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ELECTRICAL INCIDENT INVESTIGATION

IEEE-IAS Atlanta - January 2009 Meeting

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1) Why investigate incidents involving electrical power systems and equipment?
   A) Need to determine possible causes for improvements:
      i) Equipment design and manufacturing issues
      ii) System design and installation issues
      iii) System operational and maintenance issues
   B) Incidents usually have financial implications
      i) Loss of use of equipment and business interruption
      ii) Equipment repair and replacement costs
      iii) Costs for medical care, increased insurance premiums and litigation
   C) Continually increasing attention on personnel protection
      i) NFPA 70E, etc.
      ii) Study of incidents improves our database for performing arc hazard analyses
      iii) Input for changing design, installation, operating and maintenance practices to improve safety
   D) Even events that have minimal consequences ("near-misses") can provide valuable insight that helps to prevent future disasters

2) How do we go about investigating an incident? As with any engineering effort a systematic approach is critical
   A) Obtain background information
      i) Equipment and system design and as-built details including modifications over time
      ii) Usage history including any past transients or abnormal occurrences
      iii) Any weather or other relevant offsite events
      iv) Operating procedures and maintenance practices
      v) Insight from site personnel on any long term operating peculiarities
      vi) Witness statements and event timeline leading up to occurrence until time all faults are cleared, fires are out, etc.

B) Inspect relevant equipment and systems
   i) Verify de-energization and lock-out, tag-out (LOTO), and/or ground jumper connection (as appropriate) for any equipment prior to entry or disturbance – not unusual to find damaged or degraded components or sections are found to still be energized upon arrival at a site.
   ii) If any equipment must be disturbed or opened while energized for study (avoid if at all possible), analyze the hazards first and insist on proper protection for all exposed personnel including yourself.
   iii) Damaged equipment details, including any remains dislodged by event or removed afterwards (frequently may include later detailed analysis of key items at offsite laboratory facilities)
   iv) Connected line and load side equipment
   v) Details and coordination of protective features
   vi) Where possible utilize surviving event recorder data – don't forget to check with utility for their recorded data and available fault current information
   vii) Better to look at too much, talk to too many people, take too many notes, copy too many documents and make too many photographs then the other way around – invariably even after doing this for nearly 25 years I still catch myself later saying "why didn't I look closer at that"
   viii) Prior to destructive or irreversible disassembly or testing on any evidence recommend that your client/employer identify any parties with a financial or legal interest in the outcome and invite their participation
C) Analyze obtained evidence and data
   i) Utilize "arc-mapping" to locate initiation site - fault damage generally moves towards the line side direction over time.
   ii) Sequence of protective feature actuations also useful for isolating source location – note condition of fuses including on each phase
   iii) Recorded data frequently useful especially such details as voltage/current variations on differing phases
   iv) Pay close attention to any maintenance or operational events around time of subject occurrence
D) Prepare findings and conclusions
   i) Determine needs and goals of investigation for yourself and your client, employer and/or allied parties
   ii) Determine best way to document the results – in some cases the possibility for litigation may mean that minimal written conclusions and reporting to only a limited number of people is appropriate
   iii) If you have a responsibility for protection of people and resources as part of your investigation, insure that your findings on corrective actions needed are provided to appropriate parties