

1 Q. Please provide detailed information of Hydro's experience with
2 (i) transmission line failures; (ii) failure modes and; (iii) restoration times for
3 transmission line failures on the Northern Peninsula of Newfoundland.
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6 A. The table in NP-NLH-097 Attachment 1 provides details of sustained line-related
7 transmission line failures from January 1, 2004 to August 31, 2015 for transmission
8 lines on the Great Northern Peninsula.
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10 It is important to note that for the Labrador-Island Transmission Link, the line route
11 has been located approximately 14 km+ away from the coast to account for salt
12 contamination and pollution failure. Where the line comes ashore with the
13 submarine cables, available outage data was used, together with locally collected
14 pollution data from a test site, and the insulator string was dimensioned
15 accordingly. That string length underwent full-scale tests to ensure that there was
16 an appropriate design for the HVdc line. Accordingly, the line has been designed
17 taking into account prior operational experience. This follows Hydro's design
18 philosophy for its most recent lines constructed on the peninsula, TL259 (1990),
19 TL227 (25 km upgrade) and TL262 (2002). These lines have utilized increased
20 insulation level with an insulator type that is more suitable for the heavy salt
21 contamination areas. The new design lines have performed well with respect to salt
22 contamination.

Listing of Sustained Line-related Trips on the Great Northern Peninsula from January 1, 2004 to August 31, 2015

Outage Date	Hydro Transmission Line No.	Voltage Class	Line Structure Design	Equipment Outage Duration (mins)	Customer Outage Duration (mins)	Primary Failure Cause	Subcomponent Failure Cause	Fault Type	Failure Notes
Dec 06, 2004 08:34	TL227	66 kV	Wood, Single Pole	1443	12	Defective Equipment	Insulation System	Phase to ground	Broken Insulator due to wind damage
Dec 05, 2005 20:40	TL229	66 kV	Wood, Single Pole	868	868	Contact by Trees	Conductor	Phase to ground	Tree fell on conductor, high winds
Jan 22, 2006 05:31	TL227	66 kV	Wood, Single Pole	13	6	Wind	Conductor	Phase to Phase	Conductor slapping due to high winds
May 22, 2006 10:46	TL257	66 kV	Wood, double pole	309	309	Bird Contact	Conductor	Phase to ground	Bird's nest fell apart and contacted conductor
Feb 06, 2007 09:07	TL221	66 kV	Wood, Single Pole	1	0	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Feb 06, 2007 14:09	TL221	66 kV	Wood, Single Pole	279	0	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Feb 06, 2007 19:11	TL221	66 kV	Wood, Single Pole	7	0	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Feb 06, 2007 19:28	TL221	66 kV	Wood, Single Pole	5	0	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Feb 09, 2007 00:24	TL262	66 kV	Wood, Single Pole	9	3	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Feb 09, 2007 00:32	TL262	66 kV	Wood, Single Pole	182	116	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Feb 09, 2007 03:34	TL262	66 kV	Wood, Single Pole	39	0	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Feb 09, 2007 04:27	TL262	66 kV	Wood, Single Pole	43	0	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Feb 09, 2007 05:15	TL262	66 kV	Wood, Single Pole	8	0	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Feb 15, 2007 13:21	TL262	66 kV	Wood, Single Pole	3	0	Wind	Conductor	phase to phase	Conductor slapping due to high winds
Feb 15, 2007 13:24	TL227	66 kV	Wood, Single Pole	1	0	Wind	Conductor	Phase to Phase	Conductor slapping due to high winds
Feb 25, 2007 20:27	TL221	66 kV	Wood, Single Pole	69	67	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
May 21, 2007 06:51	TL261	66 kV	Wood, double pole	554	23	Defective Equipment	Conductor	Phase to ground	Phase conductor broken due to heavy Ice Buildup
Sep 15, 2007 04:49	TL221	66 kV	Wood, Single Pole	3	0	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Sep 15, 2007 06:39	TL221	66 kV	Wood, Single Pole	19	0	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Nov 05, 2007 01:36	TL221	66 kV	Wood, Single Pole	14	0	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Nov 05, 2007 05:51	TL221	66 kV	Wood, Single Pole	1	0	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Nov 05, 2007 07:08	TL221	66 kV	Wood, Single Pole	5	0	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Nov 07, 2007 20:32	TL221	66 kV	Wood, Single Pole	2	2	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Nov 07, 2007 20:35	TL221	66 kV	Wood, Single Pole	2	2	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Nov 07, 2007 20:39	TL221	66 kV	Wood, Single Pole	3	3	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Nov 07, 2007 20:46	TL221	66 kV	Wood, Single Pole	2	2	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Dec 17, 2007 07:08	TL227	66 kV	Wood, Single Pole	1	0	Wind	Conductor	Phase to Phase	Conductor slapping due to high winds
Dec 17, 2007 07:10	TL227	66 kV	Wood, Single Pole	4	4	Wind	Conductor	Phase to Phase	Conductor slapping due to high winds
Dec 17, 2007 08:09	TL227	66 kV	Wood, Single Pole	2	0	Wind	Conductor	Phase to Phase	Conductor slapping due to high winds
Dec 17, 2007 08:11	TL227	66 kV	Wood, Single Pole	2	2	Wind	Conductor	Phase to Phase	Conductor slapping due to high winds
Jun 17, 2008 10:01	TL227	66 kV	Wood, Single Pole	14	11	Defective Equipment	Insulation System	Phase to ground	Broken Insulator due to salt contamination
Aug 20, 2008 11:59	TL257	66 kV	Wood, double pole	3	3	Wind	Insulation System	Phase to ground	Conductor slapping due to high winds
Dec 03, 2009 21:23	TL227	66 kV	Wood, Single Pole	2	0	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Dec 03, 2009 22:03	TL227	66 kV	Wood, Single Pole	1	0	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Dec 03, 2009 22:48	TL227	66 kV	Wood, Single Pole	2	0	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Dec 04, 2009 02:34	TL221	66 kV	Wood, Single Pole	363	0	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Dec 04, 2009 07:21	TL227	66 kV	Wood, Single Pole	6	0	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Dec 04, 2009 08:06	TL227	66 kV	Wood, Single Pole	7	0	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Dec 04, 2009 09:32	TL221	66 kV	Wood, Single Pole	61	0	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Dec 04, 2009 21:41	TL227	66 kV	Wood, Single Pole	1	0	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Mar 06, 2010 00:28	TL261	66 kV	Wood, double pole	7	7	Ice	Insulation System	Phase to ground	Heavy Ice buildup on conductor
Jul 18, 2010 19:43	TL226	66 kV	Wood, Single Pole	1	1	Lightning	Insulation System	Phase to ground	Lightning strike to line
Jul 18, 2010 19:45	TL226	66 kV	Wood, Single Pole	1	1	Lightning	Insulation System	Phase to ground	Lightning strike to line
Jul 18, 2010 21:29	TL226	66 kV	Wood, Single Pole	1	1	Lightning	Insulation System	Phase to ground	Lightning strike to line

Outage Date	Hydro Transmission Line No.	Voltage Class	Line Structure Design	Equipment Outage Duration (mins)	Customer Outage Duration (mins)	Primary Failure Cause	Subcomponent Failure Cause	Fault Type	Failure Notes
Jul 18, 2010 21:35	TL226	66 kV	Wood, Single Pole	3	3	Lightning	Insulation System	Phase to ground	Lightning strike to line
Jan 22, 2011 02:24	TL226	66 kV	Wood, Single Pole	2	2	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Jan 22, 2011 02:27	TL227	66 kV	Wood, Single Pole	3	3	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Sep 17, 2011 12:18	TL226	66 kV	Wood, Single Pole	4209	38 to 169	Contact by Trees	Conductor	Phase to ground	Tree fell on conductor, high winds
Sep 18, 2011 22:50	TL227	66 kV	Wood, Single Pole	6	0	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Sep 19, 2011 00:05	TL227	66 kV	Wood, Single Pole	7	0	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Dec 08, 2011 17:46	TL226	66 kV	Wood, Single Pole	4141	8 to 305	Contact by Trees	Conductor	Phase to ground	Tree fell on conductor, high winds
Dec 09, 2011 01:02	TL227	66 kV	Wood, Single Pole	737	0 to 737	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Dec 09, 2011 08:49	TL229	66 kV	Wood, Single Pole	363	363	Wind	Insulation System	Phase to ground	Conductor slapping due to high winds
Dec 10, 2011 06:27	TL227	66 kV	Wood, Single Pole	111	0	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Dec 10, 2011 06:48	TL227	66 kV	Wood, Single Pole	73	0	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Dec 10, 2011 08:22	TL227	66 kV	Wood, Single Pole	2	0	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Dec 10, 2011 08:45	TL227	66 kV	Wood, Single Pole	25	0	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Dec 10, 2011 09:49	TL227	66 kV	Wood, Single Pole	6	0	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Dec 10, 2011 10:15	TL227	66 kV	Wood, Single Pole	16145	0 to 737	Wind	Structure	Phase to ground	Conductor slapping due to high winds
Dec 10, 2011 11:06	TL227	66 kV	Wood, Single Pole	3	0	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Dec 10, 2011 11:10	TL227	66 kV	Wood, Single Pole	19	0	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Dec 10, 2011 12:14	TL227	66 kV	Wood, Single Pole	2	0	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Dec 10, 2011 14:40	TL227	66 kV	Wood, Single Pole	1	0	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Feb 12, 2012 07:31	TL227	66 kV	Wood, Single Pole	6155	0 to 133	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Oct 12, 2012 14:59	TL227	66 kV	Wood, Single Pole	7	0	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Oct 12, 2012 16:20	TL227	66 kV	Wood, Single Pole	22	22	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Oct 12, 2012 17:27	TL221	66 kV	Wood, Single Pole	3	3	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Oct 12, 2012 18:28	TL221	66 kV	Wood, Single Pole	1	1	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Oct 12, 2012 18:31	TL221	66 kV	Wood, Single Pole	181	6	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Dec 24, 2012 16:34	TL227	66 kV	Wood, Single Pole	1885	62	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Dec 26, 2012 10:03	TL226	66 kV	Wood, Single Pole	1717	53 to 99	Contact by Trees	Conductor	Open Phase	Tree fell on conductor, high winds
Dec 30, 2012 16:22	TL226	66 kV	Wood, Single Pole	2	2	Snow	Insulation System	Phase to ground	Heavy wet snow buildup on conductor
Dec 30, 2012 16:37	TL226	66 kV	Wood, Single Pole	1386	49	Contact by Trees	Conductor	Phase to ground	Tree fell on conductor, high winds
Feb 06, 2013 21:14	TL221	66 kV	Wood, Single Pole	13	0	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Feb 06, 2013 21:30	TL221	66 kV	Wood, Single Pole	29	0	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Feb 06, 2013 22:51	TL221	66 kV	Wood, Single Pole	8	0	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Feb 06, 2013 23:30	TL221	66 kV	Wood, Single Pole	13	0	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Feb 06, 2013 23:49	TL221	66 kV	Wood, Single Pole	431	0	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Jul 27, 2013 20:24	TL221	66 kV	Wood, Single Pole	5	5	Lightning	Insulation System	Phase to ground	Lightning strike to line
Oct 30, 2013 15:42	TL227	66 kV	Wood, Single Pole	2941	85	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Nov 28, 2013 10:17	TL227	66 kV	Wood, Single Pole	392	0 to 392	Defective Equipment	Conductor	Phase to ground	Broken insulator and conductor due to high winds
Feb 16, 2014 10:50	TL227	66 kV	Wood, Single Pole	1	1	Wind	Insulation System	Phase to ground	Conductor slapping due to high winds
Feb 16, 2014 10:53	TL227	66 kV	Wood, Single Pole	1	1	Wind	Insulation System	Phase to ground	Conductor slapping due to high winds
Mar 26, 2014 22:14	TL227	66 kV	Wood, Single Pole	1	1	Wind	Insulation System	Phase to ground	Conductor slapping due to high winds
Mar 26, 2014 22:16	TL227	66 kV	Wood, Single Pole	51	0	Wind	Insulation System	Phase to ground	Conductor slapping due to high winds
Apr 09, 2014 00:31	TL226	66 kV	Wood, Single Pole	12	12	Wind	Insulation System	Phase to ground	Conductor slapping due to high winds
Apr 09, 2014 01:25	TL226	66 kV	Wood, Single Pole	4	4	Wind	Insulation System	Phase to ground	Conductor slapping due to high winds
May 16, 2014 09:43	TL221	66 kV	Wood, Single Pole	427	13	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Jan 14, 2015 14:48	TL227	66 kV	Wood, Single Pole	177	0	Defective Equipment	Structure	Three Phase	Broken crossarm on structure
Jan 25, 2015 12:24	TL226	66 kV	Wood, Single Pole	8	8	Wind	Insulation System	Phase to ground	Conductor slapping due to high winds
Jan 27, 2015 15:54	TL227	66 kV	Wood, Single Pole	176	176	Contact by Trees	Conductor	Phase to ground	Tree fell on conductor, high winds
Feb 15, 2015 23:56	TL227	66 kV	Wood, Single Pole	8	0	Wind	Insulation System	Phase to ground	Conductor slapping due to high winds
Feb 16, 2015 00:06	TL227	66 kV	Wood, Single Pole	462	460	Wind	Insulation System	Phase to ground	Conductor slapping due to high winds
Apr 05, 2015 09:55	TL226	66 kV	Wood, Single Pole	7	7	Wind	Insulation System	Phase to ground	Conductor slapping due to high winds

Outage Date	Hydro Transmission Line No.	Voltage Class	Line Structure Design	Equipment Outage Duration (mins)	Customer Outage Duration (mins)	Primary Failure Cause	Subcomponent Failure Cause	Fault Type	Failure Notes
Apr 05, 2015 10:26	TL226	66 kV	Wood, Single Pole	724	37 to 184	Defective Equipment	Hardware	Phase to ground	Broken jumper on deadend structure
Dec 27, 2004 19:39	TL239	138 kV	Wood, double pole	1605	2 to 40	Wind	Insulation System	Phase to Phase	Conductor slapping due to high winds
Mar 30, 2005 03:16	TL239	138 kV	Wood, double pole	2212	12	Defective Equipment	Structure	Phase to Phase	Pole broken due to Heavy high winds and wet snow buildup
Sep 30, 2005 05:16	TL259	138 kV	Wood, double pole	525	4 to 92	Defective Equipment	Structure	Phase to ground	Broken crossarm on structure due to high winds
Dec 17, 2006 20:30	TL256	138 kV	Wood, double pole	8	8	Ice	Conductor	phase to phase	Heavy Ice buildup on conductor
Aug 14, 2007 09:01	TL244	138 kV	Wood, double pole	1	1	Bird Contact	Insulation System	Phase to ground	Bird's caused contamination on insulators
Jul 18, 2010 19:55	TL239	138 kV	Wood, double pole	2	2	Lightning	Insulation System	Phase to ground	Lightning strike to line
Aug 18, 2010 10:19	TL241	138 kV	Wood, double pole	1	1	Lightning	Insulation System	Phase to ground	Lightning strike to line
Jan 04, 2011 19:15	TL239	138 kV	Wood, double pole	207	10 to 200	Contact by Trees	Conductor	Phase to ground	Tree fell on conductor, high winds
Jun 19, 2011 17:23	TL239	138 kV	Wood, double pole	1363	6 to 9	Contact by Trees	Conductor	Open Phase	Tree fell on conductor, high winds
Dec 10, 2011 05:29	TL241	138 kV	Wood, double pole	2	2	Wind	Insulation System	Phase to ground	Conductor slapping due to high winds
Dec 10, 2011 05:34	TL241	138 kV	Wood, double pole	1	1	Wind	Insulation System	Phase to ground	Conductor slapping due to high winds
Dec 10, 2011 05:37	TL241	138 kV	Wood, double pole	119	1 to 119	Wind	Insulation System	Phase to ground	Conductor slapping due to high winds
Oct 16, 2012 04:45	TL241	138 kV	Wood, double pole	122	15 to 122	Salt Spray	Insulation System	Phase to ground	Salt buildup on conductor
Feb 17, 2013 18:17	TL259	138 kV	Wood, double pole	885	0 to 42	Wind	Structure	Three Phase	Conductor slapping due to high winds
Dec 04, 2013 07:36	TL239	138 kV	Wood, double pole	823	8 to 57	Contact by Trees	Structure	Phase to ground	Tree fell on conductor, high winds
Jan 22, 2014 23:56	TL239	138 kV	Wood, double pole	1201	9 to 27	Contact by Trees	Conductor	Phase to ground	Tree fell on conductor, high winds
Feb 12, 2014 10:39	TL239	138 kV	Wood, double pole	2	2	Contact by Trees	Conductor	Phase to ground	Tree fell on conductor, high winds
Mar 26, 2014 22:19	TL239	138 kV	Wood, double pole	1	1	Wind	Insulation System	Phase to ground	Conductor slapping due to high winds
Mar 26, 2014 22:28	TL239	138 kV	Wood, double pole	2	2	Wind	Insulation System	Phase to ground	Conductor slapping due to high winds
Mar 26, 2014 22:34	TL239	138 kV	Wood, double pole	3	3	Wind	Insulation System	Phase to ground	Conductor slapping due to high winds

Note: The CEA definition of Defective Equipment. States five possible causes: deterioration due to age, incorrect manufacturing design, materials, or assembly, of lack of maintenance.