DIAGNOSTIC/TYPICAL SIGNATURES

February 1st, 2013

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#62 OTHER APPLICATION – AIR COMPRESSOR OF 735KV BREAKERS 70
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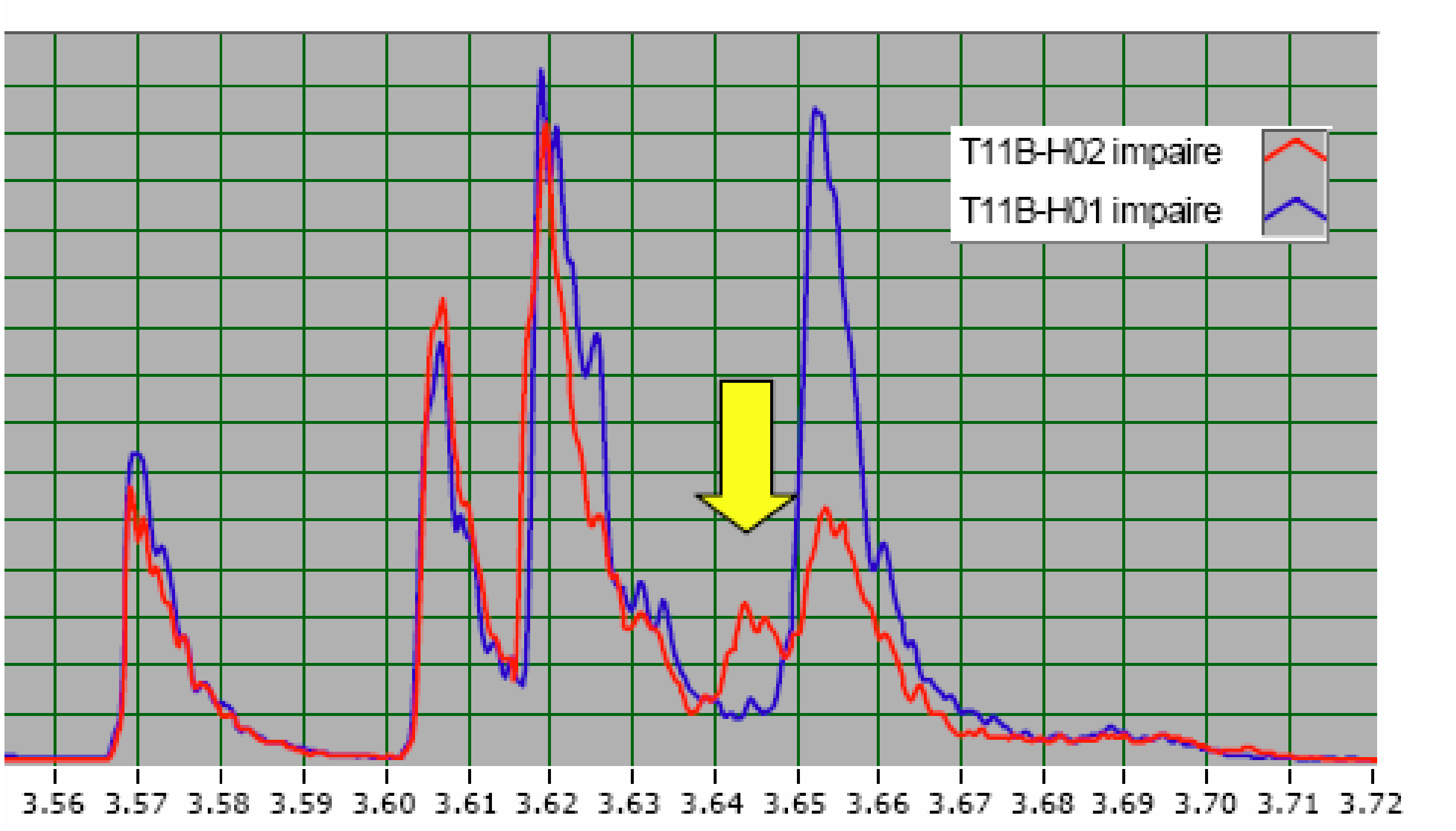
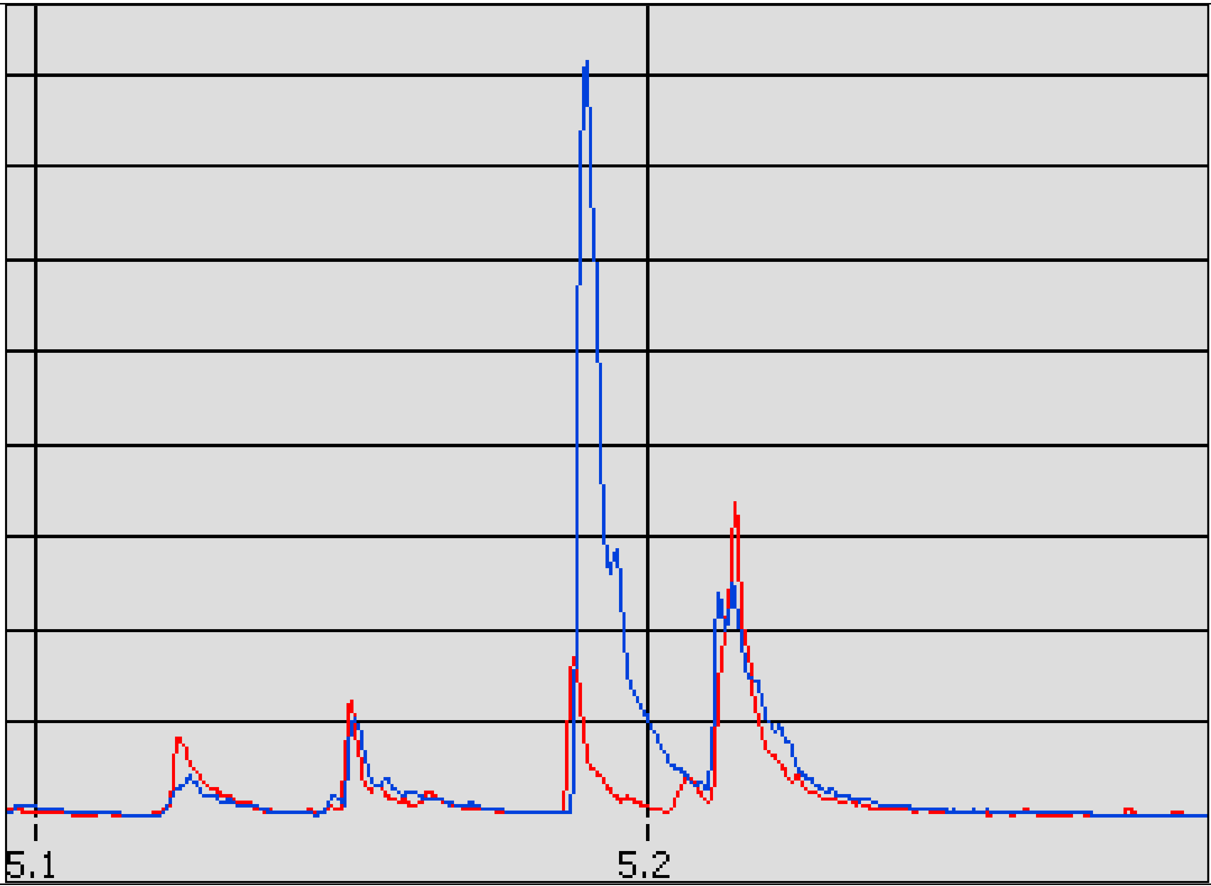
#1 ABB – UC (B, C, D, G and L) and UZ (B, C, D, E and F) - Braid improperly installed

Pictures	Description
	The signature of a switch with a braid improperly installed (red trace) is easily distinguished from a normal switch (blue trace).

Notes:

An improper installation of the braid may interfere with the operation of the mechanism and eventually cause its failure.

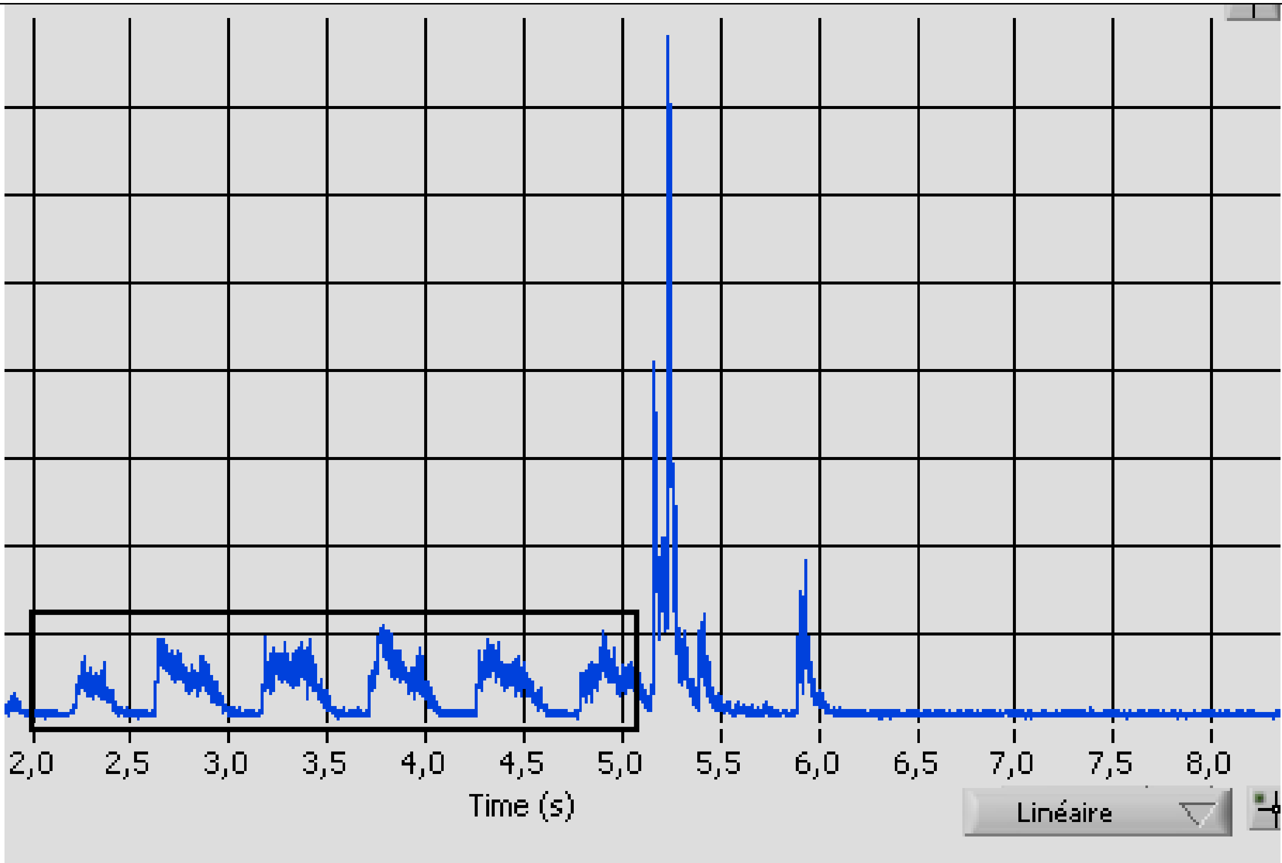
#2 ABB – UC (B, C, D, G and L) and UZ (B, C, D, E and F) - Bending of the moving main contact arm

Pictures	Description
	As a result of repeated impacts during normal operations, the copper arm of the mobile contacts is bent and the minimum distance between mobile and fixed points of tungsten (0.5 mm) is no longer respected. This anomaly may cause local overheating due to the lower conductivity of tungsten. This anomaly is visible on the noise impact of arcing contacts. To discern the phenomenon of wear, you can note that the bending of the moving contact's arm does not alter the sequence. (red trace) is contact arm bent. (blue trace) is after recovery of the arm.

Notes:

Recovery or replacement of the main contact moving arm.

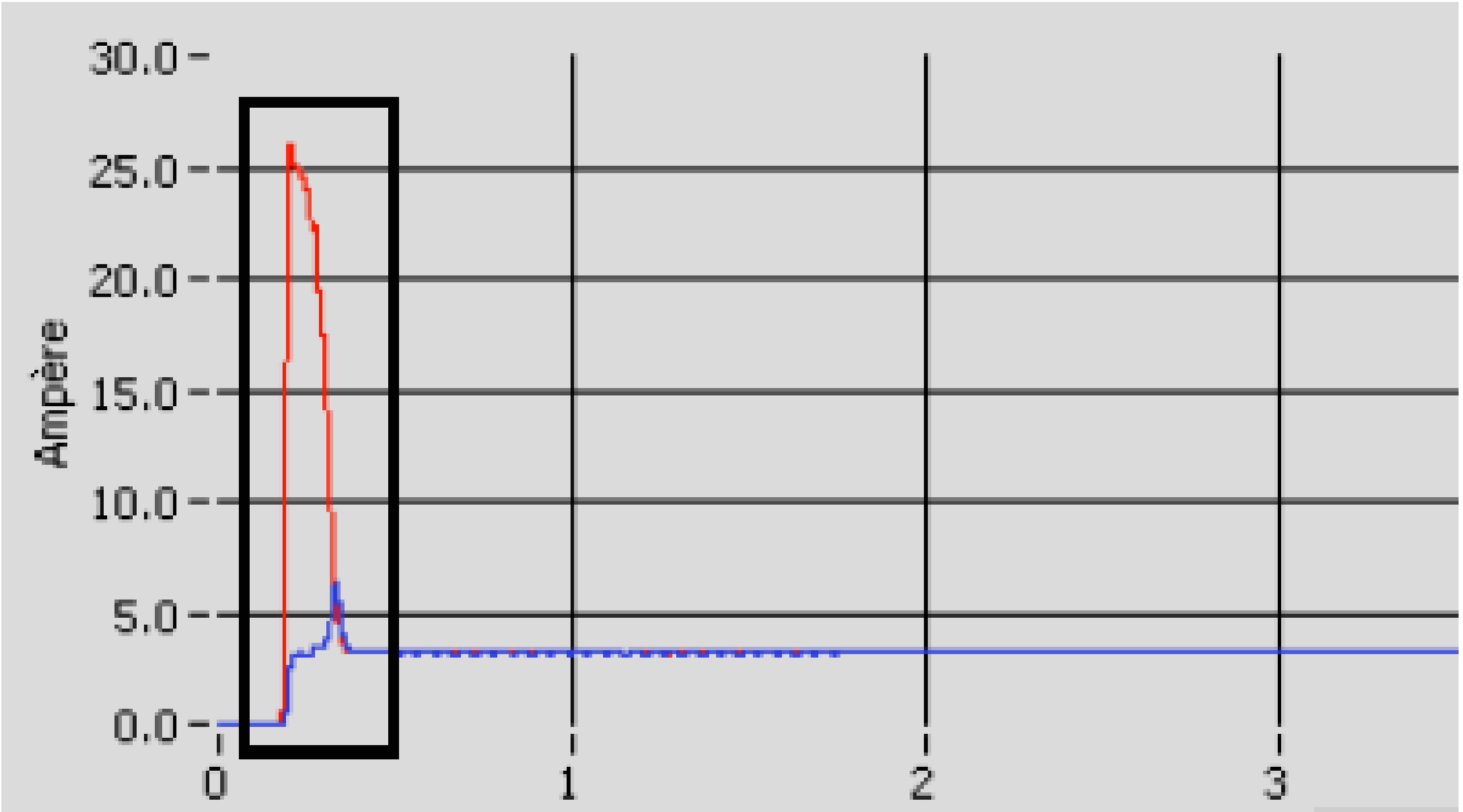
#3 ABB – UC (B, C, D, G and L) and UZ (B, C, D, E and F) - Lack of lubrication of the control gear

Pictures	Description
 	A lack of lubrication of the gear drive mechanism may affect the acoustic signature as shown in this example. This phenomenon is highlighted in particular in the signature of the lower frequencies.

Notes:

Lubrication of the control gear.

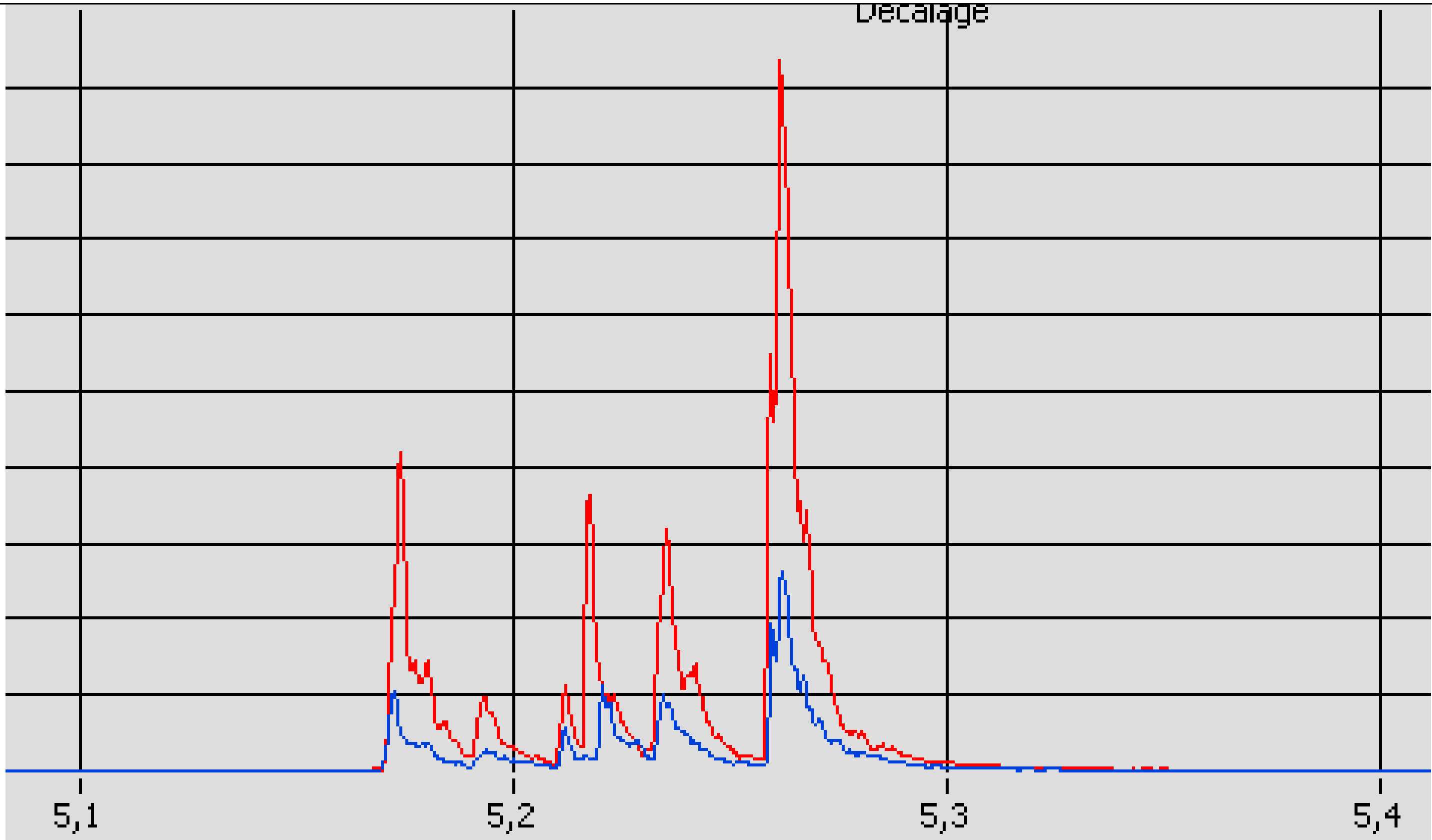
#4 ABB – UC (B, C, D, G and L) and UZ (B, C, D, E and F) - Slack in the control rod

Pictures	Description
	An important slack in the control rod can be shown in the signature of the motor current as shown above. When the motor starts with loose parts, the amplitude of the inrush current can be significantly reduced.

Notes:

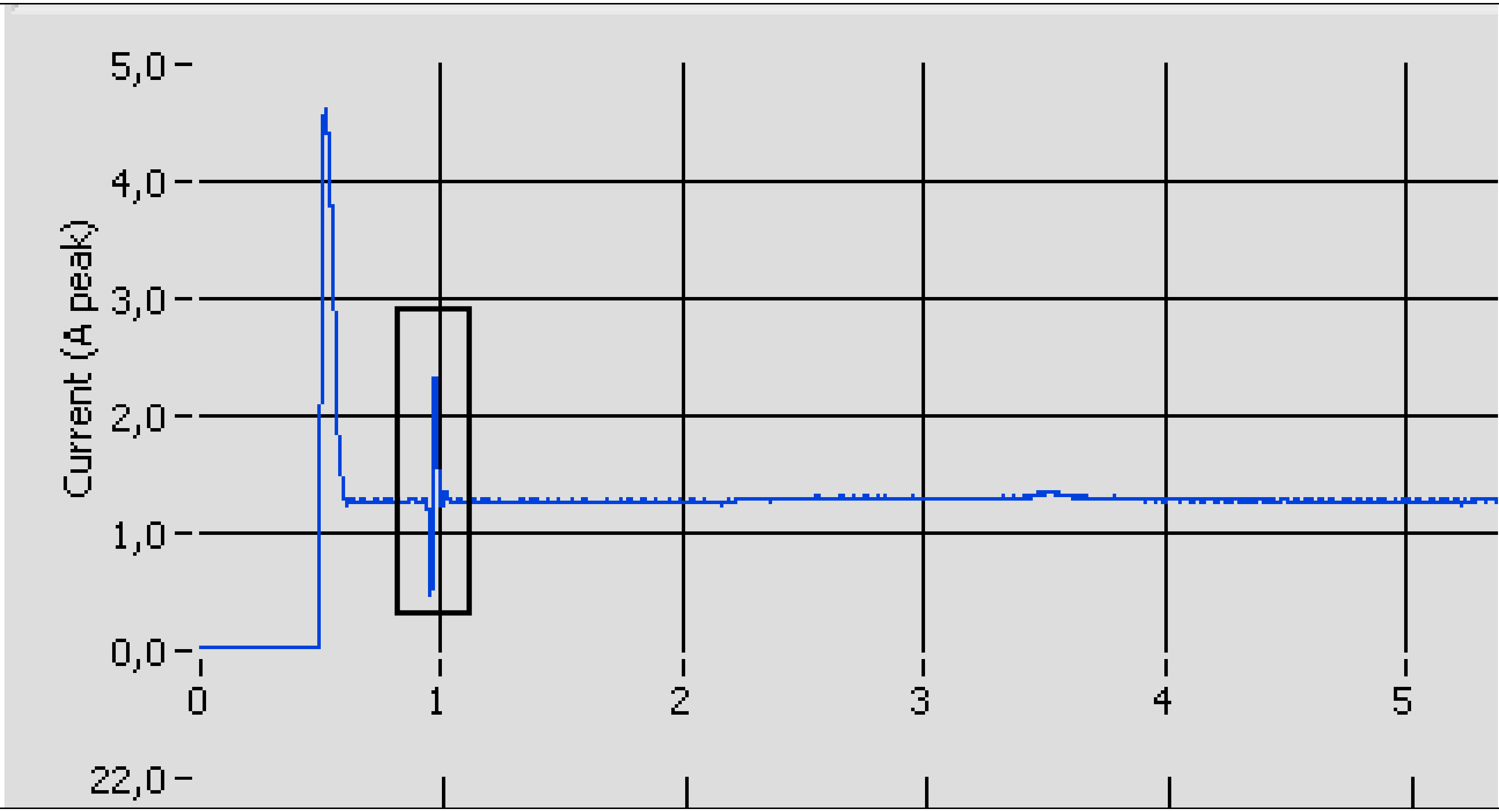
Tighten any loose components.

#5 ABB – UC (B, C, D, G and L) and UZ (B, C, D, E and F) - Advanced wear of the wheel switch

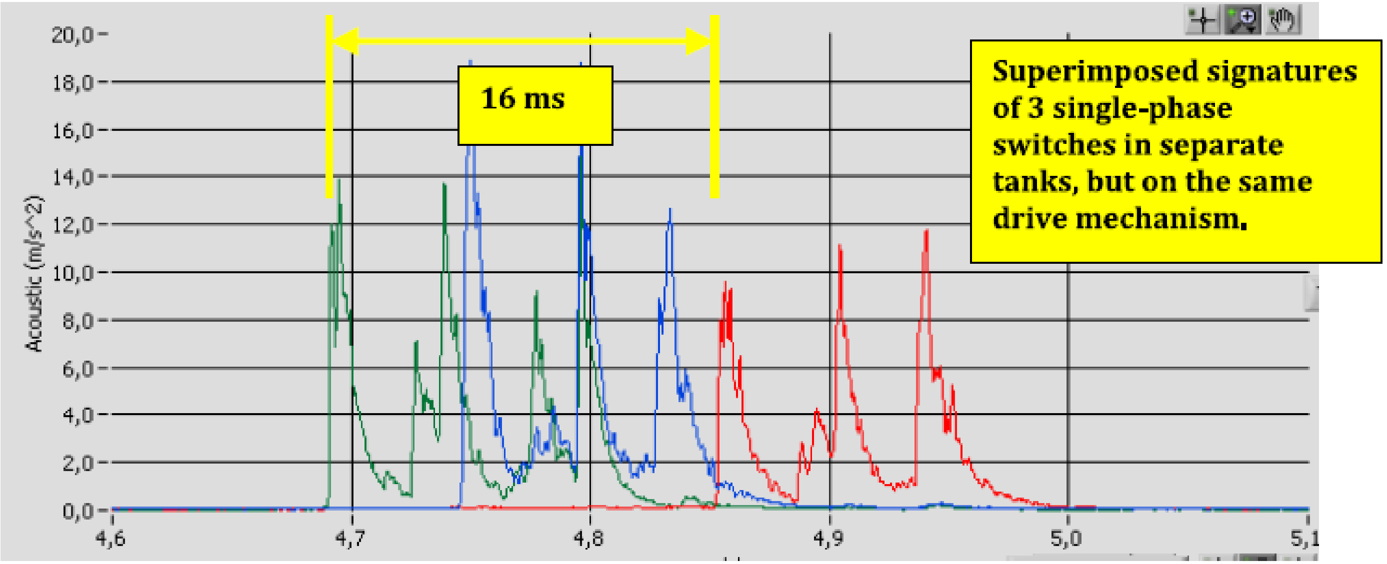
<table>
<tr><th>Pictures</th><th>Description</th></tr>
<tr><td>


</td><td>The slack caused by a very advanced wear of the wheel switch (the unit tested had accumulated above 400,000 operations) may cause the blocking of the mechanism, a loss of synchronization with the switch that can cause an arc across the terminals of the selector in the tank. This degradation is easily noticeable on the acoustic signature by a significant decrease of amplitudes with the wear. (red trace) is normal. (blue trace) is worn wheel switch.</td></tr>
<tr><td colspan="2">Notes:
Replacement of the wheel switch.</td></tr>
</table>

#6 ABB – UC (B, C, D, G and L) and UZ (B, C, D, E and F) - Faulty control relay

<table>
<tr><th>Pictures</th><th>Description</th></tr>
<tr><td>
</td><td>Anomalies of operation or of adjustment of control relays (upward, downward, maintenance, etc.) can often be observed by rapid fluctuations of the current. These anomalies are usually benign but still indicate a deterioration of the device which can ultimately lead to a refusal to operate; the operations are jerky or jumping to a position other than the set point. From the exploitation perspective, this behavior explains the reports of skipped taps.</td></tr>
<tr><td colspan="2">Notes:
Monitor this activity because it can lead to faulty tap switching.</td></tr>
</table>

#7 ABB – UC (B, C, D, G and L) - Desynchronization between switches

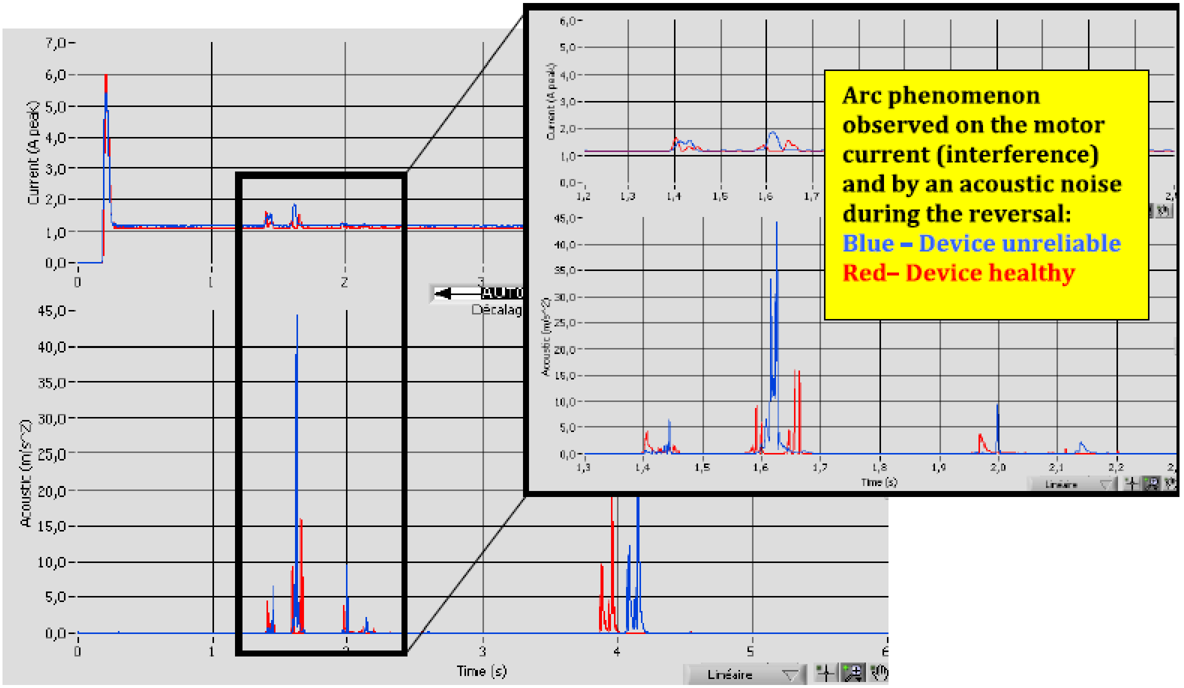
Pictures	Description
	Synchronization between single-phase switches can be accurately verified especially when they are in separate tanks but on a single mecnahnism as shown on the left. By performing the measurement with 3 accelerometers, the signatures of the 3 switches occur simultaneously and the timing is measured directly. If the manufacturer does not specify a maximum offset, the adjustment (coupling shafts) can usually be made so that the offset does not exceeds 25 ms.

Notes:

In case of multiple switches in a common tank, the signatures of the switches are superimposed and the evaluation of synchronization becomes more approximate.

When each switch is equipped with its own drive mechanism, the synchronization verification can be achieved by alternating the points of current measurement and the acoustic signature between phases (e.g. measuring current on phase A and acoustics on phase B.

#8 ABB – UC (B, C, D, G and L) - Anomaly in the voltage limiter device

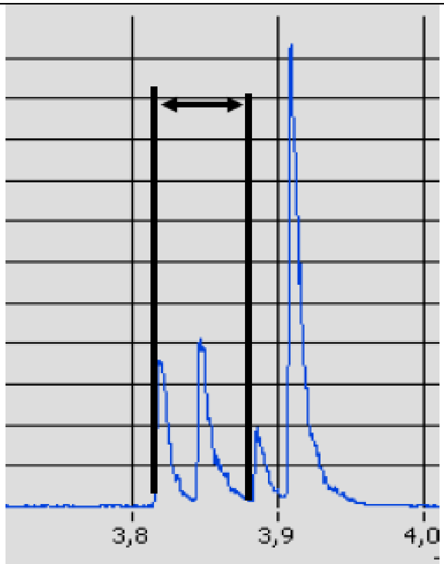
Pictures	Description
	The operation of the inverter under voltage causes a low-intensity arc, which is picked up by the current clamp (for electromagnetic interference) by means of the acoustic noise of the spark. It can often be observed at the time of the contact separation, a few altrnations to 120 Hz corresponding to voltages peaks.

Notes:

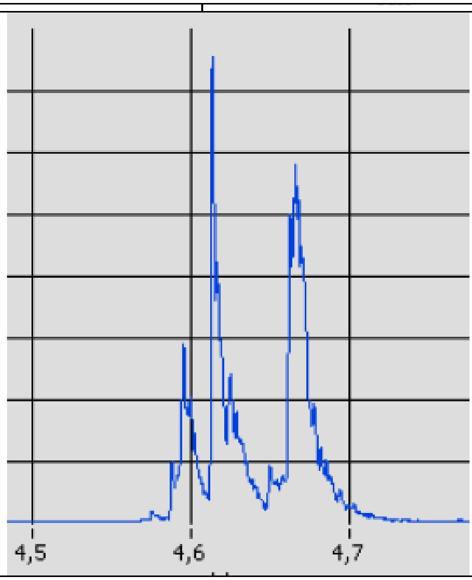
Depending on the voltage level, some manufacturers install voltage limiter devices to reduce this phenomenon. In case of this device, one can observe that the amplitudes of the noise increases as shown in the figure above. And the phenomenon can also be maintained over a longer period (not in this example).

The long-term consequences of such anomalies are not well known.

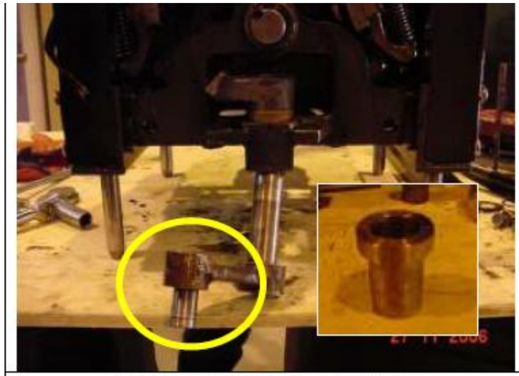
#9 ABB – UC (B, C, D, G and L) - Time of transition not perceptible

<table>
<tr><th>Pictures</th><th>Description</th></tr>
<tr><td>


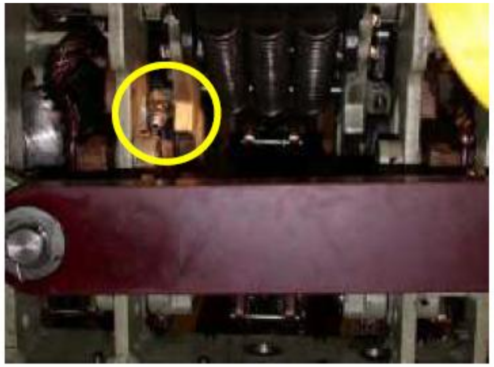
Time of transition well identified



Time of transition barely perceptible
</td><td>
When the transition time is barely perceptible by a visual examination of the acoustic signature, the most likely causes are:
-Misalignement of the mechanism (pass-through bolts)
-Wear of the mechanism
-Wear of the driving ring
These anomalies are followed by an assymetry between even and odd operations. Contacts badly worn may also complicate the identification of the 3rd pic, but without causing an assymetry.
</td></tr>
<tr><td colspan="2">
Notes:



Wear of driving finger and ring



View of the screw under the switch
</td></tr>
</table>

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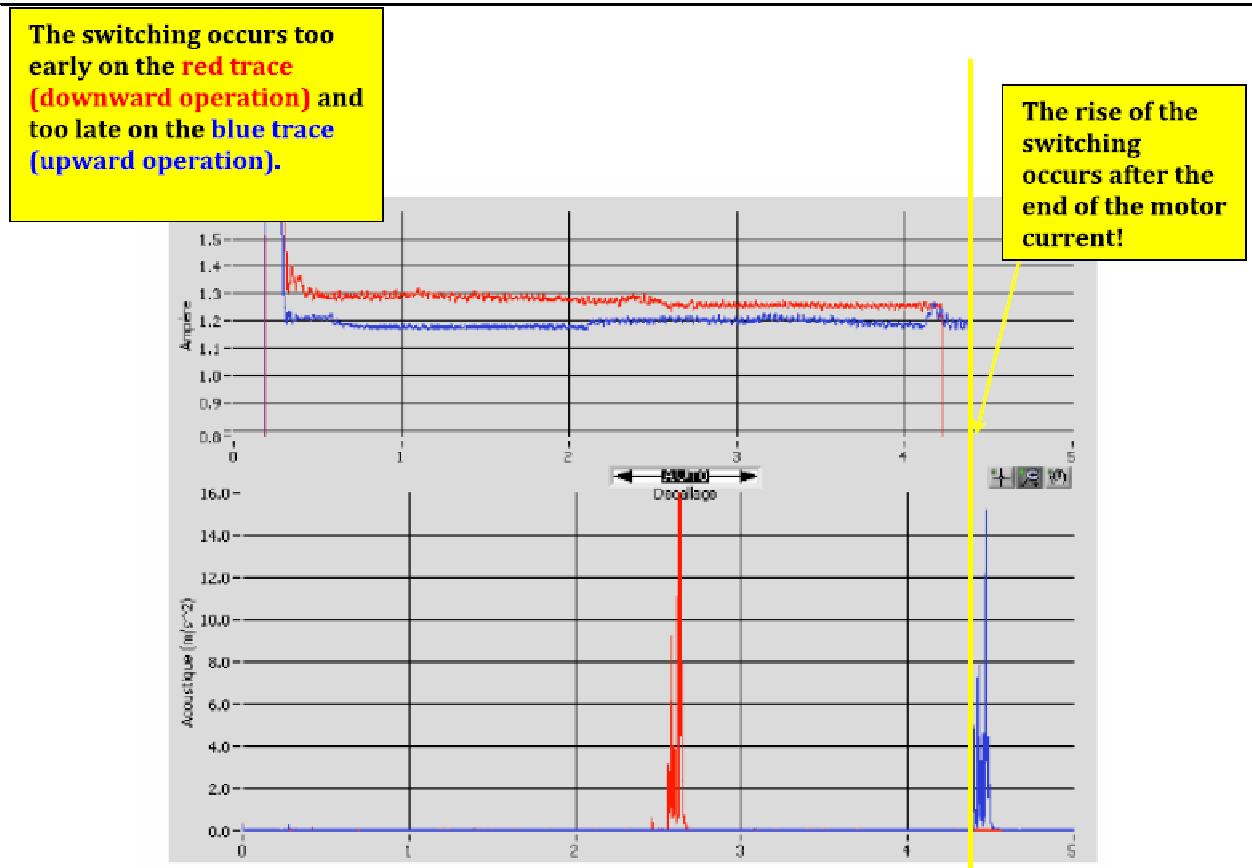
#10 ABB – UC (B, C, D, G and L) - Switching synchronization

Pictures	Description
	Following repairs, or adjustments in the driving mechanism, it is possible that the switching is out of synchronization. In these models, this anomaly can be demonstrated by comparing the upward and downward operations.

Notes:

In order to correct the adjustment, we must rebuild the shaft coupling at the output of the control box.

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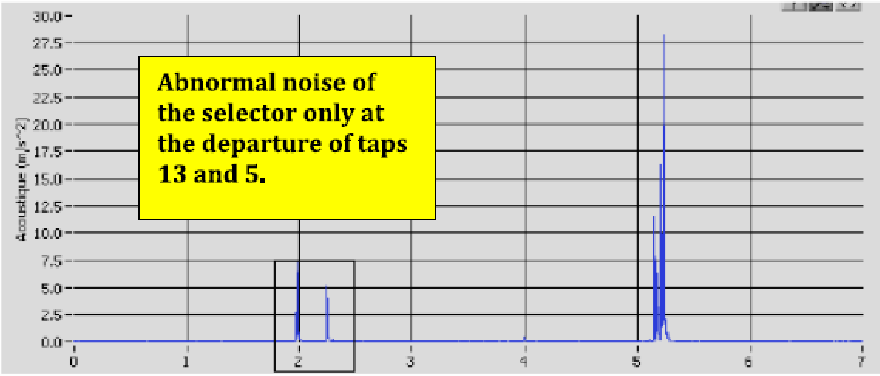
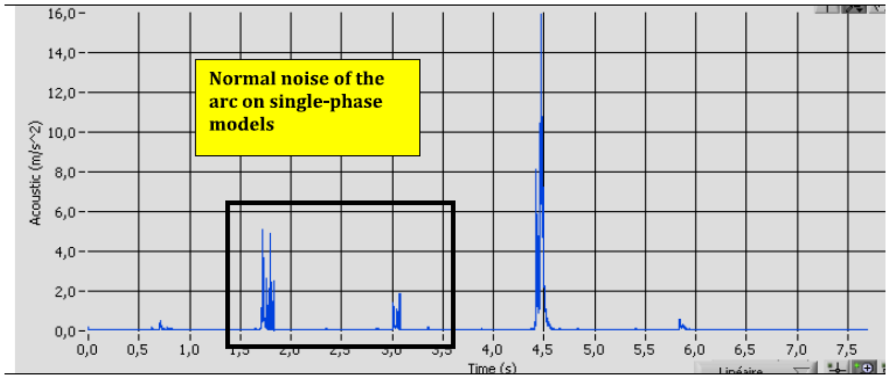
#11 ABB – UC (B, C, D, G and L) - Aligning the contacts of the selector

<table>
<tr><th>Pictures</th><th>Description</th></tr>
<tr><td>



Abnormal noise of the selector



Normal noise of the arc on a single-phase model (UCBRT)

</td><td>

A misalignment of the selector contacts can cause abnormal noise during its operation. For a model with inverter (or pre-selector) that noise will be observed in the two operations corresponding to the same tap as shown on the left. In this example, there is a noise at the departure of the taps 5 and 13 only, which corresponds to the same fixed contact.

</td></tr>
<tr><td colspan="2">

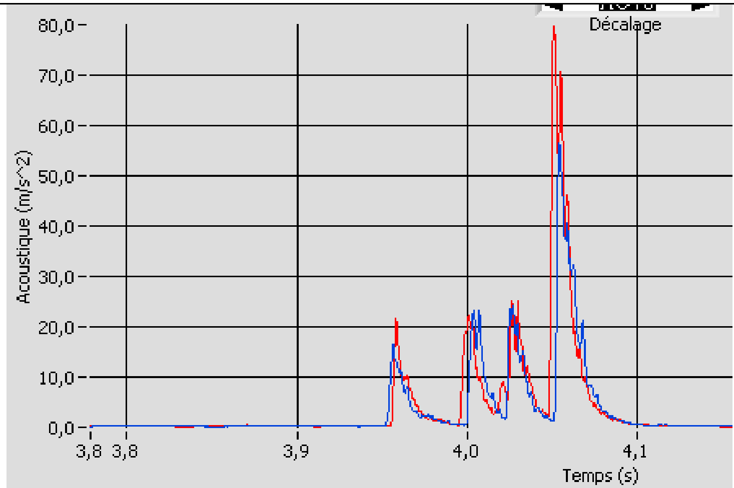
Notes:

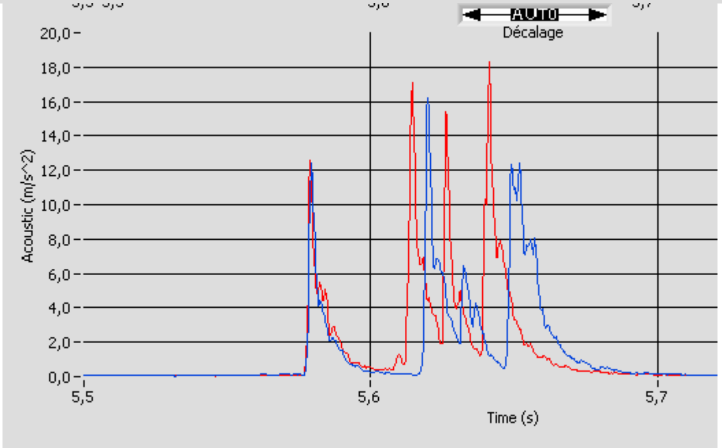
For single-phase models, this noise can be confused with a normal arc noise when the test is performed under voltage. These arc noises can be observed both at departure and arrival of the selector. The amplitude is usually a little higher at the departure of the selector when the movement removes the turns of regulation and vice versa for the arrival. For these models, the misalignment of contacts can be observed only if the test is performed disconnected from voltage.

</td></tr>
</table>

#12 ABB – UC (B, C, D, G and L) - Asymmetry of signatures switching

Pictures





Description

To check the symmetry of the switch you must graphically superimpose the signature of an even operation to an odd one.

The probable causes of this asymmetry are:

-The excessive wear of the driving wheel of the switch

-A bad adjustment of the switch (adjustment screw – pass through bolts)

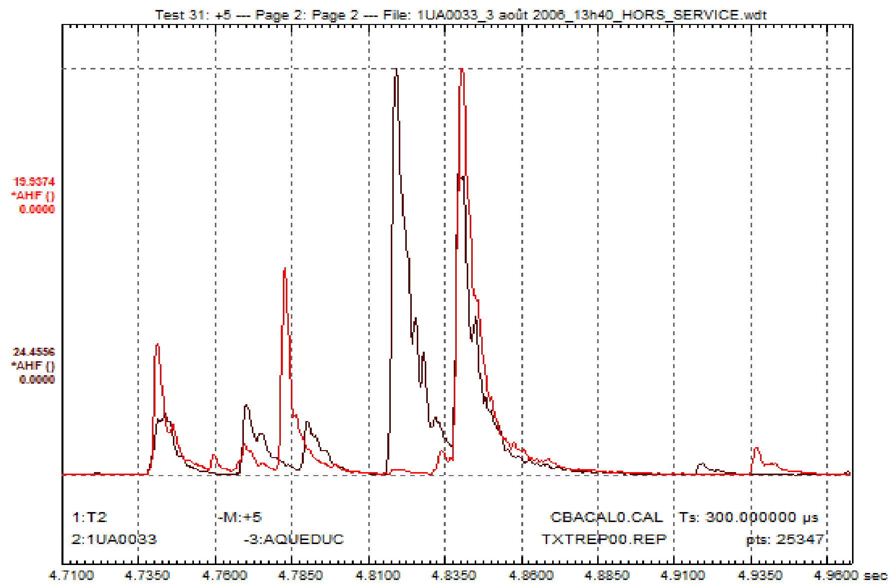
-An uneven wear of contacts between the even and odd sides.

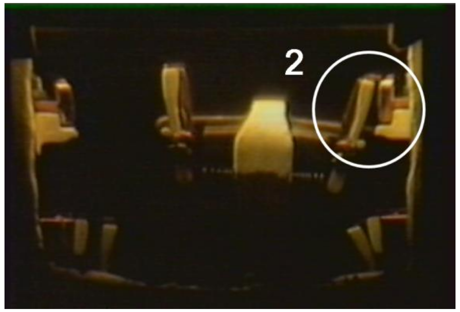
Notes:

Adjustments to correct the situation.

#13 ABB – UCCRN - Contact wear by missing impacts

Pictures





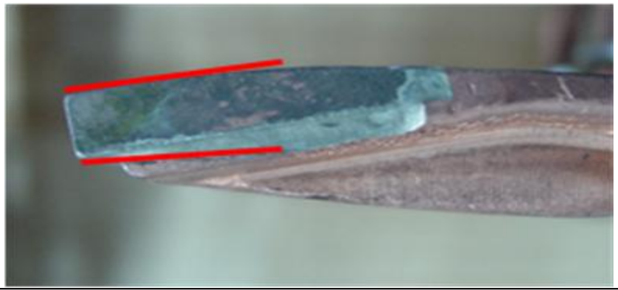
Description

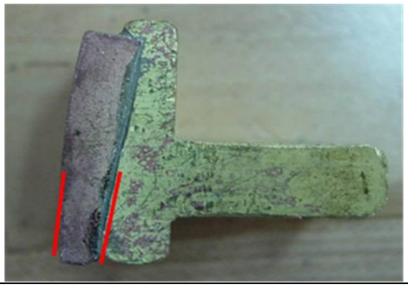
The closing of the main contacts becomes very weak with the wear of contacts.

Contact wear is confirmed by opening up the ABB UCCRN tap changer and replacing the arcing contacts, as highlighted by the traces.

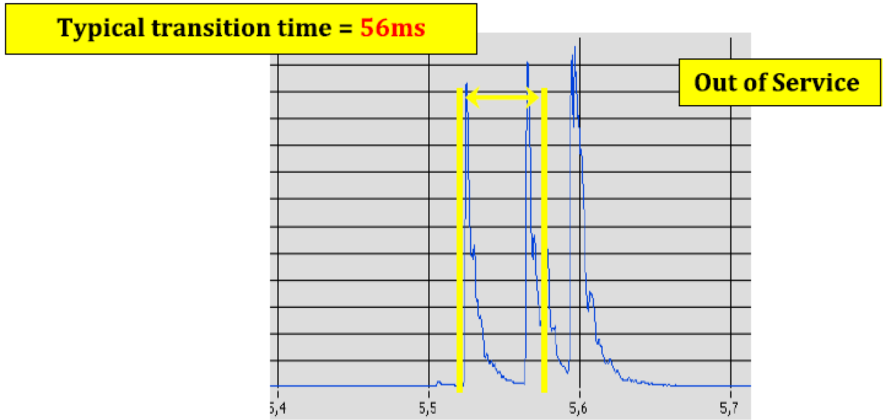
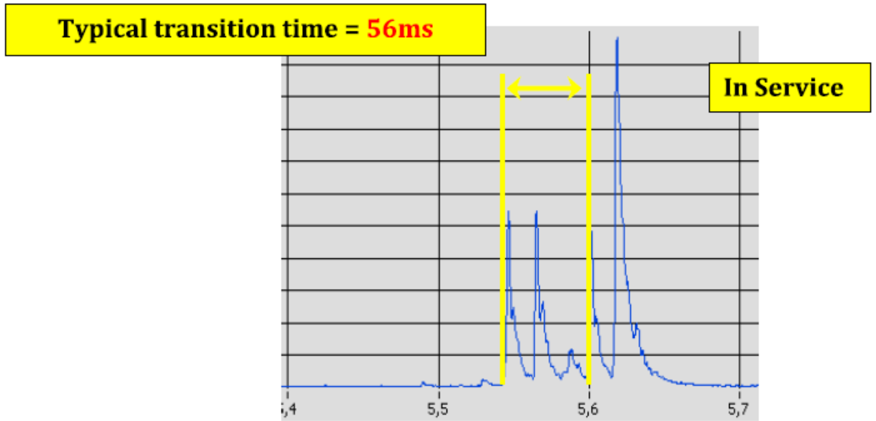
Notes:

The loss of material caused by the wear of the driving contacts, for inertial effect, a variation in the sequence and a reduction of the impact noise of the main arc contacts. Trending of the suspected contacts is necessary to know the speed of the degradation.



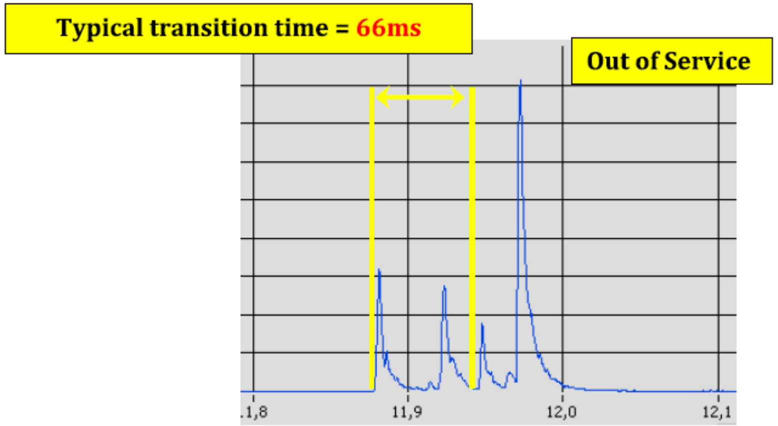
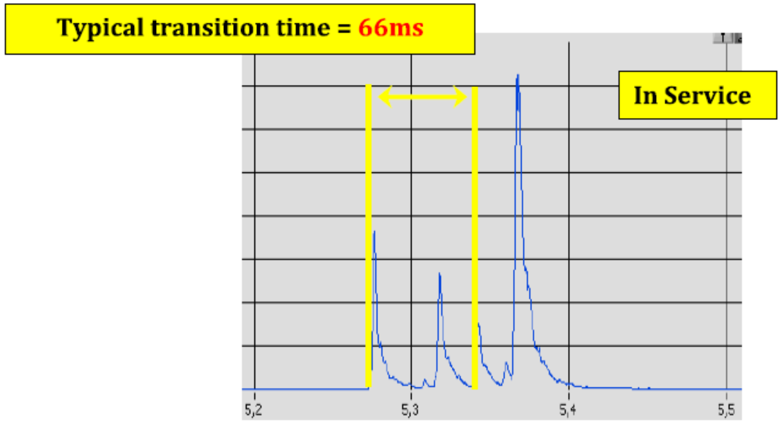


#14 ABB – UCB - Typical switching

Pictures	Description
 **Figure 3 :** ABB UCBRN switching at tap +2' in mode **Out of Service**  **Figure 4 :** ABB UCBRN switching at tap +2 in mode **In Service**	

Notes:

#15 ABB – UCC - Typical switching

Pictures	Description
 **Figure 5 :** ABB UCBRN switching at tap -8 in mode **Out of Service**  **Figure 6 :** ABB UCBRN switching at tap -4 in mode **In Service**	

Notes:

#16 ABB – UCD - Typical switching

Pictures	Description

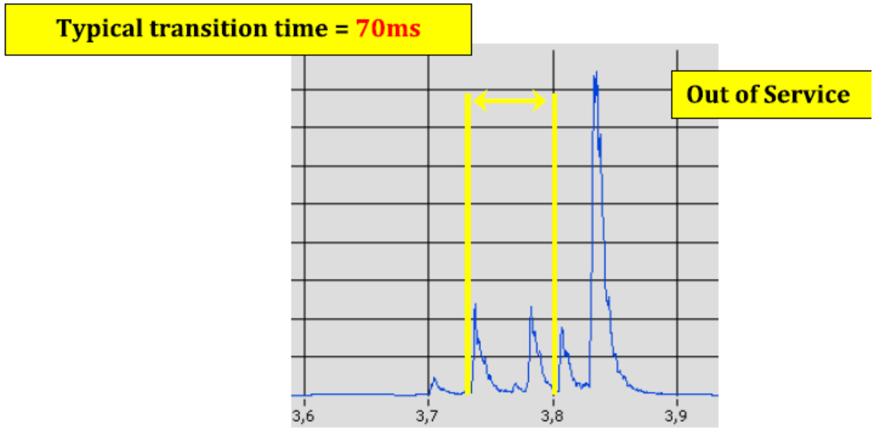


Figure 7 : ABB UCDRE switching at tap +8 in mode **Out of Service**

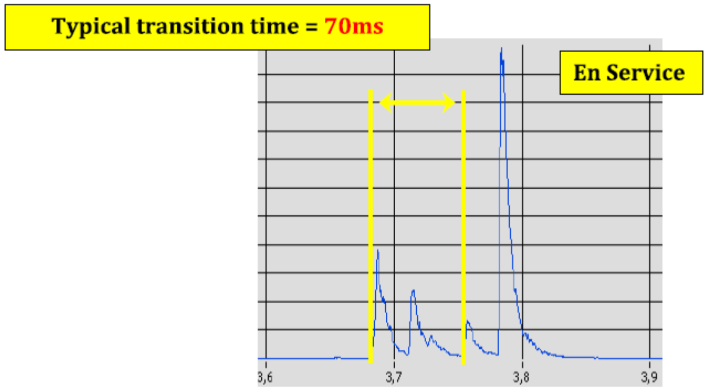


Figure 8 : ABB UCDRE switching at tap +8 in mode **In Service**

Notes:

#17 ABB – UCG - Typical switching

Pictures

Description

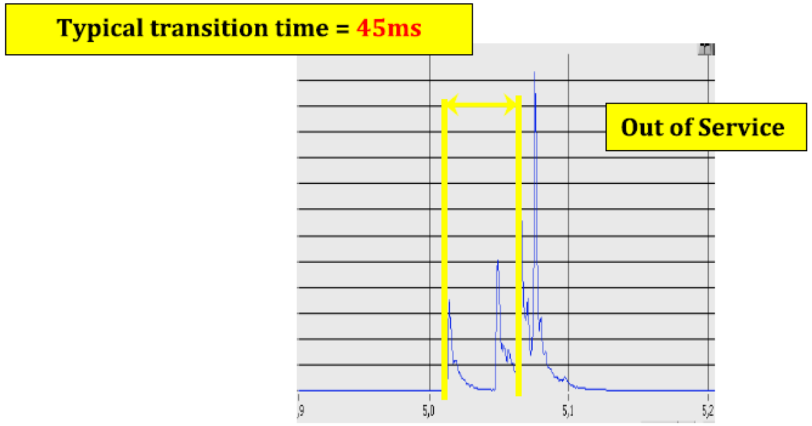


Figure 9 : ABB UCGRN switching at tap +6 in mode **Out of Service**

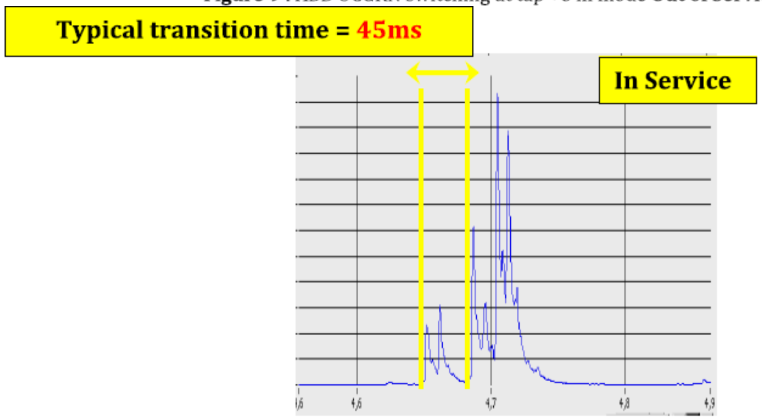


Figure 10 : ABB UCGRN switching at tap +6' in mode **In Service**

Notes:

#18 ABB – UCL - Typical switching

Pictures	Description

Only 1 switch

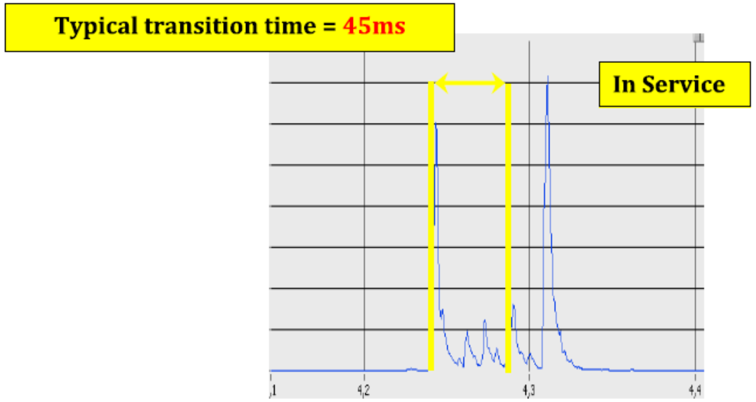


Figure 11 : ABB UCLRN switching at tap -4 in mode **In Service**

Three (3) single-phase switches within the same tank

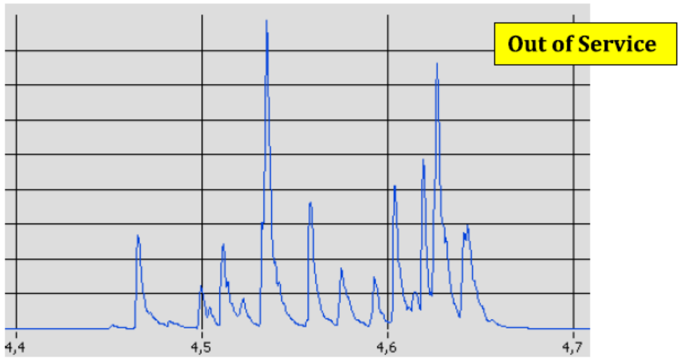
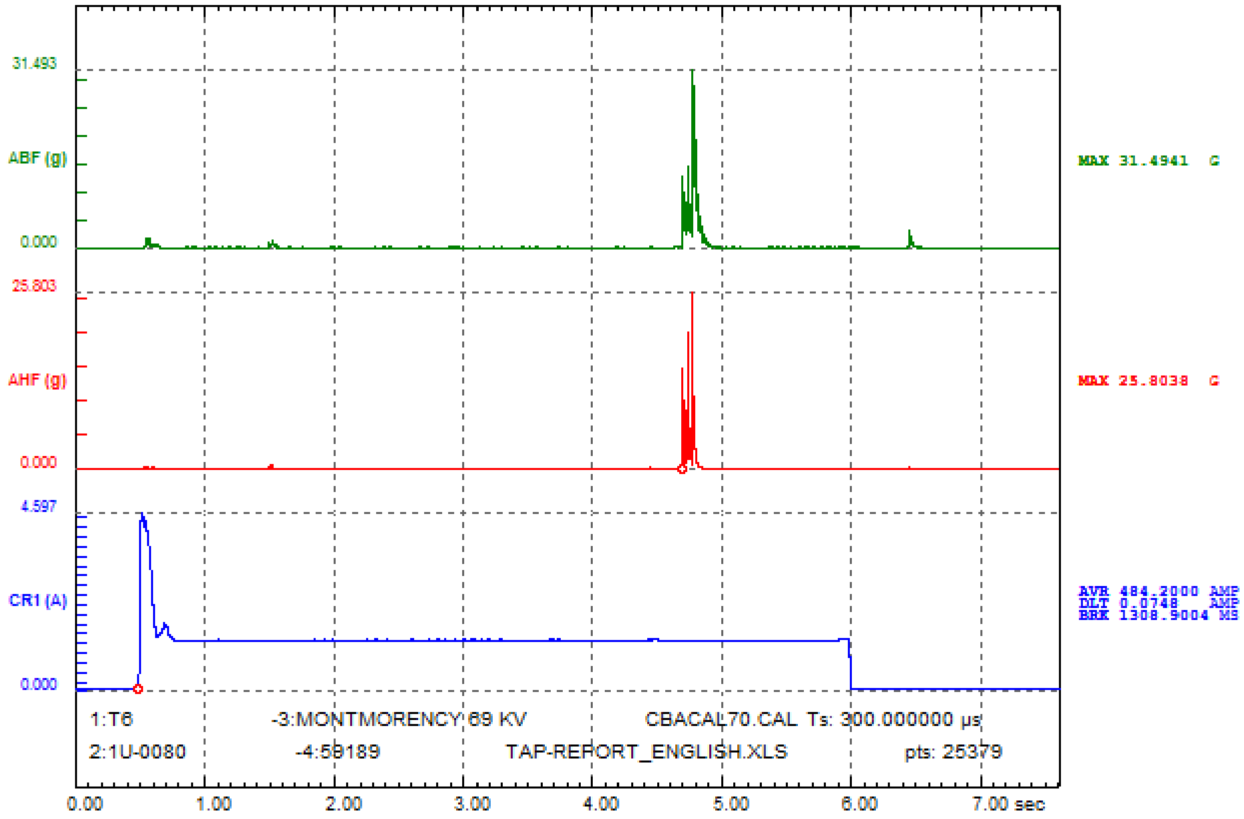


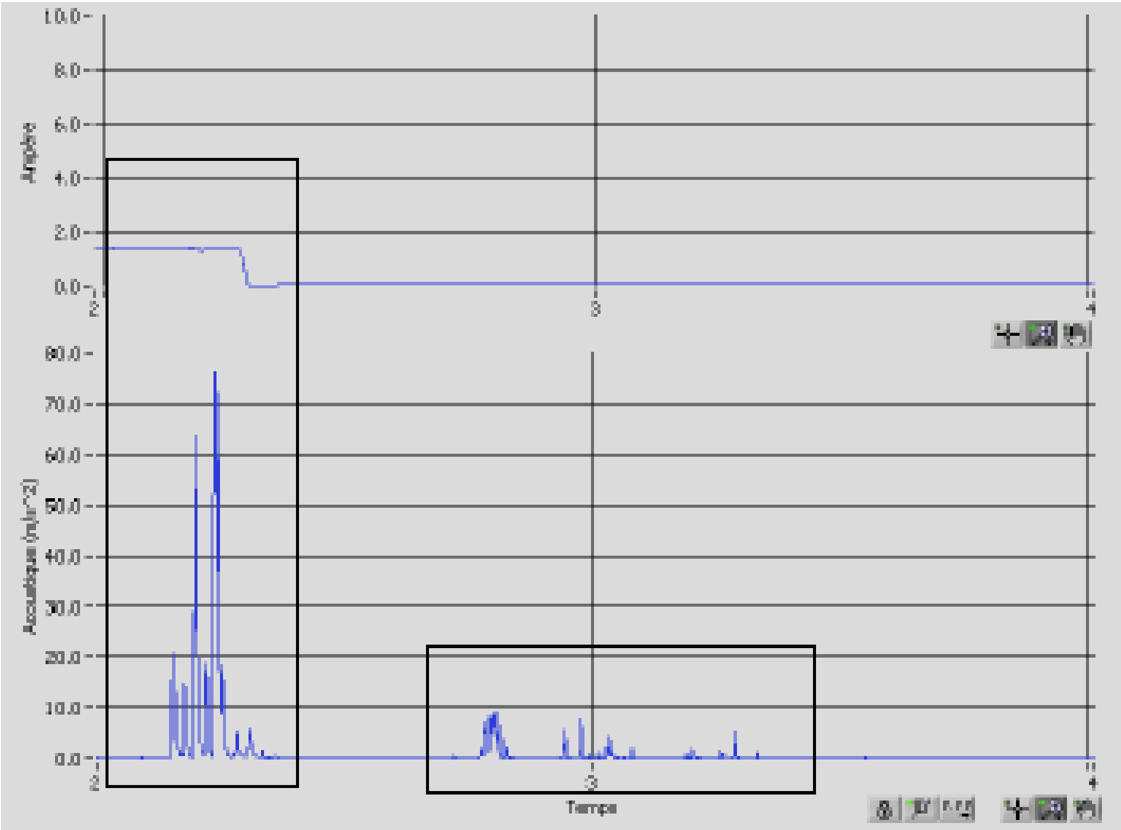
Figure 12 : ABB UCLRN switching at tap +12 in mode **Out of Service**

Notes:

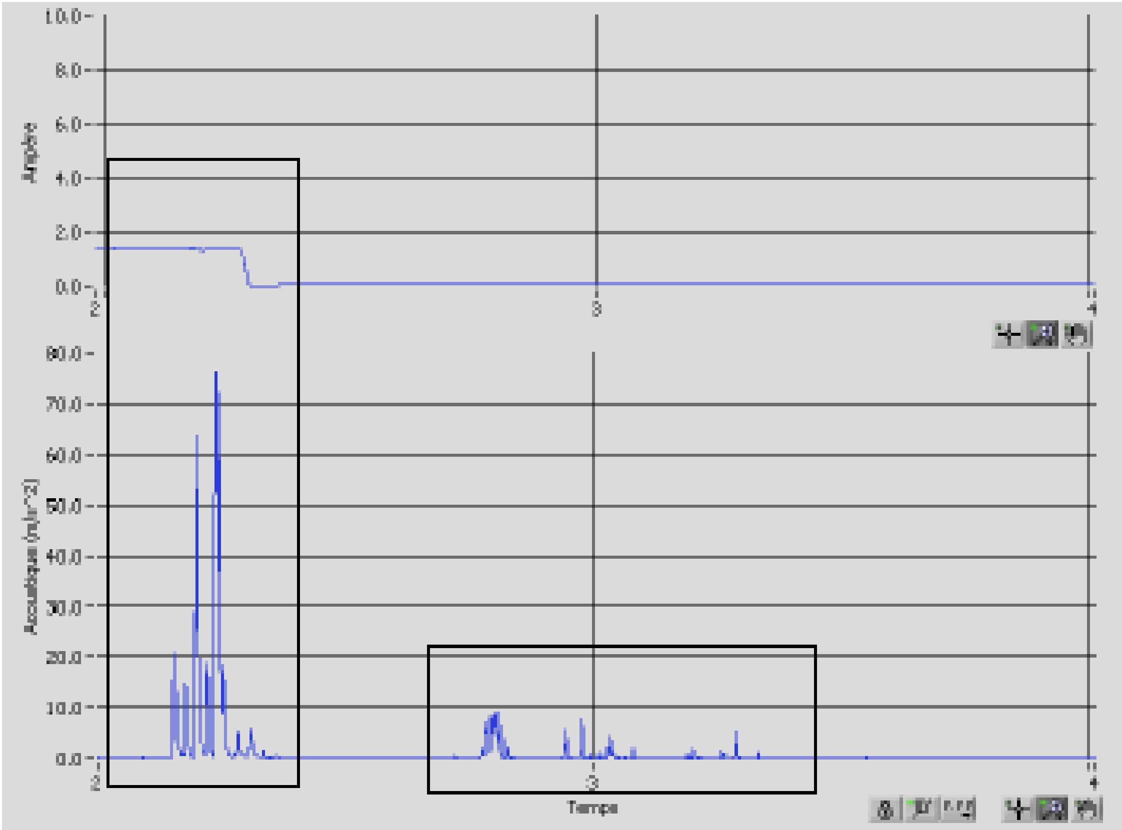
#19 ABB – UC - Expected signature

<table>
<tr><th>Pictures</th><th>Description</th></tr>
<tr><td>
</td><td></td></tr>
<tr><td colspan="2">Notes:</td></tr>
</table>

#20 ABB – UZ (B, C, D, E and F) - Brake failure

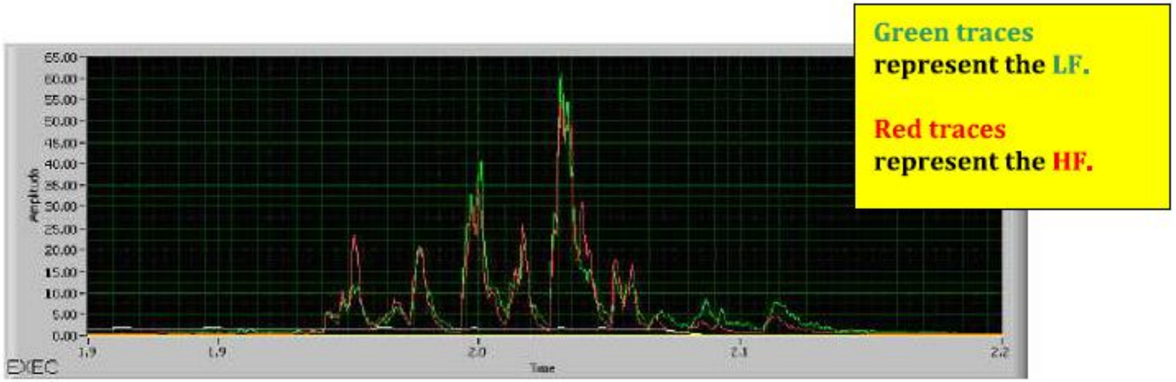
Pictures	Description
	The braking system of the ABB UZ is mechanical, by pressure pads on the inertial flywheel. These systems have experienced failures in the past, including the presence of grease on the surface, which caused malfunctions. In this case, the rotating mechanism continues its momentum and triggers the cascading of operations beyond the position required to stop at one of the extreme positions (1 or 17). The noise after the end of operation is not normal.
Notes: Verify the brake circuits and components.	

#21 ABB – UZ (B, C, D, E and F) - Brake failure

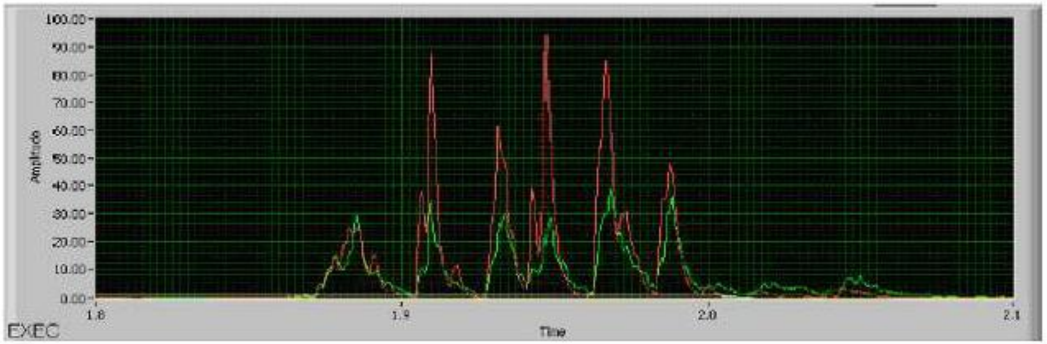
Pictures	Description
	The braking system of the ABB UZ is mechanical, by pressure pads on the inertial flywheel. These systems have experienced failures in the past, including the presence of grease on the surface, which caused malfunctions. In this case, the rotating mechanism continues its momentum and triggers the cascading of operations beyond the position required to stop at one of the extreme positions (1 or 17). The noise after the end of operation is not normal.
Notes: Verify the brake circuits and components.	

#22 ABB – UZ (B, C, D, E and F) - Wear of contacts

<table>
<tr><th>Pictures</th><th>Description</th></tr>
<tr><td>



a) New contacts (October 21, 2002)



b) Worn contacts (October 1, 2002)

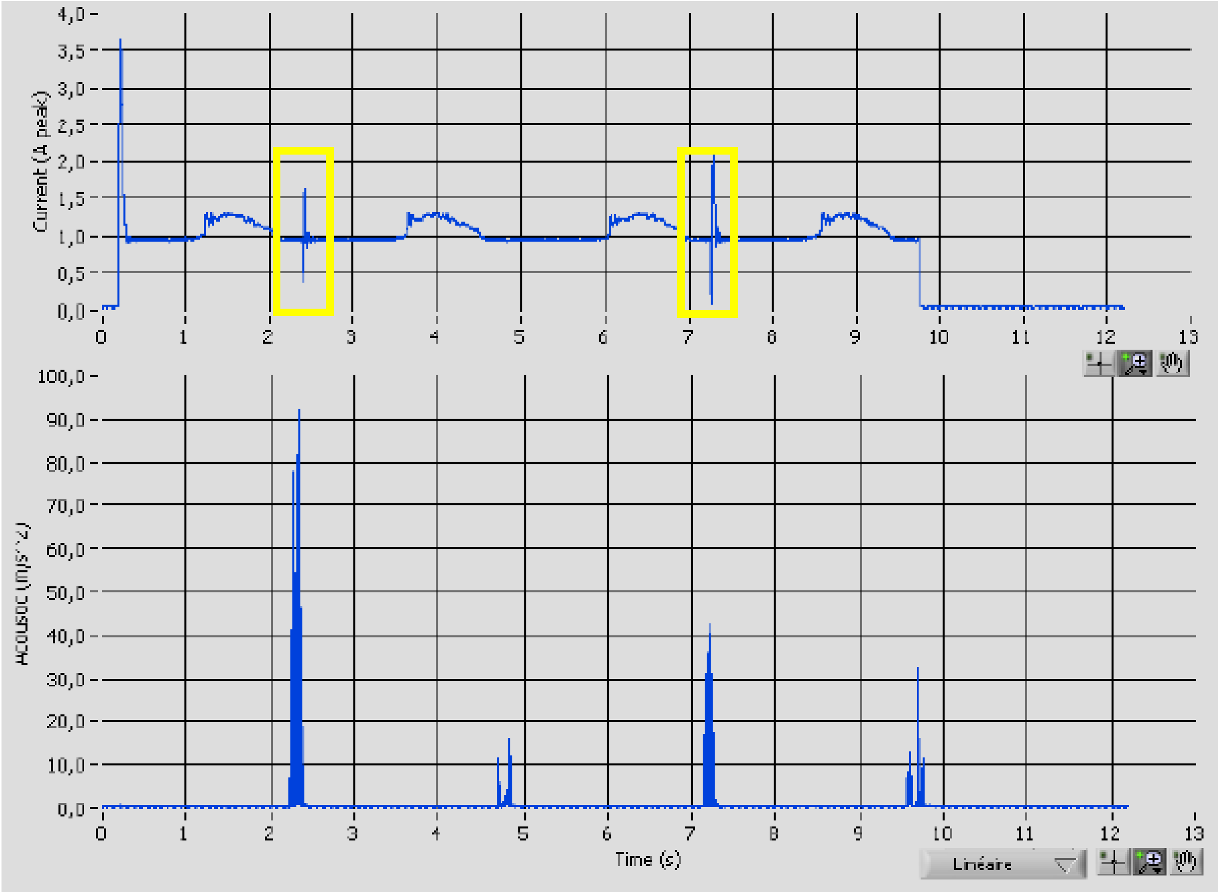
</td><td>Wear of the switch contacts appears on the acoustic signatures by a gap between the amplitudes of the traces of the High Frequency and the Low Frequency.</td></tr>
<tr><td colspan="2">

Notes:

Trending of the suspected contacts is necessary to know the speed of the degradation.

</td></tr>
</table>

#23 ABB – UZ (B, C, D, E and F) Faulty control relay

Pictures	Description
	It is to note that sometimes with multiple operations there are important current fluctuations. These phenomena are due to a malfunction of the control relay. Usually a minor problem that can be tuned either by adjusting or replacing the defective relay.

Notes:

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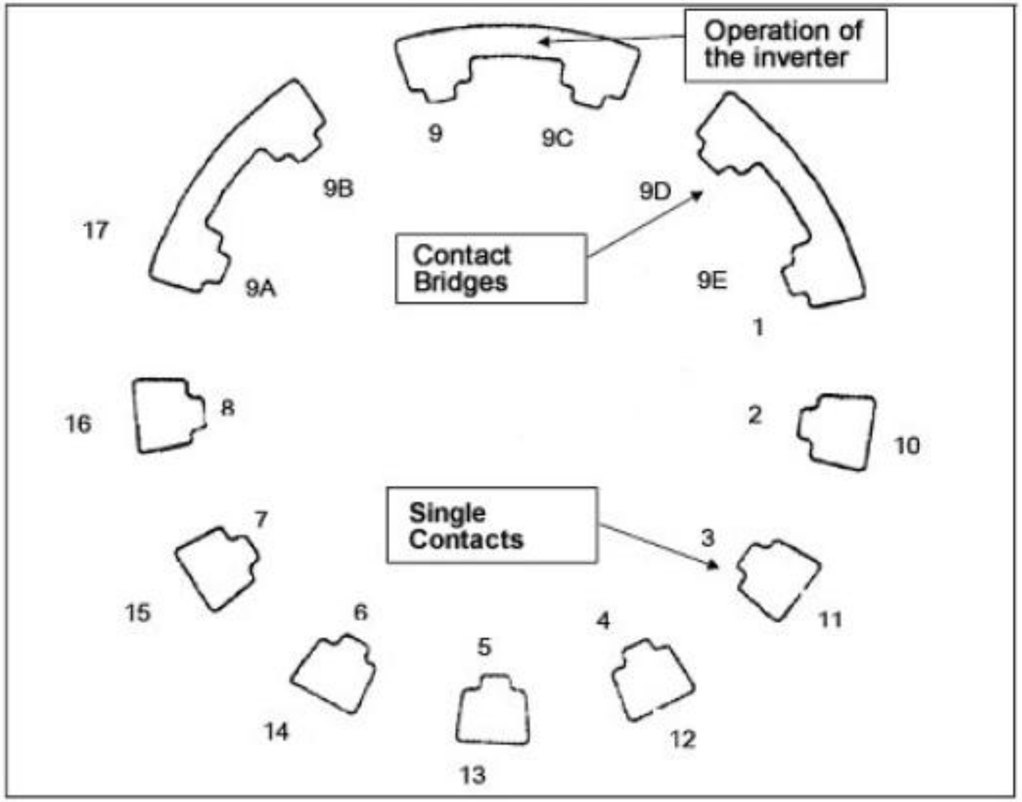
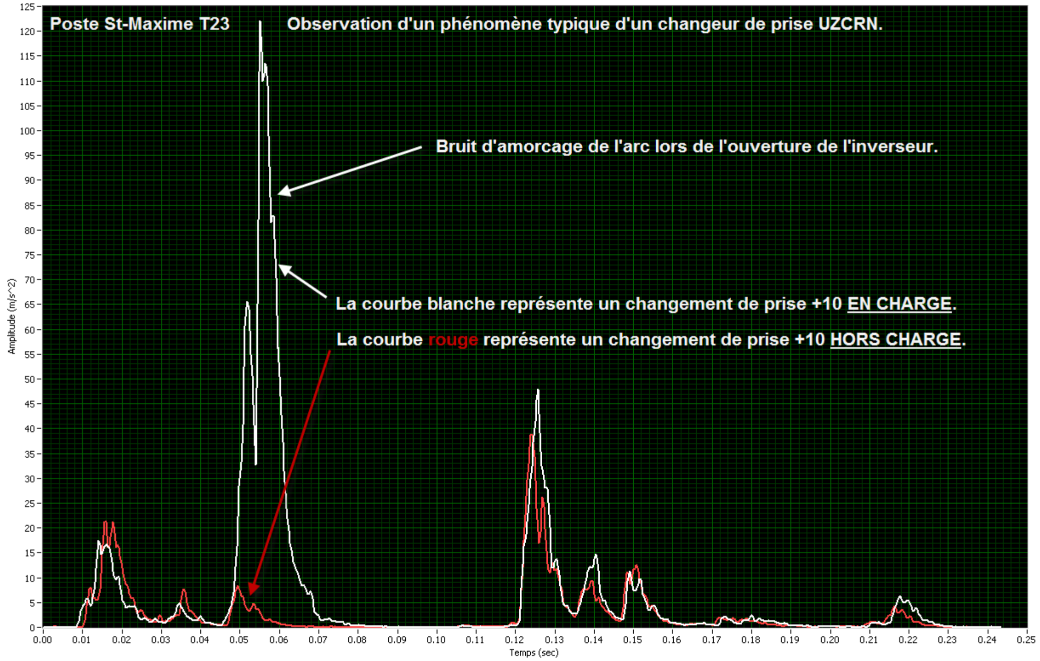
#24 ABB – UZ - Types of taps

Pictures	Description
 **Figure 1 :** Taps setup on a ABB UZ operating with 17 taps with an inverter	The figure shows the setup of the fixed contacts of an ABB UZ operating with 17 taps with an inverter. As seen, there is a representation of two types of contacts, either as: contacts bridges and single contacts. There are so many types of switching, depending of the type of departure and arrival contact: -single contact to a contact bridge -contact bridge to a single contact -switching over the same contact bridge -contact bridge to a contact bridge -switching over the same contact bridge with an operation of the inverter -single contact to a single contact.

Notes:

Each type of switching has a distinct signature since the mechanical mechanisms are themselves distinctive.

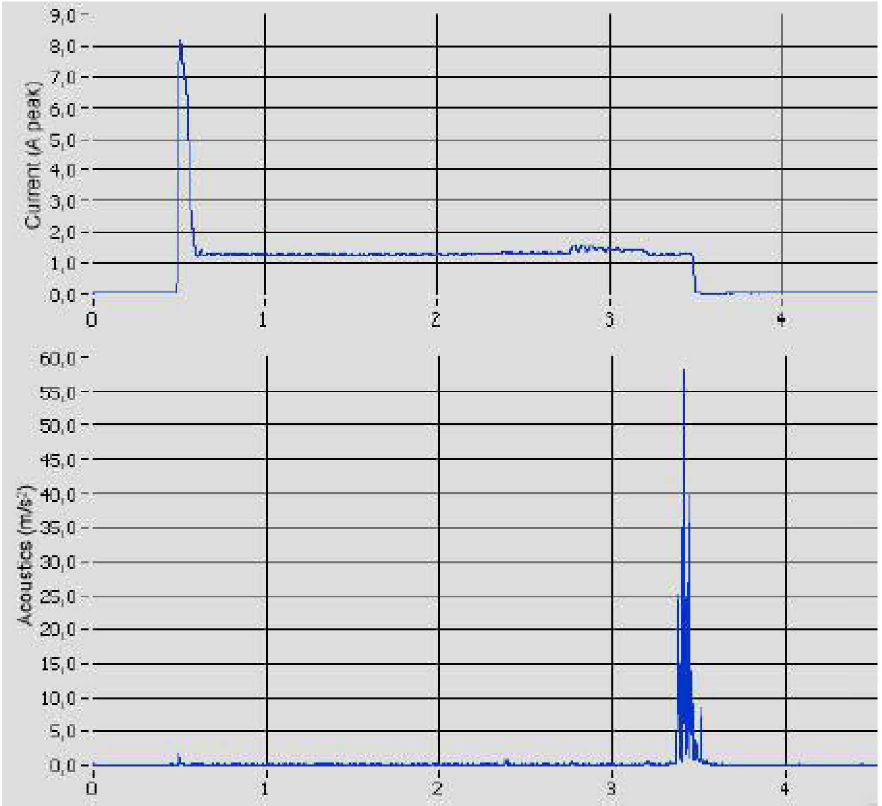
#25 ABB - UZCRN - Arcing contact

Pictures	Description
 SUPERPOSITION OF HIGH AND LOW FREQUENCIES	

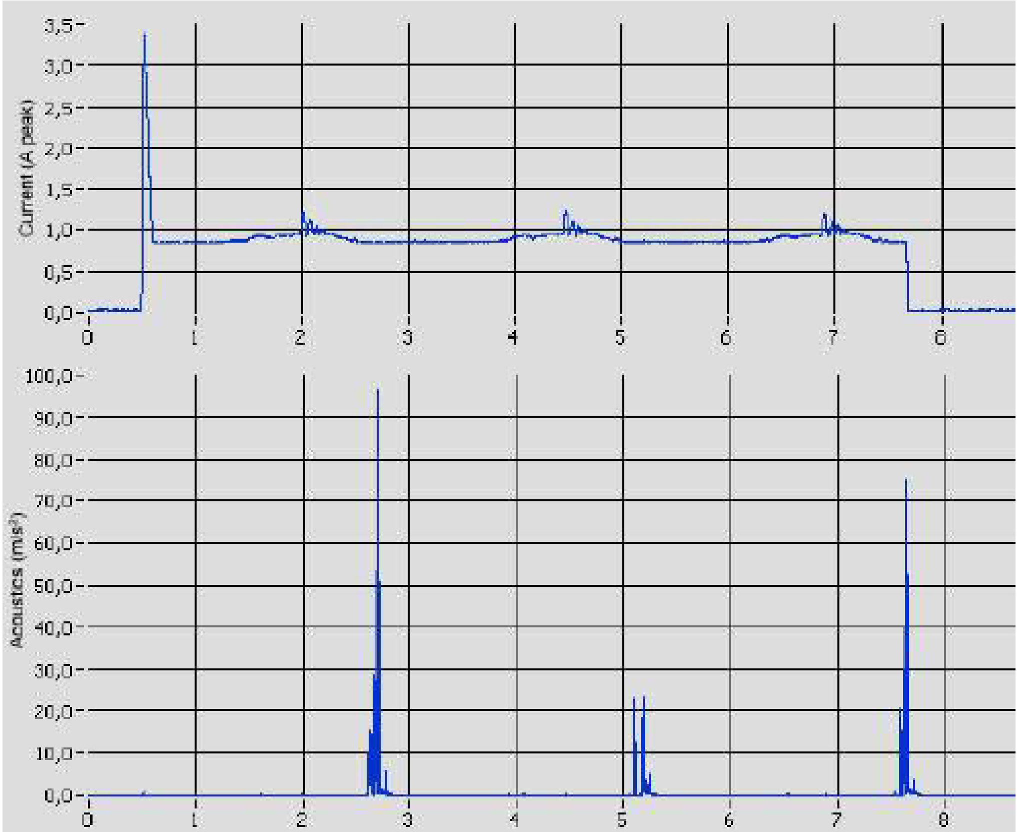
Notes:

www.zensol.com

#26 ABB – UZCRN - Single operation

Pictures	Description
 **Figure 2 :** Single operation upward of an ABB UZCRN (tap +8')	The single operation is an upward or a downward movement of the selector, followed by a transfer of the load through the switch.
Notes:	

#27 ABB – UZC, UZE and UZF - Multiple operations

Pictures	Description
 **Figure 3 :** Triple operation (9A, 9B and 9) for an ABB UCZCRN (tap +9)	Tap Changers of models ABB UZC, UZE and UZF have two different taps and several types of switching. When a moving contact must pass through several intermediate positions before reaching the next tap, the operation is called “multiple operations”. Multiple operations include triple and quadruple operations.

Notes:

For example, when a moving contact is switched from tap 8 to tap 9, the switch passes through the intermediate positions 9A and 9B. This operation is a triple operation and is expressed by multiple switching (x3) on the acoustic signature, as shown on the picture above.

#28 ABB – UZC, UZE and UZF - Typical switching

Pictures	Description

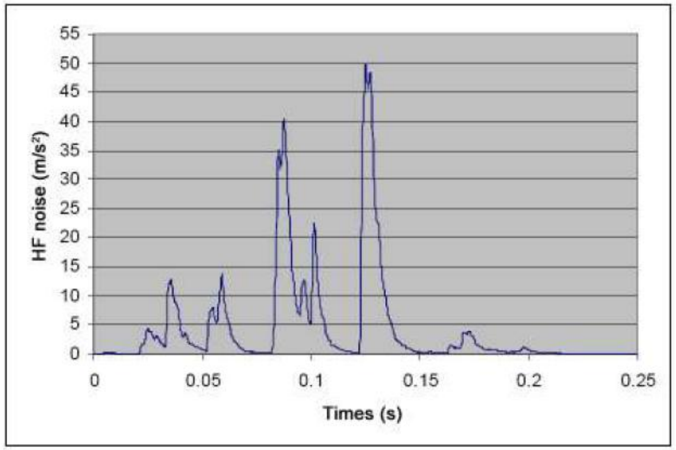


Figure 4 : Switching of a single contact to a contact bridge – **Operations** 8-9A; 16-17; 2-1 and 10-9-E

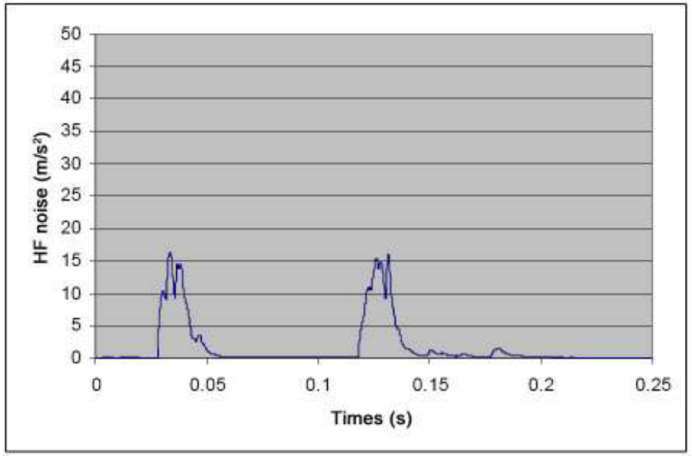


Figure 6 : Switching on a contact bridge – **Operations** 9A-9B, 9D-9E; 9B-9A and 9E-9D

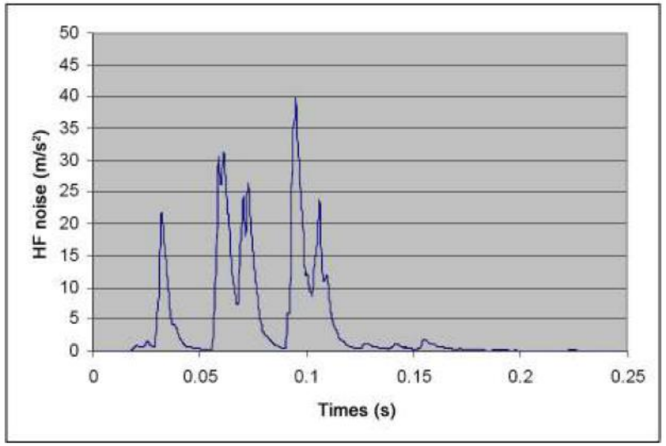


Figure 5 : Switching of a contact bridge to a single contact – **Operations** 9A-8; 17-16; 1-2 and 9E-10

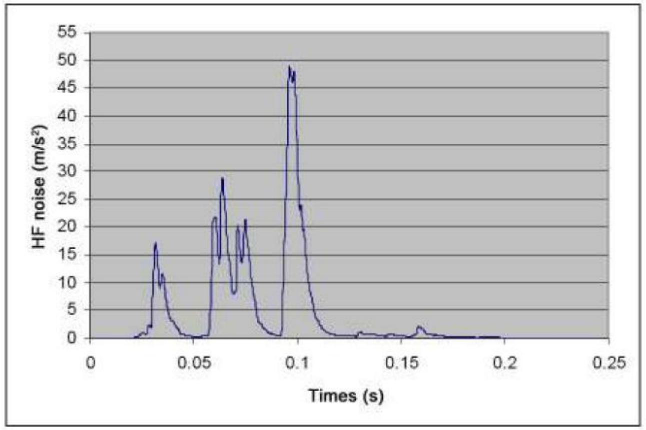
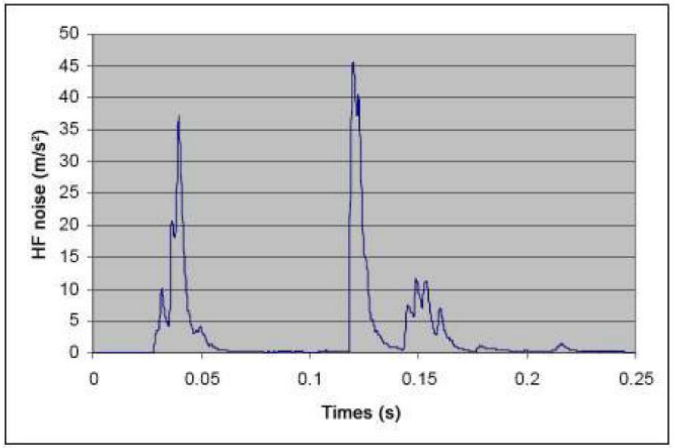
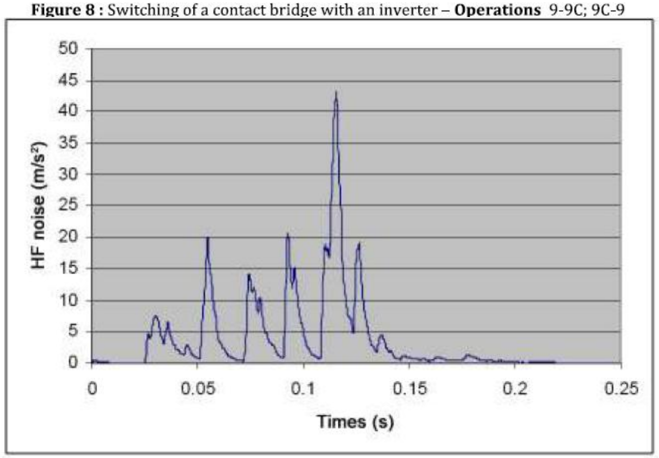


Figure 7 : Switching of a contact bridge to a contact bridge – **Operations** 9B-9; 9C-9D; 9-9B and 9D-9C

Notes:

#29 ABB – UZC, UZE and UZF - Typical switching

Pictures	Description
 **Figure 8 :** Switching of a contact bridge with an inverter – **Operations** 9-9C; 9C-9  **Figure 9 :** Switching of a single contact to a single contact – **all the other operations**	

Notes:

#30 ABB – UZB - Typical switching

<table>
<tr><th>Pictures</th><th>Description</th></tr>
<tr><td>

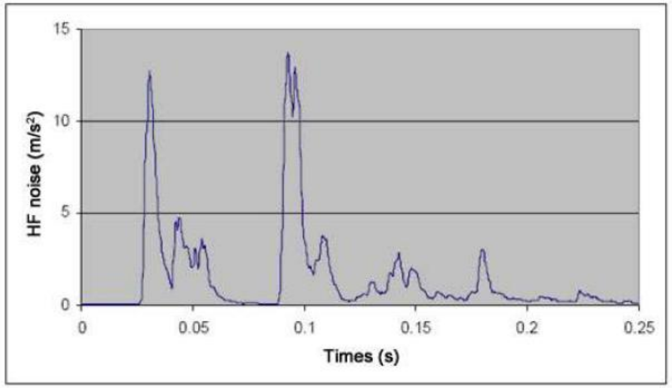


Figure 10 : Upward movement

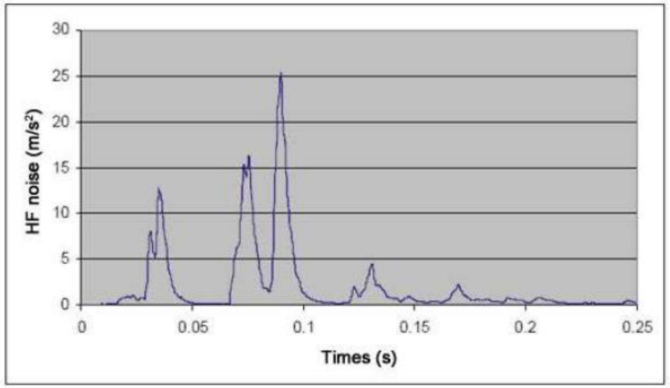


Figure 11 : Downward movement

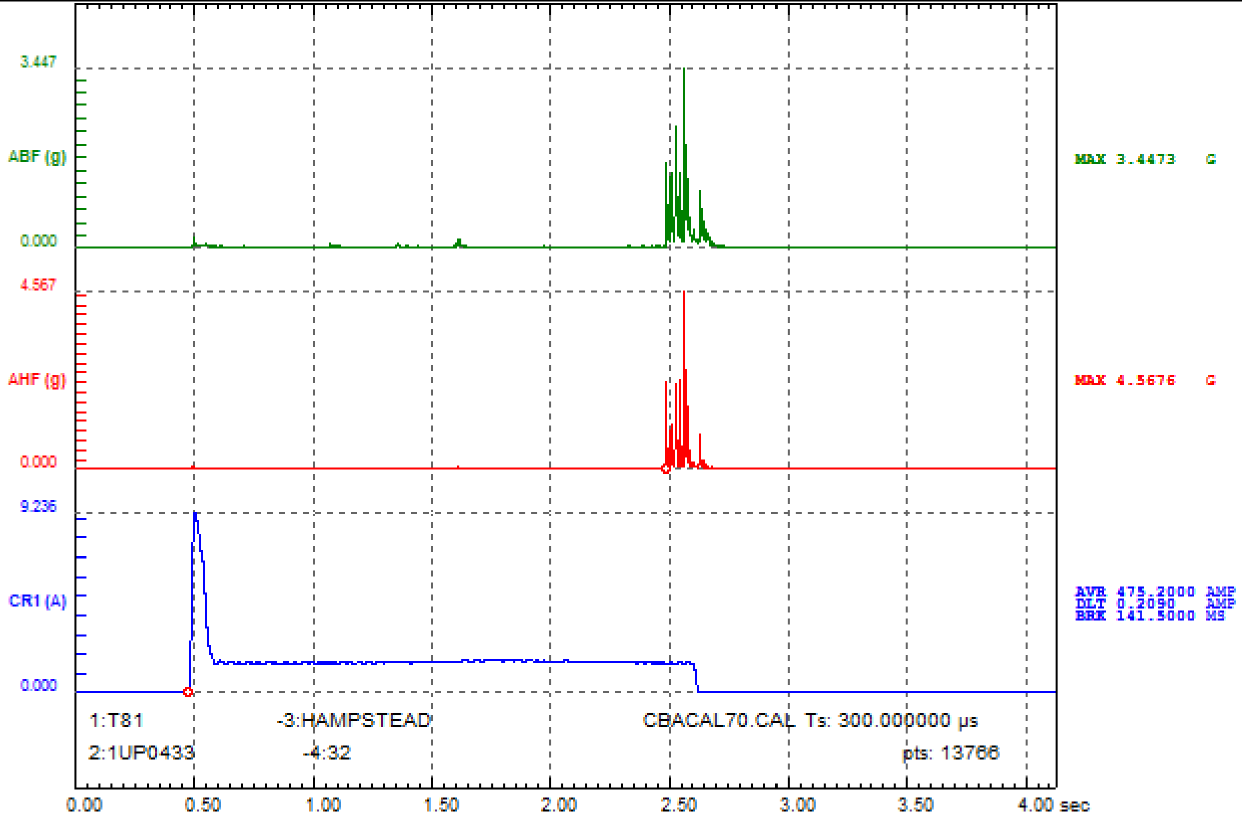
</td><td>The ABB UZB has a configuration of 17 fixed positions. This allows the operation without a pre-selector or an inverter for the usual settings of our network. This eliminates multiple switching operations.</td></tr>
<tr><td colspan="2">

Notes:

The ABB UZB is different from the other ABB UZ models due to the signatures of non-symmetrical upward and downward operations.

</td></tr>
</table>

#31 ABB UZ - Expected signature

Pictures	Description
	The normal switching operation of the ABB UZ model occurs close to the end of the motor current.
Notes:	

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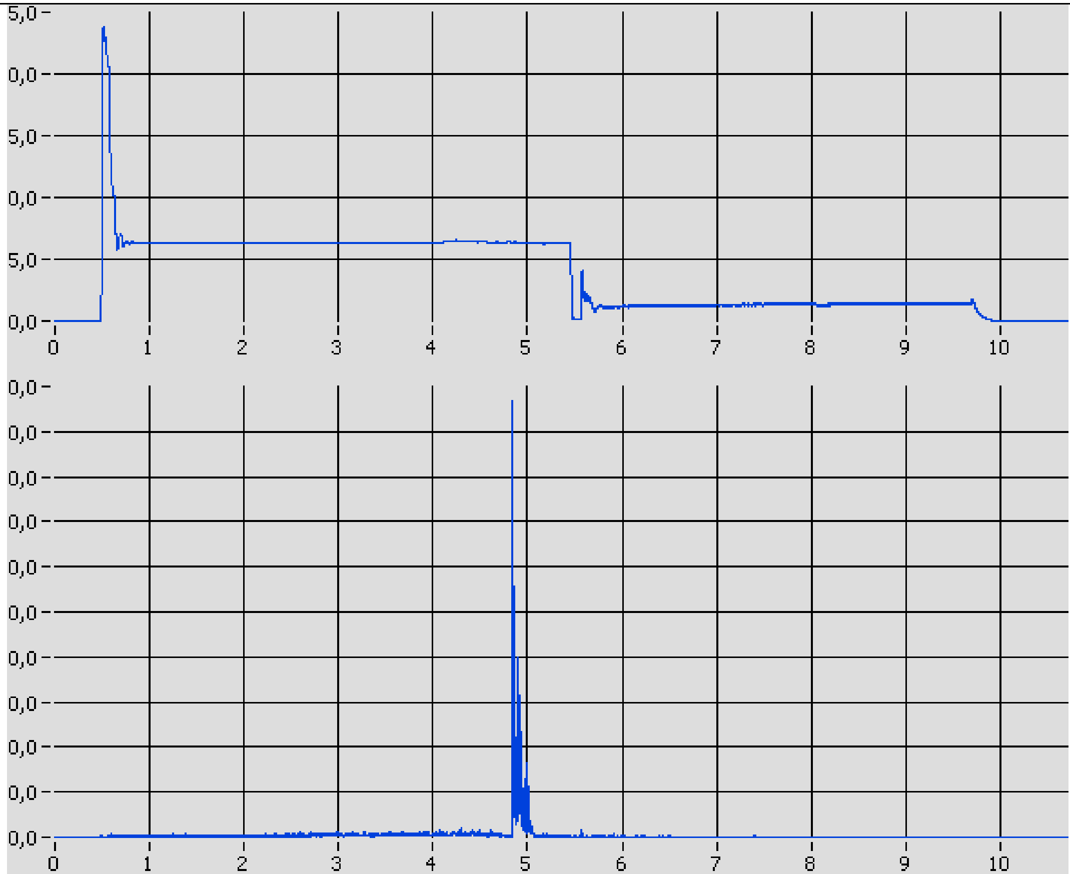
#32 FEDERAL PIONEER – REACTIVE MODELS - Extended length of the braking

Pictures



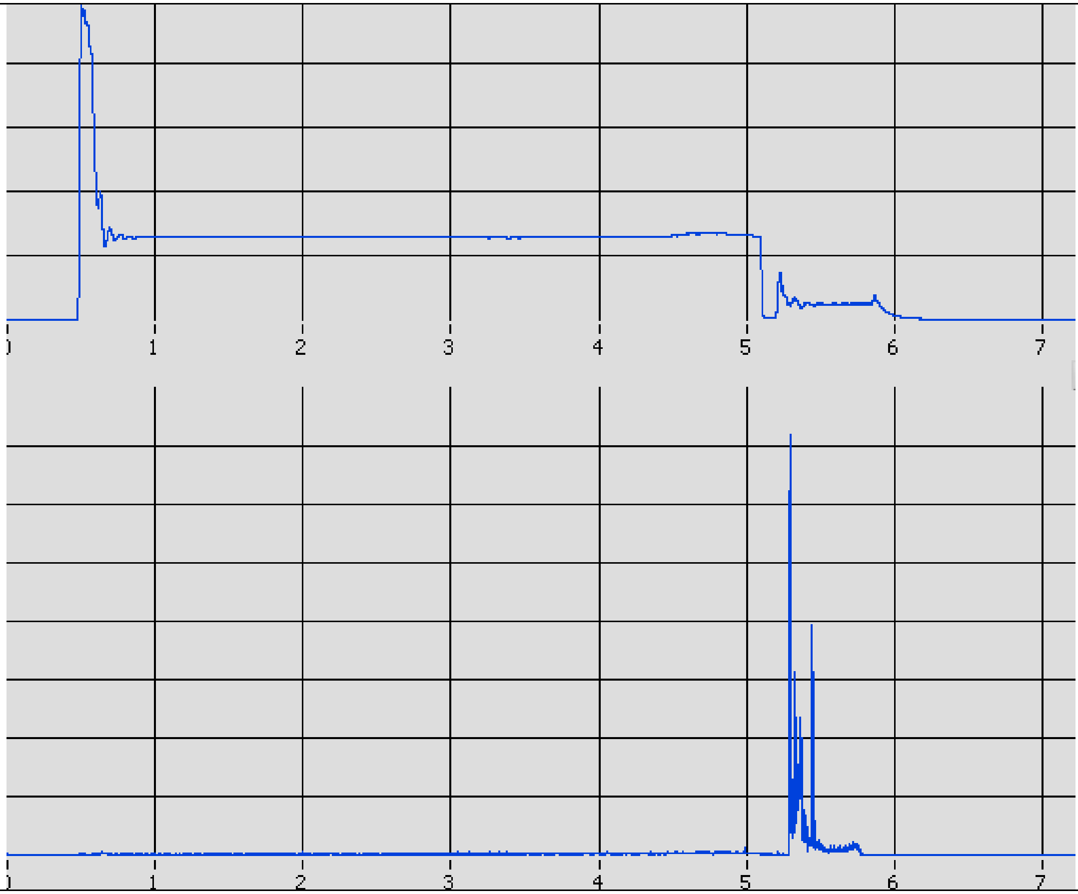
Description

The trace of the current contains an extended braking. Dynamic brake is applied for an abnormally long time.

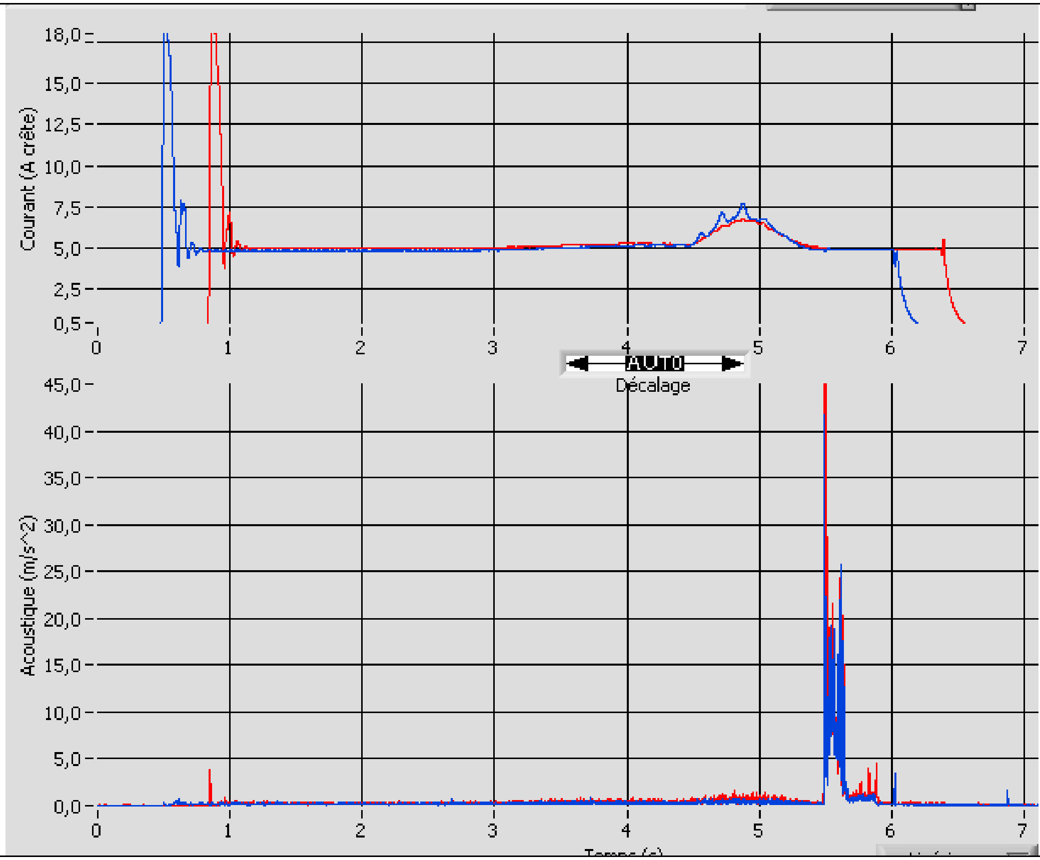
Notes:

Adjust and repair the braking system.

#33 FEDERAL PIONEER – REACTIVE MODELS - Desynchronization of the switching

Pictures	Description
	The switching occurs too early/late. It happens after the end of the motor current during the braking or much too early in the operation.
Notes: Synchronize the switching.	

#34 FEDERAL PIONEER – REACTIVE MODELS - Lack of the lubrication in the drive mechanism

Pictures	Description
	Fluctuations such as oscillations appear on the trace of the motor current during the operation of the switch, selector or inverter. (red trace) is normal. (blue trace) shows oscillations.

Notes:

Lubricate the drive mechanism.

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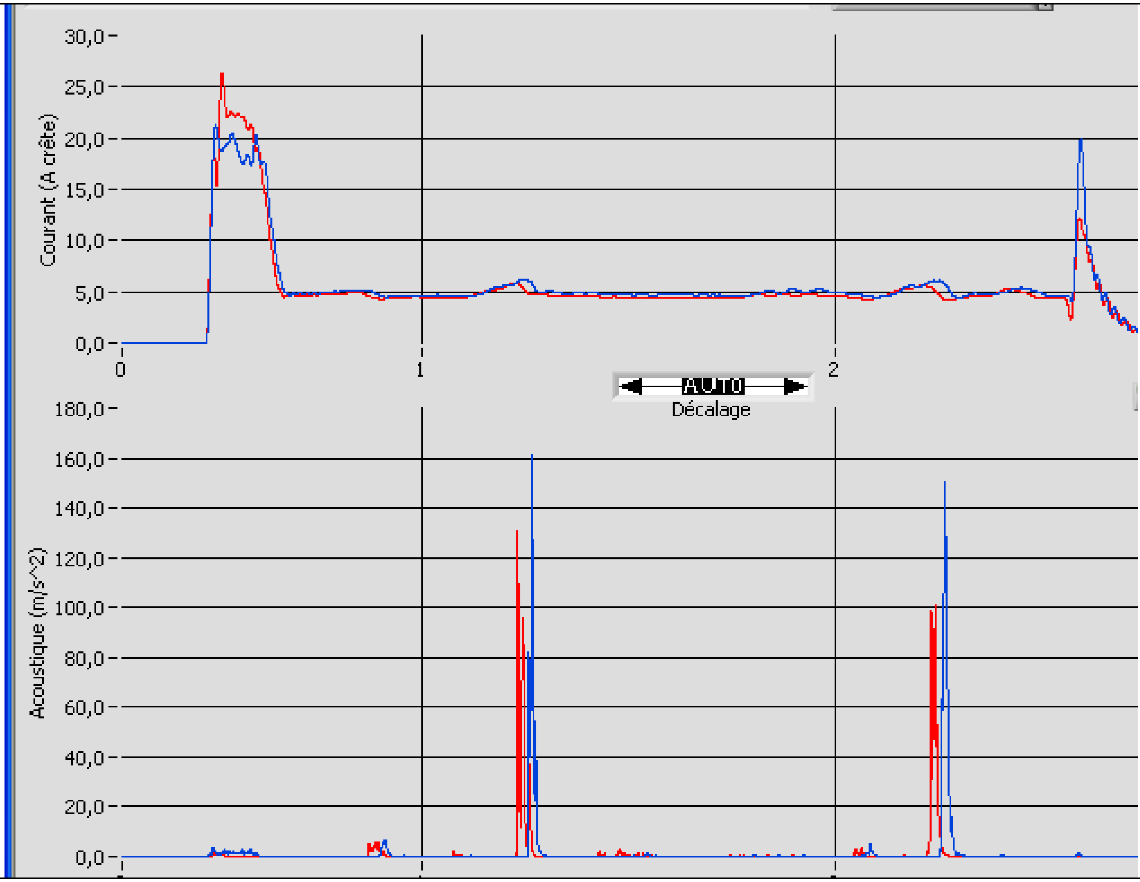
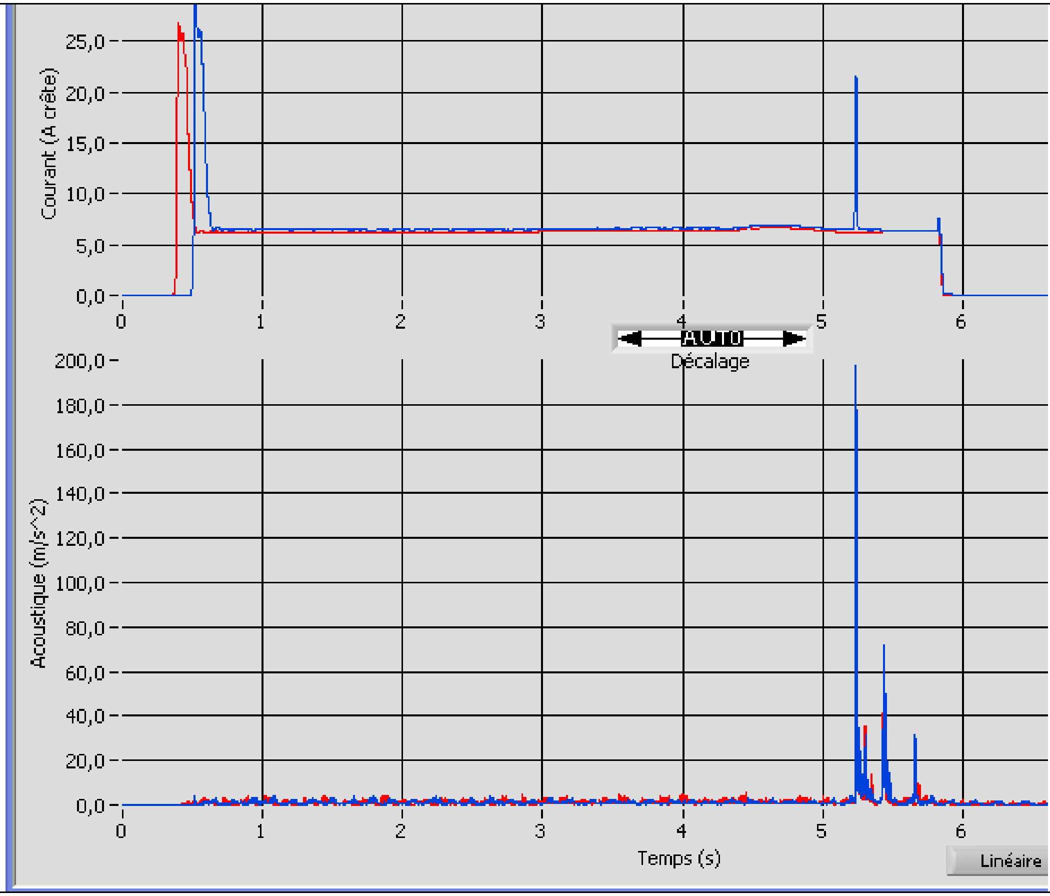
#35 FEDERAL PIONEER – REACTIVE MODELS - Motor startup contactor

Pictures	Description
	The inrush trace presents abnormal oscillations, while the normal inrush trace (blue trace) is generally smooth and stable (red trace). These oscillations can be caused by a problem with the contactor that starts the motor or with the motor itself.

Notes:

Readjust the contactor or replace the motor if it is defective.

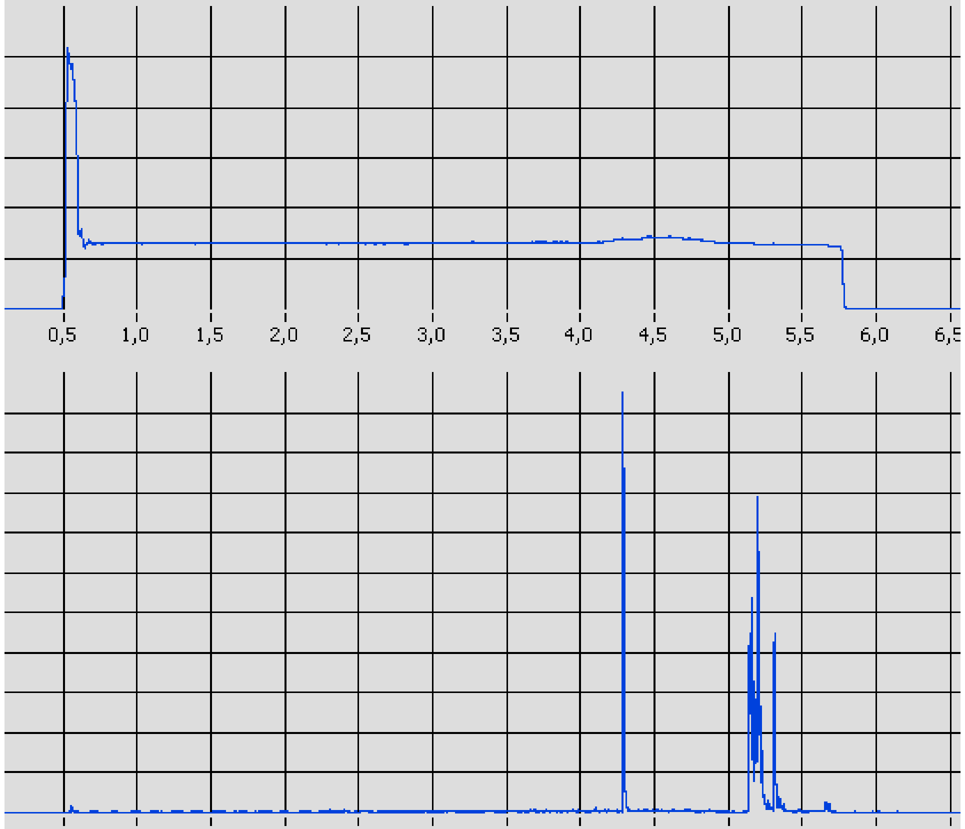
#36 FEDERAL PIONEER – REACTIVE MODELS - Noise of very high amplitude switching

Pictures	Description
	The switching shows a noise with very high amplitude compared to normal switching, and compared with other noises on the same switching. This may be due to a problem of the transition of the spring, a problem with the switch mechanism or another cause.

Notes:

Identify the cause of the problem and repair, by readjustment of the mechanism, changing the much worn parts or the springs.

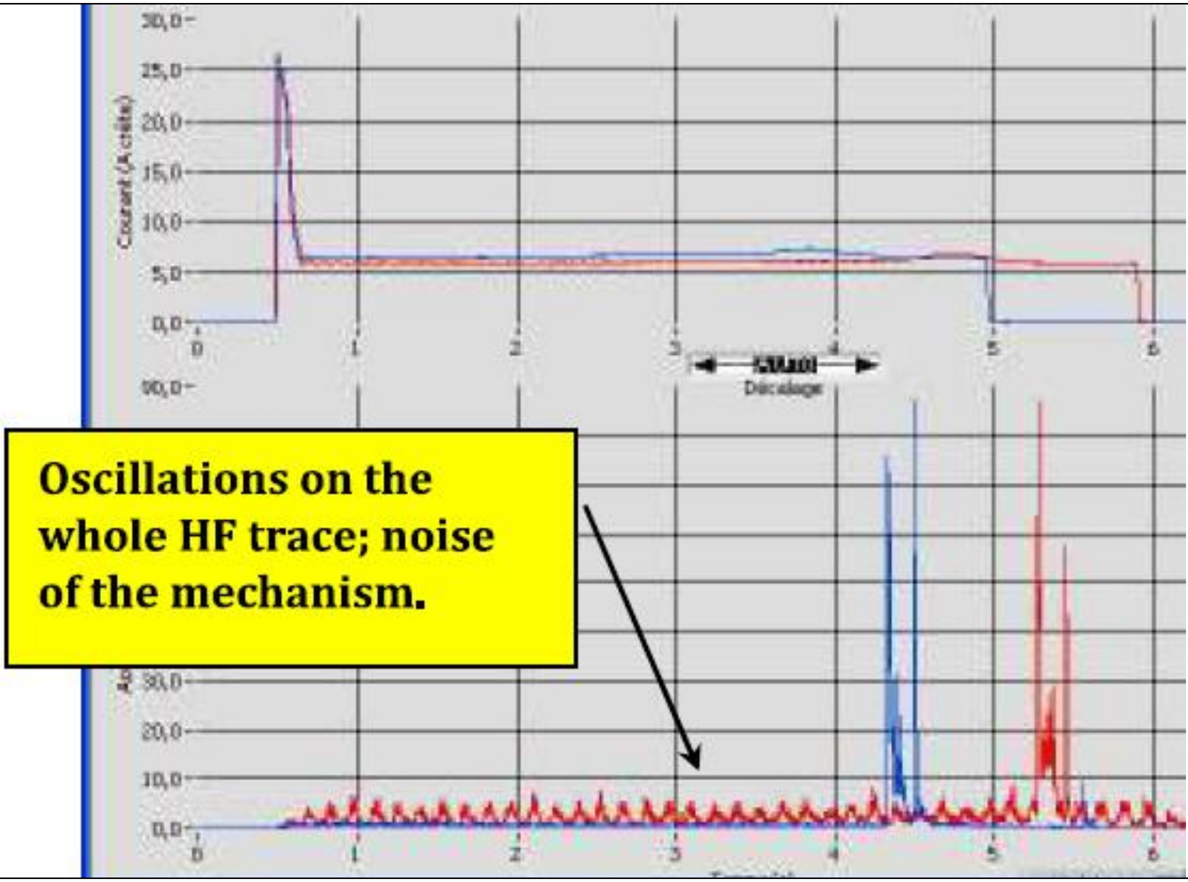
#37 FEDERAL PIONEER – REACTIVE MODELS - Noise of very high amplitude during the operation of the inverter

Pictures	Description
 	This defines an arc of very high amplitude present during the operation of the inverter. This may be due to too much carbon in the oil, or to a problem with the limiting voltage device, or other sources.

Notes:

Identify the cause of the problem and repair, change or filter the oil, etc.

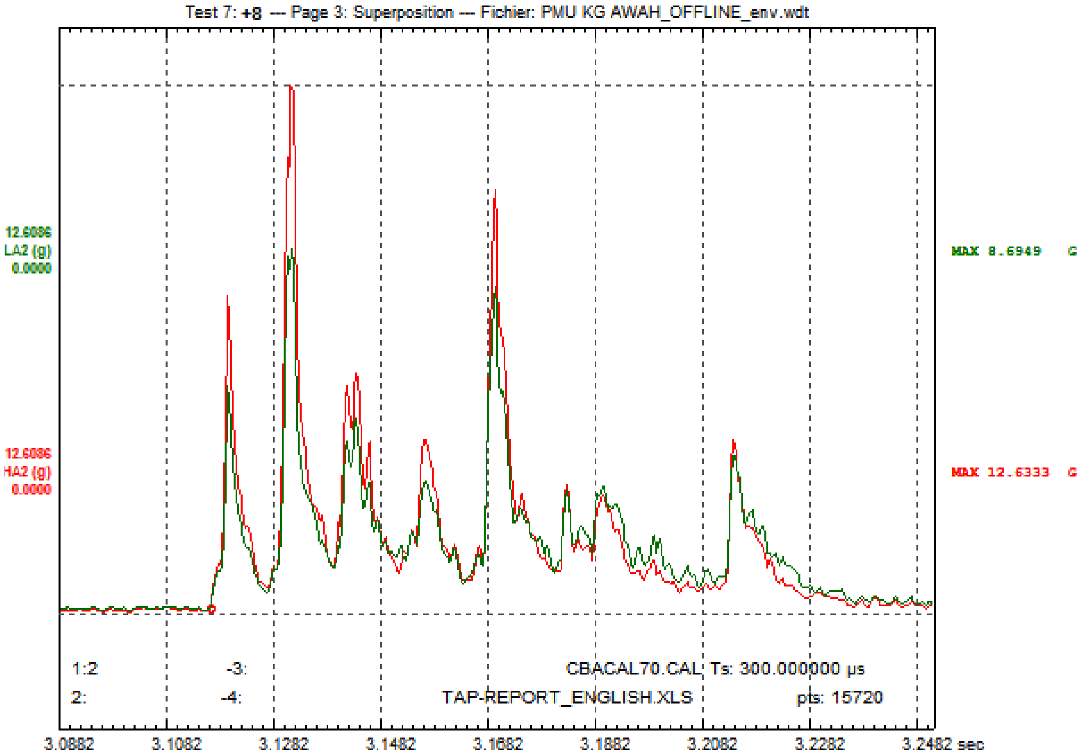
#38 FEDERAL PIONEER – REACTIVE MODELS - Noise of the mechanism during its operation

Pictures	Description
	We notice a noise of the mechanism during its operation. The oscillations are present throughout all the trace of the High Frequency. A lack of lubrication of the drive mechanism or an advanced wear of the drive mechanism is present.

Notes:

Correct the situation by lubricating or replacing worn parts or observe the OLTC periodically to monitor the problem at hand.

#39 MR REINHAUSEN – M and V - Wear of contact

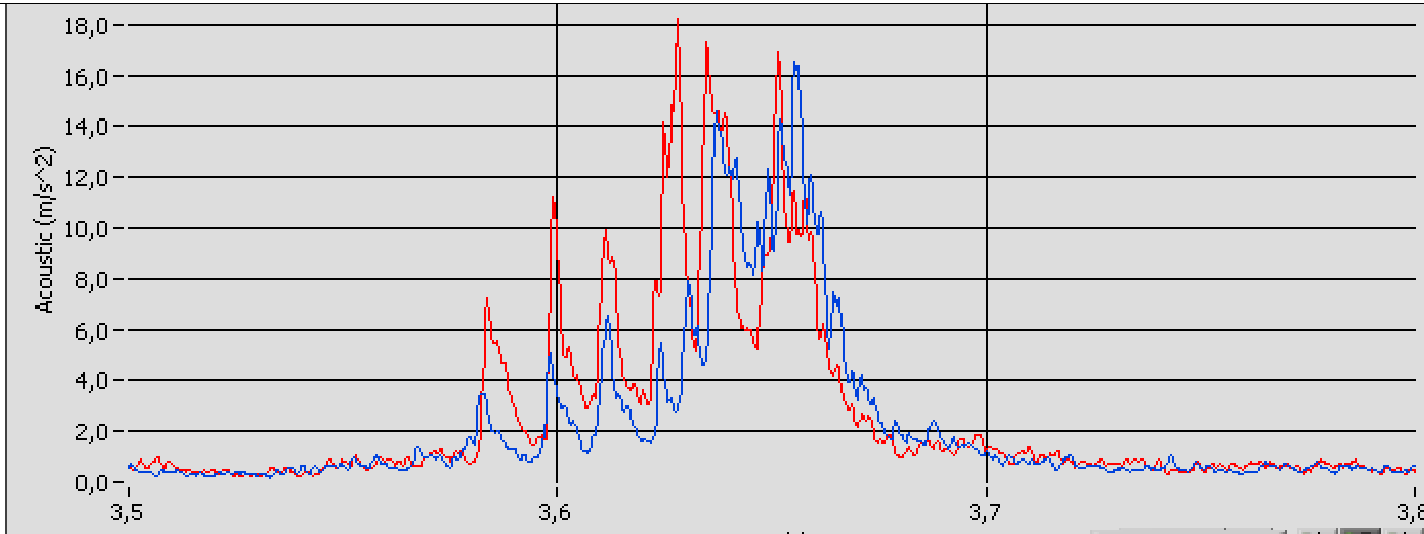
Pictures	Description
	The wear of contacts is seen as gaps between low and high frequency envelopes. A new mechanism will show similar envelopes while one of the envelopes becomes dominant as the wear increases.

Notes:

Trending of the suspected contacts is necessary to know the speed of the degradation.

#40 MR REINHAUSEN – M and V - Wear of the rolls of main contacts

Pictures




Description

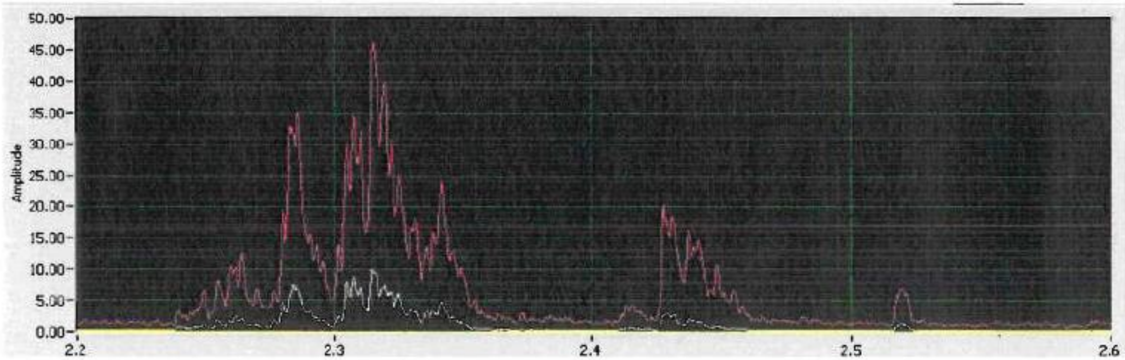
The rolls of the main contacts on a type D-0466 mechanism can wear off and show flats and streaks as above. Such type of wear can cause variations in the resistance measurements. The change of the cross is easily perceptible on the signatures of low-frequencies,
Red curve is before repairs and blue is after repairs.

Notes:

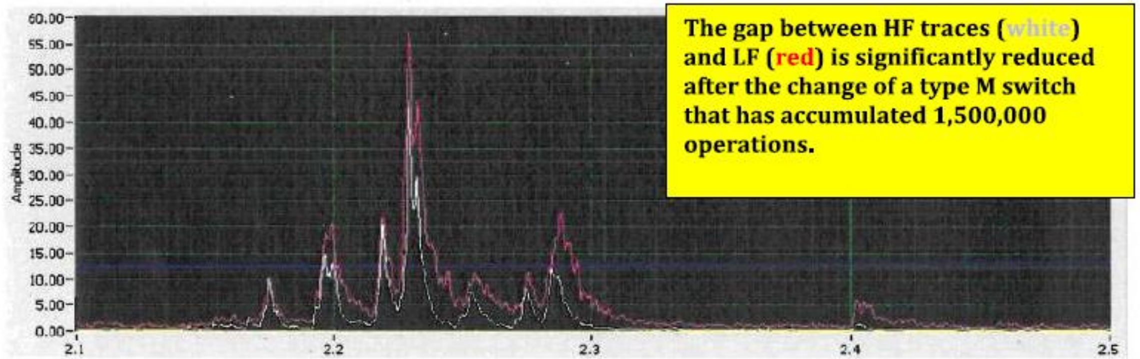
Replacement of the faulty hardware.

#41 MR REINHAUSEN – M and T - General wear of the switch

Pictures



a) Before the change of the switch



b) After the change of the switch

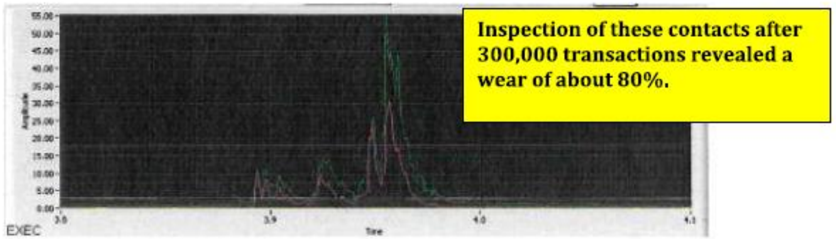
Description

In addition to the wear of contacts, gaps between frequency bands are also indicative of the general wear of the switch. This example illustrates a case of extreme wear of a type M mechanism.

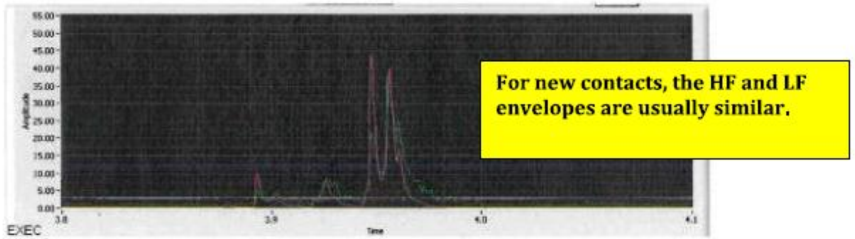
Notes:

#42 MR REINHAUSEN – M and T - Wear of contacts

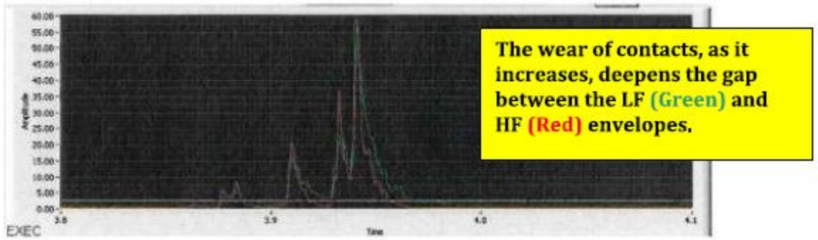
Pictures



a) After 300,000 operations (January 7, 2004 - Counter 632338 - In Load)



b) New contacts (January 15, 2004 - Counter 634015)



c) After 125,000 operations (November 5, 2004 - Counter 761087)

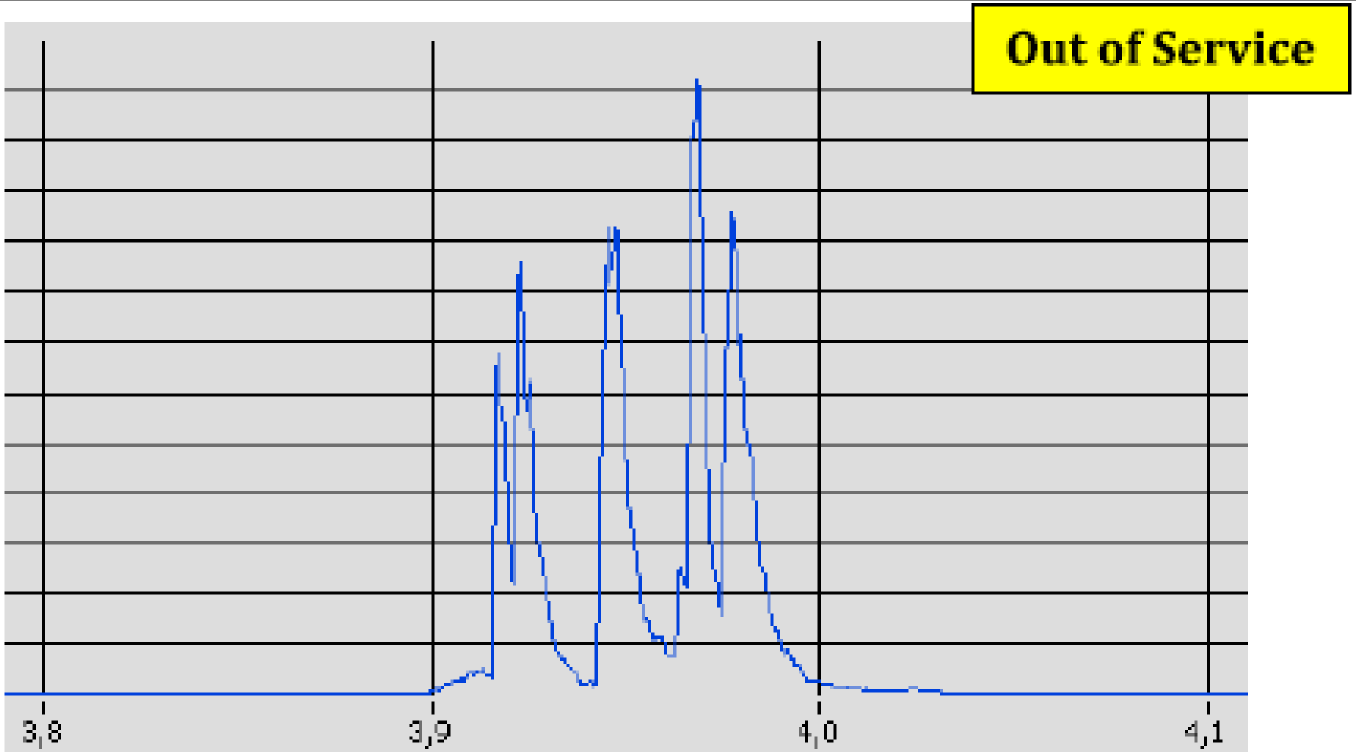
Description

The wear of contacts on types M and T, are seen as gaps between low and high frequency envelopes.

Notes:

A new mechanism will show similar envelopes while the low frequency envelope becomes dominant as the wear increases.

#43 MR REINHAUSEN – M and MS - Typical switching

Pictures	Description
 **Figure 12 :** Reinhausen M switching at tap +14 in mode **Out of Service**	
Notes:	

#44 MR REINHAUSEN – M - Single operation

<table>
<tr><th>Pictures</th><th>Description</th></tr>
<tr><td>

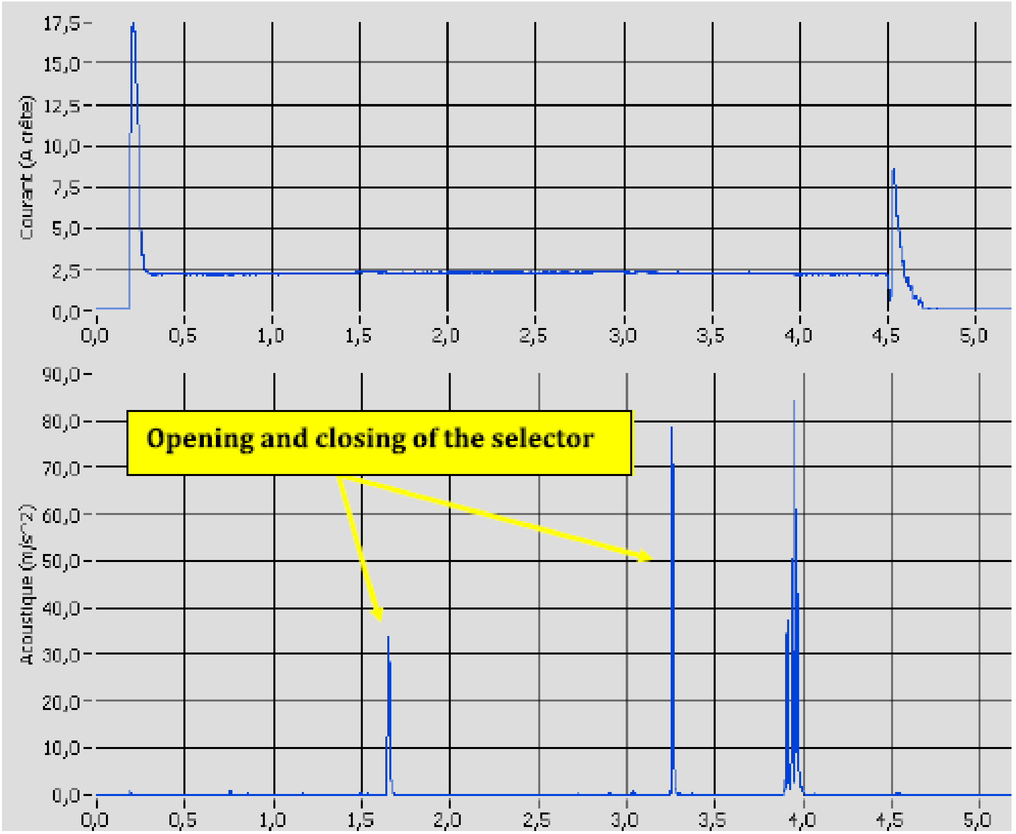


Figure 2 : Single operation upwards of a Reinhausen M (tap +8)

</td><td>The selector of the type M tap changer is very noisy, as seen on the signature.</td></tr>
<tr><td colspan="2">Notes:</td></tr>
</table>

#45 MR REINHAUSEN – M - Dual operation

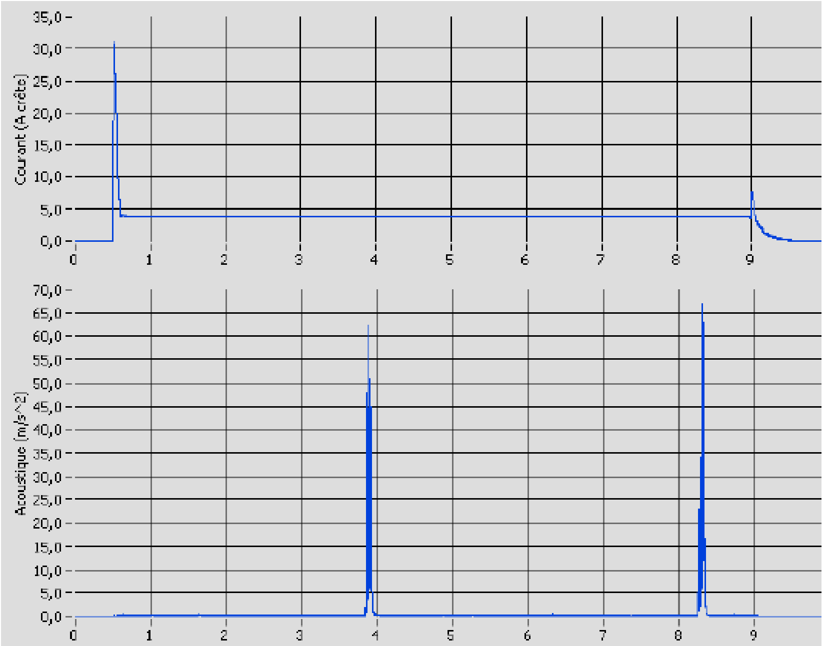
<table>
<tr><th>Pictures</th><th>Description</th></tr>
<tr><td>


Figure 3 : Operation of the inverter for a Reinhausen M (tap -9)

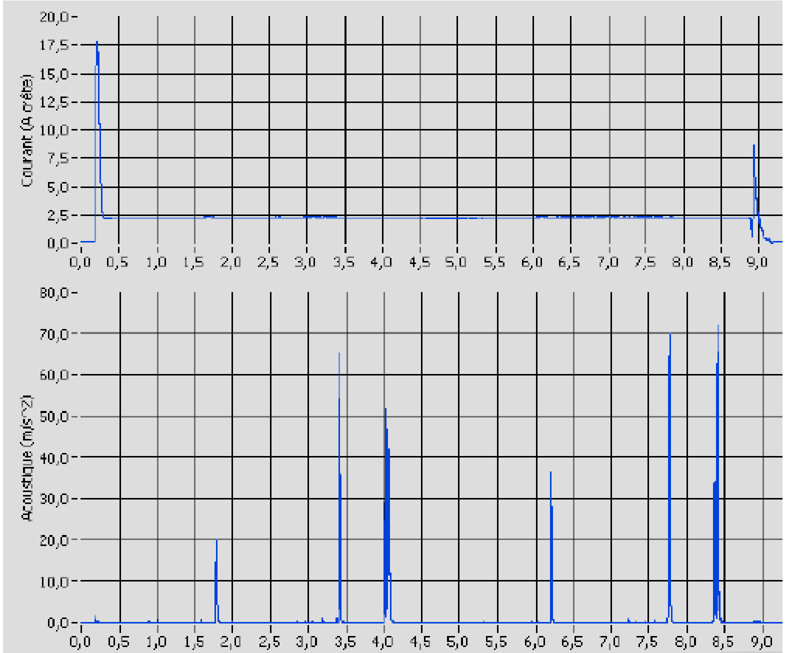
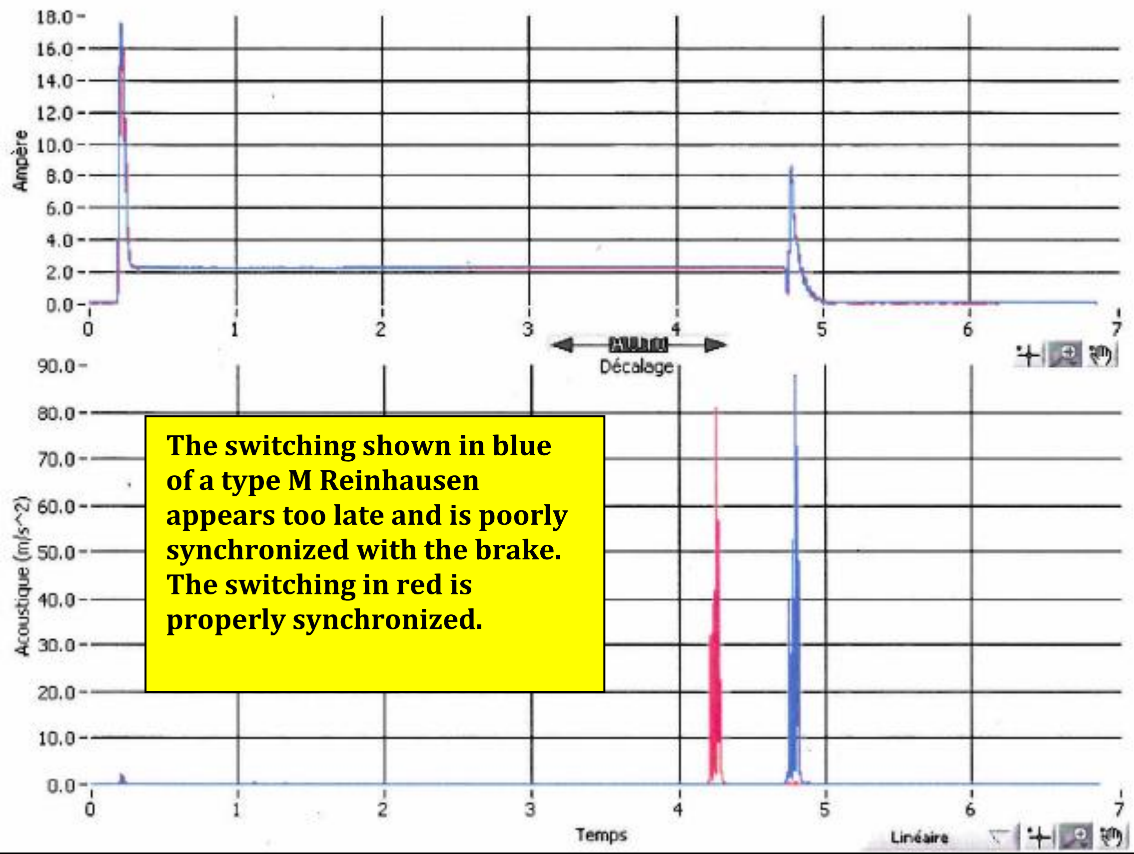


Figure 4 : Operation of the inverter for a Reinhausen M (tap -9)
</td><td>The tap changer can access a second range of positions through the inverter. During the operation of the inverter, two switch operations are performed one after another, as shown on the acoustic signature below.</td></tr>
<tr><td colspan="2">Notes:
Again, the operation of the selector is silent on all models except the M type.</td></tr>
</table>

#46 MR REINHAUSEN – C, D, E, F, G, M and T - Desynchronization of the switching

Pictures



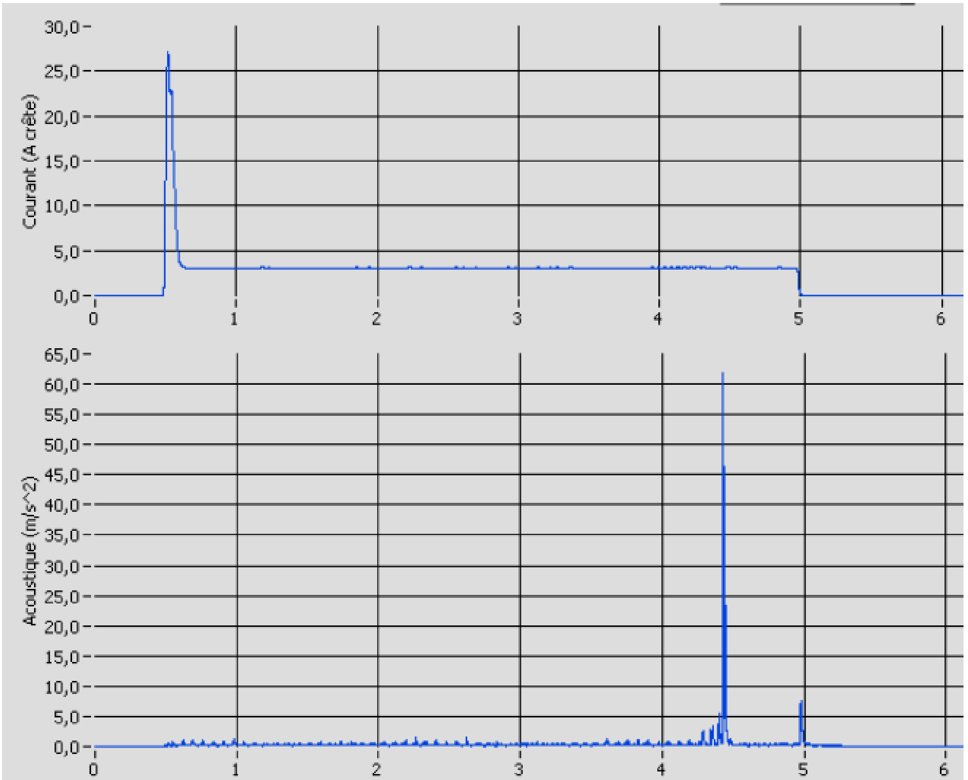
Description

A desynchronization may result from a poor adjustment, or following an inspection of a poor reinsertion. In extreme cases, the switching is so misadjusted that it may not happen in the current operation but during the subsequent operation, which may cause a delay of taps between two devices in parallel. Red curve is normal, blue curve is bad.

Notes:

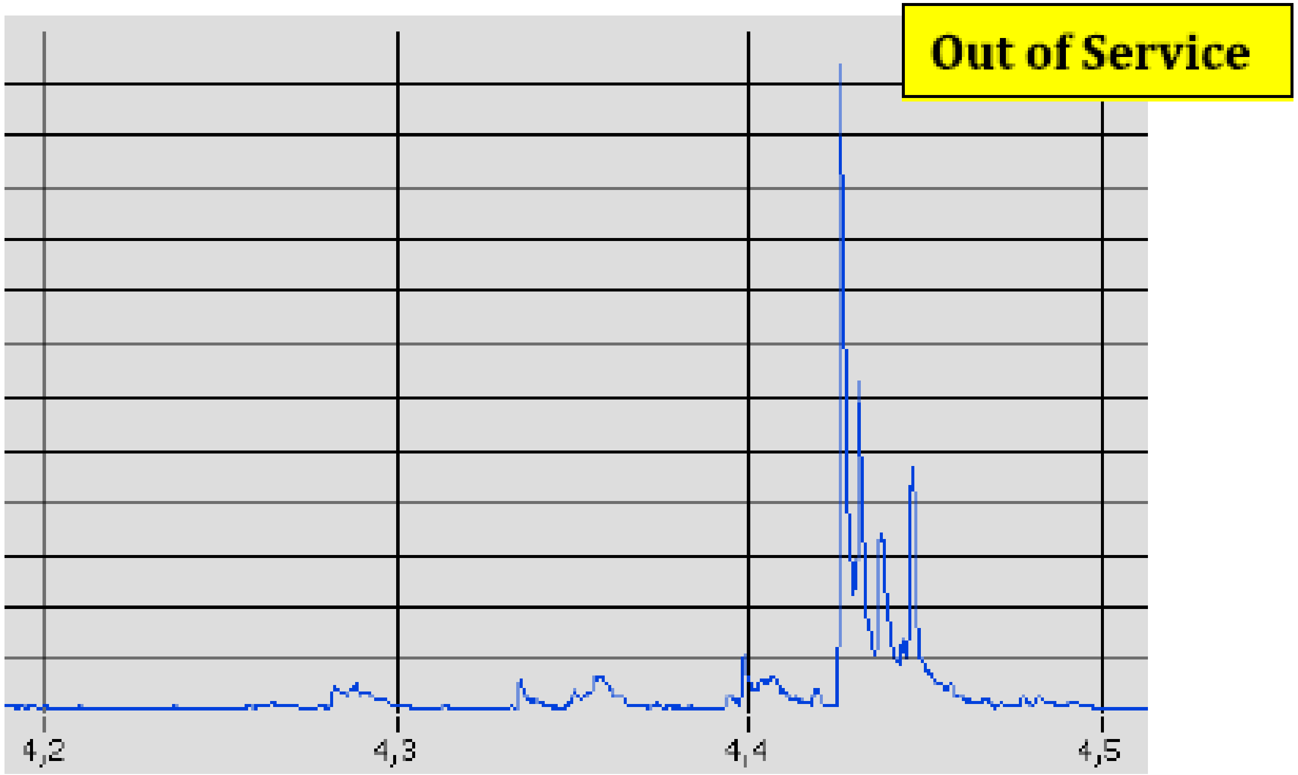
Adjustments to correct the situation.

#47 MR REINHAUSEN – C - Single operation

Pictures	Description
 **Figure 1 :** Single operation upwards of a Reinhausen C (tap +-5)	The single operation is a movement upwards or downwards of the selector, followed by a transfer of the load through the switch. The operation of the selector is silent on al Reinhausen models with exception of the M model.

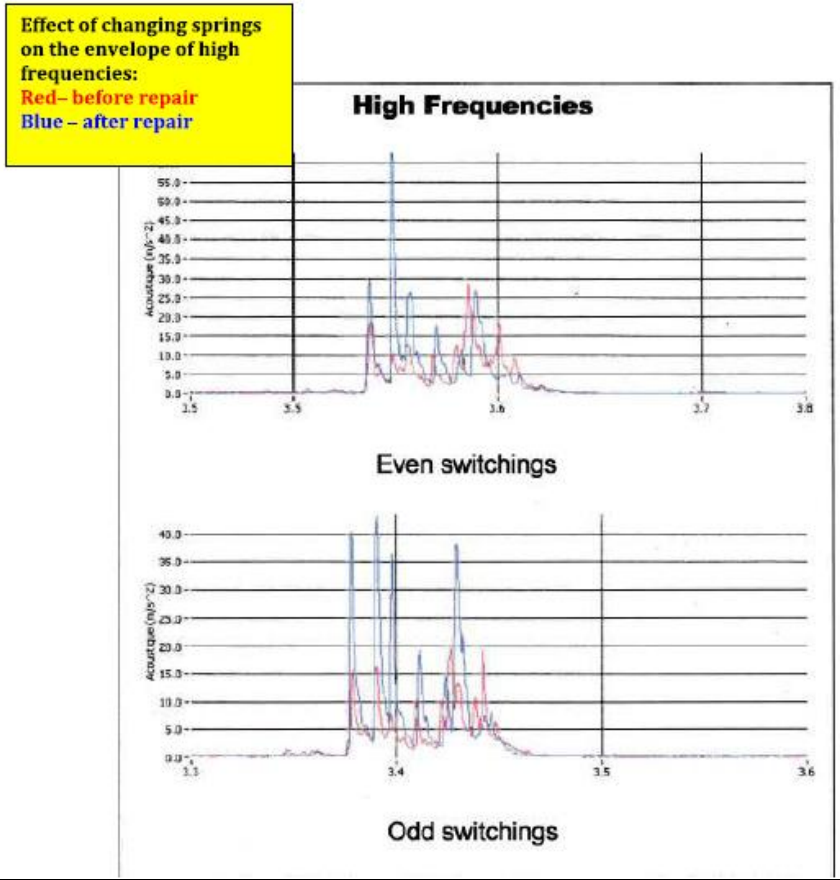
Notes:

#48 MR REINHAUSEN – C - Typical switching

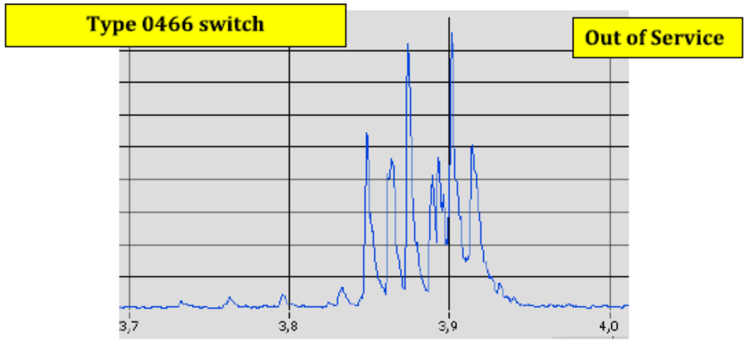
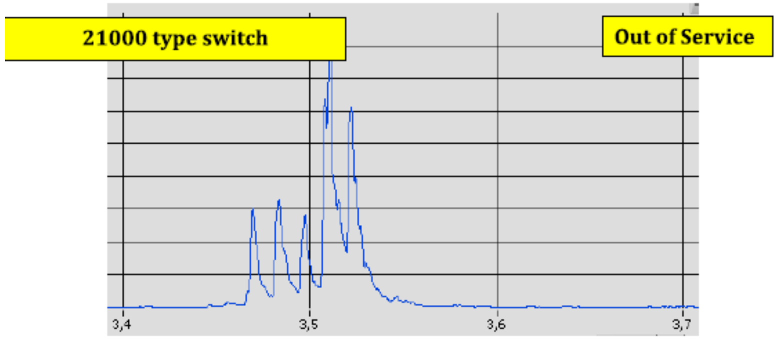
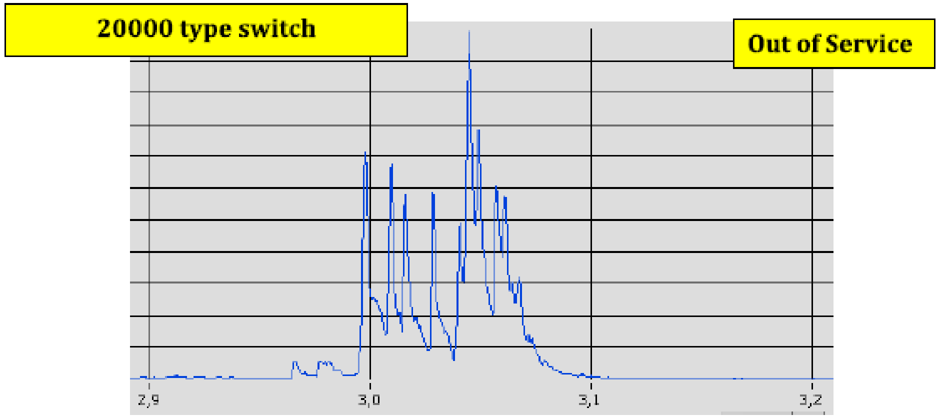
Pictures	Description
 **Figure 5 :** Reinhausen C switching at tap +-5 in mode **Out of Service**	

Notes:

#49 MR REINHAUSEN – D - Weakened springs

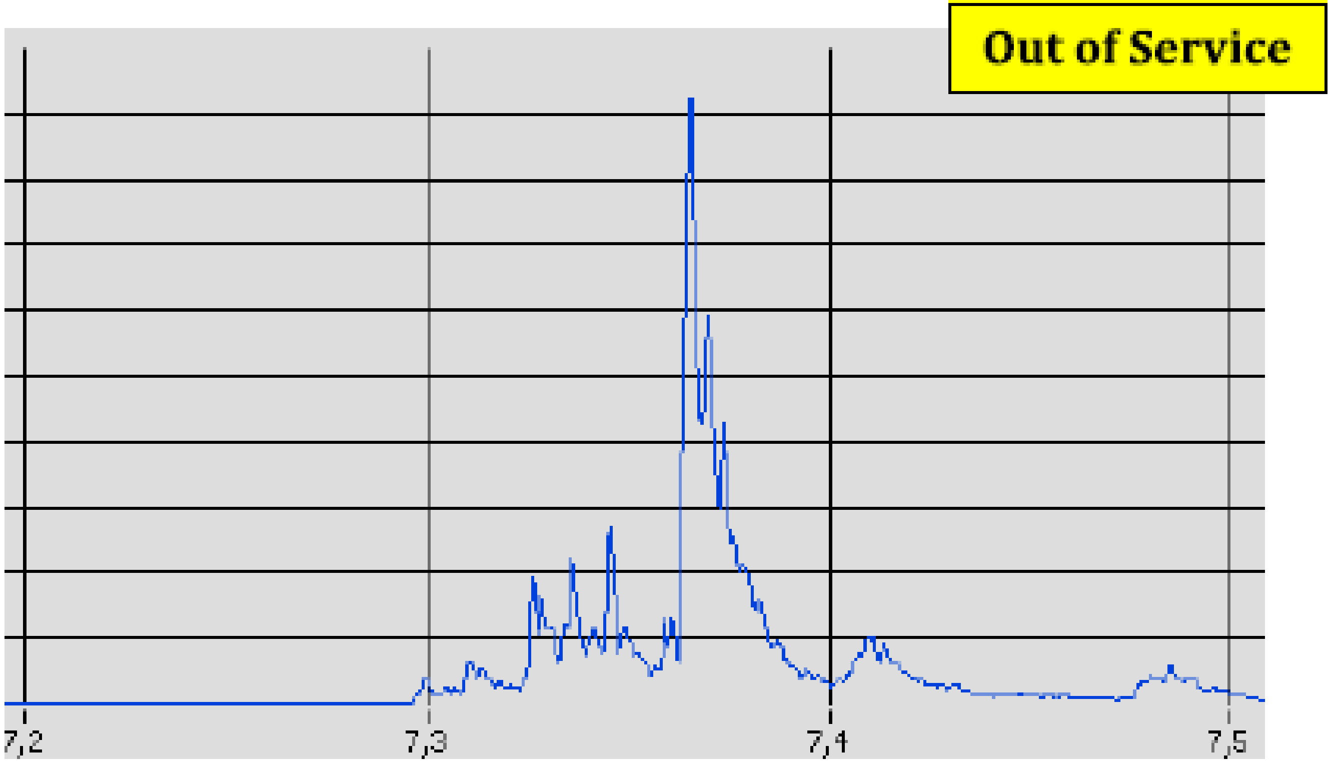
<table>
<tr><th>Pictures</th><th>Description</th></tr>
<tr><td>
</td><td>The weakening of a type D is expressed by a decrease in high frequency envelopes as shown in this example.</td></tr>
<tr><td colspan="2">Notes:</td></tr>
</table>

#50 MR REINHAUSEN – D - Typical switching

Pictures	Description
 **Figure 6 :** Reinhausen D switching with a LU D0466 switch at tap -11 in mode **Out of Service**  **Figure 7 :** Reinhausen D switching with a LU D21000 switch at tap +6 in mode **Out of Service**  **Figure 8 :** Reinhausen D switching with a LU D20000 switch at tap +11 in mode **Out of Service**	The Reinhausen type D can have three different types of switches, namely: -LU D0466 -LU D20000 -LU D21000

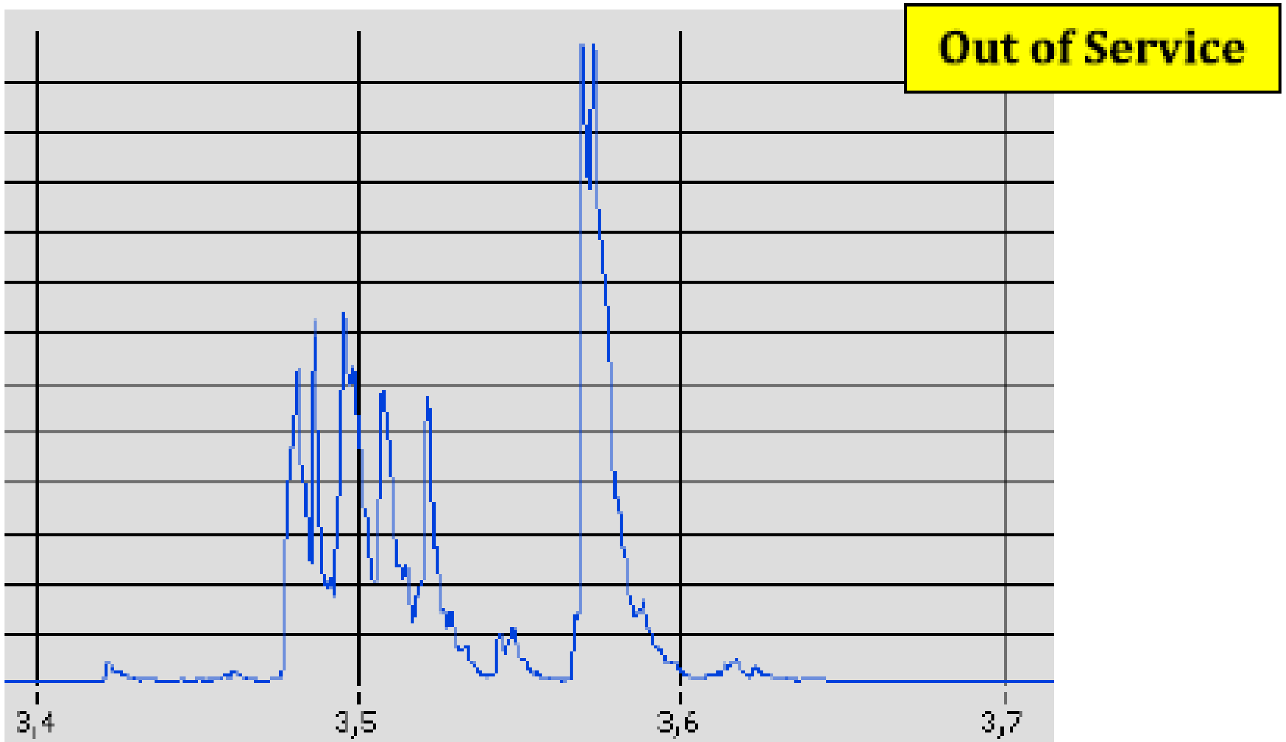
Notes:

#51 MR REINHAUSEN – E - Typical switching

Pictures	Description
 **Figure 9 :** Reinhausen E switching at tap +13 in mode **Out of Service**	

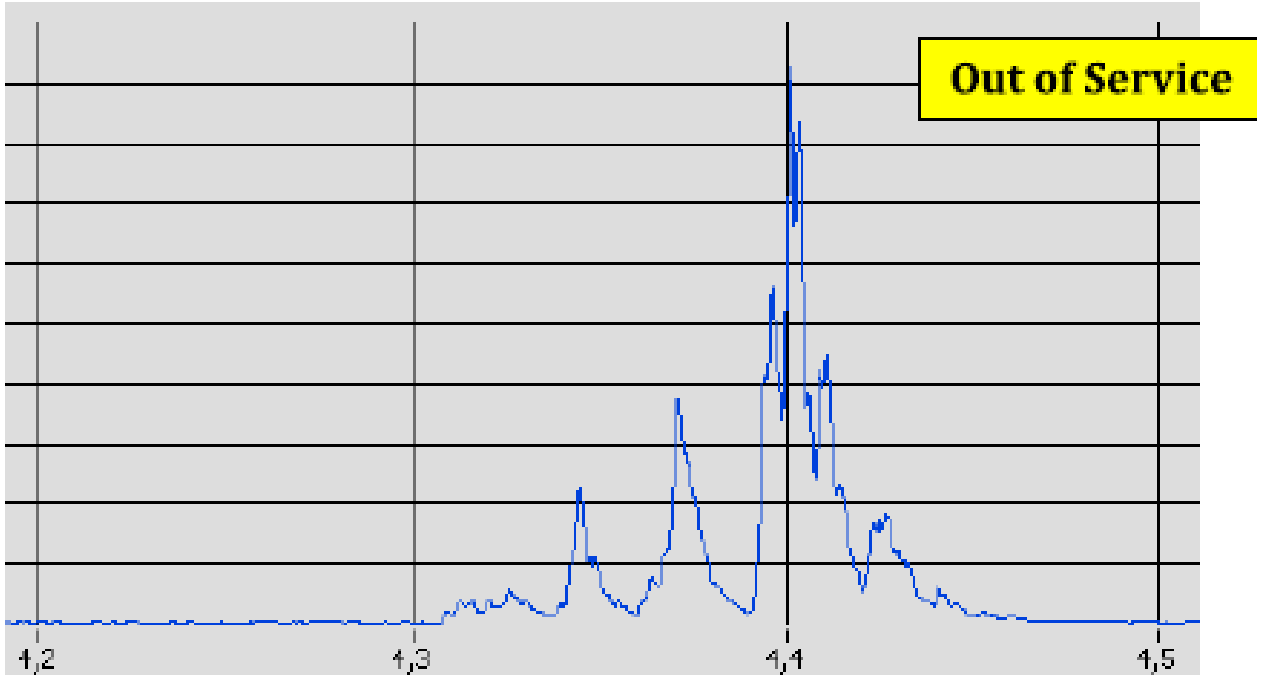
Notes:

#52 MR REINHAUSEN – F - Typical switching

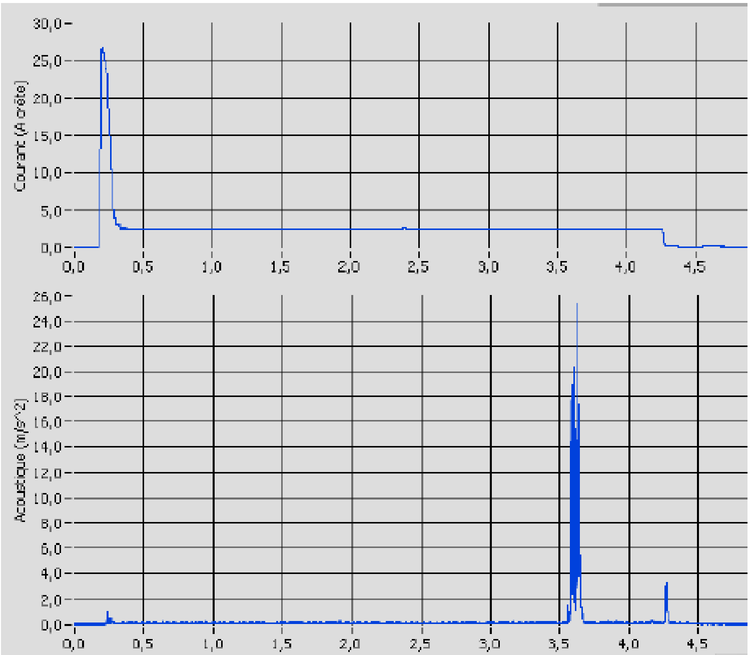
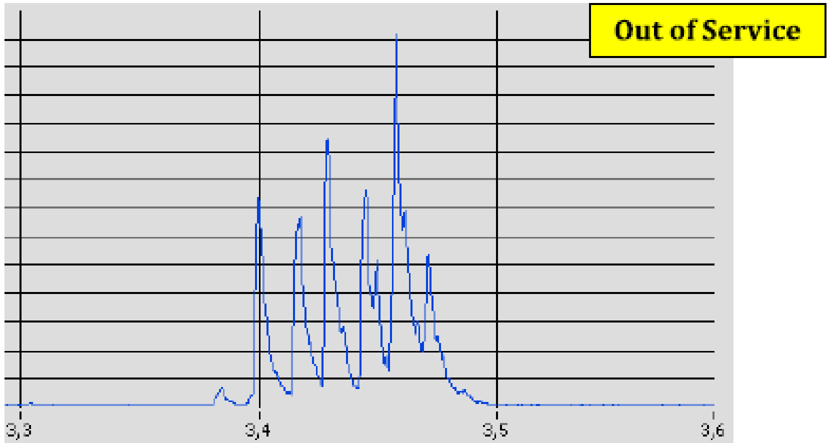
Pictures	Description
 **Figure 10 :** Reinhausen F switching at tap -11 in mode **Out of Service**	

Notes:

#53 MR REINHAUSEN – G - Typical switching

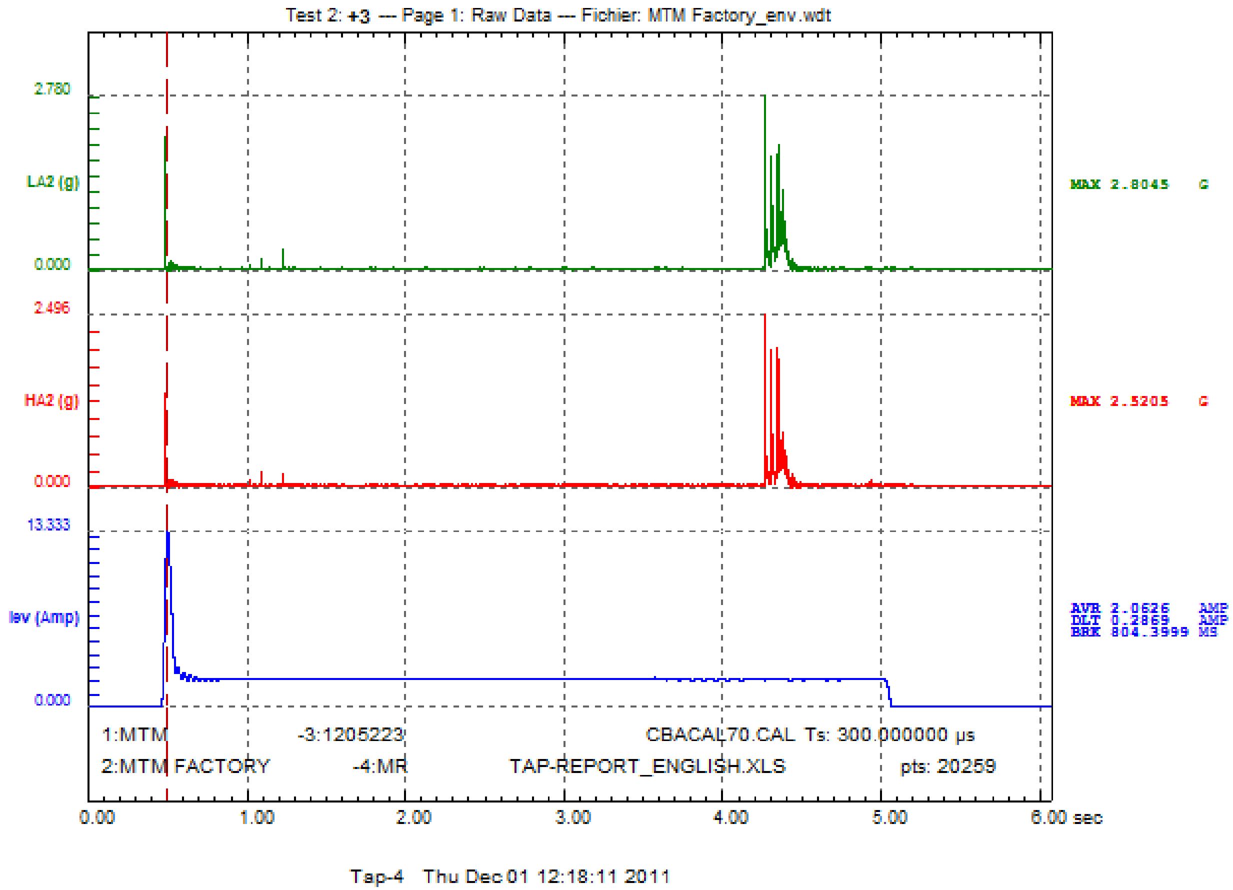
Pictures	Description
 **Figure 11 :** Reinhausen G switching at tap 7 in mode **Out of Service**	
Notes:	

#54 MR REINHAUSEN – VR - Typical switching

Pictures	Description
 Figure 13 : Single operation upwards of a Reinhausen VR (tap +16)  Figure 14 : Reinhausen VR switching at tap +15 in mode **Out of Service**	

Notes:

#55 MR REINHAUSEN – VIII - Expected signature

Pictures	Description
	

Notes:

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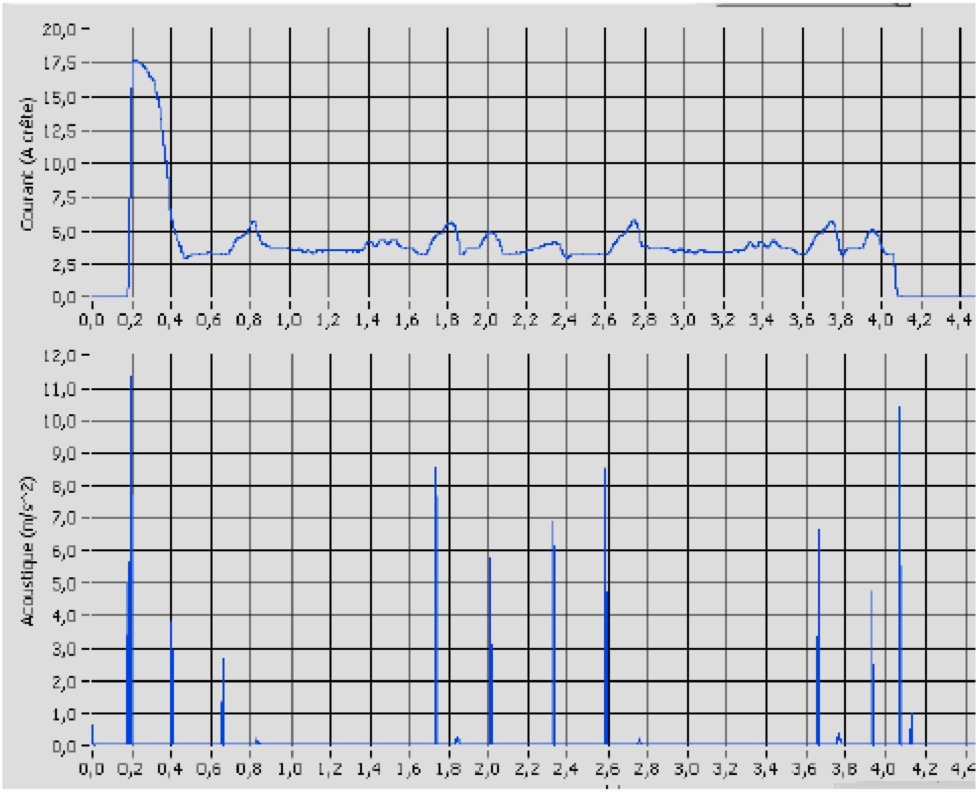
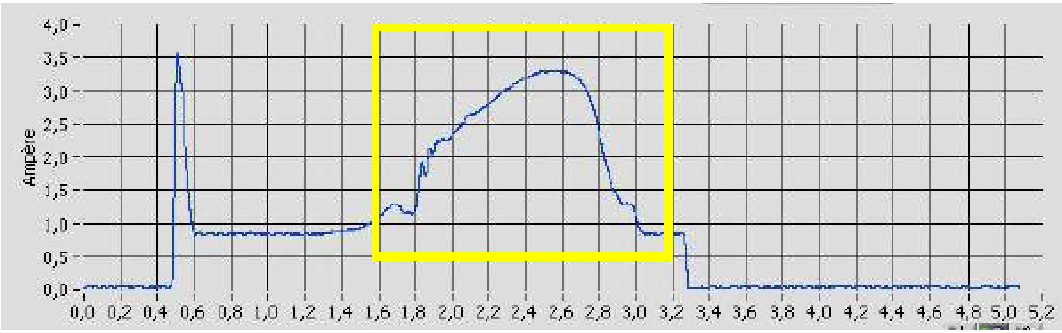
#56 MR REINHAUSEN – RMV II - Typical switching

Pictures	Description
 **Figure 15 :** Single operation upwards of a Reinhausen RMV-II (tap -11)	

Notes:

#57 ANY KIND OF TAP CHANGERS - Lack of lubrication

Pictures



Signature before lubrication

Signature after lubrication – It may be noted that high currents are substantially reduced and the operating time are slightly decreased

Description

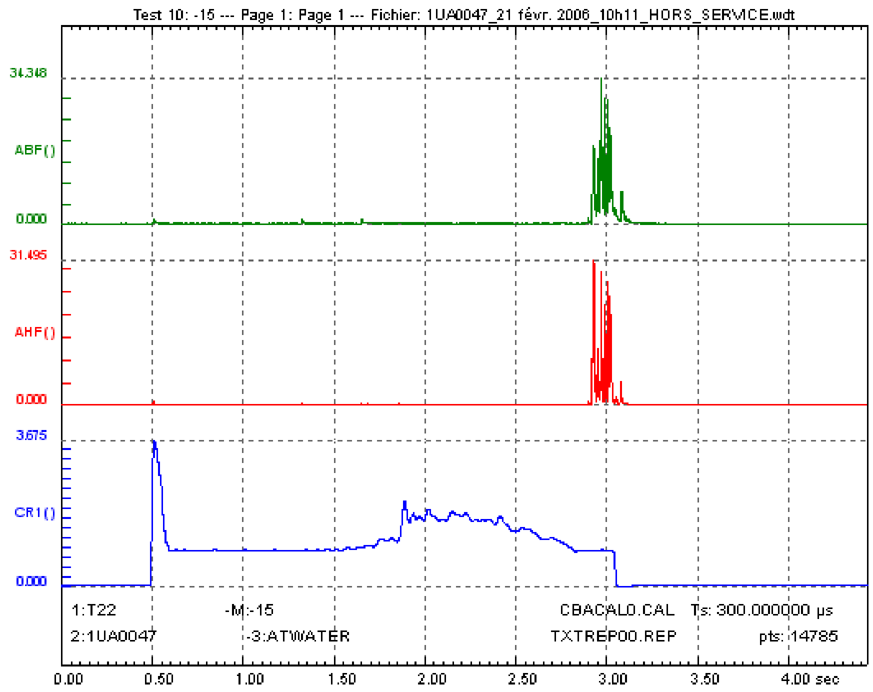
The trace of the motor current shows obvious fluctuations towards the end of the operation. There is a lack of lubrication of the drive mechanism.

The lack of lubrication of the drive mechanism has a significant effect on the stress of the motor and sometimes causes a refusal to operate followed by the start of the motor protection.

Notes:

To lubricate or replace worn parts or observe the tap changer periodically to monitor the problem at hand.

#58 ANY KIND OF TAP CHANGERS - Poor lubrication

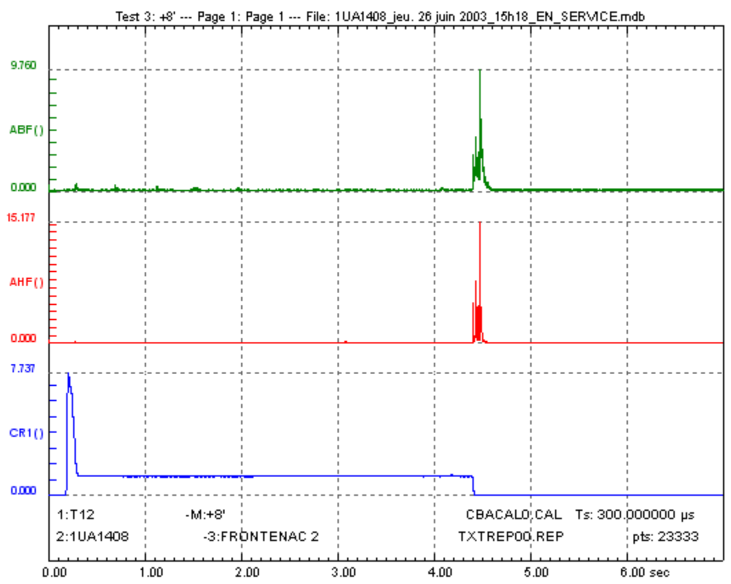
Pictures	Description
	An easy interpretation example is shown by the unusual shape of the motor current which increases at the end of the movement. Lack of lubrication leads to larger torques felt by the motor. As a result, the motor current can see sharp increases.

Notes:

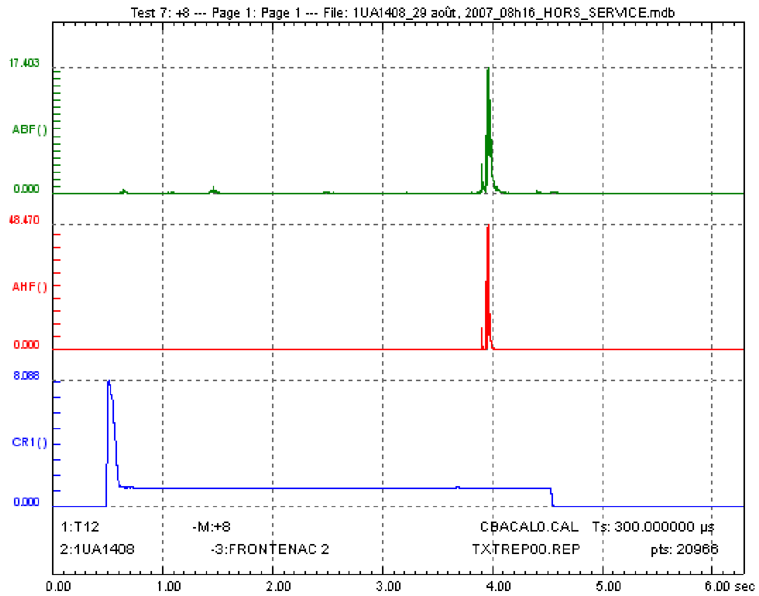
To lubricate or replace worn parts or observe the tap changer periodically to monitor the problem at hand.

#59 Unknown Tap Changer - Asynchronism

Pictures



BEFORE REPAIR



AFTER REPAIR

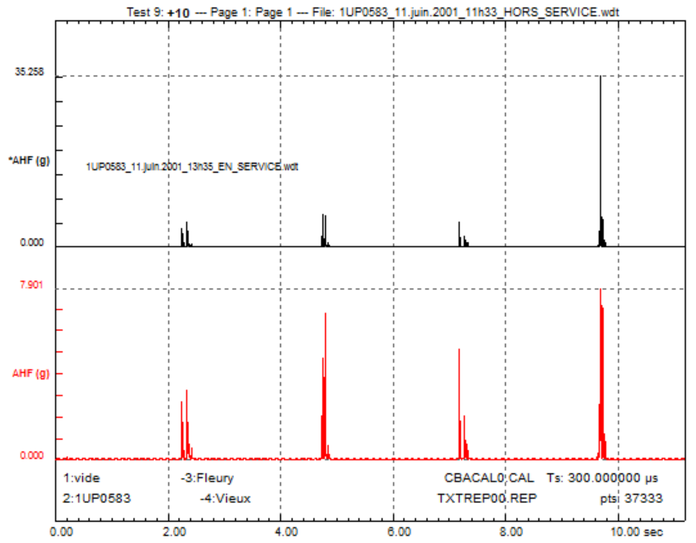
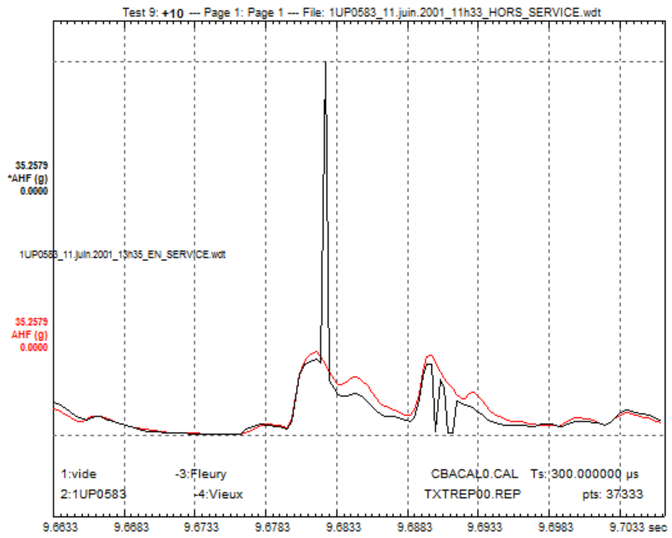
Description

Certain types of signal analysis may be easily performed without a reference signature. The example shown demonstrates a switching operation signal delayed by 120 milliseconds after the end of the current envelope.

Notes:

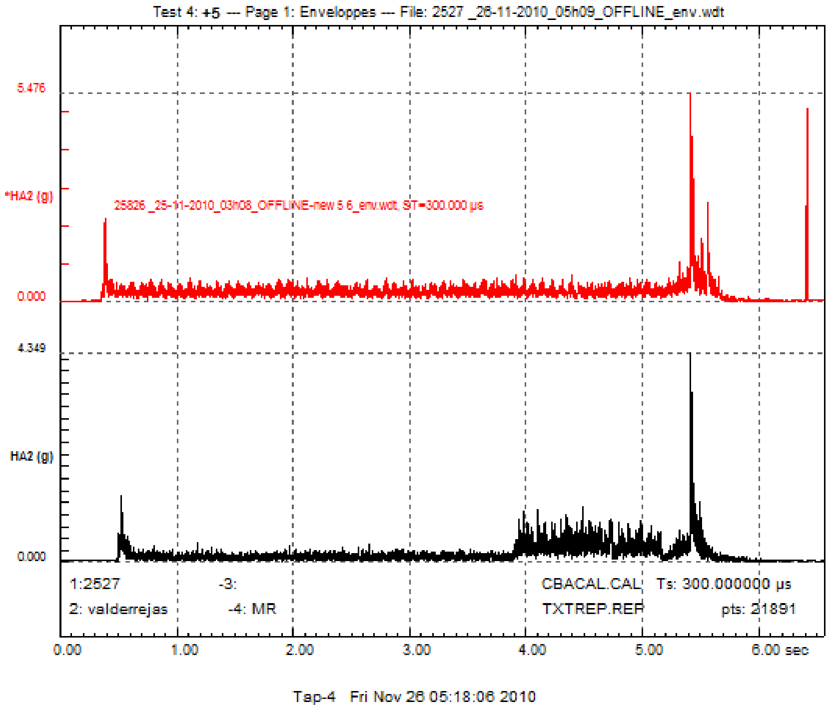
The repair was simply to uncouple the drive motor in order to adjust it so the switching occurs before the motor current drops.

#60 Unknown Tap Changer - Arcing contact

Pictures		Description
 HIGH AND LOW FREQUENCY	 SUPERPOSITION OF HIGH AND LOW FREQUENCIES	

Notes:

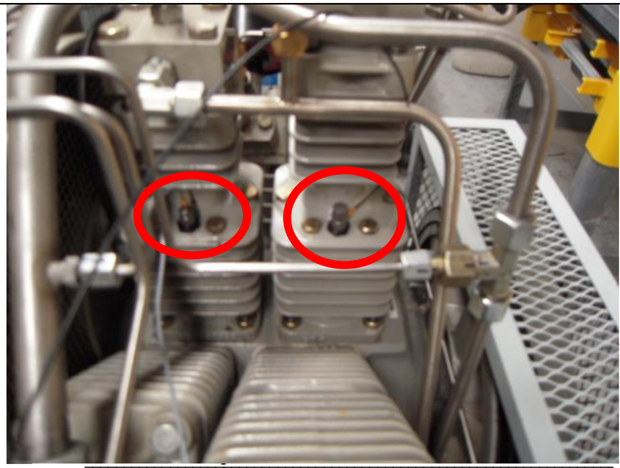
#61 Unknown Tap Changer - Job quality control

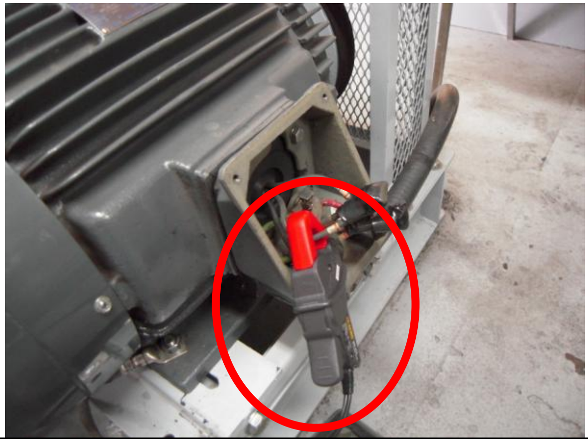
Pictures	Description
  	

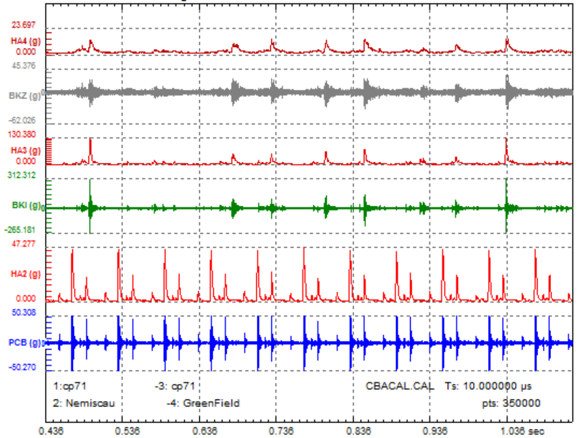
Notes:

#62 Other application – Air compressor of 735KV breakers

Pictures







Description

The purposes of these tests were:

-To verify the mounting of the compressor and make sure that it respects the manufacturer's recommendations.

-To find the origin of the random noise which is present before and after the #72 compressor mounting.

With the results, we notice that the 60 ms cycle is divided in 4 regular impacts which refer to the mechanical motion.

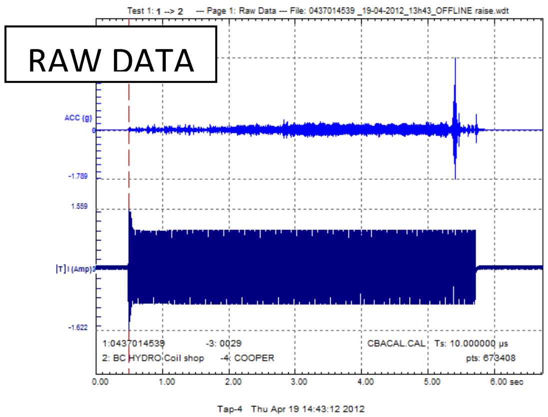
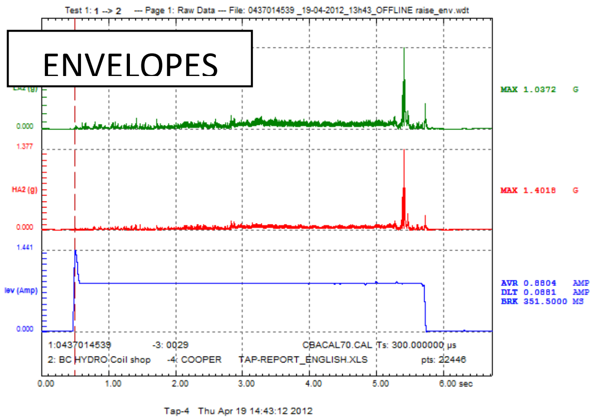
We also notice unpredictable impacts between 250G and 300G that would come from the radiator on the pipes on the #72 compressor.

Notes:

Tests have been performed with accelerometers with a range of + or – 500G and AC current clamp.

The tests allows to see regular cycles in Amplitude, Time and Shape and also allow to check that there is no seating in the bearing; no wearing on the tree; no wearing on pistons.

#63 Other application – COOPER VR 32 voltage regulator with CL 5C control

Pictures	Description
  	Exploratory tests have been performed on a voltage regulator as a tap changer is used inside. Results are pretty similar to the ones we obtain when we do tests on transformer's tap changers. We notice that the impact amplitude is quite low. It would be interesting to use a more precise accelerometer with a + or – 10G limitations instead of + or – 50Gs as we did. It also would be interesting to do a test on a same kind of regulator in order to compare each other as we do on transformer's tap changers.

Notes:

Tests have been performed OFF-LINE with accelerometers with a limitation of + or – 50G and AC current clamp.

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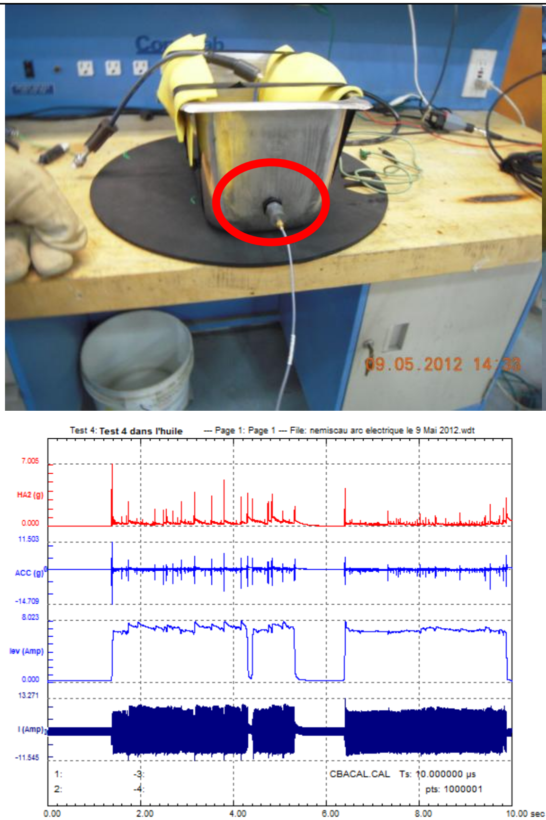
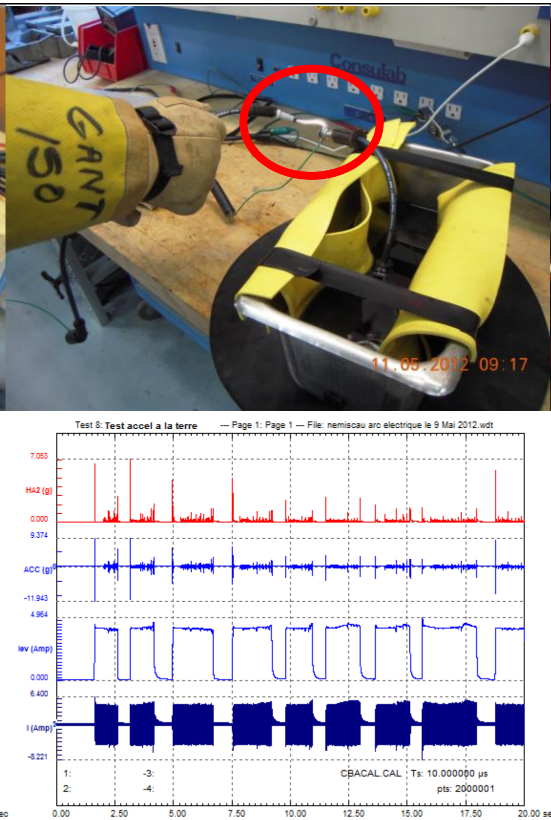
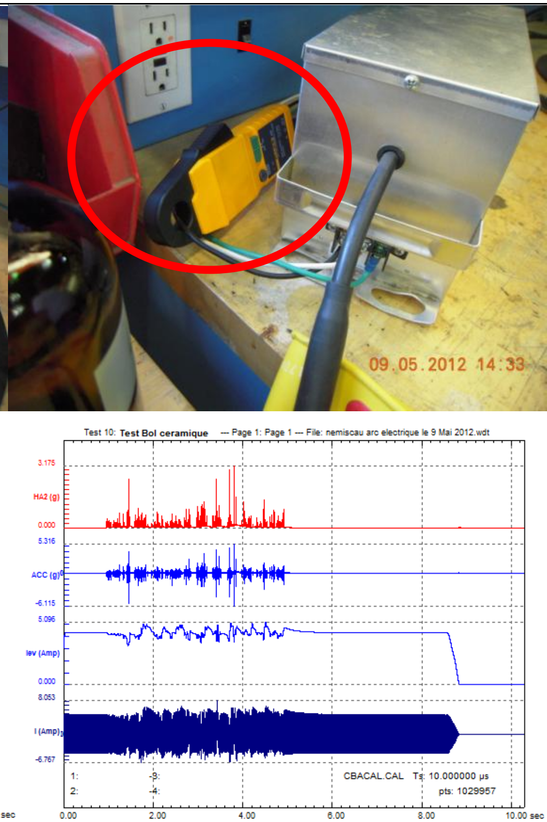
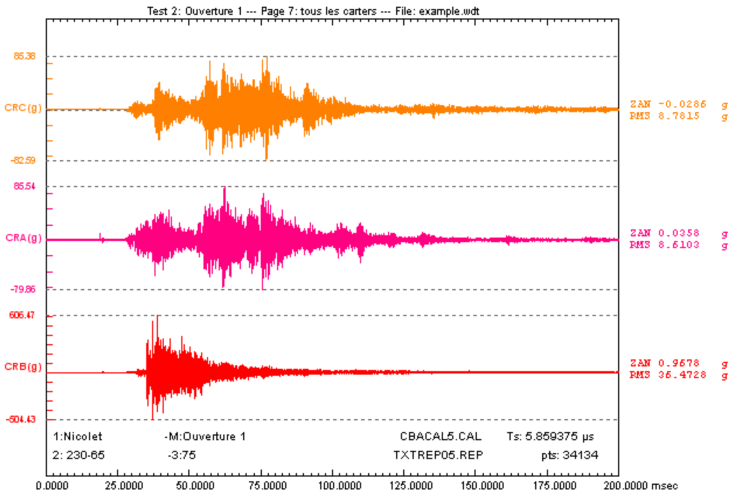
#64 Other application – Characterization of an arcing contact

Pictures	Description
 **Oil**  **Oil**  **Ceramic**	The purpose is to show that an accelerometer can detect electric arcing through a tank full of oil or a ceramic tank. The current clamp is located on the primary of the arcing generator. We clearly see when the electric arcing appears and disappears.

Notes:

Tests have been performed with accelerometers with a limitation of + or – 50G and an AC/DC current clamp.
The oil was extra dry as used for HV transformers.

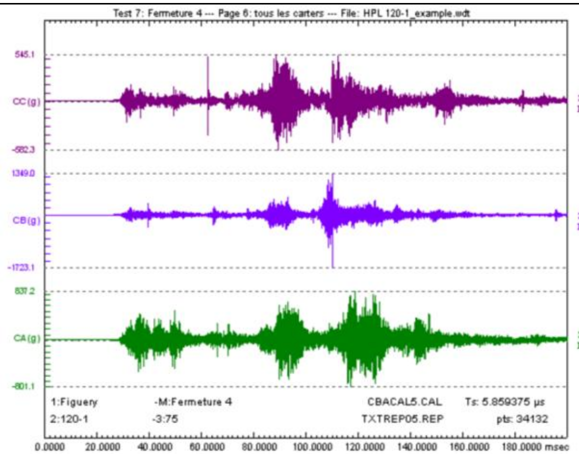
#65 Other application – Circuit breakers (bad assembly)

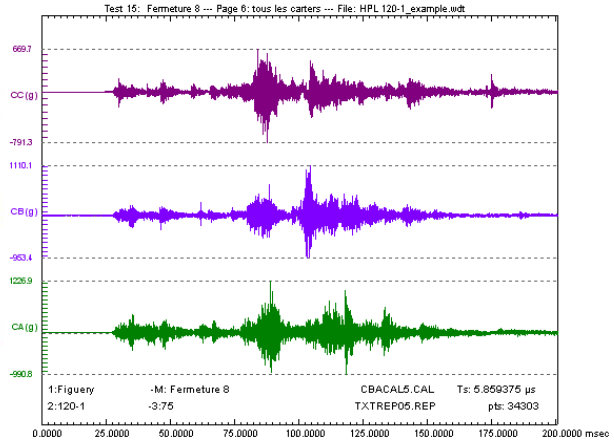
Pictures	Description
 	Here is an example where only vibration testing helped to discover an assembly problem. The figure shows an abnormally high impact (600G) and a different shape on a carter breaker on phase B. The vibration shapes and the amplitudes for phases A and C were quite similar in shape and amplitude, around 80G. All other tests, such as timing and motion, gave good results. Finally the decision was taken to open the suspected breaker phase. It was discovered that there was a mechanical part that was mounted in reverse.

Notes:

The pictures above, shows the bad assembly (rollers) at the top of the picture.

#66 Other application – Circuit breakers (bad adjustment)

<table>
<tr><th>Pictures</th><th>Description</th></tr>
<tr><td>




BEFORE REPAIR AFTER REPAIR



</td><td>
This example shows two cases where a bad adjustment has broken the casing of a breaker that has produced an explosion and the other has produced a SF6 alarm. These two cases have been detected thanks to vibration testing.

The figure shows the high impacts around 1300G for the middle trace which is phase B, whereas phases A and C show amplitude around 500G.
</td></tr>
<tr><td colspan="2">Notes: We see after repair, similar shapes and amplitudes for all three phases.
The pictures show impact marks inside the casing of phase B.</td></tr>
</table>

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