Space Weather Workshop

April 16, 2013

Astronomy Picture of the Day
2000 November 27
http://antwrp.gsfc.nasa.gov/apod/astropix.html

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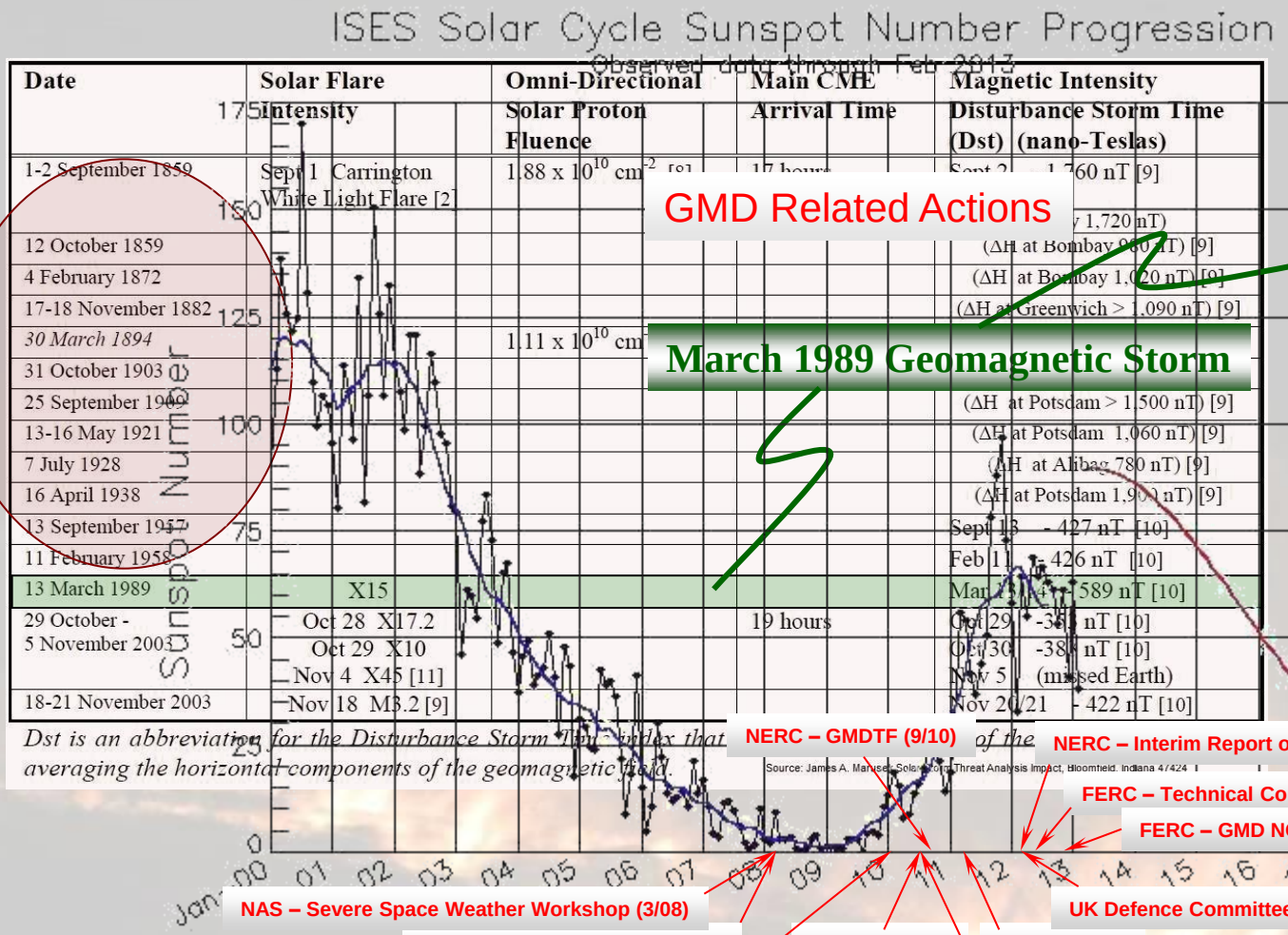
Geomagnetic Storm Levels



Date	Solar Flare Intensity	Omni-Directional Solar Proton Fluence	Main CME Arrival Time	Magnetic Intensity Disturbance Storm Time (Dst) (nano-Teslas)
1-2 September 1859	Sept 1 Carrington White Light Flare [2]	1.88 x 10^{10} cm^{-2} [8]	17 hours	Sept 2 - 1,760 nT [9]
12 October 1859				(ΔH at Bombay 1,720 nT) [9]
4 February 1872				(ΔH at Bombay 1,020 nT) [9]
17-18 November 1882				(ΔH at Greenwich > 1,090 nT) [9]
30 March 1894		1.11 x 10^{10} cm^{-2}		
31 October 1903				(ΔH at Potsdam > 1,500 nT) [9]
25 September 1909				(ΔH at Potsdam 1,060 nT) [9]
13-16 May 1921				(ΔH at Alibag 780 nT) [9]
7 July 1928				(ΔH at Potsdam 1,900 nT) [9]
16 April 1938				Sept 13 - 427 nT [10]
13 September 1957				Feb 11 - 426 nT [10]
11 February 1958				Mar 14 - 589 nT [10]
13 March 1989	X15			Oct 29 -383 nT [10]
29 October - 5 November 2003	Oct 28 X17.2 Oct 29 X10 Nov 4 X45 [11]		19 hours	Oct 30 -383 nT [10] Nov 5 (missed Earth)
18-21 November 2003	Nov 18 M3.2 [9]			Nov 20/21 - 422 nT [10]

Dst is an abbreviation for the Disturbance Storm Time index that ... of the averaging the horizontal components of the geomagnetic field.

GMD Related Actions

March 1989 Geomagnetic Storm

NERC – GMDTF (9/10)

NERC – Interim Report on GMD (2/12)

FERC – Technical Conference on GMD (4/12)

FERC – GMD NOPR (10/12)

NAS – Severe Space Weather Workshop (3/08)

UK Defence Committee EMP Threats (2/12)

EMP Commission Report (4/08)

HR 5026 (6/10)

HR 668 (2/11)

ORNL – Metatech Report (1/10)

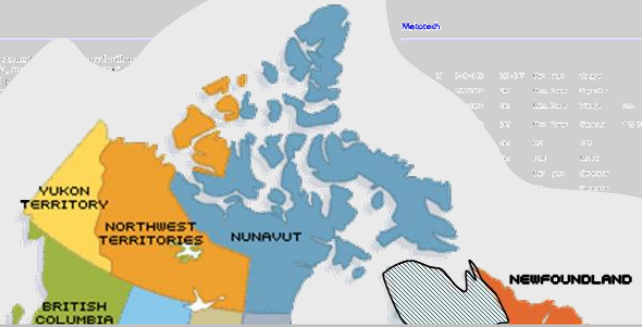
NERC/DOE – HILF REPORT (6/10)

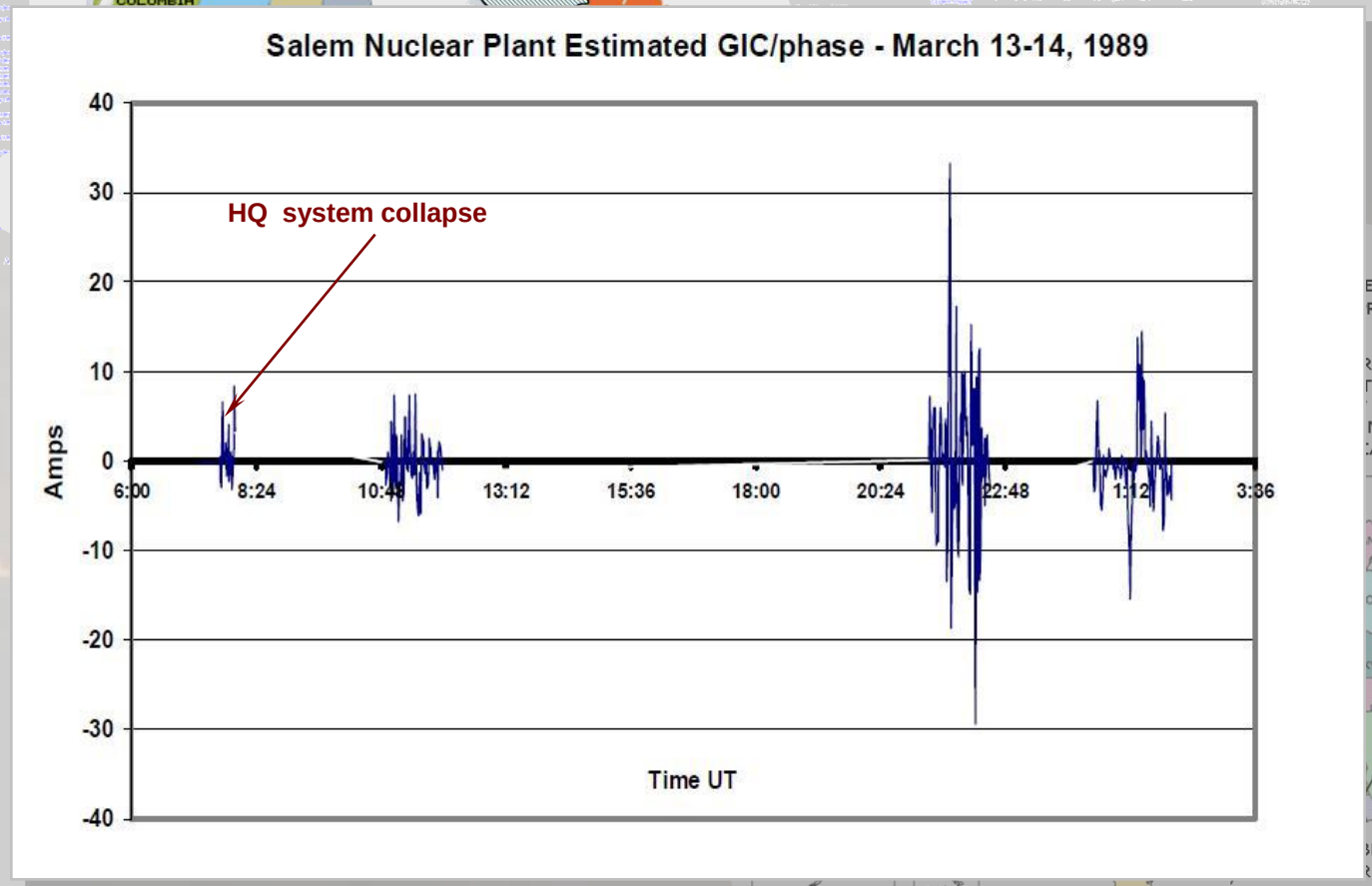
Table 4: Top 30 geomagnetic storms based on Potsdam running Ap

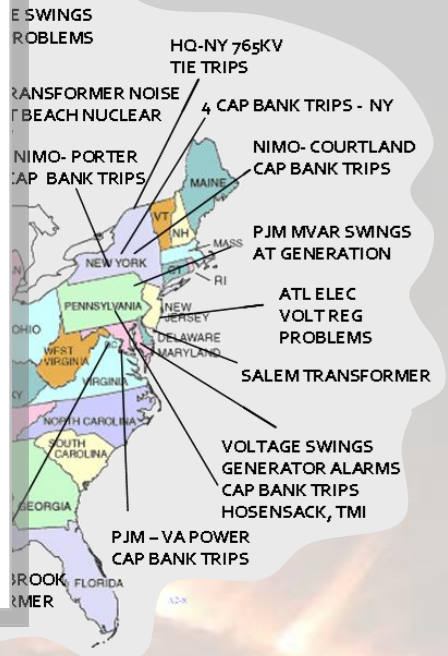
Rank	Ap	Date
1	312	09/18/1941
2	293	11/12/1960
3	285	03/13/1989
4	277	03/24/1940
5	258	10/06/1960
6	**252**	**10/29/2003**
7	252	07/15/1959
8	251	03/31/1960
9	241	05/25/1967
10	229	07/13/1982
11	228	02/07/1986
12	226	03/29/1940
13	223	08/04/1972
14	222	07/05/1941
15	221	09/04/1957
16	**221**	**10/30/2003**
17	216	07/08/1958
18	215	03/28/1946
19	214	09/22/1946
20	212	03/01/1941
21	212	07/26/1946
22	[illegible]	19/1950
23	[illegible]	06/1982
24	199	02/07/1946
25	199	02/11/1958
26	196	05/12/1949
27	196	06/04/1991
28	195	03/24/1946
29	193	05/10/1992
30	192	07/15/2000

Source: NOAA Technical Memorandum OAR SEC-88
HALLOWEEN SPACE WEATHER STORMS OF 2003

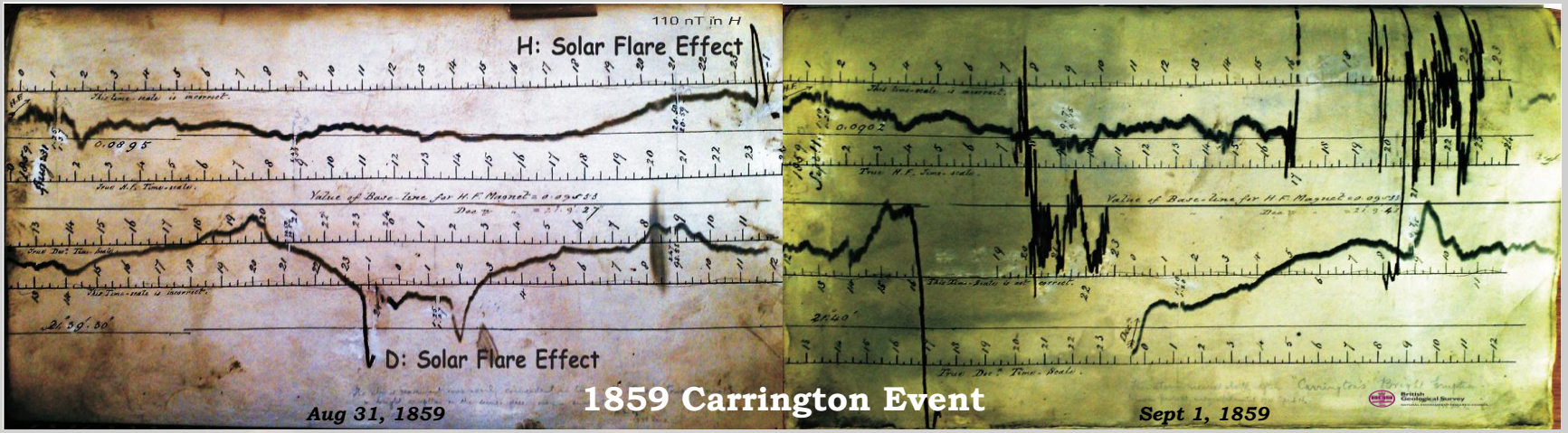
1989 North American Impacts

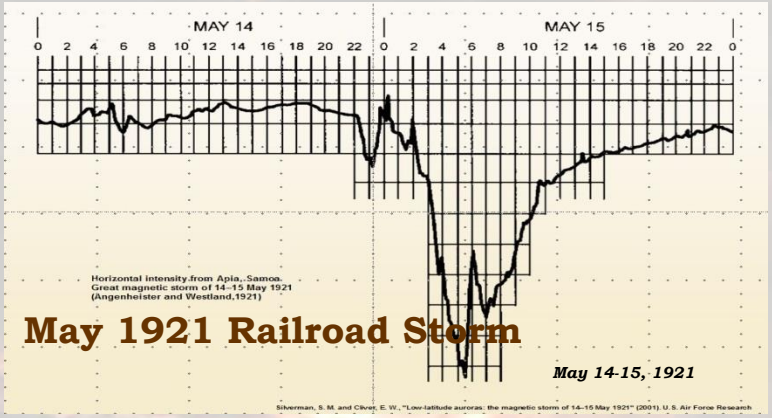


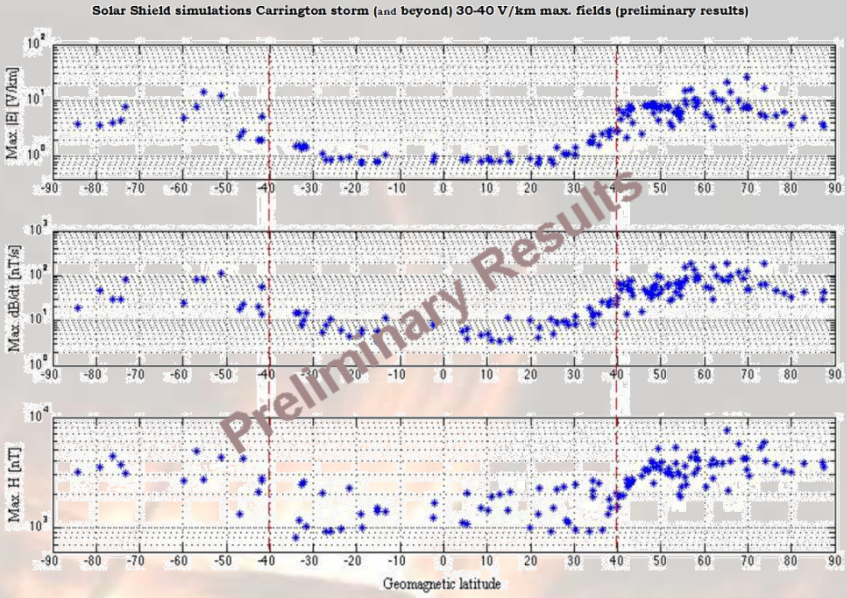




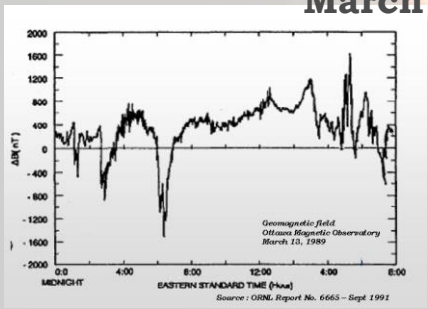
Geomagnetic Storm Comparison

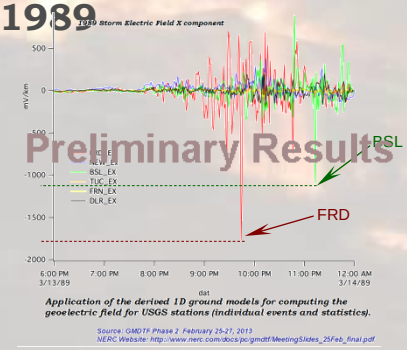






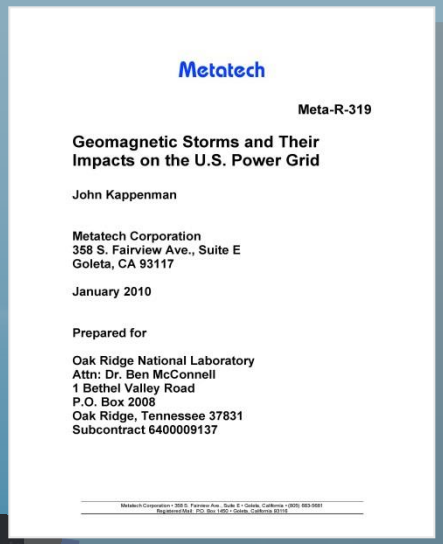
March 1989

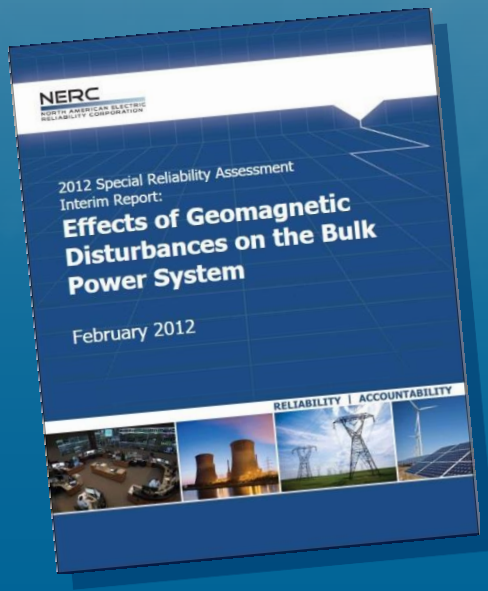


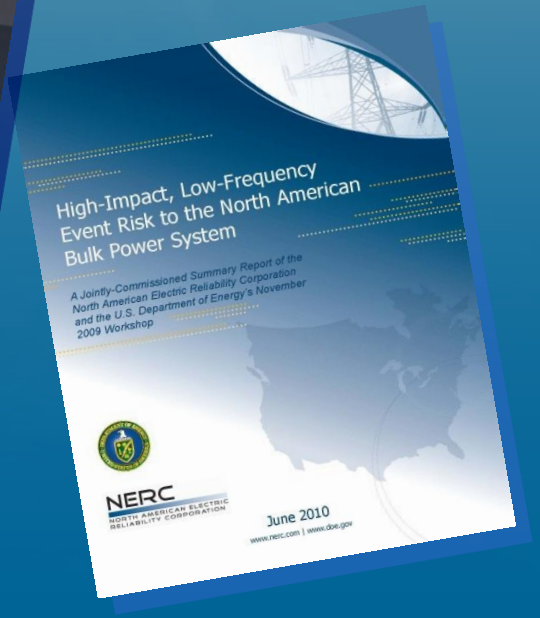


E and H Field Simulation (1859)

Reports Relating Geomagnetic Disturbances to Electric Grid Impacts







Chronology of Major Incidents

- March 24, 1940 – widespread disturbances, equipment trips, voltage swings
- September 22, 1957 – numerous disturbances
- February 11, 1958 – Toronto blackout, numerous other disturbances
- August 4, 1972 – numerous effects
- October 1980 – 500 kV line trip
- April 1981 – 500 kV line trip
- July 31, 1982 – four transformers and 15 lines tripped
- February 7-8, 1986 – numerous effects
- March 13-14, 1989 – Hydro-Quebec blackout, widespread problems, transformer damage
- September 1989 – voltage problems and relay misoperation
- March 24, 1991 – nine line trips, transformer trip, Quebec-New England line trip
- October 28, 1991 – line trip Quebec to New England
- April 3, 1994 – Transformer failures
- May 2, 1998 – widespread effects
- July 22, 1998 – effects in Northeastern U.S.
- April 6-7, 2000 – numerous problems on Hydro-Quebec and Bonneville
- July 15, 2000 – multiple equipment trip incidents in Northeast U.S.
- November 6, 2001 – New Zealand transformer loss
- October 2003 – Malmo blackout, Transformer damage in South Africa, preventive actions taken in the U.S. appear to circumvent major problems

James Bay - 1980

James Bay - 1980

Norwich Main - 1989

Meadowbrook #4 - 1989

Halfway Bush T4 – 2002 NZ

Halfway Bush T4 – 2002 NZ

Eskom

Sta 1 GSU #8 - 1989

Sta 2 Trfr #1 - 2003

Sta 2 GSU #4 - 1991

Sta 2 Trfr #1 - 2003

Sta 3 Trfr #1 - 2003

Sta 2 Trfr #2 - 2003

Sta 3 Trfr #2 - 2003

Sta 3 Trfr #4 - 2003

Sta 3 Trfr #3 - 2003

Sta 3 Trfr #4 - 2003

Sta 3 Trfr #5 - 2003

Sta 4 Trfr #6 - 2003

Sta 3 Trfr #6 - 2003

Sta 5 Trfr 2 - 2003

James Bay	2	Canada
Salem	3	USA
Meadow Brook	1	USA
Nat Grid	2	UK
Transpower	2	New Zealand
Eskom	14	So Africa

NOAA Space Weather Prediction Center

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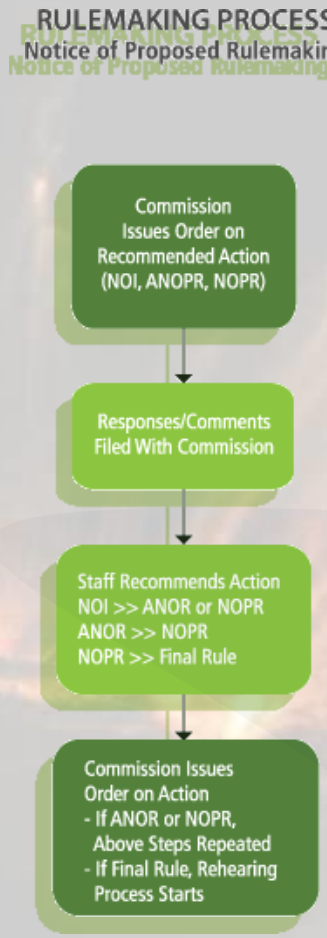
GMD Technical Conference

- Space weather events more severe that we have experienced in modern times have occurred in the past and are likely to occur again
- Large power transformers are unique in their design and you can not make blanket judgments as to whether a particular type or group of transformers will or will not be damaged.
- While there is agreement that reactive power requirements will influence system stability, we do not know at exactly what level it will cause the system to collapse
- In the end, it is indeterminable if transformer damage, system collapse or both will be the most likely consequence of a GMD event; we simply lack the information to draw either conclusion.
- Neither system collapse nor extensive transformer failure is an acceptable result of a GMD event when we have the capability to act to prevent it

Notice of Proposed Rulemaking

Reliability Standards for Geomagnetic Disturbances



Deputy Secretary.

[FR Doc. 2012–26112 Filed 10–23–12; 8:45 am]

BILLING CODE 6717–01–P

DEPARTMENT OF ENERGY

Federal Energy Regulatory Commission

18 CFR Part 40

[Docket No. RM12–22–000]

Reliability Standards for Geomagnetic Disturbances

AGENCY: Federal Energy Regulatory Commission, DOE.

ACTION: Notice of Proposed Rulemaking.

SUMMARY: Under section 215 of the Federal Power Act, the Federal Energy

Notice of Proposed Rulemaking Reliability Standards for Geomagnetic Disturbances

Deputy Secretary.

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CONCLUSION

Notice of Proposed Rulemaking:

Reliability Standards for Geomagnetic Disturbances

Federal Register / Vol. 77, No. 206/ Wednesday, October 24, 2012

Proposed Rules - pages 64935 – 64943

http://www.ferc.gov