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Downtime Coding

GADS Wind Training Module 15

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RELIABILITY | ACCOUNTABILITY

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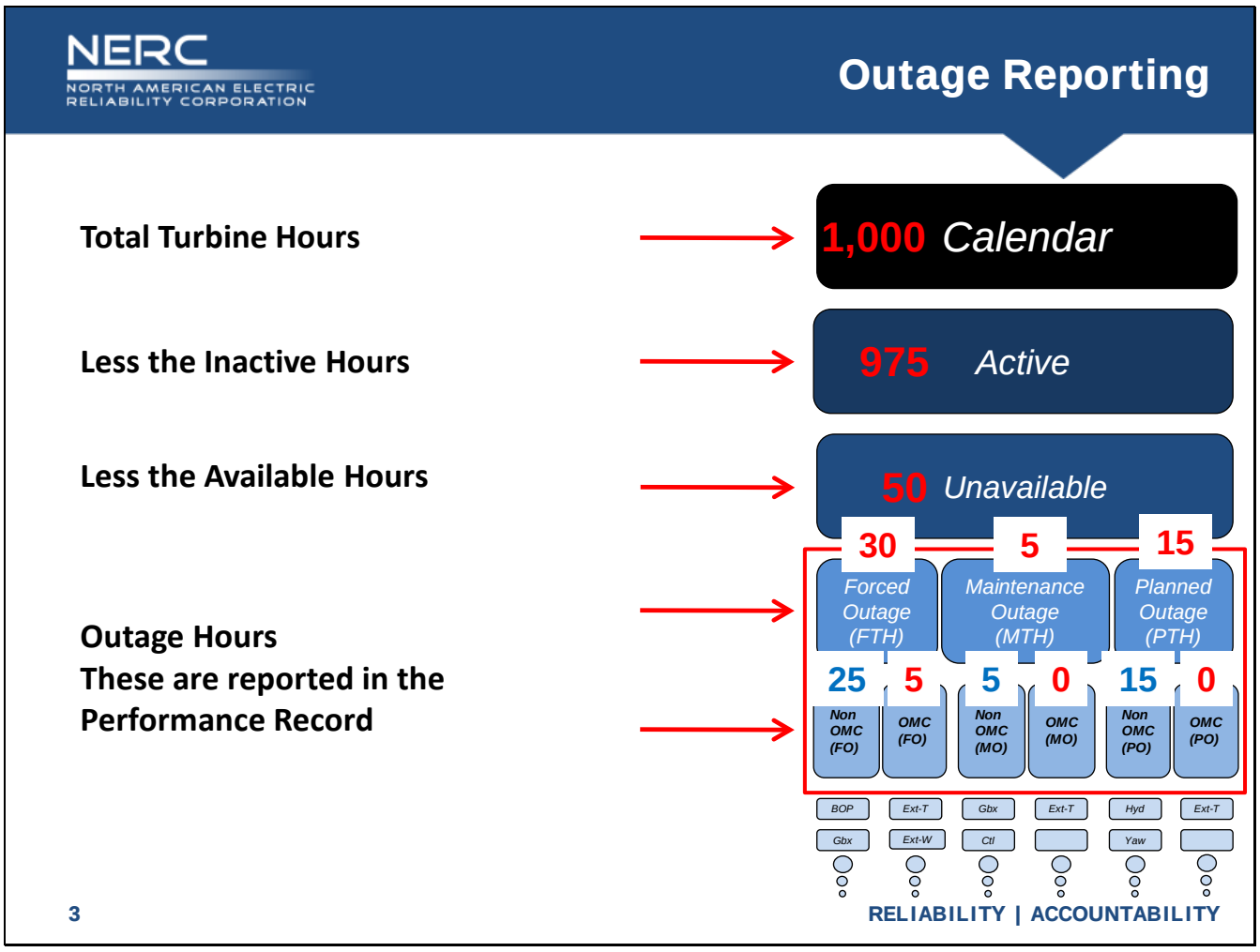
Content

- In this module we will explore:
  - Outage Reporting
  - Define what an outage is
  - Review an outage table
  - Identifying OMC
  - Forced Outage
  - Planned Outage
  - Maintenance Outage
  - The Grey Zone
  - Challenge Questions



As a review:

- We started with Calendar Hours (1,000)
- The Inactive Hours (25) were subtracted out leaving only Active Hours. (975)
- The Available Hours (925) were subtracted from the Active Hours leaving only Unavailable Hours. (50) 5% of the total hours or an outage rate of 5.13%
- The Unavailable Hours (Outage) have 3 flavors, Forced (FO) 3.08%, Maintenance (MO) 0.51% and Planned (PO) 1.54%.
- Each of the 3 have 2 sub-classifications: OMC and Non-OMC. OMC is reported in the Performance report and is a sub-set of FO. As a test OMC (FO) should never be greater than FTH.
- Each of the 2 sub-classifications can be further divided into Components. For FTH, Non-OMC (FO) and the OMC (FO) component outages should roll-up to the value for FTH

Remember that we report total Forced Hours and OMC Hours. Non-OMC Hours can be calculated by subtracting OMC from the Total Forced Hours.

What is an Outage?

An outage is anything that removes a turbine from being available to produce power. The turbine may or may not be capable of producing power. As examples:

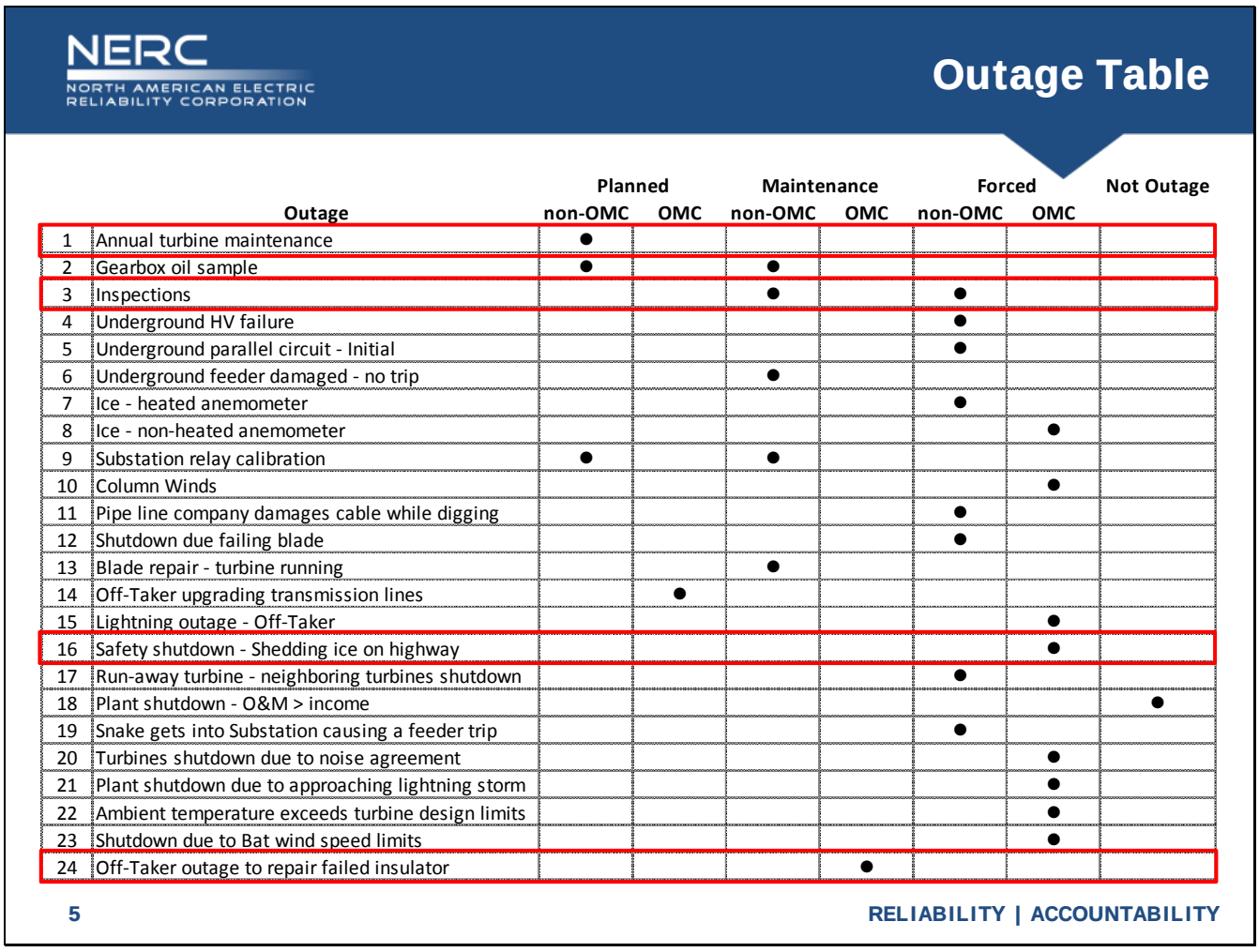
Gearbox failure – The turbine is physically not capable of producing power

Hub adapter bolt torqueing – This is a maintenance event. The turbine is not broken but removed from service so the technicians can safely perform the work

Energy not needed – The turbine is not broken but the power is not needed due to line congestion

Bird migration shutdown – The turbine is not broken but there are legal agreements with conservation groups requiring shutdown during specified periods.

- In an outage the turbine is not available to produce power. This does not necessarily mean that the turbine is not capable of producing power.
- Remember that normal system check, calibrations and internal maintenance (cable untwisting) are considered normal operations for the turbine and are part of RUTH.
- Reserve Shutdown is for negative energy pricing or lack of demand. It is considered an available state and not an outage.



Sometimes downtime categorization can be tricky. Learn the basics and apply the principles to the more complicated examples.

- Annual turbine maintenance is an event that is planned for specifically in the budget. This is long term planning therefore PO > non-OMC
- Gearbox oil sample – If the budget calls for all turbines to be sampled this year, that is long term planning PO > non-OMC. If the sample is one off during the year it is short term planning MO > non-OMC
- Inspections – Generally inspections are short term planning MO > non-OMC but you may also be inspecting a failed gearbox which is forced FO > non-OMC
- Underground HV failure – No planning FO > non-OMC
- Underground parallel circuit – initial. Underground failure (Forced) parallel circuits opened for safety. Usually, underground repairs are completed ASAP due to the large number of turbines off line. The event was not planned for therefore the safety shut down of the parallel circuits is FO > non-OMC. If the job were to be delayed for a period to meet the MO rules the parallel outage could be MO > non-OMC. The original failed cable will always be FO no matter when it is repaired.

- Underground feeder damaged – no trip – The cable insulation was damaged in this case and temporally patched with duct tape. The repair occurred several weeks later. MO > non-OMC
- Ice – heated anemometer – Ice buildup on an anemometer. The anemometer has a heater that has failed. This is a failure of the protective device. FO > non-OMC
- Ice – non-heated anemometer – In this case the anemometer was not designed to operate in ice conditions. FO > OMC
- Substation relay calibration – If it is specifically in the budget PO > non-OMC. Usually, this is a MO > non-OMC. Note: If the substation were down due improper calibration or failed relay it would be FO > non-OMC
- Column Winds – Sometimes the wind blows down the turbine rows causing high turbulence. This is FO > OMC.
- Damaged caused by others – Digging often occurs around a wind site. It is the responsibility of the site to know where the underground is and identify it before digging. Forced > non-OMC.
- Failing Blade – Could be total failure or bonding issue – Forced > non-OMC
- Blade has damage from lighting or partial seam separation but still can run. Repaired when convenient. MO > non-OMC
- Upgrades are usually planned with PO > OMC. Small upgrades could also be MO > OMC
- Lightning outage – Off-Taker – FO > OMC
- Safety shut down for ice – FO > OMC
- Run away turbine – neighboring turbines shutdown to minimize secondary damage. FO > non-OMC. This is part of the run away.
- Plant shutdown – O&M > income. Turbines can run and are available. This is Reserve Shutdown
- Snake gets into substation causing a feeder trip FO > non-OMC
- Turbines shutdown due to noise agreement. Agreements that result in outages are OMC. In this case FO > OMC
- Plant shutdown due to approaching lightning storm FO > OMC
- Ambient temp exceeds turbine design limits. Outside the operating envelope of the turbine. Not expected to run. FO > OMC
- Shutdown due to bat wind speed limits FO > OMC
- Off-Taker outage to repair failed insulator. Short term planning. System can run but needs a repair. MO > OMC

Identifying OMC

Appendix C – System-Component Codes

System	Component
External	General (OMC)
	Catastrophe (OMC)
	Economic (OMC)
	External Communication (OMC)
	Legal, Contractual or Environmental (OMC)
	Off-Taker Transmission & Distribution (OMC)
	Weather – Ice (OMC)
	Weather – Lightning (OMC)
	Weather – Temperature (OMC)
	Weather – Turbulence (OMC)
	Security (OMC)
	Execution Delays (OMC)

Use the External Component descriptions to identify potential OMC causes.

The list of External components listed in Appendix C will help identify legitimate OMC causes.

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Forced Outage (FO)

Characteristics of a Forced Outage

- It's broken – Failure to function as designed
- No planning – Little or no warning
- Usually not expected
- Surprised
- Parts may not be on hand

Examples:

1. Lightning strikes the substation and trips a breaker
2. The turbine trips off-line
3. Pitch motor fails
4. Underground splice fails
5. Gearbox near end of life fails before a replacement occurs

- Forced outages account for 80 to 90 percent of wind turbine outages.
- It is usually easy to categorize because it was not expected and there was no time to plan.
- The characteristics of a FO are general in nature. There may be exceptions but the general pattern of the outage is as described.
- Example of a failed flashlight bulb:
  - Bulb does not light. It is broken and not functioning as designed
  - There was no warning that the bulb will fail therefore there was no planning for a repair or replacement
  - The bulb was not expected to fail
  - It was a surprise
  - Because it was a surprise a replacement bulb was not available. The need for a replacement bulb was not expected.
- Example 1 – Lightning strike trips a breaker – Not broken, no planning, not expected, surprised, parts not needed.
- Example 2 – Turbine Trip – May or may not be broken, no planning, not expected, surprised, parts may or may not be needed

- Example 3 – Pitch motor fails – Broken (usually bearings or keyway), little warning (increase in encoder failures and faults, usually a surprise, parts probably in normal stock
- Example 4 – Underground splice fails – Broken, not planned not expected, surprised, repair kit usually not in stock. There may be some addition complications shutting off parallel circuits.
- Example 5 – Gbx near end of life fails before a replacement occurs:
    - Anytime a system is broken before repairs commence, it is an FO. In this case the Gbx broke
    - There may have been some planning
    - It was expected to fail but not so quickly
    - It was not a total surprise
    - Parts and equipment were moving in the direction of a repair

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Planned Outage (PO)

Characteristic of a Planned Outage

- Not broken
- Long term planning – Should be specifically in the budget
- Work clearly defined
- No surprises
- Parts on hand

Examples:

1. Turbine preventative maintenance
2. Gear oil filter housing retrofit for all turbines (in the budget)
3. Bi-annual tower torqueing
4. Periodic substation relay calibration

Challenge question – Gearboxes replacements are usually in the budget. Why are they normally not considered a planned outage?

- Planned Outages (PO) usually involve lots of planning and the work scope is clearly defined.
- Manpower requirements and materials are known ahead of time and are on hand when the Planned event starts
- Examples:
  - Turbine preventative maintenance – Not broken, in the budget for every turbine, procedures-manpower-parts, knew ahead of time, all parts ordered and received.
  - Gear oil filter retrofit – Not working to spec, retrofit for specific known turbines, procedures-manpower-parts, no surprises, parts in inventory
  - Bi-annual tower torqueing – Not broken, in the budget for every turbine, procedure-manpower, no surprises, no parts
  - Periodic substation relay calibration – Not broken, required by contract and NERC, procedure-manpower, no surprises, no parts
- Challenge Question – Usually a statistical prediction of the number of annual failures is used. Specific turbines are usually not listed in the budget. Without specifics there is no planning.

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Maintenance Outage (MO)

Characteristic of a Maintenance Outage

- Almost broke
- Some planning prior to repair
- Almost a surprise – Close to breaking
- Parts may not arrive on time for repair
- Most abused outage type.

Special rules define the boundaries:

1. Capable of being deferred until the following week or if it occurs on a weekend deferred through the following week. **(Primary rule)**
2. Was not a surprise
3. Some warning
4. Some minimal planning takes place
5. A maintenance event is for a specific purpose and it should have a time frame.

- Lucky for us, MO usually account for less than 1% of the outages seen and most are easy calls
- The tendency for the plant is to protect the indicators they are held accountable for. Pushing the definition and boundaries is not uncommon.
- The question that every plant manager needs to as is “If I owned this piece of equipment would I run it”. If it was my car would I allow my spouse to drive it?
- The common feedback is “The turbine was running ok before I turned it off”.
- A good practice is to separate O&M from engineering. Let the engineer decide what the remaining useful life is. If the recommendation is “Do not run” it is a FO and not an MO.
- Always remember the primary rule is it “Capable of being deferred until the following week or if it occurs on a weekend deferred through the following week.”

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The Grey Zone

Equipment Scheduled Outage Factor

- The below equations is from the Wind DRI
- The equation identifies the percent of time that work was scheduled
- Schedule implies some time for planning
- The dividing line between forced and maintenance outages is "could it run until next week and if it occurs during the weekend could it run until the following week".
- Faults are also included in the MO definition. Could it run until the following week without faulting?

1.B.7. Equipment Equivalent Scheduled Outage Factor (EESOF)
% of period that the WTG equipment was unavailable due to maintenance and planned downtime.

$$EESOF = \frac{(MTH + PTH + EMDTH + EPDTH)}{PDTH} \times 100$$

- At times it is difficult to ID whether an event is MO or FO – The Grey Zone
- The "could run until the next week" has some slack around it and is not a perfect dividing line
- This rule not only applies to component failures but also to faults
- The Grey Zone is an area for abuse and should be watched closely
- If a turbine faults it is an FO and its associated repair is part of the FO
- If a turbine occasionally faults on a specific fault or system (2-3 times a MO), the inspection and potential repair is MO
- If a turbine is faulting daily or weekly there is no expectation that it will run until the following week, therefore it is FO
- You cannot reset a fault, then go fix it and call it MO

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Maintenance Outage (MO)

Common MO pit falls:

- Choosing performance indicators over equipment integrity
- Pressure from management to keep things running
- A running turbine does not necessarily mean it is a healthy turbine
- Lack of ownership
- Extending the MO to other non-related FO work

Examples:

1. Rising main bearing temperature leads to a borescope exam and the bearing needs to be replaced within the next 3 months. The bearing is replaced before failure
2. The turbine is running and you want to get the blade serial numbers
3. Vibration analysis indicates a planetary bearing starting to fail. The gearbox should be replaced within 6 months. The bearing is replaced before failure
4. All the anemometers are replace with a new super winterized anemometer.

- The main point for the Pit Falls is we want to ensure equipment integrity and life and at the same time maximize our productivity and performance
- The main bearing supports the blades and rotor. Failure to address the main bearing failure can lead to gearbox failures. Temperatures and borescope are a type of condition assessment that allows us to understand the functional capability of the equipment. Early detection allow for planning and replacement on our terms.
- Getting serial numbers is a form of inspection. Generally, inspections on running turbines are MO outages.
- Vibration analysis is a form of condition assessment that allows us to proactively repair the turbine. Bearing failures increase the amount of circulating metal adding addition wear. It is not uncommon to discover several pounds of metal debris in a gearbox oil filter.
- Replacing equipment as an improvement project is a form of MO

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Challenge Questions

1. A turbine has been tripping, at least daily, on a Yaw Run Away fault for several weeks. Finally you get someone free to check out the fault. The turbine is running and the technician turns the turbine off and investigates the problem. What type of outage is this?

   Answer: Forced outage – doesn't meet the MO rules

2. During an annual maintenance the gearbox oil filter is changed and several pounds of metal debris are found. The next day the gearbox is scoped and severe damage is found on the intermediate pinion. The data is reviewed by the fleet engineer and recommends "Do not run". The site manager says "The turbine was running before maintenance and I know it could run at least a week". The turbine remains down.
   What type of outage is the maintenance, gearbox scope and after review.

   Answer 1: PO – Annual maintenance are planned work

   Answer 2: MO – Inspections on running turbines are generally MO

   Answer 3: FO – Engineering should make the major engineering decisions. In this case "Do not run"

- First question – There is no expectation that the turbine will run until next week without faulting for the same issue. Usually these types of issues are a loose wire, wire crimped on insulation or a dirty connector.
- Second question – Annual maintenance is usually in the budget therefore planned work. Other work can occur during the PO but should not extend beyond the expected PM time period. Extending beyond the outside boundary of the PM could trigger a new event.

  Inspections on running turbines are MO until proven otherwise. In this case time was taken to scope the gearbox and the data evaluated by an engineer that was independent from the site. Sometimes it can take a few weeks to get the engineer report back. The waiting for results is part of the MO.

  Both the engineer and the site manager agree that the turbine should not run. The Engineer calls it an FO because of the potential consequential damage and the site manager calls it MO because it was running before the maintenance and feels it could run another week. In this case the engineer should prevail. The engineer is relying on data and is a third party.

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