on varactor tuners show about 15dB (±2 channel) lower signal thresholds for cross modulation than mechanical tuners, and because selectivity to the mixer is similar to mechanical tuners, about equal ±4 channel ½ IF interference. Actual field performance of varactor tuners in the vast majority of service areas today is highly competitive, although there are a few locations where adjacent and ±2 channel interference are a recognized problem. Such locations include Fresno, California and Bloomington, Indiana. The present assignments afford only marginal protection in the actual service areas of some stations in these areas.

Mechanical UHF tuners are already the equal of VHF tuners on cross modulation. However, both mechanical and varactor UHF tuners are behind VHF on intermodulation and image products and oscillator radiation, because of the technical and economic factors in achieving bandwidth which is a smaller percentage of the channel frequency.

Potential improvement-mechanical tuners:

There have been proposals (by Public Broadcast Service) that mechanical tuners be upgraded in noise figure and with respect to taboos by adding an RF stage and input tuned circuit. The RF amplifier would degrade the cross modulation performance already achieved with the mixer input design due to its own distortion and to the higher signal levels at the mixer. Addition of a third tuned circuit before a diode mixer input, but without an RF amplifier would have negligible effect on noise figure while making the tuner potentially equal to VHF in IF-related interference factors, at modest cost and increased size.

However, achievable alignment and tracking of a triple tuned circuit will erode the improvement in many tuners. The present tuner has been pushed to the limit of performance achievable based on design and control of the production process. Further performance improvements must come from new innovative designs, which may be made possible by varactor tuning.

Potential improvements - varactor tuners:

Regardless of possible improvements in mechanical tuners, varactor tuners are a limiting factor in selectivity performance vis-a-vis allocations, even considering the following potential longer range selectivity improvements. Varactor tuners offer tuning ease and equality, and improved reliability. Their increasing use should be an important asset to UHF service.

The major technology limitation in varactor UHF tuners has been the Q of the tuning diode. Present tuning diodes, based on silicon technology, give unloaded tuned circuit Q's of 50, compared to 1000 for mechanical tuners; as loaded in the actual tuner this difference has resulted in the need for an additional tuned circuit and RF amplifier common to varactor designs.

Several proposals have been made to make modest increases in diode Q, which then can be utilized as selectivity and/or noise figure improvement.

Diodes based on the silicon fabrication technology, as well as alternate materials such as gallium arsenide (GaAs) have been available

experimentally for several years and permit unloaded Q of about 100 to 500 MHz, but less improvement at the higher UHF channels. This Q increase at the low and mid channels can be translated into up to 2dB in noise figure or alternatively selectivity improvement of about 3dB in ±2 channel rejection (to RF) and 7dB in ±4 channel (to mixer).

Such diodes have not been developed to production status and cost estimates to date have indicated a significant premium. However, we would expect that development of technology and experience will make such diodes practical in the future.

It is also possible to improve the operating Q if the tuning ratio is reduced, by using a selected portion of the existing silicon diode characteristic. The benefit due to omitting coverage of Channels 70-83 is calculated to be no more than half of that due to GaAs (i.e. 1dB noise figure or equivalent selectivity).

Use of PIN diodes to switch arrays of capacitors in a resonant RF circuit has been proposed. The varactor diode can be eliminated and the lower loss PIN diode, together with low loss MOS capacitors, has the potential of realizing a high Q switchable capacitor. This is still a research project.

Image rejection:

Image rejection is an aspect of selectivity which can provide a basis for allocation review. Taboos were based on 30dB image rejection. Use of a tracking image trap or nulling circuit helps both the receiver image rejection and other high side responses because of better high side selectivity. 50dB image rejection has been attained

in production by one manufacturer and this same figure is reported for some European tuners (BBC Research Department Report No. 1972/4).

Future allocations based on 40-45dB minimum image rejection appear practical, but should take account of the life time of tuners in the field.

3. Front-end linearity: Best front-end linearity today is provided when the mixer diode is the first functional device, as in mechanical tuners. Single and doubly balanced diode mixers offer potential improvement because undesired products resulting from the mixing process can be cancelled. Usefulness and cost effectiveness may be severely limited by the balance achievable in production and the higher local oscillator power required for this application.

Mixer input designs for varactor tuners are non-competitive because not enough selectivity can be attained at a satisfactory noise figure.

UHF RF amplifiers, used in varactor tuners, are commonly bipolar transistors. Based on VHF experience where MOS-FET amplifiers are often used, improved noise, linearity, and interference performance has been achieved by use of MOS-FET UHF transistors in a production UHF tuner just introduced.

Another way to address front end RF stage linearity is to protect a low noise RF stage from strong signals with a PIN diode attenuator as discussed in 7d-1., but a fully competitive design has not resulted and the FET appears to be a better potential solution.

4. Oscillator radiation: This depends on RF selectivity, isolation

of the oscillator from the antenna input, oscillator power, and shielding.

The taboo is based on an oscillator radiation limit of 1500uV/m at 100 feet. The present Rule calls for an average of 350uV/m, and a maximum of 750uV/m. Since 1967 the industry has been essentially completely converted to tuners with transistor oscillators. Shielding of these tuners is good, radiation performance being limited by the amount of oscillator voltage conducted directly to the antenna terminals.

Mechanical tuners of necessity typically average below 350uV/m at 100 feet and varactor tuners with the additional isolation of an RF stage are significantly lower. The value for the latter may be found by analyzing measurements filed with the FCC as a part of the request for certification, as was done in FCC Technical Report T 7201.

Since the potential interference comes from a neighbor's TV receiver, the statistical significance of a 6 to 12dB reduction in oscillator radiation is difficult to relate to a change in this taboo; however, it does merit review.

5. Optimum intermediate frequency (IF): It is unlikely that a better choice of IF could be made that would significantly change the basic passband or adjacent channel selectivity. The roll of IF in establishing taboos for image, oscillator radiation, and IF beat has prompted some consideration of double conversion: a high frequency first IF, followed by a 45 MHz second IF. Two first IF frequencies have received attention: one in the 300 - 400 MHz range and the other

above 1GHz. At this time the lower frequency is favored by device technology and achievable selectivity.

A tuner, mechanical or varactor, with a state-of-the-art front end and mixer, but followed by a high first IF would give substantial freedom from IF related interferences. The cost penalty is substantial and tuning stability because of a second local oscillator may be a problem. This approach is still at the research stage.

6. Direct RF pickup - IF or audio frequency: Direct pickup does not have the same significance at UHF as it does on VHF where CATV and master antenna systems may deliver a channel in the presence of a strong, near-field co-channel signal. Manufacturers have no experience where direct pickup of UHF signals has been a UHF problem.

7. Subjective picture quality: Greatest improvements in UHF picture quality can result from providing proper and adequate antennas and installations, from providing simpler and more foolproof channel selection and tuning, and from inproving the interference susceptibility of the service in fringe reception. Any allocations change without identified receiver protections can only jeopardize picture quality.

An important and growing segment of the viewing population receives UHF channels translated to another (VHF) channel, either via CATV or master antenna systems. The latter unregulated service, especially, is vulnerable to picture degradation due to equipment distortions, frequency errors, adjacent channel transmissions at uncontrolled carrier ratios, etc.

8. <u>Consequential improvements from reduction of tuning ratio, i.e., ratio of upper to lower limits of UHF TV allocation:</u> Elimination of the upper 14 channels used exclusively by TV translators and assigned to the land-mobile service was the subject of a Petition (RM-2008) by the CEG. It would appear that 20% of the UHF spectrum can already be made available for broad, more intensive, alternate use at much lower costs than would be incurred by a massive reallocation of UHF.

The potential significance of this no noise figure and selectivity has been discussed under Paragraph 7d 2.

Even if that specific benefit proves inconsequential, reduction in the frequency coverage has implications on cost and performance of both mechanical and varactor tuners:

- -- lower readout and address costs, including costs of tape displays, electronic memories, etc.
- -- larger number size on mechanical knob readouts.
- -- improved scaling of mechanical tuners, possibly bringing ±1 MHz repeatibility (required after July 1, 1976) within reach, and reduced scaling costs because fewer blades will be required and adjusted.
- -- improved selectivity tracking on all tuners, permitting more consistent realization of basic performance capabilities of any design.
- -- possibility of a wider choice of devices and more latitude for device development.

In short, if there is no intent to use Channels 70-83 for broadcast service, the band should be cleared as promptly as possible and a date set for elimination of such coverage in receivers. Such action can only benefit the UHF broadcast service and the consumer.

9. IF Selectivity - adjust channel taboos: Allocations for both UHF and VHF afford protection against adjacent (±1) channel interference. This is necessary and will continue to be necessary. The tuner is the limiting factor when strong interfering signals are involved.

IF selectivity gives protection against IF cross modulation and direct detection of the adjacent signal at the IF second detector. It is most important when receiving signals below the threshold of tuner cross modulation. Surface wave IF (SWIF) filters may eventually permit greater and more stable adjacent channel attenuation with resulting performance improvement and greater fine tuning latitude under some signal corditions.

One manufacturer is presently producting and selling limited numbers of receivers with SWIF filters to gain experience and stimulate development of this technology. Improved adjacent channel selectivity has not been achieved in these initial filters. The SWIF represents a premium in direct manufactured cost, now and in the near future, offset by the promise of more uniform and stable performance.

Question: 7e. "What techniques would be useful in reducing or eliminating taboos, e.g.:"

1. Receiver improvements per Paragraph 7d: Selectivity and linearity

improvements, especially in varactor tuners, would improve interference performance. It is not clear that the magnitude of improvement one can envision would justify significant changes in taboos.

Use of double conversion, so that the receiver input sees a higher IF, has the potential to eliminate the taboos related to the specific IF. See Paragraph 2b, c, d, e.

The discussion of 7d points out that a number of tuner configurations which may be presented by other parties as related to this Inquiry would in fact degrade receiver performance related to the taboos or in other ways affecting picture quality. The discussion further stresses that the approaches to receiver improvement which today appear most promising are still in the research or development stage. They have not been proven and neither the degree of improvement nor the possible undesired side effects are well defined.

2. Cross polarization: This technique apparently has not been used extensively because circular polarization offers more advantages.

3. Circular polarization: This subject is better covered separate from this Docket. To take advantage of the possibility of improved received signals and of rejection of signals off the back of the antenna, a circularily polarized antenna installation is required.

Reports are being made on experimental installations such as WLS-TV (Ch. 7) in Chicago. Conclusions can only be tentative until these reports are studied and discussed.

4. Very precise offset: The advantage of offset are documented in the TASO study and the co-channel taboo reflects the advantage secured.

There is significant improvement in certain intermodulation products when co-channel stations are operated precisely on the same frequency. The drift between very precise frequency standards is so slow that carriers are essentially synchronous.

The TASO Report recommended that experimental tests be made before consideration be given to this method as an allocation tool and stated:

> "For a nationwide allocations plan, based upon a very precise frequency control, it would be necessary for all stations to install the specialized equipment."

5. Transmitter site selection by FCC for optimum spectrum usage: Co-location of antennas, without regard to spectrum usage, would be in the public interest to the extent that it would improve reception by making possible an (outdoor) antenna orientation which is acceptable for all the stations so located. In addition, it is likely that more directional receiving antennas could be used with resulting improvement in ghosts and some interferences. Co-location could be important with regard to the taboos to the extent that signals at a given receiving location are approximately equal strength.

6. Station operating parameters: Those parameters (power, antenna height, directional pattern, polarization) for optimum spectrum usage may be more knowledgeably responded to by broadcasters.

Question: 7f. "Consideration must also be given to the economic and market impact of receiver improvements, from both the industry and the consumer viewpoints. The overall public interest in efficient spectrum utilization must also be considered, e.g., with regard to

receiver improvements which improve spectrum utilization in ways which may not be readily apparent to the average television viewer. Comments on these and related matters are requested."

At this time there are insufficient data to evaluate the economic and market impact of receiver improvements. Until constructive and achievable receiver improvements can be more definitively specified, it is not possible to determine cost, timing and market impact of such improvements. The potential economic consequences were covered in the introduction.

The following studies are necessary to provide a technical basis for assessing the effect of receiver improvements.

1. Present taboo type interference must be evaluated in terms of quantitive contemporary receiver performance to obtain more precise baseline data to determine if present taboos can be modified, and how specific receiver performance improvements would affect taboo immunity.
2. Resolution of issues raised by FCC Report LAB 74-01 on relating subjective taboo interference to receiver performance.
3. Further work is needed on receiver design to determine more precisely the technical feasibility, cost, and time for production for proposed improvements in receiver performance. Undesired receiver responses that result in channel assignment taboos may be reduced but not eliminated in all cases. Receiver cost will increase in relation to the degree of improvement.
4. Re-evaluate the allocation table using the more precise data from the foregoing studies.

9. Mandatory receiver standards: The receiver industry has a good record of incorporating technological advances as they become practical. One reason we are strongly opposed to mandatory standards is precisely that we believe that individual companies in the industry can best determine timely introduction of practical and needed improvements and features, and will make such introductions to enhance their competitive position.

With regard to any standard which may in fact be mandated, we ask that it address a proven and accepted public need, that it can be met with practical proven and tested receiver approaches, and that realistic lead time be provided so that segments of the industry are not penalized.

There is nothing in this Notice of Inquiry to indicate a justification that mandatory receiver standards are necessary and desirable, irrespective of any jurisdictional basis.

In addition to inviting comments on the numerous technical aspects involved in a re-evaluation of the UHF "taboos", the Commission has also requested comments on the proper jurisdictional basis, if any, for the Commission to adopt mandatory television receiver performance standards. In the opinion of EIA/CEG, there is a serious question whether the Commission has the authority to issue such standards.

Any statutory basis for the Commission to set performance standards would be contained in 47 USC §303(s).* This subsection provides that:

> "...the Commission from time to time, as public convenience, interest, or necessity requires, shall...
>
> (s) Have authority to require that apparatus designed to receive television pictures broadcast simultaneously with sound be capable of adequately receiving all frequencies allocated by the Commission to television broadcasting when such apparatus is shipped in interstate commerce, or is imported from any foreign country into the United States, for sale or resale to the public."

The argument that the Commission does have authority to set performance standards for television receiver relies on the above language giving the Commission authority to require that television receivers "be capable of adequately receiving all frequencies." This provision was passed in 1962 by Congress as a part of the All Channel Receiver Law. (P.L. 87-529), July 10, 1962). The purpose of this law was to require that television receivers be able to receiver UHF broadcasts. It is doubtful that the words "be capable of adequately receiving all frequencies" was intended to give the Commission an unlimited authority to set receiver performance standards.

---

* Although the Commission in its Notice of Inquiry also cited §151, 152(a), 153(b), and (d), 154(i), 301, 302 and 303 of Title 47 as possible sources of jurisdiction permitting the promulgation of mandatory receiver standards, it seems clear that these sections cannot realistically be so relied upon. For instance §151 merely states Congress' purpose in creating the Federal Communications Commission and in itself grants no authority whatever to the Commission.

This conclusion is supported by the legislative history of the All Channel Receiver Law.

Both the House and Senate bills as orginally proposed would have granted the FCC clear and explicit authority to prescribe minimum performance standards for television receivers. The Senate Report on the final bill states that these provisions were widely critized because they would have given the Commission "authority to prescribe any and all performance characteristics of television receivers." Senate Report, 1962 U.S. Code Cong. and Admin. News, at p. 1879. As a result, the provisions were deleted from both bills.

The Commission, however, feared that deletion of the authority to prescribe performance standards would permit manufacture and sale of receivers which had only the barest capability of receiving UHF signals. Therefore, at the Commission's behest, the word "adequately" was placed in the final bill to ensure that UHF reception would in fact be useable.

This addition was not intended, however, to give the Commission authority to set minimum performance standards apart from assuring usable UHF reception. In this regard, the Senate Report states:

> "In adopting this qualifying amendment (i.e., the addition of the word 'adequately') there are several things which your committee desires to make clear. The FCC has assured us that the practical need for procuring authority which would permit effective enforcement of this legislation would not involve the Commission broadly in the dealings of television set manufacturers. On the contrary, the Commission's authority, restrictive as it would be section 303(s), would

be most limited and narrow. On the basis of these representations, your committee agrees that the authority given to the Commission to require that all channel receivers 'be capable of adequately receiving' UHF channels is narrow in scope..."

Moreover, the basic intent of the All Channel Receiver Law as stated in the Senate Report was as follows:

"Essentially, the bills would amend the Communications Act in order to give the Federal Communications Commission certain regulatory authority to require that all television receivers shipped in interstate commerce or imported into the United States be equipped at the time of manufacture to receive all television channels. That is, the 70 UHF and 12 VHF channels."

The Notice of Inquiry in this proceeding is inconsistent with the above cited legislative history in two respects. First, the Senate Report states that the Commission's authority under Section 303(s) to enact receiver performance standards would be "most limited and narrow." This statement is a reflection of assurances made by the Commission to the Congress that the authority sought by the Commission under Section 303(s) was a "narrow authority, and certainly no broad mandate, to specify performance capabilities for the TV set industry." See letter of May 11, 1962, from Commission Chairman Newton N. Minow on behalf of the Commission to Senator John O. Pastore, Chairman of the Senate Subcommittee on Communications, 1962 U.S. Code Cong. and Admin, News at p. 1890. This letter went on to state that Section 303(s) as proposed by the Commission would "not involve the Commission broadly in the details of television set manufacturing" and that implementation of the section by the Commission would involve at most only the specification of two receiver characteristics: receiver noise level and receiver sensitivity.

Yet the Notice of Inquiry contemplates a broad ranging investigation into the feasibility of enacting receiver performance standards.

This is clearly inconsistent with both the stated intent of Congress in enacting Section 303(s) and the representations which the Commission made to Congress in connection with its support of Section 303(s).

Secondly, the focus of the Notice of Inquiry is directed toward a determination of whether, through the issuance of receiver performance standards, the current UHF taboos can be revised so as to permit the number of available UHF channels to be increased. The reason that Section 303(s) was enacted, however, was simply to ensure that television receivers would be able "adequately" to receive UHF signals. The law was not enacted in order to permit the Commission to mandate receiver standards in order to increase the possible number of UHF stations.

In the letter cited above to Senator Pastore, Chairman Minow stated that the Commission was requesting the addition of the word "adequately" in order to insure that the Commission would be able to preclude the manufacture of receivers with merely 'near-token capability of all-channel reception."

There has not been any contention that receivers now manufactured have merely a near-token capability of UHF reception. To preclude such manufacture was the purpose of Section 303(s), and it has been successful. For the Commission to attempt to use Section 303(s), not as a means of improving UHF reception, but rather as a means of increasing the number of UHF stations is contradictory of the Commission's assurances given the Congress when Section 303(s) was enacted.

Respectfully submitted,

CONSUMER ELECTRONICS GROUP
ELECTRONIC INDUSTRIES ASSOCIATION
2001 Eye Street, N.W.
Washington, D.C. 20006

By Jack Wayman
Jack Wayman
Senior Vice President

CONSUMER ELECTRONICS GROUP
ELECTRONIC INDUSTRIES ASSOCIATION
2001 Eye Street, N.W.
Washington, D.C. 20006

By J. Edward Day
J. Edward Day, Esq.

COX, LANGFORD & BROWN
21 Dupont Circle, N.W.
Washington, D.C. 20036

Attorney for
Consumer Electronics Group

October 31, 1975

36

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

RECEIVED
DEC 1 1975
F.C.C.
OFFICE OF THE SECRETARY

In the Matter of	)	
Re-evaluation and revision of the UHF TV "taboo" table.	)))	Docket No. 20485

REPLY COMMENTS ON NOTICE OF INQUIRY

On May 22, 1975, the Commission requested comments on the UHF TV "taboo" table because there had been much discussion and criticism on the efficient use of the spectrum allocated to UHF TV.

The Corporation for Public Broadcasting (CPB), the Association of Maximum Service Telecasters, Inc. (MST), and the Land Mobile Communications Council (LMCC), filed Comments in response to the Notice. This is the reply of the Consumer Electronics Group of the Electronic Industries Association (EIA-CEG) to the Comments of the afore named organizations.

CPB and MST supported their comments with engineering statements that examined the efficiency of the taboos. MST concluded that the UHF taboos do not have a significant adverse effect on spectrum use efficiency and that for significantly increased UHF channel utilization to be even theoretically achievable equipment performance would have to do more than permit reduction of taboos.

The method of analysis in CPB's engineering statement corroborates MST's last statement. The analysis was based on performance data for

current television receivers (Exhibit No. FCC-7 of the Notice) that plotted the results as mean, lower decile, lowest, upper decile, and highest. CPB, by using characteristics of the "mean receiver" for examining the efficiency of the taboos, introduced an improvement factor of about four times in receiver performance. There is about 12dB difference (5 - 17dB range) between mean and lower decile receiver performance. They found a few more channels could be squeezed in, but no significant increase.

Analysis based on the "mean receiver" ignored more than half the receiver population. For assessing the current receiver production for what it is, the lower decile values are a more true measure and reflect the accepted statistical practice of using 95% of the sample population. Additionally, there may be no such thing as a "mean receiver" as a given receiver may have wide variation in performance over the tuning range for any taboo. The true receiver population of the U.S. includes older receivers that do not have as good performance due to aging, and so forth.

The CPB statement has some errors. The image taboos are plus and minus, not just plus as supposedly discovered by CPB, because separation involves at least two sites. The image channel is n + 14/15 at one site and n - 14/15 at the other.

These two engineering statements and the EIA-CEG comments refute the contention of the LMCC that the image and other taboo mileage separation requirements can be reduced. The EIA-CEG comments stressed the importance of the IM and IF beat taboos, especially as they relate

to varactor tuners.

In a sense the MST and CPB comments also render moot the question of FCC authority to set comprehensive receiver performance requirements because they have not established the necessity for such requirements.

The EIA-CEG in its comments on this Notice of Inquiry and in opposition to the Petition for Rule Making to Reduce the Permissible Noise Level in UHF Television Receivers, RM-2577, detailed the relationship between tuner noise and tuner front-end selectivity, and stated that the performance of all UHF tuners represents a compromise between these two factors. Further, the solution of this dilemma rests on the ability of industry to exploit new technology. UHF tuners with lower noise are being introduced. Their application will spread as the cost of this improvement to the public is reduced. No respondent has substantiated that there is an overriding public need to change this normal product improvement evolution.

MST underscores the significance of cost relative to the taboos (while they prefer to ignore cost as related to lower tuner noise) when they state: "Broadcast standards cannot be based on design characteristics of equipment which is available only to the rich". Receiver performance requirements intended to eliminate or radically reduce the taboos fall in this category.

Respondents complain of the lack of progress in UHF tuners over the past score of years. The standard of performance then and now, as related to the taboos, is the "mechanical" tuner consisting of two mechanically tuned circuits ahead of a solid state diode mixer, no RF amplification, a local oscillator, and intended for 45MHz intermediate

frequency. The use of this tuner rests on its simplicity and on a firm theoretical basis. The EIA-CEG comments cover the improvements that have been made; however, these improvements have all been within the basic framework of the superhetrodyne circuit patented in 1916.

The suggestion has been made that the FCC Laboratory continue its analysis of television receivers as in Exhibit FCC-7. Rather than trying to get a mix of models roughly representative of the share of the market, the Commission should consider measuring receivers with new or improved UHF tuners so that everyone may be apprised of the trend. The performance of receivers with varactor tuners should be presented separately from that of receivers with mechanical tuners for the same reason. Varactor tuners, while they represent improvements in keeping with the spirit of the All Channel Receiver Law, are not an answer to relaxation or elimination of the taboos.

Respectfully submitted,

CONSUMER ELECTRONICS GROUP
ELECTRONIC INDUSTRIES ASSOCIATION
2001 Eye Street, N.W.
Washington, D.C. 20006

By _____
Jack Wayman
Senior Vice President

CONSUMER ELECTRONICS GROUP
ELECTRONIC INDUSTRIES ASSOCIATION
2001 Eye Street, N.W.
Washington, D.C. 20006

By _____
J. Edward Day, Esq.

COX, LANGFORD & BROWN
21 Dupont Circle, N.W.
Washington, D.C. 20036

Attorney for
Consumer Electronics Group

December 1, 1975