



Report number
PTS-ER-2014:23

Date
June 09, 2014

**The impact of rollout in the 800 MHz band on
terrestrial television – a summary for the years 2012
and 2013**



Report number
PTS-ER-2014:23

Reference number
14-6873

ISSN
1650-9862

Authors
Helena Westergren

The Swedish Post and Telecom Authority
Box 5398
102 49 Stockholm

08-678 55 00
pts@pts.se
www.pts.se

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Summary

This report covers the measures done with regard to impact from the broadband expansion in the 800 MHz band on terrestrial television. The report concerns the years 2012 and 2013. In May 2012, the Swedish Post and Telecom Authority (PTS) produced a similar report, in which a number of measurements were carried out by the authority in order to investigate the interference. For this report, PTS has requested information from the licenced operators Hi3G, Net4Mobility and TeliaSonera Mobile regarding the handling of reported television interference during 2012 and 2013.

The Swedish Telecom Advisors function as a common party for the three mobile operators who have been assigned frequencies in the 800 MHz band, and act in the role of coordinator of consumer reports on television interference. On assignment from the operators they have submitted data to PTS for the last two years.

Before the 800 MHz decision, it was apprehended to be considerable problems with interference in relation to television reception. The statistics show that in 2012, approximately 150 reports of relevant television interferences were received, i.e., reports from residents in areas where 800 MHz transmitters are located. In 2013, the number increased to just over 400 such reports to the Swedish Telecom Advisors. This may be due to increased interferences related to the expansion of the 800 MHz networks. The increase may have some other technical reasons and also an increased general knowledge of The Swedish Telecom Advisors may have some impact.

One way to remedy television interference caused by the expansion of the 800 MHz band is to connect a frequency filter to the television receiver. The frequency filters attenuate the signals from the 800 MHz band without affecting the television signal. During the second half of 2013, the mobile operators have in average, sent out sixty filters monthly. Out of these, the person who reported the original interference has come back in a few cases when the filter has not solved the problem. The exact number of filters that actually have been used or had the intended effects is unknown.

In the cases where PTS has proceeded with measurements of television interferences, the 800 MHz signal has not in these cases reached the licence conditions definition of interferences. Often, it has instead been the case of deficiencies in the television installation that have caused the problem.

PTS concludes that the mobile operators fulfil the coordination requirement in the 800 MHz licence through the Swedish Telecom Advisors' role as coordinator of reports of television interference, and that the procedures for sending filters from the mobile operators has functioned well.

Three years after assigning frequencies and a relatively comprehensive expansion of mobile services in the 800 MHz band, PTS concludes that the licence conditions have been adequate and well balanced. The impact on receiving digital terrestrial television has been limited. The license conditions fulfill their function and protect the reception of terrestrial television. In cases where the impact has been detected a solution has been offered.

1 Background

1.1 Auction in the 800 MHz band in the spring of 2011

PTS assigned the licences in the 800 MHz band in an auction in March 2011. In total six licences were awarded to HI3G Access AB, Net4Mobility HB and TeliaSonera Mobile AB. The 800 MHz band is intended to be used to meet the demand for broadband. The assignment open up for a cost-effective rollout with new technical solutions.

The total proceeds from the auction for the six licences was SEK 2,054 million of which SEK 300 million constituted a bid for coverage from Net4Mobility, which is to be used for the expansion to households and companies that lack access to broadband.

1.2 Special licence conditions in the band

The licence contains specific requirements on coverage and also requirements that the reception of terrestrial television must not be affected.

The broadband expansion in the 800 MHz band could affect terrestrial television reception. This is due to the television transmissions being in the adjacent frequency band below 800 MHz and that the television receivers are not adapted to the changes of the band.

1.2.1 Licence conditions pertaining to terrestrial television

Prohibition on causing interference to television reception

To protect terrestrial television, the 800 MHz decision includes technical conditions regarding a prohibition on causing television interference also including requirements to take actions against such television interferences. To determine if the occurrence of a television interference requires some measures, the definition in the licence conditions is used. To determine whether a permanent resident are exposed to a television interference as defined, the signal levels has to be measured with a reference antenna 10 meters above ground at the affected household. For more information, see Appendix 1.

Limitations on the conditions

The obligation to remedy interference to television receptions only encompasses the permanent resident population. This restriction corresponds to the transmission obligation contained in the broadcaster's licence of broadcast television.

Conditions concerning cooperation regarding television interference

The conditions state the measures to be taken in the cases of television interference corresponding to the definition. This also includes a condition concerning cooperation between all licence holders in the 800 MHz band regarding remedying television interference. The cooperation between 800 MHz licence holders is to include a joint contact point with good accessibility to which television viewers can report television interference directly over the telephone.

The commitment to cooperate with other licence holders and to remedy television interference was a requirement for the application of a licence and therefore a precondition for participating in the auction.

Condition to remedy television interference

Upon the discovery of interference corresponding to the definition in the licence conditions, the licence holder is required to deactivate the equipment causing the interference and keep it turned off until the interference has been remedied (see Appendix 1). The licence holders can remedy the problem in various ways, e.g. through frequency filters or through adapting and adjusting the base stations, for example through redeploying and redirecting the antennas. A licence holder who has caused an instance of television interference according to the definition in the 800 MHz decision is required to cover the cost of the measures necessary to remedy the interference.

In order to facilitate a follow-up of the condition, the licence holders are to keep records of the reports, to which PTS is to be granted access upon request.

1.3 Measures enacted by PTS after the licence assignment

1.3.1 Meetings and supervisory measures

After the 800 MHz band auction, PTS held a number of meetings with the licence holders and with interested parties from the telecom sector concerning how to handle problems with interference on terrestrial television. Information material was produced in connection with these meetings.

PTS did also follow up questions regarding television interference in writing to the licence holders¹. In December 2011, the mobile operators announced that an agreement had been reached between them and the Swedish Telecom Advisors and in the spring of 2012 PTS requested information from the licence holders.

1.3.2 Measurements carried out by PTS

PTS carried out a measurement on Tjörn in Västra Götaland County, where it was initially found that a reported instance of television interference did not conform to the definition². In total, PTS conducted around ten measurements³ in 2012 in order to provide data for a further assessment of the problems.

PTS's measurements partly aimed to get an overall view of the causes of the interference reports from the public, and partly aimed to obtain data for the continued work with supervising the licence conditions. A summary of these measurements appears in PTS's report from May 2012⁴. The authority has since then conducted a number of measurements concerning television interference, but has to date not found any cases of interference according to the definition in the 800 MHz licences.

Several cases of interference were due to deficiencies in the user's own equipment for television reception, e.g. that the household's equipment included one or more antenna amplifiers. Some of the households indicated that television reception only were exposed to interferences during evening hours, which may be due to high loads on the base stations. A higher load on the network leads to higher output from the base station. It is clear that the total output will increase with the rollout of more base stations in the 4G network, which may lead to further television interference. At the same time positive future product developments can be expected, e.g. of television receivers with improved immunity to interferences from the 800 MHz band. This means that it is difficult to assess future developments regarding television interference.

1.3.3 PTS's experiences regarding television interference

¹ PTS ref. 11-10016, 11-10017, 11-10018, 11-5309, 12-3438

² Ref. 11-9482

³ Ref. 12-5232

⁴ The impact of rollout in the 800 MHz band on terrestrial television – one year after assignment - PTS-ER-2012:19

Problems with television reception can be due to many different causes. A common reason is that the television receiver has not been maintained or upgraded simultaneously with changes in the surrounding radio environment. Problems with television reception can often be traced to:

- Antenna type and wear due to aging (e.g. in cables and contacts)
- Placement/height of the antenna
- Antenna amplifiers installed by the household
- The surrounding physical and radio environment

Frequency filters can in many cases resolve technical deficiencies in the reception equipment. Due to a large proportion of the reports submitted to PTS's section for Spectrum Supervision show faults in the customers reception equipment, it may be necessary to clarify that the customer should first check their own equipment. For such an assessment the customer may in many cases need to acquire the services of a service company.

PTS's section for Spectrum Supervision has during 2012 and 2013 received 21 reports of suspected 800 MHz band interference of television reception. Of these, nine cases of interference related to the 800 MHz band have been resolved through measures in the customer's reception equipment. 12 cases were due to causes other than the 800 MHz band (e.g. interference due to electronic equipment or that the interference has stopped).

Teracom, the Swedish Telecom Advisors and PTS provide information to the public regarding how television reception may be improved. Further information is available on the Internet.^{5 6 7}

⁵ <http://www.teracom.se/Sandarinformation/Mottagningsproblem/>

⁶ <http://telekomradgivarna.se/Dina-rattigheter2/Fel-ersattning/Avbrott--fel/Vad-gor-jag-vid-storning-pa-marksand-TV/>

⁷ <http://www.pts.se/sv/Bransch/Radio/Auktioner/Ansokan-tillstand-800-MHz-bandet/Storningar-pa-marksand-tv-som-kan-bero-pa-sandningar-i-800-MHz-bandet/>

2 The handling of consumer complaints

2.1 The appointment of the Swedish Telecom Advisors

The Swedish Telecom Advisors is appointed to provide impartial assistance to consumers concerning television, telephony and broadband subscriptions, free of charge⁸. This includes providing information to consumers regarding common problems, subscription terms and conditions, and matters concerning agreements and conducting statistical follow-ups.

The Swedish Telecom Advisors belongs to the Swedish IT & Telecom Industries and is funded by operators within television, telephony and broadband. Operators in the sector with consumer agreements are invited to participate. The board of the Swedish Telecom Advisors consists of representatives from operators in the fields of television, telephony and broadband, as well as PTS and the Swedish Consumer Agency.

2.2 Procedures by the Swedish Telecom Advisors in cases of television interference

The Swedish Telecom Advisors has been commissioned by the operators in the 800 MHz band with being a joint contact point to the public in matters of interest to consumers. This also includes receiving reports on television interference that may come from the 800 MHz band and making assessments of which operators that might cause the interference.

In order to assess whether the report concerns interference in the 800 MHz band, questions are used which the Swedish Telecom Advisors has developed in cooperation with the licence holders. This concerns contact information, whether the consumer is a customer of the television operator Boxer, when the interference was first seen, and whether the interference concerns a permanent residence. Additionally, it is asked whether the interference is constant or temporary, channels affected by interference and whether there are any channels unaffected.

After contact with the mobile operator, an answer is given whether the interference can be due to a base station in the 800 MHz band in the specific area. If it is concluded that the interference case is covered by the licence conditions, the operator sends a frequency filter to the consumer who reported

⁸ For further information, see <http://telekomradgivarna.se/>

the interference. The Swedish Telecom Advisors may also notify the operator of reported interferences originating in holiday homes, upon which the mobile operator can choose to send a filter.

The mobile operator reports back to the Swedish Telecom Advisors if they sent out a filter. An installation guide is sent with the filter and an accompanying letter from the Swedish Telecom Advisors in which the customer is asked to report whether the filter has remedied the interference.

If no mobile operator send a filter, the Swedish Telecom Advisors will advise the consumer to contact their television operator.

In case of an unsolved interference,, The Swedish Telecom Advisors may refer the consumer to PTS for further information and a possible continued investigation.

PTS concludes that the cooperation and the procedures agreed, between the mobile operators and the Swedish Telecom Advisors, works well. Comments from Boxer, Centrala Antennföreningen [Central Antenna Association] (CANT) and Elektronikförbunden [the Electronics Association] can be found in Appendix 2.

The Swedish Telecom Advisors and PTS has provided general information concerning radio interference and interference affecting television reception. The written information by the Swedish Telecom Advisors has also been evaluated. The cooperation has worked well, with frequent contact by telephone and e-mail between PTS and the Swedish Telecom Advisors.

2.3 Statistics of reported television interference

The responsibilities of the Swedish Telecom Advisors also include keeping statistics regarding the reports submitted. The Swedish Telecom Advisors has, to various extents, compiled the number of reports from customers concerning television interference.

In some cases the statistics also include neighbours television affected by interference. The summaries provide information regarding how many reports of television interference have been received and if they are relevant and concern permanent residents in areas with 800 MHz coverage, i.e. the data also includes reported interferences not covered by the licence conditions.

The data includes the number of frequency filters sent out by the mobile operators, as well as the time required for the measure. In the latter part of

2013, the Swedish Telecom Advisors has also made note of the cases where the customer has returned due to the filter not helping. However, the statistics do not reflect the fact that some choose to install filters on their own that solve the problem.

The statistics have been expanded recently and give detailed information on how the mobile operators responded to the complaints, including the number of days before a response and the number of filters sent. The procedures for sending filters have worked well, according to the information submitted to PTS. Since the second half of 2013, the number of reports are available per month, including registered addresses and postal codes.

The data shows that the total number of reports regarding television interference has risen in 2012 and 2013 as shown in the diagrams below.

The diagram states the number of reported interferences and if it concerns more than one household as it sometimes includes neighbours. It also shows the proportion of reports concerning permanent residents in areas with 800 MHz base stations.

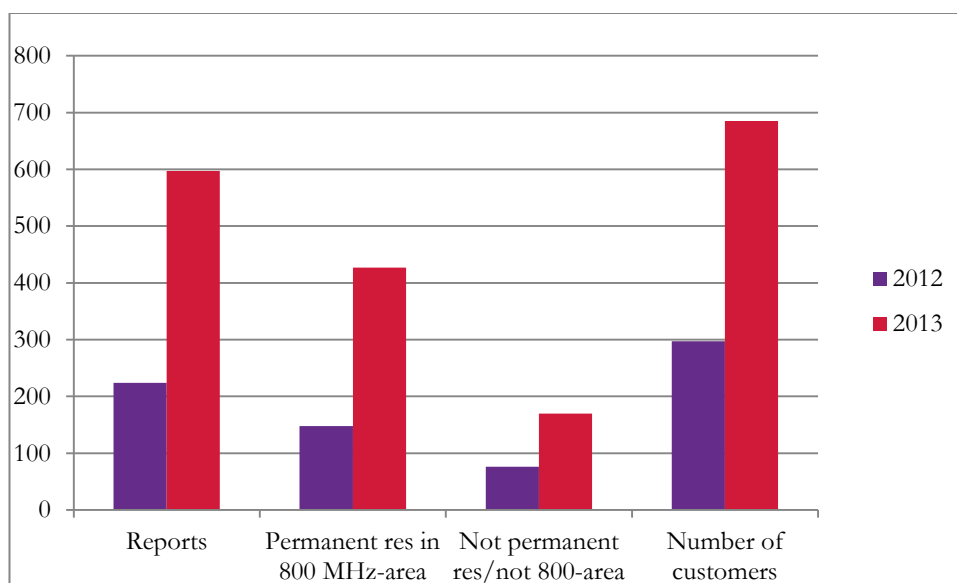


Figure 1. Total number of reports of television interference

The diagram shows an increase of the number of reports of television interference in the last year.

In 2012, just over 200 reports in total were received, of which approximately 150 reports concerned permanent residents in areas with base stations in the 800 MHz band. Corresponding figures for 2013 show approximately 600 reports of interference, of which just over 400 were from permanent residents in areas with base stations in the 800 MHz band.

An increase in cases of television interferences is expected in connection to the expansion of the 800 MHz networks. However, there are many other kinds of interference that can affect terrestrial television reception. The increase of reported television interferences may depend on an increased awareness among the public of The Swedish Telecom Advisors.

The selected data gives the total figures for 2012 and 2013. Starting from June 2013, the information also is given by month according to the diagram below.

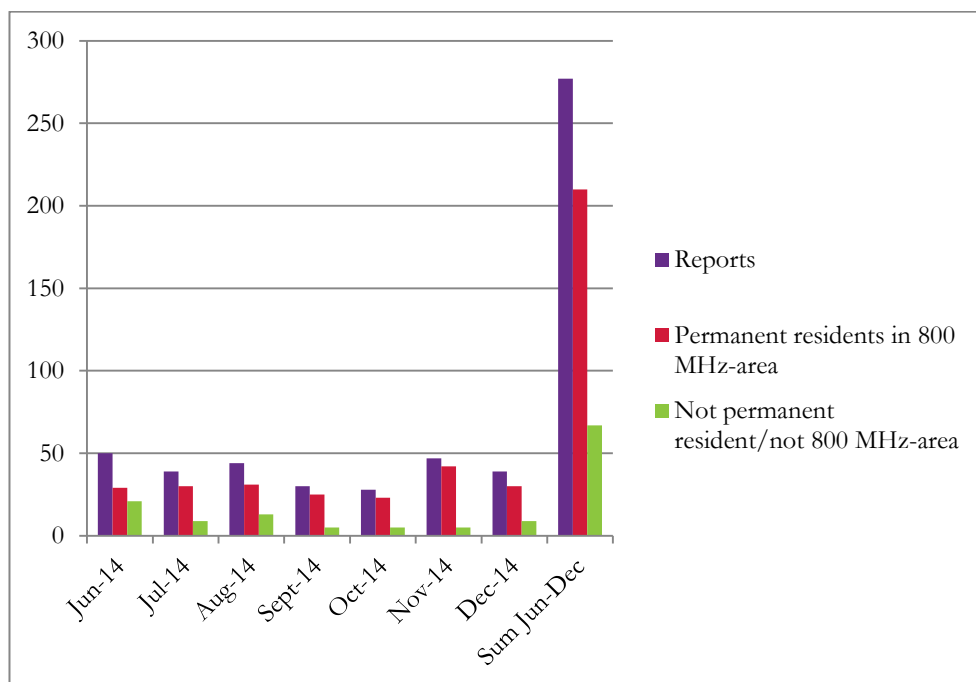


Figure 2. Number of interference reports from June to December 2013

2.3.1 Number of filters sent

In between June and December 2013, the mobile operators have sent out just over 400 filters. On average, 60 filters per month were sent out, see the following diagram.

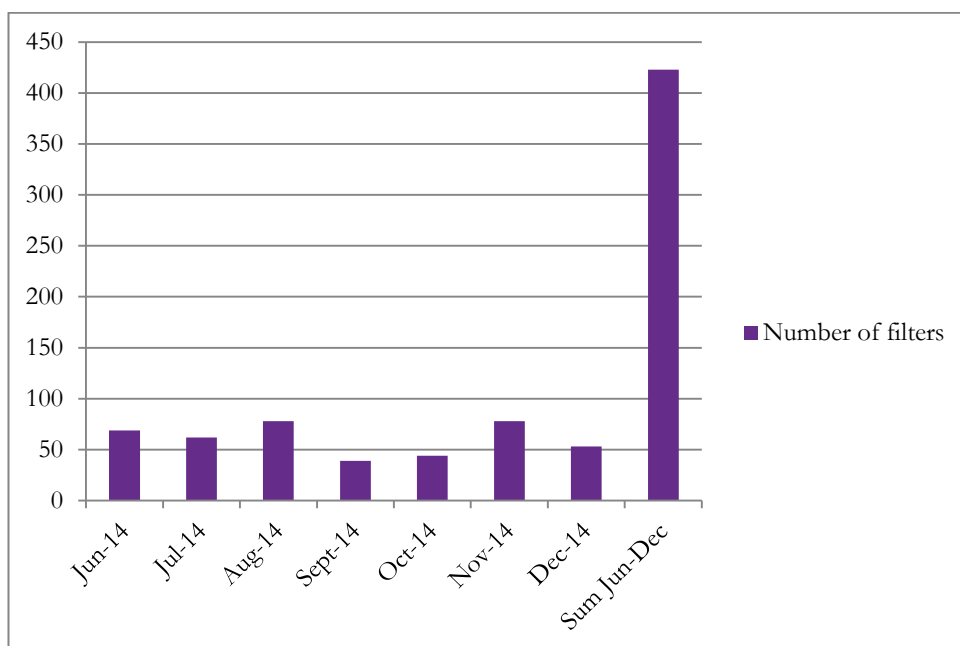


Figure 3. Number of filters from the mobile operators from June to December 2013

The result shows that some customers have received filters from several operators. Due to the filters being equivalent with regard to frequency limitations, generally only one filter should be used.

In a few cases the consumer has reported the situation when filters have not solved the interference. The number of filters actually used or that eliminated the interference is unknown, depending on the willingness to call back.

3 PTS's conclusions

The expansion in the 800 MHz band may affect the reception of terrestrial television due to the television frequencies using the adjacent frequency band. In order to protect television reception, the 800 MHz licence contain conditions stating that the mobile operators are required to remedy the television disruptions originating in the network expansion.

In connection with the work preceding the assignment of the 800 MHz band, risks of extensive interference problems were perceived, but it has been shown that interference so far has not occurred to any great extent. During 2012 and 2013 PTS received 21 reports of suspected 800 MHz band interference of television reception with none according to the definition.

It is important to point out that problems with television reception may be due to many different causes. The interference may, for example, be caused by the type of television antenna used, its location, or if any antenna amplifier is used. It is also common that television equipment is not maintained or adapted to changed radio environments. A large proportion of the reports submitted to PTS have been found to be due to faults in the customer's own reception equipment.

The statistics of the Swedish Telecom Advisors show that approximately 150 reports of interference were submitted in 2012 from permanent residents in areas subject to the expansion of the 800 MHz band. In 2013, the corresponding number increased to just over 400 reports.

In the 800 MHz licences there are requirements for all licence holders in the band to cooperate to remedy television interference. The cooperation is to include a joint contact point with good accessibility. The mobile operators fulfil the requirement of coordination in the 800 MHz licences through the Swedish Telecom Advisors functioning as coordinator of interference reports and dispatching filters, which has functioned smoothly in 2012 and 2013. The procedures for communicating with PTS have been well functioning e.g. when unsolved interference reports have been passed on to PTS for further investigation.

In the 800 MHz licences, a definition of television interference is given based on exact and measurable differences in signal levels between the broadband networks and the television signal. In the cases where interference conforming to the definition arises, the mobile operator is required to remedy the problem.

This can take place in various ways. Adding a frequency filter to the television receiver is one possibility, while another method is for the mobile operator to adjust the base stations.

The conclusion when television interferences have been further investigated by PTS is that the definition of the 800 MHz decision has not been exceeded in any single case. Along with the continued expansion in the 800 MHz band, there may be an increase of television interferences. At the same time, the technical development of television receivers is expected to improve the immunity to interferences from the 800 MHz base stations. This is one reason why the extent of future interference is difficult to predict. PTS sees no reason to believe that there will be any significant degree of television interference from the 800 MHz band.

Three years after assignment and after a relatively extensive expansion of mobile services in the 800 MHz band, it can be concluded that the effect on the reception of terrestrial television has been limited. The licence conditions are adequate and have fulfilled its function of protecting the reception of terrestrial television. In cases where an effect on television reception has been shown, a solution has been offered.

PTS will continue to follow the development of terrestrial television interferences related to 800 MHz base stations.

Appendix 1

The conditions concerning television interferences in the 800 MHz-decision (PTS ref. 10-10534), Appendix A (13-14) are set out below;

Prohibition against causing interference and measures to remedy interference to television receivers

13. The licence holder must not cause television interference to terrestrial television reception in the 470–790 MHz frequency band for the permanent resident population.⁹

Television interference means that:

- The signal level¹⁰ from the base station within the frequency block in question ($dBm/5 MHz$) exceeds the signal level from television broadcasting service transmitters within the television channels affected ($dBm/8 MHz$) by more than the signal level difference (dB) given in Table 1.
- When measuring the signal level from the base station within the frequency block in question ($dBm/5 MHz$), it exceeds the levels given in Table 2 where the respective television channel is used.
- The signal levels shall be measured¹¹ using a reference antenna ten metres above the ground – in applicable conditions – at the household affected. A starting point for the reference antenna is a directional antenna with an antenna gain of 12 dBd and a lossless cable. The reference antenna shall use the polarisation used for television broadcasts. Properties for directivity discrimination shall be based on ITU-R Recommendation BT.419. The measurement shall be made in the direction where the required television signal is strongest.

The prohibition against causing television disruption only applies if the field strength from the television broadcasting service transmitter's signal within the television channels affected exceeds $44 + 20 \log_{10}(f/500)$ dBuV/m/8 MHz (f is a centre frequency [MHz] in the respective television channel).

⁹ 'Permanent resident' means that there are people in the household who are registered at the address in the population register.

¹⁰ Signal level = Voltage above 50 ohm measured at the reference antenna's feed point

¹¹ The method of measurement will be determined by PTS in collaboration with the interested parties affected.

	FDD1	FDD2	FDD3	FDD4	FDD5	FDD6
TV channel/frequency block	791–796 MHz	796–801 MHz	801–806 MHz	806–811 MHz	811–816 MHz	816–821 MHz
60	30	30	37	37	37	37
782–790 MHz						
59	37	37	37	37	47	47
774–782 MHz						
58	37	37	47	47	47	47
766–774 MHz						
21–57	47	47	47	47	47	47
470–766 MHz						

Table 1: Signal level difference (dB) for each frequency block and for each television channel

	FDD1	FDD2	FDD3	FDD4	FDD5	FDD6
TV channel/frequency block	791–796 MHz	796–801 MHz	801–806 MHz	806–811 MHz	811–816 MHz	816–821 MHz
60	-5	-5	0	0	0	0
782–790 MHz						
59	0	0	0	0	0	0
774–782 MHz						
58	0	0	0	0	0	0
766–774 MHz						
21–57	0	0	0	0	0	0
470–766 MHz						

Table 2: Upper limit for signal level (dBm/5 MHz) for each frequency block and for each television channel

14. The licence holder shall help to:

- immediately establish cooperation between the licence holders in the 800 MHz band, with a view to coordinating measures to remedy interference (according to the definition of television interference contained in item 13) for terrestrial television reception in the 470–790 MHz frequency band for the permanent resident population,
- ensure that cooperation between the licence holders immediately offers a common point of contact with good accessibility, at least via telephone, where

television viewers whose television reception is affected by use in the 800 MHz band can make a report,

- keep a register of reports received,

- promptly identify the licence holder causing television interference in the 470-790 MHz frequency band, and

- as soon as possible thereafter, arrange an investigation at no charge and, in the event that the source of the interference is attributable to the licence holder, remedy the television interference shown in an appropriate way and at no charge, and

- immediately disconnect the radio transmitters causing the interference until the television interference has been remedied.

Appendix 2

December 2013 evaluation from Boxer to the Swedish Telecom Advisors:

How do you think that the organisation with an independent party as a joint contact point has worked?

- It has worked well, since there is easily a risk of a conflict of interest between us and the mobile operators. With an independent party there is no need to have long discussions, but it is important to have clear procedures for the independent party in order to avoid questions of interpretation.

How has your relationship with the Swedish Telecom Advisors been?

- Very good. We have had an open communication and have conferred as necessary. But we have not had to consult with each other as much recently, due to there being very few cases. Also, it is a special group at our customer service who have had the most direct contact with the Swedish Telecom Advisors concerning these cases, but as far as I know there have not been any problems in those exchanges.

How do you feel that feedback has worked?

- Good.

Do you feel that you have been able to contact the Swedish Telecom Advisors with your questions and comments?

- Yes.

Do you feel that you have received feedback on your questions and comments and that your concerns have been addressed?

- Yes.

What has worked well in general?

- It has very much been a hands-off affair, without us in the main office having to engage with individual cases particularly often. In the cases

where the reports have been legitimate,¹² the mobile operators have remedied the problem with filters, and we have not had to help the clients on our own in very many cases. The contact between our customer service and the Swedish Telecom Advisors has also worked well.

What could be improved?

- Nothing that I can think of right now, since we do not perceive this to be a significant problem for our clients. If the problems should increase, I believe more frequent consultation meetings with the Swedish Telecom Advisors would be needed in order to review the reports in general and perhaps also specific cases that have been hard to solve.

Do you consider the technical problems to have been fewer than expected, in line with your expectations, or more than you expected before transmissions in the 800 MHz band commenced?

- Fewer than expected.

Is there anything else that you would like to add?

- No.

Evaluation from CANT and Elektronikförbundet [the Electronics Association] to the Swedish Telecom Advisors:

How do you think that the organisation with an independent party as a joint contact point has worked?

- One joint contact point is good, due to it being very difficult for an affected consumer to know which operator may be causing the interference. Service technicians could figure out which operator is concerned by taking a reading of the frequency, but it is probably simpler to have one contact point for them also.

How has your relationship with the Swedish Telecom Advisors been?

¹² In this case, regarding reports of interference from permanent residents in areas with 800 MHz transmissions.

-
- We think that the contact between the Swedish Telecom Advisors and CANT has been and still is very good. The insertion of the Swedish Telecom Advisors led to a considerable improvement compared to previously.

How do you feel that feedback has worked?

- Within the framework of the mandate of the Swedish Telecom Advisors (as we perceive it), we think that feedback has been good. Of course it would have been advantageous to receive more detailed information – such as geographical data of where the problems occurred and where the base stations are located, in order to see which combinations of television and 4G frequencies have been most problematic in practice.

Do you feel that you have been able to contact the Swedish Telecom Advisors with your questions and comments?

- Yes.

Do you feel that you have received feedback on your questions and comments and that your concerns have been addressed?

- As above – within the perceived mandate of the Swedish Telecom Advisors: Yes.
For the antenna service companies it would be a considerable advantage to receive continual information on where new base stations have been deployed. This is in order to quickly judge whether a case of interference reported by a customer could have to do with 4G or not.

What has worked well in general?

- Contact between the Swedish Telecom Advisors and CANT is working well.

What could be improved?

- Many cases of interference reported have been solved immediately on site by the antenna service companies. These cases have never become known to the Swedish Telecom Advisors, despite the antenna service companies being recommended to report them. It would be preferable

if a system able to stimulate the reporting of such incidents could be created.

Do you consider the technical problems to have been fewer than expected, in line with your expectations, or more than you expected before transmissions in the 800 MHz band commenced?

- Everyone involved initially experienced difficulties judging the extent of any interference. The risk of considerable problems was palpable. Due to the number of unreported experienced and relevant cases of interference presumably being large, it is still hard to make a precise assessment, but the problems seem to correspond to our expectations.