The effect of a tramway on ECG measurements

A tramway is planned to be built in Lund, passing right by the University Hospital.. This study shows that ECG measurements will be affected by the variation in the DC current and breaks in the current powering this tramway. A large enough disturbance might risk patient safety.

ECG is a method used in medical care to diagnose and monitor the heart's electrical activity. To measure this electrical activity, electrodes are placed against the skin at predetermined positions. These electrodes are connected to a monitor via wires, which will enclose an area. A varying magnetic field passing trough the enclosed area might be able to induce a disturbances into the ECG, and if this disturbance is large enough it might risk patient safety.

A tramway, while in operation creates a magnetic field that is due to the variation in current on its wires and tracks. As a tram is travelling along a section of the tramtrack, a current is led trough that section. The cases which might give rise to a disturbance is AC ripple of the DC current, due the conversion from AC current to DC, a braking or accelerating tram, as it changes its current from max to minimum or vice versa and contact loss between pantograph and the overhead wire, where the current decays rapidly creating a large change in magnetic field.

Experimental lab measurements and measurements in real life by the tram track in Göteborg were made. In the lab an electromagnet was used to simulate the change of magnetic field representing ripple, an accelerating or braking tram and current break between pantograph and overhead wire. The ECG equipment and the electromagnet were placed such that the simulated field was equal to the field at distances 10 meters and 25 meters from a tram track. Whereas, in Göteborg the ECG equipment were placed close by the tram track and measured the ECG signals at distances approximately 10 meters and 25 meters from the track.

Experimental measurements showed a large disturbance from a ripple of 300Hz when simulating the field at a distance of 10 meters from a potential tramway in Lund. The distance between a potential tramway and the IT/MT department of the Hospital in Lund will be at it's closest about 10 meters, why simulations of this distance were considered. For the rest of the hospital a distance of 25 meters were considered, where the 300Hz ripple only created a small disturbance. A ripple of 600Hz at a distance of 10 meters showed a smaller disturbance in the ECG than the 300Hz ripple and at a distance of 25meters there was no noticeable disturbance. These are the potential cases resulting from conversion from AC to DC.

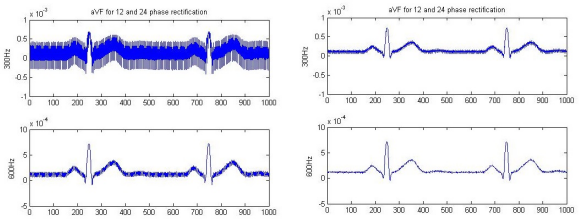

Figure 1: Ripple from the simulations, the uppermost plots shows ripple for 300Hz and the lower ones shows ripple for 600Hz, where 10 meters distance is the plots to the left and a distance of 25 meters are the one to the right.

An accelerating or braking tram created no noticeable disturbances. The case of contact loss showed only a disturbance for a measurement made with an oscilloscope, where a peak as in Fig. 2 could be seen. Measurements were made with both a monitor with a filter to remove unwanted signals and a oscilloscope with no filter. The measurements made with the oscilloscope showed larger disturbances.

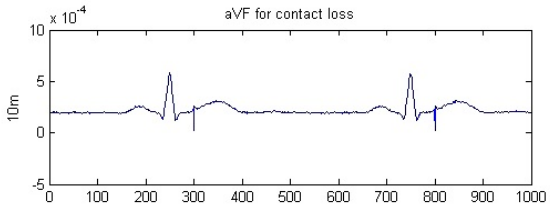

Figure 2: The disturbance from current loss.

All measurements made in Göteborg were measured with a monitor and at distances of approximately 10 meters ad 25 meters from the track. At 10 meters interference from the AC ripple could be seen in the ECG signals. The ripple in Göteborg is at300Hz. When a tram passed, there were cases both of disturbance and no noticeable disturbance in the signals, which is likely due to the amount of current powering the tram. A disturbance could also be seen when there was no tram passing by and before and after a passing tram. That this is the case might be due to stray currents and that the current is going in the whole tramway section when a tram travels on it . At a distance of 25 meters a small disturbance could be noted, though it did not correlate with passing trams. Cases of accelerating and braking trams at the measurement site showed no disturbance. Current break did not occur when measuring, why this disturbance of ECG signals could not be investigated in Göteborg.

It is clear that some disturbances will occur in the ECG and its preferable if these could be reduced, as they might make an interpretation of the ECG more challenging and maybe less accurate. The easiest way to reduce disturbances in ECG

measurements would be to reduce the area that the wires enclose. If the measured disturbances shows that a passing tramway will risk patient safety is the question that this project has tried to investigate. A case which might be of problem is atrial fibrillation. The signals for current break is also similar to the signal from a pacemaker. To make a precise judgement about how these interferences would affect the safety has to be made by trained physicians.

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