Intro to On-Call Meteorologists and Sys Ops Training – 00:00:00

Hi, everyone. For those of you that have not met me, which I think all of you, I am Jessica Grosso. I'm head of project planning and Technology here at One Energy. My team runs all of the development work that we do. My background is in engineering and atmospheric science. Originally. I deal with the on-call meteorology team. Bobbi is part of that.

Kurt is another one of our meteorologists that we have on staff and is also part of that team. Erin, who lives down in Florida, is also a meteorologist but is not on the on call team. But she is available for like during business hour stuff when weather is occurring, just not after hours. She was down in Florida, so so we have this training is what we give to the system operators.

I wasn't given a ton of context as to like how to what like this training was really supposed to be about. So we're just kind of I'm just going to give you my kind of standard presentation about how to deal with weather and what we do with it on an on call basis. What to watch for. All of our projects.

We install wind turbines at our projects, obviously, and we have to know about where the wind is blowing, how fast it's blowing when it comes to severe weather, like thunderstorms, tornadoes, obviously the wind blows a lot harder. And we need to to know that to get out ahead of stuff. There's also winter weather that severely impacts our projects, which we are getting into winter weather season.

And we have to be aware of what is impacting our projects from a winter weather standpoint as well. So I'm going to go through pretty much like a very, very crash course. Basics in weather. But really the the point of this is just to identify at the end knowing what tools we have available, knowing what alerts y'all are going to get and knowing essentially what to do in each of these situations.

Wind – 00:02:35

I'm going to go through this really quick. I'm not going to go into the detail that I go into with the system operators, but there are a few key things that are important to know when you work at a wind energy company. And one of those things is knowing about the wind. So this is a weather map that you would see from the National Weather Service, or you might see a map like this on the local news.

What this map is showing us, it's showing us high and low pressure systems. It's also showing us these lines right here, called isobars, a line of constant pressure. If you ever hear the weather person on your local weather say that there is a high pressure system in the area or a low pressure system in the area, I'm sure you've heard that before.

What does that actually mean? It actually does mean in terms of pressure, but pressure and temperature are related. So if you have a large variation in pressure, you're going to also have a larger variation in temperature. And in turn, you're going to have stronger winds. So there's this equation, pv=nrt, that if you think way back to like high school days, I'm sure that was said at some point in high school.

But it's how pressure and temperature are related. Everything on the earth and in physics in general wants to be in equilibrium. So there is I don't know if you guys are going to get like the wind 101 course which probably should've come before this. It's what all onboarding people get. Essentially the sun is heating up the earth differently because the earth is a sphere.

You get more solar radiation at the equator than you do at the polls. This causes a large temperature difference between the equator and the polls. Everything wants to be in equilibrium. If you fill up a bathtub, you know, for your kids, if you're giving your kid a bath and the water starts to cool down, you turn the hot water tap on on one side of the bathtub.

Right. That's going to heat up one side of that bathtub. If you let that sit for a while, eventually the bathtub is going to all become the same temperature. Right. You have to wait for it to essentially come into equilibrium. That's essentially what the entire Earth is trying to do all of the time. And so when you see a high and a low pressure system, that literally means that there is higher pressure in that area and lower pressure in that area.

And since everything wants to be in equilibrium, everything wants to flow from high to low to try to balance and equal everything out. So because you have a high of a low pressure system right here, and that means there's higher pressure over here at lower pressure over here, it wants to be in equilibrium, literally means the needs of the air molecules over here are going to start traveling towards this low pressure system. Now, there's a lot of things that act on this because they can't just go straight from Montana down here to Tennessee. They can't just make a straight beeline for it because there’s other things at play, the earth is spinning, there’s friction, there's a whole bunch of other forces that I will not get into and bore you all with.

But those air molecules start moving to that high from the high to the low. Literally, the movement of those air molecules from high to low is what wind is. And the larger that pressure gradient, that difference between that high and the low, the larger that difference is, the stronger the winds are going to be. So looking at this map, these lines right here are called Isobars.

They are lines of constant pressure, which means that the more lines we have and the closer they are together, that means that difference between the high and the low is even greater. So when the lines are spaced out really far, that means that the pressure difference isn't that, it’s like essentially what that is, is I mean, like who goes hiking? You ever look at a topography map and you're looking at it like, I'm going to go on this hike.

And when you start seeing on this hike that the topo lines start to get really close together, what does that typically mean? It's going to be really steep and you're going to be out of breath really quickly because that elevation is going to be changing really fast. The exact same thing here, just instead of elevation, we're talking about differences in pressure.

So the closer those lines are, the faster the winds are. It's pretty much what to take out of this. So looking at these two areas, for example, if we look at Pennsylvania right here, if you compare that to Iowa over here, weather will also really test your geography skills as well. So do we think that the winds would be higher in Iowa or Pennsylvania at particular moment in time?

Iowa. Yep. Yeah, because those isobars are a lot closer together. There's a lot more of them. There's a larger pressure gradient, which then in turn means faster ones.

So also looking at this map, you also see that there are a couple other features on here besides just this big H and this big L right here. And the isobars, you also see this blue line that comes down like that. So it's called a cold front. You also see the blue and the red dots mixed in together.

That is a stationary front. You can also get red lines with little bumps on them, that is a warm front. Also getting occluded front, essentially. So what do we know about hot air. What does it typically do? Yeah, hot air rises. So you hear that all the time in terms of like fire safety at your house and like stuff like that.

Right. So hot air rises, warm air rises that's because warm air is less dense, than cold air. So it moves up. That is literally what is happening with weather all around us all the time. It's just warm air moving up, doing things because as it moves up, things like how much water it can hold, changes things like, other things start to occur when you have that warm air moving up.

So there are a number of things that happen that I mean, essentially just weather is warm air moving up in different ways, in different places, etc.. Not really going to get into that.

Weather Maps – 00:09:40

A little bit about reading weather maps, which you won't really have to do besides what is on The National Weather Service, which I have a slide on here that I'll show you what's on the National Weather Service.

But we talked about what these maps look like a little bit already have the H, which is your high pressure system, your L, which is your low pressure system, also fun fact, there's an H, usually that means it's like clear skies, sunny clear skies. If there's an L, low pressure system are usually associated with weather. So rain, severe storms, sometimes. A low pressure system usually equals weather, high pressure systems, usually sunny, very pleasant. Not a lot going on. Other things on this weather map that are important to note are across the United States. There is a network of weather stations, you can see these weather stations and you can see these dots, there's a lot more than just what you see on here. But each one of those weather stations is recording real time data all the time.

Usually they're located at airports, sometimes they are located at places other than airports. But most of the time they're at airports. And that information from those weather stations is what is feeding the models that predict the weather out. You know, one, two, three, four, five days. So those weather stations tell us a lot about what's happening currently. They also help us predict what will happen in the future.

Reading the information from these weather stations on a real time basis, is important as we're forecasting for severe weather.

Barbs – 00:11:31

So you'll notice that pretty much the most defining thing that comes out of this is this line with these what are called barbs on them. This is telling us this little flag is telling us the wind direction and how fast the wind is blowing at each one of these weather stations.

In addition, these weather stations will also tell us things like cloud coverage. And so if the dot is filled in, in the middle, that means it's totally cloudy. If it is half filled, then partly cloudy. There's nothing filled in it's sunny, pretty straight forward. It also tells us what the weather is doing at that particular location. So there are a bunch of symbols that go along with this, like two of these stars is light snow.

So we know that there is light snow occurring in Grand Rapids and there's light rain occurring down there in North Carolina weather also tests your geography. So getting into the wind barbs because this is the one that we all are going to need to know the most. These wind barbs tell us the direction that the wind is coming from and how fast the wind is blowing.

If the flag is pointed up like this means that that means the wind is coming from the north. So it's going from the north to the south. If the barb is pointing down like this, it means that the wind is coming from the south. So coming from the south, going to the north. So if that were here, there's a wind barb that looks like this.

I would know that the wind is coming from the south, so it's coming from that direction, blowing towards that direction. The little barbs on the end of the flag tell us how fast the wind is going. So a little short one is five miles an hour or nauts. Weather people like to use nauts, and like to make different units of measurement, but the little one is five miles an hour.

The longer one is ten. And so you can stack them up until you get to 50. At 50, you get a flag that looks like that. And these are then translated. This is what we use a lot for forecasting from the National Weather Service. It's the National Weather Service website, Weather.gov type in the location. Scroll down and look at the hourly weather graph.

This is what I pull up. All of the time when I'm forecasting for weather. This tells you. So this is like right now and then this tells you for the next essentially I think it goes out five days, but you can tell what the temperature profile is doing, what the wind profile is doing, the relative humidity, sky cover, precipitation potential.

And then down here, depending on the season for this one in particular, there's this rain and thunder potential. But in the winter months, there will also be ones for sleet, freezing rain, snow. So they'll be like stacked up down here, obviously, this graph was pulled in September. So not a lot of potential for snow in September. So this one right here, the second one is always going to be what your winds are doing.

So if I look at this, I can see that at 3 p.m. the barb is pointed this way. So if the barb was pointed that way, what direction should the wind be coming from? And then where would the wind be coming from. It should be coming from the southeast and right near here.

yeah. So it's coming from southwest, going towards the northeast. And you can see that there's one long line and one short line. So what is the wind speed then, from that? Yeah, it's about 15 miles an hour. The great thing about this, which is this is really good to use to visualize, this is going to tell you how those winds are changing over a certain period.

So if we get a big storm that's coming in, we might need to know that because all the turbines change direction, you know, they're Yawing to be into the wind all of the time. So that means if the winds are shifting direction, that means the turbines are also shifting the direction that the rotor is facing. So that can be really important when it comes to things like icing, which we'll talk about a little bit, but knowing how those winds are changing and then in turn how that rotor is changing because of the wind direction changes is really important.

So the National Weather Service will, you know, put these wind barbs every hour, that purple line, though, it's like your cheat sheet. It tells you like exactly what the wind speed is. So it approximates it, so this one is 13. The long line with the short line is 15. But actually it's 15 but it's rounding up. And then over here, sometimes you'll get a blue line that goes above this purple line that blue line is if wind gusts are forecasted.

So the purple line is your steady winds that are happening essentially all of the time. If there are gusts forecasted, then it's going to get up onto a blue line there. Gusts are not always forecasted. There's like a there's an equation essentially that is used to determine if gusts are like real gusts or not.

Weather Advisories and Shutdowns – 00:17:57

But really for this, the important thing to know is that all of the turbines can shut themselves down when wind speeds get up to about 55 miles an hour. It's very rare that we ever let the turbines shut themselves down. If there is a wind advisory, if there is a severe storm, anything like that. Our on call meteorology team should be, you know, letting everyone know, hey, there's a wind advisory, there's a high wind warning for tomorrow. We need to keep an eye on it so everyone should be aware that there is the potential for that severe weather to occur.

And then the system operators can decide whether or not we want to shut the turbines down ahead of time or not.

Things like high wind warnings, usually we get a usually there's like at least like a 24 hour period before it happens and they'll know that there's a potential for it. Severe weather. We'll know that there's like a potential for severe weather. But in terms of a storm actually occurring, there's a much shorter lead time. And I'm not going to get into cloud types.

If you want to know about cloud types find Bobbi Later. Okay.

Icing and Precipitation – 00:19:20

So weather events that we care about, with the turbines, icing, winter weather, winter weather or we get different types of precipitation depending on the temperature profile. What do I mean by temperature profile? Temperature profile? I mean, how is the temperature changing as we go up in the atmosphere from the surface?

So this is the ground. and this is this what is the temperature doing as it goes up in height. So that's the temperature profile. So it's is the temperature decreasing as we go up in height in the atmosphere? It usually is. As you go away from the Earth’s surface it gets colder. So it typically does that, but there can be times when it doesn't do that.

There can be times the temperature profile makes kind of like a like a ywg type situation. And when that happens, we get different types of precipitation, especially in the wintertime. So if we have clouds and they decide that they are to the point where they want to start precipitating, if it is warm all the way down to the earth's surface, meaning above freezing comes down as rain, pretty simple.

Right. If up in the clouds, it's precipitating up there, very cold. Starts off as you know, freezing precipitation moves through a warmer layer of the atmosphere. But then, let's say at the surface, very, very cold, cold front coming through or something like that where you have a short area near the surface, it's very cold. Then that water that had melted higher up in the atmosphere freezes again, usually makes contact with something on the earth's surface, and that's freezing rain.

So it's that supercooled droplets of water that then when they hit like your car windshield or a metallic surface, something like that, it freezes on it on contact. That's when you get freezing rain. Sleet, you have a much larger cold area near the earth's surface. So that water, the rain that's falling down to that warm layer is actually able to completely freeze again.

You get like a little sleet pellets, sounds very nice, and snow as you have essentially cold all the way from the clouds all the way to the ground. So you have things on both ends of the spectrum here. Now, what didn't I talk about in terms of freezing potential that everyone has heard about? Hail. Did not mentioned hail.

Hail - 00:22:33

Hail is not a winter weather situation.

Hail does not occur in the winter time. And unless it's very rare occasions, hail only occurs during severe weather. Hail is frozen water. But what hail does is when you have very severe weather, you have a very strong thunderstorm that's moving through. Really strong thunderstorms actually have very strong updrafts associated with them. So what's happening is the rain is falling down and that updraft is taking that rain and throwing it back up all the way to the top of the storm where it freezes and then it starts to fall again and it hits other water and starts to accumulate and then it gets thrown back up.

So depending on how strong that updraft is, you get larger and larger hail. So if you have like a very, very severe storm, you can get softball sized hail. And that means that the updrafts from that severe storm, which usually probably has a tornado associated with it, had a very strong updraft and it was able to keep throwing that piece of ice back up into the storm to accumulate more freezing water.

And then it eventually is so heavy that it falls through the updraft, but hail, not a winter weather situation. Freezing rain, and sleet are definitely. Hail is not. This nice little graphic that I made. Okay. Winter weather events.

Freezing Rain, Ice Shedding and High Risk Areas – 00:24:14

Why do we care? Icing on the blades. Freezing rain and sleet are particularly important to wind energy. Both of them can cause ice to build up on the blades.

Ice builds up on anything outside in freezing rain events. It builds up on telephone poles, it builds up on your car. It builds up on your house. The difference is that if it builds up on our blades, our turbines are spinning. Eventually that ice is going to break off and because the rotor is spinning, it can be launched.

A piece of ice can be launched pretty significant way, which we model for when we site all of these projects. We have computer software that we designed that essentially predicts, like randomizes the potential sizes of pieces of ice where it might be on the blade, how it might be thrown off, at what trajectory. Going back to my high school physics days to figure out what that like trajectory of the of the piece of ice could be and where it could potentially land.

And if there are any homes, business and things like that nearby that we have to care about. So freezing rain when we're forecasting it. There are definitely parts of the country that are more prone to freezing rain than others. This is a nice little graphic over here that shows this dark blue. It's like the highest number of freezing rain events, which is like essentially where we are.

Awesome, great. So freezing rain it’s the average number of days of Freezing rain, freezing rain. A typical pattern for it is you might see a low pressure system south of us. You might see an occluded front or a stationary front with essentially warm air moving up from the Gulf of Mexico, hitting colder air up here, creating really nice conditions for freezing rain to occur, essentially occurs when there's a warm layer that's moving over a much colder layer because remember, with freezing rain, you need that very cold layer of air right at the Earth’s surface.

So what does this look like for how do we what do we need to be watching out for when we're forecasting it? So when we have the radar pulled up, usually radars have three different color schemes associated with them. In the winter time, you have all of your green yellows with severe weather. It also gets into orange and red, but you have this like normal color of radar down here, which indicates the rain up here, blue snow.

And there's all that pink stuff in the middle. That pink stuff is essentially a wintry mix. These lines are not perfect. It's a model. So what the model is doing is it's taking the inputs from those weather stations, figuring out what the temperature is at that location, and trying to predict if that precipitation is rain or snow or what it is in these specific locations.

It's not perfect by any means. But if we're looking at radar and we see that there is this area of purple in between the rain and the snow this probably means that this area, at least a good chunk of it is getting freezing rain or sleet, is getting a wintry mix in that area. And then probably we can assume some of this area down here that's actually in the green might also be getting some freezing rain, sleet.

And that also up there in the snow area, as well as again get that line, it's not like a defined, definite line. So we need to be watching the radar during the winter time. We also need to watch for alerts from Earth Networks. And we also have a couple projects that have ice sensors at them. So we have an ice sensor here at the North Findlay wind campus that will tell us tells us if ICE is building up on the sensor.

We also have one down in Greenville. But again, they're just a tool. It's not like if it doesn't go off, that means that there's no ice buildup on the blades because, again, the ice sensor is essentially like ten meters off the ground. The turbines are much higher. So it's it's a it helps us determine if there's ice, but it's not going to tell you for certain if there is ice buildup, on the blade or not.

So we have to watch for alerts from Earth Networks. We get alerts in the winter time for freezing rain events. I’m trying to remember what the other ones are Bobbi. It's freezing rain and I feel like there’s a windchill one. Yeah, there's also like blizzards. I think it might be like heavy snow. Snow. I think so We just we, we don't it's very rare. So snow can also cause ice build up on the blades, especially in a very heavy snow or like a wet snow, especially the leading edge of that blade as it's moving through the air, the leading edge of that blade and cutting through the snow is going to start to pick up and accumulate stuff on that side of the blade.

Usually, though, it's not the type of like ice buildup that can be thrown. It's not like the dangerous type. Usually when you see that, it like falls more like straight down the turbine and kind of like flutters. It's like more of like a kind of like a soft ice buildup. Freezing rain events, though. I mean, you've been in your car after like a freezing rain event, like trying to get in a vehicle and you have to like, you know, get like an ice pick essentially where to get your side door open.

Same thing is happening on the blades during freezing rain events. So when we're forecasting this, we also have to make sure that we're watching out on the forecast for freezing rain or wintry mix events in the next like seven days. So why do we really care about this? I said that the ice can be thrown from the turbines and I also said that we do model this.

So this is an example of some of the outputs of our model. In the middle of these two, the green and the orange right here are turbines and then all of these blue dots around it are called zones of interest in their houses, residences, things that we care about. And we ran the model to see if any of the pieces of ice in a randomized situation could potentially impact one of those locations.

We have setbacks for our projects. Some of our projects also have setbacks that are imposed on us from the local municipality or whoever the governing body is. So sometimes there are other setbacks besides the ones that we impose. But for the most part, all of our projects have certain setbacks that we determined were safest based on all of our studies as to how far we needed to be from a house or a private residence, things like that.

But so our setbacks were designed for the worst case scenario. But there are some of our projects that we do have to be aware of from an icing perspective. So this is what ice buildup on the blades can look like, particularly in a snow event, not so much in a freezing rain event. The freezing rain event is going to be a little bit harder to see because it's going to be more of a clear ice.

But that is what ice buildup on the blades can cause. Another thing to be aware of that does cause ice buildup on the blades is freezing fog. And we've been getting a lot more of that over the last couple of years. I think last year we had a number of days of freezing fog that we had to shut the turbines down.

So freezing fog can cause build up on the blades too, like I said, at the North Findlay Wind campus and down in Greenville we have an ice sensor, but it's at ground level, not the turbine height. We also have Earth Networks, which is our alerting software that will alert us to winter weather advisories, winter storm watches, snow, freezing rain, freezing fog.

They do have ice advisories, ice storm warnings. So we do have tools that are there to help, but they're not always 100% correct. So there are different projects that we have to know that like the turbines may be a little bit closer to some feature that we need to know about, especially during icing events. So impacts to projects for the North Findlay wind campus.

So that's this location right here turbines, the first two turbines, that’s W1 and W2 can cause during icing events can potentially cause a risk to the one energy parking lot. So they are both pretty close to the one energy parking lot right here. So if there is a very large freezing rain event, sometimes we've shut those turbines down or made sure that there's no one working in the yard.

We don't have any construction crews working in the yard. We don't want people below the blades when there is significant icing potential Z2 and Z3 down a little bit further, potentially have some impacts of the parking lots right there. People typically don't like it if ice is being thrown on their cars. So Ball 2, this is a big one.

So Ball 2 is the next three turbines a little bit further down this one down here is Z6, the furthest one is I think it's only like 500 feet from that home right there. We offered to the people that live in that home, they rent it. And so we offered to essentially pay for them to move if they wanted to.

And they said that they would see how it went. And then they said that they didn't care and they didn't really want move, so they opted to stay there. But we need to know that there are people that live there and that home is only like 500 feet away from that turbine. So during icing events, usually Z6 is like the first one that we shut down.

So Z6 is like our one that we have to be paying attention to a lot, especially now that like crypto is down there too. So we have like the crypto pods and stuff down there. We have to be really aware from an icing perspective of essentially that entire multi project. But Z6 is definitely the one out of all of the turbines that we need to be watching.

So Valfilm is those two turbines right there. So the weird thing to note about this project about the Valfilm project is that so usually we label the turbines like the northernmost one is like would be V1 and the southern would be V2. There's a miscommunication and a mix up when we were developing this project back in the day.

So the one to the north is actually V2. One to the south is actually V1, but V2, it's like 750 feet away from the house which isn’t a huge deal. 750 feet is actually a fair distance. So it's not a not a big deal. Marion the Whirlpool Marion project down down in Marion. Really the only thing is W3 There are a lot of trucks that use this entrance right here.

So during icing events, sometimes we make sure to set like W3 down, but we might not shut W1 and W2 down Greenville there is a retirement community to the south, so W1 we do end up sitting down W1 quite a lot. There’s also a Walmart right here. So W1 we might shut down before we shut down the others.

W2 and W3. W3 is not too far away from this freeway right here which we don't really want to be throwing ice onto a freeway either. So the other thing that we also have to consider is where is the wind coming from? So I want to talk about that one on this one, cause it matters a lot if the winds at this project are coming from the west, they're coming from this direction going to the east, that means that the rotor is going to be like this. That means that as the rotor is spinning, it could be flinging ice the furthest distance perpendicular to that wind direction is as the rotor is spinning.

It's going to be throwing that piece of ice in the same plane blades rotating in. So if if the winds are coming from the west and the rotor is pointing that way, that could be thrown down towards that retirement community down there. And if the winds are coming from south. So that rotor is positioned like this. The ice is being thrown in either direction like that.

Most likely. There's not a lot in that direction. So it's much less of a risk. The so we always have to be considering where the wind is coming from at that particular time as well. So if there is ice buildup suspected at a project that is at the North Findlay Wind campus, we do have binoculars and so a lot of times we'll send someone out with binoculars to go just take a look at the turbines to see if we can like physically see ice buildup,

Using Power Curves to Determine Ice Buildup – 00:39:16

If it is at a project that is remote.

The biggest telltale sign of ice buildup on the blades is if the power curve does not match what the wind speeds are. So every turbine comes with a power curve from the manufacturer. That power curve tells us at each wind speed, this tells us at each different speed what power the turbines should be outputing. If we're looking at SCADA in the winter, we see that.

So for the gold wind turbine, this is 1500 watts is what it should be producing at max wind speed which is about 22 miles an hour here. If we see that the wind speed is like 22 miles an hour and a turbine is only producing like 700 watts, there's a large difference there. And that's a red flag. That's an oh no. I also saw that there was some winter weather on radar and the forecast.

And then now I'm seeing that the Marion project is having a big mismatch in the power curve we probably means there is ice buildup on that turbine and we need to shut it down. Sometimes we let it run through those situations. The system operators like make a call depending on what project it is because if we stop the turbines during a freezing rain event, there's likely going to be more ice build up than if we let the tubine keep running and spinning, it’s less likely to get more additional build up on it.

And then eventually the ice is going to shut off the turbine, depending on what project it is like. The one that I was just going through if it was at any of those projects were if it was like Z6 we're not going to let Z6 run through that. So the System Operators need to make that call as to, okay, we see this mismatch in the power curve.

We see that there's winter weather on the radar. Probably means that theres ice buildup on this project, are we going to let it run through this. Is this is just maybe a short term situation where its like a freezing rain event happening for like, I don't know, half hour, an hour or is this like a whole day long situation so the system operators can make that call on what to do about this.

We do have some projects that have software built into the turbine. If this power curve is off by enough, it will shut the turbine down. It sort of has like a power mismatch situation. And if that happens, the turbines will shut themselves down because they essentially notice that there’s ice buildup on the blades. It's not awesome to leave the turbines running with a ton of ice build up on the blades.

It causes a lot more loading on the turbine itself. It causes a difference of loading and fatigue on the turbine causes more wear and tear. And we're not. We're in the business of keeping these things running for as good as they can work long as they can. So we would rather shut the turbines down for a few hours to put less wear and tear on them and have them maybe last longer than to have it run through it and produce energy, at that specific time. It's way more financially in our best interests. If we keep the turbines, as like low impact from that stuff as possible. So some of the projects have that software built in. Greenville does, Marion does, Lafarge might, but not all of the projects do. So if we determine that there is there is ice buildup essentially to talk to the system operators, make them aware of the situation, and they can decide whether or not we're shutting the turbines down or not.

Controlled Start-Ups – 00:44:13

Then after the event or when we think the event is ending, then we have to do a start up afterwards. Maybe it warmed up and we're pretty confident that the ice was able to melt off the blades then we can start the turbine back up, go on our happy merry way. A lot of times that's not the case.

So a lot of times we're guessing as if there is still ice buildup on the blades. We do a lot of times what's called a controlled startup, a controlled startup. Usually you either have to have someone onsite or you have to have someone watching SCADA a very, very closely. Or also, we also have cameras at Greenville which we can log in and use.

We have a couple other projects I think, that have cameras I'd like to give them at all projects so we can do this controlled startup with actually eyes on the turbine at all times. But usually we have someone that is onsite, like if it's here and we're doing a controlled startup, someone is looking out the window watching this controlled startup, usually with some binoculars, will call to give the turbine started back up.

We want to pick a time to start the turbines back up that is going to be like the least risky. One of the things that we really need to know is that all of these projects are interconnected into manufacturing facilities which have shifts. Shifts leave the plant at a very specific time every day. So if it's doing a controlled startup on W1 over here, really good one Whirlpool's doing a shift change at 2:45.

No, there's gonna to be a lot of people on this road right here. Not a good time to do a controlled startup. A bunch of people walking to their cars, not something that we want to do. So we also have to be aware of potential shifts at each of these facilities so that we can do these controlled startups at a very good time.

Also for Greenville, since that is close to like a Walmart and other things like that, like just being aware of just like times in general, like it's 5:00 on a Monday, a great time to do it. Probably a lot of people going to Walmart to get groceries on a Monday after work. Probably not the best time. So just, you know, we just need to be aware of that.

So we pick a good time to do it, turn the turbine back on and we'll see if we're actually seeing ice being thrown from the blades or not. A lot of times, especially with the projects that have the software built into it for the power curve mismatch a lot of times, we try to turn it back on and then the power grid mismatch says nope, and shuts it back off immediately.

We usually have to do that like a few times and we have to essentially wait until the ice melts off blades for the project that don't have that, though, turn it back on. And we look at SCADA and we see a lot of times see like it might start or the power curve has a huge mishmatch like that and all of a sudden you see it jump back up to the power curve.

That means that all of that ice just came off the blades pretty much. most of the time that ice is falling straight down. That's why we don't typically build anything directly below the turbines. There are two cases where that is not true. One of them is here because we have a yard, so we have to be aware.

You never want to do a controlled start up or start the turbines back up after we know there is an ice build up. If we have crews out here, Absolutely not. We either have to go talk to Chelsea or Justin and be like hey can we get everyone inside? We need to do a controlled startup on a turbine. Our other project, Haviland, one of our first projects, owned by Craig Stoller, he owns that project.

We don't we just help him like with the operations of it, and we're always keeping an eye on it for him. Craig likes to run through a bunch of things. That's his call as to whether or not he wants to shut the turbines down during icing events. So I do try to let him know because he has a bunch of people working below W3 at Haviland.

It's like in his yard where there's like a bunch of forklifts moving plastic around everywhere. And so I do try to make him aware like, Hey there is likely ice buildup at W3. We should probably shut it down, especially because it's a Tuesday at 9 a.m. and you probably have a lot of people on the yard right now.

But the rest of the projects, most of the ice falls straight down from the turbines and that's what we want. What we want to happen, that's how it was designed. We just have to make sure that we're doing this at the right time and with the right controls put in place, you start the turbine back up and it's not shedding the ice off of it.

And you see that the power curve is still mismatched. Shut it down, wait a little bit, and then we can reevaluate in a couple of hours, maybe once it warms up a little bit more.

On-Call Meteorologists – 00:49:45

So our on-call meteorologist, how they interface with the system operators is the on call meteorologists are available during severe events and but they also pretty much are just like letting the system operators know when severe weather is in the forecast like hey, there's a high wind advisory for tomorrow.

Everyone probably needs to be aware of that and keep an eye on it. There is a potential for severe weather over the next couple of days. There is you know the on-call meteorologists. Well, Kurt's up at 3:00 in the morning. A lot of watching stuff. But if I'm on call or Bobbi's on call, usually we just try to let the system operators know ahead of time that there's the potential for things to be occurring and really it's it's the system operators call as to whether or not we're shutting turbines down.

And when they're starting back up the on-call meteorologists are really there is like just a resource for the on-call system operators. Okay. Any questions about icing, winter weather? Basically ice on blades bad. Try to minimize impacts, minimize. yes. So it all depends on how fast the rotor is spinning. And but yeah, we take that into account when we model it.

It takes into account how tall the turbine is, how fast the rotor is spinning, because every model, a turbine is different on that. And then it can figure out how far that ice can go based on all of those inputs. Yes, it does change.

Severe Storms – 00:51:52

Okay. Now, the more fun one which you all won't have to worry about until like end of March, beginning of April, as severe weather starts having thundersnow, there is always a potential for thundersnow.

There is thundersnow. I love it. That's a good day. Doesn't happen often. Okay, so other weather events, severe storms, why do we care? Well the winds get a lot higher. That's why we care. So with high winds, there's increased loading on the turbines. There's also the potential for lightning and flooding and power outages is a big one. We if there is something that is going if there's a storm coming through, that is likely going to take down the grid or we've seen it take down the grid previously, like maybe it's coming across state of Ohio and we can see that there are power outage alerts in like the Van Wert area.

And the storm is coming this way probably means that the winds are high enough to take down some power lines and potentially cause some power outages here, too. So we need to know about that. We need to know about that because the turbines trip offline. If the grid goes down, the turbines are not legally allowed to run. If the grid is down, and that is for safety purposes.

So if there are workers working on the lines trying to get the grid back up and running, we can't be producing power or potentially be back feeding it onto the grid, bad things. Yep. Yeah. So can't happen. Not good. So our turbines shut off and lose power when the grid goes down, which is fine. They can do that.

But if there's a severe storm coming through and maybe there's a large wind direction shift and the turbine isn't able to YAW to be facing into the direction of the wind just coming from from that severe storm that can cause a lot of unnecessary loading on the turbine If the turbine is facing the wrong way from the very strong winds that are coming through.

So we want to make sure that we had a controlled shutdown of the turbine so that it could make sure that it was pointed in the right direction and everything like that. So severe storms. High wind events. So here are some buzz words on severe storms. So we've got straight line winds, supercells, tornados, squall lines, Derechos, Hurricanes usually don't get those here.

Downbursts, microbursts gust front my personal favorite haboobs, you don't get those here either, but they are dust storms. They're wild. If you want to Google something like Google, like Lubbock haboob and the wall of dust that comes to that town, it's insane. East or west Texas is a wild place. So each one of those things are things that you need to be watching for forecasts.

If any of those things are said, it probably means that we need to be really watching the weather. So like I said before, severe weather typically associated with low pressure systems and frontal boundaries. Tornado season or severe weather season in the Midwest is typically from March to about a June. We can get severe thunderstorms all throughout the summer in July and August.

But in terms of severe weather, usually that's happening between March and June, and that's because it's the transitional season where that cold air from the Rocky Mountains is coming down across the Great Plains and meeting up with the warm, moist air coming up with the Gulf of Mexico. When you have cold, dry air meeting up with warm, moist air, that is like the perfect combination for severe weather, which is why I don't know if you all know this, but we get a lot of tornadoes in the United States, right?

There's nowhere else on earth that gets as many tornadoes as we do. There's no other country. The second place that gets the most tornadoes is in India, where you have the cold air coming down from the Himalayas, meeting up with the warm air from the Indian Ocean. But it's still not on the same level as what we have here.

You can get some tornadoes in Italy. You have like a Alps and the Mediterranean situation occurring, But usually those aren't very big tornadoes at all. So we have like from a geographic standpoint of like where the mountains are and everything like that and then where the ocean is like perfect setup to have severe weather. And in that transitional season where we're going from winter over into summer and you're getting that cold and warm air mixing together, that's when March like March through June is when we have the most severe weather.

So we have to forecast and pay attention to a number of things with severe weather. One of those things is lightning. We have alerts because we have a rule that's 30 for 30, so there has to be no lightning within 30 miles for 30 minutes for work to restart when we have crews out on site, especially if they're doing tower work.

So if they are up tower, we do not want anyone up tower. If there's lightning within 30 miles, lightning can travel a long distance and it is going to hit the tallest thing in the area. All of the turbines have lightning rods and lightning protection on them, but especially when it's during construction like we need to we need to know.

So we have alerts that tell us if there is lightning within 30 miles of our projects under construction. So not all of our projects get lightning alerts because if it's Harpster, Harpster's been running for the last eight years, we don't have any crews there. I don't really care if there's lightning near harpster unless we have crews working at that site.

Maybe they're doing regular maintenance or something like that. So we also have to be watching what the maintenance schedule is for these projects. We also have alerts for 50 miles to kind of alert the teams that, hey, there is something coming. You should probably pull up your radar and see if it's like if we have crews working in Findlay, pull it up.

You know, if there's an alert lighting within 50 miles, we'll pull it up and we'll see if there's something maybe over here in VanWert that's like coming their direction or maybe they can pull it up and they say, it's down here near Bellefontaine and it's like not coming near us is just going to skirt along the bottom there.

We don't really have to worry about it, but the 50 miles is like a, Hey, you should pay attention and look at the radar. So forecasting for severe storms, what we can do for this is we always have to be watching the radar, but we use the Storm Prediction Center to know when severe weather is expected. So it gives a convective outlook for 1 to 5 days.

Convective outlook is essentially severe weather. So if I click on this, it is November. So we don't have a lot of severe weather forecasted. But what this will tell us is if we come over here to the convective outlook, this will say the day one day two day three, day four through eight outlook. And these maps tell us the category, this legend down here.

So there's so if its light green, that there's a potential for thunderstorms as you go up. If you get into this like orange, which is enhanced and the red which is moderate, that means that there's a good chance that severe weather is going to occur in that area. So here's a picture from a day that there was a very high potential for severe weather and essentially this told us that severe weather was expected in the center of the country.

But for us over here in Ohio, there is just there is a lower risk for severe weather to us. But if I were to guess, this is the day one, day two probably as the storm system moves further east, day two probably had us under enhanced or slight risk for severe weather as that storm moves through. So we need to watch out for alerts from Earth networks on this.

And also we need to use the forecasting from the National Weather Service and the storm prediction Center to have a heads up as to what could come down the pipeline. So that's me, severe weather, there is a difference between a warning and a watch. And it's very important because we have different protocols for each for severe weather. If you have not watched my Science short and the difference between a watch and a warning, please do.

It's great. Essentially the difference is a warning something is if that an event is happening or is imminent, a watch is that conditions are right for the event to happen. So it's like the difference between it's like the difference between having all the ingredients to make a taco. We haven't made the taco yet, so that's a watch. So you're like, okay, you'd be on the lookout for that taco over there because it might come together and have all the ingredients for it, but it just hasn't come together yet.

A warning is when you actually put the taco together, it is happening and it's imminent. You need to be taking precautions right now and there are different precautions that need to occur. So the National Weather Service warnings. So this is what a warning will look like. If you go to weather.gov, you put in your location and it's like and you see that there is a there's an alert and it's a severe thunderstorm warning.

You click on it this is what's going to come up with a whole bunch of text. Really boring, right? These are the parts you care about. Where up here there's a severe thunderstorm warning for these counties. When? It's until 6 p.m. Eastern Standard Time. What this tells you the details of it. So this says at 5 p.m. The severe thunderstorm is located over some town near some other town moving east at 30 miles an hour.

The hazard, 60 mile an hour wind gusts, potentially quarter sized hail, hail, not winter weather. Severe weather. Source radar indicated this is important. So that source will always be listed most of the time it’s going to say radar indicated the National Weather Service has meteorologists that are looking at this stuff all the time.

These meteorologists are looking at the radar and they can tell a lot from just looking at the radar. They can look at the signature on the radar and figure out like, okay, is there potentially a tornado associated with this or what's the potential for severe winds from this If it says source radar indicated that means that no one has actually witnessed that thing yet.

But based on what is occurring on the radar, they think that these things might be happening on the ground in terms of tornadoes. There are times that that's a source like emergency management, because there are actually there's a network of trained, tornado or severe weather spotters actually be trained in this and get certified in it. Most first responders or emergency management people are trained spotters.

And so if there's a tornado on the ground, they can essentially call up the National Weather Service and be like, there is a tornado on the ground at this location. So if that says source, emergency management confirmed or something like that, and it's a tornado, that means that there is a tornado on the ground. If it says radar indicated, that means that there may or may or may not be a tornado on the ground.

But based on what the meteorologists, the National Weather Service is seeing, they are guessing there either is one or there could be one formed very quickly.

Storm Tools – 01:04:56

So what tools do we have to deal with all of this severe storms, National Weather Service, there's that hourly weather graph again, see this one also has snow, freezing rain and sleet potential at the bottom of it.

The snow would also give an indication as to how much snow we might get. So that's like five inches, 1.5 inches. So that will also tell you what the accumulation is. So we use the National Weather Service for our forecasting. We also have weather stations at the North Findlay Campus and Greenville. These tell us surface wind speed, direction, temperature. We also have the storm prediction center to tell to get a good idea of the forecast over the next couple of days.

Same thing with the National weather service. We also have LiDARs, which you won't have to deal with those radar. And then the Earth Network's alerts always be watching out for those Earth Network's alerts.

Storm Tools: Reading Radar – 01:06:11

So reading Radar during severe weather events, there are different types of thunderstorms that occur. So you have a supercell, you can have a squall line, you can have a Derecho.

All of these are going to look a little bit different on radar. Supercell, is essentially a very large severe storm where it's a supercell, there's one cell and it's very big, supercell. So Supercell is usually the most severe. You can get tornadoes associated with them. They're the most likely ones to develop tornadoes. Squall lines are usually the ones forming along the cold front.

So remember the L and the H from the weather map before and there was that blue line that came down from it, that's that cold front. This is most likely a cold that cold front. There's probably an L a low pressure system up here somewhere up on the weather map associated with this. So this is that cold air is moving through and pushing out.

A bunch of that warm air in front of it and making that warm air rise and create thunderstorms. So usually happen along the cold front usually has to do with very heavy, heavy precipitation. But that doesn't last a long time. Usually lots of lightning and straight line winds associated with these. A lot of times with these as well, you get what's called a gust front.

So a gust front is essentially an area of much higher pressure and higher winds out front of the storm because that storm is essentially pushing all of the air in front of it. And you can get a gust front, so a line, a very strong winds before any of this rain actually comes to the site. Sometimes you can actually see this on radar, kicks up a bunch of dust and stuff.

So you can see the gust front like as a signature on radar, which is really cool, I think when you can see it's happening but just because like the red the precipitation doesn't start to pull back here does not mean that the winds aren't really bad right up here, especially with the storm that looks like this. There's likely a gust front out in front of this. A Derecho is it looks like a squall line, but they move very, very quickly and they start to bow out.

It's like their defining feature. We have had a couple of them. So when we're reading Radar, so reflectivity is is the different colors of radar. Green just means rain, slower reflectivity. How this works, how radar works is you have a radar looks like a soccer ball situation. So how this radar works, it looks like a big golf ball or big soccer ball.

And it is it is emitting radiation radar and that radiation is going out in a cone. Around that radar, it is going and it was hitting particles in the atmosphere like clouds or rain. And it's sending that signal back to the radar. And then depending on that return signal, there's lot that we can find out about where it hit out there in the atmosphere.

So that is called reflectivity. And so the weaker the signal coming back, less rain. So it's going to be those greens and yellows usually just usually just like light rain associated with those. The stronger, the signal returned back, the heavier the precipitation. So That's when you get oranges, reds, even pinks is much, much heavier precipitation. It's a much stronger signal that's returned to the radar.

There's a network of these radars across the United States. It's not as many of them as there should be. We're kind of in a dead zone here in Ohio or in Findlay and northwest Ohio, because the closest radars are Cleveland, which is two and a half hours away. The Detroit Weather station, which is outside of Detroit, which is also like two and a half hours away, and then Fort Wayne, Indiana, which is also 2 hours away.

And with these radars, it goes out in this cone. The further out from the radar. You are the larger the distance between the ground and what that radar see is so the further out you go, you can only see things that are tall and it's like taller and taller. The further out you go from a radar. So that's why sometimes here in Findlay you'll look outside and it'll be like, especially in the wintertime, it’ll be snowing a ton and you'll pull up the radar.

It'll be nothing on the radar to look like. It can’t be snowing there’s is literally nothing on the radar right now. That's because that snow like likely lake effect snow is happening below the radar. Lake effect snow usually happens pretty low down in the atmosphere. And because of where we're located, it's so far away from these radars. A lot of times it can't see lake effect snow here, in Findlay.

And so if you ever look outside, you're like, crap, it's snowing. Didn't see that. Like, I don't have any alerts for that. It's probably because the radar didn’t pick it up. So yeah, the further out you go, higher the beam goes might mean that the radar might miss things close to the surface green rain pink and red severe storm so like here that's heavy precipitation severe storm here over here most likely just rain.

Storm Tools: Earth Networks – 01:12:54

Earth networks provides us alerts email and text messages for all of our locations.

So there are two different groups. So we have two or three different groups. We have the office, which is everyone, and construction. So people that are probably in the field. And our system operators, each one of these groups gets different alerts. The accounting team does not care if there's lightning in Martin Marietta. They just don't like it’s not something that they care about.

So we try to reduce the number of alerts that people get all the time, because the more alerts you get more of like a boy who cried wolf situation is going to occur. And the more desensitized they're going to be to those alerts so we try to minimize that as much as possible. so we have all of our project locations, plus Martin Marietta is on there now. yeah, Yeah.

So everyone in construction or sometimes depending construction will get turned on for these operating projects. Sometimes if we have like planned maintenance, there like sometimes we have like a couple of days worth of like tower walkdowns or something like that, blade inspections. And so we might turn the alerts on for construction, which is like the lightning alerts for that specific location for a period of time.

But then the alerts are different for just like system operator stuff. So for the office, everyone in the office get severe thunderstorm warnings, tornado warnings, flood warnings and dangerous thunderstorm alerts for the North Family wind campus construction gets lightning heat index and wind chill and high winds. So high winds because when we're flying a rotor, we have to know if there's going to be high winds that day or just like really any activities that they're doing.

And then from a construction standpoint, also be good to know that heat index and the wind chill for working conditions as well. Obviously the lightning stuff system ops, we have severe storms, watches and warnings, tornado watches and warnings and observe nearby sustained winds. We have a threshold for it. That system operators will be alerted to and then all freezing precipitation in the winter time as well.

Storm Tools: Radarscope - 01:15:32

Did you all get radar scope the app from your phone? Yeah, I'm giving a presentation on this, I think next week, but it is a specific app for radar. I don't know if Chelsea is going to have you all it. I'm assuming so.

But all the system operators have this app called Radar scope it is the app that I used storm chasing and it's used by a bunch of meteorologists. It does really awesome things called mPings and other storm reports. And so it'll actually tell us… Yes. Yeah, yeah. It's not free. Okay. So these are super helpful during weather events.

So these mPing reports, do you remember I told you how there’s this network of spotters and you can be trained on it and become spotter. Well what happens is you if you're a spotter and you see something like hail or tornado or things like that, you input that into the the network, the information network, and then that gets tied to this radar scope app where you can pull that up and see it.

You can see if there are things that look like this on radar scope, it actually a hail report and you can click on it and you can that someone actually witnessed hail that was point seven inches measured at that location. There's also you see there's a bunch of different symbols and stuff like that. And if you see this symbol, it's like a Bluetooth type thing that a thunderstorm wind damage report, so you click on it.

It says magnitude unknown, but the person noticed that there were downed trees blocking a certain road. So that's also super helpful to know if you see a storm coming through and you start seeing these wind damage alerts or mPing reports and it start saying like trees down, then you're like, okay, well, trees down, power lines might be coming down. Power outage might be like probably occurring in those locations, probably something I need to know about.

But I'll go into more detail about all of this stuff from radar scope and the other one. So there's a there's a lot of info about Radar scope, its a complicated app that has a bunch of very useful information if you know how to use it.

Storm Tools: National Weather Service Radar – 01:18:24

This is what the radar looks like from the National Weather Service. It's not as sophisticated, but it will tell you it will put these boxes around all of your thunderstorm warnings, tornado warnings, which are very helpful.

Sys Op Action Plan for Severe Storms – 01:18:39

so severe action plan, I think this might have been updated, but essentially there are things that we do from a system operator standpoint during watches and warnings for severe storms, tornadoes and lightning, depending on if we are in construction or maybe we have a turbine that hasn't done its 500 hour run test yet, like at Martin Marietta, it hasn’t been running for 500 hours yet we treat them a little bit more delicately.

If they haven't done that and then all operating turbines. So if there is a severe thunderstorm warning I think all the time now, we shut down for severe thunderstorm warnings, there's tornado warnings also shut down. If there is a watch. We consult the on-call meteorologist when should this occur? when do I need to be caring about this. lightning We're in construction and have people working on site we care. It is for high winds.

If on either on SCADA we see that there is you know, wind speeds consistently over a certain amount and I think we've changed these numbers. I need to double check on this, I need to ask the system operators what their current standards are with this. But pretty much it's like sustained winds of for operating projects. We're seeing sustained winds of 20 meters per second hour gusts of 25 or gusts over 25 meters per second is usually when we shut down that 20 meters per second is roughly about 40 miles an hour, 45 miles an hour gusting.

That's 25. It's like 55 miles an hour. So that's below that threshold that the turbine had to shut itself down at 55 miles an hour. We don't like it to get to that point. The other thing to note, too, is like, when do we actually shut down? Like I said before, there might be a gust front associated with a storm that looks like this.

So that storm is moving in that direction. There might be a gust front on the leading edge. So if we have a project. That's right here, we don't want to wait until that storm is over. The project of the project. Now, we also don't want to shut it down if there's like a long time between there. So we want to, you know, shut it down with an appropriate amount of time before the storm gets there to allow the turbine to safely shut down and not be impacted by any potential gust fronts or anything like that.

And then once that storm moves through, we also have to look to see what's just this one line of storms or is this like the potential for many storms to come after it? Should I just leave it down for right now and let the rest of these storms right through? Or is this just one line of storms that needed to get through?

And then it looks pretty clear after that. These are all questions that we have to ask ourselves as to when to shut the turbines back down. And we talked about that again, the on-call meteorologists are there to alert that something might be happening in the forecast and they're there to help the system operators make decisions.

But it's ultimately up to the system operators to make the call as to whether to shut down and when to turn the turbines back on.