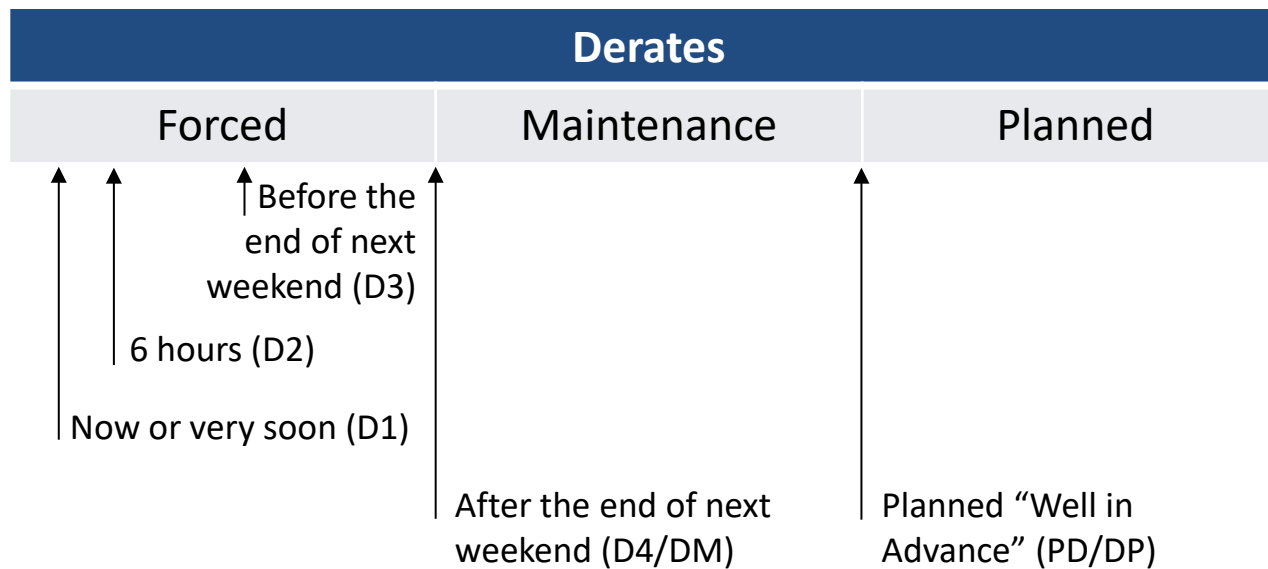- Proof of unit derates for interested parties
  - Independent System Operators (ISO)
  - Public Utility Commissions (PUC)
  - Watchdog consumer groups
- Calculate unit performance
  - Reliability – measure of how long a unit can operate normally (MTBF)
  - Availability – percentage of time that a unit is in an operable state (EAF)
    - The "E" in EAF means that derate event are included
  - Maintainability – probability that a unit can be restored to an operable state (MTTR)
- Analyze unit history
  - Feedback for "lessons learned"
  - Derates occur over twice as often as outages due to redundant equipment

- What is a derate?
  - A derate is a partial outage with an associated reduction in capacity
  - It exists when a unit can generate but not at 100% capacity
  - It starts when the unit is not capable of reaching 100% capacity
  - It ends when the equipment causing the derate is either ready for or put back in service
- Capacity is based on the capability of the unit, not on dispatch requirements
  - Load following (running at less than 100% load) is not a derate
- More than one derate can occur at a time which makes them more difficult to account for than full outages

- Timing starts when the problem is detected
  - Forced Derates (three types)
  - Maintenance Derates (one type plus extension)
  - Planned Derates (one type plus extension)

Derates		
Forced	Maintenance	Planned

Before the end of next weekend (D3)

6 hours (D2)

Now or very soon (D1)

After the end of next weekend (D4/DM)

Planned "Well in Advance" (PD/DP)

- Problem: The basement operator notices metal flakes in the oil from a forced draft fan thrust bearing. Vibration is up on the bearing but is not serious. Maintenance wants to reduce load and repair the bearing while the unit is online. Operations can't reduce load until sometime next week.

- Question: What kind of derate is this going to be?
  A. D1
  B. D2
  C. D4
  D. PD

- Answer: C. D4, maintenance derate

- Explanation: Since the unit can operate during repairs and this is not a planned event it would be a D4, maintenance derate

- Report a derate or not?
  - If a derate is less than 2% Net Maximum Capacity (NMC)

  And

  - Lasts less than 30 minutes, then it is optional to report it
  - All other derates are reported
    - Report a 1-hour derate with 1% reduction
    - Report a 15-minute derate with a 50% reduction
    - It is recommended that all overlapping derates, regardless of type, size or duration, be reported so that the correct reduction due to each can be determined

- Non-Derates
  - Ambient related losses are not reported as derates
    - Ambient related losses are determined from the performance record as
      - Ambient Losses = Net Maximum Capacity - Net Dependable Capacity
      - Ambient Losses = NMC- NDC
    - However, equipment limitations due to ambient conditions, such as maxing out a fan when the air temperature is high, are derates

```
078401222017    240D107051624                      07071711        16200              01
078401222017    240D11400                1     0                    Unit 1 limited 02
078401222017    240D11400       due to FD fans maxed out.                             03
```

  - System Dispatch requirements are not reported

- Problem: You are going through your daily routine of recording event data from the control room log book. You've been on vacation for the last two weeks and are having to catch up. There are a lot of events to record, especially derates.

- Question: Which of the following problems noted in the log is a derate?

  A. Loss of a heater drain pump

  B. Black start test

  C. Loss of 1 of 8 pulverizers (unit can make full load with 6)

  D. Not running at full load

- Answer: A. Loss of heater drain pump

- Explanation: The heater drain pump is part of the condensate system and losing it will derate the unit by a set amount

- Forced Derates
  - Immediate (D1)
    - Requires immediate reduction in capacity
  - Delayed (D2)
    - Does not require an immediate reduction in capacity but requires a reduction within six (6) hours
  - Postponed (D3)
   - Can be postponed beyond six (6) hours, but requires reduction in capacity before the end of the next weekend

- Scheduled Derates
  - Planned (PD)
    - Scheduled "well in advance" and is of a predetermined duration
  - Maintenance (D4)
    - Deferred beyond the end of the next weekend but before the next planned derate (Sunday 2400 Hours)
  - Planned Extension (DP)
    - Continuation of a planned derate
  - Maintenance Extension (DM)
    - Continuation of a maintenance derate

- Extensions are valid if:
  - They are requested to complete work started during PD and D4 events that was determined in advance as part of the "original scope of work"
  - When unexpected problems or conditions are discovered during a derate that are not part of the original scope of work and the result is a longer derate time
    - Do not use DP or DM
    - Use another derate instead
  - DP or DM must start at the same date/time that the PD or D4 ended

- ## Derates that vary in magnitude
  - Add a new event for each change in capacity (most accurate – recommend using it whenever a variable derate is overlapped)

  or

  - Average the capacity over the full derate time and use one event
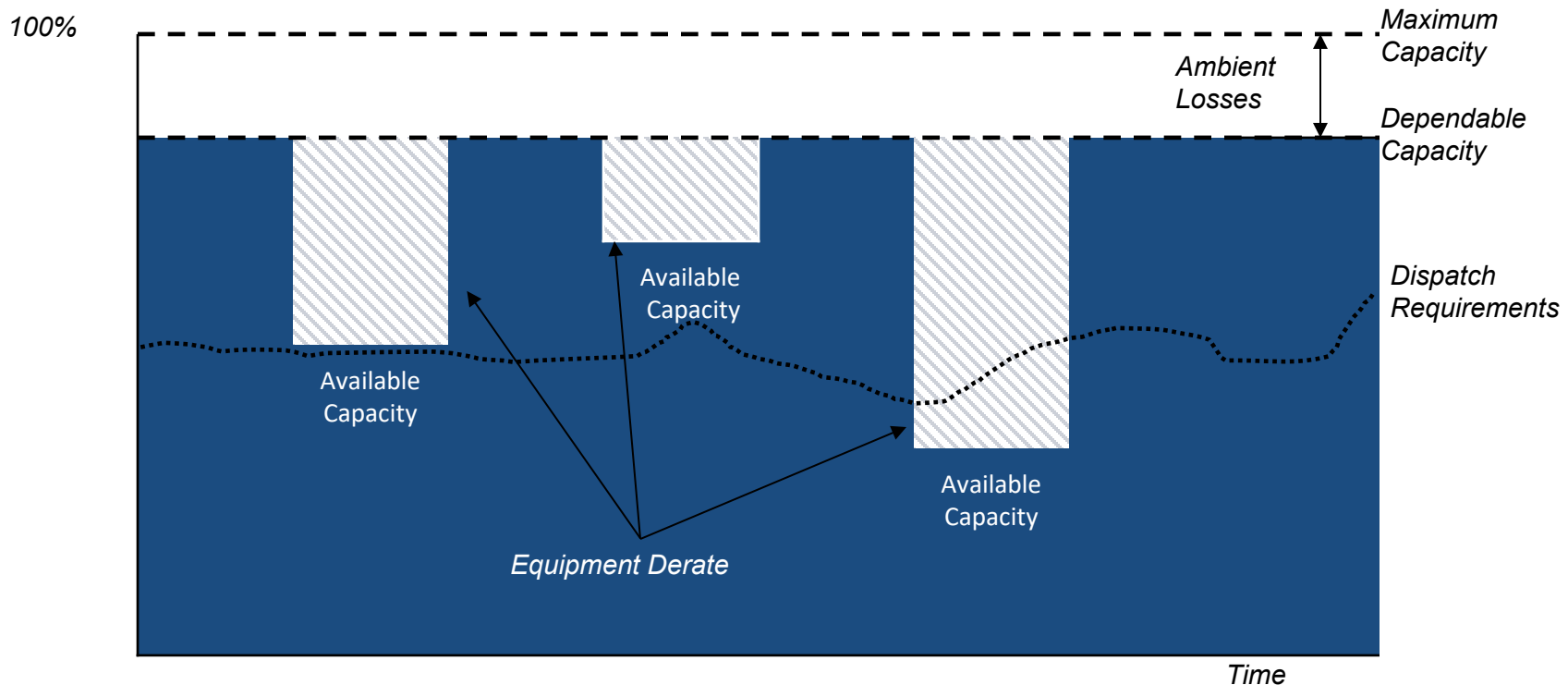
- Problem: A unit is experiencing ongoing derates of varying magnitude caused by wet coal clogging pulverizer feeders. There were 20 events in 3 hours.

- Question: What type of derate should be used to track this event? What is the best way to determine the unit's capacity?
  - A. Postponed
  - B. Delayed
  - C. Variable

- Answer: C. Variable

- Explanation: A variable derate should be used and since the problem is immediate it should be a D1. Average the capacity loss for the events and subtract from NDC to get NAC.

- Overlapping Derates
  - All derates are additive unless shadowed by an outage or a larger dominant derate
  - Shadowed portions of derates have no effect on overall unit performance
  - GADS automatically adjusts available capacity when a derate ends

- The size of a derate reduction is determined by subtracting the Net Available Capacity (NAC) from the Net Dependable Capacity (NDC).

- In cases of multiple derates, the size of the reduction of each derating will be determined by the difference in the Net Available Capacity of the unit prior to the derating and the reported Net Available Capacity as a result of the derating.

NDC

NAC1

NAC2

Derate 1

Derate 2

Reduction1 = NDC – NAC1

Reduction2 = NAC1 – NAC2

TIME
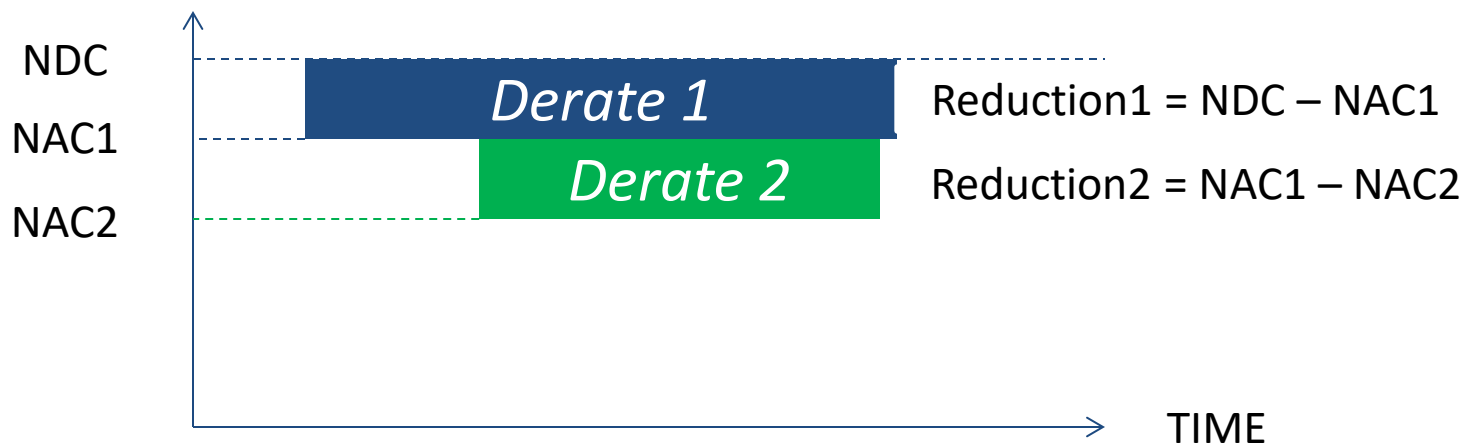
- Problem**:** Unit 1 has an ongoing small boiler tube leak that is causing a 10 MW derating. A second derate for 20 MW develops when a fuel oil gun won't go into service for a few hours.

- Question: What is the total derate on the unit when the fuel oil gun finally goes back in service?
  - A. 10 MW
  - B. 20 MW
  - C. 30 MW

- Answer: A. 10 MW

- Explanation: The total reduction on the unit is 10 MW to start. It increases to 30 MW while the fuel oil gun is out of service and it reduces back down to 10 MW when it goes back in service.

- Problem**:** One of your units is having burner air register drive problems. The cause is determined to be a faulty component installed during the last planned outage. As burners are taken out of service for repairs the unit experiences multiple overlapping derates. When you enter the GADS data you keep getting an error that one or more derates have no reduction.

- Question: What is wrong with the derate event data?

  A. You are using the wrong type of derate for the events

  B. Each derate should have the same cause code

  C. Net Available Capacity is the same

- Answer: C. Net Available Capacity is the same

- Explanation: Reduction derate 2 = NAC of derate 1 – NAC of derate 2 so if NAC is the same then the reduction is zero

- Problem: One of your units is experiencing overlapping derates during a summer run when it is really needed and management doesn't want to shut it down for repairs. When you enter the GADS data you keep getting an error that NAC is negative.

- Question: What is wrong with the derate event data?
  A. There are errors in the data you collected
  B. There are typo's in the data you entered
  C. The Net Dependable Capacity (NDC) value being used by operations and/or your software is incorrect

- Answer: It could be any or all of the above

- Explanation: By definition $0 < NAC <= NDC$. NAC cannot be negative; check your work for transposed digits, incorrect event start/end dates, and verify NDC

- A concurrent derate occurs on combined cycle or co-generation units whenever one or more components experience a problem large enough to be seen by the steam turbine

- These types of units consist of one or more Gas Turbines (GT), one or more Heat Recovery Steam Generators (HRSG), and one or more Steam Turbines (ST) where the waste heat from the GT is used to produce steam in the HRSG for the ST to increase overall efficiency

  - Example: One of the GT on a 4 x 4 x 1 combined cycle unit (4 GT x 4 HRSG x 1 ST) experiences an immediate forced outage (U1). It's HRSG is shutdown while the GT is repaired. The ST sees a 25% drop in steam so an immediate derate (D1) must be added to the ST.

- Concurrent derates can also occur on multi-boiler/multi-turbine units

- Problem: Unit 1A is a 2 x 2 x 1 combined cycle unit. GT 1A throws a blade in its compressor section and goes on a U1 forced outage. HRSG 1A is shut down as a result. GT 1B remains in service as does the steam turbine ST 1 at half load.

- Question: What type of derate must be placed on ST 1 to account for the loss of steam from HRSG 1A?
  - A. Delayed
  - B. Concurrent
  - C. Postponed

- Answer: B. Concurrent

- Explanation: Since GT 1A went on a U1, a concurrent D1 derate must be placed on ST 1 to account for the loss of steam from HRSG 1A

- Problem: Unit 1A is a 2 x 2 x 1 combined cycle unit. GT 1A comes down for a maintenance outage. HRSG 1A is shut down as a result. GT 1B remains in service as does the steam turbine ST 1 at half load.

- Question: What type of concurrent derate must be placed on ST 1 to account for the loss of steam from HRSG 1A?

  A. D1
  B. D2
  C. D4

- Answer: C. D4

- Explanation: Since GT 1A went on a MO, a concurrent D4 maintenance derate must be placed on ST 1 to account for the loss of steam from HRSG 1A
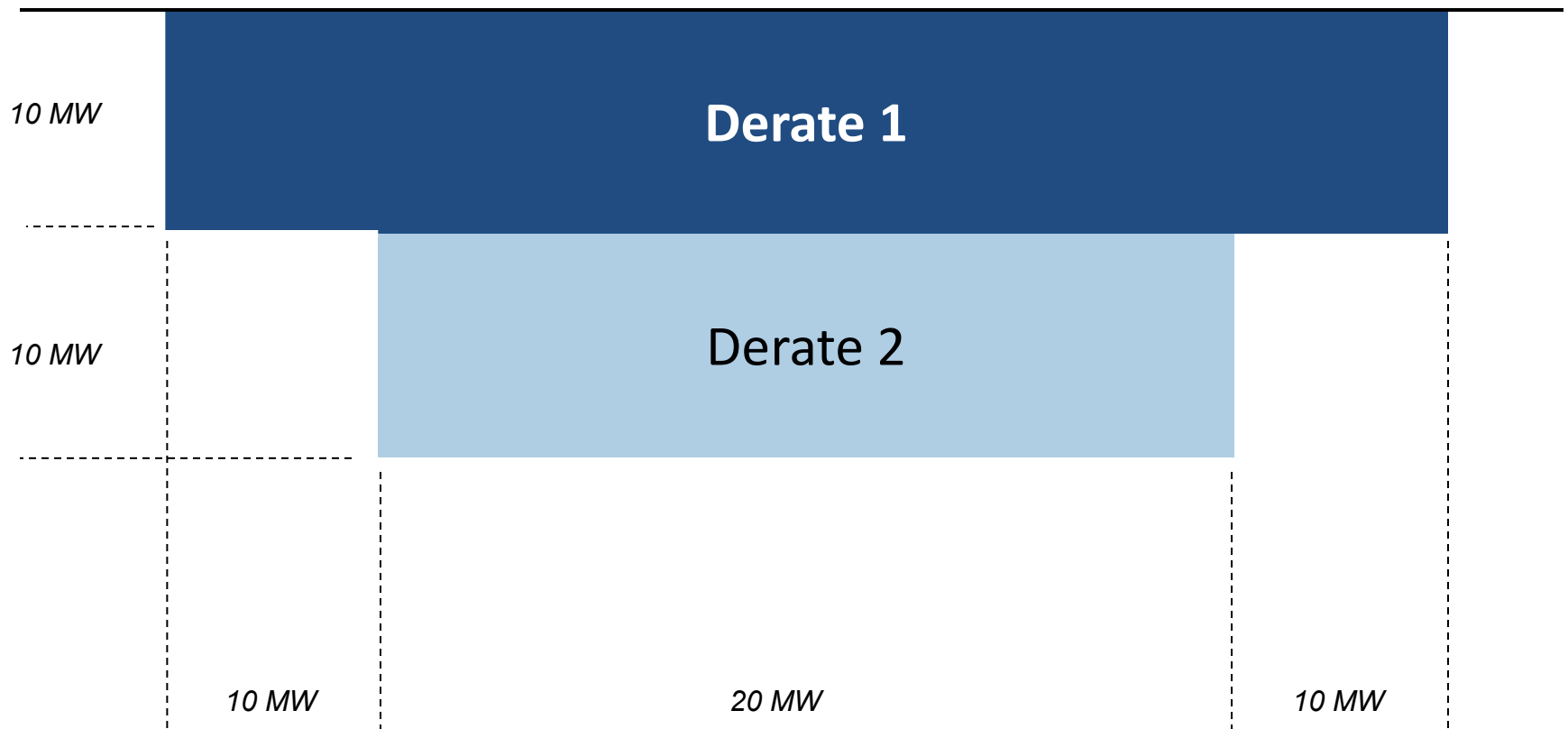
- Problem: Unit 2 is a multi-boiler unit. It has two boilers, 2A and 2B, and one steam turbine. Boiler 2A comes down for an annual overhaul. Boiler 2B remains online as does the steam turbine.

- Question: What type of concurrent derate must be placed on unit to account for the loss of steam from boiler 2A?
  A. PD
  B. D2
  C. D4

- Answer: A. PD

- Explanation: Since boiler 2A went on an annual overhaul (PO), a concurrent PD planned derate must be placed on the steam turbine to account for the loss of steam from boiler 2A

- Problem: Unit 2 is a multi-boiler unit. It has two boilers, 2A and 2B, and one steam turbine. Boiler 2A comes down for an annual overhaul. Boiler 2B remains online as does the steam turbine.

- Question: What type of outage event should you enter for boiler 2A?

  A. PO

  B. None, it is just a major component that doesn't generate power

  C. D4

- Answer: B. None, it is just a major component . . .

- Explanation: Only an event for the derate on steam turbine need be entered; the annual overhaul of the boiler can be recorded as additional work during event under the derate

- All derates are treated as being additive unless they are marked as dominant with a "D"

- A dominant derate will shadow the overlapped portions of other derates happening at the same time like an outage and those portions will have no effect on overall unit performance
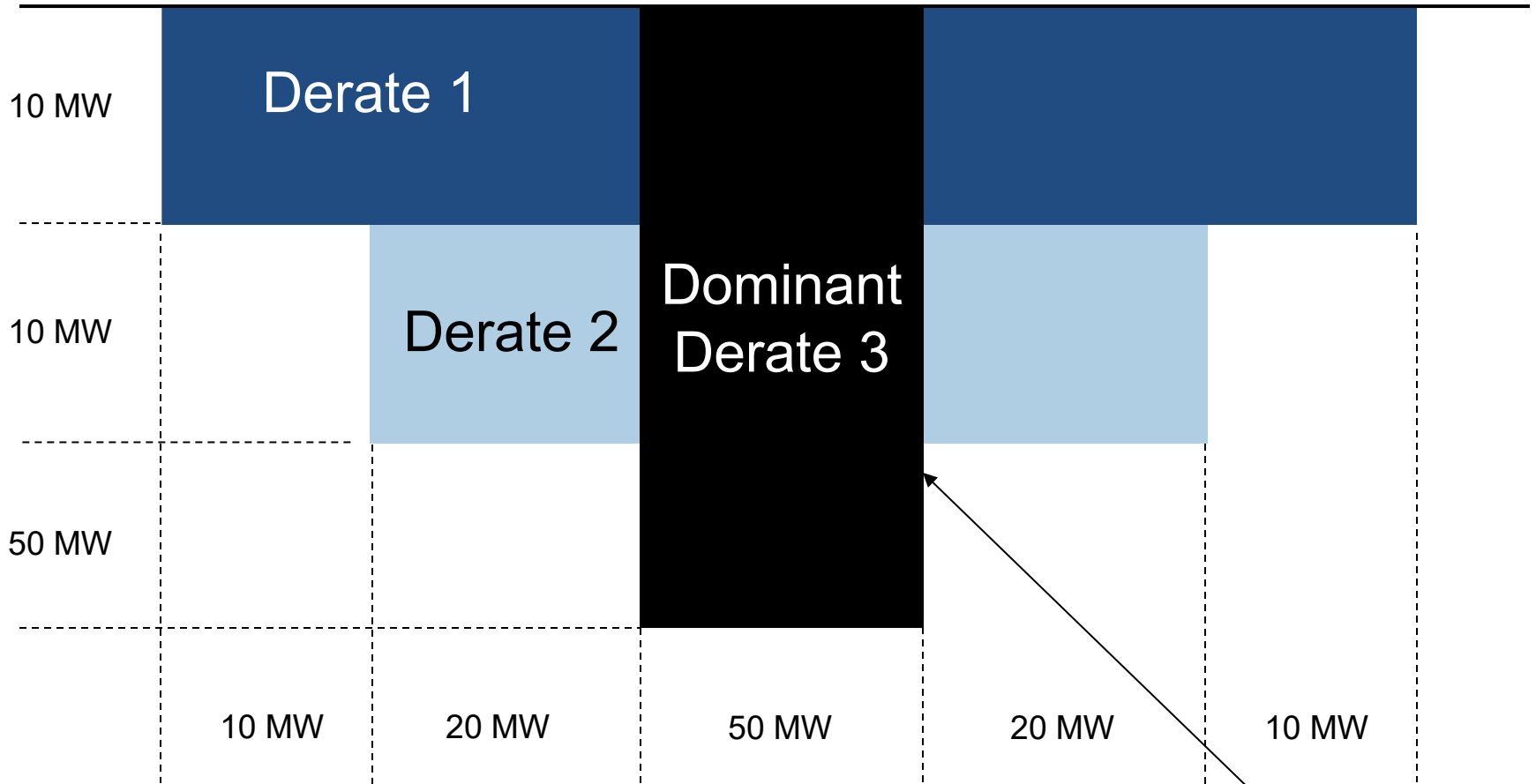
- How do you know if a derate is dominant?
  - NAC is unaffected when the smaller overlapped derate ends
  - If unsure, ask a
    - Plant control room operator
    - Plant engineer
  - If not marked dominant, the software assumes it is additive
    - This can result in inaccurate reporting

- The following slides show what happens behind the scenes
  - The software handles additive/dominant/shadowed derates automatically
- All you have to do is indicate when a derate is dominant

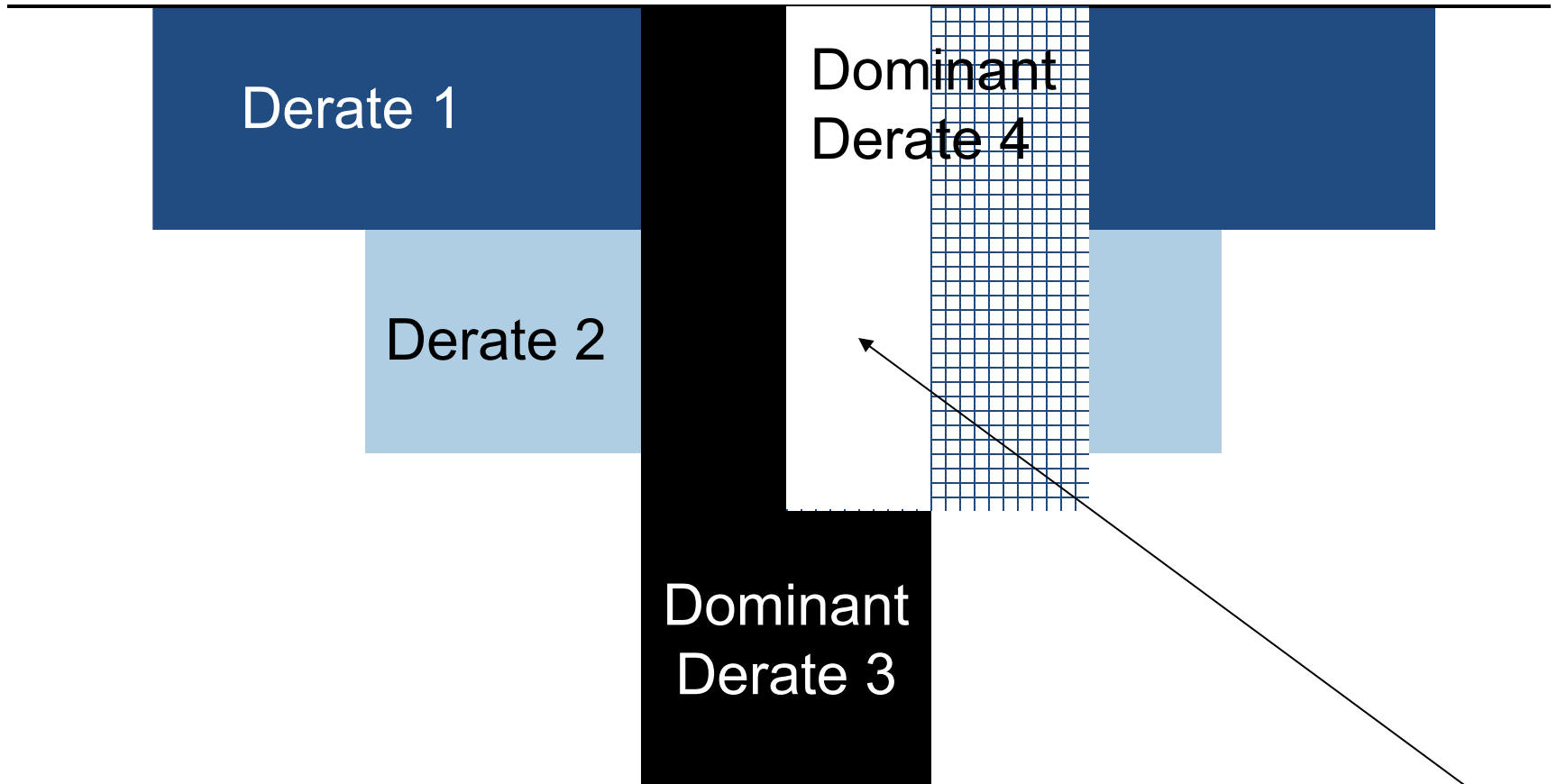Where the derates overlap their reductions are added together making them "additive"

10 MW

Derate 1

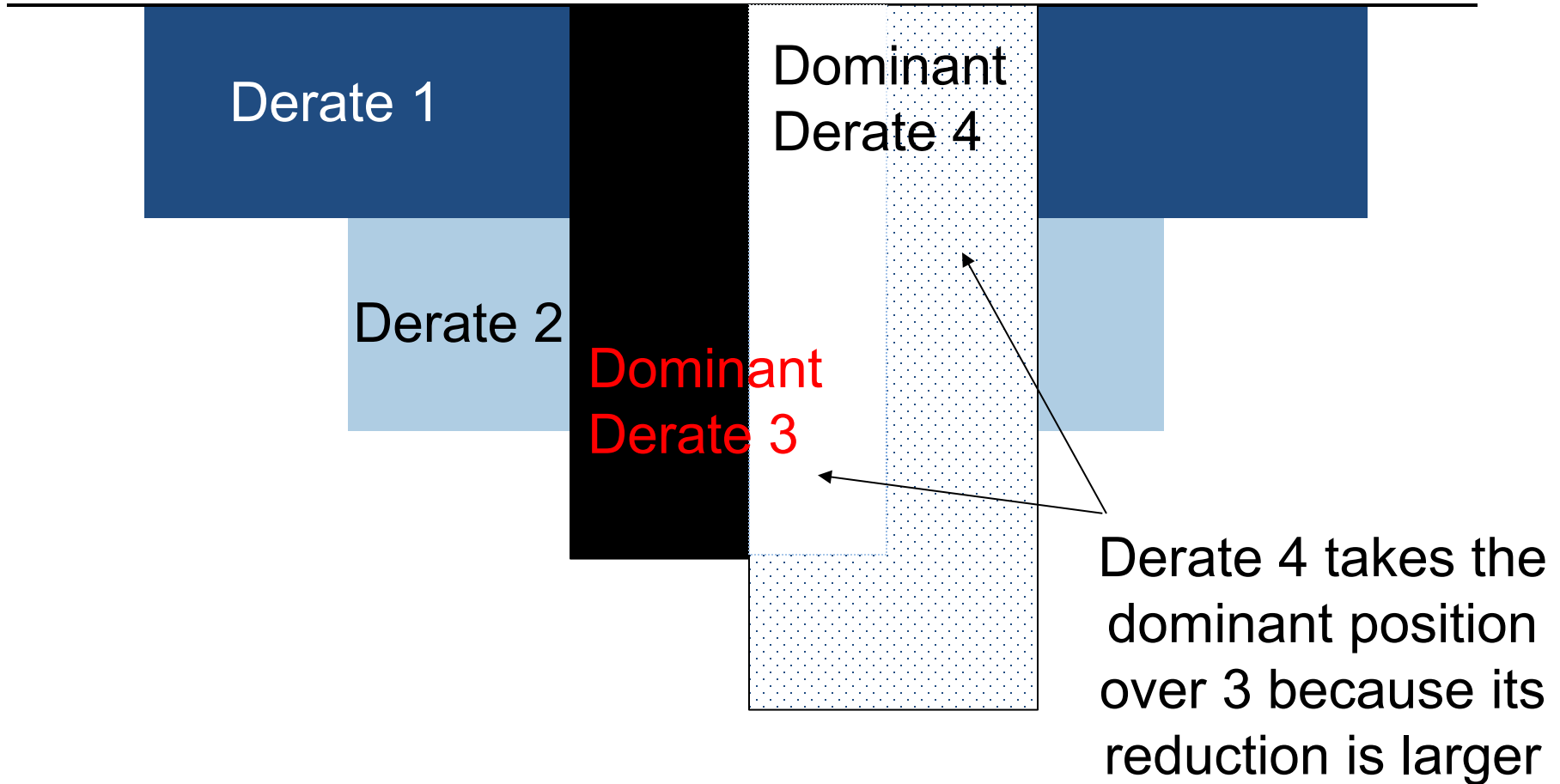10 MW

Derate 2

10 MW   20 MW   10 MW

Single Dominant Derate

10 MW	Derate 1		Dominant Derate 3	Derate 1	

Derate 2 — 10 MW

50 MW

| 10 MW | 20 MW | 50 MW | 20 MW | 10 MW |

Dominant derate 3 shadows portions of derates 1 and 2

Overlapping Dominant Derates

Derate 1

Dominant
Derate 4

Derate 2

Dominant
Derate 3

Dominant derate 3 shadows portions of derates 1, 2, and 4

Overlapping dominant derates by size of reduction

Derate 1

Derate 2

Dominant Derate 3

Dominant Derate 4

Derate 4 takes the dominant position over 3 because its reduction is larger

- Problem: Derate B started before derate A ended. When derate A ended the Net Available Capacity on the unit was not affected.

- Question: What type of derate is B?
  - A. Immediate
  - B. Delayed
  - C. Postponed
  - D. Dominant
  - E. Maintenance

- Answer: D. Dominant

- Explanation: Derate B is sufficiently larger than A such that the unit only saw the reduction due to B while it shadowed A. So when A ends during B the unit's NAC is unaffected.
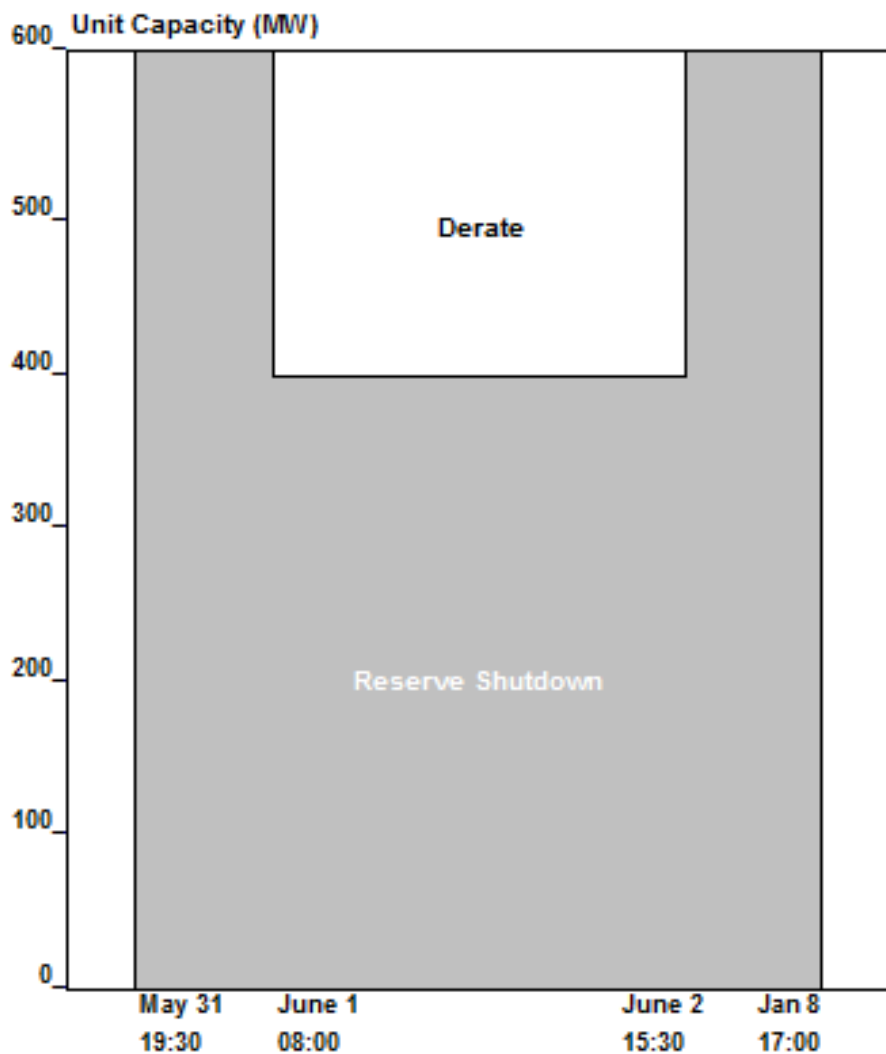
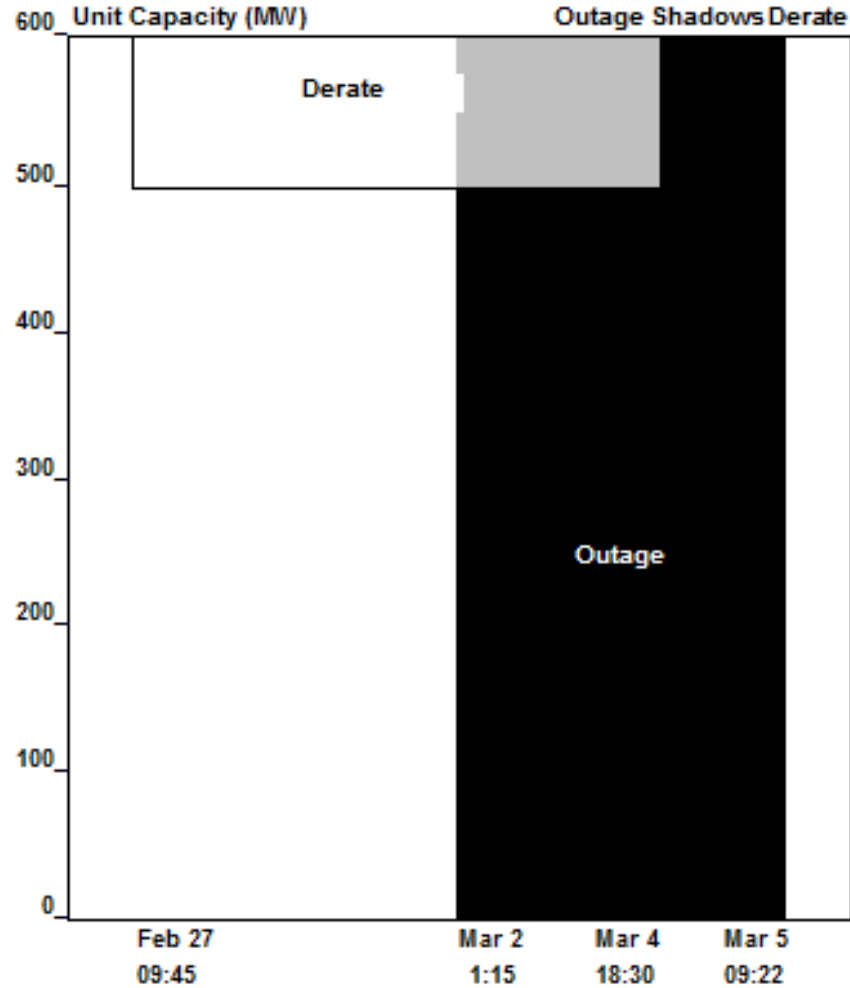Figure G-5 — Derate during a Reserve Shutdown

Figure G-6A — Derate Overlapped by an Outage
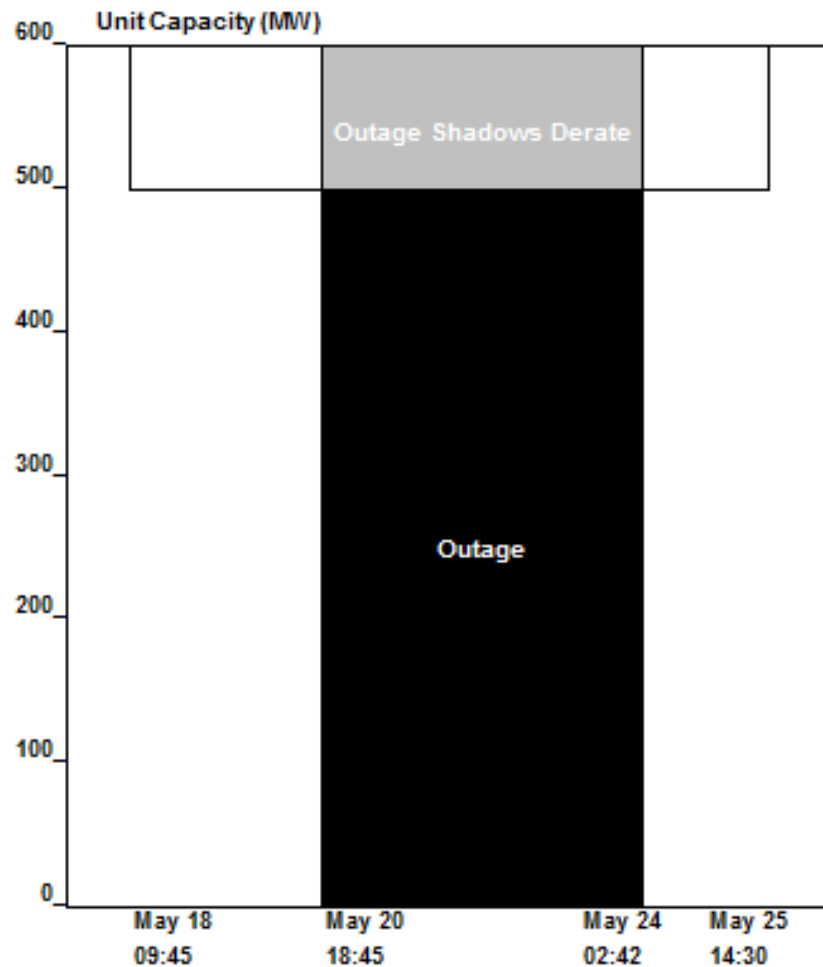Derate Ends before Outage

Figure G-6B — Derate Overlapped by an Outage
Outage Begins and Ends during Derating

- Simple Rules:
  - Maintenance work performed during an RS where work can be stopped or completed without preventing the unit from startup or reaching its available capacity is not a derate - report the work done under Section D "Additional work performed during event"
  - Otherwise report as a derate

- Problem: A steam unit requires 2 forced draft fans to make 100% capacity. One of the fans fails during operation. A week later the unit is put on RS for 6 weeks. The fan takes 4 weeks to repair.

- Question: What should you report?

- Answer: Enter a D1 forced derating for the fan that lasts 4 weeks. Enter a RS event a week later when the unit is shutdown. The derating will run in to the RS period.

- Warning: Many reporters think derating events end when the unit comes off line.

- If the unit is coasting to an outage within the normal time period, no derate

- If the unit is ramping up within the normal time period, no derate

- Nuclear coast down is not a derate unless the unit cannot recover to 100% load as demanded

- Problem: Operations fills out a daily form to collect the event data. A new operator has filled out the form and all the derates stop and start so they only occur online. You decide to teach the operator the proper way to record derate events.

- Question: During what unit states can derates occur?
  A. During service
  B. During other derates
  C. During outages
  D. During reserve shutdown
  E. All of the above

- Answer: E. All of the above

- Explanation: A derate can occur at any time during the active state, with great variety, so learn them, and you'll do well

- Problem: Your coworkers are having a hard time understanding the concepts of concurrent and dominant derates. They argue that since you don't have concurrent and dominant outages why do you need concurrent and dominant derates?

- Question: What do you say to straighten out their thinking?
  - A. Outages cannot occur simultaneously but they are always dominant
  - B. Derates can occur simultaneously and larger ones can be dominant
  - C. Concurrent derates are specified in conjunction with outages on parts of combined cycle unit equipment trains to account for domino effects
  - D. Concurrent and dominant derates can be any type of derate

- Answer: All of the above

- Explanation: Derates are more varied and frequent than outages because generating units often have redundant equipment so they can take a lot of hits and keep working at reduced loads

Questions and Answers

RELIABILITY | ACCOUNTABILITY