here you may need, you may actually need to either do your own experiments to figure out what the scanner's really doing, or possibly even talk to the service engineer. Usually, they should know, but sometimes you'd be surprised. So this is the challenge oftentimes to make sure you actually understand how the thing's working. Table feed is pretty common. That's usually okay. And there are some guides. We have some information about converting certain kinds of formats into this type of protocol and you can go to the ACR website and look for that plus some frequently asked questions. Okay. So the accreditation test, again, just to show you, these are the tests you're just going to go through with that phantom and, starting with the alignment, which is very critical, and then going through and looking at slice thickness, and then for a particular protocol, look at the CT numbers, and then there's a low-contrast image quality, a uniformity component section of the phantom, and then artifacts, and then some dose. Okay, so you first you

align the…as I said, I put the phantom in, I usually, you know, make the gantry go to zero and then look at it and make…does that really look like zero? Oftentimes, these digital displays usually are half a degree, so you could…you can move this system probably one-half a degree and at some point it's going to say .5 or -.5, and you've got a little bit of flexibility, so you just have to do the best you can to get it at what you think is zero. Oftentimes, if it says zero, and you walk into the room and it says zero, I just…I don't mess with it. I just leave it at zero. The next thing, as I said, I put the phantom in and I will, after you've done the air cal, then I will use my little level and I'll get the phantom totally level, so now, hopefully, you've got the phantom and these image planes perpendicular to the scan plane and you should be pretty much good to go, and then you line up the phantom, the first line on the foot end that's going to have the slice

thickness component, you line that up with the lasers, and so, now it says to scan with a high rez chest protocol. I do that, but, I'll tell you, you're going to waist a lot of time if you try to take a 1 or 1.5 mm slice thickness and try and get the two slice patterns lined up. I find it much easier to dial up a pretty big slice thickness, like 10, and do that the very first scan. I typically will be using a 10 mm beam and then I look at the top group, the bottom group, is the center bar in the center on both of them, are you symmetric in the middle, and so I get that…and then what I can do, I can…at this point I don't touch the gantry. I just change the, ever so slightly, the elevation of the phantom, and as you do this—we can talk about it a little later—you can make very, very, very fine adjustments. You're probably make .01 degree adjustments, and you just about have to get to about .01 degree to get the two sections lined up and the system lined up. So, we're going

through, doing that and, as I said, you can…this…at…I leave the gantry alone once I get started and then the only thing I'll ever change is maybe just tweak that a little bit so I can get the images and the slice thickness to line up correctly, and this just shows your alignment along the line, side alignment. Oh yes, just…and then get these things out of the way. Okay, so what I'm getting at is, I so this is the ______ view of the first section, so you've got a ramp on the top and one on the bottom, and there's, as you can just see right in here, there's one pin that crosses the midline, so this pin actually crosses over. So this is the very center of the ramp. Down here there's another one. It's hard for me to see from here, there it is…Now the critical thing is those two have to be, if you're a really good physicist, or anal, or whatever, you want to get those right in the middle, okay. And, sometimes that's where I've seen people fail, that they…they see the four BB's okay, but they don't have those two bars visible in the image when they actually do a 1 mm slice, and if you don't get that right, there's not much the reviewers can do. We basically have to say, It's a major default 'cause you didn't get lined up and, so, it's pull the curtain time. So, I would say this is critical and you'll chase yourself around if you try and align a phantom using a 1 mm slice thickness, at least that's my opinion. I, typically, will scan with a 10 mm beam and look at this and say, you know: Is that one in the middle? Is that one in the middle? Do I have, you know, like, is this 5 mm above, 5 mm below, etc. etc., and then I can tweak the phantom, I can tilt it. And then once you get good at this you know these two ramps, the two ramps are kind of like this, and you can say, what if my phantom is skewed? And then you can

start to say, what do I have to do? Do I have to tilt down, or the bottom up? You get good at this after a while, don't you, Mike? And, you know, be a physicist. It's incredible. So this is what you're going to end up with and these are typical values for the pins that are in there. And then there is an insert; it's the other thing that's very important is you need to know that the water is on the side where there's polyethylene and acrylic and don't make your water measurements over here between bone and air, besides oftentimes you'll see beam hardening artifact in here as well, so you get the unit correct Hounsfield values. And there is an actual insert. The company that makes the phantom, they do a pretty good job of making solid water equal to water, but they do an even better job of making this insert almost like perfectly water, and I don't think we've seen probably more…a variation of more than a fraction of a Hounsfield number for this insert,

and you can actually see if you do a…narrow the window down and adjust the level, you can actually see where this has been placed inside the phantom. There's a little faint line all around this one. So, it's critical that you make sure you make this measurement as directed by the protocol. And this is just a picture showing here, now that pin, there's the pin that goes all the way across, and this is like, probably, a 1 mm or 1.5 mm scan and you see the pin's there, but it's not in the middle. It's okay. It's within .5…the distance between alternate pins is .5 mm, so if you were to actually say, what is the slice thickness? You count the number of pins, divided by 2. So, this is a 1.5 mm slice thickness and you can see…but you can see it. And I've…as I said, I've oftentimes seen people not have this pin and this pin in the same picture. You can get one and one, but not both. And, of course, if you see these…the pin that crosses over, there's no way

you cannot see the…well, maybe a possible way you cannot see it, but normally, if that's okay then your four BB's are okay, unless your phantom is really cockeyed in the gantry, which usually you can see that by your own naked eye. Okay, so then you just…once you've aligned it, this is the…that particular image, the one with the ramps, that's the most critical and so you scan that. Then you do go to the far end of the phantom, so you go 120 mm to the…the high resolution section and you make sure you see…there's BB's at that end as well. So you have to see BB's, and then that long wire in what we call module one, and then you go to the other end of the phantom and you need to see the four BB's and, so that's your pass part. I don't think I have…Any questions on that, so far, in that part? Have people had problems with that? (inaudible question)…This passes, 'cause you can see them. (inaudible) Oh, that'd still pass.

(inaudible) Yes, yes, as long as you see them in the slice and even though they're not at the exact same position, that's still okay. I mean, you're within pretty good tolerance. Mike, comment? (inaudible) Yes, so…What? I think there's some metal…they are metal, I believe, but they're very small. I don’t know if they’re lead or if they’re steel. I think they’re probably steel. I think they’re little steel BB’s that they’re like little ball bearings and they just imbed them, but they’re pretty small. You can see them in the phantom. Okay, so on we go. So, now, once you’re aligned, now you’re going to play the slice-thickness game, so you go through, and, of course, don’t touch anything. Once you get this thing aligned, don’t jiggle the table. Be very careful. Don’t let anybody in the room, and that’s one thing…once you get this all set, you don’t…kind of gauge yourself. Oftentimes, somebody says, oh, you can have the scanner from 12 o’clock to

1 o’clock, and you go, (yes), and…’cause 1 o’clock comes and you go, Oh, man, I’m just getting going and all of a sudden, you know, oh we have to have a clinical…so I don’t like to do it between 12 and 1. I like to do it more like 6 o’clock or whenever they let me have it, but at the end of the day or at the end of their clinical study. And, I don’t know, if you get good at this, I can do this in about two hours, from start to finish, so, but I’m…I’m rocking on. So then you go through, use an abdomen protocol and you start doing…and use the slice thicknesses that they tell you, so there’s, typically, the high resolution, which is your narrowest, and then, typically, your, like, 3, 5, 7, I think are the ones that are recommended, or as close to that as your scanner, 3, 5, 7 and high rez. And then you…you count the number lines that you see. They tell you what window and mean…window level and window width…and you count the lines, divide by 2, and

that’s your slice thickness. And then for some…and then you’ll always measure water for each and every one of these images, and make sure you, of course, measure it in the proper location. And the whole idea is that, typically, as most of you probably know, CT scanners are set so that they have a calibration file for each and every slice thickness, and so you’re, basically, just seeing that are these calibration files are they current and are they correct. And, every once in a while, usually it’s usually the…two things you see on scanners. Oftentimes, for the very thin cuts, the 1 mm cut, they may or may not have that calibration file updated correctly, so you may get a Hounsfield number that’s further away from zero than you’d like. And the other thing, oftentimes service engineers--they have to have calibration files for every particular kV. They know we use 120; they know we use 140, and they go, they don’t use 80 very much--so

oftentimes you’ll go and do some 80 scans and those Hounsfield numbers are all over the place. They’re like +25 or…so you go (no), and so it not good, so you have to get after the service guys if they didn’t do that. Okay. So, this just shows you how you set your region of interest, and, again, it’s pretty obvious. You make…I might even make them a little bit smaller than that ‘cause there are some…a little bit of edge effects, but this is pretty typical, and, so, you get your Hounsfield values for these, and there’s a place to put them in your data form. And this is showing how to measure the slice width, so if you count these lines, there’s 11 of them, divided by 2, so that’s 5.5; down here it was felt that there was 10. And it does get subjective. I mean, you look at some of these and you have to…you know, those of you who go way back, a few of us, probably the company that, sort of, first kind of did this correctly was Phillips in the early

days, and they would do full-width, half-maximum. As physicists, you know, this is discreet stuff, but if you actually…they had…if you…you could take like a sliding window and you could go…and if you had just…instead of a bunch of wires, if you had just a thin aluminum ramp and you would image that, and then you had a little sliding window of a narrow window to look at the Hounsfield numbers, and you could just start plotting Hounsfield numbers and then you get to a maximum and then you'd go down to a minimum, and then you'd get a little plot of a…of a, sort of, Gaussian curve, or at least a distribution curve, and then you do a full width, half max, and that is the true definition of slice thickness. Well, we can't…it's…that's just too rigorous for this program, so we have discreet little wires. But the whole idea is that wire, is this half maximum? Is it less than the intensity? Is it half…is it below half the intensity of the

previous wire, and if it is then you don't count it. So what I'm getting up to is use your brain. I know it's tough, but, you know…I don't know…too old. Okay, so and this is just the form where you record this information for the different…for the high-resolution chest, the different slice thicknesses, etc., the mean values, and the slice at the top and the bottom. And, like I say, you have the tolerance, typically, of about…what is our total…I think 1.5 mm, I believe. Is that right? And then, of course, you'll do some scans at whatever kVp's…and we do request that you…every kVp that is loaded in the scanner, in other words, if you can do it, we want to see it, so usually that's 3 kV's. Every once in a while, though, I've found some scanners where either the x-ray tube is old and they finally decided, we're not going to let you…the service guys have just have by software blocked you out, and so we're not going to let you do the 80 kV, or we're

not going to let you do the 140, so that…every once in a while…and so…but make…if that happens, make a note. Make a note that, yes, I know that this scanner has the capability, but it's been blocked out, for whatever reason by the service guys. Okay, the low contrast…we're going to have to zip along here. I talk too much. The scan module is two, there are some pins, four pins, and of varying…they all have the same contrast. It's approximately six Hounsfields and they just have different diameters, and so you image them and then you see if you can see all four. And, again, that's…it gets to be somewhat subjective, you know, from this distance I can see those, I can more or less see these, and there's sort of a blur there. So, you, basically…and I would recommend probably not…I would say, when you do your scoring, I've made…I've oftentimes the monitor at the CT scanner that you're working from is a…is kind of old. I

wouldn't use that. I would wait, image them and I would do the scoring just like the reviewer's going to do the scoring. I would do the thing from the film, from the laser film, and I think Mike would probably…So, it's fine to look at it as you're doing the scans, you can do a lot of stuff as you're doing, but for this particular scoring, I'd wait 'til you print the laser picture and then look at that and then see what…get back and view it under proper conditions and then see what you think you see on the laser picture, 'cause that's what's the reviewer's are going to be looking at, so that just a little caveat, isn't it? And, just a place where you record things. Then in module three, there's imaging uniformity and noise. It's basically…we do have some pins in here. Some day there's…you can do some MTF stuff with these pins and you can do some measurement stuff because you know the distance between them. Right now, we're not using the pins for

anything and you just have a uniform phantom. And, then, this is just to get the uniformity. You get the center, and then you go to 12 o'clock, 3 o'clock, 6 o'clock, 9 o'clock, and put your data down. And then look to make sure there's no cupping, no capping, no aliasing artifacts, no streaks, etc…just a place to put the thing. High contrast module is a…some line pairs. These are line pairs per centimeter, and then you image them and then you're instructed to set up your window width and your window level. I normally find that okay, but make sure. And the level, of course, you can vary to get it to its best viewing position, and then you…so you see, obviously, this is not right, then you record your data. Now, dose…okay. The doses that we're looking for…I'm going to move through rather quickly here…we're looking at…we're going to ultimately end up with CTDIw and CTDI volume, is what we're going to end up…and then

there's some other calculations. So, I'm not going to go through all that. This is, obviously, well referenced in the literature. You will have to have…you will have to have to supply your own phantom. That's not supplied by the _____, so you'll have to have a CTDI acrylic 32 and 16-inch diameter phantom with the appropriate holes. The only hole you need is the hole 1cm in from the edge and the center, so you don't…some phantoms come with all kinds of holes in them, but you just need those two. And then you go about making the measurements in the center and the 12 o'clock position. And, again, this is just review of the multiple scan dose index versus just a single scan profile. And that's, basically, the CTDIw value. And then if you do body scanning, of course, you throw in another…you're averaging. You're taking the dose…this is kind of a little bit…I don't…I don't totally object to it, but it's…I don't know. It's hard to say,

but you're spiraling the dose, you know, around the phantom. If you want to think about it as an average, well, then, you're going to divide by pitch and you're going to be spreading the dose out there, and so this is just the example of that. And, so, typical dose values…so this would be like a four detector row type system…four by two…and oftentimes it's kind of nice to…most of the scanners have somewhere the doses in mGy's listed; oftentimes, not on the images, but at least in the protocols, but it's kind of fun. You should be able to correlate what you measure with what the vendor does, and, so, you can kind of look for that. And most of the new scanners have or display CTDI volume, so you can kind of check your values versus them. So…Now, the only thing I'll comment…I usually don't find problems with chest, abdomen, and pelvis, but we're finding…I don't know…do you know the percentage of heads that are falling outside that…it's

probably at least 30% off the top of my head, or typically like seven, eight rads or, you know, 70-80 mGy. And, so those are just the reference values…now some other stuff, physics…don't need that…there's a part of the final calculations you can get affective doses and that's part of the spreadsheet, so…This is all…should be on the website. I apologize for zooming through all this. Okay, so we're basically heading…So from head to toe…this is a modification of Cynthia's…And there we are…If you need certain information contact the ACR…This is great. I like these cubicles; they're little fish…And that's it.