SOUND IMPACT EVALUATION AND ASSESSMENT

Ronkonkoma Substation Upgrades

Hamlet of Lake Ronkonkoma, Town of Brookhaven

Suffolk County, New York

Prepared for:

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EXECUTIVE SUMMARY

PSEG Long Island LLC (PSEG Long Island) is proposing upgrades to the existing Ronkonkoma Substation ("Substation") located between 200 and 228 Hawkins Avenue in the Hamlet of Lake Ronkonkoma, Town of Brookhaven, Suffolk County, New York. The Substation is located on a 3.84-acre parcel of land owned by Long Island Lighting Company (LILCO) ("Project Site"). The Ronkonkoma Substation Upgrades ("Substation Upgrades") include a new transformer and battery enclosure. The purpose of the Substation Upgrades is to improve electric service reliability and capacity to the surrounding service area.

New noise generating equipment at full build-out includes one (1) new 33 MVA 138/13.8kV transformer, and two (2) new exhaust fans and heat-pump/air conditioning units (PTAC) for the new battery enclosure.

PSEG Long Island requested that PS&S Engineering, PC (PS&S) perform a Sound Impact Evaluation and Assessment ("the Assessment") for the Substation Upgrades to assess the potential sound-level impacts at the nearest property boundaries of the Project Site. PS&S completed the requested Assessment in accordance with accepted noise level evaluation standards, procedures, requirements and guidelines. The Assessment included:

- Measurement of existing ambient (background) daytime and nighttime noise levels at the property lines of the Project Site, and identification and characterization of noise source influences in the area;
- Performing sound propagation modeling of anticipated sound-level contributions from the Substation Upgrades using the nationally recognized SoundPLAN Essential (V. 5.0) three-dimensional acoustic propagation model software; and
- Comparing the results of the sound propagation modeling to the applicable New York State Department of Environmental Conservation (NYSDEC) Noise Policy Guidelines, the Suffolk County Ordinance, Chapter 618 – Noise ("Suffolk County Noise Ordinance"), and the Town of Brookhaven Noise Code, Chapter 50 – Noise ("Town of Brookhaven Noise Code").

Noise Monitoring Results: The existing ambient background noise levels in the vicinity of the Project Site are dominated by local roadway vehicular traffic, noise from local businesses and surface parking lots, and non-anthropogenic sound sources such as wildlife and wind noise. The L_{eq} existing ambient background daytime noise levels measured at the property lines of the Project Site varied between 49 dBA and 64 dBA, and nighttime ambient background noise levels varied between 49 dBA and 56 dBA. Noise levels were highest at monitoring site M1, located at the entrance to the Project Site along Hawkins Avenue, with noise generated from vehicular traffic recorded as high as 73.6 dBA during the daytime period and as high as 70.1 dBA during the nighttime period.

Sound Modeling Results & Conclusions: The sound propagation modeling was performed for the future worst-case noise level operating scenario for the Substation, which includes the simultaneous operation of the two existing transformer banks in addition to the Proposed Upgrades (the new transformer bank, the two PTACs and two exhaust fans for the new battery enclosure) operating under worst-case conditions. Worst-case conditions account for the operation of the three transformer banks at peak load, and with the PTACs and exhaust fans operating at maximum capacities. It should be noted that a similar situation would only occur during hot summer days during periods of high or peak-power demand.

The sound propagation modeling results indicate that the projected future worst-case noise levels at the nearest property boundaries of the Project Site will be no greater than 49.7 dBA at the nearest residential property receptors, and no greater than 47.2 dBA at the nearest commercial property receptors. Given that existing ambient background noise levels in both the daytime and nighttime periods are either greater than the modeled noise levels, or within 3 dB of modeled noise levels, the Proposed Upgrades will not result in an any perceptible noise increase above existing ambient noise levels at the nearest residential property receptors.

Based on these results, noise levels at the Substation resulting from the Proposed Upgrades would be in compliance with the Town of Brookhaven Noise Code which restricts noise levels to 65 dBA at residential and commercial property boundaries during the daytime period (7 AM to 10 PM), and limits nighttime (10 PM to 7 AM) sound levels to 50 dBA at residential properties and 65 dBA at commercial properties. The sound propagation modeling results also indicate that noise levels at the Project Site resulting from the Proposed Upgrades would comply with the NYSDEC Noise Policy Guidelines (i.e., would not result in noise levels at residential property boundaries above 65 dBA, and will not result in an increase to existing ambient noise levels at residential property boundaries by more than 6 dBA).

1.0 INTRODUCTION

PSEG Long Island LLC (PSEG Long Island) is proposing upgrades to the existing Ronkonkoma Substation ("Substation") located between 200 and 228 Hawkins Avenue in the Hamlet of Lake Ronkonkoma, Town of Brookhaven, Suffolk County, New York. The Substation is located on a 3.84-acre parcel of land owned by Long Island Lighting Company (LILCO) ("Project Site"). The proposed Ronkonkoma Substation Upgrades ("Substation Upgrades") include a new transformer bank and a battery enclosure. The purpose of the Substation Upgrades is to improve electric service reliability and capacity to the surrounding service area.

New noise generating equipment under the proposed build condition includes one (1) new 33 MVA 138/13.8kV transformer, two (2) new exhaust fans and two (2) new heat-pump/air conditioning units (PTAC) for the new battery enclosure. Two (2) existing 33 MVA 138/13.8kV transformers are operational at the Substation.

PSEG Long Island requested that PS&S Engineering, PC (PS&S) perform a Sound Impact Evaluation and Assessment ("Assessment") for the Substation Upgrades to assess potential sound-level impacts at receptors in the vicinity of the Project Site. PS&S completed the Assessment in accordance with accepted noise level evaluation standards, procedures, requirements and guidelines. The Assessment included the following:

- Measurement of existing ambient (background) daytime and nighttime noise levels at the property boundaries of the Project Site, and identification and characterization of noise source influences in the area;
- Performing sound propagation modeling of anticipated sound-level contributions from the Substation Upgrades using the nationally recognized SoundPLAN Essential (V. 5.0) three-dimensional acoustic propagation model software; and
- Comparing the results of the sound propagation modeling to the applicable New York State Department of Environmental Conservation (NYSDEC) Noise Policy Guidelines; the Suffolk County Ordinance, Chapter 618 – Noise ("Suffolk County Noise Ordinance"); and

the Town of Brookhaven Noise Code, Chapter 50 – Noise (“Town of Brookhaven Noise Code”).

Information on survey approach and noise-level monitoring procedures are presented in **Appendix A**. Appendix A also presents a discussion of basic noise/sound fundamentals including: noise-level standards/criteria, noise abatement criteria, noise monitoring survey methodology, equipment, calibration, procedures, statistical descriptors (A-weighting, equivalent sound level (L_{eq}), residual sound level), and sound propagation modeling methodology.

2.0 PROJECT LOCATION & SOUND LEVEL STANDARDS

2.1 Site Location

The Project Site is located between 200 and 228 Hawkins Avenue in the Hamlet of Lake Ronkonkoma, Town of Brookhaven, Suffolk County, New York. The Project Site is bordered along its northern and southern property boundaries by commercial properties; along its western property boundary by residential properties; and by Hawkins Avenue and residential properties to the east. Hawkins Avenue runs north and south along the eastern property boundary. The nearest residential properties are located immediately adjacent to the western boundary of the Project Site. The Project Site is currently an active substation surrounded by a gated chain link security fence. The Project Site currently has one entrance from Hawkins Avenue, located along the eastern boundary of the Project Site, and another from Waltess Road located along the southwestern boundary of the Project Site.

2.2 Noise/Sound-Level Standards & Criteria

The Town of Brookhaven Noise Code limits noise impacts from a commercial or industrial source to a maximum allowable A-weighted sound pressure level (SPL) of 65 dBA at residential receiving properties during the daytime period of 7 AM to 10 PM, and 50 dBA during the nighttime period of 10 PM to 7 AM. The Town of Brookhaven Noise Code also limits noise impacts from a commercial and or industrial source at commercial receiving properties to a maximum allowable A-weighted SPL of 65 dBA during both daytime and nighttime periods. The Town of Brookhaven Noise Code is included in this Assessment as **Appendix B**.

The Suffolk County Noise Ordinance limits noise on county-owned properties or within county roadways and does not apply to activities undertaken on privately-owned properties such as the Project Site. The Suffolk County Noise Ordinance is included in this Assessment as **Appendix C**.

NYSDEC Noise Policy Guidelines are detailed in the Program Policy Memorandum/Noise Policy Guidelines titled *Assessing and Mitigating Noise Impacts* (NYSDEC, October 6, 2000, Revised February 2, 2001). The NYSDEC Noise Policy Guidelines (included as **Appendix D)** provide guidance on when sound-levels resulting from proposed projects have the potential for adverse noise impacts and details when projects may require review and possible mitigation measures. This guidance document states that the goal for any new operation should ideally not exceed existing ambient noise levels by more than 6 dBA at the receptor. An SPL increase of 10 dBA, which results in a perceived doubling of loudness, deserves consideration of avoidance and/or mitigation measures in most cases. The guidance also states that SPL increases ranging from 0 to 3 dBA should have no appreciable effect on receptors. Furthermore, the addition of any new noise generating equipment in a non-industrial (e.g., residential) setting should not raise the ambient noise level above a maximum of 65 dBA, which is the level that allows for undisturbed speech at a distance of approximately three feet.

3.0 EXISTING NOISE MONITORING SURVEY AND RESULTS

3.1 Noise/Sound-Level Monitoring

The existing daytime and nighttime ambient/background noise levels were measured at five locations in the vicinity of the Substation on February 11, 2020 during both daytime (7 AM – 10 PM) and Nighttime (10 PM – 7 AM) periods. Existing noise sources potentially influencing the area and observed during noise monitoring activities were also noted.

PS&S performed the noise monitoring in accordance with accepted sound-level standards, procedures, requirements, and other guidance. Noise-level measurements were obtained by a PS&S acoustical professional trained and certified under the Rutgers Noise Technical Assistance Center. The noise level measurements were obtained with a certified and calibrated Quest SoundPro Model SE/DL "precision" sound-level meter set to the "A-weighting" scale and "slow" measurement speed and a wind screen was used on the sound level meter during all readings. The wind speed and temperature were recorded at the beginning and end of each measurement period. The sound-level meter was calibrated at hourly intervals as well as at the beginning and end of the noise-level monitoring during the survey. The monitored noise-level readings were stored in the sound-level meter memory, and later transferred to a computer for compilation and tabulation.

3.2 Noise Monitoring Locations

The noise monitoring locations are shown in **Figure 3-1**. These noise monitoring locations were selected to document the existing noise-levels at the nearest property boundaries of the Site, and at nearby residential and commercial receptors.

3.3 Noise / Sound-level Measurement Results (A-weighted)

The L_{eq} statistical monitoring mode was used in the assessment to represent the consistent existing ambient background noise levels. L_{eq} is the preferred method to describe sound levels that vary over time, resulting in a single decibel value which takes into account the total sound energy over the period of time of interest. L_{eq} noise monitoring was conducted in 10-second intervals for a period of 10 minutes at each monitoring location, and the resulting data was averaged to produce the noise monitoring data summary. The residual background ambient noise level is the minimum sound-level reading in the absence of identifiable or intermittent local sources.

A summary of the noise monitoring data is presented in **Table 3-1** below. This table lists the L_{eq}, L_{max} and L_{min} values from the noise monitoring data collected at each of the five monitoring locations during the daytime and nighttime periods. The monitored existing ambient background L_{eq} noise levels varied between 49.18 dBA to 64.16 dBA, with daytime L_{eq} noise levels ranging from 49.36 dBA to 64.16 dBA, and the nighttime L_{eq} noise levels ranging from 49.18 dBA to 56.25 dBA.

The major sound-level influences in the vicinity of the Project Site during the noise monitoring were from local vehicular roadway traffic as well as contributions from non-anthropogenic sound sources such as wildlife and wind rustling nearby leaves. Vehicular traffic in the surface parking lots of the nearby commercial properties also provided brief, significant increases in noise levels.

Table 3-1: Noise/Sound-Level Measurement Data Summary

MONITORING PERIOD	MONITORING LOCATION ID	MONITORING LOCATION DESCRIPTION	MEASURED SOUND LEVEL		
			L_{eq} [dBA]	L_{min} [dBA]	L_{max} [dBA]
Daytime	**M1**	Site entrance at the eastern site boundary along Hawkins Avenue.	64.16	51.5	73.6
	M2	Northern boundary of the Site (parking lot of 228 Hawkins Avenue)	56.48	52.1	65.7
	M3	Northwestern boundary of the Site along Innis Avenue	49.36	48.5	50.3
	M4	Site entrance at the southwestern site boundary on Waltess Road	54.11	51.7	57.4
	M5	Southern boundary of the Site (parking lot of 200 Hawkins Avenue)	57.04	50.1	66.5
Nighttime	**M1**	Site entrance at the eastern site boundary along Hawkins Avenue.	56.25	45.7	70.1
	M2	Northern boundary of the Site (parking lot of 228 Hawkins Avenue)	55.36	48.0	67.0
	M3	Northwestern boundary of the Site along Innis Avenue	49.18	43.2	56.3
	M4	Site entrance at the southwestern site boundary on Waltess Road	53.16	47.3	61.2
	M5	Southern boundary of the Site (parking lot of 200 Hawkins Avenue)	54.41	45.7	69.1

NOTES:

Sound-level measurement data was collected on 02/11/2020.

All sound-level measurements were obtained by a PS&S acoustical professional trained and certified by the Rutgers Noise Technical Assistance Center.

A calibrated Quest SoundPro SE/DL Type 1 sound level meter that was equipped with a wind screen and set to the 'slow' measurement speed was used to obtain sound-level data. At the beginning and end of the sound-level monitoring, wind speed and temperature were recorded. The meter calibration was additionally verified at the end of the monitoring event.

Daytime monitoring was performed between 5:15 PM and 6:20 PM on 02/11/2020 (Regulated Daytime Period is 7 AM to 10 PM). Nighttime monitoring was performed between 10:00 PM and 11:05 PM on 02/11/2020 (Regulated Nighttime Period is 10 PM to 7AM).

FIGURE 3-1

Noise Monitoring Location Plan

Legend

Noise Monitoring Location

Site Location

PS&S
114 OLD COUNTRY ROAD
FIRST FLOOR, SUITE 100
MINEOLA, NEW YORK 11501
PHONE: (516) 512-7300

NOISE MONITORING LOCATION MAP

PSEG Long Island
Ronkonkoma Substation Upgrades
Lake Ronkonkoma
Suffolk County, New York

Drawn By: DM	Scale: 1" = 100'	Project No. 01315.0663
Chk'd By: ES	Date: 2/6/2020	Figure No. 3-1

Sources:
Esri, StreetMap USA, 2012
Esri, World Imagery, 2019

Path: \\psands.aec\ProjectData\Projects\01315\0663\DWGs\Y-GIS\Maps\Fig03-1_NoiseMonitoring_20200206_00.mxd

4.0 SOUND MODELING

4.1 Equipment Description

The sound propagation modeling for the Proposed Upgrades includes the two (2) existing 33 MVA 138/13.8kV transformer banks (Bank No. 1 and Bank No. 2), as well as the proposed noise generating equipment planned to be installed at full build out. This new substation equipment consists of one (1) new 33 MVA 138/13.8kV transformer bank (Bank No. 3), and two (2) new exhaust fans and PTACs for the proposed battery enclosure. Specifications for all noise generating equipment are in this Assessment as **Appendix E.**

4.2 Sound Sources – Assumptions and Model Inputs

The sound propagation modeling performed for this assessment conservatively assumes that:

- All of the above-specified equipment is installed;
- The transformers will be operating at maximum load with all fans in operation;
- All exhaust fan and PTAC equipment for the proposed battery enclosure will be operating at maximum load 24 hours a day; and
- Existing ambient sound-level measurements, the NYSDEC Noise Policy Guidelines, and the Town of Brookhaven Noise Code limits are used as comparisons to the model projections.

Transformers

Both the existing transformers and the new transformer are proposed to be VonRoll 33 MVA 138/13.8kV transformer. Based on equipment specifications provided by PSEG Long Island, the transformer is rated with regard to noise performance at a worst-case SPL of 60.9 dBA at an unspecified distance. Under this worst-case scenario the transformer is operating "fully loaded" with all cooling fans in operation. Transformers are expected to only occasionally operate at this level. A worst-case scenario typically only occurs during hot summer days during periods of high or peak-power demand.

Sound power levels (LwA) were calculated using a reference distance of 2 meters when forced cooling is in operation, based on the equipment specifications provided by PSEG Long Island and the standard measurement procedures outlined in IEEE Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers (IEEE Std. C57.12.90.13-2015). The corresponding sound power level (LwA) is 81.7 dB with the fans in operation. The transformer was modeled using a typical frequency spectrum (octave bands) for axial fans.

Exhaust Fan

The proposed battery enclosure will have two Canarm AX14-1v shutter-mounted fans. Based on equipment specifications provided by PSEG Long Island, the rated outdoor SPL for each unit is 67 dBA measured at a distance of 1.52 meters. The corresponding sound power level (LwA) is 78.5 dBA (modelled at 78.5 dBA).

PTAC Unit

The proposed new battery enclosure is planned to include two Amana Model PTH 123G35A PTAC air conditioner and heat-pump units. The rated SPL is not available for this unit, but previous Amana units utilized at PSEG Long Island substation facilities were modelled at a sound power level (LwA) of 61.2 dBA. As such, the 61.2 dBA LwA was utilized for each unit in the sound propagation model for this Assessment.

Site Model Layout

The locations of the existing transformer banks, the proposed transformer bank, exhaust fans, PTAC noise sources, and the noise/sound receptor locations used in the computer sound propagation modeling, are depicted on **Figure 4-1**.

4.3 Sound Impact Modeling

An acoustic sound propagation model was used to assess the Substation Upgrades for compliance with applicable noise codes and guidance based on potential worst-case operating conditions under the future build condition. The sound propagation modeling was performed using the equipment and sound-level specifications identified above, at the nearest residential and commercial property boundaries at the Project Site. Projections of sound-level contributions from the equipment were predicted using the nationally recognized SoundPLAN Essential (V. 5.0) three-dimensional acoustic propagation model software (Braunstein and Berndt, GmbH/SoundPLAN LLC, 2019). The SoundPLAN industrial noise type option was used for the sound modeling calculations.

The SoundPLAN software allows for calculation of sound from multiple sound sources at multiple receivers while accounting for specific Project Site sound radiation patterns and propagation effects of structures. The sound sources are identified in the propagation modeling with x and y coordinates and a relative height above terrain. The Substation Upgrade equipment identified in this assessment was modeled as point sources and digitized in a geo-referenced coordinate system based on Project Site plan dimensions. The model receptors are also identified with three-dimensional x, y and z coordinates. Model receptors were located along the nearest property boundaries at an average ear level height of 1.5 meters above ground level in accordance with applicable modelling guidance. The projected sound-levels were then compared to the Town of Brookhaven Noise Code sound-level limits and the NYSDEC Noise Policy Guidelines.

In addition to the proposed noise sources, existing noise sources, specific site conditions and equipment layout can influence sound propagation, as described below.

Elevation

SoundPLAN software uses a digital ground model (based on elevation contours). Existing ground elevations for the immediately surrounding properties for the Project Site were used in the modeling, based on data incorporated from Google Earth. No change in the existing ground elevations were assumed under the build condition for the modeling.

Buildings

Existing buildings were digitized from Google Earth and PSEG Long Island provided Site plans and actual and proposed dimensions were included in the model calculations (i.e., calculation of diffraction around buildings).

Structure Reflections

Structures may modify the noise radiation patterns of equipment. The SoundPLAN software includes calculations to account for potential sound amplification from reverberation/reflection off the exterior surfaces of the existing and proposed structures based on the structure's facade. A reflection loss coefficient is assigned to each building or structure based on the material of the facade. All structures were conservatively modeled as "minimally absorbent" (default reflection loss of 1 dB).

4.4 Modeling Results (Projected A-weighted Sound Pressure Levels)

The table below presents a summary of the projected (modeled) cumulative equipment sound levels at the nearest residential and commercial property boundary receptors.

The worst-case sound level impact of the Proposed Upgrades operating at maximum capacity was modeled to be no greater than 49.7 dBA at the nearest residential property receptors, and no greater than 47.2 dBA at the nearest commercial property line receptors.

Table 4-1: Summary of Modeled Worst-Case Future Sound-Levels Generated from Substation Upgrades at Nearest Residential & Commercial Property Boundaries

RECEPTOR NO.	RECEPTOR LOCATION	ALL EQUIPMENT OPERATING AT MAX CAPACITY (DBA)
M1	Site entrance at the eastern site boundary along Hawkins Avenue (Residential).	41.6
M2	Northern boundary of the Site (parking lot of 228 Hawkins Avenue) (Commercial)	47.2
M3	Northwestern boundary of the Site along Innis Avenue (Residential)	49.7
M4	Site entrance at the southwestern site boundary on Waltess Road (Residential)	37.0
M5	Southern boundary of the Site (parking lot of 200 Hawkins Avenue) (Commercial)	33.0

FIGURE 4-1

Modeled Worst-Case Future Sound Levels with All New Substation Noise Generating Equipment Operating at Maximum Capacity

Figure 4-1

PSEG Long Island
Ronkonkoma Substation Upgrades

MODELED WORST CASE FUTURE SOUND LEVELS WITH ALL NEW SUBSTATION NOISE GENERATING EQUIPMENT OPERATING AT MAXIMUM CAPACITY

The Substation was modeled based on the Plot Plan and Equipment Specs provided by PSEGLI for full Build-Out of the Substation.
Substation Sound Sources:
-Three (3) 33 MVA 33/13kV Transformers (Bank 1 at 81.7dB, Bank 2 at 81.7 dB, and Bank 3 at 81.7 dB)
-Two (2) Exhaust Fan Units at 78.5 dB each; and
-Two (2) PTAC Units at 61.2 dB each
Town of Brookhaven Noise Code Sound Level Limts:
-Commercial
65 dBA (24 hours)
-Residential
65 dBA (7AM-10PM)
50 dBA (10PM-7AM)

Signs and symbols

Substation Property Line
On-Site Structure
Adjacent Property Building
Receptors at Property Line
Adjacent Roadway
Substation Sound Source

Level tables

Day/Night Modeled Noise Levels

1 : 2000

0 10 20 40 60 80 m

PS&S

5.0 SUMMARY AND CONCLUSIONS

The recorded existing ambient background daytime L_{eq} noise levels at the adjacent property boundaries of the Project Site varied between 49.36 dBA to 64.16 dBA, with the nighttime L_{eq} noise levels ranging from 49.18 dBA to 56.25 dBA. The major sound-level influences in the vicinity of the Project Site during the noise monitoring were from local vehicular traffic on surrounding roadways, local wildlife, and occasional wind gusts.

The sound propagation modeling was performed for the future worst-case noise level operating scenario for the Substation, which includes the simultaneous operation of the two existing transformer banks in addition to the Proposed Upgrades (the new transformer bank, the PTACs and exhaust fans for the new battery enclosure) under worst-case conditions. Worst-case conditions account for the operation of the three transformer banks at peak load, and with the two PTACs and exhaust fans operating at maximum capacities.

The sound propagation modeling results indicate that the projected future worst-case noise levels at the nearest property boundaries of the Project Site will be no greater than 49.7 dBA at the nearest residential property receptors, and no greater than 47.2 dBA at the nearest commercial property receptors. Given that existing ambient background noise levels in both the daytime and nighttime periods are either greater than the modeled noise levels, or are within 3 dB of the modeled noise levels, the Proposed Upgrades will not result in an any perceptible noise increase above existing ambient noise levels.

Based on these results, noise levels at the Substation resulting from the Proposed Upgrades would be in compliance with the Town of Brookhaven Noise Code which restricts noise levels to 65 dBA at residential and commercial property boundaries during the daytime period (7 AM to 10 PM), and limits nighttime (10 PM to 7 AM) sound levels to 50 dBA at residential properties and 65 dBA at commercial properties. The sound propagation modeling results also indicate that noise levels at the Project Site resulting from the Proposed Upgrades would comply with the NYSDEC Noise Policy Guidelines (i.e., would not result in noise levels at residential property boundaries above 65 dBA, and will not result in an increase to existing ambient noise levels at residential property boundaries by more than 6 dBA).

Note that for this Assessment to appropriately represent noise levels at the Substation under the build condition, the equipment to be installed should be consistent with the specifications provided by PSEG Long Island and in locations consistent with the site model layout depicted on Figure 4-1. If deviations from the PSEG Long Island-provided information are implemented, such as the use of equipment other than that provided by the Client or changes to the site layout, a revaluation of this Assessment would be necessary.

6.0 REFERENCES

Braunstein and Berndt. SoundPLAN Essential Version 5.0. Braunstein and Berndt GmbH/ SoundPLAN LLC, May 2019.

IEEE Std C57.12.90-2015. Transformers Committee of the IEEE Power Engineering Society. IEEE Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers.

New York State Department of Environmental Conservation (NYSDEC). Assessing and Mitigating Noise Impacts. Department ID: DEP-00-1. Office of Environmental Permits. October 6, 2000, Revised February 2, 2001.

Town of Brookhaven, Suffolk County New York, Noise Control Code. Adopted by the Town Board of the Town of Brookhaven June 16, 1987, and amended most recently on February 14, 2019, amendments noted where applicable.

Suffolk County New York, Noise Control Code. Adopted by the Suffolk County Legislature December 7, 1999, amendments noted where applicable.

APPENDIX A

Environmental Sound / Noise Fundamentals

Appendix: Environmental Noise Fundamentals

1.0 Sound / Noise Basics

Sound

Sound is generated when a vibrating object (sound source) creates a physical disturbance that sets the parcels of air or other surrounding medium nearest to it in motion, causing pressure variations that form a series of alternating compression and expansion pressure waves that move or propagate outward away from the source in a spherical pattern.

Sound propagates at different speeds depending on the medium.

- In air sound propagates at a speed of approximately 340m/s;
- In liquids the propagation velocity is greater and in water is approximately 1500 m/s; and
- In solids can be even greater and is 5000 m/s in steel.

Factors that affect how sound is perceived by the human ear include the amplitude or loudness, the frequency, and the duration of the sound, as well as the location of the receiver relative to the source of sound. The sound levels we encounter in daily life vary over a wide range. The lowest sound pressure level the ear can detect is more than a million times less than that of a jet take-off. The audible sound frequency range for young persons is from approximately 20hz to 20,000Hz.The decibel is used as a unit of sound amplitude or loudness and is derived from a comparison sound pressure, in air, with a reference pressure. Broadband sound covers the whole of the audible frequency range and is made up of many tones.

Noise

The terms “sound” and “noise” are often used synonymously Noise is unwanted sound usually composed of a spectrum of many single frequency components, each having its own amplitude. The disturbing effects of noise depend both on the intensity and the frequency of the tones. For example, higher frequencies are often more disturbing than low frequencies. Pure tones can be more disturbing than broadband sound.

Frequency

Noise with distinct tones, for example, noise from fans, compressors, or saws, can be more disturbing than other types of noise. This annoyance factor is not taken into account in a broadband measurement.

A spectral analysis may be needed to identify/assess disturbance. Pure tones can be assessed subjectively, as the human ear is good at detecting tones. Regulations often require an objective measurement of tonal content as well. In practice, this is can be done by octave, 1/3-octave analysis or narrow-band analysis (FFT - Fast Fourier Transform).

***A-Weighting (dBA)* -** Noise measurements are most often taken using the "A-weighted" frequency response function. The A-weighted frequency or dBA scale simulates the response of the human ear to sound levels (particularly low-level sound) and has been given prominence as a means for estimating annoyance caused by noise, for estimating the magnitude of noise-induced hearing damage, in hearing conservation criteria, for speech interference measurements, and in procedures for estimating community reaction to (general broad band) noise (Clayton, et al. 1978; Cheremisinoff, et al. 1977). Sound measurements are often made using the "A" frequency weighting when assessing environmental noise. The Leq or, better, the LAeq (the A-weighted equivalent continuous sound level) is an important parameter.

1.1 Noise Descriptors

There are a number of noise descriptors used to characterize various aspects of noise that take into account the variability of noise levels over time which most environments experience. Various criteria and guidelines used to characterize noise are discussed below. The different descriptors are applicable to different situations. Commonly used descriptors are discussed below.

Equivalent Sound Level (Leq)

The equivalent sound level (Leq) is the value of a steady-state sound which has the same A-weighted sound energy as that contained in the time-varying sound. The Leq is a single sound level value for a desired duration, which includes all of the time-varying sound energy during the measurement period. The U.S. EPA has selected Leq as the best environmental noise descriptor for several reasons, but primarily because it correlates reasonably well with the effects of noise on people, even for wide variations of environmental sound levels and different time exposure patterns. Also, it is easily measurable with available equipment.

Statistical Descriptors

Statistical sound level descriptors such as L_1, L_{10}, L_{50}, and L_{90} are used to represent noise levels that are exceeded 1, 10, 50, and 90 percent of the time, respectively. L_{50}, the Sound Pressure Level (SPL) exceeded 50 percent of the time, provides an indication of the median sound level. L_{90} represents the residual level, or the background noise level without intrusive noises.

Residual Noise Level

Measurement of the residual or background sound level is useful in characterizing a community with respect to noise. The residual sound level is the minimum sound level in the absence of identifiable or intermittent local sources. It is not the absolute minimum sound level during a long observation period, but rather the lowest reading that is reached repeatedly during a given period. The L90 (referred to as the ambient level) is a statistical descriptor, which represents the level that is exceeded 90 percent of the time. Comparisons of data have shown that the L90, measured with a continuous statistical sound meter, and the residual sound level, measured by trained personnel with a sound-level meter, are closely correlated with one another. (Bolt, Beranek, and Neman, Inc. 1978)

Ambient noise is the noise from all sources combined - factory noise, traffic noise, birdsong, running water, etc. Specific noise is the noise from the source under investigation. The specific noise is a component of the ambient noise and can be identified and associated with the specific source.

Day/Night Equivalent Sound Level (Ldn)

The day/night equivalent sound level (Ldn) is the A-weighted equivalent level for a 24-hour period. (U.S. EPA 1974). The Ldn is estimated from the equivalent daytime Ld and nighttime Ln levels with an additional 10 dBA weighting imposed on the equivalent sound levels occurring during nighttime.

The U.S. EPA suggests this descriptor be used to relate noise in residential areas to annoyance caused by interference with speech, sleep and other activity. Based on interpretation of available scientific information, U.S. EPA identified an outdoor Ldn of 55 dBA as a level protective of public health and welfare with an adequate margin of safety, without concern for economic and technical feasibility. (U.S. EPA 1978)

1.2 Noise Standards/Criteria

FHWA Noise Abatement Criteria

The Federal Highway Administration (FHWA) has established noise abatement criteria for motor vehicle noise on roadways (23 CFR 772). These criteria are intended to apply to highway projects, which this is not. However, these criteria can be used as guidance for assessing traffic noise. These criteria represent maximum desirable noise levels for various land-uses and associated human activities, for use in assessing noise levels from roadway traffic. An exterior Leq of 67 dBA is the Noise Abatement Criterion typically used to evaluate noise levels along highways, Activity Category (B), applicable to residential areas. The FHWA Noise Abatement Criterion for areas not considered sensitive receptors, such as manufacturing zones, is an Leq of 72 dBA, Activity Category (C).

Noise sensitivity criteria used by the FHWA for evaluating the significance of noise impacts are presented in Table 1. Generally, a three dBA or smaller change in sound pressure (noise) level would be barely perceptible to most listeners, whereas a ten dBA change is normally perceived as a doubling (or halving) of noise levels. Increases in average or cumulative noise levels of five dBA or more are clearly noticeable. These criteria provide an indication of individual perception of changes in noise levels. A three-dBA increase is commonly used as the threshold for assessing the potential significance of noise impacts.

New York State

The New York State Department of Environmental Conservation (NYSDEC) has published a policy and guidance document titled *Assessing and Mitigating Noise Impacts* (October 6, 2000). This document provides guidance on when noise due to projects has the potential for adverse impacts and requires review and possible mitigation in the absence of local regulations. The NYSDEC guidance indicates that local noise ordinances or regulations are not superceded by NYSDEC guidance. The New York State Guidance Document contains a Table identifying expected human reaction to various increases in sound pressure levels. This Table is included as Table 2 below. The guidance indicates that a noise increase of 10 dBA deserves consideration of avoidance and mitigation measures in most cases. It is further indicated that the addition of a noise source, in a non-industrial setting, should not raise the ambient noise level above a maximum of 65 dBA.

The City Environmental Quality Review (CEQR) Noise Code was adopted to prevent unreasonably loud and disturbing noise.

New Jersey State Noise Standards

The State of New Jersey noise standards (Noise Control Regulations) require that sound from any industrial or commercial operation measured at any residential property line must not exceed a continuous sound level of 65 dBA during the daytime (7:00 a.m. to 10:00 p.m.), or a level of 50 dBA during the nighttime (10:00 p.m. to 7:00 a.m.). These standards also limit continuous sound from any industrial or commercial operation measured at any other commercial property line to 65 dBA (New Jersey Administrative Code 7:29, 2000).

Octave band sound levels have been specified by the State of New Jersey, which limit the sound intensity at residential and commercial property boundary lines (New Jersey Administrative Code 7:29, 1997). An octave band sound level limit requires a noise analysis of sound levels at various frequencies. The sound signal energy can be electronically separated into frequency bands, known as octave bands, each of which covers a 2 to 1 range of frequencies. For example, the effective band for the 1,000 Hz octave band center frequency extends from 710 to 1,420 Hz.

New Jersey Model Noise Ordinance

The Model Noise Ordinance was developed to be adopted, enforced, and adjudicated locally. It is a performance code designed to empower municipalities to respond to noise complaints within their community in a timely manner. The model noise ordinance regulates more sound-source categories than the State's Noise Control Regulations, including residential and multi-use properties. The noise standards in this model noise ordinance are the same as that for the New Jersey State Noise Control Regulations.

Local Municipalities

Local municipalities may have their own noise control code or noise ordinance that may regulate noise more stringently than state standards/criteria. Local noise codes will be considered on a project specific basis.

Table 1
Noise Sensitivity Criteria
Decibel Changes and Loudness

Change (dBA)	Relative Loudness
0	Reference
3	Barely perceptible change
5	Readily perceptible change
10	Half or twice as loud
20	1/4 or four times as loud
30	1/8 or eight times as loud

Source: Based on Highway Traffic Noise Analysis and Abatement – Policy and Guidance. (FHWA, June 1995.)

Table 2 HUMAN REACTION TO INCREASES IN SOUND PRESSURE LEVEL	
Increase in Sound Pressure (dB)	**Human Reaction**
Under 5	Unnoticed to tolerable
5 – 10	Intrusive
10 – 15	Very noticeable
15 – 20	Objectionable
Over 20	Very objectionable to intolerable

Source: New York State Department of Environmental Conservation. Assessing and Mitigating Noise Impacts. (NYSDEC October 6, 2000.)

2.0 NOISE MONITORING SURVEY

2.1 Methodology

The following describes the equipment and procedures utilized during this noise survey.

2.2 Equipment

The sound-level meter (SLM) is the conventional instrument used to measure the instantaneous sound-pressure level (SPL), in decibels (dB), of sound energy. The SLM contains a microphone, amplifier, weighting and filter networks, detector networks, and indicators.

An integrating sound-level meter (ISLM) has the capability to compute the long-term root-mean-square (rms) level of time-varying sound energy. The time-averaged, mean square SPL is referred to as the Leq (equivalent constant SPL). The ISLM used for this assessment can compute Leq measurements automatically, providing greater ease and accuracy of Leq determination.

Noise levels were measured and analyzed with a Bruel and Kjaer (B&K) Modular Precision Sound Level Meter Type 2231 and/or a Bruel and Kjaer (B&K) Modular Precision Sound Level Meter Type 2250. A B&K Microphone Type 4189 was used in conjunction with the B&K 2231 and B&K 2250. Both the B&K 2231 and B&K 2250 are Type 1 instruments in accordance with the American National Standards Institute (ANSI), S1.4-1983 Type 1. This instrument can be used to perform a wide range of measurements, take several measurements simultaneously, and automatically store data at the end of a preset time period. The B&K 2231 and 2250 can measure sound levels ranging from 24 to 113 decibels A-weighted (dBA). Measured data can be stored in the instrument memory, which has battery backup, to maintain data integrity. The B&K 2231 and 2250 can be used with modules to enhance the basic functions of the meter.

The B&K 2231 can be used in conjunction with a B&K 1625 Octave Band Filter, to perform octave band measurements. The B&K 1625 Band Pass Filter Set contains 10 active filters with center frequencies from 31.5 Hz to 16 kHz. Each octave filter satisfies requirements of IEC Recommendation R 225-1996, DIN 45651 and ANSI S1, 11-1966 Class II. The total frequency range is from 14 Hz to 28 kHz. The B&K 1625 filter set covers the audio-frequency range with center frequencies arranged according to the preferred frequencies of ISO R266, DIN 45401 and ANSI □1.6-1960. The B&K 2250 has a software module that allows real-time frequency measurements in 1/1 and 1/3 Octave Bands.

2.3 Calibration

Calibration of the B&K 2231 and/or the B&K 2250 was performed using the B&K Calibrator 4230 and/or B&K 4231. Calibrations of the B&K 2231 and/or B&K 2250 were performed prior to and immediately following noise monitoring.

2.4 Procedures

There are many noise monitoring methodologies available for performing baseline noise monitoring studies. Most consist of various data acquisition and analysis procedures, and also include a high degree of subjectivity (Greenberg, et al. 1979). The approach utilized follows appropriate general guidelines and recommended practices.

Observations are made, during measurement, such as with regard to temperature, wind, relative humidity, cloud cover, and wind induced noises (i.e., leaves rustling, etc.). Atmospheric conditions such as rainfall (precipitation), high humidity (greater than 90 percent), and high wind (greater than around 12 to 15 miles per hour) are avoided during field measurement because of their potential influence to have an adverse effect on noise measurements. A microphone windscreen is utilized (as appropriate) during measurements to minimize potential wind effects.

Nearby buildings and other structures can modify outdoor noise radiation patterns. In addition, specific site conditions and equipment layout can influence sound propagation. To characterize sound levels from a facility requires considering site conditions, facility design, and receptor locations.

2.5 Noise Monitoring Locations

A-Weighted noise measurements are taken at various locations in the vicinity of the equipment/location of concern. Noise monitoring may be performed at a number of different locations; near the noise source along the site perimeter; along adjoining residential property boundaries.

2.6 Sensitive Receptors

Areas or receptors that are considered potentially sensitive to noise include residences, schools, hospitals, and recreational facilities (U.S. Environmental Protection Agency, 1974). Potentially sensitive receptors located near the noise source usually include residential areas near the site. The location of closest residence to the noise source is identified and is commonly a candidate for noise monitoring.

2.7 Other Equipment

A Quest Technologies Q-500 Multi-Function Noise Analyzer (a data-logging dosimeter) is sometimes used for noise monitoring. The Q-500 is a Type 1 instrument in accordance with the American National Standards Institute (ANSI), S1.4-1983 Type 1, and has many of the features of an ISLM. The Q-500 dosimeter can be used to record Leq noise levels in one-minute time history intervals over the course of a 24-hour period. The Q-500 can measure sound levels ranging from 40 to 140 decibels A or C-weighted. The A-weighted (dBA) scale can be utilized with the sound level range set at 40 to 115 decibels. An exchange rate of three (3) was used in conjunction with a slow response. Measured data is stored in the instrument memory, which has battery backup, to maintain data integrity.

Calibration of the Q-500 Multi-Function Noise Analyzer is performed using the QC-20 Calibrator set at 94 dB. Calibrations of the dosimeter are usually performed prior to and following noise monitoring.

3.0 NOISE MODELING

3.1 Noise Modeling Methodology

Noise level contributions due to operation of a particular noise source can be estimated using quantitative techniques (noise modeling). Projected noise levels can be estimated using a noise modeling technique, based on a relationship that expresses noise attenuation as a logarithmic function of receptor distance from the noise source. Noise contribution levels from a noise source can be estimated at selected receptor locations (i.e., noise monitoring locations).

Noise propagation calculations are based on the assumption that, at distances greater than around 50 feet (15 meters) from a source, noise levels are reduced by 6 dB for each doubling of distance away from the noise source (Peterson and Gross 1972). This tends to be a conservative approach, since attenuation due to buildings, barriers, and vegetation are often not taken into account; nor are factors such as relative humidity and wind.

3.2 Modeling Results

Receptor locations can be influenced by many noise sources at the same time but to different degrees, depending on the distances the receptors are from the various noise sources, as well as the magnitude, time and duration of noise from these different noise sources. In a situation with many noise sources, it is sometimes difficult to distinguish which noise sources are influencing a given receptor and what their noise level contributions are.

Noise level estimates of potential contributions from a specific noise source can be made at receptor points (monitoring locations from a noise study or sensitive receptor locations), utilizing the noise propagation techniques discussed above. Approximate distances from each facility component (noise source) to various receptor (property boundary, residential etc.) locations are used in an analysis.

Environmental factors (e.g., any buildings or structures between sources and receptors, buildings, vegetation, etc.) usually are not included in the modeling. These factors could serve to make actual noise levels lower than the modeled estimates.

A noise assessment is usually performed using the noise level estimates for a noise source or measured existing noise levels at the source or similar source. Projected noise, associated with a noise source, can be compared to measured existing noise levels.

4.0 MITIGATION MEASURES

If a review of the noise assessment results suggests that reducing noise levels from existing or proposed new equipment (noise sources) a site may be warranted then mitigation methods should be considered. Mitigation measures to reduce measured or projected noise levels include the following, which may be appropriate for different situations:

- Design considerations – specify "quiet equipment designs" depending on installation and site
- Sound absorption panels barrier panels
- Check/improve installation
- Consider enclosures, buildings, or other structures, isolating equipment, etc.
- Interior wall/window treatments

Retrofit to improve a noise problem after placement can be difficult, and more costly. The above methods can vary widely in their effectiveness, installation and cost.

Installation of indoor mitigation materials/wall treatments:
Take the obvious steps to seal off all cracks, crevices, and paths where sound could escape. Sound can pass through cracks and every crack will offer sound an escape route. Unless you are thorough in sealing off the entire room, you will not achieve the maximum benefit of sound-proofing materials. Sometimes this can be difficult to accomplish, depending on the number of vents, electrical plugs, windows, doors, and other breaks in the wall. Doors and windows are often overlooked. Make sure that doors and windows fit their frames snuggly and that they form a tight seal.

There must be no loose studs, and the sill plates must really hug the floor. The wallboard must be well fitted and all potential cracks must be caulked. (caulk should be flexible, not rigid, and should not crack when the building settles). Do not put holes in sound walls for outlets or pipes; use surface mount electrical fittings and caulk around any wires that pierce gypsum.

Sound can travel through any medium and it passes through solids better than through air. Sound intensity is reduced in the transition from one material to another, as from the air to a wall and back. The amount of reduction (called the transmission loss) is related to the density of the wall, as long as it doesn't move in response to the sound.

Any motion caused by sound striking one side of the wall will result in sound radiated by the other side, an effect called coupling. If the sound hits a resonant frequency, the wall will boom like a drum. Most isolation techniques are really ways to reduce coupling and prevent resonances.

Mass loaded vinyl (MLV) sound barrier is an effective, relatively inexpensive treatment for airborne noise. For multi-level buildings, mass loaded vinyl can be used as an underlayment beneath the floor. This material can be laid directly on the floor under carpets, between sheets of plywood, or over cement.

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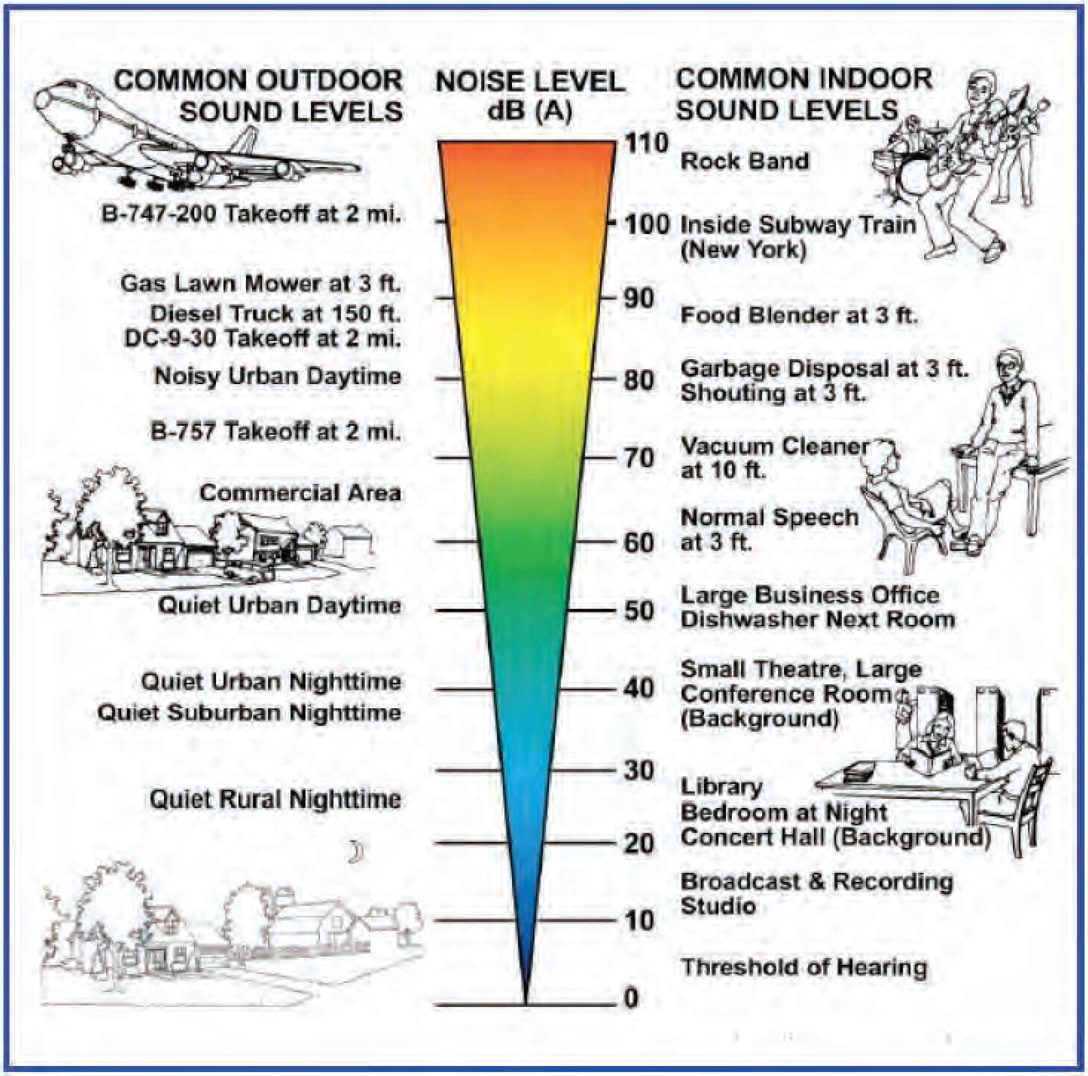
Common Activities and Typical Sound Levels



This chart shows approximate noise levels that are typically generated by various common outdoor and indoor activities. Note, that, typical noise levels in a residential–commercial urban area ranges from 60 to 70 dBA. Also, indoor sound levels with conversation (normal speech at 3 feet) can range at 60 to 70 dBA.

APPENDIX B

Town of Brookhaven Noise Control Code

Town of Brookhaven, NY
Thursday, October 3, 2019

Chapter 50. Noise Control

[HISTORY: Adopted by the Town Board of the Town of Brookhaven 6-16-1987 by L.L. No. 7-1987. Amendments noted where applicable.]

GENERAL REFERENCES
Parks and recreation areas — See Ch. **10**.
Building construction — See Ch. **16**.
Dog control and animal welfare — See Ch. **23**.
Peddlers — See Ch. **36**.
Highways — See Ch. **38**.
Excavating and topsoil removal — See Ch. **53**.

ATTACHMENTS
050a Table I

§ 50-1. Findings; applicability.

A. Whereas excessive sound is a serious hazard to the public health, welfare, safety and the quality of life; and whereas a substantial body of science and technology exists by which excessive sound may be substantially abated; and whereas the people have a right to and should be ensured of an environment free from excessive sound; now, therefore, it is the policy of the Town of Brookhaven to prevent excessive sound that may jeopardize the health, welfare or safety of the citizens or degrade the quality of life.

B. This chapter shall apply to the control of sound originating from stationary and certain mobile sources within the limits of the Town of Brookhaven.

§ 50-2. Definitions; word usage.

A. All terminology defined herein which relates to the nature of sound and the mechanical detection and recordation of sound is in conformance with the terminology of the American National Standards Institute or its successor body.

B. As used in this chapter, the following terms shall have the meanings indicated:

A-WEIGHTED SOUND PRESSURE LEVEL
The sound pressure level measured in decibels with a sound level meter set for A-weighting, abbreviated "dBA."

COMMERCIAL AREA
A group of commercial properties and the abutting public rights-of-way and public spaces.

COMMERCIAL PROPERTY
Any property currently or hereinafter zoned for any classification of business or commercial zoning according to the Zoning Map of the Town of Brookhaven or any facility or property used for activities involving the furnishing or handling of goods or services, including but not limited to:

(1) Commercial dining.

(2) Off-road vehicle operation, such as repair, maintenance and terminaling.

(3) Retail services.

(4) Wholesale services.

(5) Banking and office activities.

(6) Recreation and entertainment.

(7) Community services.

(8) Public services.

(9) Other commercial activities.

CONSTRUCTION
Any site preparation, assembly, erection, repair, alteration or similar action, but excluding demolition, of buildings or structures.

DECIBEL (dB)
The practical unit of measurement for sound pressure level. The number of decibels of a measured sound is equal to 20 times the logarithm of the base 10 of the ratio of the sound pressure of the measured sound to the sound pressure of a standard sound (20 micropascals), abbreviated "dB."

DEMOLITION
Any dismantling, intentional destruction or removal of buildings or structures.

EMERGENCY WORK
Any work or action necessary to deliver essential services, including but not limited to repairing water, gas, electricity, telephone and sewer facilities and public transportation, removing fallen trees on public rights-of-way and abating life-threatening conditions.

INDUSTRIAL PROPERTY
Any facility or property used for activities involving the production, fabrication, packaging, storage, warehousing, shipping or distribution of goods, including any property currently or hereinafter zoned for any classification of industrial zoning according to the Zoning Map of the Town of Brookhaven.

MOTOR VEHICLE
Any vehicle which is propelled or drawn on land by an engine or motor.

MULTIDWELLING BUILDINGS
Any building wherein there are two or more dwelling units.

NOISE
Any airborne sounds of such level and duration as to be or tend to be injurious to human health or welfare or that would unreasonably interfere with the enjoyment of life or property.

NOISE CONTROL ADMINISTRATOR
The noise control officer designated as the official liaison with all municipal departments, empowered to grant permit for variances.

NOISE CONTROL OFFICER
Any employee of the Town of Brookhaven trained in the measurement of sound and empowered to issue a summons for violations of this chapter.

NOISE DISTURBANCE
Any sound that:

(1) Endangers the safety or health of any person;

(2) Disturbs a reasonable person of normal sensitivities; or

(3) Endangers personal or real property.

PERSON
Any individual corporation, company, association, society, firm, partnership, joint-stock company, the state or any political subdivision, agency or instrumentality of the state.

PUBLIC RIGHT-OF-WAY
Any street, avenue, boulevard, road, highway, sidewalk, alley or similar place that is owned or controlled by a governmental entity.

PUBLIC SPACE
Any real property or structures thereon that are owned or controlled by a governmental entity.

REAL PROPERTY LINE
Either:

(1) The imaginary line, including its vertical extension, that separates one parcel of real property from another; or

(2) The vertical and horizontal boundaries of a dwelling unit that is one in a multi-dwelling-unit building.

RESIDENTIAL AREA
A group of residential properties and the abutting public rights-of-way and public spaces.

RESIDENTIAL PROPERTY
Any property used for human habitation.

SOUND LEVEL
The sound pressure level measured in decibels with a sound level meter set for A-weighting. Sound level is expressed in dBA.

SOUND LEVEL METER
An instrument for the measurement of sound levels.

SOUND PRESSURE LEVEL
The level of a sound measured in decibel units with a sound level meter which has a uniform response over the band of frequencies measured.

WEEKDAY
Any day, Monday through Friday, that is not a legal holiday.

§ 50-3. Enforcement; powers and duties of Noise Control Administrator.

A. The provisions of this chapter shall be enforced by the noise control officers.

B. The Noise Control Administrator shall have the power to:

(1) Coordinate the noise control activities of all municipal departments and cooperate with all other public bodies and agencies to the extent practicable.

(2) Review the actions of other municipal departments and advise such departments of the effect, if any, of such actions on noise control.

(3) Review public and private projects, subject to mandatory review or approval by other departments, for compliance with this chapter.

C. The Noise Control Administrator shall have the authority to grant permit for variances as provided in § **50-8** of this chapter.

D. The Noise Control Administrator shall not use this chapter in situations within the jurisdiction of the Federal Occupational Safety and Health Act.

§ 50-4. Responsibility of departments.

A. All departments and agencies of the Town of Brookhaven shall, to the fullest extent consistent with other law, carry out their programs in such a manner as to further the policy of this chapter and shall cooperate with the Noise Control Administrator in the implementation and enforcement of this chapter.

B. All departments charged with new projects or changes to existing projects that may result in the production of noise shall consult with the Noise Control Administrator prior to the approval of such projects to ensure that such activities comply with the provisions of this chapter.

§ 50-5. Maximum permissible sound pressure levels.

A. No person shall cause, suffer, allow or permit the operation of any source of sound on a particular category of property or any public land or right-of-way in such a manner as to create a sound level that exceeds the particular sound level limits set forth in **Table I**[1] when measured at or within the real property line of the receiving property, except those acts specifically prohibited in § **50-6** of this chapter for which no measurement of sound is required.

[1] *Editor's Note: **Table I** is included at the end of this chapter.*

B. When measuring noise within a multidwelling unit, all doors and windows shall be closed, and the measurements shall be taken in the center of the room.

C. The following are exempt from the A-weighted sound pressure level limits of **Table I**:

(1) Noise from domestic power tools, lawn mowers and agricultural equipment, when operated with a muffler, between the hours of 8:00 a.m. and 8:00 p.m. on weekdays and 9:00 a.m. and 8:00 p.m. on weekends and legal holidays, provided that they produce less than 85 dBA at any real property line of a residential property.

(2) Sound from church bells and church chimes when part of a religious observance or service.

(3) Noise from construction activity, except as provided in § **50-6B(7)**.

(4) Noise from snowblowers, snow throwers and snowplows, when operated with a muffler, for the purpose of snow removal.

(5) Noise from stationary emergency signaling devices owned and operated by any public utility, municipal subdivision, Fire Department or ambulance corps when used in connection with an emergency or for testing purposes.

(6) Noise from a burglar alarm of any building or motor vehicle, provided that such burglar alarm shall terminate its operation within 15 minutes after it has been activated and shall not be operated more than 15 minutes in any one-hour period.

§ 50-6. Prohibited acts.

A. No person shall cause, suffer, allow or permit to be made verbally or mechanically any noise disturbance. Noncommercial public speaking and public assembly activities conducted on any public space or public right-of-way shall be exempt from the operation of this section.

B. No person shall cause, suffer, allow or permit the following acts:

(1) Sound reproduction systems: operating, playing or permitting the operation or playing of any radio, television, phonograph or similar device that reproduces or amplifies sound in such a manner as to

create a noise disturbance for any person other than the operator of the device. However, the playing of bands or other music on any commercial property shall be governed by § **50-5**.
[Amended 3-19-1996 by L.L. No. 10-1996, effective 3-22-1996]

(2) Loudspeakers and public address systems: use or operation of any loudspeaker public address system or similar device between the hours of 10:00 p.m. and 7:00 a.m. in the following day during weekdays and between 10:00 p.m. and 11:00 a.m. in the following day on Saturdays and Sundays, except when used in connection with a public emergency by officers of any Police Department, Fire Department or of any municipal entity.

(3) Animals and birds: owning, possessing or harboring any pet animal or pet bird that frequently or for continued duration makes sounds that create a noise disturbance across a residential real property line. For the purpose of this section, a "noise disturbance from a barking dog" shall be defined as that created by a dog barking continuously or intermittently for 15 minutes.
[Amended 5-5-1998 by L.L. No. 11-1998, effective 5-11-1998]

(4) Loading and unloading: loading, unloading, opening, closing or other handling of boxes, crates, containers, building materials, liquids, garbage cans, refuse or similar objects or the pneumatic or pumped loading or unloading of bulk materials in liquid, gaseous, powder or pellet form or compacting refuse by persons engaged in the business of scavenging or garbage collection, whether private or municipal, between the hours of 10:00 p.m. and 6:00 a.m. and the following day when the latter is a weekday and between the hours of 10:00 p.m. and 7:00 a.m. the following day when the latter is on a holiday, except by permit, when the sound therefrom creates a noise disturbance across a residential real property line.

(5) Standing motor vehicles: operating or permitting the operation of any motor vehicle or any auxiliary equipment attached to such a vehicle, for a period of longer than three minutes in any hour while the vehicle is stationary, for reasons other than traffic congestion or emergency work, on a public right-of-way or public space within 150 feet (46 meters) of a residential area between the hours of 8:00 p.m. and 8:00 a.m. in the following day.

(6) Motor vehicle repairs and testing: repairing, rebuilding, modifying or testing any motor or engine in such a manner as to exceed any applicable limit in **Table I**[1] across a residential area property line.
[1] *Editor's Note: Editor's Note: **Table I** is included at the end of this chapter.*

(7) Construction: operating or permitting the operation of any tools or equipment used in construction, drilling, earth moving, excavating or demolition work between the hours of 6:00 p.m. and 7:00 a.m. the following day on weekdays or at any time on weekends or legal holidays, except:
[Amended 12-15-1992 by L.L. No. 15-1992, effective 12-24-1992]

(a) For emergency work.

(b) By special variance issued pursuant to § **50-3**.

(c) (Reserved)

(d) When the result of the operation of any of said equipment by or for any municipal agency.

§ 50-7. Exceptions.

A. The provisions of this chapter shall not apply to:

(1) The emission of sound for the purpose of alerting persons to the existence of an emergency, except as provided in § **50-5C(5)** or **(6)**.

(2) The emission of sound in the performance of emergency work.

B. Noise from municipally sponsored celebrations or events shall be exempt from the provisions of this chapter.

§ 50-8. Variances.

A. Any person who owns or operates any stationary noise source may apply to the Noise Control Administrator for a variance from one or more of the provisions of this chapter. Applications for a variance shall supply information, including but not limited to:

(1) The nature and location of the facility or process for which such application is made.

(2) The reason for which the variance is requested.

(3) The nature and intensity of noise that will occur during the period of the variance.

(4) A description of interim noise control measures to be taken by the applicant to minimize noise and the impacts occurring therefrom.

(5) A specific schedule of the noise control measures which shall be taken to bring the source into compliance.

B. Failure to supply the information required by the Noise Control Administrator shall be cause for rejection of the application.

C. The Noise Control Administrator shall charge fees as established by Town Board resolution.
[Amended 11-23-2010 by L.L. No. 44-2010, effective 12-7-2010; 2-14-2019 by L.L. No. 2-2019, effective 2-25-2019]

D. The Noise Control Administrator may, at his/her discretion, limit the duration of the variance, which shall never be longer than 15 days. Any person holding a variance and requesting an extension of time may apply for a new variance under the provisions of this section. No person shall be entitled to variances totalling more than 30 days during any calendar year.

E. The variance shall operate as a stay of prosecution.

F. The variance may be revoked by the Noise Control Administrator if the terms of the variance are violated.

§ 50-9. Penalties for offenses.

[Amended 2-15-1994 by L.L. No. 2-1994, effective 2-22-1994]

A. Any person who violates any provision of this chapter shall be guilty of a violation and shall be punishable as follows: upon a first conviction, by a fine of not less than $25 and not exceeding $100; upon a second conviction, by a fine of not less than $50 and not exceeding $150; upon a third or subsequent conviction, by a fine of not less than $100 and not exceeding $250.

B. Each two-hour period of violation of any provision of this chapter shall constitute a separate violation.

§ 50-10. Abatement.

A. Except as provided in Subsection **B**, in lieu of issuing a summons, the Noise Control Administrator may issue an order requiring abatement of any source of sound alleged to be in violation of this chapter within a reasonable time period and according to guidelines which the Noise Control Administrator may prescribe.

B. An abatement order shall not be issued when the Noise Control Administrator has reason to believe that there will not be compliance with the abatement order, when the alleged violator has been served with a previous abatement order or has previously been convicted for a violation of this chapter.

§ 50-11. Construal.

[Amended 12-7-1993 by L.L. No. 21-1993, effective 12-13-1993]

No provision of this chapter shall be construed to impair any common law or statutory cause of action, or legal remedy therefrom, of any person for injury or damage arising from any violation of this chapter or from other law. Nothing herein shall be construed to abridge the emergency powers of any health department or the right of such department to engage in any necessary or proper activities. Nothing herein shall abridge the powers and responsibilities of any police department or law enforcement agency to enforce the provisions of this chapter.

§ 50-12. (Reserved)

§ 50-13. (Reserved)

Ch. 50 Attachment 1

Town of Brookhaven
Table I
Maximum Permissible A-Weighted Sound Pressure Levels by Receiving Property Category, in dBA

	Receiving Property Category					
	Another Apartment Within Multidwelling Building		Residential			
Sound Source Property Category	7:00 a.m. to 10:00 p.m.	10:00 p.m. to 7:00 a.m.	7:00 a.m. to 10:00 p.m.	10:00 p.m. to 7:00 a.m.	Commercial All Times	Industrial All Times
Apartment within multidwelling building	45	40	55	50	65	75
Residential	--	--	55	50	65	75
Commercial or public lands or rights-of-way	--	--	65	50	65	75
Industrial	--	--	65	50	65	75

APPENDIX C

Suffolk County Noise Ordinance

Chapter 618

NOISE

GENERAL REFERENCES

Light pollution — See Ch. 149.

Agricultural operations — See Ch. 274.

Alarms — See Ch. 290.

Demonstrations — See Ch. 404.

Parks and park facilities — See Ch. 643.

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§ 618-1. Legislative intent.

A. This Legislature hereby finds and determines that excessive noise can endanger the general health of individuals exposed to it and can actually cause hearing loss.

B. This Legislature further finds that many persons cause excessive noise through the use of radios and amplifiers and other devices that play music, including boom boxes, which can be deleterious to the health, safety and general well being of the public.

C. Therefore, the purpose of this chapter is to limit noise on County-owned properties.

§ 618-2. Definitions. [Amended 5-13-2003 by L.L. No. 18-2003]

As used in this chapter, the following terms shall have the meanings indicated:

AMBIENT SOUND — An all-encompassing composite of sounds from many sources associated with a given environment.

A-WEIGHTED SOUND LEVEL — The sound pressure level in decibels, as measured on a sound level meter using the A-weighting network slow response (dBA).

CONTINUOUS SOUND — Any sound that is not an impulsive sound.

DECIBEL — A unit for measuring the pressure level of a sound, equal to 1/10 of a bel.

IMPULSIVE SOUND — A sound characterized by brief excursions of peak sound pressure which significantly exceed the ambient sound.

NOISE DISTURBANCE — Any sound that:

A. Endangers the safety or health of any person;

B. Disturbs a reasonable person of normal sensitivities; and/or

C. Endangers personal or real property.

PEAK SOUND PRESSURE — The maximum absolute value of the instantaneous sound pressure level during a specified time interval.

PERSON — Any natural person, individual, corporation, unincorporated association, proprietorship, firm, partnership, joint venture, joint-stock association or other entity or business organization of any kind.

SHOOTING RANGE — An outdoor range equipped with targets for use with firearms and shall include, but not be limited to, all rifle, pistol, and shotgun ranges.

SOUND — Any variation in ambient barometric pressure.

SOUND DEVICE OR APPARATUS — Any radio device or apparatus or any device or apparatus for the amplification of sounds from any radio, phonograph or other sound-making or sound-producing device or apparatus for the reproduction or amplification of the human voice or other sounds.

SOUND PRESSURE LEVEL — When measured in decibels, equal to 20 times the logarithm to the base 10 of the ratio of the effective pressure of the sound measured to the standard reference pressure of a sound.

STANDARD REFERENCE PRESSURE OF A SOUND — Twenty micronewtons per square foot.

§ 618-3. Prohibitions.

A. No person shall cause, suffer, allow or permit to be made mechanically any noise disturbance on any County highway or within the limits of the right-of-way of such highway or upon any parcel of real estate owned by the County of Suffolk, in whatever capacity and for whatever purpose, or upon buses owned, leased or operated by the County of Suffolk.

B. No person shall cause, suffer, allow or permit the operation or playing of any noise device or apparatus on any County highway or within the limits of the right-of-way of such highway, in whatever capacity or for whatever purpose, or upon any parcel of real estate owned by the County of Suffolk or upon buses owned, leased or operated by the County of Suffolk in such a manner as to create a noise disturbance.

§ 618-4. Restrictions.

No person shall cause, suffer, allow or permit the operation of any source of sound on any County highway or within the limits of the right-of-way of such highway or upon any parcel of real estate owned by the County of Suffolk or upon buses owned, leased or operated by the County of Suffolk in such a manner as to create a sound level that exceeds the particular sound level limits set forth in Table I of this section, when measured at or within the real property line of the County-owned property, except those acts specifically prohibited in § 618-3 of this chapter for which no measurement of sound is required.

Table I

Maximum Permissible A-Weighted Sound Pressure Levels by Receiving Property Category, in dBA

	Receiving Property Category			
Sound Source Property Category	**Residential, 7:00 a.m. to 10:00 p.m.**	**Residential, 10:00 p.m. to 7:00 a.m.**	**Commercial, all times**	**Industrial, all times**
County highways or within the limits of the right-of-way of such highway or upon any parcel of real estate owned by the County of Suffolk or upon buses owned, leased or operated by the County of Suffolk	65	50	65	70

§ 618-5. Applicability.

A. This chapter shall apply to all actions occurring on or after the effective date of this chapter.

B. Section 618-3 of this chapter shall not apply to the following activities:

(1) The noise from domestic power tools, lawn mowers and agricultural equipment, when operated with a muffler, between the hours of 8:00 a.m. and 8:00 p.m. on weekdays and 9:00 a.m. and 8:00 p.m. on weekends and legal holidays, provided that they produce less than 85 dBA at any real property line of County-owned property.

(2) The sound from church bells and church chimes when a part of a religious observance or service.

(3) The noise from construction activity, except for operating or permitting the operation of any tools or equipment used in construction, drilling, earth-moving, excavating or demolition work between the hours of 6:00 p.m. and 7:00 a.m. the following day on weekdays or at any time on weekends or legal holidays, except:

(a) Emergency work.

(b) When the sound level does not exceed any applicable limit specified in Table I of § 618-4.

(c) When it is the result of the operation of any said equipment by or for any municipal entity.

(4) Noise from snowblowers, snow throwers and snowplows, when operated with a muffler, for the purpose of snow removal.

(5) Noise from stationary emergency signaling devices owned and operated by any public utility, municipal subdivision, fire department or ambulance corps when used in connection with an emergency or for testing purposes.

(6) Noise from a burglar alarm of any building or motor vehicle, provided that such burglar alarm shall terminate its operation within 15 minutes after it has been activated and shall not operate more than 15 minutes in any one-hour period.

C. This chapter shall not apply to: **[Amended 5-13-2003 by L.L. No. 18-2003]**

(1) The emission of sound for the purpose of alerting persons to the existence of an emergency or the creation of sound in the performance of emergency work.

(2) Noise from noncommercial public-speaking and public-assembly activities.

(3) Noise from municipally sponsored celebrations or events.

(4) Noise emanating from the recreational discharge of firearms at a County-owned, -operated- or -leased shooting range, the site for which was being used as a facility for the recreational discharge of firearms prior to January 1, 1980.

§ 618-6. Penalties for offenses.

Any person who intentionally violates any provision of § 618-3 or 618-4 of this chapter shall be guilty of an unclassified misdemeanor, punishable by a fine of $500 and/or up to one year of imprisonment. Each such violation shall constitute a separate and distinct offense.

APPENDIX D

NYSDEC Noise Policy Guidance

Assessing and Mitigating Noise Impacts

New York State
Department of Environmental Conservation

PROGRAM POLICY	**Department ID:** **DEP-00-1**	**Program ID:** **n/a**
Issuing Authority: Environmental Conservation Law Articles 3, 8, 23, 27 Name: Jeffrey Sama Title: Director Signature: /S/ Date: 10/6/00	**Originating Unit: Division of Environmental Permits** Office/Division: Environmental Permits Unit: Phone: (518) 402-9167	
Issuance Date: October 6, 2000 Revised: February 2, 2001	Latest Review Date (Office Use):	

Abstract: Facility operations regulated by the Department of Environmental Conservation located in close proximity to other land uses can produce sound that creates significant noise impacts for proximal sound receptors. This policy and guidance presents noise impact assessment methods, examines the circumstances under which sound creates significant noise impacts, and identifies avoidance and mitigative measures to reduce or eliminate noise impacts.

Related References: See references pages 27 and 28.

I. PURPOSE[1]

This policy is intended to provide direction to the staff of the Department of Environmental Conservation for the evaluation of sound levels and characteristics (such as pitch and duration) generated from proposed or existing facilities. This guidance also serves to identify when noise levels may cause a significant environmental impact and gives methods for noise impact assessment, avoidance, and reduction measures. These methods can serve as a reference to applicants preparing environmental assessments in support of an application for a permit. Additionally, this guidance explains the Department's regulatory authority for undertaking noise evaluations and for imposing conditions for noise mitigation measures in the agency's approval

[1] A Program Policy Memorandum is designed to provide guidance and clarify program issues for Division staff to ensure compliance with statutory and regulatory requirements. It provides assistance to New York State Department of Environmental Conservation (DEC) staff and the regulated community in interpreting and applying regulations and statutes to assure that program uniformity is attained throughout the State. Nothing set forth in a Program Policy Memorandum prevents DEC staff from varying from that guidance as specific circumstances may dictate, provided the staff's actions comply with applicable statutory and regulatory requirements. As this guidance document is not a fixed rule, it does not create any enforceable right by any party using the Program Policy Memorandum.

of permits for various types of facilities pursuant to regulatory program regulations and the State Environmental Quality Review Act (SEQR).

II. BACKGROUND

Noise is defined as any loud, discordant or disagreeable sound or sounds. More commonly, in an environmental context, noise is defined simply as unwanted sound. Certain activities inherently produce sound levels or sound characteristics that have the potential to create noise. The sound generated by proposed or existing facilities may become noise due to land use surrounding the facility. When lands adjoining an existing or proposed facility contain residential, commercial, institutional or recreational uses that are proximal to the facility, noise is likely to be a matter of concern to residents or users of adjacent lands.

A. Sources of Noise Generation

The three major categories of noise sources associated with facilities are (1) fixed equipment or process operations; (2) mobile equipment or process operations; and (3) transport movements of products, raw material or waste. The fixed plant may include a very wide range of equipment including: generators; pumps; compressors; crushers of plastics, stone or metal; grinders; screens; conveyers; storage bins; or electrical equipment. Mobile operations may include: drilling; haulage; pug mills; mobile treatment units; and service operations. Transport movements may include truck traffic within the operation, loading and unloading trucks and movement in and out of the facility. Any or all of these activities may be in operation at any one time. Singular or multiple effects of sound generation from these operations may constitute a potential source of noise.

B. Potential for Adverse Impacts

Numerous environmental factors determine the level or perceptibility of sound at a given point of reception. These factors include: distance from the source of sound to receptor; surrounding terrain; ambient sound level; time of day; wind direction; temperature gradient; and relative humidity. The characteristics of a sound are also important determining factors for considering it as noise. The amplitude (loudness), frequency (pitch), impulse patterns and duration of sound all affect the potential for a sound to be a noise. The combination of sound characteristics, environmental factors and the physical and mental sensitivity of a receptor to a sound determine whether or not a sound will be perceived as a noise. This guidance uses these factors in assessing the presence of noise and the significance of its impacts. It relies upon qualitative and quantitative sound evaluation techniques and sound pressure level impact modeling presented in accepted references on the subject.

C. Mitigation

Mitigation refers to actions that will be taken to reduce the effects of noise or the noise levels on a receptor. Adverse noise effects generated by a facility can be avoided or reduced at the point of generation thereby diminishing the effects of the noise at the point of reception. This guidance identifies various mitigation techniques and their proper application either at the source of noise generation or on a facility's property. Alternative construction or operational methods, equipment maintenance, selection of alternative equipment, physical barriers, siting of activities, set backs, and established hours of construction or operation, are among the techniques that can successfully avoid or reduce adverse noise effects.

D. Decision Making

When an assessment of the potential for adverse noise impacts indicates the need for noise mitigation, it is preferred that specifications for such measures be incorporated in a noise analysis and in the applicant's work or operational plan necessary for a complete application. Presenting a plan that incorporates effective noise mitigation provisions facilitates the Department's technical and environmental review and minimizes or negates the imposition of permit conditions by the Department. Adherence to these plans becomes a condition of a permit.

Noise avoidance and mitigation measures may also be imposed directly as conditions of permit issuance. This guidance will review the statutory authority under which the Department can require the mitigation of noise effects.

III. POLICY

In the review of an application for a permit, the Department of Environmental Conservation is to evaluate the potential for adverse impacts of sound generated and emanating to receptors outside of the facility or property. When a sound level evaluation indicates that receptors may experience sound levels or characteristics that produce significant noise impacts or impairment of property use, the Department is to require the permittee or applicant to employ reasonable and necessary measures to either eliminate or mitigate adverse noise effects. Options to be used to fulfill this guidance should be implemented within the existing regulatory and environmental review framework of the agency.

Regulatory authority for assessing and controlling noise effects are contained in both SEQR and specific Department program regulations. Specific regulatory references are as follows:

Section 3-0301(1)(i) of the Environmental Conservation Law (ECL) states that the commissioner shall have the power to: "i. Provide for prevention and abatement of all water, land and air pollution including but not limited to that related to particulates, gases, dust, vapors, noise, radiation, odor, nutrients and heated liquids."

To comply with Article 8 of the ECL and 6 NYCRR Part 617, State Environmental Quality Review Act, consideration of all relevant environmental issues must be undertaken in making a determination of environmental significance. Noise impact potential is one of many potential issues for consideration in a SEQR review.

Environmental Conservation Law (ECL) Article 23, Title 27, Mined Land Reclamation Law (MLRL), requires applicants for permits to prepare and submit a mined land use plan to the Department for approval. The plan must describe, "the applicant's mining method and measures to be taken to minimize adverse environmental impacts resulting from the mining operation." The provisions to be incorporated in a Mined Land Use Plan, as specified in 6 NYCRR Section 422.2, include the control of noise as a component of the plan.

The solid waste regulations at 6 NYCRR Subdivision 360-1.14(p), establish A-weighted decibel levels that are not to be exceeded at the property line of a facility.

The Division of Air Resources has regulations in 6 NYCRR Parts 450 through 454 that regulate the allowable sound level limits on certain motor vehicles. The statutory authority for these regulations is found in the New York State Vehicle and Traffic Law, Article 10, Section 386.

This guidance does not supercede any local noise ordinances or regulations.

IV. RESPONSIBILITY

The environmental analyst, acting as project manager for the review of applications for permits or permit modifications and working in concert with the program specialist, is responsible for ensuring that sound generation and noise emanating from proposed or existing facilities are properly evaluated. For new permits or significantly modified permits, there should be a determination as to the potential for noise impacts, and establishment of the requirements for noise impact assessment to be included in the application for permit. Where the Department is lead agency, the analyst is responsible for making a determination of significance pursuant to SEQR with respect to potential noise impacts and include documentation for such determination.

Where impacts are to be avoided or reduced through mitigation measures, the analyst, or where there are program requirements to address noise, the program specialist, should determine the effectiveness and feasibility of those measures and ensure that the permit conditions contain specific details for such measures. It should also be determined if additional measures to control noise are to be imposed as a condition of permitting. Appropriate permit language for the permit conditions should be developed by the program specialist and the analyst. The results of noise impact evaluations and the effectiveness of mitigation measures shall be incorporated into SEQR documents and, where necessary, permit conditions shall be placed in final permits to ensure effective noise control.

When it is determined that potential noise effects, as well as other issues, warrant evaluation of impacts and mitigation measures in a Draft Environmental Impact Statement (EIS) prepared pursuant to SEQR, the environmental analyst with the Division of Environmental Permits assumes responsibility for determining the level of evaluation needed to assess sound level generation, noise effects, and mitigation needs and feasibility.

For existing facilities, the program specialist will determine the need for additional mitigation measures to control noise effects either in response to complaints or other changes in circumstances such as new noise from existing facilities or a change in land-use proximal to the facility.

The applicant or their agent, in preparing an application for a permit and supporting documentation, is responsible for assessing the potential noise impacts on area receptors. When potential adverse noise impacts are identified, the applicant should incorporate noise avoidance and reduction measures in the construction or operating plans. The applicant's submittal should also assess the effectiveness of proposed mitigation measures in eliminating adverse noise reception. Where noise effects are determined to be a reason in support of a SEQR positive declaration, the applicant shall assess noise impacts, avoidance, and mitigation measures in a Draft EIS using methodologies acceptable to this Department.

V. PROCEDURE

The intent of this section is to: introduce terms related to noise analyses; describe some of the various methods used to determine the impacts of sound pressure levels on receptors; identify some of the various attenuators of noise; and list some of the mitigative techniques that can be used to reduce the effects of noise on a receptor. At the end of the section three levels of analysis are described. The first level determines the potential for adverse noise impacts based on noise characteristics and sound pressure increases solely on noise attenuation over distance between the source and receptor of the noise. The second level factors other considerations such as topography and noise abatement measures in determining if adverse noise impacts will occur. The third level evaluates noise abatement alternatives and their effectiveness in avoiding or reducing noise impacts.

The environmental effects of sound and human perceptions of sound can be described in terms of four characteristics:

1. Sound Pressure Level (SPL may also be designated by the symbol L_p) or perceived loudness is expressed in decibels (dB) or A-weighted decibel scale dB(A) which is weighted towards those portions of the frequency spectrum, between 20 and 20,000 Hertz, to which the human ear is most sensitive. Both measure sound pressure in the atmosphere.

2. Frequency (perceived as pitch), the rate at which a sound source vibrates or makes the air vibrate.

3. Duration i.e., recurring fluctuation in sound pressure or tone at an interval; sharp or startling noise at recurring interval; the temporal nature (continuous vs. intermittent) of sound.

4. Pure tone which is comprised of a single frequency. Pure tones are relatively rare in nature but, if they do occur, they can be extremely annoying.

Another term, related to the average of the sound energy over time, is the Equivalent Sound Level or $L_{eq.}$ The L_{eq} integrates fluctuating sound levels over a period of time to express them as a steady state sound level. As an example, if two sounds are measured and one sound has twice the energy but lasts half as long, the two sounds would be characterized as having the same equivalent sound level. Equivalent Sound Level is considered to be directly related to the effects of sound on people since it expresses the equivalent magnitude of the sound as a function of frequency of occurrence and time. By its derivation L_{eq} does not express the maximum nor minimum SPLs that may occur in a given time period. These maximum and minimum SPLs should be given in the noise analysis. The time interval over which the L_{eq} is measured should always be given. It is generally shown as a parenthetic; $L_{eq\ (8)}$ would indicate that the sound had been measured for a period of eight hours.

Equivalent Sound Level (L_{eq}) correlates well and can be combined with other types of noise analyses such as Composite Noise Rating, Community Noise Equivalent Level and day-night noise levels characterized by L_{dn} where an $L_{eq(24)}$ is measured and 10 dBA is added to all noise levels measured between 10 pm and 7 am. These different types of noise analyses basically combine noise measurements into measures of cumulative noise exposure and may weight noise occurring at different times by adding decibels to the actual decibel level. Some of these analyses require more complex noise analysis than is mentioned in this guidance. They may be used in a noise analyses prepared for projects.

Designations for sound levels may also be shown as $L_{(10)}$ or $L_{(90)}$ in a noise analysis. These designations refer to the sound pressure level (SPL) that is exceeded for 10% of the time over which the sound is measured, in the case of $L_{(10)}$, and 90% of the time, in the case of $L_{(90)}$. For example, an $L_{(90)}$ of 70 dB(A) means that 70 dB(A) is exceeded for 90% the time for which the measurement was taken.

A. Environmental Setting and Effects on Noise Levels

1. Sound Level Reduction Over Distance - It is important to have an understanding of the way noise decreases with distance. The decrease in sound level from any single noise source normally follows the "inverse square law." That is, SPL changes in inverse proportion to the square of the distance from the sound source. At distances greater than 50 feet from a sound source, every doubling of the distance produces a 6 dB reduction in the sound. Therefore, a sound level of 70 dB at 50 feet would have a sound level of approximately 64 dB at 100 feet. At 200 feet sound from the same source would be perceived at a level of approximately 58 dB.

2. Additive Effects of Multiple Sound Sources - The total sound pressure created by multiple sound sources does not create a mathematical additive effect. Below Table A is given to assist you in calculating combined noise sources. For instance, two proximal noise sources that are 70 dBA each do not have a combined noise level of 140 dBA. In this case the combined noise level is 73 dBA. Since the difference between the two sound levels is 0 dB, Table A tells us to add 3 dB to the sound level to compensate for the additive effects of the sound. To find the cumulative SPL assess the SPLs starting with the two lowest readings and work up to the difference between the two highest readings. For several pieces of equipment, operating at one

time, calculate the difference first between the two lowest SPLs, check Table A and add the appropriate number of decibels to the higher of the two sound levels. Next, take the sound level that was calculated using Table A and subtract the next lowest sound level to be considered for the operation. Consult Table A again for the additive effect and add this to the higher of the two sound levels. Follow this process until all the sound levels are accounted for. As an example, let us say that an area for a new facility is being cleared. The equipment to be used is: two chainsaws, one operating at 57 dBA and one at 60 dBA; a front end loader at 80 dBA; and a truck at 78 dBA. Start with the two lowest sound levels: 60 dBA - 57 dBA = 3 dBA difference. Consulting the chart add 2 dBA to the higher sound level. The cumulative SPL of the two chainsaws is 62 dBA. Next, subtract 62 dBA from 78 dBA. 78 dBA - 62 dBA = 16 dBA. In this case, 0 dBA is added to the higher level so we end up with 78 dBA. Lastly, subtract 78 dBA from the 80 dBA. 80 dBA - 78 dBA = 2 dBA a difference of 2 dBA adds 2 dBA to the higher SPL or 82 dBA. The SPL from these four pieces of equipment operating simultaneously is 82 dBA.

Table A

Approximate Addition of Sound Levels

Difference Between Two Sound Levels	Add to the Higher of the Two Sound Levels
1 dB or less	3 dB
2 to 3 dB	2 dB
4 to 9 dB	1 dB
10 dB or more	0 dB

(USEPA, Protective Noise Levels, 1978)

3. Temperature and Humidity - Sound energy is absorbed in the air as a function of temperature, humidity and the frequency of the sound. This attenuation can be up to 2 dB over 1,000 feet. Such attenuation is short term and, since it occurs over a great distance, should not be considered in calculations. Higher temperatures tend to increase sound velocity but does

not have an effect on the SPL. Sound waves bend towards cooler temperatures. Temperature inversions may cause temporary problems when cooler air is next to the earth allowing for more distant propagation of sound. Similarly, sound waves will bend towards water when it is cooler than the air and bounce along the highly reflective surface. Consequently large water bodies between the sound source and the receptor may affect noise attenuation over distance.

4. Time of Year - Summer time noises have the greatest potential for causing annoyance because of open windows, outside activities, etc. During the winter people tend to spend more time indoors and have the windows closed. In general, building walls and windows that are closed provide a 15 dB reduction in noise levels. Building walls with the windows open allow for only a 5 dB reduction in SPL.

5. Wind - Wind can further reduce the sound heard at a distance if the receptor is upwind of the sound. The action of the wind disperses the sound waves reducing the SPLs upwind. While it is true that sound levels upwind of a noise source will be reduced, receptors downwind of a noise source will not realize an increase in sound level over that experienced at the same distance without a wind. This dispels the common belief that sound levels are increased downwind due to wind carrying noise.

6. Land forms and structures - In certain circumstances, sound levels can be accentuated or focused by certain features to cause adverse noise impacts at specified locations. At a hard rock mine, curved quarry walls may have the potential to cause an amphitheater effect while straight cliffs and quarry walls may cause an echo. Buildings that line streets in cities can cause a canyon effect where sound can be reflected from the building surfaces similar to what might happen in a canyon. Consideration of noise impacts associated with these types of conditions may require specialized expertise to evaluate impact potential and to formulate suitable mitigation techniques.

Consideration of existing noise sources and sound receptors in proximity to a proposed activity can be important considerations even when the activity under review is not a noise source. Topography, vegetation, structures and the relative location of noise receptors and sources to these features are all aspects of the environmental setting that can influence noise impact potential. As such, land alteration may also indirectly create an adverse noise impact where natural land features or manmade features serve as a noise barrier or provide noise attenuation for existing sources of noise, i.e. highway, railroads, manufacturing activity. Removal of these features, i.e. hills, vegetation, large structures or walls, can expose receptors to increased sound pressure levels causing noise problems where none had previously existed.

B. Impact Assessment

1. Factors to Consider

Factors to consider in determining the impact of noise on humans, are as follows:

a. Evaluation of Sound Characteristics

(1) Ambient noise level - A noise can only intrude if it differs in character or SPL from the normal ambient sound. Most objective attempts to assess nuisance noise adopt the technique of comparing the noise with actual ambient sound levels or with some derived criterion.

(2) Future noise level - The ambient noise level plus the noise level from the new or proposed source.

(3) Increase In Sound Pressure Level - A significant factor in determining the annoyance of a noise is Sound Pressure Level (SPL). SPLs are measured in decibels.

(4) Sharp and Startling Noise - These high frequency and high intensity noises can be extremely annoying. When initially evaluating the effects

of noise from an operation, pay particular attention to noises that can be particularly annoying. One such noise is the back-up beepers required to be used on machinery. They definitely catch one's attention as they were meant to do. Continual beeping by machinery can be mitigated (see Section V.C. Mitigation - Best Management Practices). Another impulse noise source that can be very annoying is the exhaust from compressed air machinery. This exhaust is usually released in loud bursts. Compressed air exhaust can also be mitigated if it causes a noise problem by using readily available mufflers or specifically designed enclosures.

(5) Frequency and Tone - Frequency is the rate at which a sound source vibrates or makes the air vibrate. Frequency is measured in Hertz (Hz). Frequency can also be classified as high ("sharp"), low ("dull"), and moderate. Pure tones are rare in nature. Tonal sounds usually consist of pure tones at several frequencies. Pure tones and tonal sounds are discerned more readily by the human ear. Pure tones and tonal sounds are compensated for in sound studies by adding a calculated number of dB(A) to the measured sound pressure.

(6) Percentile of Sound Levels - Fluctuations of SPLs can be expressed as a percentile level designated as $L_{(n)}$ where a given decibel level is exceeded *n* % of the time. A designation of $L_{(10)}$ = 70 dBA means the measured SPLs exceeded 70 dBA 10% of the time. A designation of $L_{(90)}$ = 70 dBA means the measured SPLs were exceeded 90% of the time. $L_{(90)}$ is often used to designate the background noise level.

(7) Expression of Overall Sound - Part of the overall assessment of sound is the *Equivalent Sound Level* (L_{eq}) which assigns a single value of sound level for a period of time in which varying levels of sound are experienced over that time period. The L_{eq} value provides an indication of the effects of sound on people. It is also useful in establishing the ambient sound levels at a potential noise source.

In order to evaluate the above factors in the appropriate context, one must identify the following: 1) appropriate receptor locations for sound level calculation or measurement; 2) ambient sound levels and characteristics at these receptor locations; and 3) the sound pressure increase and characteristics of the sound that represents a significant noise effect at a receptor location.

b. Receptor Locations

Appropriate receptor locations may be either at the property line of the parcel on which the facility is located or at the location of use or inhabitance on adjacent property. The solid waste regulations require the measurements of sound levels be at the property line. The most conservative approach utilizes the property line. The property line should be the point of reference when adjacent land use is proximal to the property line. Reference points at other locations on adjacent properties can be chosen after determining that existing property usage between the property line and the reference point would not be impaired by noise, i.e., property uses are relatively remote from the property line. The location of the facility should be shown on a map in relation to each potential receptor. Any future expansion should be described in a narrative as well as depicted on a map. The map and narrative should also include the distance of the operation to each point of reception including the distance at the point in time when an expanding operation will be closest to the receptors.

c. Thresholds for Significant Sound Pressure Level (SPL) Increase

The goal for any permitted operation should be to minimize increases in sound pressure level above ambient levels at the chosen point of sound reception. Increases ranging from 0-3 dB should have no appreciable effect on receptors. Increases from 3-6 dB may have potential for adverse noise impact only in cases where the most sensitive of receptors are present. Sound pressure increases of more than 6 dB may require a closer analysis of impact potential depending on existing SPLs and the character of surrounding land use and receptors. SPL increases approaching 10 dB result in a perceived doubling of SPL. The perceived doubling of the SPL results from the fact that SPLs are measured on a logarithmic scale. An increase of 10 dB(A) deserves consideration of avoidance and mitigation measures in most cases. The above thresholds as indicators of impact potential should be viewed as guidelines subject to adjustment as appropriate for the specific circumstances one encounters.

Establishing a maximum SPL at the point of reception can be an appropriate approach to addressing potential adverse noise impacts. Noise thresholds are established for solid waste management facilities in the Department's Solid Waste regulations, 6 NYCRR Part 360. Most humans find a sound level of 60 - 70 dB(A) as beginning to create a condition of significant noise effect (EPA 550/9-79-100, November 1978). In general, the EPA's "Protective Noise Levels" guidance found that ambient noise levels # 55 dBA $L_{(dn)}$ was sufficient to protect public health and welfare and, in most cases, did not create an annoyance (EPA 550/9-79-100, November 1978). In non-industrial settings the SPL should probably not exceed ambient noise by more than 6 dB(A) at the receptor. An increase of 6 dB(A) may cause complaints. There may be occasions where an increase in SPLs of greater than 6 dB(A) might be acceptable. The addition of any noise source, in a non-industrial setting, should not raise the ambient noise level above a maximum of 65 dB(A). This would be considered the "upper end" limit since 65 dB(A) allows for undisturbed speech at a distance of approximately three feet. Some outdoor activities can be conducted at a SPL of 65 dB(A). Still lower ambient noise levels may be necessary if there are sensitive receptors nearby. These goals can be attained by using the mitigative techniques outlined in this guidance.

Ambient noise SPLs in industrial or commercial areas may exceed 65 dB(A) with a high end of approximately 79 dB(A) (EPA 550/9-79-100, November 1979). In these instances mitigative measures utilizing best management practices should be used in an effort to ensure that a facility's generated sound levels are at a minimum. The goal in an industrial/commercial area, where ambient SPLs are already at a high level, should be not to exceed the ambient SPL. Remember, if a new source operates at the same noise level as the ambient, then 3 dB(A) must be added to the existing ambient noise level to obtain the future noise level. If the goal is not to raise the future noise levels the new facility would have to operate at 10 dB(A) or more lower than the ambient.(see Table A)

Table B

HUMAN REACTION TO INCREASES IN SOUND PRESSURE LEVEL

Increase in Sound Pressure (dB)	**Human Reaction**
Under 5	Unnoticed to tolerable
5 - 10	Intrusive
10 - 15	Very noticeable
15 - 20	Objectionable
Over 20	Very objectionable to intolerable

(Down and Stocks - 1978)

Impact assessment will vary for specific project reviews, but must consist of certain basic components for all assessments. Additional examination of sound generation and noise reception are necessary, where circumstances warrant. Sound impact evaluation is an incremental process, with four potential outcomes:

- exemption criteria are met and no noise evaluation is required;
- noise impacts are determined to be non-significant (after first-level evaluation);
- noise impacts are identified as a potential issue but can be readily mitigated (after second level evaluation); or
- noise impacts are identified as a significant issue requiring analysis of alternatives as well as mitigation (third level evaluation).

All levels of evaluation may require preparation of a noise analysis. The required scope of noise impact analysis can be rudimentary to rather sophisticated, depending on circumstances and the results obtained from initial levels of evaluation. Recommendations for each level of evaluation are presented below.

2. Situations in Which No Noise Evaluation is Necessary

When certain criteria are satisfied, the need for undertaking a noise impact analysis at any level is eliminated. These criteria are as follows:

a. The site is contained within an area in which local zoning provides for the intended use as a “right of use”. It does not apply to activities that are permissible only after an applicant is granted a special use permit by the local government; and

b. The applicant’s operational plan incorporates appropriate best management practices (BMPs [see Section V.C. Mitigation - Best Management Practices]) for noise control for all facets of the operation.

Where activities may be undertaken as a “right of use”, it is presumed that noise has been addressed in establishing the zoning. Any residual noise that is present following BMP implementation should be considered an inherent component of the activity that has been found acceptable in consideration of the zoning designation of the site.

3. First Level Noise Impact Evaluation

The initial evaluation for most facilities should determine the maximum amount of sound created at a single point in time by multiple activities for the proposed project. All facets of the construction and operation that produce noise should be included such as land clearing activities (chain saw and equipment operation), drilling, equipment operation for excavating, hauling or conveying materials, pile driving, steel work, material processing, product storage and removal. Land clearing and construction may be only temporary noise at the site whereas the ongoing operation of a facility would be considered permanent noise. An analysis may be required for various phases of the construction and operation of the project to assure that adverse noise effects do not occur at any phase.

To calculate the sound generated by equipment operation, one can consult the manufacturers' specifications for sound generation, available for various types of equipment. Another option for calculating the sound to be generated by equipment is to make actual measurements of sound generated by existing similar equipment, elsewhere.

Tables C and D summarize noise measurements from some common equipment used in construction and mining. Table E summarizes the noise level, in decibels (dB[A]), from some common sources. This information can be used to assist Department staff in relating potential noise impacts to sound levels produced by commercial and industrial activities. Use of these tables in the first level of analysis will help determine whether or not noise will be an issue and whether actual measurements should be made to confirm noise levels.

Table C

PROJECTED NOISE LEVELS

Noise Source	Measurements	1,000 feet	2,000 feet	3,000 feet
Primary and secondary crusher	89 dB(A) at 100 ft	69.0 dB(A)	63.0 dB(A)	59.5 dB(A)
Hitachi 501 shovel loading	92 dB(A) at 50 ft	66.0 dB(A)	60.0 dB(A)	56.5 dB(A)
Euclid R-50 pit truck loaded	90 dB(A) at 50 ft	64.0 dB(A)	58.0 dB(A)	54.4 dB(A)
Caterpillar 988 loader	80 dB(A) at 300 ft	69.5 dB(A)	63.5 dB(A)	60.0 dB(A)

(The Aggregate Handbook, 1991)

Table D
Common Equipment Sound Levels

EQUIPMENT	**DECIBEL LEVEL**	**DISTANCE** in feet
Augered earth drill	80	50
Backhoe	83-86	50
Cement mixer	63-71	50
Chain saw cutting trees	75-81	50
Compressor	67	50
Garbage Truck	71-83	50
Jackhammer	82	50
Paving breaker	82	50
Wood Chipper	89	50
Bulldozer	80	50
Grader	85	50
Truck	91	50
Generator	78	50
Rock drill	98	50

(excerpt and derived from Cowan, 1994)

Table E

Sound Source	dB(A)°	Response Criteria
	150	
Carrier Deck Jet Operation	140	
	130	Painfully Loud Limit Amplified Speech
Jet Takeoff (200 feet) Discotheque	120	
Auto Horn (3 feet) Riveting Machine	110	Maximum Vocal Effort
Jet Takeoff (2000 feet) Shout (0.5 feet)	100	
N.Y. Subway Station Heavy Truck (50 feet)	90	Very Annoying Hearing Damage (8 hours, continuous exposure)
Pneumatic Drill (50 feet)	80	Annoying
Freight Train (50 feet) Freeway Traffic (50 feet)	70	Telephone Use Difficult Intrusive
Air Conditioning Unit (20 feet)	60	
Light Auto Traffic (50 feet)	50	Quiet
Living Room Bedroom	40	
Library Soft Whisper (15 feet)	30	Very Quiet
Broadcasting Studio	20	
	10	Just Audible
	0	Threshold of Hearing

(The Aggregate Handbook, 1991)

The sound level at receptor locations should be calculated using the inverse square rule whereby sound is attenuated over distance. Again, each doubling of the distance from the source of a noise decreases the SPL by 6 dB(A) at distances greater than 50 feet. This calculation should first consider the straight line distance between the point of noise generation and the point of noise reception with the presumption that no natural or manmade features exist along the transect between the two points that would further attenuate sound level. Calculations should be performed for each point of reception in all directions being careful to evaluate the worst case noise impact potential by considering activities at the point where they would be closest to a receptor. The sound level calculated for the point of reception should be related to ambient sound levels. Ambient sound levels can be either measured or assumed based on established references for the environmental setting and land use at the point of reception. For estimation purposes, ambient SPLs will vary from approximately 35 dB(A) in a wilderness area to approximately 87 dB(A) in a highly industrial setting. A quiet seemingly serene setting such as rural farm land will be at the lower end of the scale at about 45 dB(A), whereas an urban industrial area will be at the high end of this scale at around 79 dB(A) (EPA 550/9-79-100, November 1978). If there is any concern that levels based on reference values do not accurately reflect ambient SPL, field measurements should be undertaken to determine ambient SPLs.

Where this evaluation indicates that sound levels at the point of reception will not be perceptible, similar to or only slightly elevated as compared to ambient conditions, no further evaluation is required. When there is an indication from this initial analysis that marginal or significant noise impact may occur, further evaluation is required. In determining the potential for an adverse noise impact, consider not only ambient noise levels, but also the existing land use, and whether or not an increased noise level or the introduction of a discernable sound, that is out of character with existing sounds, will be considered annoying or obtrusive. (see B.1.a Evaluation of Sound Characteristics)

4. Second Level Noise Impact Evaluation

Further refine the evaluation of noise impact potential by factoring in any additional noise attenuation that will be provided by existing natural topography, fabricated structures such as buildings, walls or berms or vegetation located between the point of noise generation and noise reception. This analysis may require consideration of future conditions and the loss of natural noise buffers over time.

Dense vegetation that is at least 100 feet in depth will reduce the sound levels by 3 to 7 dB(A). Evergreens provide a better vegetative screen than deciduous trees. Keep in mind that if a vegetative screen does not currently exist, planting a vegetative screen may require 15 or more years of growth before it becomes effective.

The degree to which topography attenuates noise depends on how close the feature is located to the source or the receptor of the noise. Topography can act as a natural screen. The closer a hill or other barrier is to the noise source or the receptor, the larger the sound shadow will be on the side opposite the noise source. Certain operations such as mining and landfills may be able to use topography to maintain a screen between the operation and receptors as they progress. Mining operations may be able to create screens by opening a mine in the center of the site using and maintaining the pit walls as barriers against sound (Aggregate Handbook, 1991).

If after taking into account all the attenuating features the potential still exists for adverse noise impact, other types of noise analyses or modeling should be used to characterize the source. An Equivalent Sound Level (L_{eq}) analysis or a related type of noise analysis may better define activities or sources that require more mitigation or isolation so that noise emanating from these sources will not cause an adverse impact.

Where it is demonstrated that noise absorbing or deflecting features further attenuate sound reception to a level of no significant increase, no further analysis is necessary. Where it is determined that noise level or the character of the noise may have a significant adverse effect on receptors, other noise mitigation measures should be evaluated in an expanded noise analysis.

5. Third Level - Mitigation Measures

When the above analyses indicate significant noise effects may or will occur, the applicant should evaluate options for implementation of mitigation measures that avoid, or diminish significant noise effects to acceptable levels (see Section V.C. Mitigation - Best Management Practices). Adequate details concerning mitigation measures and an evaluation of the effectiveness of the mitigative measures through additional sound level calculations should be provided in a noise analysis. These calculations are to factor in the noise reduction or avoidance capabilities of the mitigation measures. In circumstances where noise effects cannot readily be reduced to a level of no significance by project design or operational features in the application, the applicant must evaluate alternatives and mitigation measures in an environmental impact statement to avoid or reduce impacts to the maximum extent practicable per the requirements of the State Environmental Quality Review Act (SEQR).

The noise analysis should be part of the application or a supplement to it, and will be part of the SEQR environmental assessment by reference. Duplicative noise analysis information is not required for the permit application and the assessment of impacts under SEQR. A proper analysis can satisfy information needs for both purposes.

C. Mitigation - Best Management Practices (BMP) for Reducing Noise

Various noise abatement techniques are available for reducing frequency of sound, duration of sound or SPLs at receptor locations. The mitigation techniques given below are listed according to what sound characteristic they mitigate.

1. Reduce noise frequency and impulse noise at the source of generation by:

   a. Replacing back-up beepers on machinery with strobe lights (subject to other requirements, e.g., OSHA and Mine Safety and Health Administration, as applicable). This eliminates the most annoying impulse beeping;

   b. Using appropriate mufflers to reduce the frequency of sound on machinery that pulses, such as diesel engines and compressed air machinery;

   c. Changing equipment: using electric motors instead of compressed air driven machinery; using low speed fans in place of high speed fans;

   d. Modifying machinery to reduce noise by using plastic liners, flexible noise control covers, and dampening plates and pads on large sheet metal surfaces; and

2. Reduce noise duration by:

   a. Limiting the number of days of operation, restricting the hours of operation and specifying the time of day and hours of access and egress can abate noise impacts.

   b. Limiting noisier operations to normal work day hours may reduce or eliminate complaints.

   Limiting hours of construction or operation can be an effective tool in reducing potential adverse impacts of noise. The impacts of noise on receptors can be significantly reduced by effectively managing the hours at which the loudest of the operations can take place.

Implementation of hours of operation does not reduce the SPL emanating from a facility. Determining whether or not hours of operation will be effective, mitigation requires consideration of: public safety, for example road construction at night may reduce traffic concerns and facilitate work; duration of the activity, is it a one time event necessary to meet a short term goal or will the activity become an ongoing operation; and surrounding land use, consider what type(s) of land use is proximal to the activity and at what time(s) might a reduction of noise levels be necessary. There may be other factors to consider due to the uniqueness of a given activity or the type of land use adjacent to the activity. Hours of operation should also consider weekend activities and legal holidays that may change the types of land use adjacent to the permitted activity or increase traffic levels in an area.

The best results from using hours of operation as a mitigative measure will be obtained if the hours are negotiated with the owner or operator of the facility. The less noisy aspects of an operation may not have to be subject to the requirements of hours of operation such as preparing, greasing and maintaining machinery for the upcoming day's operation. The more noisy operations can be scheduled to begin when people in the receptor area are less likely to be adversely effected. Hours of operation should be included in the operation plans for a facility that becomes part of the permit, or in the event that there is no operation plan, can be included as a permit condition.

3. Reduce Noise sound pressure levels by:

   a. Increasing the setback distance.
   b. Moving processing equipment during operation further from receptors.
   c. Substituting quieter equipment (<u>example</u> - replacing compressed air fan with an electric fan could result in a 20 dB reduction of noise level).

d. Using mufflers selected to match the type of equipment and air or gas flow on mechanical equipment.
e. Ensuring that equipment is regularly maintained.
f. Enclosing processing equipment in buildings (<u>example</u> - enclosing noisy equipment could result in an 8-10 dB noise level reduction, a 9 inch brick wall can reduce SPL by 45-50 dB).
g. Erecting sound barriers such as screens or berms around the noise generating equipment or near the point of reception. The angle of deflection also increases as the height of a screen or barrier increases. Screens or barriers should be located as close to the noise source or the receptor as possible. The closer the barrier is located to the source or the receptor, the greater the angle of deflection of the sound waves will be creating a larger "sound shadow" on the side opposite the barrier. Stockpiles of raw material or finished product can be an effective sound barrier if strategically placed.
h. phasing operations to preserve natural barriers as long as possible.
i. altering the direction, size, proximity of expanding operations.
j. Designing enclosed facilities to prevent or minimize an SPL increases above ambient levels. This would require a noise analysis and building designed by a qualified engineer that includes adequate ventilation with noise abatement systems on the ventilation system.

Public notification of upcoming loud events can also be used as a form of mitigation although it doesn't fit easily into the categories above. People are less likely to get upset if they know of an upcoming event and know that it will be temporary.

The applicant should demonstrate that the specific mitigation measures proposed will be effective in preventing adverse noise effects on receptors.

D. Decision Making - Conditioning Permits to Limit Noise Impacts

Preferably, the mitigation measures as outlined in the construction and operational plans should be relied upon to mitigate the effects of noise on receptors. The permit should state that the activity will be conducted in accordance with the approved plan. Otherwise, mitigation measures and BMP's can be imposed within specific permit conditions.

It is not the intention of this guidance to require decibel limits to be established for operations where such limits are not required by regulation. There are, however, instances when a decibel limit may be established for an operation to ensure activities do not create unacceptable noise effects, as follows:

1. The review of a draft and final environmental impact statement demonstrates the need for imposition of a decibel limit;
2. A decibel limit is established by the Commissioner's findings after a public hearing has been held on an application;
3. The applicant asks to have a decibel limit to demonstrate the ability to comply; or
4. A program division seeks to establish a decibel limit as a permit condition, when necessary to demonstrate avoidance of unacceptable noise impact.

Ultimately, the final decision must incorporate appropriate measures to minimize or avoid significant noise impacts, as required under SEQR. Any unavoidable adverse effects must be weighed along with other social and economic considerations in deciding whether to approve or deny a permit.

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9) United States Environmental Protection Agency, Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety, EPA 550/9-74-004, March 1974, Office of Noise Abatement and Control, Washington, D.C.

10) City of Davis General Plan, Appendix E Background Information on Environmental Acoustics, November 1996.

11) The Australian National University, "Physics and Psychophysics of Music", ACAT 1003, David Worrall, http://www.anu.edu.au/ITA/ACAT/drw/PPofM/Intensity2.html, 1998.

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Additional Reading

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b. Beranek, Leo L., Noise and Vibration Control, Institute of Noise Control Engineering, Revised Edition, Washington, C.C., 1988.

c. Diehl, George, M., Machinery Acoustics, John Wiley & Sons, New York, 1973.

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APPENDIX E

Equipment Specifications

VonRoll TRANSFORMER PLANT HIGH VOLTAGE LABORATORY	DESIGN AND ROUTINE TEST REPORT	Test Report No.: 2359 Page : 1 Type : 13785 Serial No. : 13836/1

RATING DATA

Purchaser: National Grid

Order No. : 571142

Date of test : 06.06.2013

Specification: SR.04.02.001-L
Object : Three phase power transformer
Rated Power [MVA] : 16.8/22.4/28.0/33.0
Temperature rise : 65°C
Rated Voltage [kV] : 138.6/13.8 (7967) Regulation: H.V ± 2x2.5%, L.V. ± 16x0.625%
Rated Current [A]: 70.0/ 702.9 - 16.8 MVA 116.6/1171.0 - 28.0 MVA
93.3/ 937.1 - 22.4 MVA 137.5/1381.6 - 33.0 MVA
Cooling class : ONAN/ONAF/ONAF/ONAF
Frequency [Hz]: 60
Polarity and angular displacement: D – yn1 connection, 30°

Guaranteed and measured value:

	Guaranteed	Measured
No load losses (Unom,16.8MVA)	Po [kW] : 15.5	Po [kW] : 16.06
Exciting current (Unom,based on 16.8MVA)	Io [%] : -	Io [%] : 0.15
No load losses (1.1Unom)	Po [kW] : -	Po [kW] : 24.44
Exciting current (1.1Unom)	Io [%] : -	Io [%] : 0.87
Load losses (based on 16.8MVA and 85°C)	Pcu [kW] : 39.7	Pcu [kW] : 38.89
Total losses (based on 16.8MVA and 85°C)	Ptot [kW] : 55.2	Ptot [kW] : 54.55
Impedance between 138.6 / 13.80 kV (based on 16.8MVA and 85°C)	uk [%] : 9.0	uk [%] : 9.28

We hereby certify that this is a true report based on factory test made in accordance to IEEE C57.12.00-2006, IEEE C57.12.90-2006 and specification SP.04.02.001-L that transformer withstood successfully all tests stated in this test report.

Date : 06.10.13 Approved by: Kotovski Andrei Tested by: Shenkerman Mark

Rated power [kVA]: 33000	Rated Voltage [kV]: 138.6 / 13.8
Frequency [Hz]: 60	Rated current [A]: 137.5/1381.6

Date : 06.10.13

VonRoll **TRANSFORMER PLANT** **HIGH VOLTAGE LABORATORY**	**NAME PLATE**	Test Report No.: 2359 Page : 3 Type : 13785 Serial No. : 13836/1

Rated power [kVA]: 33000	Rated Voltage [kV]: 138.6 / 13.8
Frequency [Hz]: 60	Rated current [A]: 137.5/1381.6

VONROLL TRANSFORMERS LTD

THREE PHASE TRANSFORMER

TYPE 13785 SERIAL NO. 13836 NAMEPLATE NO. 904

MONTH JUNE YEAR 2013 FREQUENCY 60 Hz

16800/22400/28000/33000 KVA CLASS ONAN/ONAF/ONAF/ONAF 65°C TEMPERATURE RISE

138600-13800GrdY/7967

INSULATION LEVELS

HIGH VOLTAGE 550KV BIL
LOW VOLTAGE 110KV BIL

MAXIMUM SOUND LEVEL

RATING, KVA	16800	28000	33000
SOUND LEVEL, DBA	59.1	60.1	60.9

COOLING CLASS	RATED POWER	RATED CURRENT, A	
		HV	LV
ONAN	16800	70	703
ONAF	22400	93.3	937
ONAF	28000	116.6	1171
ONAF	33000	137.5	1381

WEIGHTS:

CORE AND COILS	67000	Lb.
TANK AND FITTINGS	41320	Lb.
OIL (4660gal)	39530	Lb.
TOTAL	147850	Lb.
UNTANKING	73000	Lb.
SHIPPING	95600	Lb.

BUSHING CURRENT TRANSFORMER MULTI RATIO
CT1 ACC.CLASS C-800, RTF-2

CURRENT RATIO	TAP	CURRENT RATIO	TAP
100:5	X1-X2	900:5	X1-X3
200:5	X3-X4	1000:5	X2-X4
400:5	X4-X5	1100:5	X1-X4
600:5	X3-X5	1400:5	X2-X5
800:5	X2-X3	1500:5	X1-X5

BUSHING CURRENT TRANSFORMER, MULTI RATIO
CT2, CT4-A ACC. CLASS C-800, RTF-2
CT4-N ACC. CLASS C-400, RTF-2

CURRENT RATIO	TAP	CURRENT RATIO	TAP
300:5	X3-X4	1200:5	X1-X3
400:5	X1-X2	1500:5	X1-X4
500:5	X4-X5	1600:5	X2-X5
800:5	X2-X3	2000:5	X1-X5
1100:5	X2-X4		

DE-ENERGIZED TAP CHANGER		HV WITH LTC ON POS. N	
POS.	CONNECTS	VOLTS	AMPERES AT 33000 KVA
1	6-5	145200	131.2
2	5-7	142000	134.2
3	7-4	138600	137.5
4	4-8	135200	140.9
5	8-3	132000	144.3

LTC ABB TYPE UZFRN 200/600

LOAD TAP CHANGER			RATING	LV WITH DETC ON POS.3	
POS.	CONNECTION		kVA	VOLTS	AMPERES
16R	17-19	16-20	33000	15180	1255
15R		15-20		15094	1262
14R		14-20		15008	1270
13R		13-20		14921	1277
12R		12-20		14835	1284
11R		11-20		14749	1292
10R		10-20		14663	1299
9R		9-20		14576	1307
8R		8-20		14490	1315
7R		7-20		14404	1323
6R		6-20		14318	1331
5R		5-20		14231	1339
4R		4-20		14145	1347
3R		3-20		14059	1355
2R		2-20		13973	1364
1R		1-20		13886	1372
N		17-20		13800	1381
NA	17-18				
1L		16-20	32803	13714	
2L		15-20	32596	13628	
3L		14-20	32390	13541	
4L		13-20	32184	13455	
5L		12-20	31978	13369	
6L		11-20	31771	13283	
7L		10-20	31565	13196	
8L		9-20	31359	13110	
9L		8-20	31152	13024	
10L		7-20	30946	12938	
11L		6-20	30740	12851	
12L		5-20	30533	12765	
13L		4-20	30327	12679	
14L		3-20	30121	12593	
15L		2-20	29914	12506	
16L		1-20	29708	12420	

OIL QUANTITIES

MAIN TANK	4645	gal
RADIATORS	296	gal
TAP CHANGER	106	gal
CONSERVATOR AT 25°C	199	gal
TO BE REMOVED (FROM MAIN TANK) UP TO THE CORE	230	gal

IMPEDANCES.%

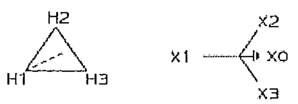
AT 16800KVA, DETC ON POS.3

POS. LTC	16R	N	16L
POSITIVE SEQUENCE HV-LV	9.61	9.34	9.18
ZERO SEQUENCE FROM LV SIDE	8.92	9.59	8.88

CAUTION!

1. BEFORE INSTALLING OR OPERATING READ CAREFULLY THE INSTRUCTION BOOK
2. MAIN TANK PRESSURE WITHSTAND.
   - POSITIVE, 10 PSI,
   - NEGATIVE, FULL VACUUM.
3. CONSERVATOR CAN NOT WITHSTAND FULL VACUUM.
4. TRANSFORMER IS FILLED WITH ASTM D3487 TYPE II INHIBITED OIL. OIL CONTAINS NO DETECTABLE PCB AT THE TIME OF THE MANUFACTURING.
5. THE DE-ENERGIZED TAP CHANGER MUST NOT BE OPERATED WHEN THE TRANSFORMER IS ENERGIZED.
6. CONDUCTOR MATERIAL OF WINDINGS IS COPPER.
7. MAX. CURRENT SEEN BY LTC IS 232.5AMPS.
8. CORE DESIGN IS 3-LEGGED CORE.

PHASE RELATION



PROJECT : LIPA
NATIONAL GRID

CATALOG No.0299359905

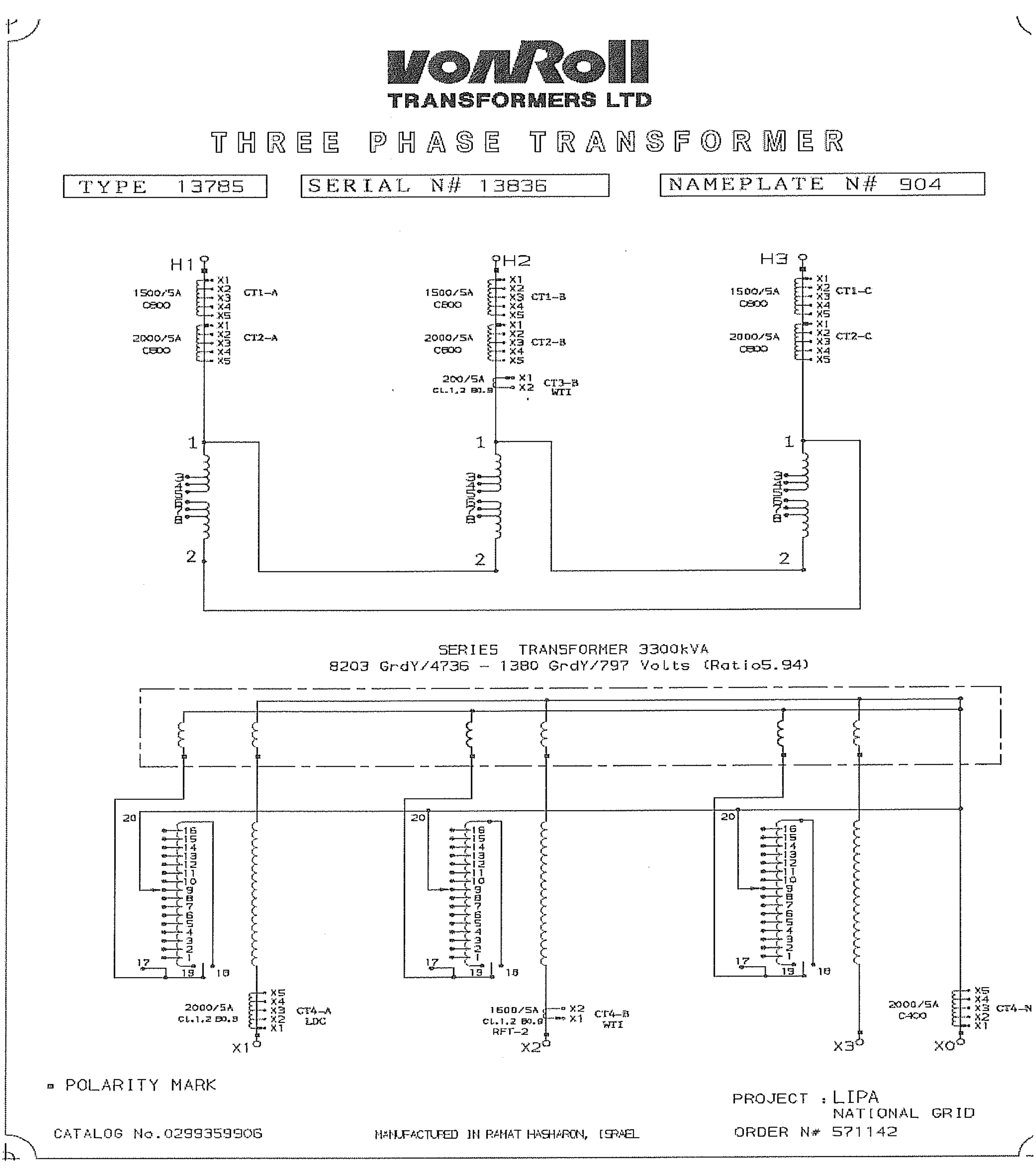
MANUFACTURED IN RAMAT HASHARON, ISRAEL

ORDER N# 571142

Date : 06.10.13

VonRoll TRANSFORMER PLANT HIGH VOLTAGE LABORATORY	NAME PLATE	Test Report No.: 2359
		Page : 4
		Type : 13785
		Serial No. : 13836/1

Rated power [kVA]: 33000 Rated Voltage [kV]: 138.6 / 13.8
Frequency [Hz]: 60 Rated current [A]: 137.5/1381.6



Date : 06.10.13

VonRoll **TRANSFORMER PLANT** **HIGH VOLTAGE LABORATORY**	**RATIO AND POLARITY TEST**	Test Report No.: 2359 Page : 5 Type : 13785 Serial No. : 13836/1

Rated power [kVA]: 33000	Rated Voltage [kV]: 138.6 / 13.8
Frequency [Hz]: 60	Rated current [A]: 137.5/1381.6

Measured values

On-Load Tap Changer position	High voltage [kV]	Low Voltage [kV]	Calculated ratio	Measured deviation [%]		
				H1-H2/X2-X0	H2-H3/X3-X0	H3-H1/X1-X0
				[%]		
16R		15.180	15.814	+0.11	+0.13	+0.15
15R		15.094	15.904	+0.12	+0.13	+0.15
14R		15.008	15.996	+0.03	+0.03	+0.16
13R		14.921	16.089	+0.08	+0.09	+0.12
12R		14.835	16.182	+0.09	+0.11	+0.13
11R		14.749	16.277	+0.06	+0.07	+0.09
10R		14.663	16.372	+0.10	+0.11	+0.13
9R		14.576	16.470	+0.07	+0.09	+0.10
8R		14.490	16.567	+0.06	+0.07	+0.09
7R		14.404	16.666	+0.06	+0.07	+0.09
6R		14.318	16.766	+0.06	+0.07	+0.09
5R		14.231	16.869	+0.01	+0.01	+0.03
4R		14.145	16.972	+0.09	+0.09	+0.11
3R		14.059	17.075	+0.16	+0.17	+0.18
2R		13.973	17.180	+0.08	+0.09	+0.11
1R		13.886	17.288	+0.07	+0.08	+0.09
N	138.6	13.800	17.396	+0.05	+0.07	+0.07
1L		13.714	17.505	+0.05	+0.07	+0.08
2L		13.628	17.615	+0.06	+0.08	+0.09
3L		13.541	17.729	+0.08	+0.10	+0.11
4L		13.455	17.842	+0.11	+0.13	+0.13
5L		13.369	17.957	+0.09	+0.10	+0.11
6L		13.283	18.073	+0.13	+0.16	+0.15
7L		13.196	18.192	+0.13	+0.15	+0.13
8L		13.110	18.311	+0.13	+0.17	+0.15
9L		13.024	18.432	+0.15	+0.19	+0.17
10L		12.938	18.555	+0.12	+0.16	+0.13
11L		12.851	18.680	+0.15	+0.19	+0.17
12L		12.765	18.806	+0.14	+0.19	+0.16
13L		12.679	18.934	+0.17	+0.23	+0.21
14L		12.593	19.063	+0.19	+0.24	+0.22
15L		12.506	19.196	+0.15	+0.21	+0.18
16L		12.420	19.329	+0.19	+0.23	+0.21

Off-Load Tap Changer position	High voltage [kV]	Low Voltage [kV]	Calculated ratio	Measured deviation [%]		
				H1-H2/X2-X0	H2-H3/X3-X0	H3-H1/X1-X0
				[%]		
1	145,2		18.224	+0.40	+0.42	+0.44
2	142.0		17.823	+0.18	+0.18	+0.20
3	138.6	13.800	17.396	+0.06	+0.06	+0.10
4	135.2		16.969	±0.00	±0.00	+0.02
5	132.0		16.567	-0.24	-0.24	-0.23

Date : 06.10.13

VonRoll TRANSFORMER PLANT HIGH VOLTAGE LABORATORY	RESISTANCE MEASUREMENT	Test Report No.: 2359 Page : 6 Type : 13785 Serial No. : 13836/1

Rated power [kVA]: 33000	Rated Voltage [kV]: 138.6 / 13.8
Frequency [Hz]: 60	Rated current [A]: 137.5/1381.6

Measured resistance in Ohm at 26.8°C

Off-Load Tap Changer Position	H1-H2	H2-H3	H3-H1
1	1.882	1.879	1.875
2	1.824	1.822	1.817
3	1.774	1.765	1.760
4	1.709	1.710	1.703
5	1.653	1.652	1.646

Measured resistance in mOhm

On-Load Tap Changer Position	X1-X0	X2-X0	X3-X0
-	8.253	8.129	8.142

On-Load Tap Changer Position	X1-X2	X2-X3	X3-X1
-	16.057	15.939	16.090

Preliminary Test - Regulation winding and series transformer were not connected ; in mOhm and t=26.8°C

Regulation Winding			
On-Load Tap Changer Position	Phase X1	Phase X2	Phase X3
16R	54.946	54.587	55.359
N	1.262	1.033	1.480
16L	54.928	54.285	56.050
Series Transformer (Booster)			
(20 - 17)	33.159	33.019	32.521

Date : 06.10.13

VonRoll TRANSFORMER PLANT HIGH VOLTAGE LABORATORY	LOAD LOSSES AND IMPEDANCES	Test Report No.: 2359 Page : 7 Type : 13785 Serial No. : 13836/1

Rated power [kVA]: 33000	Rated Voltage [kV]: 138.6 / 13.8
Frequency [Hz]: 60	Rated current [A]: 137.5/1381.6
Guaranteed Pk [kW] : 39.7(based on 16.8MVA)	Guaranteed uK[%]: 9.00 (based on 16.8MVA)
Measured Pk [kW] : 38.91 (16.8MVA)	Measured uK[%]: 9.34 (based on 16.8MVA)

Measured values

Supply and measured on H.V. side Frequency :60Hz L.V. side short-circuited t= 31.0°C

Off-Circuit Tap Changer position	On-Load Tap Changer position	Measured Terminal	Phase Voltage U[kV]	Average Voltage U [kV]	Phase Current I[A]	Average Current I [A]	Losses P[kW]
3	16R	H1	14.470	14.473	132.1	131.7	123.1
		H2	14.476		130.8		
		H3	14.475		132.1		
3	N	H1	13.961	13.963	131.2	130.8	121.8
		H2	13.967		129.9		
		H3	13.963		131.3		
3	16L	H1	13.786	13.788	131.8	131.4	146.4
		H2	13.793		130.5		
		H3	13.787		131.9		
1	16R	H1	15.759	15.761	131.0	130.5	130.2
		H2	15.764		129.7		
		H3	15.762		130.9		
1	N	H1	15.413	15.415	131.8	131.4	133.8
		H2	15.419		130.5		
		H3	15.413		131.9		
1	16L	H1	15.159	15.160	131.1	130.7	159.3
		H2	15.166		129.8		
		H3	15.157		133.7		
5	16R	H1	14.862	14.865	147.1	146.5	149.9
		H2	14.868		145.6		
		H3	14.867		147.0		
5	N	H1	13.661	13.664	139.7	139.2	133.8
		H2	13.667		138.3		
		H3	13.664		139.6		
5	16L	H1	13.494	13.497	140.9	140.5	157.8
		H2	13.501		139.5		
		H3	13.496		141.0		

Calculated values at rated current

	Load losses in kW at 31.0 °C			Load losses in kW and u_k in % at 85°C, 33MVA			
Tap pos.	Pcu	Padd	Pk	Pcu	Padd	Pk	Uk /16.8MVA
3 – 16R	101.10	33.07	134.17	121.67	27.48	149.15	9.61
3 – N	102.96	31.56	134.53	123.91	26.23	150.13	9.34
3 – 16L	102.01	27.75	129.76	122.76	23.06	145.82	9.18
1 – 16R	99.53	32.04	131.57	119.78	26.62	146.40	9.62
1 – N	101.39	32.09	133.49	122.01	26.67	148.68	9.35
1 – 16L	100.74	29.30	130.03	121.22	24.35	145.57	9.24
5 – 16R	102.64	42.79	145.43	123.51	35.56	159.07	9.78
5 – N	104.50	39.39	143.88	125.75	32.73	158.48	9.47
5 – 16L	103.25	31.74	134.99	124.25	26.38	150.63	9.27

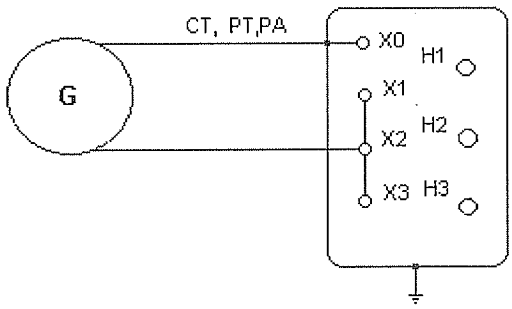
Date : 06.10.13

VonRoll TRANSFORMER PLANT HIGH VOLTAGE LABORATORY	ZERO-PHASE SEQUENCE IMPEDANCE VOLTAGE	Test Report No.: 2359 Page : 8 Type : 13785 Serial No. : 13836/1

Rated power [kVA]: 33000	Rated Voltage [kV]: 138.6 / 13.8
Frequency [Hz]: 60	Rated current [A]: 137.5/1381.6
	Measured Z_0 [%]: 9.59 (based on 16.8MVA)

Zero sequence impedance, at 16.8MVA;

Supply and measured on L.V. side; Frequency :60Hz				
TP- HV	TP- LV	U[V]	I[A]	Z_0[%.]
3	N	262.50	724.4	9.59
3	16R	265.53	651.4	8.92
3	16L	193.38	712.4	8.88



Auxiliary cooling equipment power

Number of fans	Phase Voltage [V]	Current [A]	Losses [kW]
8	213.8	6.9	1.42

Date : 06.10.13

VonRoll TRANSFORMER PLANT HIGH VOLTAGE LABORATORY	NO-LOAD LOSSES AND EXCITING CURRENT	Test Report No.: 2359 Page : 9 Type : 13785 Serial No. : 13836/1

Rated power [kVA]: 33000
Frequency [Hz]: 60
Guaranteed Po (Unom) [kW]: 15.5
Measured Po (Unom) [kW]: 16.06

Rated Voltage [kV]: 138.6 / 13.8
Rated current [A]: 137.5/1381.6
Guaranteed Io (Unom, on 16.8MVA) [%]: -
Measured Io (Unom, on 16.8MVA) [%]: 0.15

NO-LOAD LOSSES AND EXCITING CURRENT

L.V. side fed. On-Load Tap Changer on position – N, 16L, 16R. H.V. side open.
The test voltage was reading with a voltmeter responsive to mean value of voltage (U' – phase voltage).
Another reading of the voltage was from a true R.M.S. voltmeter (U).
Voltage, current and losses were measured on L.V. side of the tested transformer. Test frequency 60Hz

Tap position 3/N

	U'[kV]	U[kV]	I_{X1}[A]	I_{X2}[A]	I_{X3}[A]	I_m[A]	P_O[kW]
1.00xUnom	7.977	7.986	1.268	0.819	1.170	1.085	16.06
0.8xUnom	6.377	6.373	0.697	0.505	0.547	0.583	9.01
0.9xUnom	7.173	7.171	0.820	0.558	0.666	0.681	11.81
0.95xUnom	7.568	7.570	0.941	0.616	0.797	0.784	13.60
1.05xUnom	8.361	8.394	2.308	1.606	2.287	2.067	19.44
1.10xUnom	8.757	8.871	6.507	5.234	6.609	6.116	24.44

Tap position 3/16R

	U'[kV]	U[kV]	I_{X1}[A]	I_{X2}[A]	I_{X3}[A]	I_m[A]	P_O[kW]
1.00xUnom	8.759	8.792	2.305	1.601	2.230	2.045	24.53
0.8xUnom	7.036	7.039	0.908	0.590	0.771	0.756	13.56
0.9xUnom	7.899	7.906	1.132	0.722	1.010	0.954	17.88
0.95xUnom	8.333	8.346	1.429	0.936	1.326	1.230	20.76
1.05xUnom	9.208	9.301	5.733	4.426	5.739	5.299	30.17
1.1xUnom	9.642	9.912	18.28	16.13	18.52	17.64	38.26

Tap position 3/16L

	U'[kV]	U[kV]	I_{X1}[A]	I_{X2}[A]	I_{X3}[A]	I_m[A]	P_O[kW]
1.0xUnom	7.169	7.203	2.832	1.994	2.838	2.554	24.60

SINGLE PHASE TEST.

Tap position 3/16R. The test was done after core demagnetization (at the end of No-Load Losses Test).

Fed terminal	Grounded terminals	U[kV]	I[mA]	P[W]
H1	H2,X3,X0	10	16.1	95
H2	H3,X1,X0	10	22.0	130
H3	H1,X2,X0	10	22.0	130

Date : 06.10.13

Rated power [kVA]: 33000
Frequency [Hz]: 60
Guaranteed Po (Unom) [kW]: 15.5
Measured Po (Unom) [kW]: 16.06

Rated Voltage [kV]: 138.6 / 13.8
Rated current [A]: 137.5/1381.6
Guaranteed Io (Unom, on 33MVA) [%]: -
Measured Io (Unom, on 33MVA) [%]: 0.15

HARMONICS OF THE NO-LOAD CURRENT

The harmonics of the no-load current were measured at the nominal voltage (Tap pos. 3/N). The magnitude of the harmonics is expressed as a percentage of the fundamental component. The frequency was 60 cycles.

Order	I_{X1}=1.059A,H01	I_{X2}=0.557A,H01	I_{X3}=0.946A,H01
1	100.00	100.00	100.00
2	0.338	1.308	0.834
3	21.480	43.708	18.979
4	0.286	1.063	0.535
5	39.219	52.715	44.029
6	0.171	0.229	0.066
7	23.428	32.675	25.761
8	0.090	0.416	0.318
9	2.534	6.324	3.613
10	0.071	0.257	0.133
11	8.578	14.450	10.506
12	0.047	0.063	0.068
13	5.911	8.891	5.850
14	0.055	0.074	0.111
15	0.267	0.600	0.266

Date : 06.10.13

VonRoll TRANSFORMER PLANT HIGH VOLTAGE LABORATORY	DIELECTRIC TESTS	Test Report No.: 2359 Page : 11 Type : 13785 Serial No. : 13836/1

Rated power [kVA]: 33000
Frequency [Hz]: 60
Rated Voltage [kV]: 138.6 / 13.8
Rated current [A]: 137.5/1381.6

Insulation resistance tests, in GOhm   Megohmeter 5kVDC   t=29.4°C

	Time [minutes]										
Connexion	1	2	3	4	5	6	7	8	9	10	K
HV/LV,T to guard	24.3	35.9	48.9	61.1	73.2	83.8	92.6	99.1	104	108	4.4
HV/T,LV to guard	41.3	46.8	49.4	51.6	53.7	54.9	55.8	56.7	57.3	57.8	1.4
LV/T,HV to guard	13.8	18.9	22.1	24.2	25.4	26.3	27.0	27.5	27.8	28.0	2.0
CoretoTank,2.5kVDC	15.1										

Applied voltage test   Time [s] : 60

H.V. [kV] : 230   L.V. [kV] : 34   The transformer withstood the test

Lightning impulse test - pages 15 - 50

The Transformer withstood the test

Insulation power - factor test
Test was made with guard circuit.

Applied Voltage [kV]	Cx [pF]	PF [%]	Connection diagram
10	9054	0.17	H.V. to L.V. winding and ground
10	3207	0.22	H.V. and to ground, guard on L.V. winding
10	5841	0.15	H.V. to L.V. winding
10	19318	0.18	L.V. to H.V. winding and ground
10	5842	0.15	L.V. to H.V. winding
10	13469	0.19	L.V. to tank, H.V. winding to guard

Oil temperature 25.0°C   Temperature correction factor K= 1.13

Date : 06.10.13

VonRoll TRANSFORMER PLANT HIGH VOLTAGE LABORATORY	DIELECTRIC TESTS	Test Report No.: 2359 Page : 12 Type : 13785 Serial No. : 13836/1

Rated power [kVA]: 33000	Rated Voltage [kV]: 138.6 / 13.8
Frequency [Hz]: 60	Rated current [A]: 137.5/1381.6

Bushing Insulators capacity
Test was made with guard circuit using DOBLE M4000 Insulation Analyzer

Capacity	Applied Voltage [kV]	Cx [pF]	Power-Factor [%]	Serial number
C1H1	10	480.4	0.35	13-149105
C2H1	2	3494	0.32	
C1H2	10	475.4	0.29	13-149262
C2H2	2	3479	0.33	
C1H3	10	479.7	0.31	13-149097
C2H3	2	3452	0.28	
C1X1	10	538.7	0.29	1000063042
C2X1	2	265.6	0.21	
C1X2	10	545.4	0.28	1000063584
C2X2	2	262.2	0.30	
C1X3	10	527.7	0.23	1000063577
C2X3	2	264.7	0.29	
C1X0	10	537.1	0.23	1000063517
C2X0	2	262.3	0.26	

Partial discharge measurement

LV side was fed, HV side was open. HV side was measured.
Test frequency -225Hz. X0 terminal was grounded. Tap position N.
The phase voltage was raised to 125kV for 5minutes. After that the phase voltage was raised to the enhancement level 145kV and held for 32sec. Then the voltage was reduced to the one hour level (125kV) and held for one hour.
During this period, partial discharge measurements were made on each HV terminals.
The partial discharge also was measured at the start and finish of the test.

Radio -Influence Voltage (RIV) and Partial Discharge Measurement [pC / μV]

Terminal	t [min]	1	5	32sec	5	10	15	20
	Uph [kV] (HV)	0	125	145	125	125	125	125
H1		5/6	30/6	-	13/6	15/6	12/6	16/6
H2		4/6	14/8	-	6/8	6/8	6/8	7/8
H3		4/10	21/12	-	21/12	29/12	75/12	26/12

Terminal	t [min]	25	30	35	40	45	50	55	60
	Uph [kV]	125	125	125	125	125	125	125	125
H1		6/6	18/6	28/6	15/6	14/6	35/6	37/6	40/6
H2		5/8	4/8	7/9	6/9	6/8	15/8	17/8	18/8
H3		85/12	51/11	44/11	43/12	39/12	75/11	73/12	68/11

The transformer withstood the test.

Date: 06-10-13

Rated power [kVA]: 33000	Rated Voltage [kV]: 138.6 / 13.8
Frequency [Hz]: 60	Rated current [A]: 137.5/1381.6

On-Load Tap Changer Test

The tests were performed with the tap changer fully assembled on the transformer, at final assembled condition on the transformer, filled with oil.

8 complete operating cycles with the transformer not energized, at 100% rated auxiliary supply voltage.

1 complete operating cycles with the transformer not energized, at 85% rated auxiliary supply voltage.

1 complete operating cycles with at 100% rated auxiliary supply voltage, with the transformer energized at rated voltage and frequency, at no-load.

1 tap changer operation at 100% rated auxiliary supply voltage, with ±16 steps on higher and lower side of principal tapping, with 100% rated current of the transformer, with L.V. winding short circuited.

10 tap changer operations at 100% rated auxiliary supply voltage, with ±2 steps on higher and lower side of principal tapping, with 100% rated current of the transformer, with L.V. winding short circuited.

Oil Test

- Breakdown voltage - 79.1 kV
- Dissipation factor at 90°C - 0.188 %
- Water content - 4.9 ppm

Date : 06.10.13

VonRoll **TRANSFORMER PLANT** **HIGH VOLTAGE LABORATORY**	**CONTROL PANEL** **TEST**	Test Report No.: 2359 Page : 14 Type : 13785 Serial No. : 13836/1

Rated power [kVA]: 33000 | Rated Voltage [kV]: 138.6 / 13.8

Frequency [Hz]: 60 | Rated current [A]: 137.5/1381.6

Title	Checked	Remarks
1. Control cabinet layout	✓	
2. Control cabinet - internal arrangement	✓	
3. Auxiliary power distribution	✓	
4. Cooling power	✓	
5. Cooling control	✓	
6. Main tank alarms:	✓	
- Buchholtz relay	✓	
- oil level gauge	✓	
- pressure relief	✓	
- tank oil thermometer	✓	
- ETM - Qualitrol	✓	
- Hydro M2	✓	
7. LTC alarms:	✓	
- pressure relay	✓	
- pressure relief	✓	
- oil level gauge	✓	
- oil temperature	✓	
8. Current transformer	✓	Ratio - O.K. ; Polarity - O.K.
9. LTC control	✓	
10. LTC motor drive / light / heating / oil filter	✓	
11. LTC position indicator and signals	✓	
12. Terminal diagrams	✓	
13. Insulation of auxiliary wiring	✓	
14. Grounding	✓	
15. Tank oil temperature -alarm 100°C	✓	
16. LTC oil temperature -alarm 100°C	✓	
17. Winding temperature - fans of stage 1 75°C - fans of stage 2 85°C - alarm 120°C	✓	

Date : 06.10.13

Test Report

Impulse Analysing System by Haefely Test AG

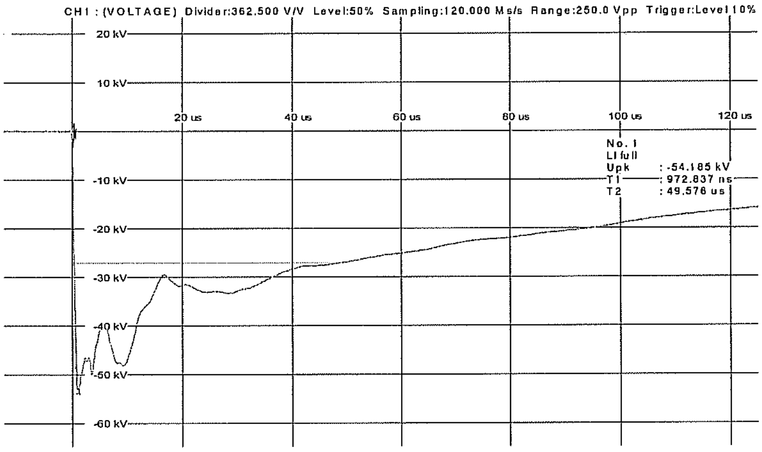
HAEFELY HIGH VOLTAGE TEST

LOW VOLTAG

Test Information

Test manager	Kotovski Andrei	Test Report No.2359
Test engineer	Ashtar Avidan	Transformer Serial No. 13836-1
		Impulse Generator
Standards	IEEE ANSI	2s1p Rs=50+50 , Rp=1000
		Rext=250
		Tap pos. 5/16L

LOW VOLTAGE WI
X1



50225

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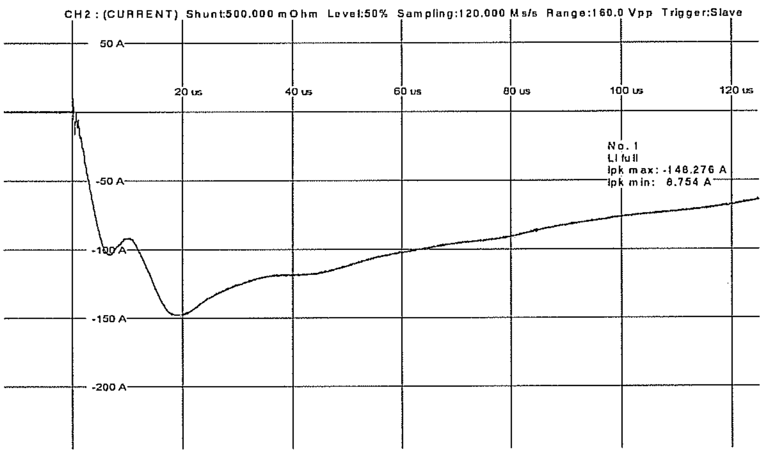
LOW VOLTAGE WI
X1



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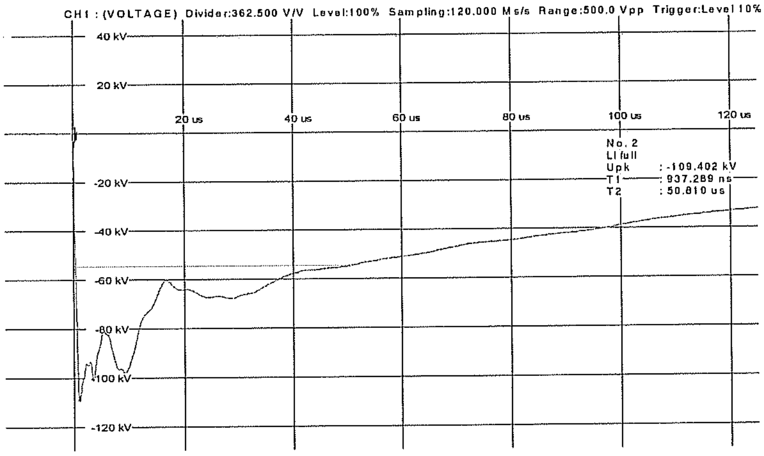
Test Report

Impulse Analysing System by Haefely Test AG

HAEFELY HIGH VOLTAGE TEST

LOW VOLTAGE WI
X1



50227

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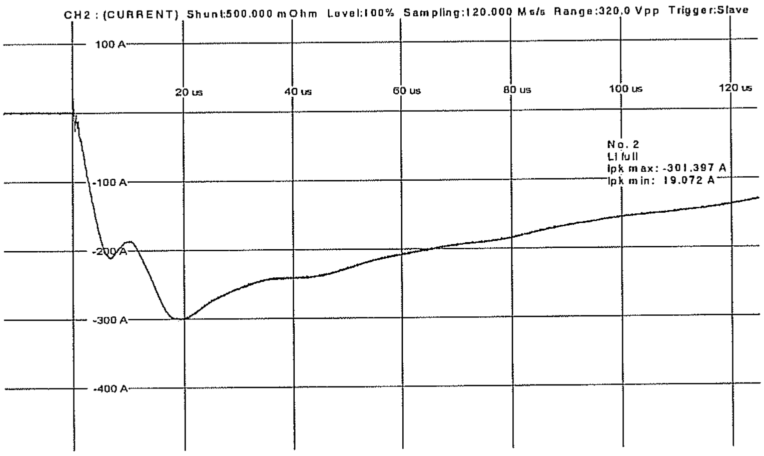
LOW VOLTAGE WI
X1



50228

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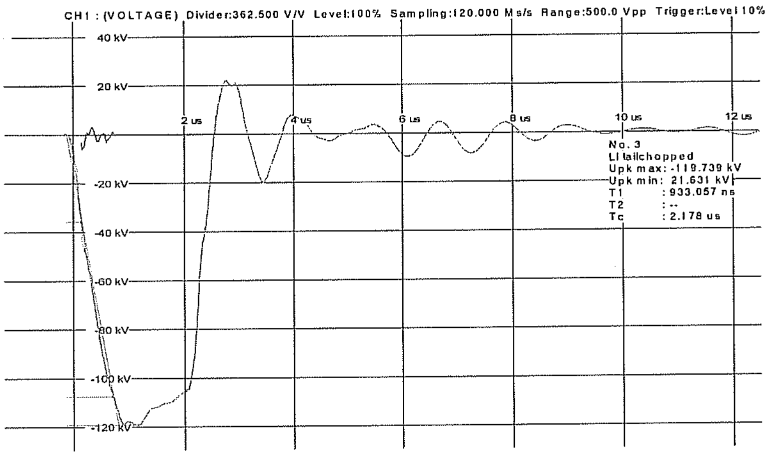
LOW VOLTAGE WI
X1



50229

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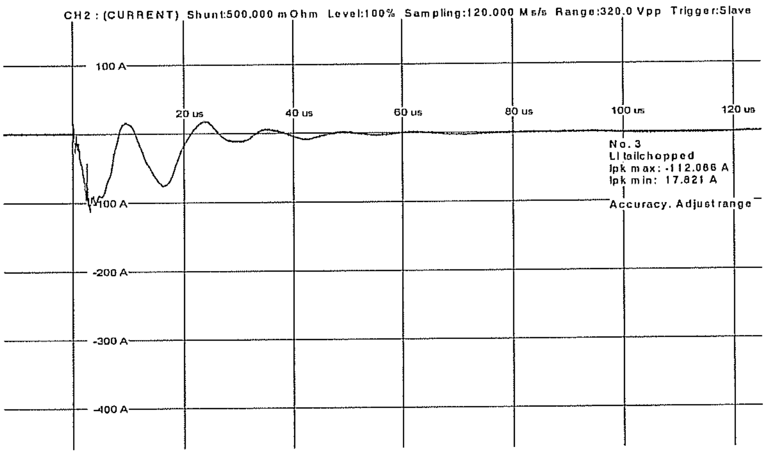
LOW VOLTAGE WI
X1



50230

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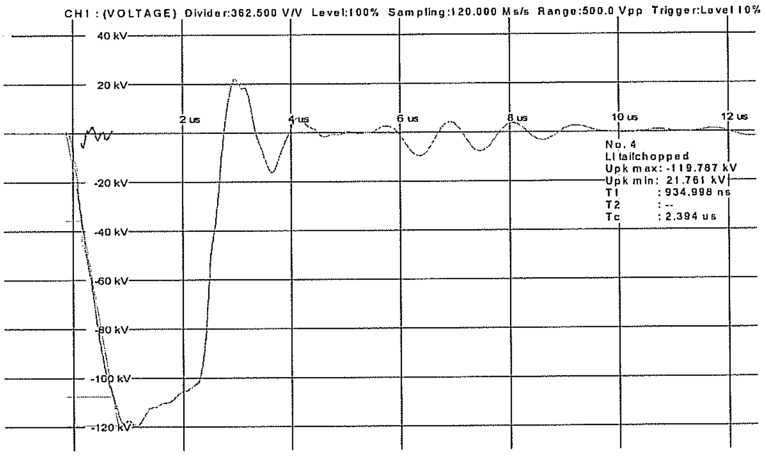
Test Report

Impulse Analysing System by Haefely Test AG

HAEFELY HIGH VOLTAGE TEST

LOW VOLTAGE WI
X1



50231

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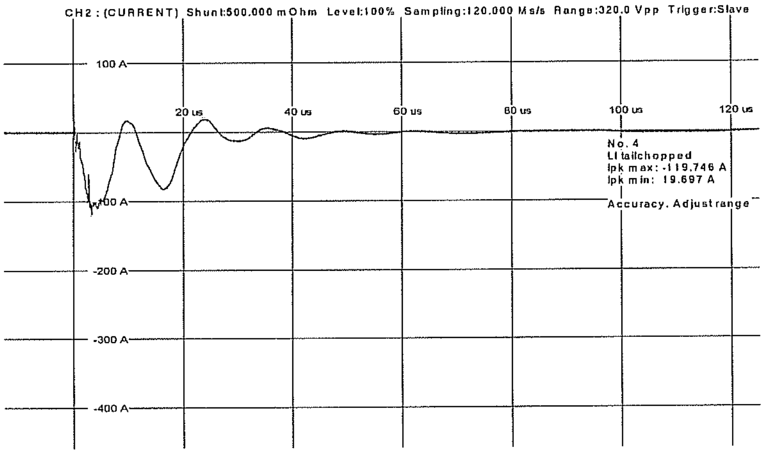
LOW VOLTAGE WI
X1



50232

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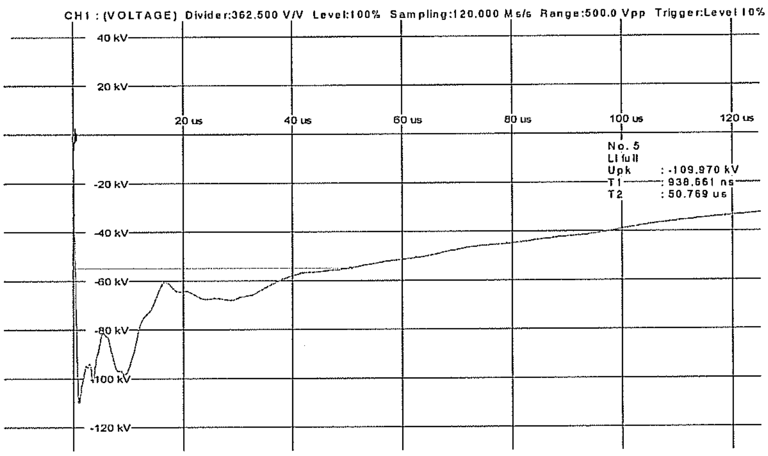
LOW VOLTAGE WI
X1



50235

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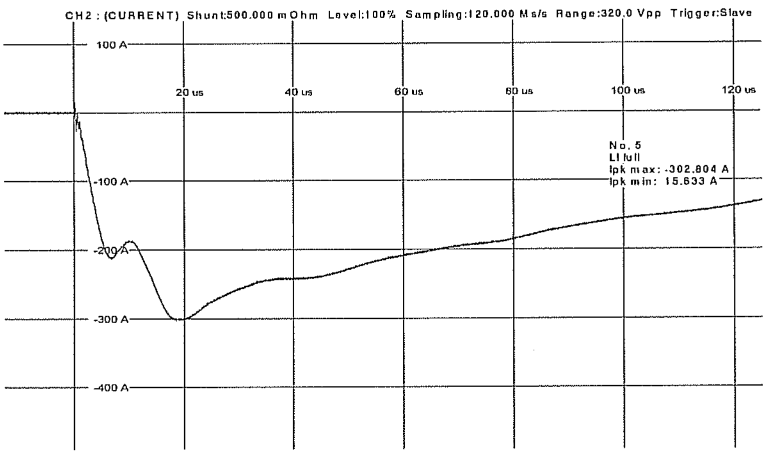
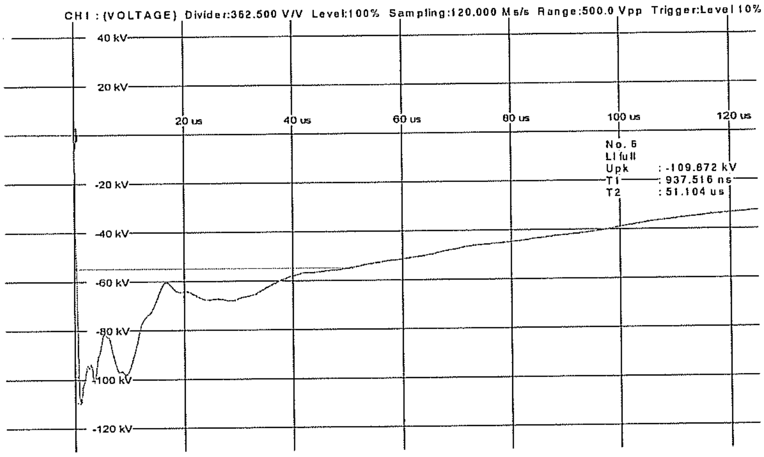
LOW VOLTAGE WI
X1



50236

6/6/2013 7:49:43

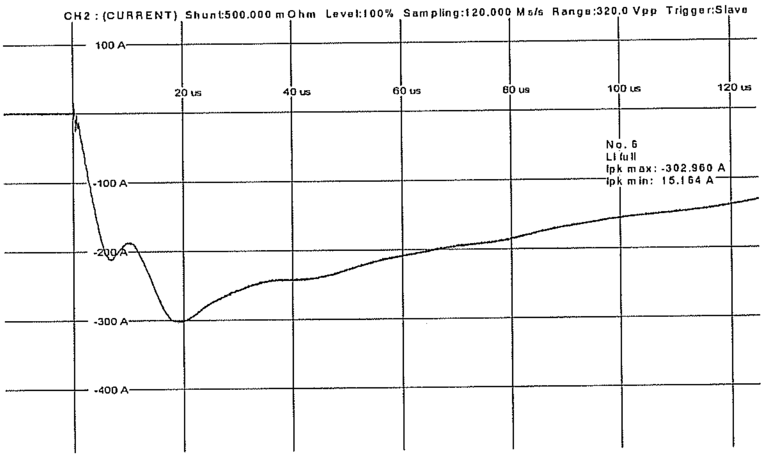
LOW VOLTAGE WI
X1



50237

6/6/2013 7:50:24

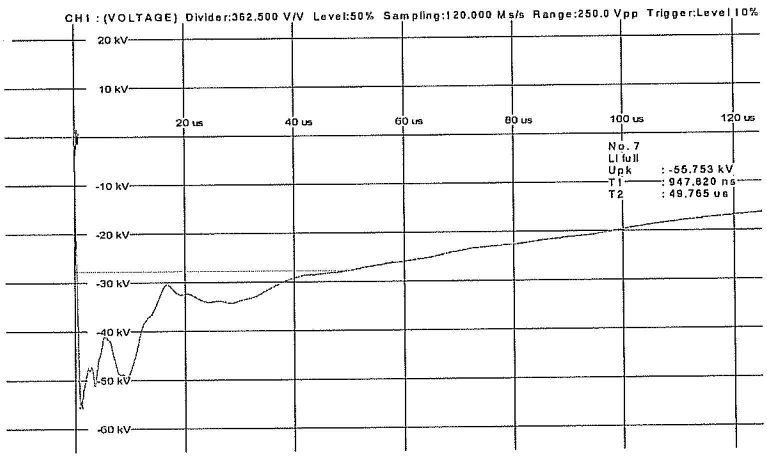
LOW VOLTAGE WI
X1



50238

6/6/2013 7:50:24

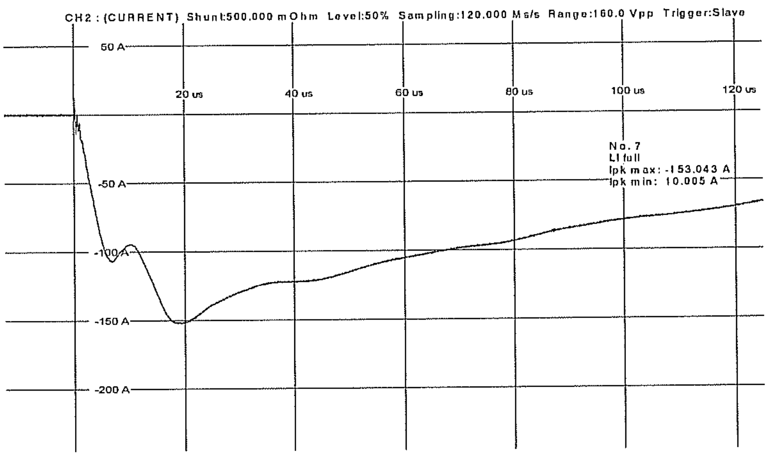
LOW VOLTAGE WI
X1



50239

6/6/2013 7:51:25

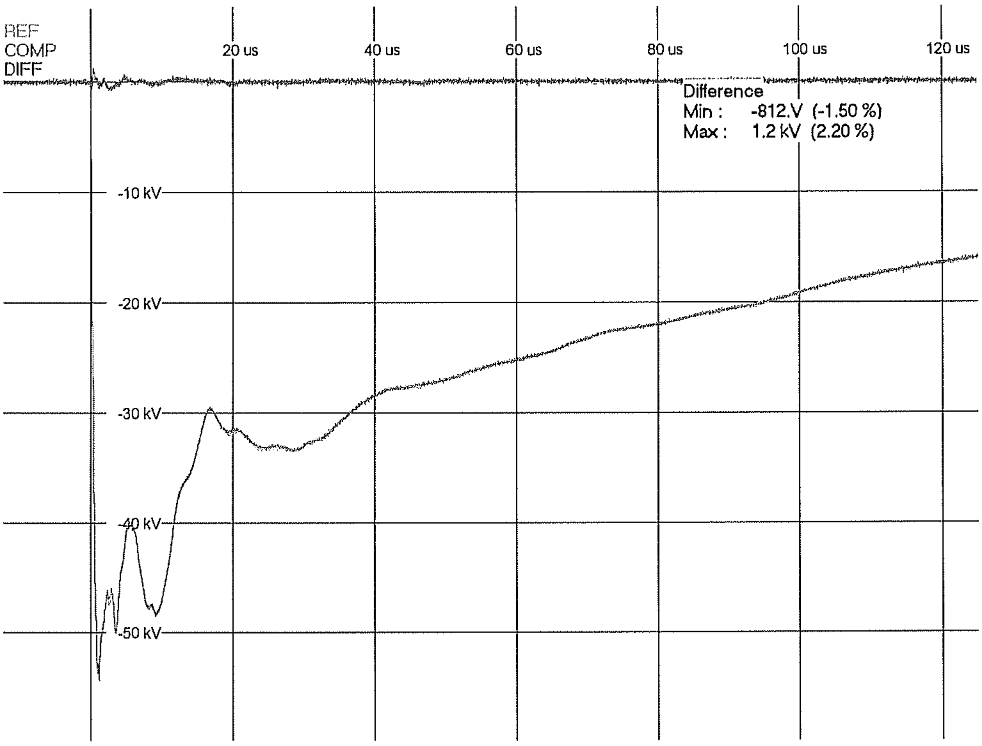
LOW VOLTAGE WI
X1



50240

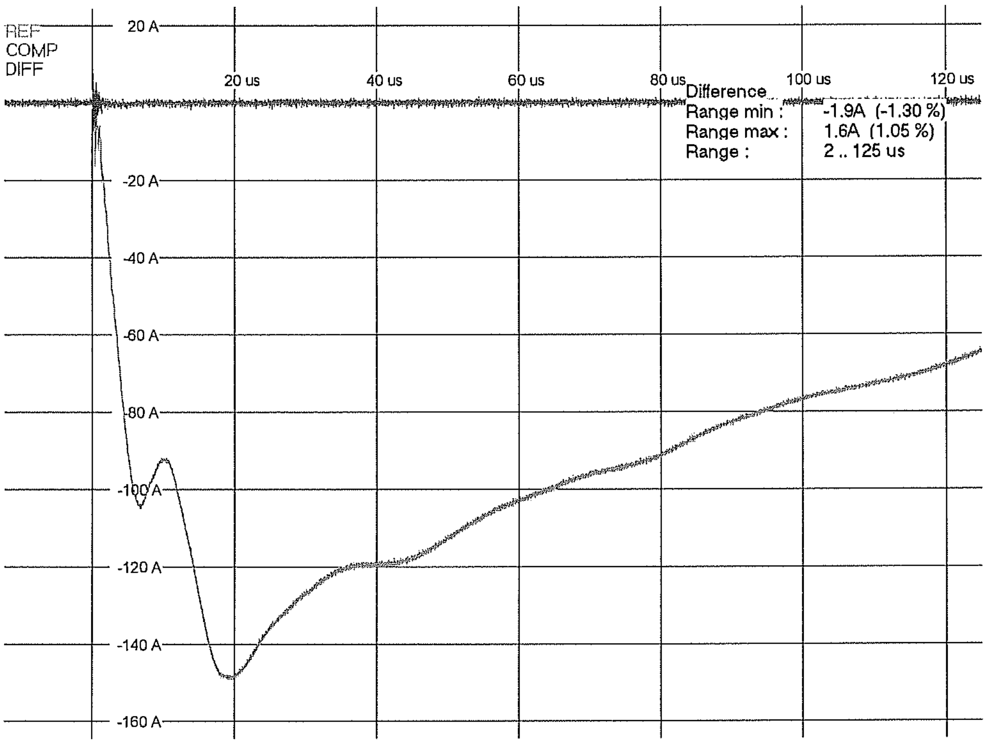
6/6/2013 7:51:25

LOW VOLTAGE
X1
6/6/2013 7:52:22 #50241



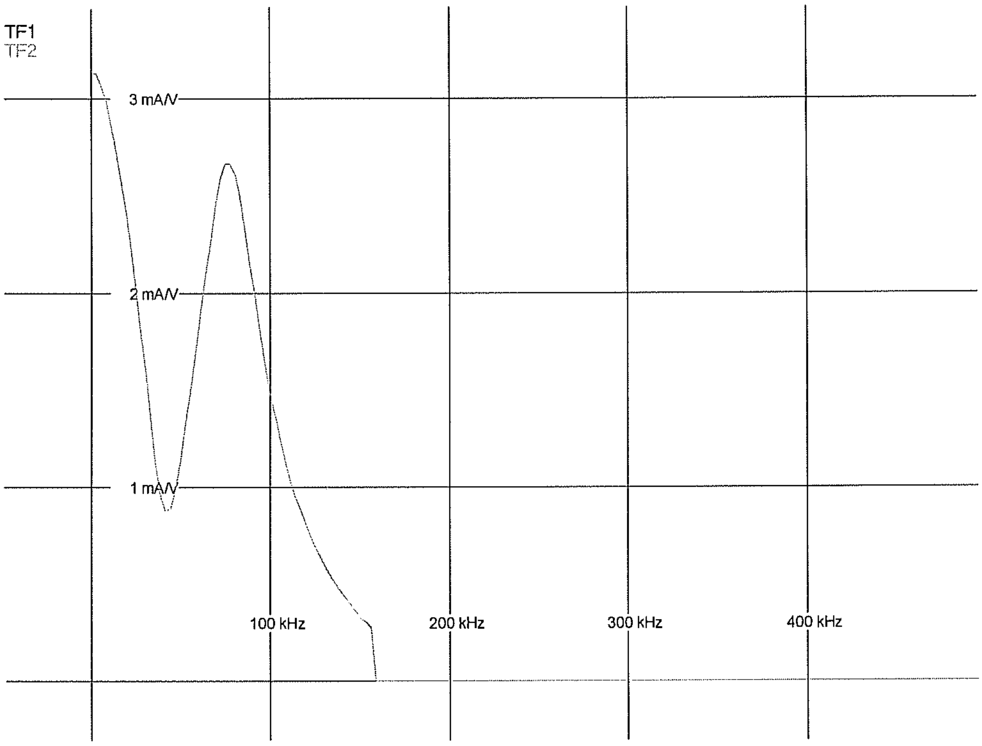
REF: CH1 -54.185 kV #50225 COMP: CH1 -109.87 kV #50237

LOW VOLTAGE
X1
6/6/2013 7:53:02 #50242



REF: CH2 -148.27 A #50226 COMP: CH2 -302.96 A #50238

LOW VOLTAGE
X1
6/6/2013 7:54:18 #50244



6/6/2013 7:43:18 AM; LI full; Xout: CH2 -148.27 A #50226, Threshold 0.5;
Xin: CH1 -54.185 kV #50225, Threshold 0.5
6/6/2013 7:50:24 AM; LI full; Xout: CH2 -302.96 A #50238, Threshold 0.5;
Xin: CH1 -109.87 kV #50237, Threshold 0.5

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Test Report

Impulse Analysing System by Haefely Test AG

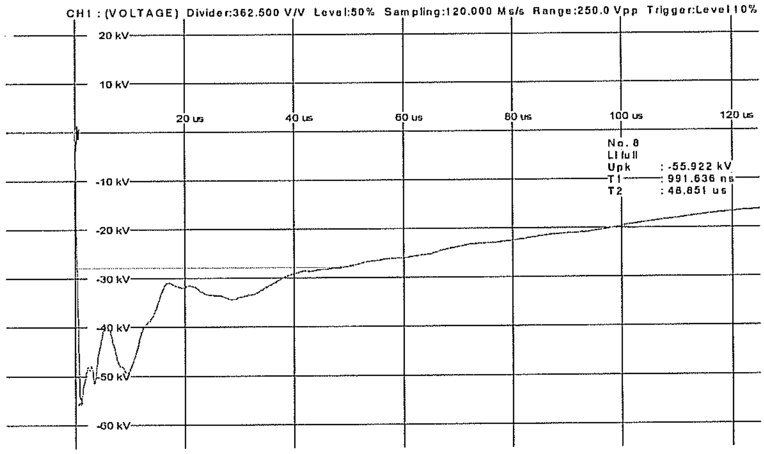
HAEFELY HIGH VOLTAGE TEST

LOW VOLTAG

Test Information

Test manager	Kotovski Andrei	Test Report No.2359
Test engineer	Ashtar Avidan	Transformer Serial No. 13836-1
		Impulse Generator
Standards	IEEE ANSI	2s1p Rs=50+50 , Rp=1000
		Rext=250
		Tap pos. 5/16L

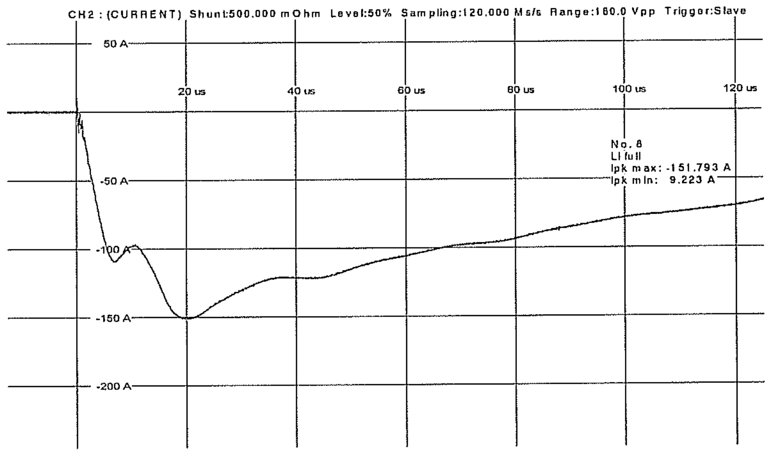
LOW VOLTAGE WI
X2



50245

6/6/2013 7:59:32

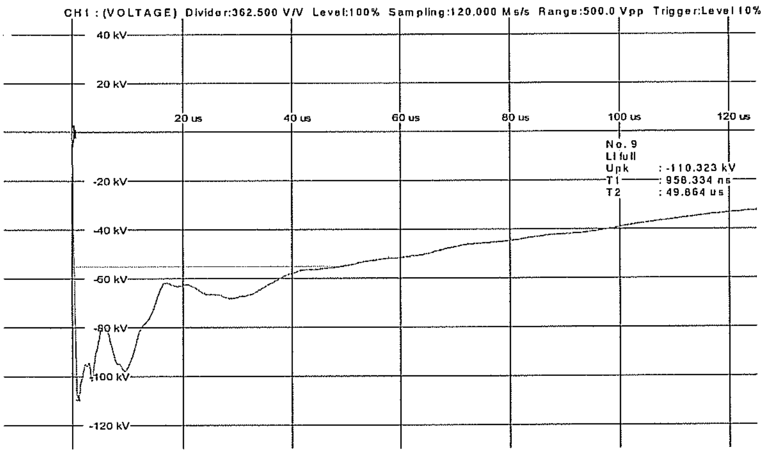
LOW VOLTAGE WI
X2



50246

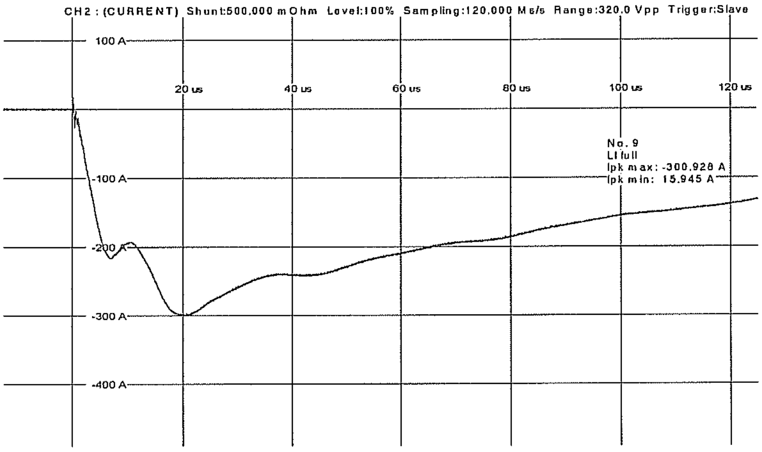
6/6/2013 7:59:32

LOW VOLTAGE WI
X2



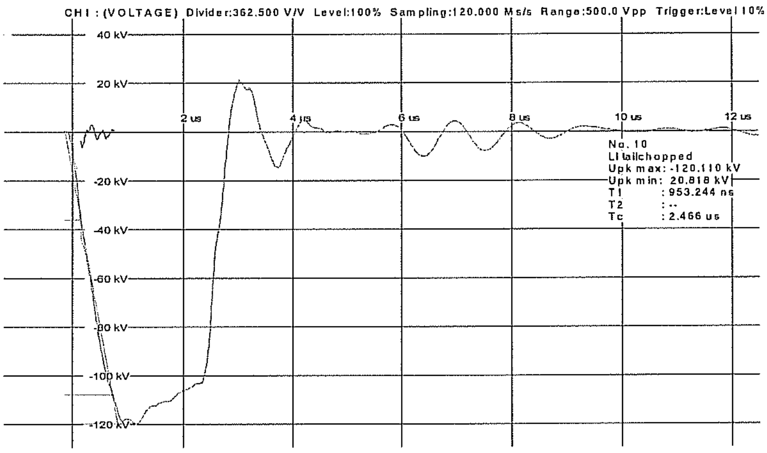
50247
6/6/2013 8:00:43

LOW VOLTAGE WI
X2



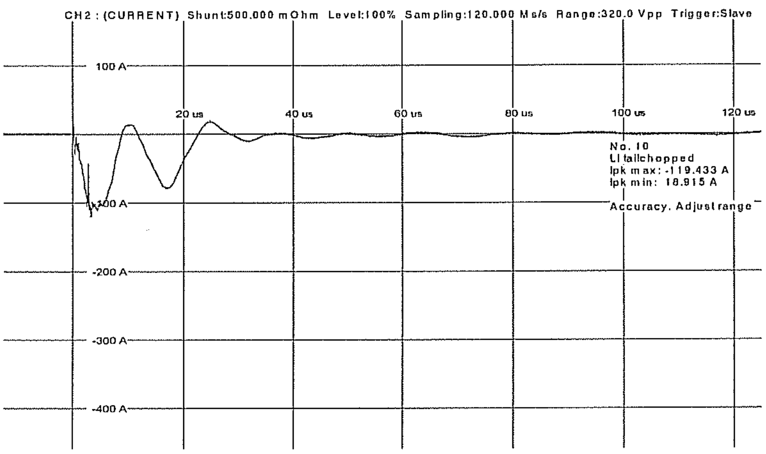
50248
6/6/2013 8:00:43

LOW VOLTAGE WI
X2



50249
6/6/2013 8:02:51

LOW VOLTAGE WI
X2



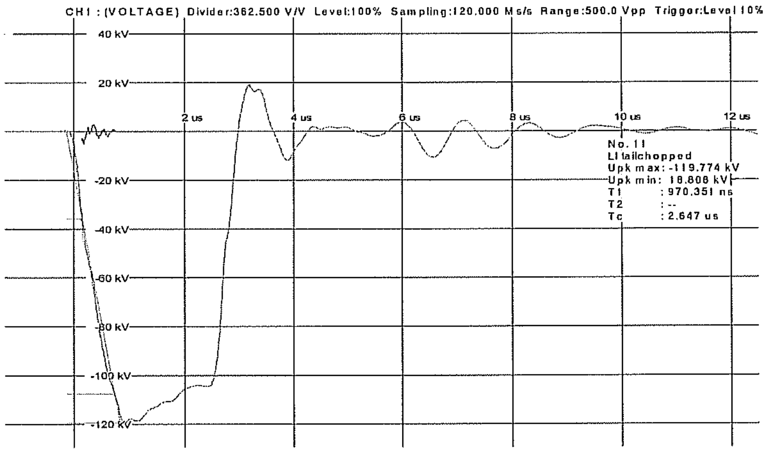
50250
6/6/2013 8:02:51

Test Report

Impulse Analysing System by Haefely Test AG

HAEFELY HIGH VOLTAGE TEST

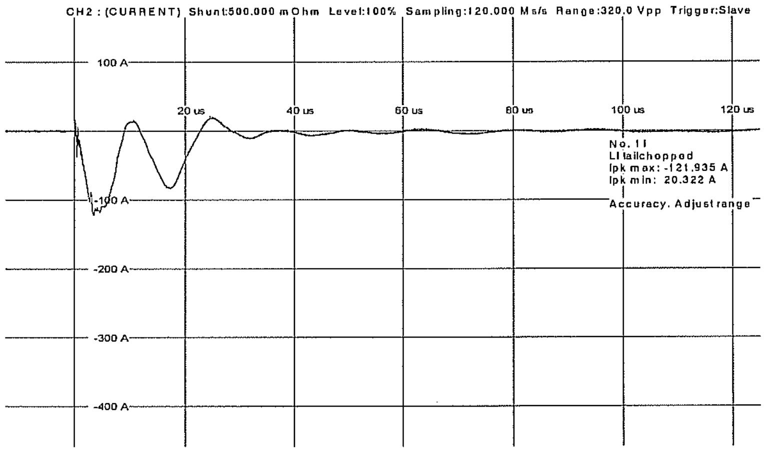
LOW VOLTAGE WI
X2



50251

6/6/2013 8:03:35

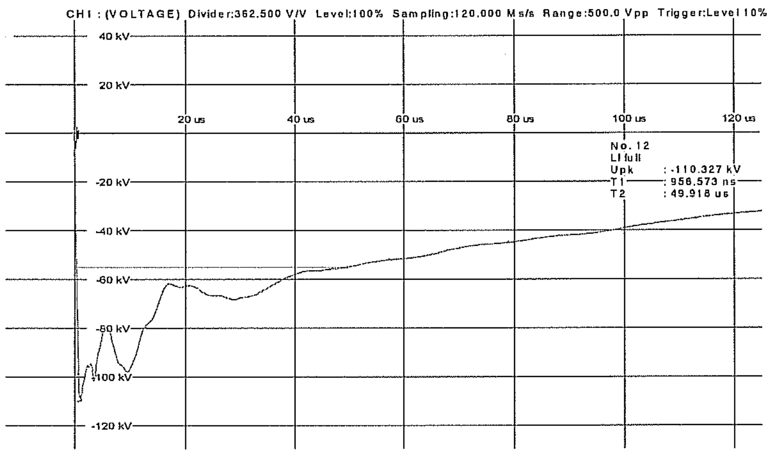
LOW VOLTAGE WI
X2



50252

6/6/2013 8:03:35

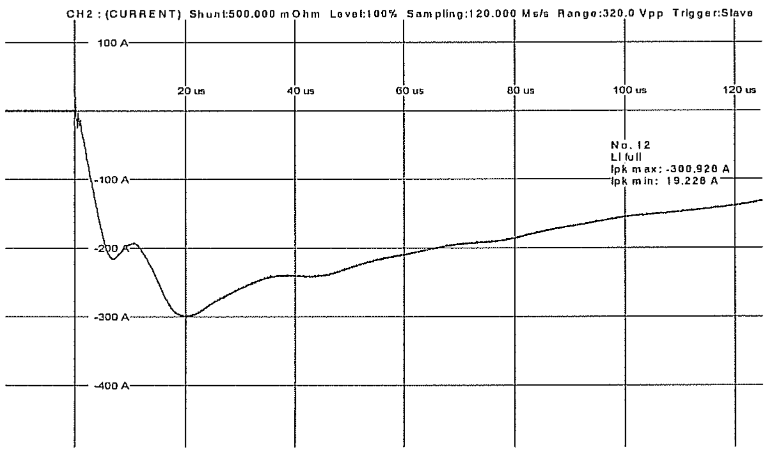
LOW VOLTAGE WI
X2



50253

6/6/2013 8:05:19

LOW VOLTAGE WI
X2

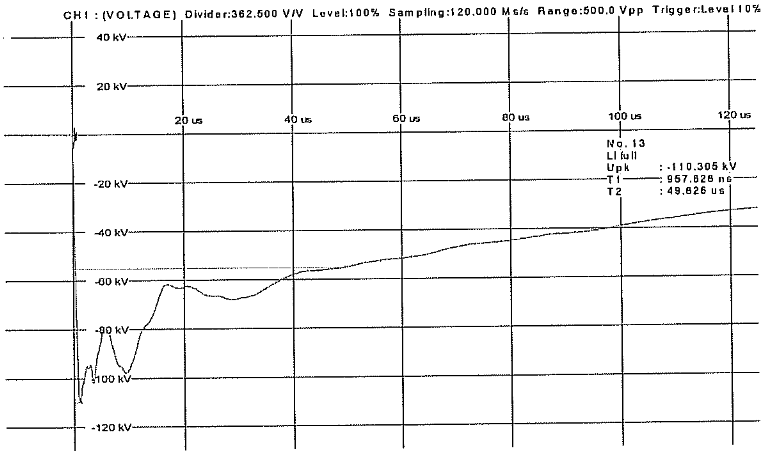


50254

6/6/2013 8:05:19

Test Report Impulse Analysing System by Haefely Test AG HAEFELY HIGH VOLTAGE TEST

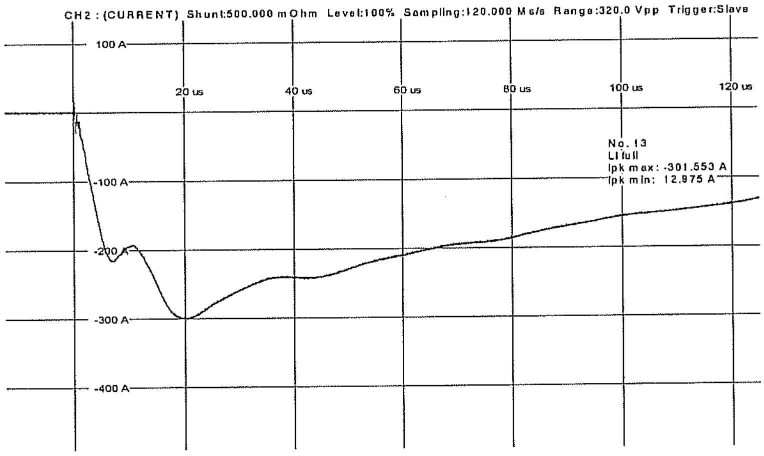
LOW VOLTAGE WI
X2



50255

6/6/2013 8:06:01

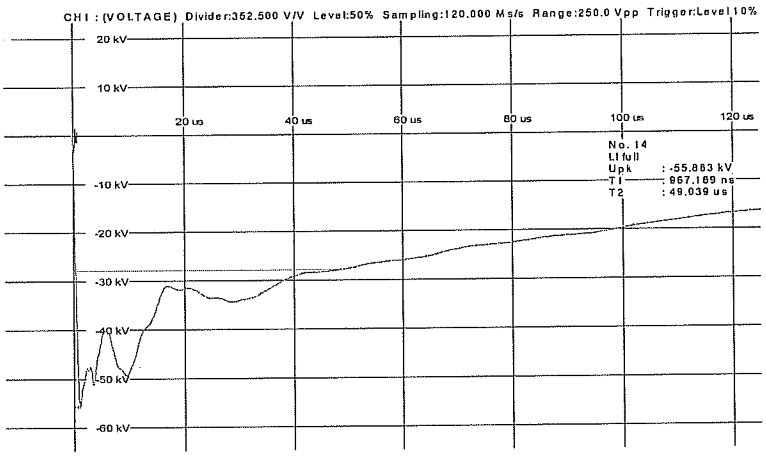
LOW VOLTAGE WI
X2



50256

6/6/2013 8:06:01

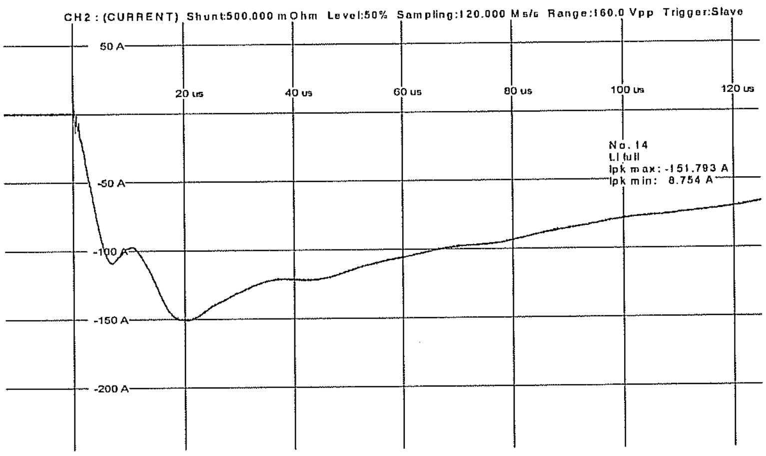
LOW VOLTAGE WI
X2



50257

6/6/2013 8:07:10

LOW VOLTAGE WI
X2



50258

6/6/2013 8:07:10

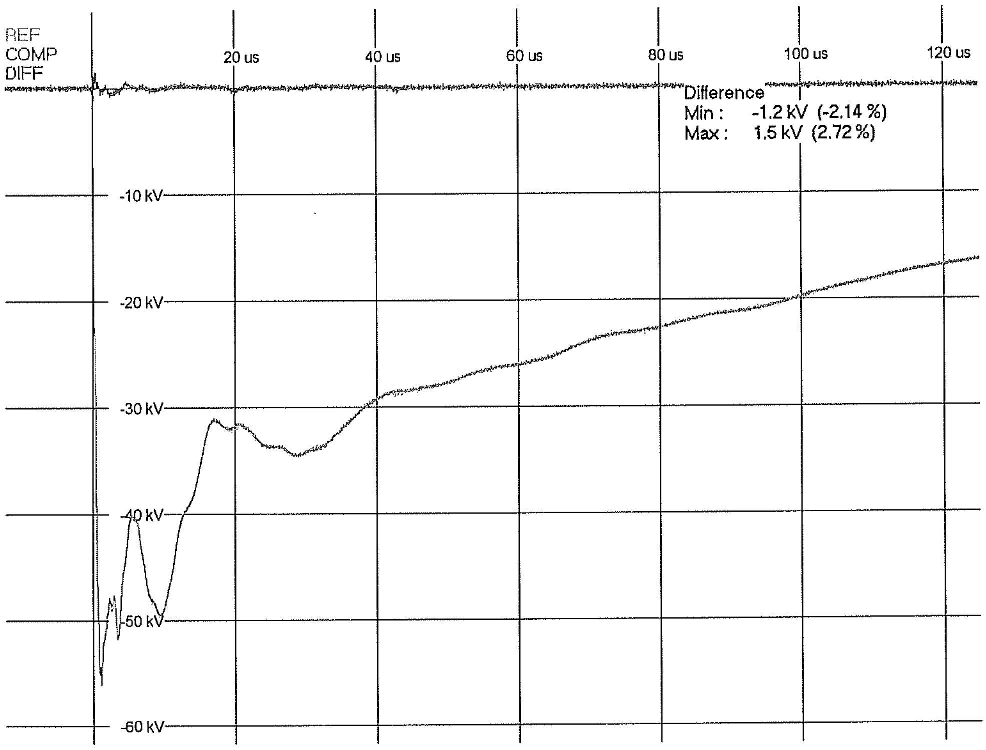
Test Report

Impulse Analysing System by Haefely Test AG

HAEFELY HIGH VOLTAGE TEST

LOW VOLTAGE
X2

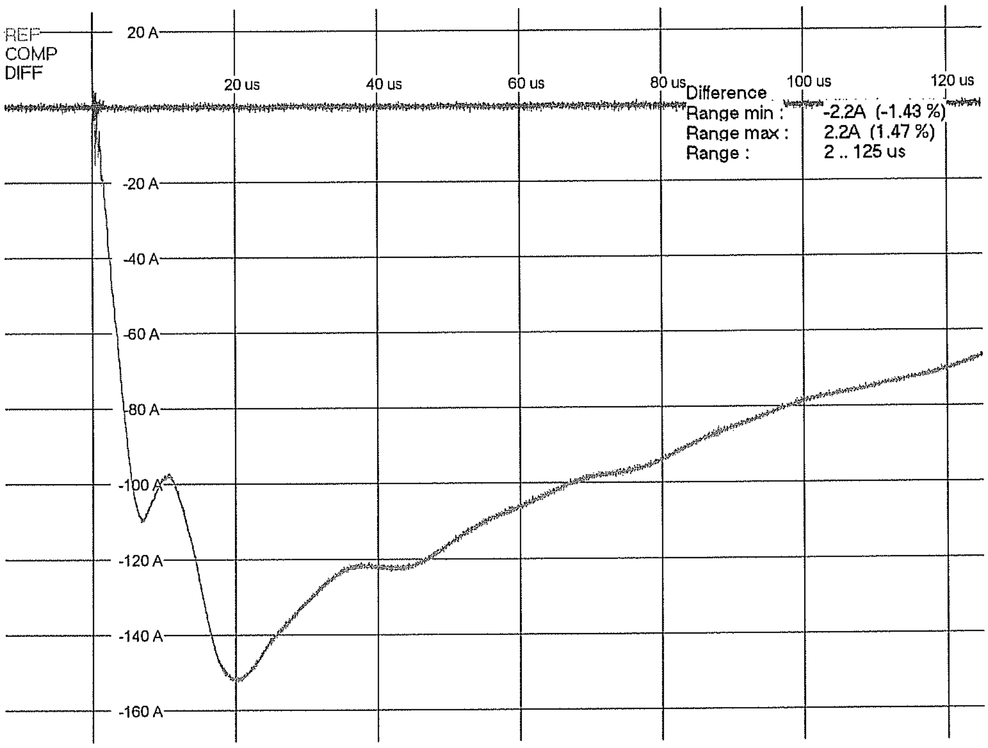
6/6/2013 8:07:34 #50259



REF: CH1 -55.922 kV #50245 COMP: CH1 -110.30 kV #50255

LOW VOLTAGE
X2

6/6/2013 8:08:00 #50260



REF: CH2 -151.79 A #50246 COMP: CH2 -301.55 A #50256

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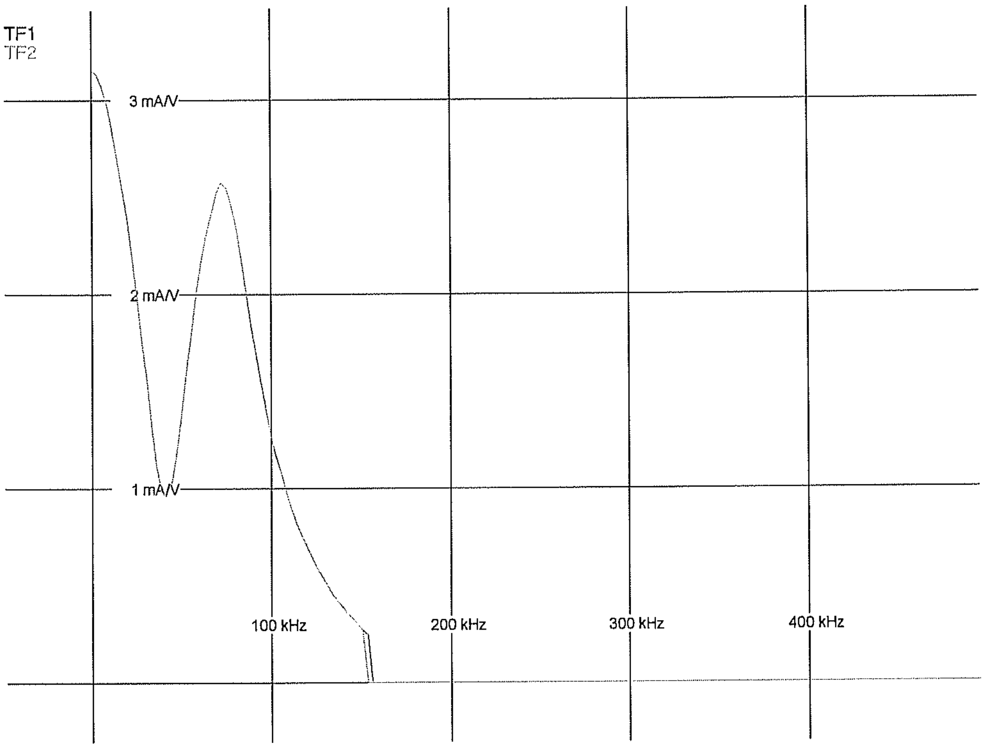
LOW VOLTAGE
X2

6/6/2013 8:08:22 #50261



6/6/2013 7:59:32 AM; LI full; Xout: CH2 -151.79 A #50246, Threshold 0.5;
Xin: CH1 -55.922 kV #50245, Threshold 0.5
6/6/2013 8:06:01 AM; LI full; Xout: CH2 -301.55 A #50256, Threshold 0.5;
Xin: CH1 -110.30 kV #50255, Threshold 0.5

Test Report

Impulse Analysing System by Haefely Test AG

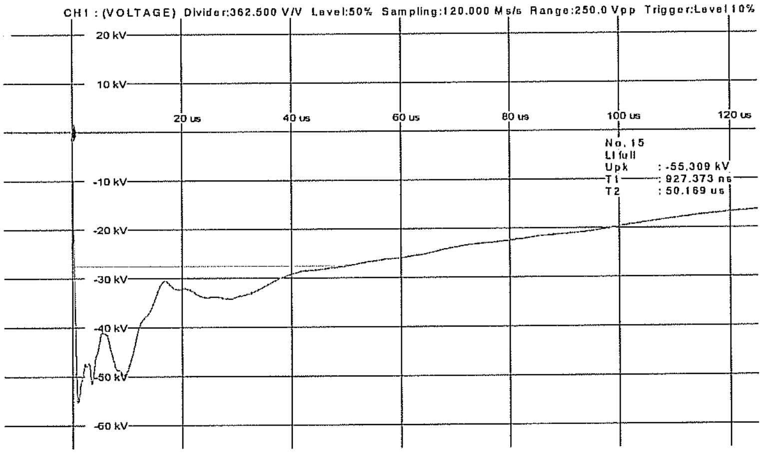
HAEFELY HIGH VOLTAGE TEST

LOW VOLTAG

Test Information

Test manager	Kotovski Andrei	Test Report No.2359
Test engineer	Ashtar Avidan	Transformer Serial No. 13836-1
		Impulse Generator
Standards	IEEE ANSI	2s1p Rs=50+50 , Rp=1000
		Rext=250
		Tap pos. 5/16L

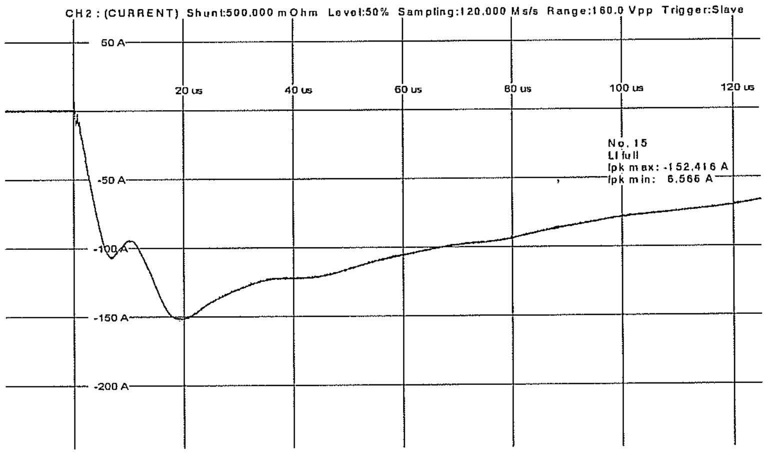
LOW VOLTAGE WI
X3



50262

6/6/2013 8:13:33

LOW VOLTAGE WI
X3



50263

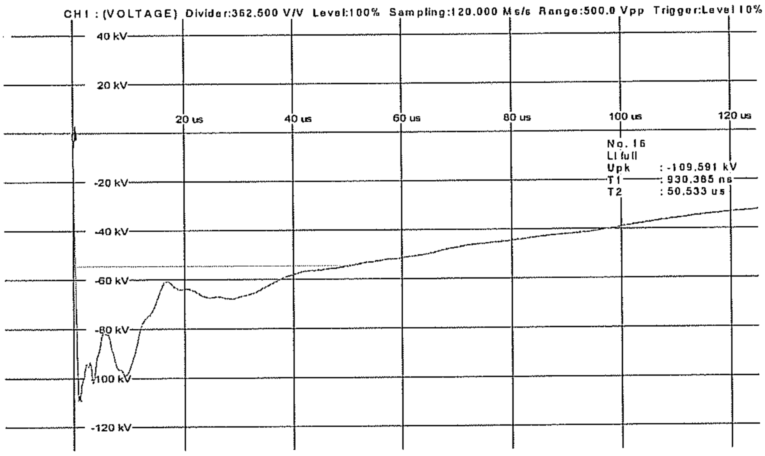
6/6/2013 8:13:33

Test Report

Impulse Analysing System by Haefely Test AG

HAEFELY HIGH VOLTAGE TEST

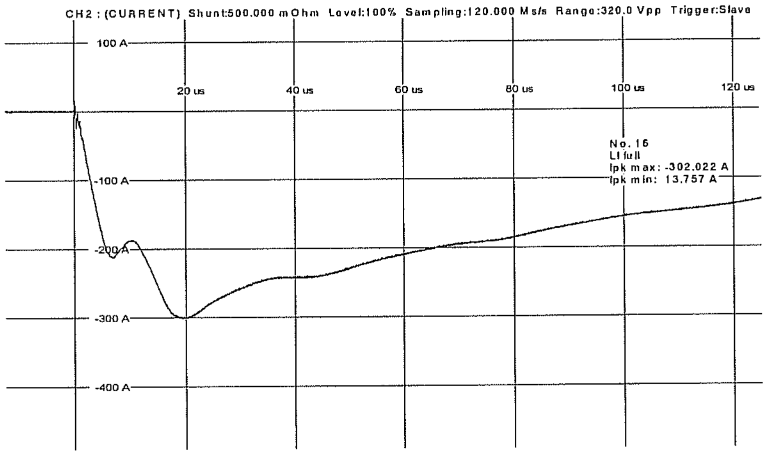
LOW VOLTAGE WI
X3



50264

6/6/2013 8:14:47

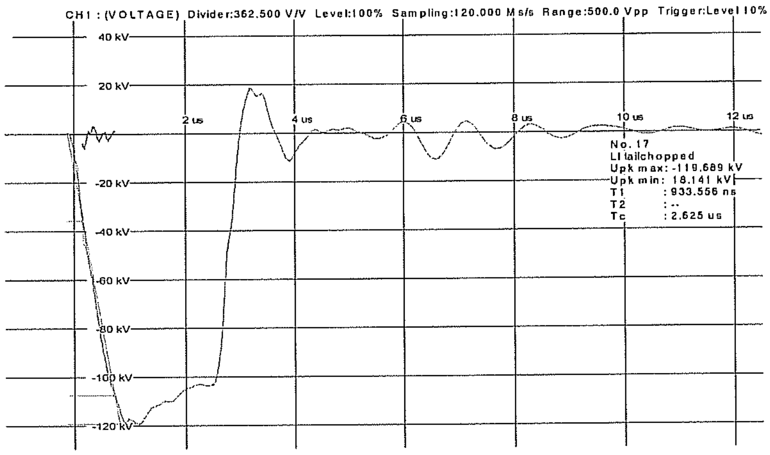
LOW VOLTAGE WI
X3



50265

6/6/2013 8:14:47

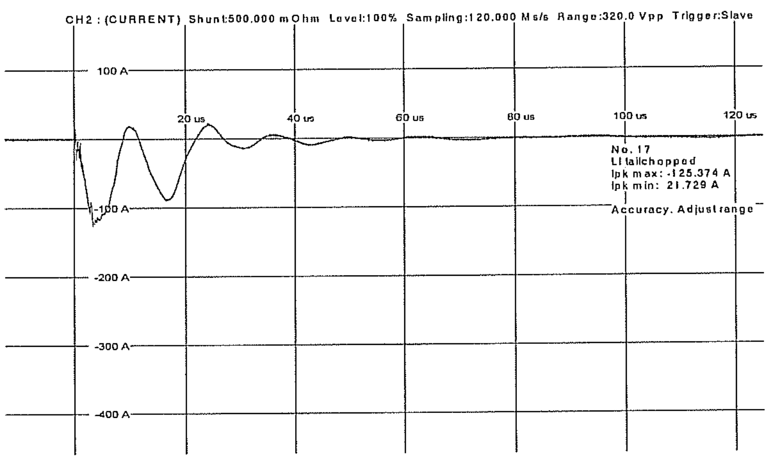
LOW VOLTAGE WI
X3



50266

6/6/2013 8:16:35

LOW VOLTAGE WI
X3



50267

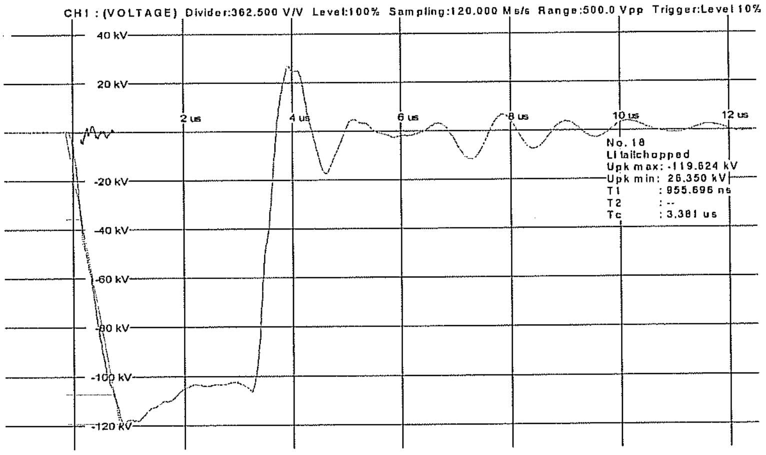
6/6/2013 8:16:35

Test Report

Impulse Analysing System by Haefely Test AG

HAEFELY HIGH VOLTAGE TEST

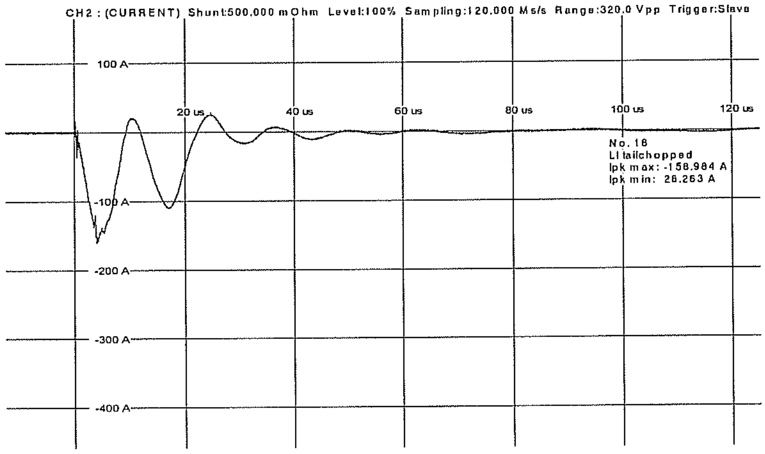
LOW VOLTAGE WI
X3



50268

6/6/2013 8:17:24

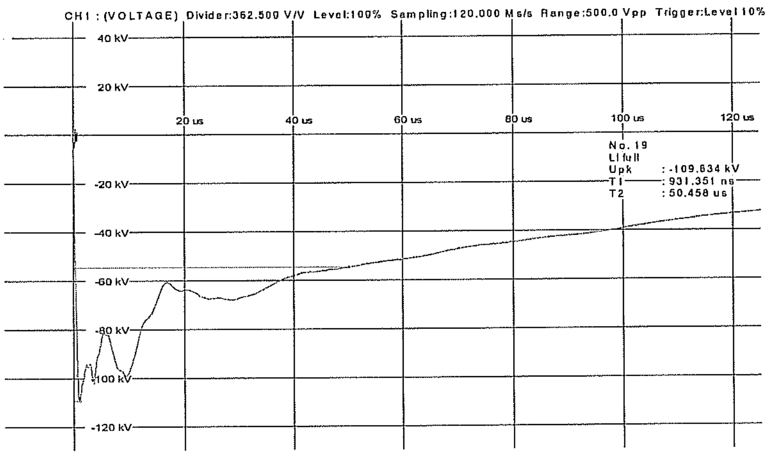
LOW VOLTAGE WI
X3



50269

6/6/2013 8:17:24

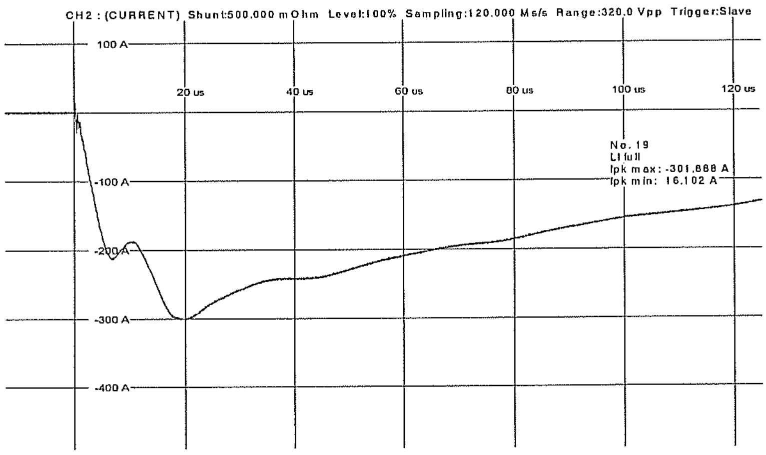
LOW VOLTAGE WI
X3



50270

6/6/2013 8:19:04

LOW VOLTAGE WI
X3



50271

6/6/2013 8:19:04

Test Report

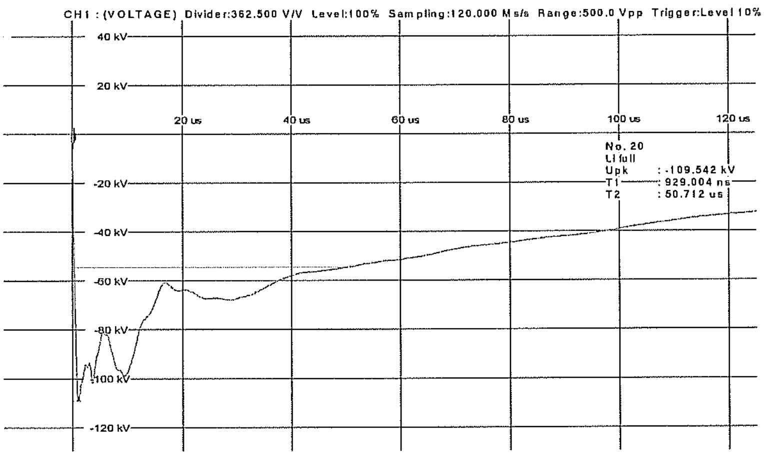
Impulse Analysing System by Haefely Test AG

HAEFELY HIGH VOLTAGE TEST

LOW VOLTAGE WI
X3

50272

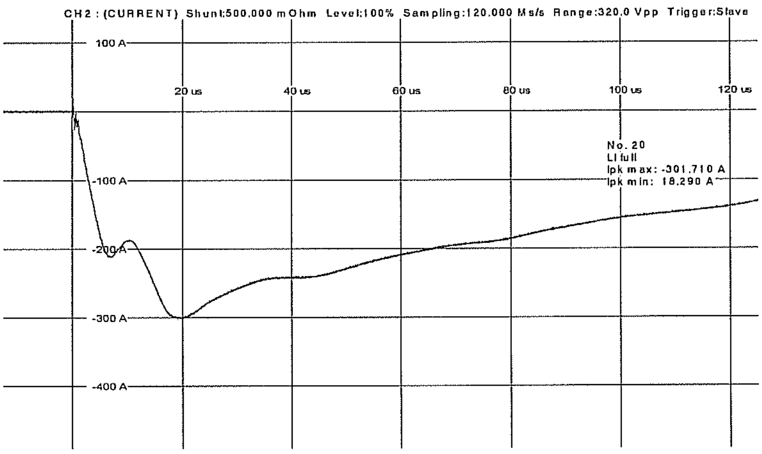
6/6/2013 8:19:46



LOW VOLTAGE WI
X3

50273

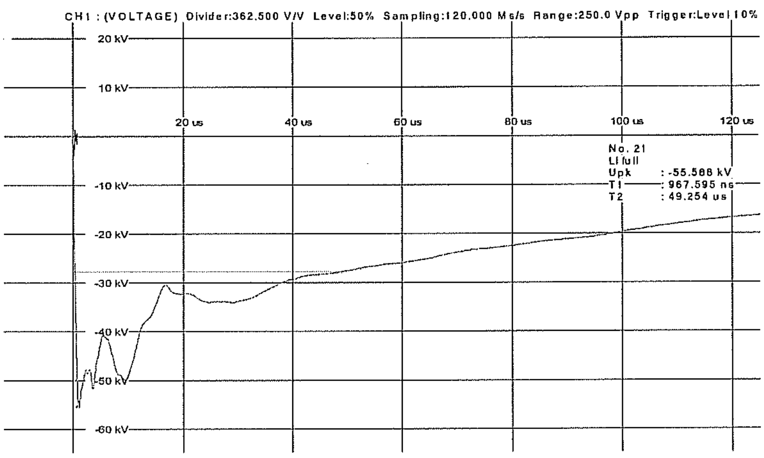
6/6/2013 8:19:46



LOW VOLTAGE WI
X3

50274

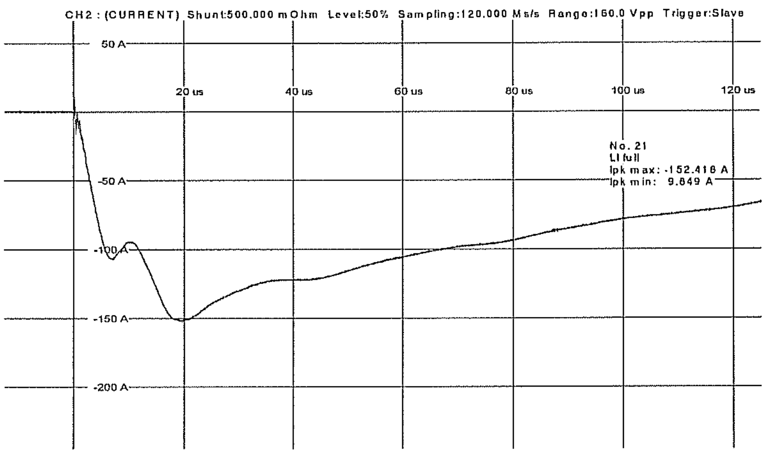
6/6/2013 8:20:40



LOW VOLTAGE WI
X3

50275

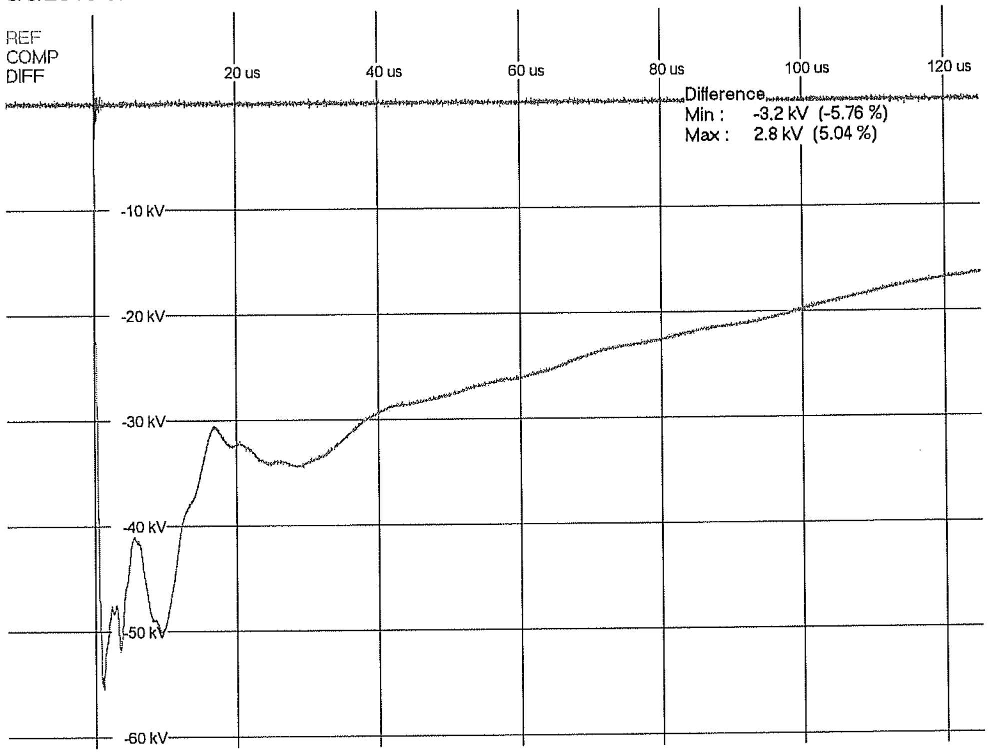
6/6/2013 8:20:40



Test Report

LOW VOLTAGE
X3

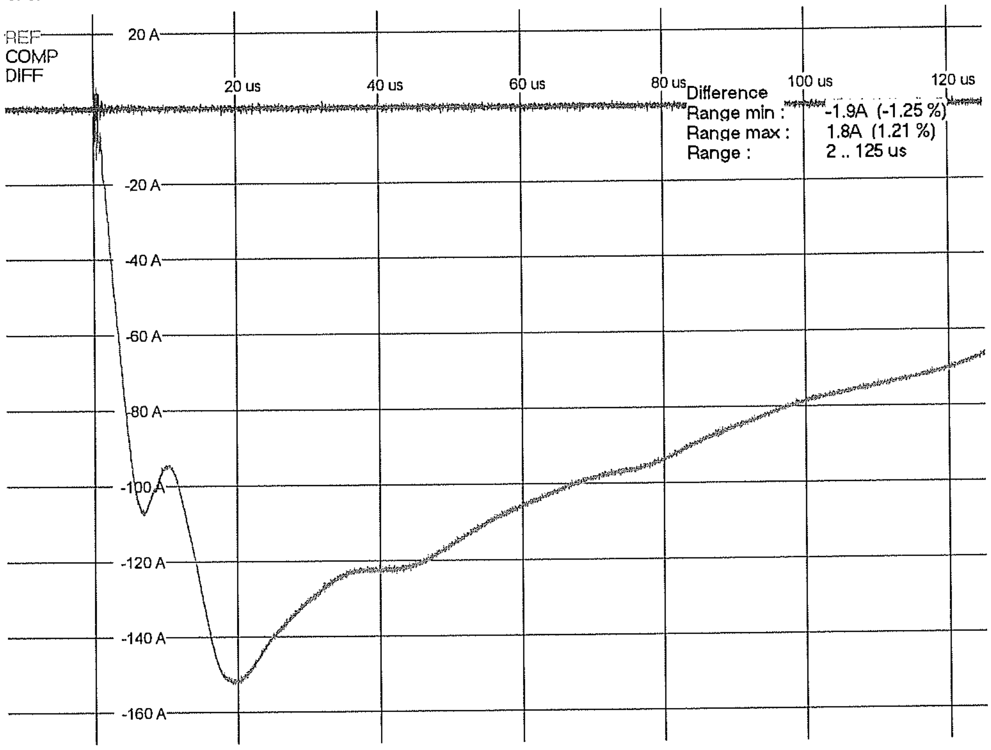
6/6/2013 8:21:10 #50276



REF: CH1 -55.309 kV #50262 COMP: CH1 -109.54 kV #50272

LOW VOLTAGE
X3

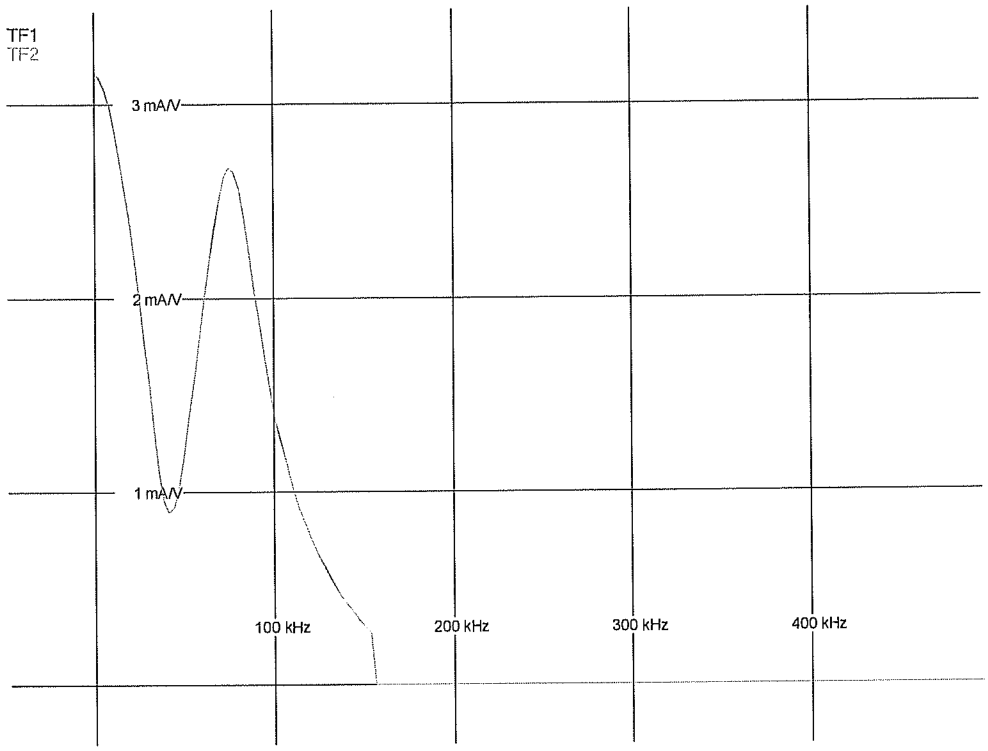
6/6/2013 8:21:23 #50277



REF: CH2 -152.41 A #50263 COMP: CH2 -301.71 A #50273

LOW VOLTAGE
X3

6/6/2013 8:22:12 #50278



6/6/2013 8:13:33 AM; LI full; Xout: CH2 -152.41 A #50263, Threshold 0.5;
Xin: CH1 -55.309 kV #50262, Threshold 0.5
6/6/2013 8:19:46 AM; LI full; Xout: CH2 -301.71 A #50273, Threshold 0.5;
Xin: CH1 -109.54 kV #50272, Threshold 0.5

Test Report

Impulse Analysing System by Haefely Test AG

HAEFELY HIGH VOLTAGE TEST

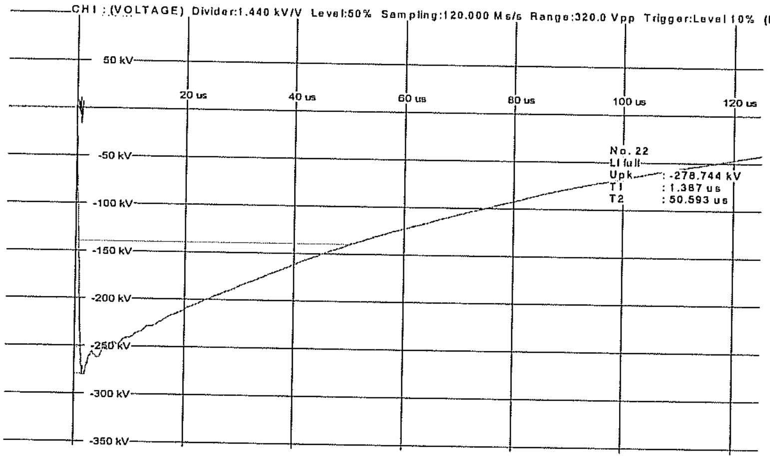
HIGH VOLTAG

Test Information

Test manager	Kotovski Andrei
Test engineer	Ashtar Avidan
Standards	IEEE ANSI

Test Report No.2359
Transformer Serial No. 13836-1
Impulse Generator
5s1p Rs=22+8 , Rp=92+22
Tap pos. 5/16L

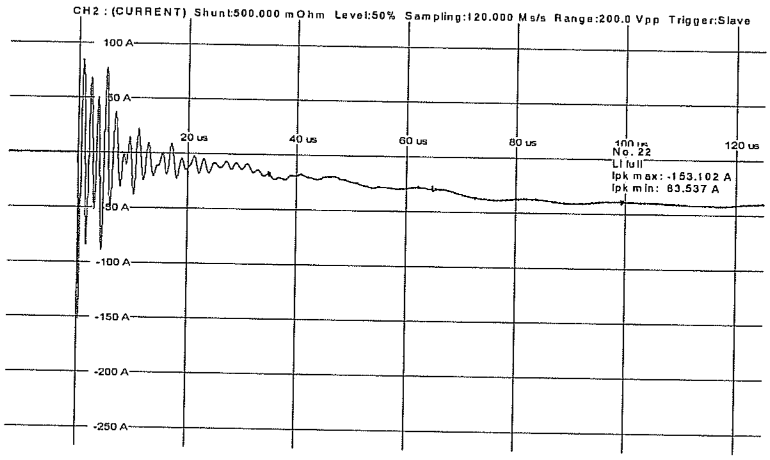
HIGH VOLTAGE WI
H1



50290

6/6/2013 10:03:1

HIGH VOLTAGE WI
H1



50291

6/6/2013 10:03:1

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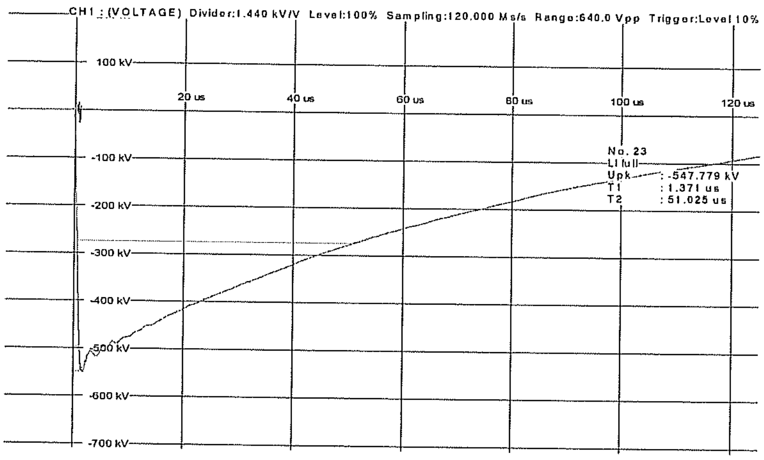
Test Report

Impulse Analysing System by Haefely Test AG — HAEFELY HIGH VOLTAGE TEST

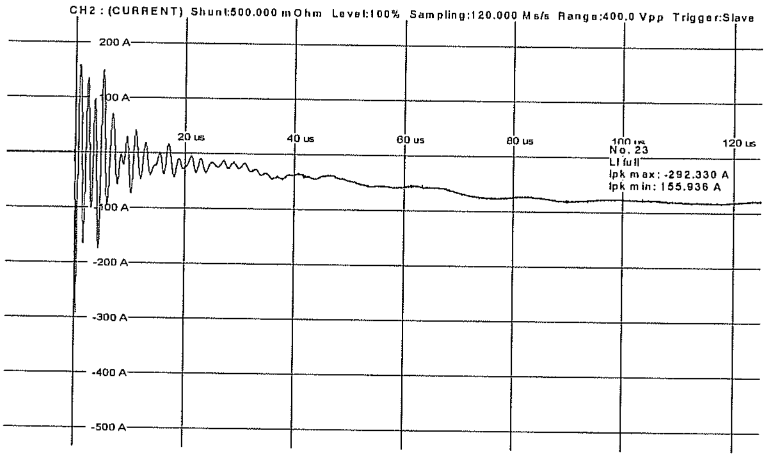
HIGH VOLTAGE WI
H1



50292

6/6/2013 10:04:3

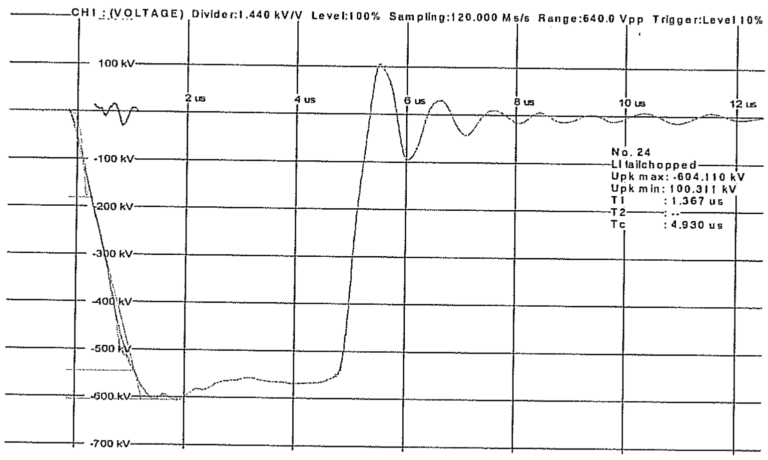
HIGH VOLTAGE WI
H1



50293

6/6/2013 10:04:3

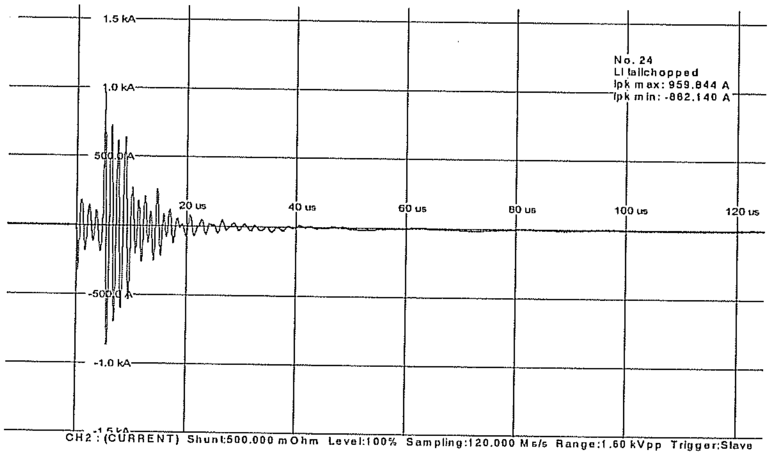
HIGH VOLTAGE WI
H1



50297

6/6/2013 10:10:2

HIGH VOLTAGE WI
H1



50298

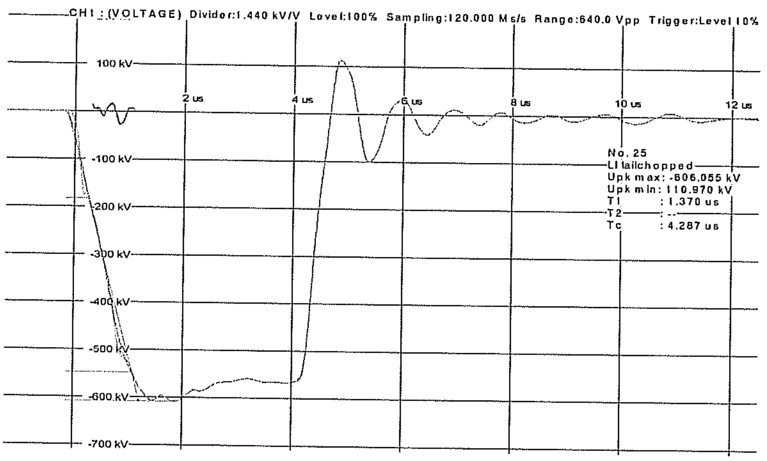
6/6/2013 10:10:2

Test Report

Impulse Analysing System by Haefely Test AG

HAEFELY HIGH VOLTAGE TEST

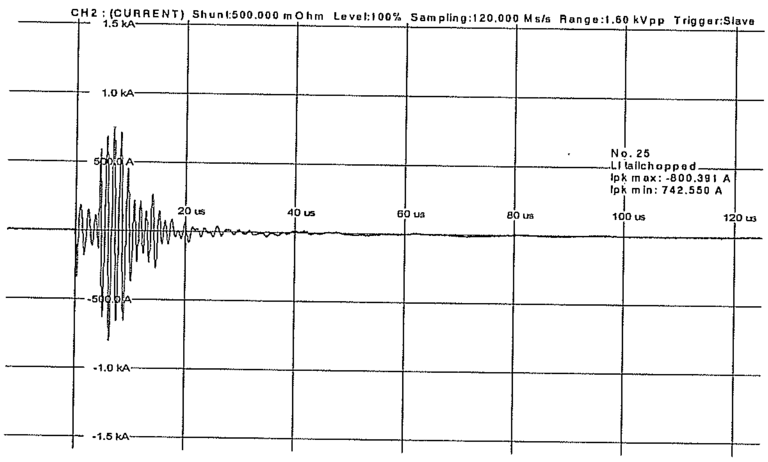
HIGH VOLTAGE WI
H1



50299

6/6/2013 10:11:3

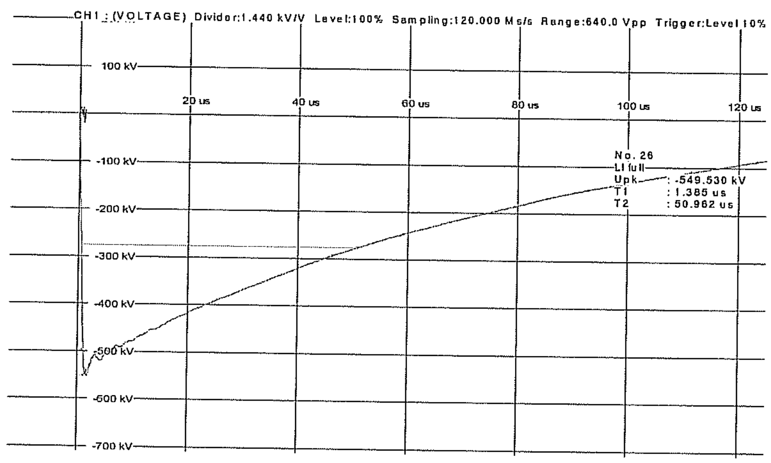
HIGH VOLTAGE WI
H1



50300

6/6/2013 10:11:3

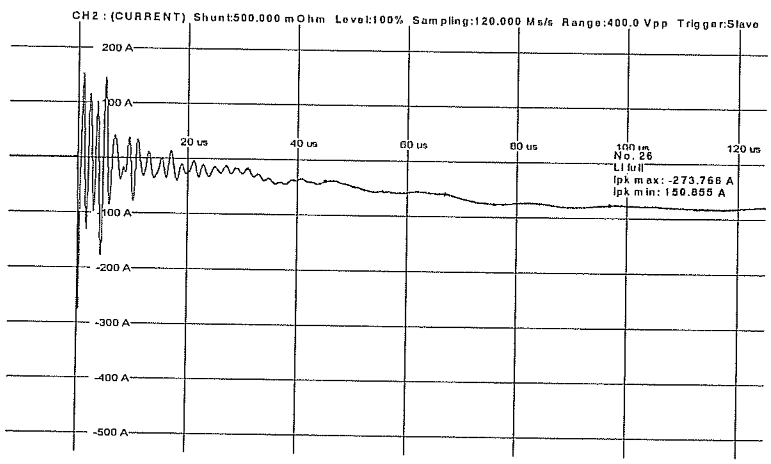
HIGH VOLTAGE WI
H1



50301

6/6/2013 10:13:2

HIGH VOLTAGE WI
H1



50302

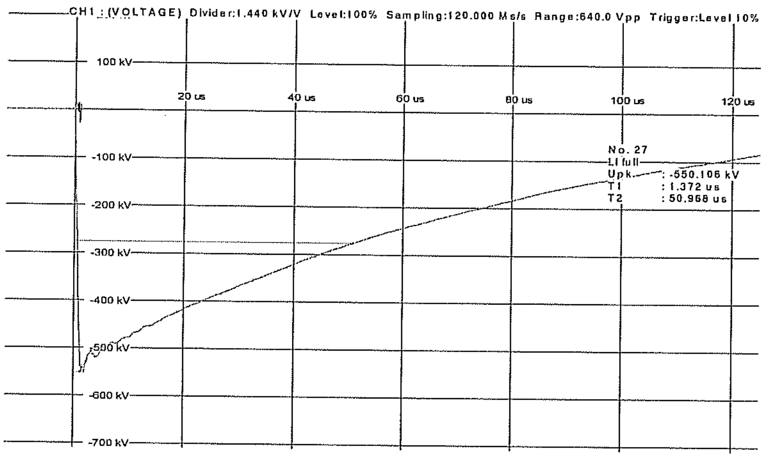
6/6/2013 10:13:2

Test Report

Impulse Analysing System by Haefely Test AG

HAEFELY HIGH VOLTAGE TEST

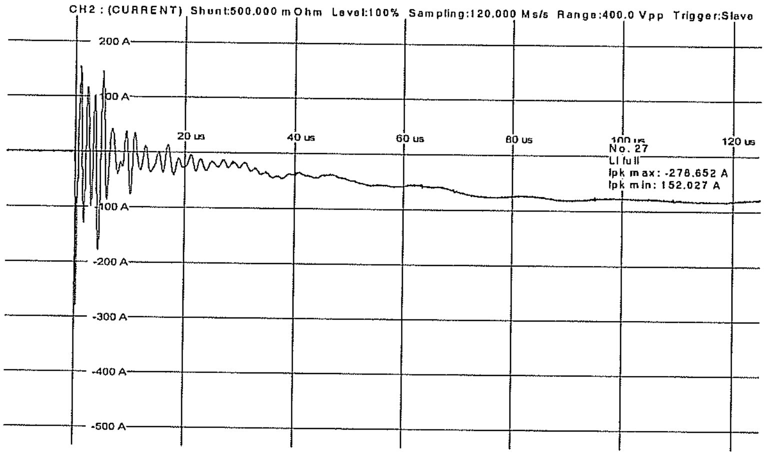
HIGH VOLTAGE WI
H1



50303

6/6/2013 10:14:0

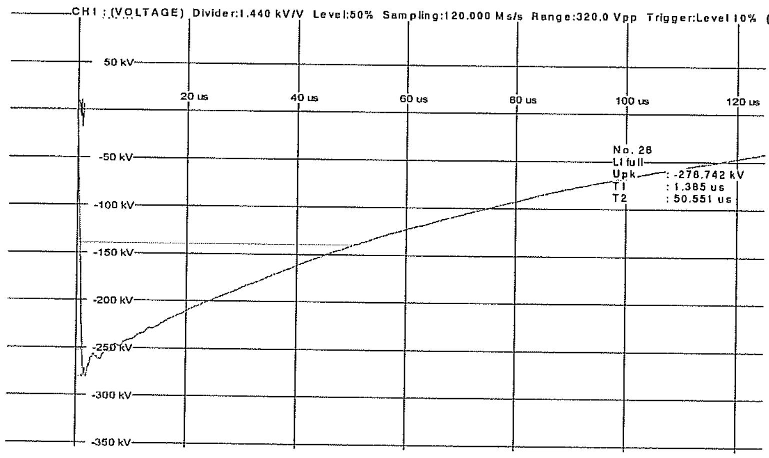
HIGH VOLTAGE WI
H1



50304

6/6/2013 10:14:0

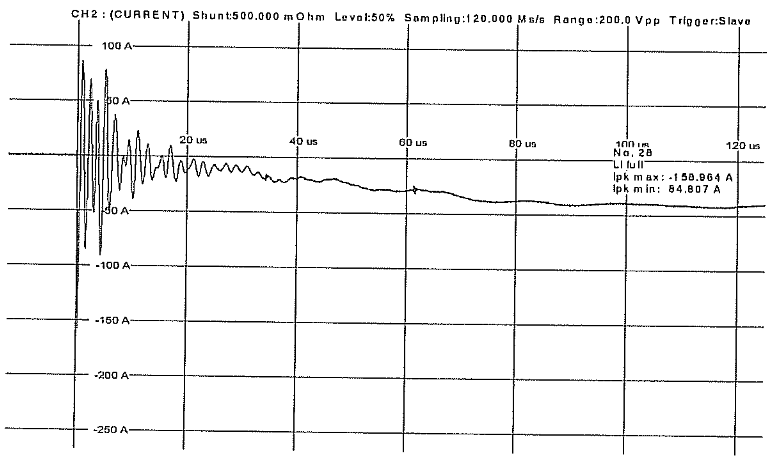
HIGH VOLTAGE WI
H1



50305

6/6/2013 10:15:1

HIGH VOLTAGE WI
H1



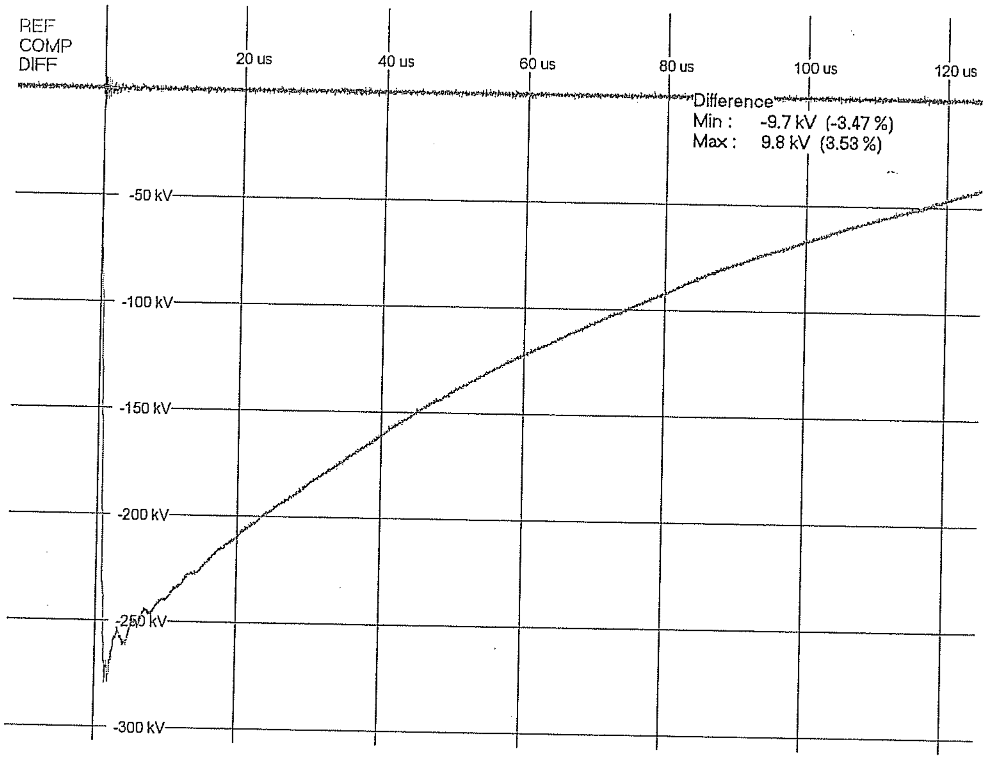
50306

6/6/2013 10:15:1

Test Report

HIGH VOLTAGE
H1

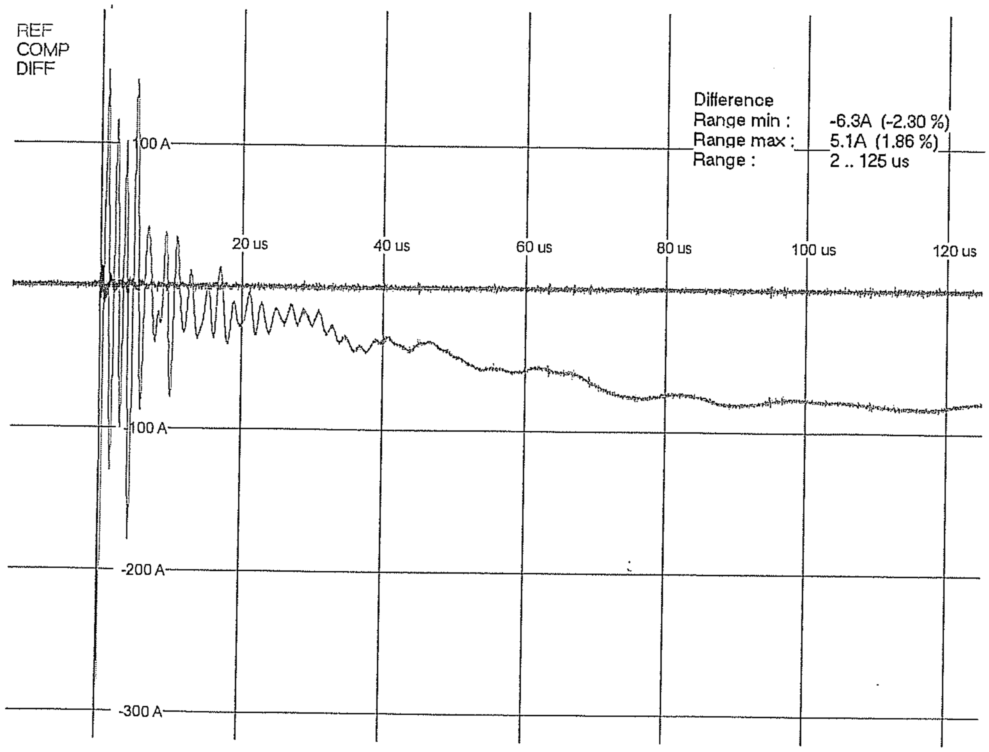
6/6/2013 10:16:0 #50307



REF: CH1 -278.74 kV #50290 COMP: CH1 -550.10 kV #50303

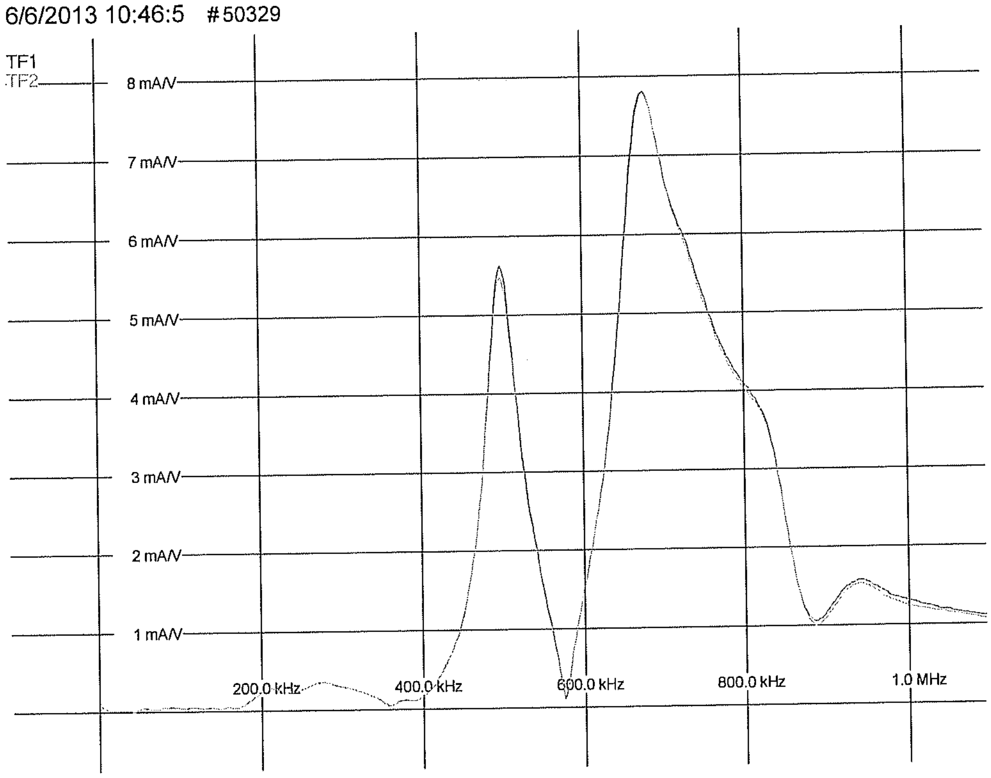
HIGH VOLTAGE
H1

6/6/2013 10:16:2 #50308



REF: CH2 -153.10 A #50291 COMP: CH2 -278.65 A #50304

HIGH VOLTAGE
H1
6/6/2013 10:46:5 #50329



6/6/2013 10:39:02 AM; LI full; Xout: CH2 -167.56 A #50322, Threshold 0.5;
Xin: CH1 -278.64 kV #50321, Threshold 0.5
6/6/2013 10:46:13 AM; LI full; Xout: CH2 -326.33 A #50328, Threshold 0.5;
Xin: CH1 -546.77 kV #50327, Threshold 0.5

Test Report

Impulse Analysing System by Haefely Test AG

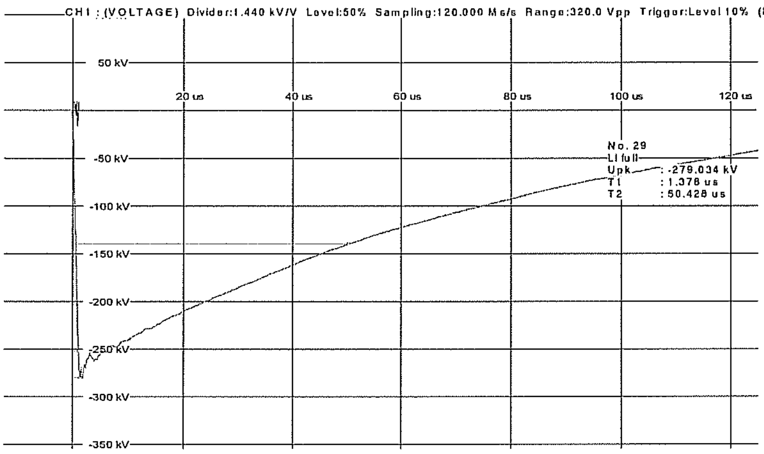
HAEFELY HIGH VOLTAGE TEST

HIGH VOLTAG

Test Information

Test manager	Kotovski Andrei	Test Report No.2359
Test engineer	Ashtar Avidan	Transformer Serial No. 13836-1
		Impulse Generator
Standards	IEEE ANSI	5s1p Rs=22+8 , Rp=92+22
		Tap pos. 5/16L

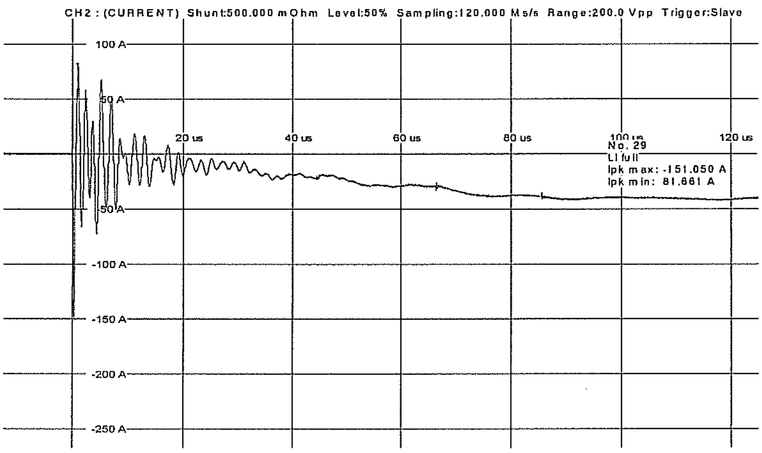
HIGH VOLTAGE WI H2



50340

6/6/2013 11:02:4

HIGH VOLTAGE WI H2

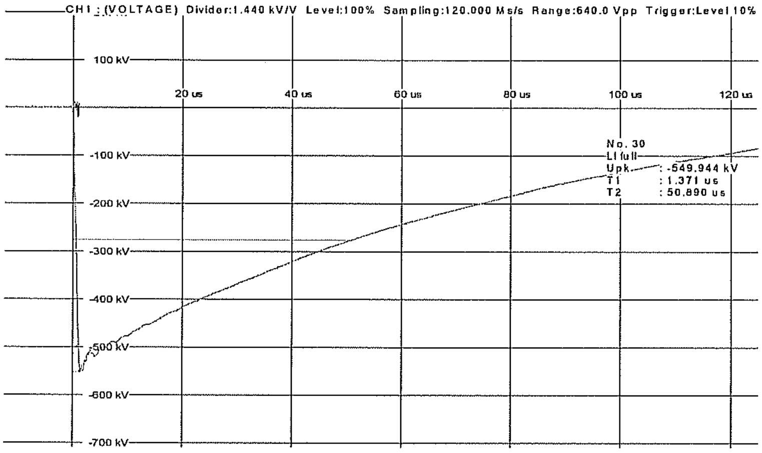


50341

6/6/2013 11:02:4

page 40

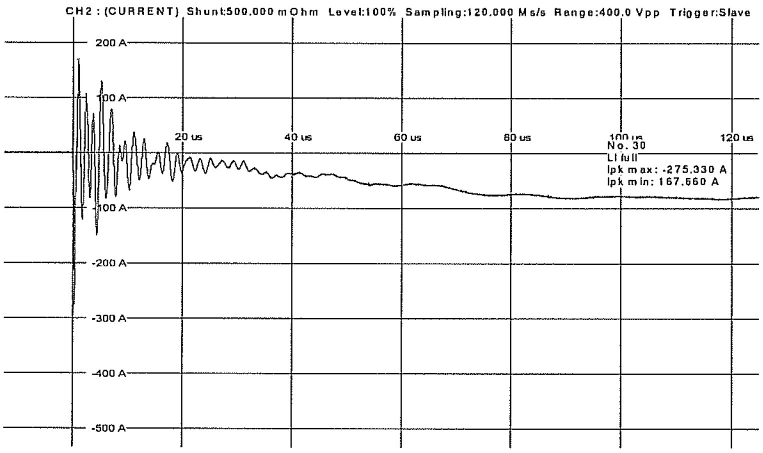
HIGH VOLTAGE WI
H2



50342

6/6/2013 11:04:1

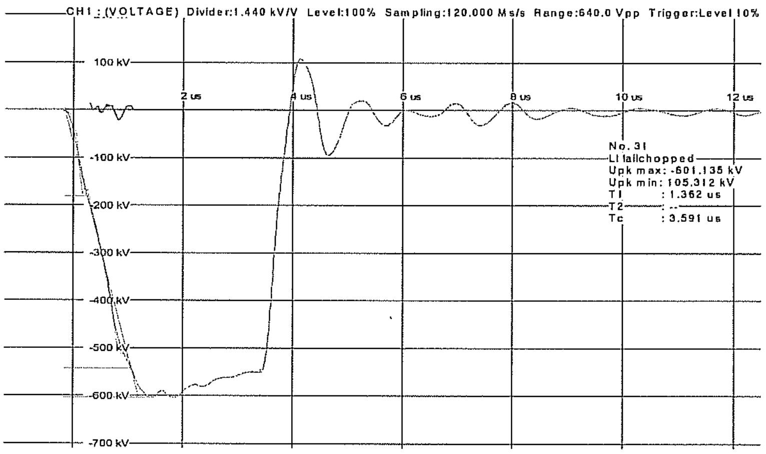
HIGH VOLTAGE WI
H2



50343

6/6/2013 11:04:1

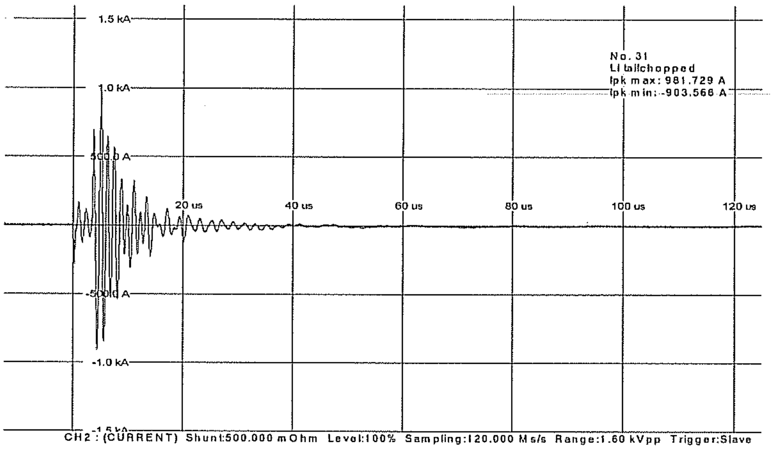
HIGH VOLTAGE WI
H2



50344

6/6/2013 11:06:4

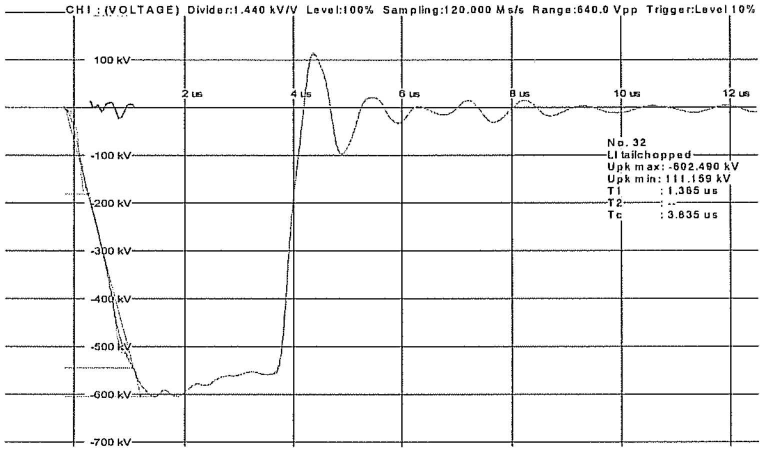
HIGH VOLTAGE WI
H2



50345

6/6/2013 11:06:4

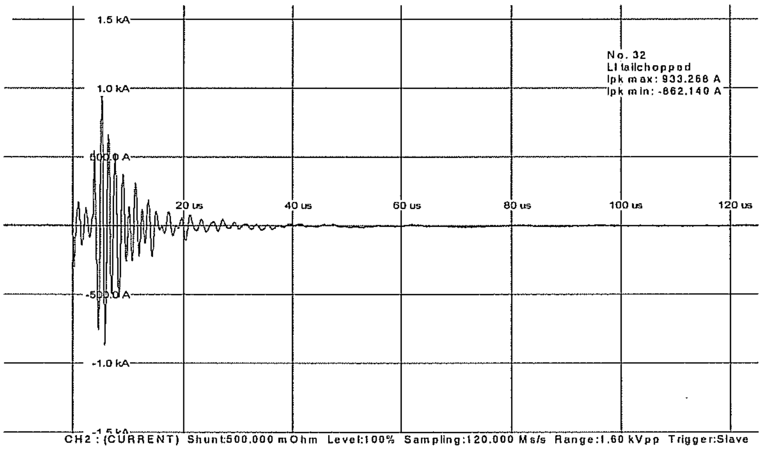
HIGH VOLTAGE WI
H2



50346

6/6/2013 11:07:3

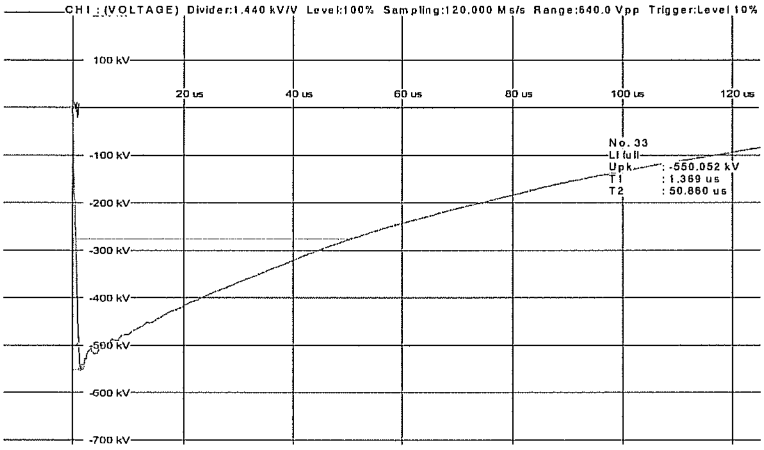
HIGH VOLTAGE WI
H2



50347

6/6/2013 11:07:3

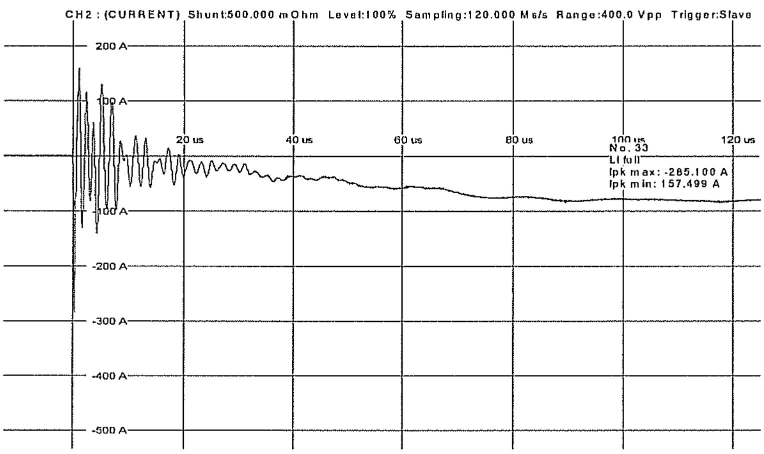
HIGH VOLTAGE WI
H2



50348

6/6/2013 11:09:3

HIGH VOLTAGE WI
H2



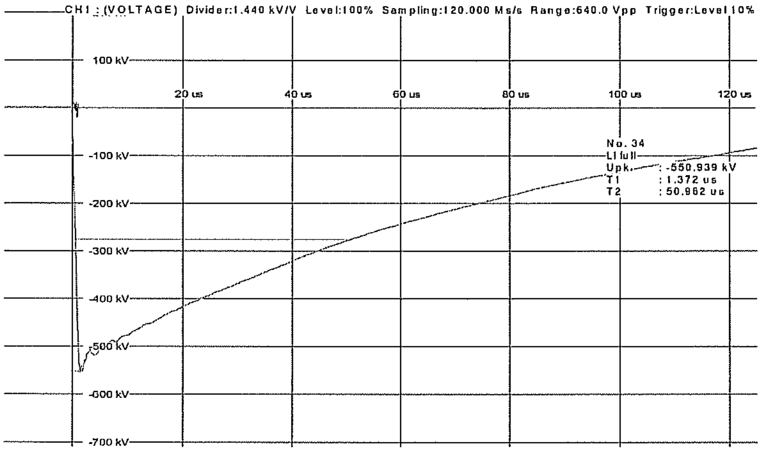
50349

6/6/2013 11:09:3

HIGH VOLTAGE WI
H2

50350

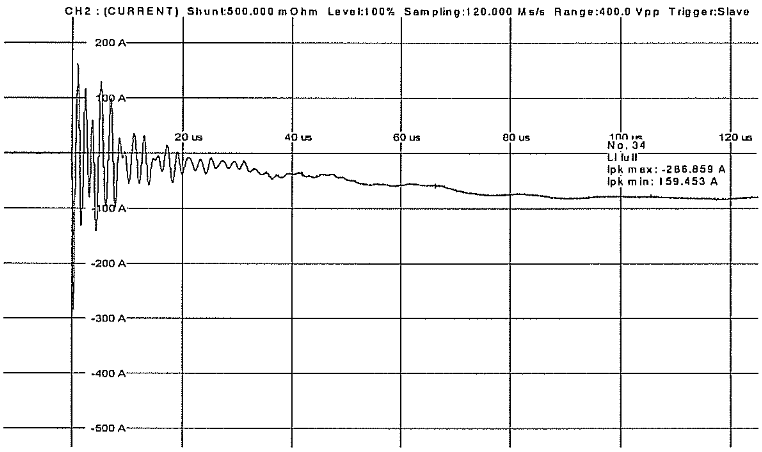
6/6/2013 11:10:3



HIGH VOLTAGE WI
H2

50351

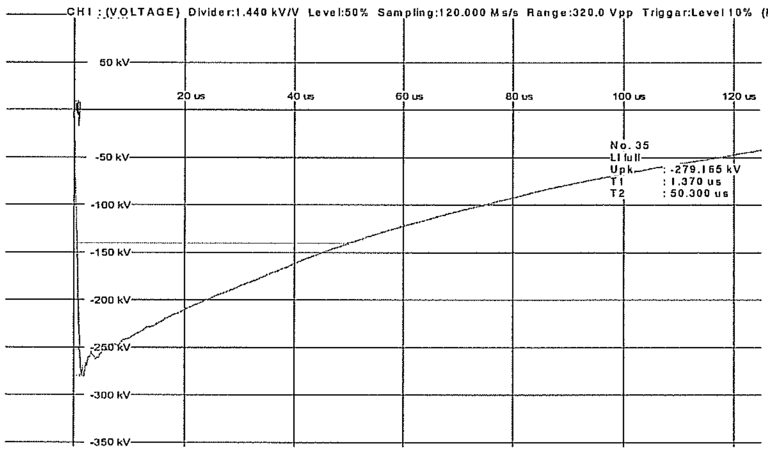
6/6/2013 11:10:3



HIGH VOLTAGE WI
H2

50352

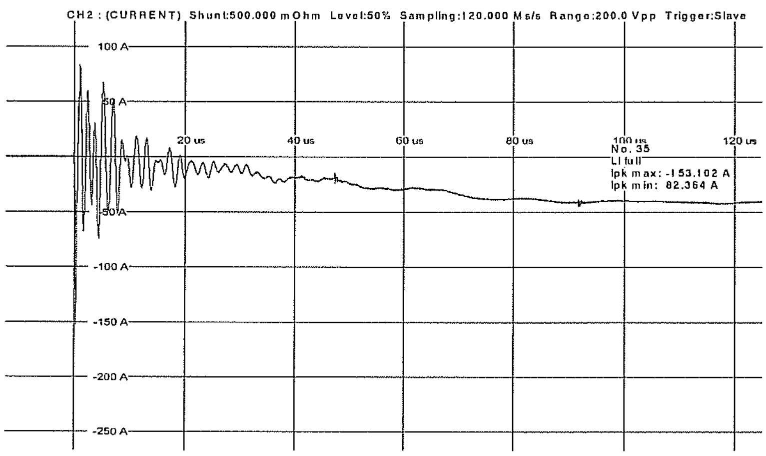
6/6/2013 11:12:4



HIGH VOLTAGE WI
H2

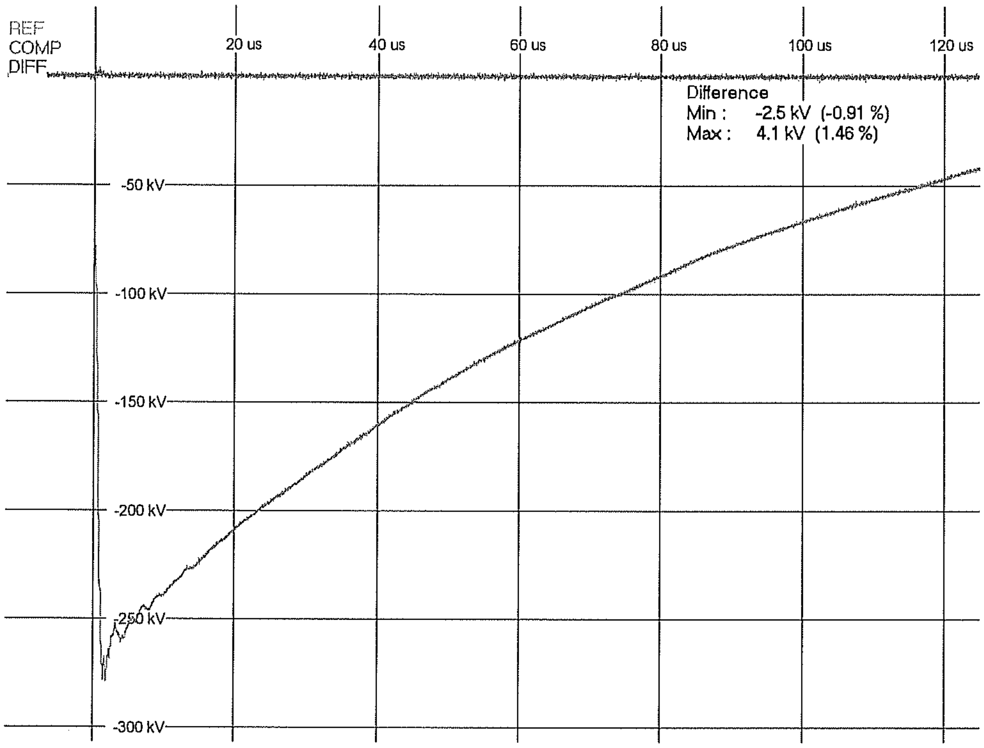
50353

6/6/2013 11:12:4



HIGH VOLTAGE
H2

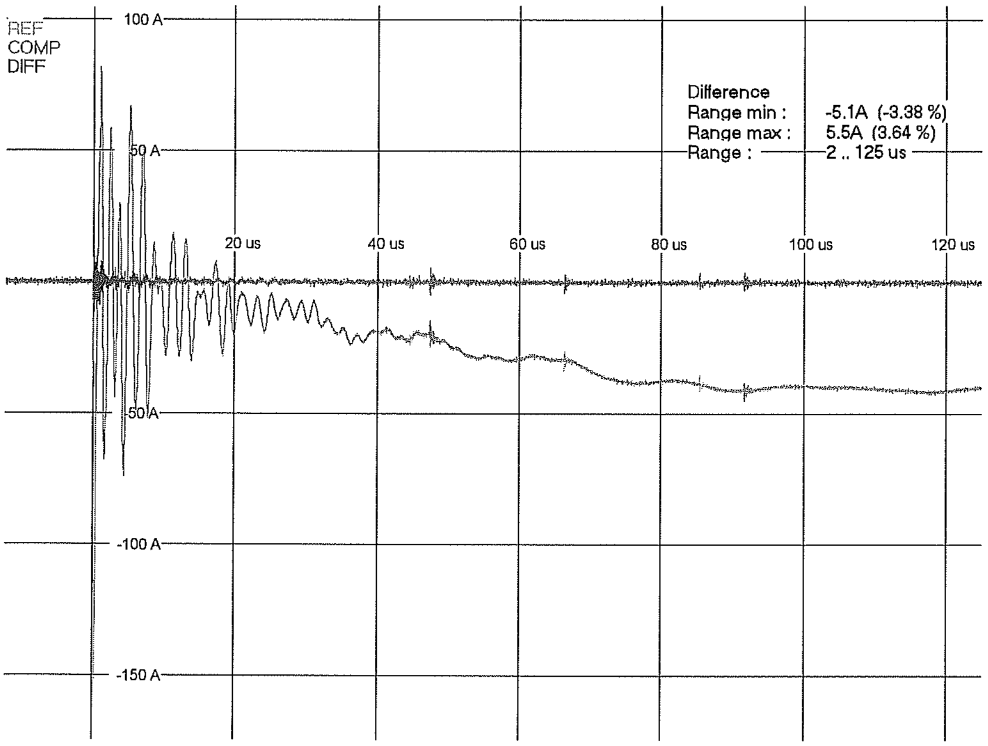
6/6/2013 11:13:2 #50354



REF: CH1 -279.03 kV #50340 COMP: CH1 -279.16 kV #50352

HIGH VOLTAGE
H2

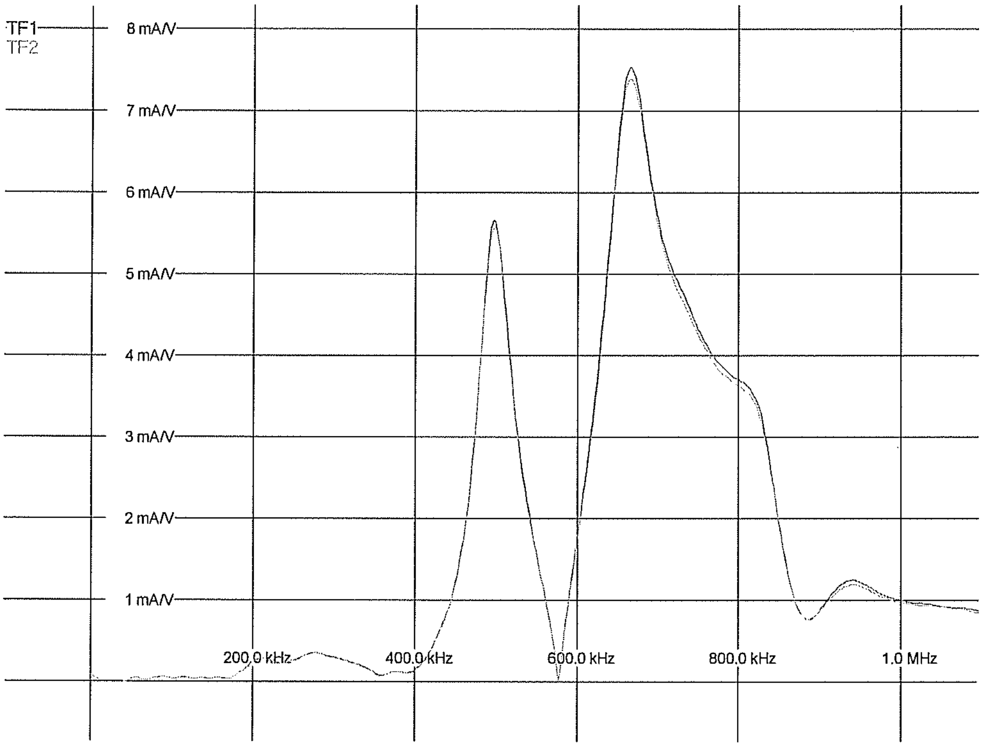
6/6/2013 11:13:4 #50355



REF: CH2 -151.05 A #50341 COMP: CH2 -153.10 A #50353

HIGH VOLTAGE
H2

6/6/2013 11:14:5 #50356



6/6/2013 11:12:47 AM; LI full; Xout: CH2 -153.10 A #50353, Threshold 0.5;
Xin: CH1 -279.16 kV #50352, Threshold 0.5
6/6/2013 11:10:34 AM; LI full; Xout: CH2 -286.85 A #50351, Threshold 0.5;
Xin: CH1 -550.93 kV #50350, Threshold 0.5

Test Report

Impulse Analysing System by Haefely Test AG

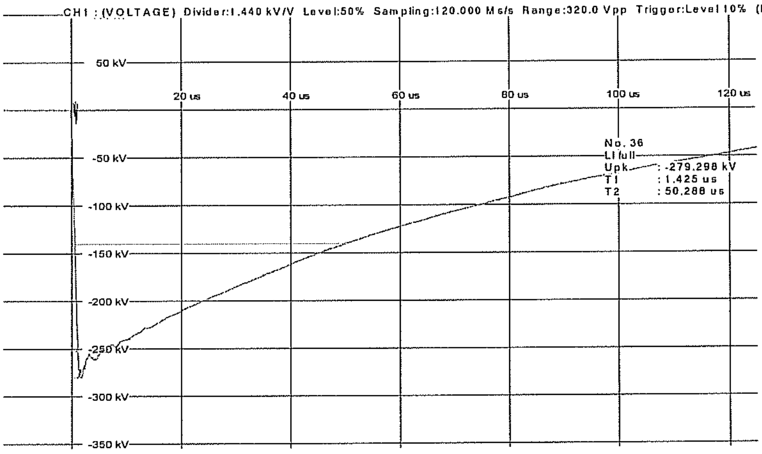
HAEFELY HIGH VOLTAGE TEST

HIGH VOLTAG

Test Information

Test manager	Kotovski Andrei	Test Report No.2359
Test engineer	Ashtar Avidan	Transformer Serial No. 13836-1
		Impulse Generator
Standards	IEEE ANSI	5s1p Rs=22+8 , Rp=92+22
		Tap pos. 5/16L

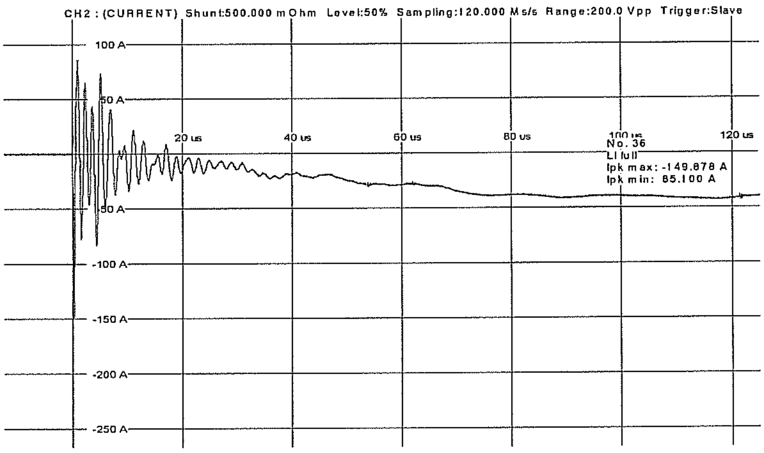
HIGH VOLTAGE WI
H3



50357

6/6/2013 11:24:1

HIGH VOLTAGE WI
H3



50358

6/6/2013 11:24:1

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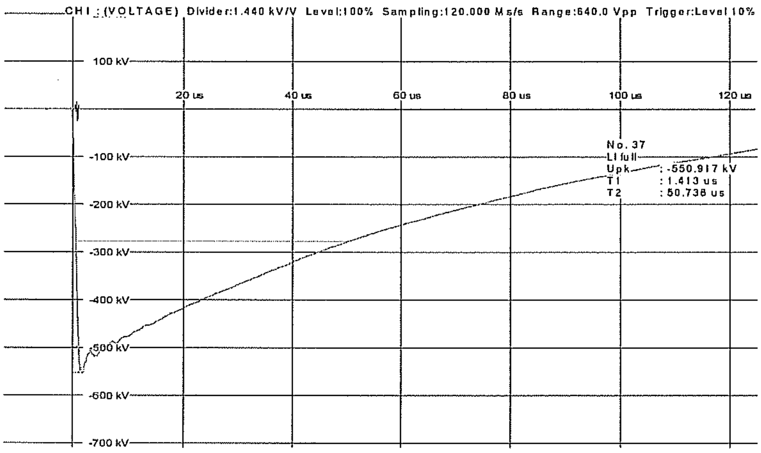
Test Report

Impulse Analysing System by Haefely Test AG

HAEFELY HIGH VOLTAGE TEST

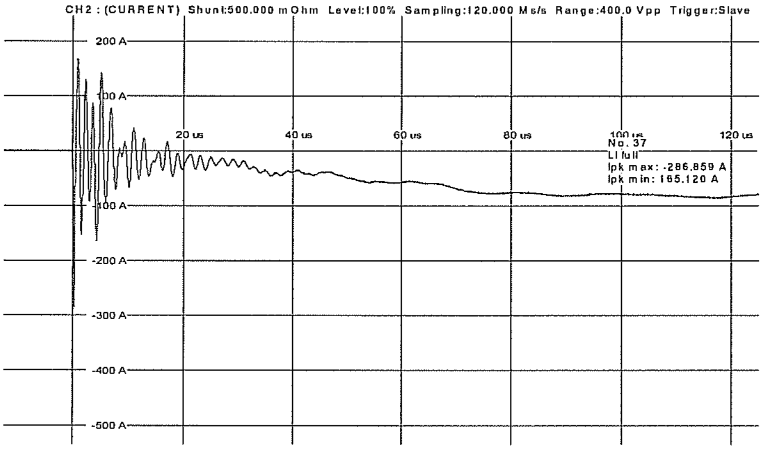
HIGH VOLTAGE WI
H3



50359

6/6/2013 11:25:3

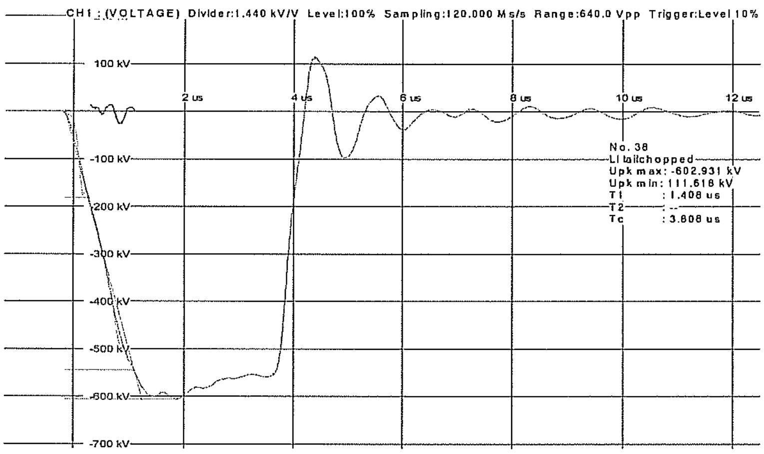
HIGH VOLTAGE WI
H3



50360

6/6/2013 11:25:3

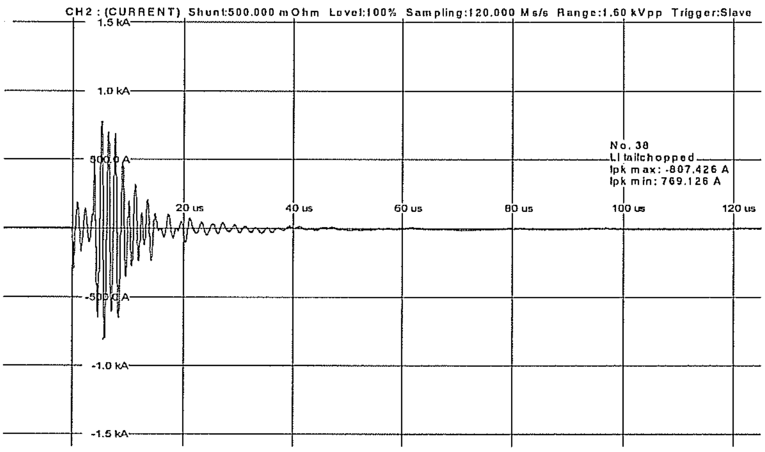
HIGH VOLTAGE WI
H3



50363

6/6/2013 11:30:4

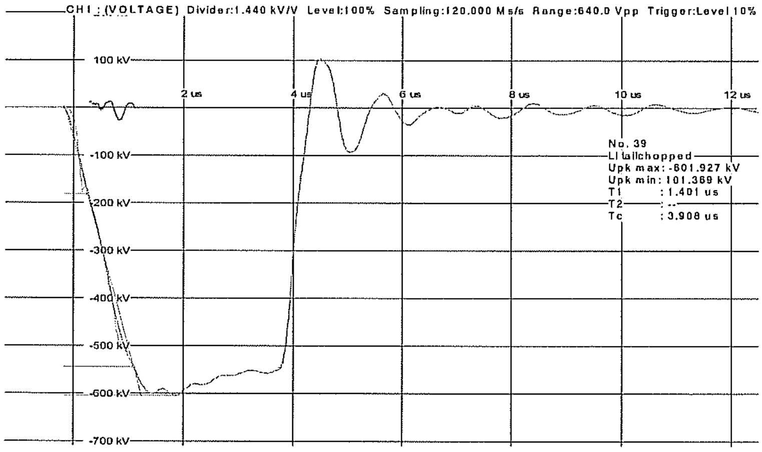
HIGH VOLTAGE WI
H3



50364

6/6/2013 11:30:4

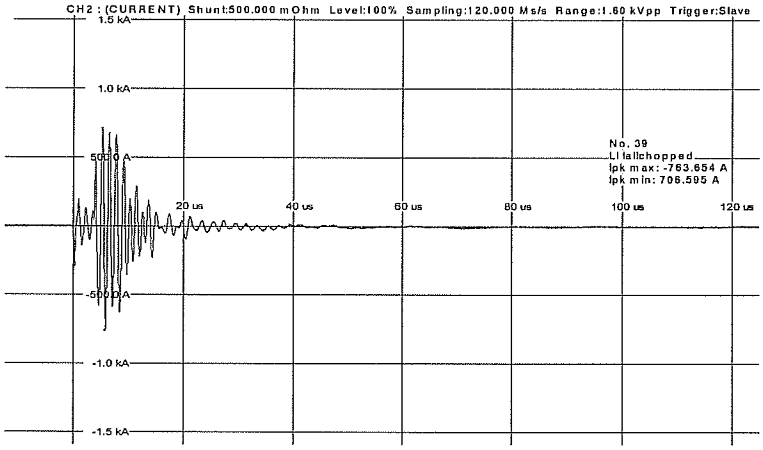
HIGH VOLTAGE WI
H3



50365

6/6/2013 11:31:3

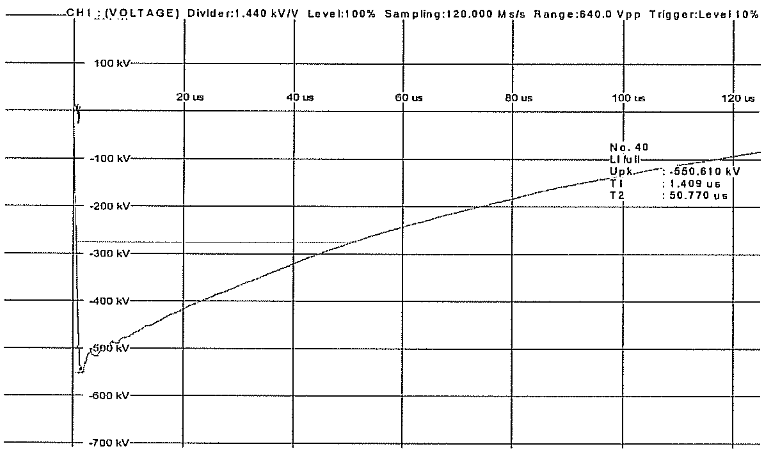
HIGH VOLTAGE WI
H3



50366

6/6/2013 11:31:3

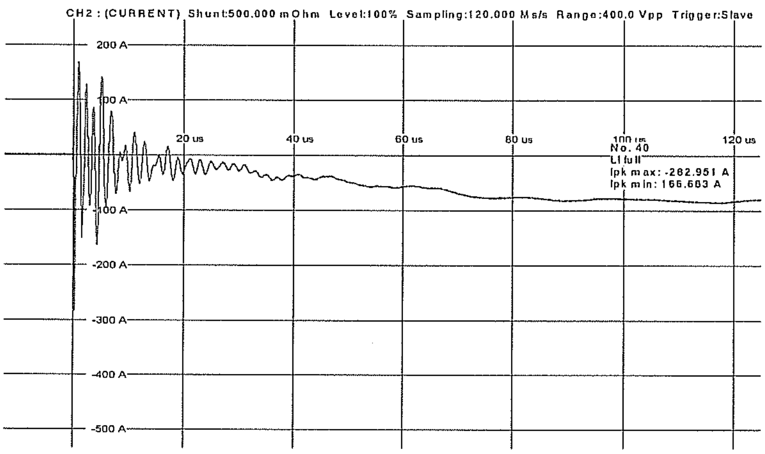
HIGH VOLTAGE WI
H3



50367

6/6/2013 11:33:4

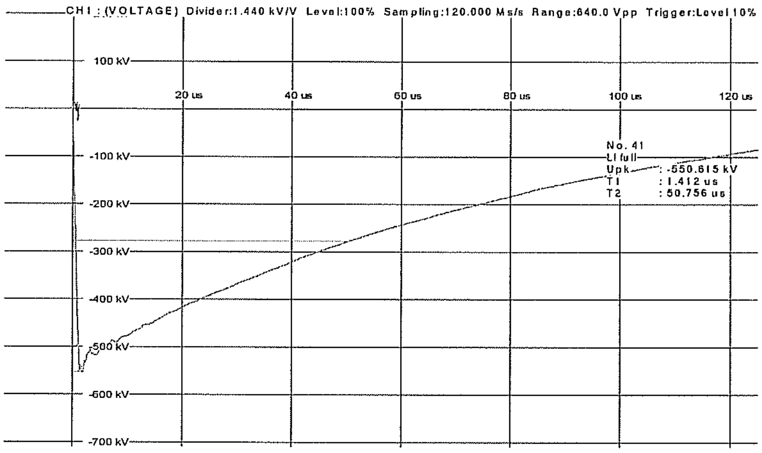
HIGH VOLTAGE WI
H3



50368

6/6/2013 11:33:4

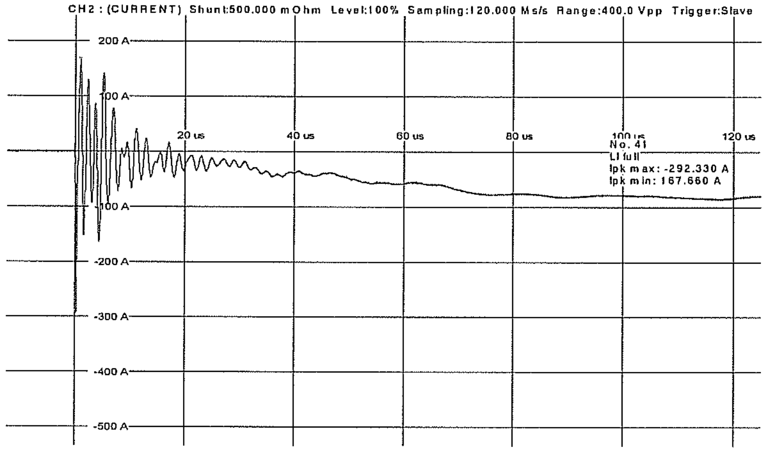
HIGH VOLTAGE WI
H3



50369

6/6/2013 11:34:3

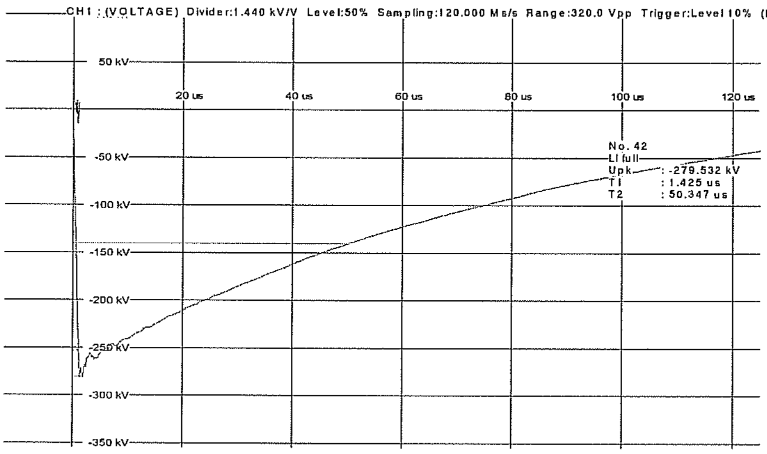
HIGH VOLTAGE WI
H3



50370

6/6/2013 11:34:3

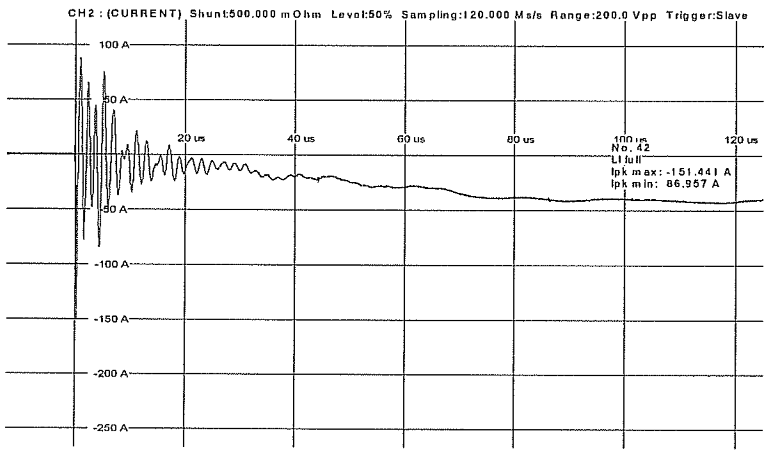
HIGH VOLTAGE WI
H3



50371

6/6/2013 11:35:3

HIGH VOLTAGE WI
H3

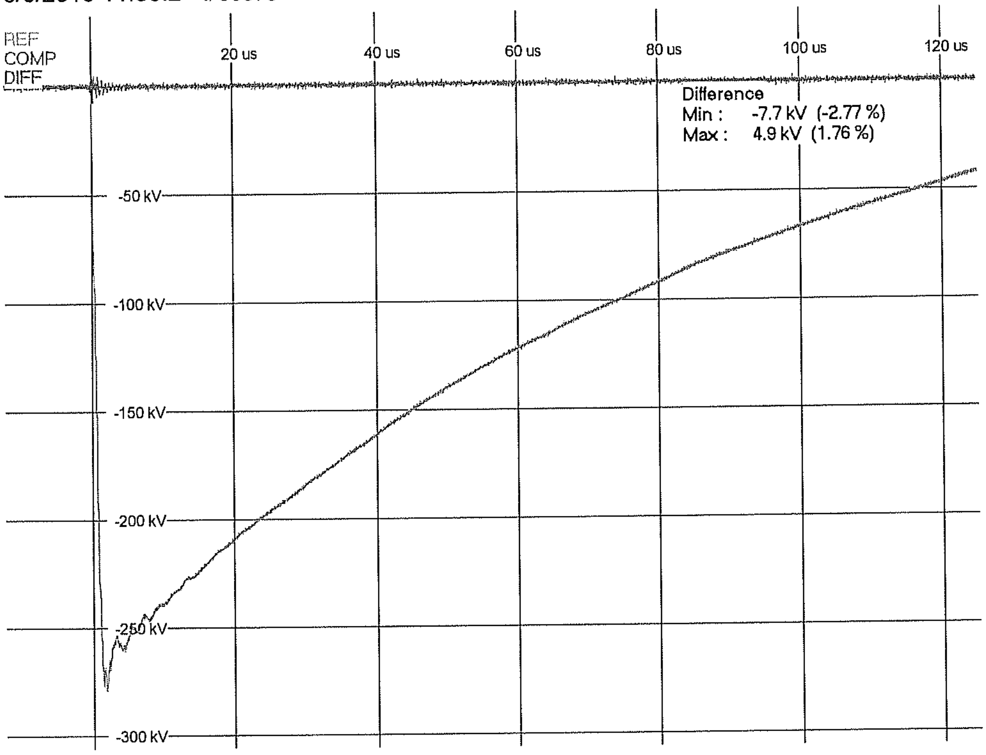


50372

6/6/2013 11:35:3

HIGH VOLTAGE
H3

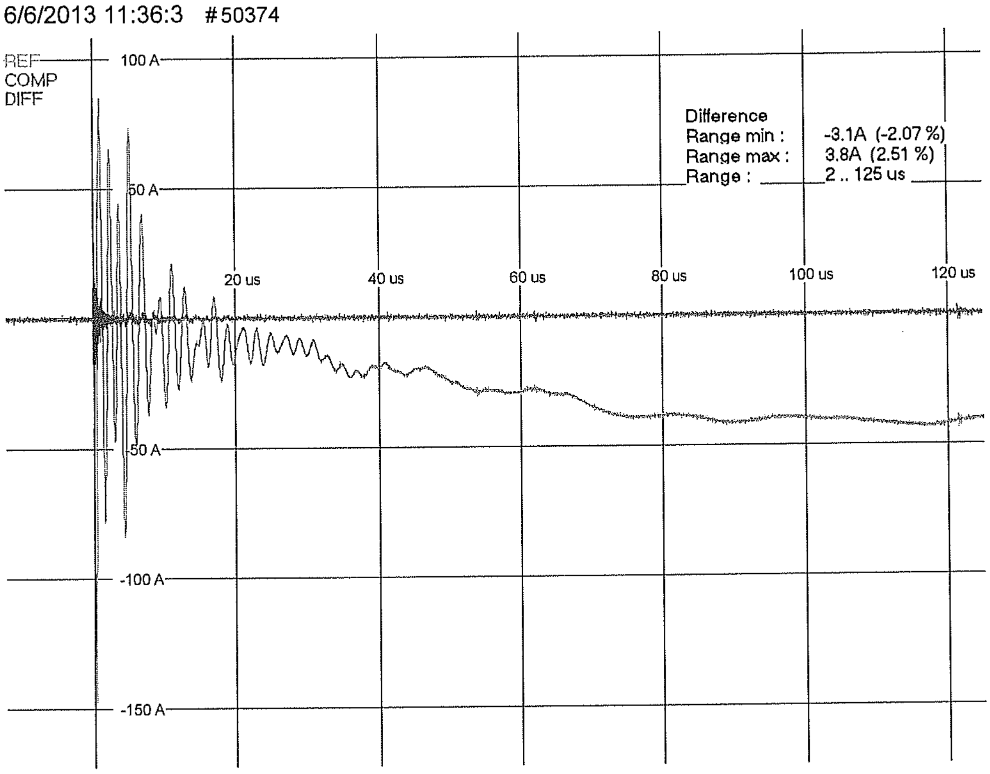
6/6/2013 11:36:2 #50373



REF: CH1 -279.29 kV #50357 COMP: CH1 -550.61 kV #50369

HIGH VOLTAGE
H3

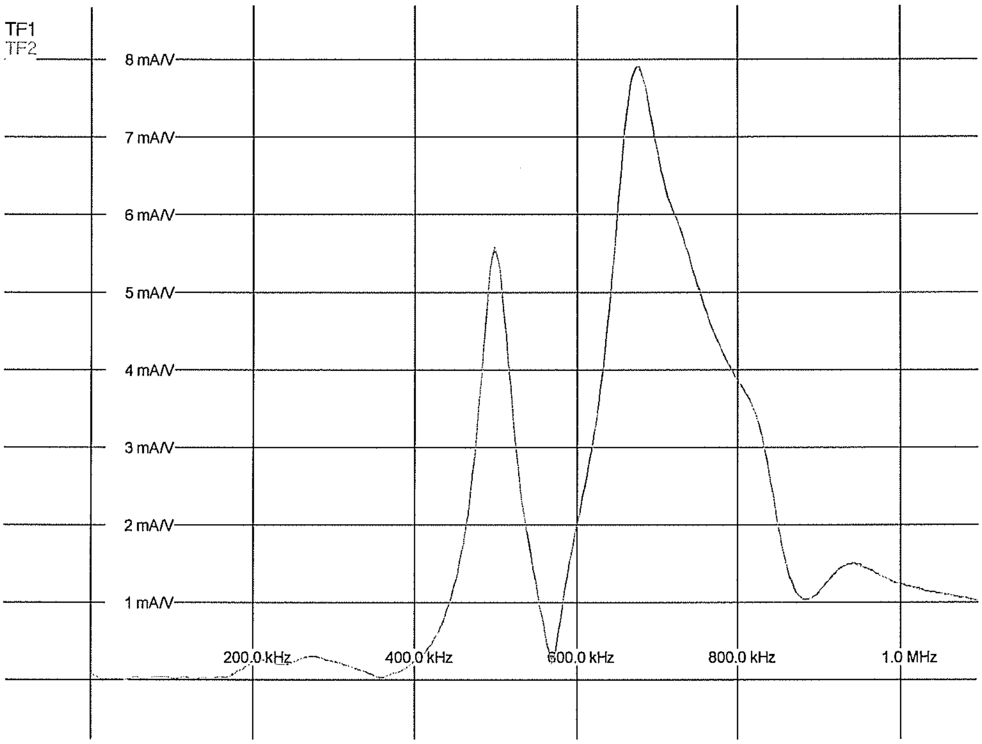
6/6/2013 11:36:3 #50374



REF: CH2 -149.87 A #50358 COMP: CH2 -292.33 A #50370

HIGH VOLTAGE
H3

6/6/2013 11:37:5 #50375



6/6/2013 11:24:13 AM; LI full; Xout: CH2 -149.87 A #50358, Threshold 0.5;
Xin: CH1 -279.29 kV #50357, Threshold 0.5
6/6/2013 11:34:30 AM; LI full; Xout: CH2 -292.33 A #50370, Threshold 0.5;
Xin: CH1 -550.61 kV #50369, Threshold 0.5

Bushing Current transformer test   page 51/1
Test Report 2359

CERTIFIED CURRENT TRANSFORMER TEST REPORT

PAGE 1

MERAMEC Electrical Products Co., Inc.

VON ROLL TRANSFORMERS LTD.			
CUSTOMER P.O. #:	044100		
S.O.-J.O. #:	55152 - 320830		
DES. # 09A- 035-554		QTY.:	3
CUSTOMER C.T. #:	0518547851		
STANDARD:	IEEE C57.13		
RATIO:	100/900/1100/1500:5		
ACCURACY:	C800 @ 1500:5		
FREQ.:	60 HZ	BURDEN:	8.0 OHMS
R.F.:	1.5 @ ALL RATIOS		
DATE:	02/12/13		

THERMAL 1 SEC.:	142.17	kA RMS SYM
THERMAL 3 SEC.:	82.5	kA RMS SYM
MECH. / DYNAMIC:	383.9	kA PEAK MAX.

FINISHED DIMENSIONS		
O.D.	15.7500	IN.
I.D.	7.8750	IN.
HT.	4.1250	IN.
WT.	101.8	LBS.

TURNS RATIO, POLARITY, & CT DIMENSIONS ARE VERIFIED ON EACH UNIT.

VERIFIED: ✓

LEGEND

Green cells (light shade in B&W) indicates PASS, Red cells (dark shade in B&W) indicates FAIL.

APPROVED BY: [signature]

Certificate of Compliance

Each unit was tested in full accordance with the referenced standard. All information reported in this document is certified to be true, accurate and complete. All units listed herein were found to be in full compliance.

APPLIED POTENTIAL TEST:

2500 V RMS @ 60 HZ FOR 60 SECONDS

INTER-TURN INSULATION TEST:

1600 V RMS @ 400 HERTZ FOR 18 SEC @ 1500:5

Limits set forth for secondary excitation are derived from the Meramec published curves using tolerances as defined in IEEE C57.13

SECONDARY EXCITATION VOLTS VERSUS AMPS					SECONDARY EXCITING CURRENT, Iex	RATIO CORRECTION FACTOR (RCF = 1 + Iex/Inom)	RESISTANCE ACROSS FULL WINDING w/ LEADS (if applicable)
MEASURED RATIO: 1500:5		SECONDARY CONNECTION: X1-X5					
TESTING LIMITS:	10 AMPS MAX.	0.065 AMPS MAX.	0.036 AMPS MAX.	0.021 AMPS MAX.	0.15 A. MAX.	1.03 MAX.	0.632 min. & 0.861 max.
SERIAL NUMBER	844.1 V (Es)	474 VOLTS	237 VOLTS	118 VOLTS	42.2 VOLTS	100%	@ 75 DEG. C
320830-1	0.24 AMPS	0.052 AMPS	0.030 AMPS	0.018 AMPS	0.008	1.0020	0.700 OHMS
320830-2	0.25 AMPS	0.051 AMPS	0.030 AMPS	0.018 AMPS	0.008	1.0020	0.705 OHMS
320830-3	0.27 AMPS	0.052 AMPS	0.031 AMPS	0.018 AMPS	0.008	1.0020	0.697 OHMS

CURRENT TRANSFORMER SERIAL No.	CT MOUNTED ON POWER TRANSFORMER No. 13836/1 Phase	CT
320830-3	H1	CT1-A
320830-2	H2	CT1-B
320830-1	H3	CT1-C

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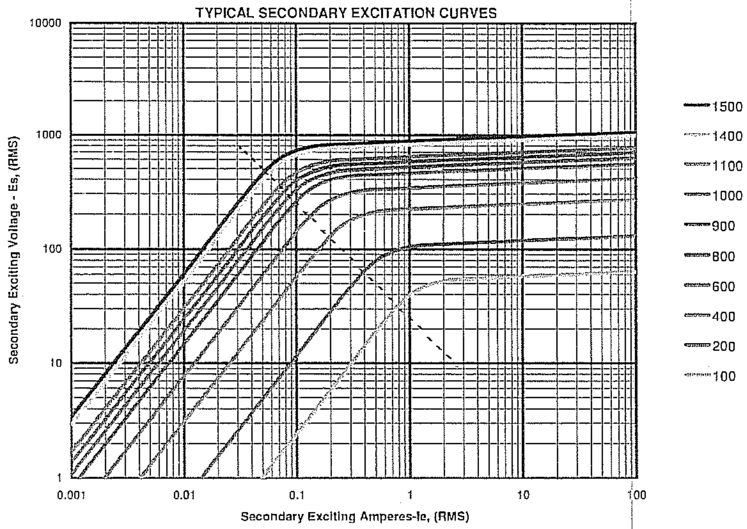
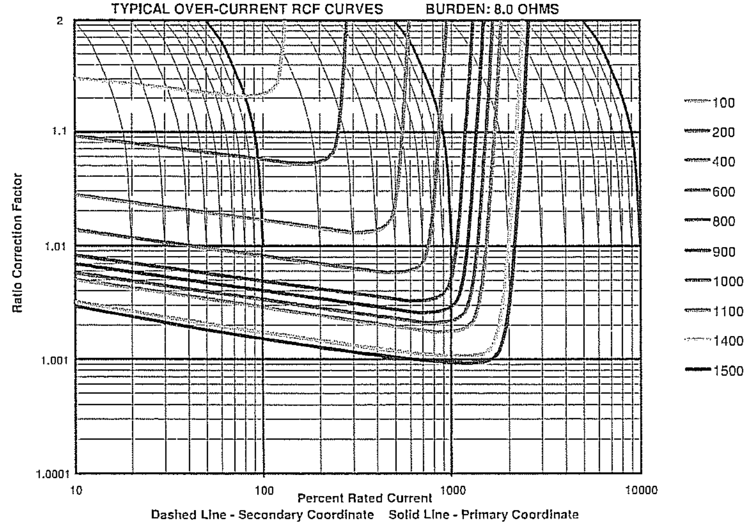
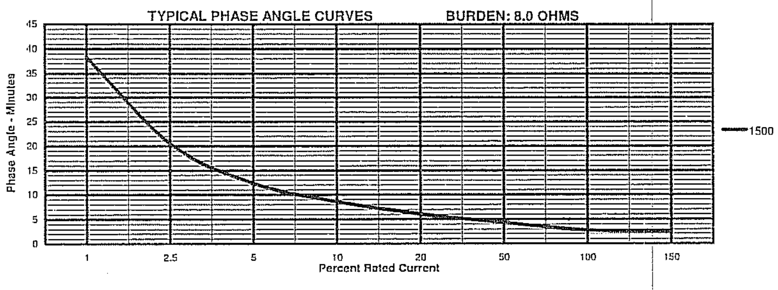
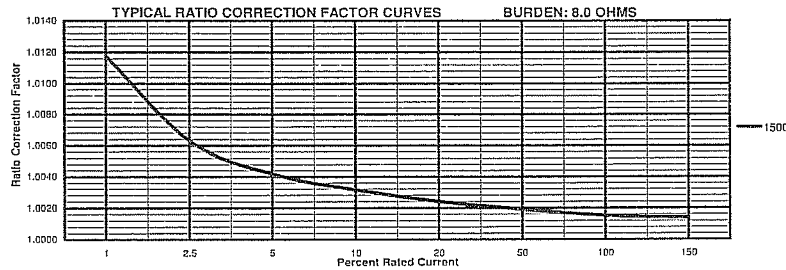








DESIGN SPECIFICATIONS

FINISHED OUTSIDE DIAMETER:	15.75 inches / 400 mm	
FINISHED INSIDE DIAMETER:	7.875 inches / 200 mm	
FINISHED HEIGHT:	4.125 inches / 105 mm	
FINISHED WEIGHT:	91.8 lbs / 46.2 kGs	
STANDARD:	IEEE C57.13	
TYPE:	BUSHING CURRENT TRANSFORMER	
INSULATION LEVEL:	0.6kV CLASS	
TEMPERATURE CLASS:	105° C.	
FREQUENCY:	60	HZ
DESIGN RATIO:	100/900/1100/1500:5	
GUARANTEED @ RATIO:	1500 : 5	
TOTAL SECONDARY TURNS:	300	
SECONDARY RESISTANCE @ 75° C:	0.00259	OHMS / TURN
LEAD RESISTANCE @ 75° C: (2 LEADS OF #8 GUAGE)	0.00154	OHMS / FT
LEAD RESISTANCE @ 75° C: (2 LEADS OF #10 GUAGE)	0.00245	OHMS / FT
LEAD RESISTANCE @ 75° C: (2 LEADS OF #12 GUAGE)	0.00382	OHMS / FT
CONTINUOUS THERMAL RATING FACTOR:	1.5	TIMES RATED @ ALL TAPS
THERMAL 1 SECOND: (94.8 times nominal ratio)	142.2	kA RMS SYM @ FULL RATIO
THERMAL 3 SECOND: (55 times nominal ratio)	82.5	kA RMS SYM @ FULL RATIO
MECH. / DYNAMIC RATING: (255.9 times nominal ratio)	383.9	Pk MAX
ACCURACY CLASS:	C800 @ 1500:5	

TYPICAL CHARACTERISTIC CURVES

DESIGN NOTES

RATIO	TURNS	CONNECTION
100 : 5	20	X1-X2
200 : 5	40	X3-X4
400 : 5	80	X4-X5
600 : 5	120	X3-X5
800 : 5	160	X2-X3
900 : 5	180	X1-X3
1000 : 5	200	X2-X4
1100 : 5	220	X1-X4
1400 : 5	280	X2-X5
1500 : 5	300	X1-X5

The Secondary Excitation Curves dashed (---) line represents the knee point (Ek) the point tangent to the curve at 45° to the exciting current Ie.

TOLERANCE OF CURVE VALUE: To the right of this line at any current Ie the voltage Es cannot be <95%. To the left of this line at any voltage Es the current Ie cannot be >125%.

REVISION HISTORY

REV.	DATE	DESCRIPTION

VON ROLL TRANSFORMERS LTD.

Part Number: 0518547851

Drawn by: [signature] 01/06/11

Meramec Drawing: 09A-035-554 REV. 00

MERAMEC Electrical Products Co., Inc.

CERTIFIED CURRENT TRANSFORMER TEST REPORT

PAGE 1

MERAMEC Electrical Products Co., Inc.

VON ROLL TRANSFORMERS LTD.

CUSTOMER P.O. #:	044100
S.O.-J.O. #:	55152 - 320832
DES. # 09A- 035-907	QTY.: 3
CUSTOMER C.T. #:	0518547853
STANDARD:	IEEE C57.13
RATIO:	2000:5
ACCURACY:	C800 @ 2000:5
FREQ.:	60 HZ · BURDEN: 8.0 OHMS
R.F.:	2.0 @ ALL RATIOS
DATE:	02/12/13

THERMAL 1 SEC.:	189.56	kA RMS SYM
THERMAL 3 SEC.:	109.9	kA RMS SYM
MECH. / DYNAMIC:	511.8	kA PEAK MAX.

FINISHED DIMENSIONS

O.D.	15.7500	IN.
I.D.	7.8750	IN.
HT.	3.3750	IN.
WT.	79.7	LBS.

TURNS RATIO, POLARITY, & CT DIMENSIONS ARE VERIFIED ON EACH UNIT.

VERIFIED: ✓

LEGEND

Green cells (light shade in B&W) indicates PASS, Red cells (dark shade in B&W) indicates FAIL.

APPROVED BY: [signature]

Certificate of Compliance

Each unit was tested in full accordance with the referenced standard. All information reported in this document is certified to be true, accurate and complete. All units listed herein were found to be in full compliance.

APPLIED POTENTIAL TEST:

2500 V RMS @ 60 HZ FOR 60 SECONDS

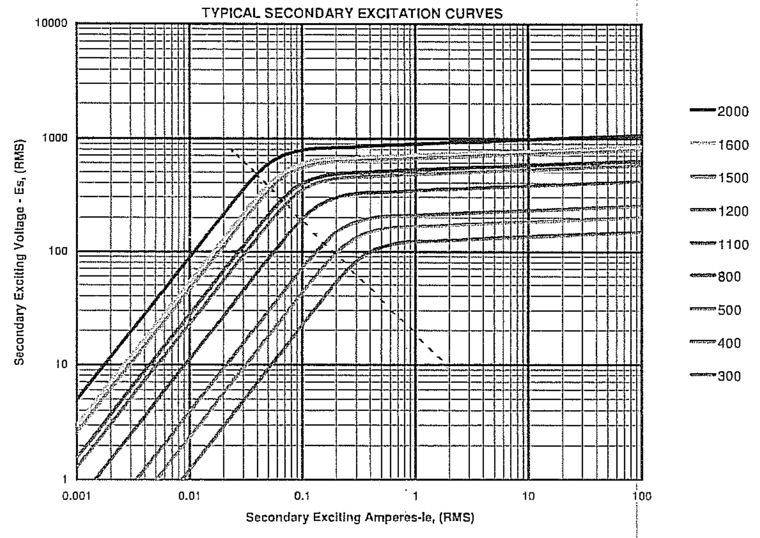
INTER-TURN INSULATION TEST:

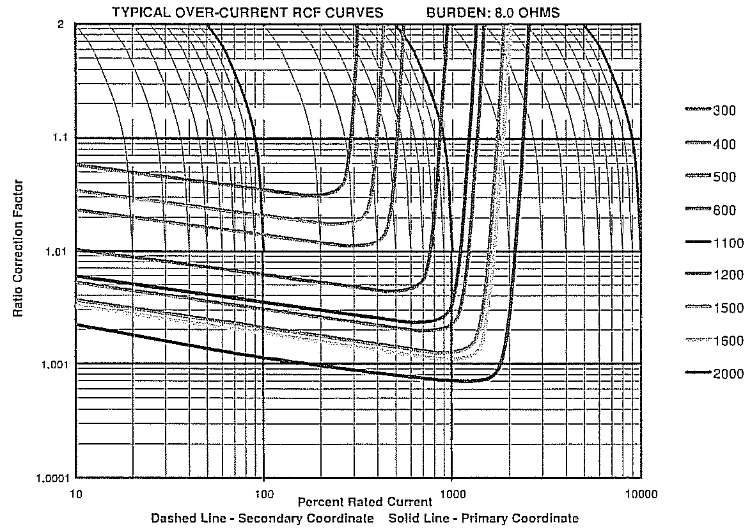
1600 V RMS @ 400 HERTZ FOR 18 SEC @ 2000:5

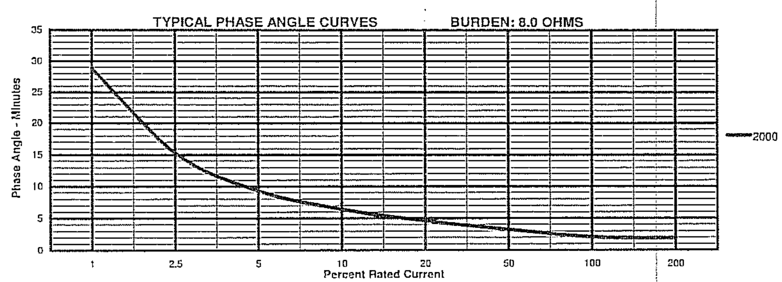
Limits set forth for secondary excitation are derived from the Meramec published curves using tolerances as defined in IEEE C57.13

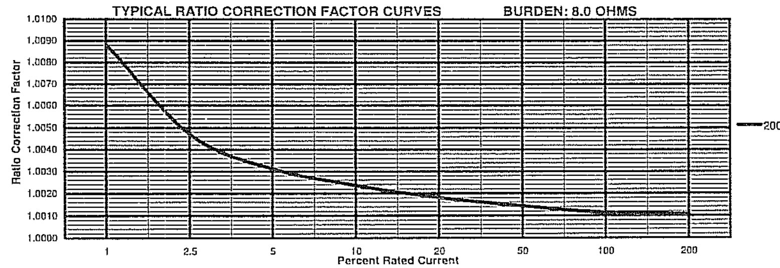
SECONDARY EXCITATION VOLTS VERSUS AMPS								SECONDARY EXCITING CURRENT, Iex	RATIO CORRECTION FACTOR (RCF = 1 + Iex/Inom)	RESISTANCE ACROSS FULL WINDING w/ LEADS (if applicable)	
MEASURED RATIO: 2000:5			SECONDARY CONNECTION: X1-X5								
TESTING LIMITS:	10 AMPS MAX.		0.048 AMPS MAX.		0.027 AMPS MAX.		0.016 AMPS MAX.	0.15 A. MAX.	1.03 MAX.	0.746 min. & 1.017 max.	
SERIAL NUMBER	852.7	V (Es)	474	VOLTS	237	VOLTS	118 VOLTS	42.6 VOLTS	100%	@ 75 DEG. C	
320832-1	0.35	AMPS	0.041	AMPS	0.024	AMPS	0.014 AMPS	0.007	1.0010	0.838	OHMS
320832-2	0.30	AMPS	0.040	AMPS	0.024	AMPS	0.014 AMPS	0.006	1.0010	0.827	OHMS
320832-3	0.34	AMPS	0.040	AMPS	0.024	AMPS	0.014 AMPS	0.007	1.0010	0.829	OHMS

CURRENT TRANSFORMER SERIAL No.	CT MOUNTED ON POWER TRANSFORMER No. 13836/1	
	Phase	CT
320832-2	H1	CT2-A
320832-1	H2	CT2-B
320832-3	H3	CT2-C









DESIGN SPECIFICATIONS

FINISHED OUTSIDE DIAMETER:	15.75 Inches / 400 mm	
FINISHED INSIDE DIAMETER:	7.875 Inches / 200 mm	
FINISHED HEIGHT:	3.375 Inches / 86 mm	
FINISHED WEIGHT:	69.7 lbs / 36.1 kGs	
STANDARD:	IEEE C57.13	
TYPE:	BUSHING CURRENT TRANSFORMER	
INSULATION LEVEL:	0.6kV CLASS	
TEMPERATURE CLASS:	105° C.	
FREQUENCY:	60	HZ
DESIGN RATIO:	2000:5MR	
GUARANTEED @ RATIO:	2000 : 5	
TOTAL SECONDARY TURNS:	400	
SECONDARY RESISTANCE @ 75° C:	0.00231	OHMS / TURN
LEAD RESISTANCE @ 75° C: (2 LEADS OF #8 GUAGE)	0.00154	OHMS / FT
LEAD RESISTANCE @ 75° C: (2 LEADS OF #10 GUAGE)	0.00245	OHMS / FT
LEAD RESISTANCE @ 75° C: (2 LEADS OF #12 GUAGE)	0.00382	OHMS / FT
CONTINUOUS THERMAL RATING FACTOR:	2.0	TIMES RATED @ ALL TAPS
THERMAL 1 SECOND: (94.8 times nominal ratio)	189.6	kA RMS SYM @ FULL RATIO
THERMAL 3 SECOND: (55 times nominal ratio)	110.0	kA RMS SYM @ FULL RATIO
MECH. / DYNAMIC RATING: (256 times nominal ratio)	511.9	Pk MAX
ACCURACY CLASS:	C800 @ 2000:5	

TYPICAL CHARACTERISTIC CURVES

DESIGN NOTES

REVISION HISTORY

REV.	DATE	DESCRIPTION

RATIO	TURNS	CONNECTION
300 : 5	60	X3-X4
400 : 5	80	X1-X2
500 : 5	100	X4-X5
800 : 5	160	X2-X3
1100 : 5	220	X2-X4
1200 : 5	240	X1-X3
1500 : 5	300	X1-X4
1600 : 5	320	X2-X5
2000 : 5	400	X1-X5

The Secondary Excitation Curves dashed (---) line represents the knee point (Ek) the point tangent to the curve at 45° to the exciting current Ie.
TOLERANCE OF CURVE VALUE: To the right of this line at any current Ie the voltage Es cannot be <95%. To the left of this line at any voltage Es the current Ie cannot be >125%.

VON ROLL TRANSFORMERS LTD.

Part Number: 0518547853

Drawn by: 01/06/11

Meramec Drawing: 09A-035-907 REV. 00

MERAMEC Electrical Products Co., Inc.

CERTIFIED CURRENT TRANSFORMER TEST REPORT

VON ROLL TRANSFORMERS LTD.

CUSTOMER P.O. #: 044100
S.O.-J.O. #: 55152 - 320831
DES. # 09A- 035-555 QTY.: 1
CUSTOMER C.T. #: 0518547852
STANDARD: IEEE C57.13
RATIO: 200:5
ACCURACY: 1.2B0.9 @ 200:5

FREQ.: 60 HZ | BURDEN: 0.9 OHMS
R.F.: 2.0 @ ALL RATIOS
DATE: 02/12/13

THERMAL 1 SEC.: 18.956 kA RMS SYM
THERMAL 3 SEC.: 11.0 kA RMS SYM
MECH. / DYNAMIC: 51.2 kA PEAK MAX.

FINISHED DIMENSIONS
O.D. 15.7500 IN.
I.D. 7.8750 IN.
HT. 2.6250 IN.
WT. 60.8 LBS.

TURNS RATIO, POLARITY, & CT DIMENSIONS ARE VERIFIED ON EACH UNIT.
VERIFIED: ✓

LEGEND
Green cells (light shade in B&W) indicates PASS, Red cells (dark shade in B&W) indicates FAIL.

APPROVED BY: Miguel [signature]

MERAMEC Electrical Products Co., Inc.

Certificate of Compliance
Each unit was tested in full accordance with the referenced standard. All information reported in this document is certified to be true, accurate and complete. All units listed herein were found to be in full compliance.

APPLIED POTENTIAL TEST:
2500 V RMS @ 60 HZ FOR 60 SECONDS
INTER-TURN INSULATION TEST:
200 V RMS @ 400 HERTZ FOR 18 SEC @ 200:5

The ordinates must lie within a parallelogram when expressed as TCF=RCF-PA/2600 where limits of RCF are the same as TCF

TESTED ACCURACY: 1.2B | TESTED RATIO: 200:5 | SEC. CONN.: X1-X2

% CURRENT READINGS	PHASE ANGLE-MINUTES					RATIO CORRECTION FACTOR (RCF = 1 - RE/100)					RESISTANCE ACROSS FULL WINDING w/ LEADS (if applicable)
TESTING LIMITS:	± 124.8	± 62.4	± 62.4			± 2.4 %	± 1.2 %	± 1.2 %			0.1 min. & 0.131 max.
SERIAL NUMBER	10 %	100 %	200 %			10 %	100 %	200 %			@ 75 DEG. C
320831-1	53.00	23.90	17.40			1.0152	1.0105	1.0097			0.117 OHMS

CT MOUNTED ON POWER TRANSFORMER No.: 13836/1	
Phase	CT
H2	CT3-B

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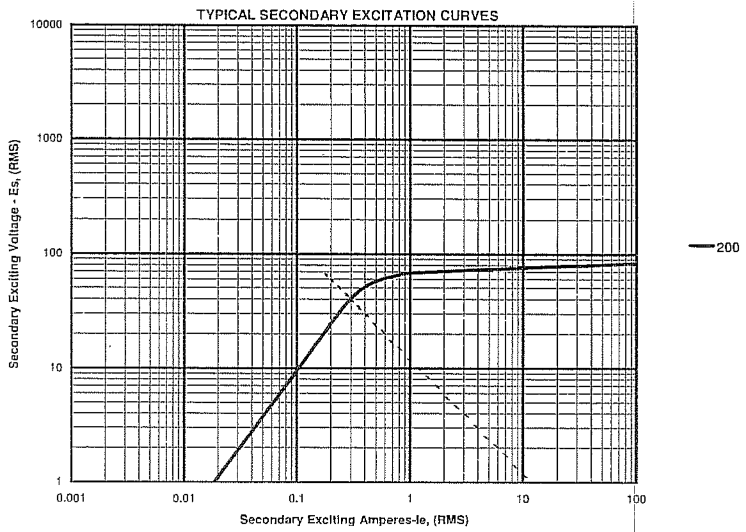

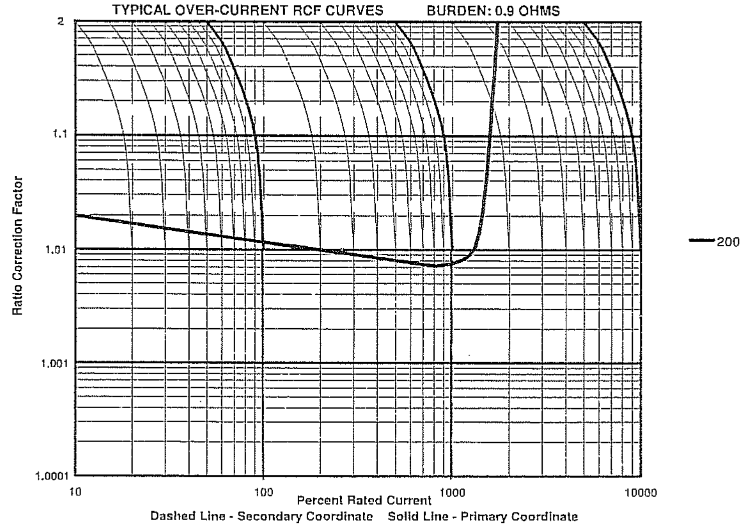

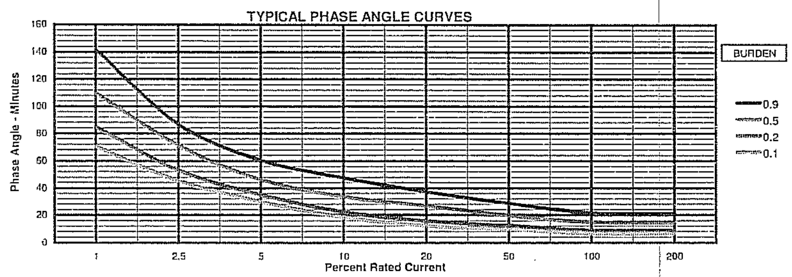

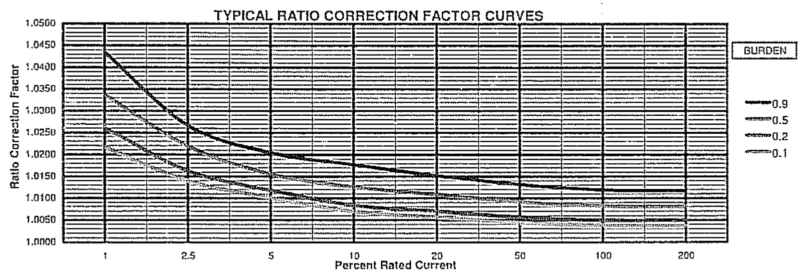

DESIGN SPECIFICATIONS

FINISHED OUTSIDE DIAMETER:	15.75 inches / 400 mm	
FINISHED INSIDE DIAMETER:	7.875 inches / 200 mm	
FINISHED HEIGHT:	2.625 inches / 67 mm	
FINISHED WEIGHT:	50.8 lbs / 27.6 kGs	
STANDARD:	IEEE C57.13	
TYPE:	BUSHING CURRENT TRANSFORMER	
INSULATION LEVEL:	0.6kV CLASS	
TEMPERATURE CLASS:	105° C.	
FREQUENCY:	60	HZ
DESIGN RATIO:	200:5SR	
GUARANTEED @ RATIO:	200 : 5	
TOTAL SECONDARY TURNS:	40	
SECONDARY RESISTANCE @ 75° C:	0.00204	OHMS / TURN
LEAD RESISTANCE @ 75° C: (2 LEADS OF #8 GUAGE)	0.00154	OHMS / FT
LEAD RESISTANCE @ 75° C: (2 LEADS OF #10 GUAGE)	0.00245	OHMS / FT
LEAD RESISTANCE @ 75° C: (2 LEADS OF #12 GUAGE)	0.00382	OHMS / FT
CONTINUOUS THERMAL RATING FACTOR:	2.0	TIMES RATED
THERMAL 1 SECOND: (95 times nominal ratio)	19.0	kA RMS SYM @ FULL RATIO
THERMAL 3 SECOND: (55 times nominal ratio)	11.0	kA RMS SYM @ FULL RATIO
MECH. / DYNAMIC RATING: (256 times nominal ratio)	51.2	Pk MAX
ACCURACY CLASS:	1.2B0.9 @ 200:5	

TYPICAL CHARACTERISTIC CURVES

DESIGN NOTES

RATIO	TURNS	CONNECTION
200 : 5	40	X1-X2

The Secondary Excitation Curves dashed (---) line represents the knee point (Ek) the point tangent to the curve at 45° to the exciting current Ie. TOLERANCE OF CURVE VALUE: To the right of this line at any current Ie the voltage Es cannot be <95%. To the left of this line at any voltage Es the current Ie cannot be >125%.

REVISION HISTORY

REV.	DATE	DESCRIPTION

VON ROLL TRANSFORMERS LTD.

Part Number: 0518547852

Drawn by: [signature] 01/06/11

Meramec Drawing: 09A-035-555 REV. 00

MERAMEC Electrical Products Co., Inc.

PAGE 1

CERTIFIED CURRENT TRANSFORMER TEST REPORT

VON ROLL TRANSFORMERS LTD.

CUSTOMER P.O. #:	044100
S.O.-J.O. #:	55152 - 320828
DES. # 09A- 033-364	QTY.: 1
CUSTOMER C.T. #:	0518547454
STANDARD:	IEEE C57.13
RATIO:	2000:5
ACCURACY:	1.2B0.9 @ 2000:5
FREQ.:	60 HZ — BURDEN: 0.9 OHMS
R.F.:	2.0 @ ALL RATIOS
DATE:	02/12/13

THERMAL 1 SEC.:	189.56	kA RMS SYM
THERMAL 3 SEC.:	109.9	kA RMS SYM
MECH. / DYNAMIC:	511.8	kA PEAK MAX.

FINISHED	DIMENSIONS	
O.D.	10.0000	IN.
I.D.	5.5000	IN.
HT.	1.8750	IN.
WT.	11.8	LBS.

TURNS RATIO, POLARITY, & CT DIMENSIONS ARE VERIFIED ON EACH UNIT.

VERIFIED: ✓

LEGEND

Green cells (light shade in B&W) indicates PASS, Red cells (dark shade in B&W) indicates FAIL.

APPROVED BY: [signature]

MERAMEC Electrical Products Co., Inc.

Certificate of Compliance

Each unit was tested in full accordance with the referenced standard. All information reported in this document is certified to be true, accurate and complete. All units listed herein were found to be in full compliance.

APPLIED POTENTIAL TEST:
2500 V RMS @ 60 HZ FOR 60 SECONDS

INTER-TURN INSULATION TEST:
200 V RMS @ 400 HERTZ FOR 18 SEC @ 2000:5

The ordinates must lie within a parallelogram when expressed as TCF=RCF-PA/2600 where limits of RCF are the same as TCF

For 1% readings, uncertainty of phase angle measurement is ±6 minutes

TESTED ACCURACY: 1.2B — TESTED RATIO: 2000:5 — SEC. CONN.: X1-X5

% CURRENT READINGS	PHASE ANGLE-MINUTES					RATIO CORRECTION FACTOR (RCF = 1 - RE/100)					RESISTANCE ACROSS FULL WINDING w/ LEADS (if applicable)
TESTING LIMITS:	± 124.8	± 62.4				± 2.4 %	± 1.2 %				0.388 min. & 0.527 max.
SERIAL NUMBER	10 %	100 %				10 %	100 %				@ 75 DEG. C
320828-1	2.86	1.19				1.0009	1.0006				0.432 OHMS

CT MOUNTED ON POWER TRANSFORMER No. 13836/1	
Phase	CT
X1	CT4-A

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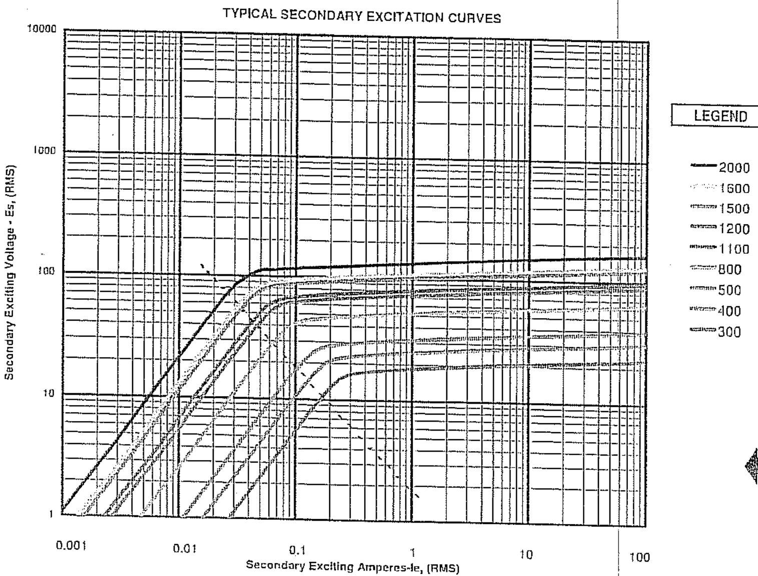
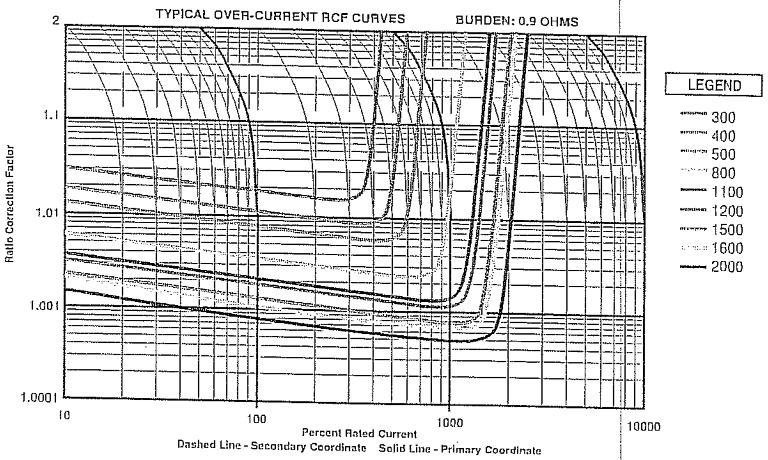




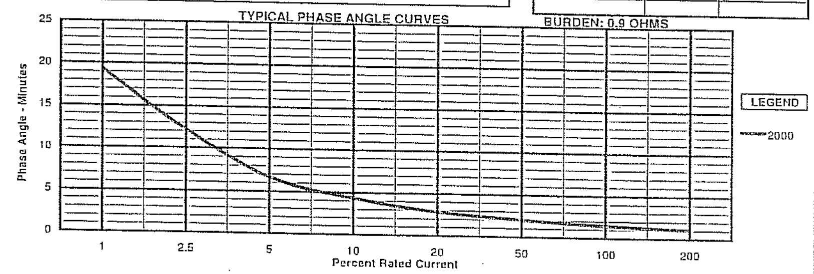
DESIGN PARAMETERS

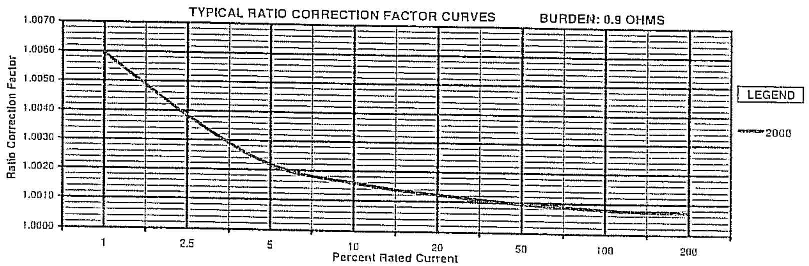
STANDARD:		IEEE C57.13
TYPE:		BUSHING CURRENT TRANSFORMER
INSULATION LEVEL:		0.6kV CLASS
TEMPERATURE CLASS:		105° C.
FREQUENCY:		60 HZ
MAXIMUM RATIO:		2000 : 5
TOTAL SECONDARY TURNS:		400
SECONDARY RESISTANCE @ 75° C:	(0.475 full winding w/ leads)	0.00109 OHMS/TURN
ACCURACY CLASS:		1.2B0.9 @ 2000:5
CONTINUOUS THERMAL RATING FACTOR:		2.0 TIMES RATED @ ALL TAPS
THERMAL RATING @ 3 SECONDS:	(55 times nominal)	110.0 KA RMS SYM. @ FULL RATIO
MECHANICAL RATING @ SECONDS:	(110 times nominal)	219.9 KA RMS SYM. @ FULL RATIO

DESIGN NOTES

RATIO	TURNS	CONNECTION
300 : 5	60	X3-X4
400 : 5	80	X1-X2
500 : 5	100	X4-X5
800 : 5	160	X2-X3
1100 : 5	220	X2-X4
1200 : 5	240	X1-X3
1500 : 5	300	X1-X4
1600 : 5	320	X2-X5
2000 : 5	400	X1-X5

The dashed (---) line represents the knee point (Ek) the point tangent to the curve at 45° to the exciting current Ie.
TOLERANCE OF CURVE VALUE:
To the right of this line at any current Ie the voltage Es cannot be <95%
To the left of this line at any voltage Es the current Ie cannot be >125%





REV.	DATE	CURVE REVISION HISTORY
01	11/05/09	INITIAL CURVE CREATION UPDATE

drawn for:	VON ROLL TRANSFORMERS LTD.		
part number:	0518547454		
drawn by:	[signature]	01/19/10	Drawing Design Number
checked by:	[signature]	01/19/10	09A-033-364

MERAMEC Electrical Products Co., Inc.

TYPICAL CHARACTERISTIC CURVES

REV. 01

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CERTIFIED CURRENT TRANSFORMER TEST REPORT

PAGE 1

VON ROLL TRANSFORMERS LTD.

CUSTOMER P.O. #:	044100
S.O.-J.O. #:	55152 - 320827
DES. # 09A- 033-365	QTY.: 1
CUSTOMER C.T. #:	0518547453
STANDARD:	IEEE C57.13
RATIO:	1600:5
ACCURACY:	1.2B0.9 @ 1600:5
FREQ.:	60 HZ — BURDEN: 0.9 OHMS
R.F.:	2.0 @ ALL RATIOS
DATE:	02/12/13

THERMAL 1 SEC.:	151.648	kA RMS SYM
THERMAL 3 SEC.:	88.0	kA RMS SYM
MECH. / DYNAMIC:	409.4	kA PEAK MAX.

FINISHED DIMENSIONS

O.D.	10.0000	IN.
I.D.	5.5000	IN.
HT.	1.8750	IN.
WT.	10.5	LBS.

TURNS RATIO, POLARITY, & CT DIMENSIONS ARE VERIFIED ON EACH UNIT.

VERIFIED: ✓

LEGEND

Green cells (light shade in B&W) indicates PASS, Red cells (dark shade in B&W) indicates FAIL.

APPROVED BY: *[signature]*

MERAMEC Electrical Products Co., Inc.

Certificate of Compliance

Each unit was tested in full accordance with the referenced standard. All information reported in this document is certified to be true, accurate and complete. All units listed herein were found to be in full compliance.

APPLIED POTENTIAL TEST:
2500 V RMS @ 60 HZ FOR 60 SECONDS

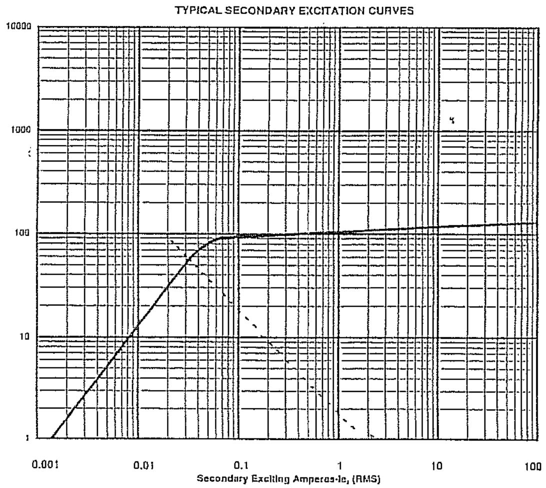
INTER-TURN INSULATION TEST:
200 V RMS @ 400 HERTZ FOR 18 SEC @ 1600:5

The ordinates must lie within a parallelogram when expressed as TCF=RCF-PA/2600 where limits of RCF are the same as TCF

For 1% readings uncertainty of phase angle measurement is ±3 minutes — TESTED ACCURACY: 1.2B — TESTED RATIO: 1600:5 — SEC. CONN.: X1-X2

% CURRENT READINGS	PHASE ANGLE-MINUTES					RATIO CORRECTION FACTOR (RCF = 1 - RE/100)					RESISTANCE ACROSS FULL WINDING w/ LEADS (if applicable)
TESTING LIMITS:	± 124.8	± 62.4	± 62.4			± 2.4 %	± 1.2 %	± 1.2 %			0.306 min. & 0.414 max.
SERIAL NUMBER	10 %	100 %	200 %			10 %	100 %	200 %			@ 75 DEG. C
320827-1	3.51	1.19	0.85			1.0015	1.0009	1.0009			0.340 OHMS

CT MOUNTED ON POWER TRANSFORMER No. 13836/1	
Phase	CT
X2	CT4-B



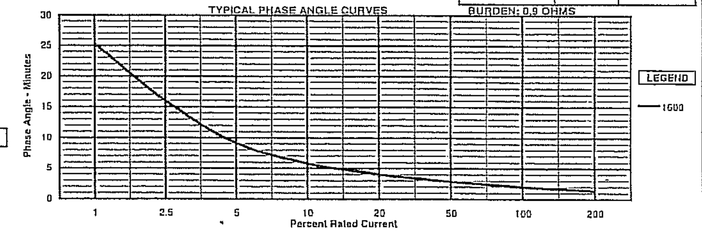
DESIGN PARAMETERS

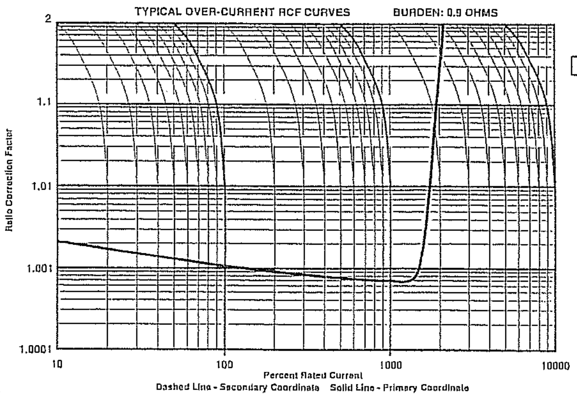
STANDARD:		IEEE C57.13
TYPE:		BUSHING CURRENT TRANSFORMER
INSULATION LEVEL:		0.6kV CLASS
TEMPERATURE CLASS:		105°C.
FREQUENCY:		60 HZ
MAXIMUM RATIO:		1600 : 5
TOTAL SECONDARY TURNS:		320
SECONDARY RESISTANCE @ 75°C:	(0.373 full winding w/ leads)	0.00104 OHMS/TURN
ACCURACY CLASS:		1.2B0.9 @ 1600:5
CONTINUOUS THERMAL RATING FACTOR:		2.0 TIMES RATED @ ALL TAPS
THERMAL RATING @ 3 SECONDS:	(55 times nominal)	88.0 KA RMS SYM.
MECHANICAL RATING @ SECONDS:	(110 times nominal)	175.9 KA RMS SYM.

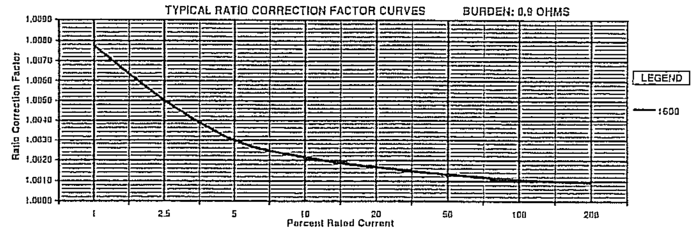
DESIGN NOTES

RATIO	TURNS	CONNECTION
1600 : 5	320	X1-X2

The dashed (—) line represents the knee point (Ek) the point tangent to the curve at 45° to the exciting current Ie.
TOLERANCE OF CURVE VALUE:
To the right of this line at any current Ie the voltage Es cannot be <95%
To the left of this line at any voltage Es the current Ie cannot be >125%







REV.	DATE	CURVE REVISION HISTORY
01	11/05/09	INITIAL CURVE CREATION UPDATE

drawn for: VON ROLL TRANSFORMERS LTD.

part number: 0518547453

drawn by: [signature] 01/19/10

checked by: [signature] 01/19/10

Drawing Design Number: 09A-033-365

MERAMEC Electrical Products Co., Inc.

TYPICAL CHARACTERISTIC CURVES

REV. 01

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PAGE 1 — CERTIFIED CURRENT TRANSFORMER TEST REPORT

VON ROLL TRANSFORMERS LTD.

CUSTOMER P.O. #: 044100
S.O.-J.O. #: 55152 - 320829
DES. # 09A- 033-361 QTY.: 1
CUSTOMER C.T. #: 0518547463
STANDARD: IEEE C57.13
RATIO: 2000:5
ACCURACY: C400 @ 2000:5

FREQ.: 60 HZ | BURDEN: 4.0 OHMS
R.F.: 2.0 @ ALL RATIOS
DATE: 02/12/13

THERMAL 1 SEC.: 189.56 kA RMS SYM
THERMAL 3 SEC.: 109.9 kA RMS SYM
MECH. / DYNAMIC: 511.8 kA PEAK MAX.

FINISHED DIMENSIONS
O.D. 10.0000 IN.
I.D. 5.5000 IN.
HT. 3.6250 IN.
WT. 30.4 LBS.

TURNS RATIO, POLARITY, & CT DIMENSIONS ARE VERIFIED ON EACH UNIT.
VERIFIED: ✓

LEGEND
Green cells (light shade in B&W) indicates PASS, Red cells (dark shade in B&W) indicates FAIL.

APPROVED BY: [signature]

MERAMEC Electrical Products Co., Inc.

Certificate of Compliance
Each unit was tested in full accordance with the referenced standard. All information reported in this document is certified to be true, accurate and complete. All units listed herein were found to be in full compliance.

APPLIED POTENTIAL TEST:
2500 V RMS @ 60 HZ FOR 60 SECONDS

INTER-TURN INSULATION TEST:
800 V RMS @ 400 HERTZ FOR 18 SEC @ 2000:5

Limits set forth for secondary excitation are derived from the Meramec published curves using tolerances as defined in IEEE C57.13

SECONDARY EXCITATION VOLTS VERSUS AMPS									SECONDARY EXCITING CURRENT, Iex	RATIO CORRECTION FACTOR (RCF = 1 + Iex/Inom)	RESISTANCE ACROSS FULL WINDING w/ LEADS (if applicable)	
MEASURED RATIO:	2000:5		SECONDARY CONNECTION:			X1-X5						
TESTING LIMITS:	10 AMPS MAX.		0.032 AMPS MAX.		0.018 AMPS MAX.		0.01 AMPS MAX.		0.15 A. MAX.	1.03 MAX.	0.584 min. & 0.796 max.	
SERIAL NUMBER	442.9	V (Es)	236	VOLTS	118	VOLTS	59	VOLTS	22.1 VOLTS	100%	@ 75 DEG. C	
320829-1	0.83	AMPS	0.026	AMPS	0.016	AMPS	0.009	AMPS	0.004	1.0010	0.644	OHMS

CT MOUNTED ON POWER
TRANSFORMER No. 13836/1

Phase	CT
X0	CT 4-N

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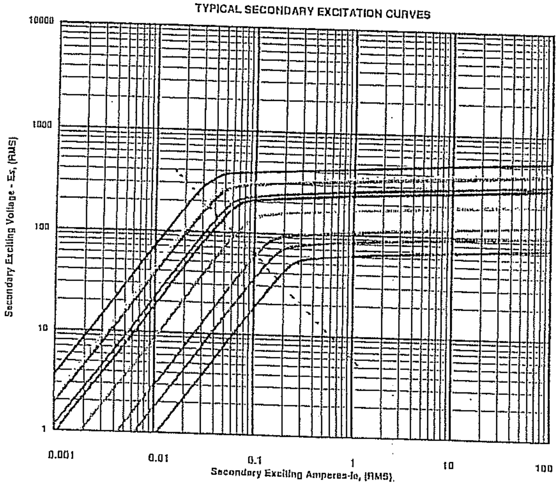
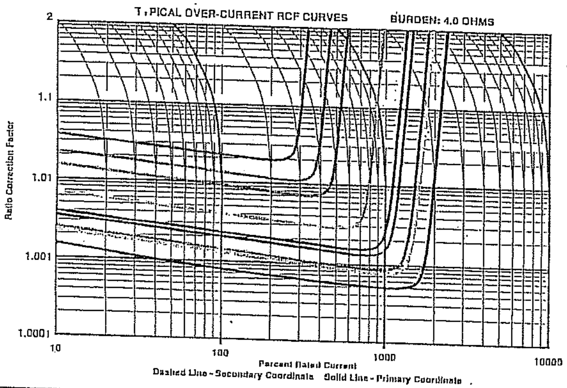




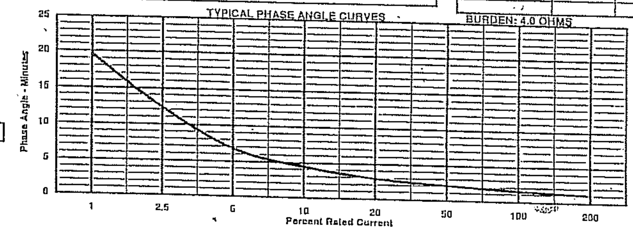
DESIGN PARAMETERS

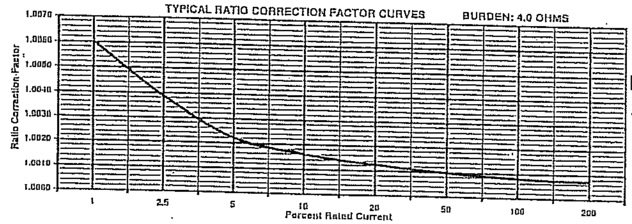
STANDARD:		IEEE C57.13
TYPE:		BUSHING CURRENT TRANSFORMER
INSULATION LEVEL:		0.6kV CLASS
TEMPERATURE CLASS:		105° C.
FREQUENCY:		60 HZ
MAXIMUM RATIO:		2000 : 5
TOTAL SECONDARY TURNS:		400
SECONDARY RESISTANCE @ 75° C:	(0.710 full winding w/ leads)	0.00170 OHMS/TURN
ACCURACY CLASS:		C400 @ 2000:5
CONTINUOUS THERMAL RATING FACTOR:		2.0 TIMES RATED @ ALL TAPS
THERMAL RATING @ 3 SECONDS:	(55 times nominal)	110.0 KA RMS SYM. @ FULL RATIO
MECHANICAL RATING @ SECONDS:	(110 times nominal)	219.9 KA RMS SYM. @ FULL RATIO

DESIGN NOTES

The dashed (---) line represents the knee point (Ek) the point tangent to the curve at 45° to the exciting current Io.
TOLERANCE OF CURVE VALUE:
To the right of this line at any current Io the voltage Es cannot be <95%
To the left of this line at any voltage Es the current Io cannot be >125%

RATIO	TURNS	CONNECTION
300 : 5	60	X3-X4
400 : 5	80	X1-X2
500 : 5	100	X4-X5
800 : 5	160	X2-X3
1100 : 5	220	X2-X4
1200 : 5	240	X1-X3
1500 : 5	300	X1-X4
1600 : 5	320	X2-X5
2000 : 5	400	X1-X5





REV.	DATE	CURVE REVISION HISTORY
01	11/05/09	INITIAL CURVE CREATION UPDATE

drawn for: VON ROLL TRANSFORMERS LTD.
part number: 0518547463
drawn by: [signature] 01/19/10
checked by: [signature] 01/19/10
Drawing Design Number: 09A-033-361

MERAMEC Electrical Products Co., Inc.

TYPICAL CHARACTERISTIC CURVES

REV. 01

High and Low Voltage bushings test page 52/1
Test Report 2359

HUBBELL
Power Systems, Inc.

Bushings Certified Test Reports

Our Bushing Certified Test Reports are currently updated every Monday morning. To search our Bushing Certified Number and click on Search. Information is available starting in year 2000.

Helpful Hint: Our Serial Numbers may end with either a 5 or 6 digit number.
Ex: 04-XXXXXX PRC
Ex: 04-XXXXX or 04-XXXXXX POC

Find a Certified Test Report

Serial #:
13-149105 Search

POC Bushing Certified Test Report for Serial Number 13-149105

Serial Number: 13-149105
Catalog Number: POC550G0800S
Batch: 6867
kV Class: 115
BIL: 550
Current Rating: 800/1200/1600
60 Hz Withstand Level: 260
C1 Power Factor @ 10kV: 0.37
C1 Capacitance: 484
C2 Power Factor 2: 0.25
C2 Capactiance: 3482
IEEE Standards Applied: True
CAN Standards Applied: False
Date Certified: 3/15/2013

Printer Friendly Version

THE BUSHING WAS TESTED IN ACCORDANCE WITH IEEE C57.19.00 AND IEEE C57.19.01 (LATEST REVISION), U BUSHING HAS PASSED THE FOLLOWING TESTS:

1. VOLTAGE TAP WITHSTAND AT 20 kV OR TEST TAP WITHSTAND AT 2 kV FOR ONE MINUTE (WHERE APPLICABL
2. RI.V. (NEMA 107) AT 1.5 TIMES OPERATING VOLTAGE WITH NO MORE THAN 10 MICRO VOLTS TOTAL.
3. POWER FACTOR AND CAPACITANCE WERE MEASURED IN STEPS TO THE REQUIRED WITHSTAND LEVEL.
4. A 60 Hz ONE-MINUTE WITHSTAND AT THE ABOVE LEVEL.
5. REPEAT STEPS 2 AND 3 COMPARING VALUES.
6. INTERNAL PRESSURE TEST AT 20 psig WITH NO LEAKAGE.

ALL GAGES AND EQUIPMENT HAVE BEEN CALIBRATED, TRACEABLE TO NATIONALLY RECOGNIZED STANDARDS. DETECTABLE) DIELECTRIC FLUID IN ACCORDANCE WITH FEDERAL REGULATIONS. SAMPLES OF OIL ARE REGUL METHOD FOR ANALYZING FLUOROCARBONED INSULATING LIQUIDS BY GAS CHROMATOGRAPHY.

HUBBELL
Power Systems, Inc.

Bushings Certified Test Reports

Our Bushing Certified Test Reports are currently updated every Monday morning. To search our Bushing Certified Number and click on Search. Information is available starting in year 2000.

Helpful Hint: Our Serial Numbers may end with either a 5 or 6 digit number.
Ex: 04-XXXXXX PRC
Ex: 04-XXXXX or 04-XXXXXX POC

Find a Certified Test Report

Serial #:
13-149262 Search

POC Bushing Certified Test Report for Serial Number 13-149262

Serial Number: 13-149262
Catalog Number: POC550G0800S
Batch: 6871
kV Class: 115
BIL: 550
Current Rating: 800/1200/1600
60 Hz Withstand Level: 260
C1 Power Factor @ 10kV: 0.31
C1 Capacitance: 480
C2 Power Factor 2: 0.28
C2 Capactiance: 3469
IEEE Standards Applied: True
CAN Standards Applied: False
Date Certified: 3/16/2013

Printer Friendly Version

THE BUSHING WAS TESTED IN ACCORDANCE WITH IEEE C57.19.00 AND IEEE C57.19.01 (LATEST REVISION), U
BUSHING HAS PASSED THE FOLLOWING TESTS:

1. VOLTAGE TAP WITHSTAND AT 20 kV OR TEST TAP WITHSTAND AT 2 kV FOR ONE MINUTE (WHERE APPLICABL
2. RI.V. (NEMA 107) AT 1.5 TIMES OPERATING VOLTAGE WITH NO MORE THAN 10 MICRO VOLTS TOTAL.
3. POWER FACTOR AND CAPACITANCE WERE MEASURED IN STEPS TO THE REQUIRED WITHSTAND LEVEL.
4. A 60 Hz ONE-MINUTE WITHSTAND AT THE ABOVE LEVEL.
5. REPEAT STEPS 2 AND 3 COMPARING VALUES.
6. INTERNAL PRESSURE TEST AT 20 psig WITH NO LEAKAGE.

ALL GAGES AND EQUIPMENT HAVE BEEN CALIBRATED, TRACEABLE TO NATIONALLY RECOGNIZED STANDARDS.
DETECTABLE) DIELECTRIC FLUID IN ACCORDANCE WITH FEDERAL REGULATIONS. SAMPLES OF OIL ARE REGUL
METHOD FOR ANALYZING FLUOROCARBONED INSULATING LIQUIDS BY GAS CHROMATOGRAPHY.

Bushings Certified Test Reports

Our Bushing Certified Test Reports are currently updated every Monday morning. To search our Bushing Certified Number and click on Search. Information is available starting in year 2000.

Helpful Hint: Our Serial Numbers may end with either a 5 or 6 digit number.
Ex: 04-XXXXXX PRC
Ex: 04-XXXXX or 04-XXXXXX POC

Find a Certified Test Report

Serial #:
13-149097 Search

POC Bushing Certified Test Report for Serial Number 13-149097

Serial Number: 13-149097
Catalog Number: POC550G0800S
Batch: 6867
kV Class: 115
BIL: 550
Current Rating: 800/1200/1600
60 Hz Withstand Level: 260
C1 Power Factor @ 10kV: 0.32
C1 Capacitance: 483
C2 Power Factor 2: 0.25
C2 Capactiance: 3439
IEEE Standards Applied: True
CAN Standards Applied: False
Date Certified: 3/15/2013

Printer Friendly Version

THE BUSHING WAS TESTED IN ACCORDANCE WITH IEEE C57.19.00 AND IEEE C57.19.01 (LATEST REVISION), U
BUSHING HAS PASSED THE FOLLOWING TESTS:

1. VOLTAGE TAP WITHSTAND AT 20 kV OR TEST TAP WITHSTAND AT 2 kV FOR ONE MINUTE (WHERE APPLICABL
2. RI.V. (NEMA 107) AT 1.5 TIMES OPERATING VOLTAGE WITH NO MORE THAN 10 MICRO VOLTS TOTAL.
3. POWER FACTOR AND CAPACITANCE WERE MEASURED IN STEPS TO THE REQUIRED WITHSTAND LEVEL.
4. A 60 Hz ONE-MINUTE WITHSTAND AT THE ABOVE LEVEL.
5. REPEAT STEPS 2 AND 3 COMPARING VALUES.
6. INTERNAL PRESSURE TEST AT 20 psig WITH NO LEAKAGE.

ALL GAGES AND EQUIPMENT HAVE BEEN CALIBRATED, TRACEABLE TO NATIONALLY RECOGNIZED STANDARDS.
DETECTABLE) DIELECTRIC FLUID IN ACCORDANCE WITH FEDERAL REGULATIONS. SAMPLES OF OIL ARE REGUL
METHOD FOR ANALYZING FLUOROCARBONED INSULATING LIQUIDS BY GAS CHROMATOGRAPHY.

025W2000BE *1000063042*

Alamo, Tennessee
CERTIFIED TEST REPORT
Status: Passed

Test Date: 2/5/2013 5:32:04 AM
Apparatus: Condenser Bushing **ABB Job Number:** 22130320
Bushing Type: O Plus C **ABB Order Number:** XAT15631
Style: 025W2000BE **Version:** 7
Rating: 25 kV
BIL: 150kV 2000 **Amps (Bottom Connected)**
Max L-G Voltage: 16kV
Serial Number: 1000063042
Ambient Temperature: 21 °C **Humidity:** 38%

1. **Power Factor and Capacitance**
The power factor/capacitance test is conducted per IEEE Std. C57.19.00-2004 & Std. C57.19.01-2000. An Ailtech NM-21FFT radio noise meter per NEMA 107-1987 is used for partial discharge measurements in microvolts. Test equipment includes a dielectric test set for measurements above 10kV and a dissipation factor/capacitance bridge #018
Before 60 Hz Withstand

Measurement	Applied kV	Power Factor (%)	Capacitance (Pfd)
(C1) Stud to Tap	10	.29	538
(C2) Tap to Flange	1	NA	NA
Stud to Flange	10	NA	NA

2. **Tap Test:** 2 kV 60 Hz one minute applied test, tap to flange: Passed
3. **Dry 60 Hz Withstand and Partial Discharge:**
The tests were conducted per IEEE Std. C57.19.00-2004, IEEE Std. C57.19.01-2000 specifications. The dielectric and partial discharge detection equipment is designed to meet or exceed IEEE 454-1973, C57.113-1991, and C63.2-1996 requirements which includes dividers, detectors, power sources to 1MV, and partial discharge detectors.

		Start	Finish
Test Voltage (kV)	Test Duration (Min)	PC	PC
24	NA	1	NA
75	1	1	1
24	NA	1	NA
NA	NA	NA	NA
NA	NA	NA	NA

4. **After 60 Hz Withstand (Nameplate information):**

Measurement	Applied kV	Power Factor (%)	Capacitance (Pfd)
(C1) Stud to Tap	10	.29	538
(C2) Tap to Flange	1	.20	263
Stud to Flange	10	NA	NA

The pressure and vacuum sealing of this bushing has been verified by testing in accordance with IEEE C57.19.00 - 2004 section 7.4.5. This unit was filled at the factory with PCB-free (non-detectable) dielectric fluid in accordance with U.S. Federal polychlorinate biphenyl (PCB) regulation 40 CFR 61, dated May 31, 1979. The analysis is verified per ASTM-D4059 with a detection level of less than 1 ppm. Bushings are filled with mineral oil that is certified passivator free and certified tested corrosive sulfer free. All tests were conducted on bushings that meet or exceed IEEE C57.19.00-2004.
All dielectric withstand levels for power frequency meet or exceed the routine test levels required by the applicable **IEC** standards.

Test Specialist: Ej Jelks **Date:** 2/5/2013 5:28:49 AM

Remarks:
.29 *538* *.20* *263*

025W2000BE *1000063584*

Alamo, Tennessee
CERTIFIED TEST REPORT
Status: Passed

Test Date:	2/12/2013 8:52:17 AM		
Apparatus:	Condenser Bushing	**ABB Job Number:**	22143360
Bushing Type:	O Plus C	**ABB Order Number:**	XAT15631
Style:	025W2000BE	**Version:** 7	
Rating:	25 kV		
BIL:	150kV	2000 Amps (Bottom Connected)	
Max L-G Voltage:	16kV		
Serial Number:	1000063584		
Ambient Temperature:	22 °C	**Humidity:** 33%	

1. **Power Factor and Capacitance**
The power factor/capacitance test is conducted per IEEE Std. C57.19.00-2004 & Std. C57.19.01-2000. An Ailtech NM-21FFT radio noise meter per NEMA 107-1987 is used for partial discharge measurements in microvolts. Test equipment includes a dielectric test set for measurements above 10kV and a dissipation factor/capacitance bridge #018
Before 60 Hz Withstand

Measurement	Applied kV	Power Factor (%)	Capacitance (Pfd)
(C1) Stud to Tap	10	.28	545
(C2) Tap to Flange	1	NA	NA
Stud to Flange	10	NA	NA

2. **Tap Test:** 2 kV 60 Hz one minute applied test, tap to flange: Passed
3. **Dry 60 Hz Withstand and Partial Discharge:**
The tests were conducted per IEEE Std. C57.19.00-2004, IEEE Std. C57.19.01-2000 specifications. The dielectric and partial discharge detection equipment is designed to meet or exceed IEEE 454-1973, C57.113-1991, and C63.2-1996 requirements which includes dividers, detectors, power sources to 1MV, and partial discharge detectors.

		Start	Finish
Test Voltage (kV)	Test Duration (Min)	PC	PC
24	NA	1	NA
75	1	1	1
24	NA	1	NA
NA	NA	NA	NA
NA	NA	NA	NA

4. **After 60 Hz Withstand (Nameplate information):**

Measurement	Applied kV	Power Factor (%)	Capacitance (Pfd)
(C1) Stud to Tap	10	.28	545
(C2) Tap to Flange	1	.16	262
Stud to Flange	10	NA	NA

The pressure and vacuum sealing of this bushing has been verified by testing in accordance with IEEE C57.19.00 - 2004 section 7.4.5. This unit was filled at the factory with PCB-free (non-detectable) dielectric fluid in accordance with U.S. Federal polychlorinate biphenyl (PCB) regulation 40 CFR 61, dated May 31, 1979. The analysis is verified per ASTM-D4059 with a detection level of less than 1 ppm. Bushings are filled with mineral oil that is certified passivator free and certified tested corrosive sulfer free. All tests were conducted on bushings that meet or exceed IEEE C57.19.00-2004.
All dielectric withstand levels for power frequency meet or exceed the routine test levels required by the applicable **IEC** standards.

Test Specialist: Sonny Brice **Date:** 2/12/2013 8:48:26 AM

Remarks:
.28 *545* *.16* *262*

025W2000BE | ABB | page 52/6 *1000063577*

Alamo, Tennessee
CERTIFIED TEST REPORT
Status: Passed

Test Date: 2/12/2013 9:27:06 AM

Apparatus: Condenser Bushing **ABB Job Number:** 22143360

Bushing Type: O Plus C **ABB Order Number:** XAT15631

Style: 025W2000BE **Version:** 7

Rating: 25 **kV**

BIL: 150kV 2000 **Amps (Bottom Connected)**

Max L-G Voltage: 16kV

Serial Number: 1000063577

Ambient Temperature: 22 °C **Humidity:** 32%

1. **Power Factor and Capacitance**
The power factor/capacitance test is conducted per IEEE Std. C57.19.00-2004 & Std. C57.19.01-2000. An Ailtech NM-21FFT radio noise meter per NEMA 107-1987 is used for partial discharge measurements in microvolts. Test equipment includes a dielectric test set for measurements above 10kV and a dissipation factor/capacitance bridge #018
Before 60 Hz Withstand

Measurement	Applied kV	Power Factor (%)	Capacitance (Pfd)
(C1) Stud to Tap	10	.26	527
(C2) Tap to Flange	1	NA	NA
Stud to Flange	10	NA	NA

2. **Tap Test:** 2 kV 60 Hz one minute applied test, tap to flange: Passed
3. **Dry 60 Hz Withstand and Partial Discharge:**
The tests were conducted per IEEE Std. C57.19.00-2004, IEEE Std. C57.19.01-2000 specifications. The dielectric and partial discharge detection equipment is designed to meet or exceed IEEE 454-1973, C57.113-1991, and C63.2-1996 requirements which includes dividers, detectors, power sources to 1MV, and partial discharge detectors.

		Start	Finish
Test Voltage (kV)	Test Duration (Min)	PC	PC
24	NA	1	NA
75	1	1	1
24	NA	1	NA
NA	NA	NA	NA
NA	NA	NA	NA

4. **After 60 Hz Withstand (Nameplate information):**

Measurement	Applied kV	Power Factor (%)	Capacitance (Pfd)
(C1) Stud to Tap	10	.26	527
(C2) Tap to Flange	1	.20	265
Stud to Flange	10	NA	NA

The pressure and vacuum sealing of this bushing has been verified by testing in accordance with IEEE C57.19.00 - 2004 section 7.4.5. This unit was filled at the factory with PCB-free (non-detectable) dielectric fluid in accordance with U.S. Federal polychlorinate biphenyl (PCB) regulation 40 CFR 61, dated May 31, 1979. The analysis is verified per ASTM-D4059 with a detection level of less than 1 ppm. Bushings are filled with mineral oil that is certified passivator free and certified tested corrosive sulfer free. All tests were conducted on bushings that meet or exceed IEEE C57.19.00-2004.
All dielectric withstand levels for power frequency meet or exceed the routine test levels required by the applicable **IEC** standards.

Test Specialist: Sonny Brice **Date:** 2/12/2013 8:59:48 AM

Remarks:
.26 *527* *.20* *265*

ABB

025W2000BE *1000063517*

Alamo, Tennessee
CERTIFIED TEST REPORT
Status: Passed

Test Date:	2/11/2013 2:52:47 PM		
Apparatus:	Condenser Bushing	**ABB Job Number:**	22143356
Bushing Type:	O Plus C	**ABB Order Number:**	XAT15631
Style:	025W2000BE	**Version:** 7	
Rating:	25 kV		
BIL:	150kV	2000 Amps (Bottom Connected)	
Max L-G Voltage:	16kV		
Serial Number:	1000063517		
Ambient Temperature:	22 °C	**Humidity:** 31%	

1. **Power Factor and Capacitance**
The power factor/capacitance test is conducted per IEEE Std. C57.19.00-2004 & Std. C57.19.01-2000. An Ailtech NM-21FFT radio noise meter per NEMA 107-1987 is used for partial discharge measurements in microvolts. Test equipment includes a dielectric test set for measurements above 10kV and a dissipation factor/capacitance bridge #018
Before 60 Hz Withstand

Measurement	Applied kV	Power Factor (%)	Capacitance (Pfd)
(C1) Stud to Tap	10	.26	537
(C2) Tap to Flange	1	NA	NA
Stud to Flange	10	NA	NA

2. **Tap Test:** 2 kV 60 Hz one minute applied test, tap to flange: Passed
3. **Dry 60 Hz Withstand and Partial Discharge:**
The tests were conducted per IEEE Std. C57.19.00-2004, IEEE Std. C57.19.01-2000 specifications. The dielectric and partial discharge detection equipment is designed to meet or exceed IEEE 454-1973, C57.113-1991, and C63.2-1996 requirements which includes dividers, detectors, power sources to 1MV, and partial discharge detectors.

		Start	Finish
Test Voltage (kV)	Test Duration (Min)	PC	PC
24	NA	2	NA
75	1	2	2
24	NA	2	NA
NA	NA	NA	NA
NA	NA	NA	NA

4. **After 60 Hz Withstand (Nameplate information):**

Measurement	Applied kV	Power Factor (%)	Capacitance (Pfd)
(C1) Stud to Tap	10	.26	537
(C2) Tap to Flange	1	.18	262
Stud to Flange	10	NA	NA

The pressure and vacuum sealing of this bushing has been verified by testing in accordance with IEEE C57.19.00 - 2004 section 7.4.5. This unit was filled at the factory with PCB-free (non-detectable) dielectric fluid in accordance with U.S. Federal polychlorinate biphenyl (PCB) regulation 40 CFR 61, dated May 31, 1979. The analysis is verified per ASTM-D4059 with a detection level of less than 1 ppm. Bushings are filled with mineral oil that is certified passivator free and certified tested corrosive sulfer free. All tests were conducted on bushings that meet or exceed IEEE C57.19.00-2004.
All dielectric withstand levels for power frequency meet or exceed the routine test levels required by the applicable IEC standards.

Test Specialist: Sonny Brice **Date:** 2/11/2013 2:49:22 PM

Remarks:

.26 *537* *.18* *262*

Test Report 2359

Pub. No. TR 1
Pg. 1

TR 1-7.02 TRANSFORMER TEST REPORT

Manufacturer VonRoll Transformers Ltd. **Spec.** SR.04.02.001-L **Order Number** 571142
Purchased by National Grid **Customer Order No:** 571142
Cooling Class ONAN/ONAF/ONA **Phase** 3 **Hertz** 60 **Insulating Fluid** Mineral Oil

Winding #1	138600	**Volts**	**Winding #2**	13800	**Volts**
	= 16800/ /22400 /28000 /33000	**kVA**		= 16800/ /22400 /28000 /33000	**kVA**
			Winding #3		**Volts**
				=	**kVA**

Taps 138600± 2X2.50% 13800± ±16X0.625% **Volts**

RESISTANCE, EXCITING CURRENT, LOSSES AND IMPEDANCE-Based on normal rating unless otherwise stated.
Losses and regulation are based on wattmeter measurements.
For three-phase transformers the resistances given are the sum of the three phases in series.

Serial No.	**Resistance in Ohms at 85 °C of 1**	**of 2**	**of 3**	**% Exciting Current at 100% Voltage**	**Core kW at Vr and 85 °C**	**kW Loss and Impedance at 85 °C** 138600 kV to 13800 kV 16800 kVA **Coil**	**%IZ**	138600 kV to 13800 kV 28000 kVA **Coil**	**%IZ**	138600 kV to 13800 kV 33000 kVA **Coil**	**%IZ**
13836/1	3.2385	0.0294	-	0.15	16.06	38.9	9.34	108.1	15.56	150.1	18.34
Nameplate No. **904**											
								aux.	1.11	aux.	1.42
						Total	55	Total	125.3	Total	167.6

Efficiency in Tap pos. 3/N PF=0.85 28000kVA					**Voltage Regulation at**	**28000**	**kVA**
100%	**load-** 99.481	**50%**	**load-** 99.639		**at85°C when PF =**	**1.0**	**0.8**
75%	**load-** 99.571	**25%**	**load-** 99.618		**%VR (avg.) =**	1.60	10.39

TEMPERATURE RISES are calculated, using data from heat runs performed on thermally similar units.

Cool Mode	**Disipated Losses kW**	**Temp. Rise Guar. °C**	**Energized Wdg. Tap kV**	**Amps**	**Shorted Wdg. Tap kV**	**Amps**	**Fluid Temp. Rise °C-Top Oil Above Ambient**	**Winding Temperature Rise °C by Resistance Above Ambient of 1**	**of 2**	**of 3**	**Hot Spot Wind Temp. Rise Above Ambient of 1**	**of 2**
OA	65	65	132.00	66.1	12.420	702.9	36.6	35.7	36.4	-	44.5	46.2
FA	183	65	132.00	129.9	12.420	1381.0	47.6	49.8	52.3	-	64.1	67.5

DIELECTRIC TESTS - If Impulse Tests are required, see separate Transformer Impulse Test Report.

APPLIED POTENTIAL TEST	**Rating Voltage of Tested Winding (V)**	**Applied Voltage kV**	**Test Duration Second**
Voltage applied between each winding and all other windings connected to core and ground.	138600	230	60
	13800	34	60

INDUCED POTENTIAL TEST 2 times rated voltage across full winding at 225 **hertz** 7200 **cycles**

Phase relation / Polarity:

	Dd 0 (0)		**Dy 5 (150)**		**Dd 10 (300)**		**Yd 5 (150)**	
	Dy 1 (30)		**Dd 6 (180)**		**Dy 11 (330)**	X	**Yy 6 (180)**	
Additive polarity X	**Dd 2 (60)**		**Dy 7 (210)**		**Yy 0 (0)**		**Yd 7 (210)**	
Sub. polarity	**Dd 4 (120)**		**Dd 8 (240)**		**Yd 1 (30)**		**Yd 11 (330)**	
	Other (specify):							

SOUND LEVEL TEST (dB)		**OA**	**FA**
	Meas.	62.0	61.6
	Guar.	62	65

Serial No	**Insulation Resistance - Megger (Mega Ohms) Core - Gnd.**	**LV - Gnd.**	**HV-Gnd.**	**HV Vs LV&Gnd.**	**% Power Factor (Doble) CH**	**CL**	**CHL**	**Zero Seq. Impedance Z_{L-T} %**		
13836-1	15100	28000	57800	108000	0.22	0.19	0.15	16R	N	16L
					Cx [pF]			8.92	9.59	8.88
					3207	13469	5842			

I hereby certify this is a true report based on factory tests made in accordance with the Transformer Test Code C57.12.00-2006 current edition of the American National Standards Institute, and that each Transformer withstood the above insulation tests.

Tested by: Shenkerman Mark Date 06.10.2013 Approved by: Kotovski Andrei

AX - SHUTTER MOUNTED FANS

Designed for Industrial, Commercial & Farming applications.

AX SERIES MOTOR

c ETL LISTED us
Intertek

The AX series exhaust fan is a sturdily constructed, direct drive, horizontal discharge fan that is typically used for general ventilation of factories, garages, warehouses and other industrial or commercial buildings. The AX fans are available in multiple single-speed variations as well as two-speed and variable speed models.
The AX series housings are constructed of heavy duty aluminum with built in shutters that automatically open when the fan starts and gravity closes when the fan stops.

Some models now available with optional DC volt motor. Call for details.

EXPLOSION PROOF MOTOR

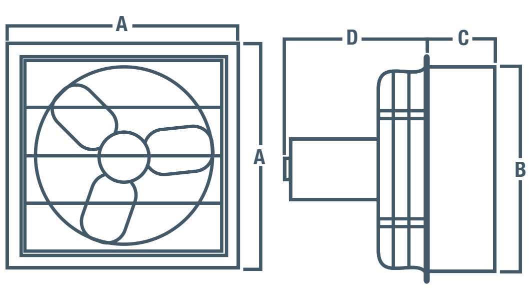
FEATURES

- Sturdily constructed from all-aluminum extrusions.
- 8" - 24" models have heavy wire chrome plated OSHA guards on intake side of fan. 30", 36" & 42" models have grey powder coated guards.
- Totally enclosed air over motor with overload protection.
- Ships fully assembled.

DIMENSIONS

MODEL	A	B	C	D	
				AX	AX-4~
AX08	14 3/4"	11 3/4"	5"	7"	-
AX10	14 3/4"	11 3/4"	5"	7"	-
AX12	16 3/4"	13 3/4"	5"	11"	13 3/4"
AX14	18 3/4"	15 3/4"	5"	11"	13 3/4"
AX16	20 3/4"	17 3/4"	5"	11"	13 3/4"
AX18	22 3/4"	19 3/4"	5"	12"	14"
AX20	24 3/4"	21 3/4"	5"	12"	14"
AX24	28 3/4"	25 3/4"	5"	12"	13 3/4"
AX30	35 1/4"	32 3/4"	5"	13"	-
AX36	41 1/4"	38 3/4"	5"	12"	-
AX42	47 3/4"	44 3/4"	5"	11"	-

~ Explosion Proof Motor, 50 Hz or 3 phase



SPECIFICATIONS

SINGLE PHASE	THREE PHASE	BLADE DIAMETER	RPM	HP (SINGLE PHASE)	VOLTAGE (SINGLE PHASE)	AMPS (FLA) (SINGLE PHASE)	WEIGHT (LBS)	dB(A) @5 ft	CFM @ STATIC PRESSURE				FRAMING DIMENSIONS
									0.00"	0.10"	0.125"	0.25"	
SINGLE SPEED - VARIABLE SPEED FANS													
AX12-1V	AX12-1*	12"	1700	1/3	115/230	5.0/2.5	26	63	1650	1560	1525	1400	14" X 14"
AX12-1VHE	-	12"	1450	1/15	115	1.0	22	60	1350	1290	1275	1150	14" X 14"
AX14-1V	AX14-1*	14"	1700	1/3	115/230	5.0/2.5	29	67	2170	2030	1950	1900	16" X 16"
AX14-1VHE	-	14"	1450	1/15	115	1.0	25	64	1600	1525	1500	1300	16" X 16"
AX16-1V	AX16-1*	16"	1700	1/3	115/230	5.0/2.5	30	68	2570	2470	2410	2260	18" X 18"
AX16-1VHE	-	16"	1450	1/15	115	1.0	26	63	1850	1750	1700	1550	18" X 18"
AX18-1V	AX18-1*	18"	1700	1/3	115/230	3.8/1.9	36	71	3150	3000	2900	2575	20" X 20"
AX20-1V	AX20-1*	20"	1700	1/3	115/230	3.8/1.9	39	77	3620	3420	3340	3120	22" X 22"
AX24-1V	--	24"	1100	1/3	115/230	4.4/2.2	43	72	5500	5400	5310	5100	26" X 26"
--	AX24-1*	24"	1100	1/3	--	--	43	77	5500	5400	5310	5100	26" X 26"
SINGLE SPEED FANS													
AX12-2	--	12"	1625	1/4	115	1.8	27	63	1640	1540	1510	1390	14" X 14"
AX14-2	--	14"	1625	1/4	115	1.8	30	67	2170	2070	2030	1860	16" X 16"
AX16-2	--	16"	1625	1/4	115	1.8	31	68	2370	2270	2210	2060	18" X 18"
AX18-2	--	18"	1625	1/3	115	4.0	37	73	3200	3090	3040	2920	20" X 20"
AX20-2	--	20"	1625	1/3	115	4.0	39	77	3420	3220	3170	2920	22" X 22"
AX24-2	--	24"	1100	1/3	115	5.4	45	70	5000	4500	4300	3600	26" X 26"
AX30-2	--	30"	1100	1/3	115/230	4.4/2.2	72	82	8000	7000	6000	5000	33" X 33"
AX36-7	AX36-7M**	36"	850	1/2	115/230	6.6/3.3	88	72	10000	8500	8000	6200	39" X 39"
AX42-7 (NEW)	--	42"	850	1	230	5.5	122	84	14900	13550	13210	10800	45" X 45"
TWO SPEED FANS													
AX08-3	--	8"	1600/1300	1/20	115	1.7	14	48	360/300	270/150	230/110	--	12" X 12"
AX10-3	--	10"	1600/1300	1/20	115	1.7	14	56	690/580	590/460	570/390	--	12" X 12"
AX12-3	--	12"	1725/1140	1/4	115	3.4	27	64	1670/1100	1600/950	1575/900	1450/625	14" X 14"
AX14-3	--	14"	1725/1140	1/4	115	3.4	31	67	2190/1440	2080/1325	2000/1300	1950/850	16" X 16"
AX16-3	--	16"	1725/1140	1/4	115	3.4	34	69	2580/1770	2480/1620	2430/1560	2270/1020	18" X 18"
AX18-3	--	18"	1725/1140	1/3	115	5.3/2.9	38	74	3200/2310	3050/2030	2950/1960	2625/1750	20" X 20"
AX20-3	--	20"	1725/1140	1/3	115	5.3/2.9	41	77	3640/2420	3440/2270	3360/2210	3140/1890	22" X 22"
SINGLE SPEED EXPLOSION PROOF FANS (Explosion Proof Motors are DIVISION 1 - CLASS 1 - GROUP C & D and CLASS 2 - GROUP F & G)													
Class I, Group C - Atmospheres containing ethyl ether, ethylene, gases or vapors of equivalent hazard. **Class I, Group D** - Atmospheres such as acetone, ammonia, benzene, butane, cyclopropane, ethanol, gasoline, hexane, methane, natural gas, naphtha, propane, or gases or vapors of equivalent hazard. **Class II Group F** - Atmospheres containing carbonaceous dust, including carbon black, charcoal, coal, or coke dusts that have more than 8% total entrapped volatiles, or dusts that have been sensitized by other materials so that they present an explosion hazard. **Class II Group G** - Atmospheres containing combustible dusts not included in group E or F, including flour, grain, wood, plastic and chemicals.													
AX12-4	AX12-4*	12"	1725	1/3	115/208-230	6.6/3.1-3.3	49	63	1670	1600	1575	1450	14" X 14"
AX14-4	AX14-4*	14"	1725	1/3	115/208-230	6.6/3.1-3.3	49	67	2190	2080	2000	1950	16" X 16"
AX16-4	AX16-4*	16"	1725	1/3	115/208-230	6.6/3.1-3.3	51	68	2580	2480	2430	2270	18" X 18"
AX18-4	AX18-4*	18"	1725	1/3	115/208-230	6.6/3.1-3.3	56	73	3200	3050	2950	2625	20" X 20"
AX20-4	AX20-4*	20"	1725	1/3	115/208-230	6.6/3.1-3.3	57	77	3640	3440	3360	3140	22" X 22"
AX24-4	AX24-4*	24"	1725	1/3	115/208-230	6.6/3.1-3.3	57	77	5520	5410	5330	5130	26" X 26"

For three phase motors, substitute "*" with "M" for 230/460 volt or "P" for 575 volt
**NOTE: AX36-7M is only available in 208-230/460 volt for three phase applications
Other voltages in single or three phase are available. 50HZ voltages are available. Consult factory.

ACCESSORIES

- Speed controls
- Thermostats
- Front guard
- Weather hoods

For a complete listing on all available accessories, see page D16.
For a complete listing of all available hoods, see page D11.
For all available control options, see Controls & Thermostats tab.