Thank you all for attending the webinar on May 13. Below are answers to the questions that were submitted.
If you have any further questions, please do not hesitate to ask. My contact information is below.

Best regards,
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Do you recommend PD testing on all new installed cables, 600V and up?
Partial discharge is typically not considered to cause significant damage at voltages below 3 KV. So on systems over 3 kKV yes it is recommended to perform testing on new installed cables. If a splice or termination is done incorrectly PD will typically start immediately. We have had a number of early finds on new installations being tested and issues found.

Are the types of PD listed in order of % occurrence?
Surface discharge is far more common than internal discharge and progresses at a much faster rate. TEV and Corona discharge are next in frequency. Because Corona is not considered as destructive as TEV it is considered less critical, but as I said in the presentation typical MV gear is designed not to have corona discharge. If it is present it could be an early indicator of a problem and can over time develop into PD so it should be noted and investigated at the earliest convenient time.
Contact/floating metal is less common usually caused by poor grounding.

Most transmission cables don't have isolation. Do we see the PD effect as well?
On transmission lines the cables are typically not insulated but there are isolation bushing at the towers that can be cracked or have defects on them. Also they can have surface contamination on them that will overtime break down either their insulation material (ceramic) causing electrical trees or the contaminate can reduce the ability to withstand the voltage level and flash over.

Also, loose connections can be a source of PD. So there is still a potential for PD on transmission lines. One of the most effect methods of testing transmission lines is with the use of RF detection. The RF instruments operate in the radio wave spectrum typically above 600 MHz. the reason for this is that Corona discharge usually stops at 600 MHz, by setting the receiver above 600MHz, say 800 MHz Corona discharge is filtered out but we are still in the PD range that goes up to 1000MHz.

The CT channel that was cut would not be visible. How was its location detected?
The CT was identified using a specialized TEV instrument. The instrument has two detectors that can be moved around. Based on time of flight between the two sensors it can be determined which one detects the TEV pulse first. So, by moving the sensors around they were able to determine which sensor was closest to the PD source. The instrument that was used can identify the source to within 4 inches.

How often should one perform partial discharge testing for cable assessment?
Our recommendation for cables with no problems identified has been to perform online testing every 2 years. For cables/gear with PD we recommend retesting for trending purposes between 3 and 12 months based on the levels detected. The ANSI 2019 standard recommends online PD testing of cables and switchgear annually as part of the PM cycle.

Can Corona occur within an enclosure which is Nitrogen purged?
Yes, it can. The inception and extinguish levels may be different than if in air but it will still occur.

Is there special accommodation of testing in case of cable used in hydropower plant?
No that I am aware of. The cables don't know that they are in a hydro plant. Unless it is a special cable design or application there should be no difference.

Why didn't you mention IEEE 400.4?
My intent was to reference the IEEE 400 standard and give some examples of what is contained within the IEEE and IEC PD standards. Because of time and space limitations I did not include all the IEEE 400 and IEC subsets. It definitely applies for testing of shielded power cables rated 5kV and above.

Any difference between VLF PD testing vs 60Hz PD testing?
Probably the most significant difference is going to be the size of the test equipment. The test set need to be able to generate voltages that are multiples of the nominal voltage. So for a 34 kV system you will typically test to between 51kV (1.5x's) and 102kV (3x's). Some people even test to 170 kV (5x's). additionally, the test set needs to be able to generate enough current at those voltages. By using the lower frequencies, .01-1 Hz, the test equipment can be made much smaller than would be required for a 60 Hz test system.

What are the current thoughts regarding hi-pot testing during commissioning of new plants. Is it still reasonable or are cables being degraded (slightly?) before being put into operation?
Testing during the commissioning of new plants is highly recommended. The methods used is the main question. Hi pot testing of switchgear etc. is very useful to detect problems.
Hi-pot testing of PILC cables is ok.
Extruded cables hi-pot testing is generally avoided because of the potential of damaging a cable during testing. People have successfully tested but it takes extreme care, knowledge and experience to insure that not damage occurs. This is why equipment like the VLF test sets have become common and have replaced the traditional DC hi-pot. They can be used on all types of cables and switchgear with little risk of causing damage.

TEV does not work on cables

TEV is not effective for testing an entire length of cable. The primary limiting factor is attenuation of the TEV signal. So as a primary test method for detecting PD along the length of a cable I will agree. But it is effective for detecting internal PD on terminations as was shown in the second example at the end of the presentation. And we have seen far more failures on terminations/splices than mid cable faults.

Also we have had success using our TEV locator instrument to find a PD source on cables. The locator has two TEV probes. When these probes are placed on the jacket of the cable near a PD source it can determine which probe detects the TEV wave first. The TEV wave attenuates quickly on the outer jacket, withing 100 or so feet. So our technicians have been able to get an approximate distance through either the online or offline testing then go out with the locator probes and work their way down the cable to find the location.
So with regards to cable testing there are limitations for TEV testing but there are applications where TEV can be of great value when trying to find the PD source.

While acceptance testing a new cable to get a tan delta result, is there an industry accepted resource which outlines expected values for different types of insulations?
I don't know of a standard for Tan Delta but the following NEETRAC guide is helpful.

https://www.neetrac.gatech.edu/publications/CDFI/6-Tan-Delta-21_with-Copyright.pdf

A 5MVA 13.8kV\2.3kV transformer with gassing indicating PD activity. What steps to take to evaluate?

Based on initial levels typically you can begin with trending that would involve performing DGA analysis on an increased interval, somewhere between 2-9 months. If the levels are constant you would just continue monitoring at a moderate interval say every 6, 9 or 12 months until the levels start to increase. If the results have rapidly increasing levels and it can be determined from the analysis what is causing the gassing, paper breakdown, oil, polymer insulation etc. then you may be able to determine a possible source. At some point the transformer will have to be taken out of service.

Once the transformer can be removed from service then you can perform insulation resistance testing winding to winding and winding to ground.
You can then perform insulation power factor or dissipation factor testing on all windings followed by the same testing or hot collar testing on the bushings.
If you have access to the core ground strap you would perform a core insulation resistance test.

The detection of PD is intended to give you an early indicator of a problem that can then be further investigated and isolated with other traditional tests performed on transformers. This with an emphasis on being able to perform the testing on a planned basis as opposed to performing repairs after a failure.

a mechanically damaged 15kV cable that is in service. what Testing would you recommend in-service
For in service, online, testing of cables RFCT testing provides the best results.

Is it possible to accurately measure PD on unshieled cables using VLF-PD test; We use unshileded 5 kV cables
Since there is no ground shield, cables are prone to fail for phase to phase fault. The only way to test and validate the insulation is to use other two phases as ground. This is how typically VLF Hi-pot test done. Similar arrangement can be used for VLF TD & PD.

does Hi-pot applicable to only switchgears??
Because of damage done to early versions of extruded cables it is not recommended to perform Hi-pot testing on cables. There are many variations of traditional Hi-pot testing including Meggar, VLF etc that have addresses conditions that are found in the field that may cause problems with traditional Hi-pot machines. That being said Hi-pot testing is still widely used for factory acceptance testing of switchgear and other devices. The manufacturer should be consulted as to application and tolerances.

Could you please let me know what tools you use for a preventive maintenance system based on the information?
I'm not sure of what this is asking for but I'll try:

Examples of physical tools and instrument would be:

UltraTEV Plus2 for ultrasonic, TEV and RFCT cable spot testing.
Cable Data Collector for RFCT cable testing
PD Hawk for UHF testing of high voltage transmission line substations.
Cable data monitor for fulltime switchgear and cable monitoring.

For tracking the health and condition of a power systems assets where the collected data is combined and analyzed a program line EA technologies Asset Investment Management (AIM) software tools deliver Condition Based Risk Management (CBRM) solutions.

The above response provides examples of EA Technologies instruments and software as examples of what can be used. They can be found on the EA Technology web site at https://www.eatechnology.com/americas/

If I didn't answer the question please send me a follow up at: tim.erwin@eatehnologyusa.com and I'll get you an answer.

Please clarify / differentiate when/why to use coulombs, current, or dB (what ration is expressed in dB)?
The use of columns, DB or current is defined by the test method and instrument used.

Typically with RFCT testing of cables the unit is measured in micro or pico-coulombs as a representation of electrical charge. A coulomb represents the amount of electricity conveyed in one second by a current of one amp.
For ultrasonic and TEV testing it is measured in dBµV and does not have a direct correlation to current levels. The ultrasonic unit is based on an audio signal picked up by a microphone and displayed as a value of microvolts on a decibel scale.

Can water tree be detected by RFCT ?
Not typically. Water treeing has a different electrical characteristic that cannot be detected. It is one of the reasons water trees are difficult to detect.

For MV system - what is the recommended time-period for PD testing?
ANSI and IEC both recommend annual online testing for offline testing I have not been able to find a defined interval, but most testing companies work on a 2-5 year offline test cycle.

We have tested a SF6 switchgear lineup gear line and found poor reading. How do we track down the location of the fault without removing all the gas and disassembly?
I think this is asking about locating a fault in gas insulated bus/switchgear.
This is a broad question for different types of configurations. It also gets a little outside of our expertise.
You could try to isolate the location by moving your sensors around the equipment trying to locate the largest signal strength. Based on the configuration of the joints and seams this may work.
At some point it will require removal of the gas and disassembly, but the goal will be to limit the number of sections that need to be opened.
Another great source for testing information would most likely be the NETA organization. NETA is the International Electrical Testing Association. They can be found at www.NETAWORLD.org.