IEEE HVDC-FACTS SUBCOMMITTEE MEETING

2006 IEEE-PES Technical Committee Meeting,

Minutes of Meeting

January 18, 2006, Las Vegas, NV

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Draft Minutes of Meeting

LIST OF APPENDICES

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Minutes of Meeting (Draft)

Chair:	Dennis Woodford
Vice Chair/Secretary:	Ben Mehraban
Acting Secretary:	Joanne Hu

1. Introduction

Dennis Woodford, Chairman of the HVDC-FACT Subcommittee, welcomed attendees. Sixteen persons were present and the list of attendance is given in Appendix 1. An agenda for this meeting is also attached.

2. Approval of Minutes of Meeting

Wayne Litzenberger moved, seconded by Gene Wolf, that the minutes of the meeting held on June 15, 2005 in San Francisco be approved. The motion carried.

3. Sub-Committee General Business

3.1 Next Winter Meeting of PES T&D Technical meeting

The winter technical meeting was proposed and discussions were made as follows.

- The possibility of holding a winter technical meeting in Las Vegas, in January 2007.
- Bill Long and Gene Wolf recommended panel section and paper section.
- Brian Johnson suggested that transaction papers, which are normally not presented in the general meeting, be presented in the meeting. Filtering would be required for presenting transaction papers as advised by Bill Long.

3.2 HVDC and FACTS Sub-Committee Website Update

The subcommittee website updating and maintenance will be taken over from Jack Christofersen.

Website: http://www.tc.umn.edu/~chris143/HVDC&FACTS/

3.3 New Working Groups

Dennis Woodford proposed 4 new WGs.

1. Task force for topical HVDC and FACTS articles
2. Working Group on AC to DC Transmission Conversion. This is to include right-of-way issues for dc transmission such as narrow width, use of rail ROW for new dc

lines, economics and technical considerations of conversion, performance enhancements, reliability, tripole and bipole etc.

3. Working Group on Compensation and Interconnection of Wind Farms, Reactive power and ac voltage control, Rating of FACTS compensators, Performance, Interconnection through dc converters.
4. Working Group on Refurbishment of HVDC and FACTS Controls and Protections. This working group would prepare a guide. (Not duplicate work by the substation committee, Dennis)

Approval of New Working Groups was moved by Bill long, seconded by Gene Wolf.

3.4 General Discussions

- A new working group entitled "Integrating Renewable Energy into Transmission and Distribution" has been proposed. The name may change. It does not have any members at this time but a lot of interest has been expressed.

- The HVDC & FACTS subcommittee will continue to meet during both the summer and winter meetings.

- Dennis will step down from being the chairman at the end of year 2006. Ben Mehraban will be the new chairman. Dennis noted that he had a volunteer to take over the secretary position.

3.5 HVDC and FACTS Functional Coordinators—Dennis Woodford announced names of the T&D functional coordinators. These are:

Andrew Isaacs – Meetings Coordinator (ai@electranix.com)

Dragan Jovcic – Conference Paper Review Coordinator (d.jovcic@abdn.ac.uk)

Karl Mortensen – Standards Subcommittee Member (kmortensen@GREnergy.com)

Kalyan Sen – Transactions Paper Review Coordinator (kalyan.sen@emd.curtisswright.com)

Donald Shoup – Panel Session Coordinator (don.shoup@meppi.com)

4. Reports of Working Groups

4.1 WG 15.05.02 - Dynamic Performance and Modeling of HVDC Systems and Power Electronics for Transmission Systems, Chair: Ram Adapa

The working group met on January 16, 2006. There were 13 persons in attendance. The main items of business were:

1. Working Group Position Papers
   a). EMTP-type Models for Conventional DC Systems—identified contributors for the paper.
   b). EMTP-type Models for VSC based FACTS—work in progress—draft near completion, to be circulated.
   c). EMTP-type Models for VSC based DC Transmission—work near completion.

d). Position paper on Models related to Inclusion of Wind Generation in Power Networks. The principal focus is on the power electronics circuits and controls. There was a discussion about other committees and subcommittees developing these types of models.

2. Benchmark Test Systems to validate HVDC and FACTS

Two benchmark test systems were presented.

a). Reduced WECC system with about 107 buses: completed.

b). IEEE test system with 8 buses and 4 generators for use as a test-bed to investigate various FACTS device applications. The system manifests several different phenomena which could be addressed by FACTS solutions:

- Transmission bottlenecks following certain contingencies.
- Voltage support problems.
- Low damping following certain disturbances.
- The possibility of including wind generation and the associated FACTS devices for system integration.

The test system model is available with 3 different flavours:

- Model for small signal (eigenvalue type) analysis.
- Dynamic model for stability studies.
- EMTP type model.

IEEE paper describing paper:

- Steady State Comparison without FACTS.
- Inclusion of UPFC and IPFC.
- Preliminary comparison of small signal and EMTP type models including small signal stability.
- A technical paper was accepted for presentation at IEEE T&D Conference.

3. Work is in progress on developing a fact sheet with some minimal information on existing FACTS installations around the world. It is being coordinated with the activities from HVDC & FACTS Bibliography Working group, the SVC/FACTS list from Substations Committee, and the HVDC list from CIGRE.

4.2 WG 15.05.08 - HVDC & FACTS Economics and Operating Strategies, Chair: Mark Reynolds

Working Group 15.05.08 met on Tuesday January 17 with 14 persons in attendance. A major item of the meeting was for the chair to provide a draft new WG scope. The main items of business were:

1. Review of previous minutes
   The minutes of the IEEE PES meeting held in San Francisco on June 14, 2005 were approved.

2. General Discussions

- Increasing refurbishment plans especially of SVC stations are underway. The issue of replacement is getting more urgent as the systems and the O&M personnel age.
- Interface standards and procedures would be useful to lower the planned replacement costs.
- It was pointed out that more than controls replacement needs to be considered. Other areas may involve in replacing relays, network interface and etc. Applications of fibre optical devices (PT/CT), and plug-and play systems were also mentioned.
- There are certain concerns about the network security and high warranty risk.

3. Discussion of new draft WG scope

The chair provided a brief commentary as to the items listed in the new WG scope as attached in Appendix 3.

a). Development of survey and other tools to investigate operating experience, lessons learned and potentially beneficial new operating techniques and strategies.

- Statistics on converter transformer failures and various sub-systems in HVDC stations are being studied.. Several projects are underway by the utilities in CIGRE and User forums to establish cause and affect relationship of failures and statistical relevance of the data gathered.
- System suppliers still struggle to obtain post-warranty information, and data gathering is becoming more difficult with downsized utility organizations. A tool called Zoomerang™ is suggested that may provide a significant data "mining and gathering" operation. However, extensive CIGRE survey/instruments was cautioned to be onerous for utilities to fill out.

b). Performance and maintenance experience reporting related to HVDC and HVAC solid-state electronic valves and related supporting subsystems, device, and related equipment.

- It was pointed out that OEM device replacements are still available, but are at very high costs. Failure rate of thyristors in typical projects still range to about 10-12 per year. Discussion of ageing phenomena will continue well beyond this WG existence.

c). HVAC Transmission line convertibility, design guidance, economic assessments, system operational constraints and operating experience performance reporting.

- Transmission line construction is difficult in the USA, Canada and the rest of the world (China and Korea exempted). One major issue is the outage time to replace or reconfigure lines. Another issue is process bound and long public involvement process associated with obtaining right-of-way. New schemes such as joint ROW including (gas insulated line) GIL HVAC and cable based HVDC systems may need some exploration.

- The need for transmission expansion will create pressure on governments and utilities for both capital and ROWs. The IEEE might be able to help the development of potential large bulk transmission schemes such as massively multi-terminal networks. There were some discussions on application of VSC converters for overhead lines and its maximum available ratings.
- The low possibility of HVAC to HVDC line conversions (with the exception of the Bi-Directional valve project) was indicated. . Potential future WG focus is discussed: DC line conversions or bulk DC (+/- 800 kV, +3000 MW)?

d). HVDC System

- 800kV HVDC networks are under close examination for possible applications in S.Africa, India, and China. The potential problem with these network expansions is the impact of a single line loss. However, these systems may survive the loss of 3000 to 5000MW due to large capacities.

e). The issue of education and tutorial leadership was highlighted yet again to encourage utilities to objectively evaluate HVDC as a suitable network solution. It is suggested the WG consider an IEEE PES magazine issue or series that would showcase DC around the world.

f). Wind Generation

- Wind Generation has been a very interesting topic to many utilities. One way to attract people and utility budgets is to get involved with wind transmission integration issues and solutions.
- The AWEA and UWIG user community would very highly welcome a strong IEEE-PES response to WTG transmission solutions and related topics.

4. Reports from attendees on current projects, significant issues, and opportunities have always been a highlight of this group. It was suggested that new projects should be presented with a "FACTS SHEET" suitable to capture the significant project parameters and that a new liaison should be completed with CIGRE HVDC Compendium and a revised IEEE projects summary effort.

5. New business for next meeting

- Orchestrate panel session on economics and refurbishment
- Plan a panel session focused on large bulk transmission on HVDC networks. (Plan for a panel session in San Diego in June 2007)
- The chairman and Dennis Woodford asked the attendees to suggest additional new activities for the working group and potential candidates. All the suggestions should be forwarded to the chairman.
- The chairman reiterated need for volunteers for the co-chair and secretary of this WG and asked attendees to consider the opportunity.

6. Next Meeting (proposed Dallas, T&D Meeting, and Montreal CN PES Meeting) a proposed date and time for the sessions will be coordinated through each of the session organizers and the attendees list to this session

4.3 WG 15.05.14 - HVDC & FACTS Devices Education, Chair: Bill Long

Working Group 15.05.14, HVDC/FACTS Education, met with 12 members and guests in attendance. The following decisions were made:

1. A two-hour Dynamic Reactive Power panel session will be presented at the May 2006 T&D Conference in Dallas. Panelists include Heinz Tyll (Siemens), Sharma Kolluri (Entergy), and Ani Gole (University of Manitoba). The panel will be tutorial in nature; it is a revision of the previously-offered VAR Basics panel session.

2. A new panel session tentatively titled "HVDC System Solutions" is well along in planning for the fall, 2006 Power Systems Conference and Exposition in Atlanta. The intended audience is system planners and developers, and transmission engineers. General topics include what is HVDC, the role played by HVDC in power systems, the evolution of the Pacific Intertie, point of interconnection issues, and system planning including study tools. Brian Johnson (University of Idaho) will lead this activity, persons who have agreed to present or arrange for presentations include Mike Henderson (NE-ISO), Mike Bahrman (ABB), and Wayne Litzenberger (BPA).

3. A proposed future topic is increasing the capacity of existing rights-of-way. Mark Reynolds will bring some talking points to the next meeting of the Working Group in Montreal, June 2006.

4. Chair Bill Long will step down after July 1, 2006. He has headed the working group since its inception in 2001.

4.4 Uno Lamm Award Committee

The Uno Lamm Award committee had received several nominations. A decision on the successful nomination for 2006 will be made shortly.

4.5 WG 15.05.15 – Use of Power Electronics in Major Grids for Generation Requirements, Chair: Geza Joos

The Working Group met Tuesday January 17, 2006 in Las Vegas, Nevada. There were 12 persons. The main items of business were:

1. Review of the WG scope

The scope of the Working Group was reviewed with its objective being to provide a guide to IPP's, grid planners and other involved entities to coordinate the design of system transmission expansion plans to meet the projected North America Grid Requirements.

2. Review of the Report Outline

The outline of the report was reviewed with attentions placed on Chapter 4 "Description of Major Power Grid(s) of the Future". Assignments have been made for the sections and the goal is to have this section drafted for the General Meeting in Montreal in June 2006. Draft of the outline is attached in Appendix 4.

4.6 WG 15.05.13 – Transmission System Application Requirements, Dennis (Mike Henderson)

Report will be presented in Montreal in June 2006 instead.

4.7 WG 15.05.17 – HVDC & FACTS Bibliography, chair: Rajiv Varma

The Working Group met Tuesday January 16, 2006 in Las Vegas, Nevada. The main items of business were:

1. Progress on the HVDC and FACTS Bibliography for year 2005

Bibliographies on HVDC Transmission and FACTS have been prepared for the years 2004 and 2005. These have been accepted as conference papers for the IEEE PES General Meeting to be held in Montreal in June 2006. The CIGRE and international conference papers are not included as they are not available from IEEE Xplore or Google searches.

2. Financial Support for the compilation of HVDC &FACTS Bibliography

In order to continue this activity in the future, including preparing the Bibliography from 1998 until present, some remuneration needs to be provided to the graduate students for their time. Rajiv Varma will submit a revised proposal to Wayne Litzenberger outlining the budgetary needs for the Bibliography activity. Wayne Litzenberger kindly agreed to approach various manufacturers for seeking funds for this activity.

3. HVDC and FACTS Projects Listing

The HVDC project listing is being updated by the suppliers. The Substations Committee will be requested to provide the FACTS projects listing. Alternatively, a link will be made to their website. Robyn Taylor (Teshmont) has volunteered to maintain this list.

4. The next meeting is scheduled for the IEEE PES General Meeting to be held in Montreal, Canada, in June 2006.

5. General Report on HVDC and FACTS Projects/Research

- Andrew Isaacs reported that Electranix is currently supporting a wind power developer with discussion of its connection to the Manitoba Hydro AC network.

- Neil Kirby reported that AREVA has received the order for back-to-back converter station totally 1800 MW in Saudi Arabia; AREVA is also replacing the mercury-arc valves with thyristor valves on the Demark-Sweden dc link; AREVA is providing a line de-icer to Hydro Quebec which will normally operate as a static compensator. AREVA is type testing a new generation of thyristor valves.

- Dave Fletcher reported that Teshmont had recently completed a life extension investigation of Eel River Converter Station. This converter station utilizes air-cooled valves and was the first commercial thyristor valve converter station. It was built by GE.

- Dave Fletcher noted that work was continuing on selecting the route for the Bipolar III transmission line from the Nelson River to Winnipeg.

- Gene Wolf noted that his company was upgrading the Blackwater back-to-back converter station likely to proceed with the refurbishment of the Converter Station.

- Wayne Litzenberger stated that BPA is going to procure a metallic return transfer breaker.

- Brian Johnson is working on wide area controls using synchronized angle measurements with GPS.

- Mark Reynolds stated that a new group has been established in Siemens focusing on renewable energy. Dynamic models of wind farms are being developed. Siemens is bidding on converter transformers in China and India.

- Rajiv Varma stated the research activities, including application of remote signals and SVC in conjunction with wind generation, at University of Western Ontario.

6. Liaison Reports

A number of reports were given.

7. Presentations

- Dennis Woodford presented "Segmentation of the Power System with DC Links (Harrison Clark)" (See Appendix 5)

  References:

  [1] George C. Loehr, "Take my Grid, Please! " Public Utilities Fortnightly wer pp. 44-50 May 1, 2001

- Lionel Barthold gave a presentation on Characteristics of the Triple System and its Application Issues. (See Appendix 5)

8. Future PES Meetings

1. 2006 IEEE PES General Meeting, Montreal, Québec, Canada, June 18-22, 2006

2. Next Winter Power Technical Meeting, Las Vegas, in January 2007

Respectfully Submitted,

Joanne Hu

Acting Secretary (for this meeting)

Appendix 1

List of Attendees

Appendix 2

HVDC & FACTS Subcommittee Agenda

NOTICE OF MEETING OF
THE IEEE HVDC AND FACTS SUB-COMMITTEE
MEETING AGENDA

Time: 8:00AM-12:00PM, Wednesday January 18, 2006
Location: 2006 IEEE-PES Technical Committee Meeting
Westin Casuarina Las Vegas Hotel
Las Vegas, NE

Agenda:

1. Welcome and Announcements
2. Introductions
3. Approval of Minutes of Meeting of June 15, 2005
4. Sub-Committee General Business

   - Proposed Winter Power Meeting
   - HVDC and FACTS Functional Coordinators
   - HVDC and FACTS Sub-Committee Website Update
   - New Working Groups

5. Reports of Working Groups:

   - WG 15.05.02-- Dynamic Performance and Modeling of HVDC Systems and Power Electronics for Transmission Systems
   - WG 15.05.08—HVDC and FACTS Economics and Operating Strategies
   - WG 15.05.14—HVDC and FACTS D4evices Education
   - Uno Lamm Award Committee
   - WG 15.05.15--- Use of Power Electronics in Major Grid for Generation Requirements
   - WG 15.05.16--- Government Education of FACTS
   - WG 15.05.17---HVDC and FACTS Bibliography

6. Reports of Substation Subcommittee

Subcommittee I0, WG I4, WG I5, and WG I8

7. Liaison reports
8. Presentations

   - Ram Adapa--- Presentation on Working Group 15.05.02-- -- Dynamic Performance and Modeling of HVDC Systems and Power Electronics for Transmission Systems.
   - Lionel Barthold—Characteristics of the Triple System and its Applications Issues.
   - Harrison Clark (presented by Dennis Woodford)—Segmentation of the Power System with DC Links.

9. General Reports on HVDC and FACTS Projects/Development.

Appendix 3

Working Group 15.05.08

HVDC & FACTS Economics and Operating Strategies

Proposed WG Scope (Draft)

IEEE WORKING GROUP 15.05.08

HVDC & FACTS ECONOMICS AND OPERATING STRATEGIES

SCOPE (Proposed Draft)

General Discussion:

In the deregulated electrical utility operating environment of today (>2000) a number of key factors have or will have a significant impact on the operating reliability and overall economics related to the development of the best strategies for; project execution, systems maintenance, and overall transmission reliability improvements for HVDC and FACTs systems. The focus of WG 15.05.08 will be the examination of key factors and technology areas that influence strategies and operating conditions and provide knowledge driven engineering approaches to solving problems and making improvements to these systems. This research and reporting effort will rely on the use of: open consultation reports, survey tools, direct utility observation(s), utility operating experience(s) and the systems supplier(s) analysis and reports. It is the goal of this WG to provide a working environment where both utilities and suppliers can share meaningful information for the basis of general improvements to the; specification, operating guideline(s) development, system improvements, and best practices, to enhance the reliability and economic/efficiency of transmission network systems classed as FACTs and HVDC systems.

POTENTIAL PROJECTS & DELIVERABLES

The information to be gained by the working members of this WG would be used to develop various arrangements including, but not necessarily limited to the following activities:

1. The development of survey (instruments) and other tools to investigate operating experiences, lessons learned, and potentially beneficial new operating technique and strategies. Investigation reporting and distribution of the subsequent recommendations would be based on utility and supplier information relapse policies.
2. The development of reports, field data, and comparison charts and guidelines concerning the system operating reliability issues and observed phenomena focused on HVDC and FACTs systems.
3. Equipment (apparatus) and subsystem performance reporting investigation and research related to projects of (FACTS and related HVDC systems).
4. Control & Protection system operating guides and potential standards projects recommendations for development concerning: Control hardware, control & protection software development, control & protection (simulation, training, replacement, software "portability" and inter-operational interface(s), and reliability experience(s) and recommendations)
5. Performance and maintenance experience reporting related to HVDC and HVAC solid state electronic "valve(s)" and related supporting subsystems, devices, and related equipment, including equipment "aging" mechanisms, and device replacement strategies and guidance.

6. HVAC Transmission line convertibility, design guidance, economic assessments, system operational constraints, and operating experience performance reporting.
7. HVDC high precision revenue metering system recommendations and requirements for the development and economic assessment of the value of such improved systems.
8. Spares management guidance related to software based systems and high power electronic device storage care, handling and "on-shelf " testing and verification
9. Replacement, refurbishment, and enhancement of existing HVDC and FACTS systems and subsystems. Appropriate economic justification guidelines and approaches will be detailed to provide reference information to guide utilities in the development of such projects. This information will be based on practical experiences and utility histories whenever possible.

These analysis and reporting efforts will culminate in the development of papers, panel discussions and potential draft guideline project proposals for standards, and other such documentation and presentations relevant to the subject of the investigation or research area.

The preceding technical areas of suggest work are, dependent on; the WG member interest, current industry relevance, and topical impact of the work area, and the guidance of the IEEE-PES T&D Technical Committee direction. Significant findings would be proposed as Topical Panel Sessions, proposed operating guide development, and/or potential standards project proposal recommendations.

Guidelines and Standards project proposals would be taken under the specific authorization of the IEEE Technical Committee authorization, and would necessarily require the WG to establish; 1) the need and relevance of such work, 2) the fact that the work does not duplicate or conflict other activities inside the IEEE, 3) And the work complements other work in other technical organizational bodies such as CIGRE, or the ISO (IEC) or defined IEEE/ANSI standards projects, or other relevant proposed projects.

Further it is envisioned that the WG would bring statistically relevant and topical information to the attention of the relevant standards making organizations with the goal of overall improvement to the utility industry and the suppliers to the transmission utility industry.

Deliverables

After priorities are established by the WG members a specific list of projects and associated target schedules will be developed. Projects that will culminate in the production of IEEE Guides, recommendation for standards development and panel sessions and papers discretions will be forwarded through the appropriate IEEE process.

Appendix 4

Use of Power Electronics in Major Grids for Wind Generation Projects

Report Outline (Draft)

Draft
Use of Power Electronics in Major Grids for Wind Generation Projects
Report Outline (Subject to further revision)

Introduction

Membership

1. Overview
    1.1. Scope
    1.2. Purpose
2. References
3. Objectives
4. Description of Major Power Grid(s) of the future
    4.1.1 Concepts, vision and requirements (economics, quality, environment)
    4.1.2 Generation expansion
    4.1.3 Power system security (safety)
    4.1.4 Security of the electric power supply (fuel security)
    4.1.5 Transmission upgrade – life extension
    4.1.6 Integration coal-wind (environmental)
    4.1.7 Storage
    4.1.8 Communication, monitoring, control and protection
    4.1.9 Segmentation
    4.1.10 Customer reliability, energy efficiency

4.2. Generation Expansion
    4.2.1. Base Load Generation
    4.2.2. Alternate and Renewable Generation
    4.2.3. Wind Generation
        4.2.3.1. Grid Integration Requirements – Voltage Levels
        4.2.3.2. AC and DC links – Features and Advantages
        4.2.3.3. WGS – Options and Technologies
        4.2.3.4. Wind Farm Topologies
        4.2.3.5. Storage Systems
        4.2.3.6. Interconnection Requirements and Guidelines

5. Engineering Issues and Studies

5.1. Electrical System Engineering Issues

5.1.1. Voltage Control and Regulation

5.1.2. Reactive Power- Harmonics - Power Quality

5.1.3. Operation Under Fault Conditions – contrib.

5.1.4. Voltage Stability

5.1.5. Transient Stability Issues

5.1.6. Wide Area Measurement Control

5.2. Transmission Lines

5.2.1. Overhead Lines

5.2.2. AC and DC Cables

5.2.3. Gas Insulated Lines

5.3. Power Electronic Devices and Control Principles

5.3.1. AC System Alternatives

5.3.1.1. Reactive Power and Stabilization Controls

5.3.1.2. SVC – TSC

5.3.1.3. STATCOM (and TSC) – SMES - BESS

5.3.1.4. Series Compensation

5.3.2. HVDC Configurations

5.3.2.1. Thyristor Converters – Conventional and Others

5.3.2.2. Thyristor Converters with STATCOM

5.3.2.3. VSC-based Converters

5.4. Dynamic Performance Models

5.4.1. Energy System Models – Wind Turbine generators

5.4.2. Electric Power System Benchmarks – System Studies

6. Protection Requirements

6.1. Ride-through

6.2. Re-synchronization

7. Impact on System Security and Other Impacts

7.1. Reliability – Availability - Maintainability

7.2. Impact on the Electric Power System

7.3. Grid Support

8. Interconnection Standards

8.1. International Standards – IEEE and IEC – Electrical and Mechanical

8.2. Utility Interconnection Requirements – National Standards

9. Characterizing Equipment Performance

10. Installation requirements
11. Economics
12. Case Studies
13. Bibliography

Appendix 5

Presentations

1. Segmentation of the Power System with DC Links (Harrison Clark, Presented by Dennis Woodford)
2. George C. Loehr, “Take my Grid, Please! “ Public Utilities Fortnightly Report pp. 44-50 May 1, 2001
3. Characteristics of the Triple System and its Application Issues (Presented by Lionel Barthold)

Segmentation of the Power System with DC Links

Harrison Clark, Presented by Dennis Woodford

Reference on Segmentation
“Take my Grid, Please!”

George C. Loehr

Characteristics of the Triple System and its Application Issues

Presented by Lionel Barthold