## Torben Aabo, Principal Engineer

Torben Aabo received a Bachelor's Degree in electrical engineering from Aarhus Technical College, Denmark, in 1967 and did graduate work in electrical engineering and industrial management at Fairleigh Dickinson University in New Jersey, 1972-1974.

He joined Phelps Dodge Cable and Wire Company in 1970 and his early assignments were in the Extra High Voltage Research Laboratory in dielectric and thermal test and analysis of 500 kV pipe-type and 138 kV solid dielectric cable systems.

Mr. Aabo joined Power Technologies, Inc. (PTI), in 1974 and participated in the design of many pipe-type and solid dielectric transmission cable circuits. Research projects were part of his responsibilities at PTI and included projects to increase pipe-cable section length, fluid leak location on pipe-type cable systems, and investigations of alternate insulation material.

In May 1995, Mr. Aabo formed Power Cable Consultants, Inc. (PCC), a consulting company specializing in engineering projects pertaining to underground transmission and distribution cable systems. His work involves failure investigations of 600 V through 400 kV cables and their accessories in the US, Europe, Asia, and the Middle East. He is one of the principle instructors of a principle and practice transmission cable course which is presented annually.

He has been project manager for several 115 and 138 kV transmission cable projects which involved initial cost evaluation, bid specifications, pre-bid meetings, supplier evaluation, EMF issues, factory inspections, and final acceptance of the cable circuits. He participated in the development of operations and maintenance manuals for both HPFF and XLPE transmission cable systems.

He participated in a 345 kV submarine failure investigation and a 38 kV submarine cable failure where he was part of the QA team during the repair process. He also participated in the upgrading of a cable system used for the operation of Deep Sea Remote Operating Vessels.

He has testified before the Commonwealth of Virginia State Corporation Commission regarding a proposed 230 overhead transmission line. When a 115 kV overhead line was proposed in Telluride, Colorado, he testified before the Public Utilities Commission of the State of Colorado in favor of an underground installation. He also testified before the Connecticut Siting Council regarding 345 kV proposed overhead and underground transmission circuits. Being involved with a proposed 115 kV overhead transmission line, he testified before the Vermont Public Service Board concerning undergrounding portions of the line.

Mr. Aabo was a team member on the projects investigating the large power outage covering most of New Jersey in July 1999. In 2000 he became a team member investigating distribution manhole events and auditing electric utilities distribution systems. Follow-on projects were initiated in 2004, 2008, and 2009. These reviews have resulted in recommendations that are helping the utilities improve their network and distribution cable systems' reliability.

Mr. Aabo is a member of IEEE and a voting member of the Insulated Conductors Committee. He is the past chairman of working groups involved with development of transmission cables.

## Torben Aabo
## TECHNICAL PUBLICATIONS

1. "Forced Cooling Tests on 230 kV and 345 kV HPOF Cable Systems," IEEE Winter Power Meeting, New York, NY, 1976, Paper A76 201-4, (co-authors, J.A. Williams and E.D. Eich).

2. "Thermal Analysis of 230 kV and 345 kV HPOF Cables," IEEE 1976 Underground Transmission and Distribution Conference, Atlantic City, NJ, September 1976, (co-authors, J.A. Williams and E.D. Eich).

3. "Increasing Pipe Cable Section Lengths," 7th IEEE/PES Transmission and Distribution Conference, Atlanta, GA, April 1978, (co-authors, J.A. Moran and J.F. Shimshock).

4. "Cell Tests for Dielectric Performance of Glass," 7th IEEE/PES Transmission and Distribution Conference, Atlanta, GA, April 1978, (co-authors, J.A. Williams and K.R. Kormanyos).

5. "Thermo-Mechanical Bending of Pipe Type Cables," PTI Newsletter, *Power Technology*, Issue 30, July 1982.

6. "Thermo-Mechanical Bending Effects in EHV Pipe-Type Cables," IEEE/PES 1984 T&D Conference, Kansas City, MO, April 29 - May 4, 1984, (co-authors J.A. Moran and J.F. Shimshock).

7. "Pressure Surge Reflector for Pipe Type Cable System," Paper 89 TD 369-0 PWRD, presented at the IEEE/PES T&D Conference, New Orleans, LA, April 2-7, 1989, (co-authors, H. Chu, H.A. ElBadaly, R. Ghafurian, R.J. Ringlee, J.A. Williams, and J. Melcher).

8. "Pulling Pipe Type Cables," presented at the EPRI Cable Pulling Workshop, New Orleans, LA, October 10-11, 1989, (co-author, J.A. Moran).

9. "A Fourier Transform Technique for Calculating Cable and Pipe Temperatures for Periodic and Transient Conditions," IEEE Paper No. 91 WM 248-5 PWRD, IEEE/PES Winter Meeting, New York, NY February 3-7, 1991, (co-authors, G. C. Thomann, E. C. Bascom, R. Ghafurian, and T. M. McKernan).

10. "Pressure Surge Testing of Pothead and Joint for Pipe Type Cable Circuits," IEEE/PES 1991 Transmission & Distribution Conference, Dallas, TX, September 22-27, 1991, (co-authors, J. A. Williams, R. J. Ringlee, H. Chu, and R. Ghafurian).

11. "Field Test Program and Results to Verify HPFF Cable Rating," IEEE/PES 1991 Transmission & Distribution Conference, Dallas, TX, September 22-27, 1991, (co-authors, J.A. Williams, E.C. Bascom, and B. Horgan).

12. "Laboratory Analysis of Failed Samples: What is Important?" presented at a panel session "Cable, Joint and Termination Failure Analysis" during the IEEE/PES 1991 Transmission & Distribution Conference, Dallas, TX, September 22-27, 1991.

13. "Underground Transmission Cables: Cost Effective Ampacity Improvements." PTI's Newsletter, *Power Technology*, Issue No. 75, October 1993, (co-author, W. G. Lawson).

14. "Upgrading the Ampacity of HPFF Pipe-Type Cable Circuits," IEEE/PES 1994 Transmission and Distribution Conference, Chicago, IL, April 11-16, 1994 (co-authors, W. Graham Lawson, Sunil V. Pancholi).

15. “Hybrid Transmission: Aggressive Use of Underground Cable Sections with Overhead Lines.” 36th CIGRE Session, 25-31 August 1996 (co-authors, E.C. Bascom, III, D.A. Douglass, and G.C. Thomann).

16. “Diagnostic Testing of Cable Systems,” presented at the Pennsylvania Electric Association T&D Committee Meeting, September 1996 (co-author, Edwin Pultrum).

17. “Testing of XLPE Transmission Cable Terminations at Three Utilities,” EPRI Report TR-108073, Final Report, May 1997 (co-author, Edwin Pultrum).

18. “Directional Drilling Installation of Transmission Cable & Fiber Optic Circuit,” presented at the 1997 T&D World EXPO, Atlanta, Georgia, November 11 - 13, 1997 (co-author, Isaac Green).

19. “Diagnostic Tool for Distribution Cables: VLF Partial Discharge Detection,” presented at the 1997 T&D World EXPO, Atlanta, Georgia, November 11 - 13, 1997 (co-author, Willem Boone).

20. “Cost Effective Maintenance of Distribution Cable Circuits Using Diagnostic Testing,” presented at the 1998 Doble Conference, Boston, Massachusetts, March 30 – April 3, 1998 (co-author, Willem Boone).

21. “Diagnostic Testing Comes to the Rescue,” Transmission & Distribution World magazine, July 1998 (co-authors Stanley V. Heyer, et. al.)

22. “Cost Effective Diagnostic Maintenance Testing of Distribution Cable Circuits,” presented at the 2000 T&D World EXPO, Cincinnati, Ohio, April 26 - 28, 2000 (co-author, Edward Horgan).

23. “Diagnostic Testing Reveals Cable Health,” Transmission & Distribution World magazine, August 2000

24 “High Voltage Testing of an ROV Electro-Optical Tether Cable,” presented at the IEEE/MTS Oceans 2001 Conference Proceedings, Honolulu, HI, November 5-8 2001. IEEE Press. (co-authors, Ed Mellinger, A. Bowen, C. Katz, R. Petitt).

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# PCC RATE SCHEDULE

1. Power Cable Consultants, Inc. (PCC) undertakes engineering projects on a time-and-material basis. Rates for engineering services are given below:

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| Principal Engineers | $150/hour |
| Senior Engineers | $120/hour |
| Engineers | $100/hour |
| Engineering Assistants | $85/hour |
| Associate/sub contractors | as quoted |

2. Time spent in hearings as expert witnesses will be billed 20% higher than these rates. This schedule may be revised at any time. For work begun under this schedule, 60 days notice will be given before the revised schedule becomes effective.

3. These rates include all normal secretarial, reproduction, and telephone services. There will be additional charges for projects, which have unusual demands for these services. Rates do not include any taxes or fees other than those imposed under New York and Federal Law. Any other taxes or fees will be added to the invoice.

4. PCC engineering rates may be reduced by 5% for projects, which have a contract commitment of more than 800 man-hours per year.

5. Domestic travel and living expenses will be billed at cost. Airline travel will be in coach class unless otherwise approved by the client. Any air travel exceeding 10 hours will be billed at business class rates. International travel and living expenses will be billed at cost plus 10%.

6. Material and subcontractor expenses will be billed at cost plus 10%.

7. Firm-price contracts may be negotiated for those projects where work requirements, including project schedules, can be very clearly specified. Milestones will be identified for progress payments.

8. PCC will make available for client review, all time sheets for time periods covering work on the client's projects, plus material and subcontractor invoices and receipts for travel and living expenses.

9. Monthly invoices will be provided and will be payable within 30 days. A fee of 1.5% per month will be assessed for late payments.

10. PCC undertakes all work on a best effort basis. If contract billings are projected to exceed budgeted amounts on time and material contracts, PCC will work with the client to adjust the level of effort to complete the work within budget, or to complete the work scope within a revised budget.