

Carol A. Gerou

From: Barry Francis [bfrancis@bepc.com]
Sent: Thursday, November 19, 2009 2:35 PM
To: mro-uflsdt-mem@midwestreliability.org
Subject: [mro-uflsdt-mem] FW: load shedding performance and generation protection setting comments

I think I sent this to the wrong address. I hope it works this time.

Barry

From: Barry Francis
Sent: Thursday, November 19, 2009 1:48 PM
To: 'Carol A. Gerou'; UFLS Drafting Team
Cc: 'Kral, David S'
Subject: load shedding performance and generation protection setting comments

Carol, Chuck, Dave, and the UFLS standards drafting team

Below are my comments in regards to the section on load shedding performance on paper for overloads up to 25%. This also ties in with generation protection. I started with the stuff we had written up during the last couple of meetings, and tried to use that as a template to get my thoughts down a little more clearly. I reorganized the order in which the points are made to put the load shedding performance stuff up front. I also made edits to most of the original text, or replaced it completely, so please read this carefully to catch my changes. I am just trying to get my thoughts down clearly and hope my comments stimulate further thinking. I know this is rather wordy but this is the best I can do right now. The original text follows mine at the end of this document.

Barry

1. To match the design emphasis that is included in R4.3, we suggest “. . . no less than the performance curve for the simulated events.”
2. The MRO program satisfies the [minimum frequency limit of 58Hz](#) for a 25% imbalance but frequency drops below 58 Hz for the 30% loss of generation scenarios the program is designed to cover.
3. The title for Attachment 1 should clearly state that the Under Frequency Performance Characteristic line in Attachment 1 only applies for an imbalance of 25% or less. The implication is that lower minimum frequencies, or slower frequency recovery times, are acceptable when dealing with overloads in excess of a 25% imbalance.

4. The Under Frequency Load Shedding Performance Characteristic line in Attachment 1 should be defined by a line of constant slope, (when shown on a log scale) extending from some minimum allowable frequency up to 59.5 Hz. This removes the knee of the curve where frequencies in the 58.7 Hz to 59.5 Hz band are presently limited to 30 seconds. We suggest the performance characteristic line be extended to give a recovery time of 500 seconds at 59.5 Hz while retaining the 30 second limit at 58.7 Hz. There are two reasons for this change. First of all, we find there is no technical justification for establishing a 30 second recovery time limit for the 58.7 Hz to 59.5 Hz band as this is much more conservative than equipment capabilities. This limit is completely arbitrary. The second reason is that the worst case frequency recovery time between 58.7 Hz and 59.5 Hz may occur for small imbalance conditions, significantly less than 25%, where the governor response plays a significant role in forcing frequency recovery. For instance a possible worst case may be where the governor response prevents some, or all, of the load shedding blocks from picking up following small overloads, and where frequency recovery times may be solely a function of governor response, system inertia, and load damping characteristics.

[If the NERC SDT doesn't accept this suggestion to redefine the performance characteristic, we will propose a variance performance line for MRO that follows this suggestion]

We question how his 30 second limit for the 58.7 Hz to 59.5 Hz band ever ended up in this standard. It appears this might make some sense as an UFLS program design objective but only if applied to a maximum overload condition where the load shed = generation lost (this is often about all that is looked at in some regional programs). In that instance frequency recovery does not rely on governor action and is just a function of the program block sizes, relaying times, load damping and system inertia. Basically this 30 second time limit becomes a proxy by which basic design is judged, but this approach is hardly necessary or the most direct way of ensuring a well designed program. If some regions want to apply something of this nature for their design work, then fine, but don't include this in a NERC standard.

4. Generation Protection coordination with load shedding. We recommend that discussion of generation off-nominal frequency protection coordination with load shedding and the associated time delay requirements be addressed in the PRC-006 standard instead of PRC024. Off-nominal frequency protection of generation is a key aspect of under frequency load shedding coordination and design. It makes little sense to split such a basic and critical part of UFLS coordination off into a different standard. Actually, it would be more appropriate for these standards to address the need to coordinate generation protection with load shedding instead of trying to specify what is appropriate for generation up front in a NERC standard. This is discussed in detail in item 7.

The generation time delay curve should not be included in Attachment 1. We are recommending this be eliminated from both PRC024 and PRC006. If this is not accepted, and if this continues to be included as part of PRC024, then as a minimum this should be removed from PRC006 and instead PRC006 should just refer to PRC-024.

5. Generation protection settings in PRC024 conflict with existing settings. It appears the generation protection minimum time delay versus frequency limits in PRC024 conflict with the generation protection settings associated with existing UFLS programs. We are quite confident that many of the regional programs will need longer delays at the lower frequencies, may need to accept lower minimum frequencies, and conversely, might even find it acceptable to use shorter time delays at the higher frequencies than what is allowed in PRC024. We expect that most regions will have to ask for variances to what is proposed for PRC024 so that they can use the "right" settings for their systems.

We would like to point out that to make the generation off-nominal protection settings in PRC024 acceptable to the 30% load shedding program for MRO, that the slope has to be changed to better match the generation protection time settings specified for the MRO program. This can be done by extending the line between 57 Hz (at .3 sec) to 59.5Hz (at 1800 sec). Although the MRO UFLS program allows instant tripping at 57.6 Hz, we believe that using 57 Hz as an endpoint on this characteristic properly conveys the concept that most generation can momentarily operate down to 57 Hz and that we expect this capability from the equipment manufacturers. This is probably not going to be sufficient for large load shedding programs or even the Canadian portion of MRO. Those types of larger load shedding programs will most likely need to make use of the inherent capability below 58 Hz and will need longer delay times at any given frequency. In other words, they need a different characteristic that is a better fit for their system.

6. Generator off-nominal frequency settings in PRC024 are only appropriate for an UFLS programs of a certain size. It would only be appropriate to include requirements of this type in a NERC standard if such settings apply to all load shedding programs, no matter what size. The engineering reality is that different size programs will have different performance characteristics and generation protection settings will have to be set accordingly. Consequently it is not possible to develop a “one size fits all” generation protection characteristic that is appropriate for all different sizes of load shedding programs that are in use today.

7. Coordination of load shedding and generation protection is a complex issue. Coordinating UFLS and generation protection is a much more complex coordination problem than what is implied by the simple generation protection minimum time delay curve in PRC024. For MRO, we first defined how large of a load shedding program was needed and then designed a load shedding program which gave the quickest frequency recovery possible, for a range of different assumptions, subject to addressing overfrequency concerns and subject to keeping the starting frequency of the load shedding program consistent with neighboring regions (i.e. we start at 59.3 Hz). We accepted slightly lower minimum frequencies than given by the old program (MAPP and MAIN programs) to get better overall coordination between the various objectives, with emphasis on minimizing overfrequency problems. That seemed to be a reasonable tradeoff. At that point we said our program gives as good of a frequency recovery as is possible given our constraints, and we knew that we had to set generation time delays longer than our expected frequency recovery times to make things secure. The reality check was that our final generation protection settings were not too different than used in other regions for similar size UFLS programs.

Basically, generation protection has to be evaluated in the context of what is needed to satisfy load shedding objectives. Load shedding studies in turn have to consider the hard limits associated with generation, such as instant trip requirements, and the planners need to have some idea of how much accelerated loss of life generation is exposed to when operating at frequencies below 60 Hz. This in turn depends on the type of generation in an island. This type of coordination is inherently a complex iterative process involving give and take and not all of the generation off-nominal frequency capability information that we would like to have is readily available. UFLS program design and the selection of appropriate generation protection settings will always involve tradeoffs between conflicting objectives. Proper choice of generation protection settings is part of what is needed to achieve coordination between many of the conflicting objectives. The amount of tradeoffs increase as load shedding programs get larger. Although PRC006 defines a minimum load shedding requirement, we are confident that many areas will continue to shed more than 25% of their load. To coordinate with larger load shedding programs, it is likely that we will need to accept lower minimum frequencies and will need to require longer time delays at a given frequency before generator tripping is allowed. If not, then we have to compromise on some other area of UFLS performance, to the detriment of the UFLS program. In the end we have to rely on a lot of common sense. We believe the only way to set appropriate generation off-nominal frequency protection set points and delay times is to let the regional UFLS

programs each define what is appropriate for their island. Basically, such planning groups can look into all of the relevant issues in much more detail. It is just prudent practice that such groups, who are most informed as to the issues, should be responsible for developing generation off-nominal frequency minimum delay time versus frequency type of settings. Those UFLS planning type of groups are the only ones who are likely to have all of the relevant information to make informed decisions.

We would like to see the specific generation off-nominal frequency time delay criteria be completely removed from PRC024, and in general we believe that the NERC standards should not get overly proscriptive when it comes to how such generation protection is applied. It appears that so far the NERC SDT's are basically trying to establish generation protection minimum time delay versus frequency settings without consideration that different UFLS programs will have different needs and without a rigorous industry wide technical evaluation of generation off-nominal frequency capabilities to support such a standard. To further complicate matters, even if such an industry wide study was available to reference, it would still fall short of what is needed to define a "Standard". Such an investigation would only be able to identify what total times below 60 Hz (over the life of a plant) will result in 100% probable accelerated loss of life (typical way information is presented for steam plants), or the point when additional maintenance and inspection is required (typical for combustion turbines). Let's just assume we could define this type of capability. It would still not be enough to use for the standards drafting process as it will not tell us what % accelerated loss of life per event represents an appropriate tradeoff. That is a subjective judgment call that has to be weighed against all of the other tradeoffs. The groups who actually study load shedding are going to be in a much better position to decide on what compromises are appropriate. The size of the load shedding program will play a large role in what is judged as "appropriate". Larger programs have to accept more tradeoffs. Some settings, such as where units have to be tripped instantly, will have to be adhered to, but at higher frequencies it becomes much more subjective. It boils down to a judgment call about what is an acceptable amount of accelerated loss of life for some hypothetical event which we hope will never happen anyway. If such an event does occur, the actual loss of life exposure for the generators will be a function of how well the load shedding program works. We will only get into the trip settings when the load shedding effort fails to rebalance load and generation. So to the extent that load shedding gets the job done, the hypothetical accelerated loss of life that a generation may be exposed to is going to be less than what the trip settings imply. We have to resist the urge to get too conservative and to allow tripping too soon. The system is unlikely to recover once generation starts to trip. We also need to ensure that we have an adequate margin between expected UFLS performance "on paper" and the point where generation will actually trip during a real world event. The real world performance is unlikely to be as nice and neat as it will be on paper, so don't cut the safety margin too close.

We can look at the time delay standard in PRC024 another way. When it comes to designing under frequency load shedding programs, we need to avoid laying down too many "givens" up front as when we do that we will find our options are much more limited. As we add more constraints we find that we can only make the program work over a smaller range of overloads, so we will then adopt smaller load shedding programs and have a smaller safety net.

*****end of Barry's comments*****

Hello All,

The MRO UFLS SDT met today. I was asked to email out to all of you **2** items:

1] MRO UFLS SDT reviewed the requirement "4.1. Frequency shall remain above the Under Frequency Performance Characteristic curve in Attachment 1 and" of the NERC standard PRC-006. The draft comments

are below. Please review these comments and revise them accordingly. If you have any suggested changes just email them back to me.

1. To match the design emphasis that is included in R4.3, we suggest “. . . no less than the performance curve for the simulated events.”
2. We took a look at this limit and determined for the present MRO system characteristics and inertia that 58Hz is acceptable for the stated 25% overload or imbalance.
3. The title for attachment 1 should clear state that this applies for a 25% or less imbalance.
4. We suggest adding the following note to the attachment, "Larger size UFLS programs (e.g., 40%) may require less restrictive (lower and/or longer time delays) underfrequency limits." UFLS programs shedding more than 25% of connected load will need to increase generation protection delay times and/or change set points to achieve coordination with load shedding.
5. We recommend that the Generation Owner frequency protection requirements be included in the PRC-006 standard. And that, the generation protection time delay curve should be applicable for load shedding levels even beyond the 25%. The generation limit curve needs to be selected to coordinate with load shedding programs that may be 30%, 40%, or 50%. The line should extend to 57 Hz (at .3 sec) to 59.5Hz (at 1800 sec). [Should we check whether this curve would work for a 50% program.] The minimum frequency of 57.0 Hz was chosen because most conventional generation can briefly operate down to 57.0 Hz and large load shedding programs may need to make use of that capability to achieve coordination with these UFLS programs. If the NERC SDT doesn't accept including the GO frequency protection requirements in this standard then the generation time delay curve should not be included in Attachment 1 figure but should refer to the generation time delay curve in the PRC-024 standard.
6. The Under Frequency Performance Characteristic line in Attachment 1 should be extended to 59.5 Hz (at 500 sec). The reason for this change is that the worst case response between 58.7 Hz and 59.5 Hz may occur for imbalance conditions significantly less than 25% where the governor response prevents the load shedding blocks from picking up and where response recovery times is a function of governor response and system inertia (30 seconds to 500 seconds). This removes the knee of the curve at 30 seconds and extends the curve up to 500 seconds. This changes the 30 second at 58.9 Hz cut off point to 500 seconds. [If the NERC SDT doesn't accept this suggestion, we may propose a variance performance line that following this suggestion]

2] Also, the drafting team tentatively planned to have the next meeting on December 1, 2009 from 1:00 – 3:00 PM CST. If you would like to reschedule the meeting to another date and time just let me know by Friday (11/19/09).

Sincerely,

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