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The Telecom Regulatory Authority of India
Mahanagar Door Sanchar Bhawan
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New Delhi-110002

Subject: TRAI Consultation Paper on Valuation and Reserve Price of Spectrum in 700, 800, 900, 1800, 2100, 2300 and 2500 Mhz bands

Dear Sir,

1. This is with reference to the TRAI Consultation Paper No. 6/2015 dated November 26, 2015 on Valuation and Reserve Price of Spectrum in 700, 800, 900, 1800, 2100, 2300 and 2500 Mhz bands.

2. In this regard, please find enclosed our response for your kind perusal.

We hope that our views and submissions will merit the kind consideration and support of the Authority.

Regards,

Rajan S. Mathews
Director General

CC : Shri. Ram Sewak Sharma, Chairman, TRAI
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COAI

COAI Response to

TRAI Consultation Paper
On
Valuation and Reserve Price of Spectrum in 700, 800, 900, 1800, 2100, 2300 and 2500 MHz Bands

Released on November 26, 2015

Preamble

1. We would like to state that spectrum is a critical resource for mobile networks and the issue of its 'availability' at the 'right price' is central to the growth of services in the country.

2. While we deal with specific issues under various questions, our preliminary comments are as follows:

   a. **800 MHz** – We recommend that entire commercially available spectrum in 800 MHz band should be put to auction.

   b. Further, though the Authority has sought to highlight the availability issues in 800 MHz, however we request that Authority also take note of the urgency in making available more spectrum in other access bands as follows :

      i. **900 MHz** – The total allocation of 900 MHz across the country varies from 14 MHz to 22.2 MHz. Thus, clearly there is scope for making additional 900 MHz available in circles. TRAI should recommend to DoT that this issue should be pursued with Defence and other users so that all incremental spectrum be made available for auction. This additional spectrum could, in fact, lead to availability of 5 MHz contiguous blocks in some circles, which would also be bring more revenue opportunity to the Government.

      ii. **1800 MHz** – The issue of harmonization has been under discussion at DoT for nearly last six months and all operators have agreed for such an exercise. In DoT's reference to TRAI dated 09.07.2015, DoT has expressed the view that it intends to complete the harmonization exercise prior to the next auction. Hence, it is requested that harmonization of 1800 MHz band be conducted before the start of auction, so that additional spectrum is available to operators. Even if the harmonization takes time, the spectrum made available due to this exercise, can be put to auction with a condition that payments would be made on allocation of the spectrum at a subsequent date.

iii. **2100 MHz** – We have the following submissions:

a) The issue of interference is already in the TDSAT and the Hon'ble committee appointed by the Ld. TDSAT has already recommended swap of frequencies for interfering frequencies. Hence, the first priority has to be swap of spectrum for existing spectrum. The TRAI has also recommended the following in its recommendations on Valuation and Reserve Price of Spectrum: 2100 MHz Band dated December 31, 2014:

> *"4.5 The Authority recommends that the issue of interference, reported in the 2100 MHz band in some LSAs, needs to be resolved before putting fresh spectrum blocks to auction in these LSAs. Further, it is imperative to ensure that spectrum blocks being put to auction are interference-free."*

b) The spectrum made available from STEL should also be put to auction.

c) In case an operator is already having 1-2 blocks of the spectrum in 2100 MHz band, acquires an additional block in the same band, DoT shall strive to ensure contiguity of the holdings so as to ensure efficient utilization of spectrum and better user experience. In case an operator bid for two or more blocks, then the DoT should endeavto allocate those blocks as a contiguous spectrum irrespective of their rank, etc.

iv. In addition, the consultation paper is ambiguous about the auction of MTNL spectrum. The Authority is required to ensure level playing field for all operators. The Authority is fully aware that just recently the DoT and subsequently even the Supreme Court rejected the extension of licenses signed by operators in 1994-1996, despite there being a specific extension clause in the license. In view of the same there cannot be any different treatment for MTNL and hence the spectrum available with them should be put to auction immediately.

It is also submitted that in case Government considers granting spectrum to MTNL at auction discovered prices (as has been done in the past), then the Authority should ensure that spectrum be allocated to MTNL only basis the traffic justification, since the MTNL continues to hold excess spectrum without valid justification for the same. The spectrum unused by MTNL can be used much more effectively by operators who are having dense and congested networks.

v. It is submitted that DoT is obliged to allot clean, interference free and usable spectrum to the operators in all the bands. The "as is where is" concept cannot be applied to licenced Spectrum. In fact, the NFAP, which is formulated in line with the Radio Regulations of the ITU in order to cater to newly emerging technologies as well as to ensure equitable and optimum utilization of the scarce limited natural resource of radio frequency spectrum also states that interference issues needs to be resolved. Para 11 of the presently effective. NFAP of 2011 clearly provides that **"All necessary technical, operational, regulatory and administrative measures shall be taken so as to avoid harmful interference.**"

vi. On the issue of Roll-out obligations - we reiterate that for any market driven auctions, there exists no rationale for insisting on any roll-out obligation. The competitive situation forces the operators to roll-out services wherever a viable business case for the same exists. The coverage criteria, testing procedures, etc were recently made tougher in 2012 and in fact achieving even that kind of coverage is a huge challenge given the various problems such as the absence of maps for rural areas, complex testing procedures etc. Hence there is no need to enhance the coverage requirements.

vii. We also submit that at present the start date of all the financials obligations of a TSP is the date of Letter of Intent (LOI), instead of the actual date of allotment of spectrum. In many cases there is a large time gap in the date of LOI and date of allotment of spectrum, which is a source of major inconvenience to the operators. Therefore, it is requested that the start date of any financial and non-financial obligation for an operator should start from the date of allocation of spectrum and not from the date of issue of LOI. This should also be made applicable for the previously autioned spectrum.

viii. Spectrum Usage Charges: At present the operators have to make advance payments for SUC. It is submitted that the same should be payable at the end of the quarter like in the case of license fees.

Another point regarding SUC is that the Government has introduced a principle of auctioned spectrum being applied a uniform SUC [5% of AGR in case of the February 2014 and March 2015 auctions], whereas in the case of existing allocations, the principle of weighted average is used to determine the applicable SUC. It is submitted that once this principle has been accepted, the future auctions can be conducted at a SUC of 1% of AGR. We thus submit that the Authority may recommend applicable SUC at 1% AGR for the spectrum acquired in the forthcoming auctions.

ix. Keeping in view the fact that less than nine months have passed since the successful conduct of the auction in March 2015, there is no need to index the value of spectrum for the time gap between the auction held in March 2015 and forthcoming auction.

x. Spectrum Caps should only increase with time. Once an absolute spectrum cap in terms of quantum of spectrum has been declared by DoT, it should not be lowered.

ISSUE WISE SUBMISSIONS

Q1. Whether the entire spectrum available with DoT in the 800 MHz band be put for auction? Justify your answer.

Q2. How can the spectrum in the 800 MHz band, which is not proposed to be auctioned due to non-availability of inter-operator guard band, be utilised?

COAI Response

1. All the commercially usable spectrum suitable for new technologies available in 800 MHz band should be put up for auction.

Q3. What should be the block size in the 700 MHz band?

Q10. Suggest an appropriate coverage obligation upon the successful bidders in 700 MHz band? Whether these obligations be imposed on some specific blocks of spectrum (as was done in Sweden and UK) or uniformly on all the spectrum blocks?

Q11. Should it be mandated to cover the villages/rural areas first and then urban areas as part of roll-out obligations in the 700 MHz band?

Q21. Should the value of 700 MHz spectrum be derived on the basis of the value of 1800 MHz spectrum using technical efficiency factor? If yes, what rate of efficiency factor should be used? Please support your views along with supporting documents/literature.

Q22. Should the valuation of 700 MHz spectrum be derived on the basis of other sub-GHz spectrum bands (i.e. 800 MHz/900 MHz)? If yes, what rate of efficiency factor should be used? Please support your views along with supporting documents/literature.

Q23. In the absence of financial or non-financial information on 700 MHz, no cost or revenue based valuation approach is possible. Therefore, please suggest any other valuation method/approach to value 700 MHz spectrum band along with detailed methodologies and related assumptions.

COAI Response

1. In India, this band has been identified for IMT services and India has also adopted the APT 700 model for using this band in FDD mode.
2. However, there are two aspects which need to be considered before this band is put up for auction.

   a. The Authority has stated in the Paper that at present only 35 MHz is available as against 45 MHz as per the APT plan and moreover, the carrier details have not been decided yet by DoT and it needs consultation with Defence. It is desirable that the entire 45 MHz in this band is made available for mobile industry and then auctioned.

b. Secondly, the operators will only be able to use this spectrum efficiently once the eco-system for this band is developed globally. As per GSA report, at present only 7 operators have commercially launched LTE services using the APT700 (700 MHz) spectrum, all of them using the internationally harmonized FDD band plan configuration known as 3GPP band 28.

3. Both the above factors are out of the actual control of the operators, however, they have to suffer on these accounts. An example of the latter already exists in India, where the operators are unable to launch the services on the BWA spectrum (2.3 GHz). This is primarily on account of delay in development of the requisite device and network ecosystem, a prime factor which is predominantly out of the control of the TSPs.

4. When timing the auction of any spectrum band it is important to balance the need for the spectrum with the development of the local ecosystem of network and devices for that band. Not taking the ecosystem evolution into account can lead to underutilization of the spectrum and to blocking of funds by operators which could have otherwise been spent on expanding network deployment. Opening of new 700 band will additionally lock a lot of investments in buying the spectrum and this could become a limiting factor in network rollout including expansion of the existing 3G network.

5. Before opening further bands, it is important for the 4G services to flourish in the already allocated bands. 700MHz shall be option only when all the other bands have been completely allocated and there are further capacity requirements of the subscribers.

6. It will take time for the 700 MHz market to mature and provide affordable devices in this spectrum range for the subscribers. Under these circumstances, any untimely auction of spectrum in 700 MHz band may accrue revenue to the Government, but the commercial exploitation of such scarce resource for the larger interest of the society may be permanently impaired if the operators are forced to bid for such auction ahead of its commercial viability.

7. It is thus important for the Authority to first conduct an eco-system development study for this band as well as an interference study (with Defence as well as Broadcasting) before the auction of this band.

8. However, in case the Authority decides to recommend auction of 700 MHz then it should take a cautious approach while deciding on the terms of auction of this band including the reserve price and the rollout obligations for the same.

9. The Authority may also keep in mind the experience and learning from the 2300MHz, while deciding on the auction of 700MHz.

10. In terms of propagation characteristics, 700 MHz band is similar to 800 MHz and thus, the value of the band should be derived from the value of 800 MHz band. There is a long way to go before the eco-system in this band is fully developed like other commercial bands.

11. Keeping in view the fact that the valuation of any spectrum band is a function of the development of the eco-system in that particular band, the value of 700 MHz band should

not be more than 50% of the value of the 800 MHz band discovered in 2013-2015 auction. Alternatively, the value of 700 MHz band should at best be kept same as that of 1800 MHz.

12. The block size may be kept at 2x5MHz.

13. The rollout obligations also need to be conservatively prescribed and be required to be met over a time frame of at least 5-7 years. Furthermore, the rollout has to be uniformly applied on all blocks.

14. There should be no rollout obligation such as villages only first, as this will be against the principle of optimal utilization of spectrum, will lead to an anomaly between the Metros and the Circles and not be desirable in a market where the allocations are far lower than global averages.

Q4. Whether there is any requirement to change the provisions of the latest NIA with respect to block size and minimum quantum of spectrum that a new entrant/existing licenses/expiry licensee is required to bid for in 800, 900, 1800 and 2100 MHz bands. Please give justification for the same.

COAI Response

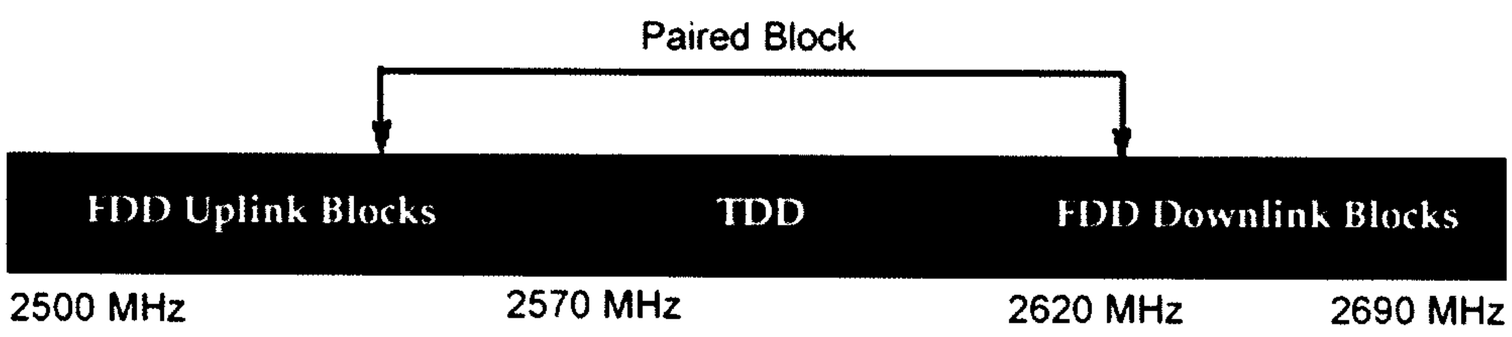
1. These requirements should be the same as prescribed for the March 2015 auction.

2. Moreover, in the 900 MHz and 1800 MHz band, the spectrum available with MTNL, which is due to expire in 2017 should also be put up for auction. The DoT in 1999 promised that MTNL will be subject to the same terms and conditions as the private operators

Q5. What should be the block size in the 2300 MHz and 2500 bands?

COAI Response

1. Regarding the 2500 MHz band, while the preferred ITU Option 1 would have allowed for 2 x 70 MHz of FDD spectrum, while having a 50 MHz TDD portion in the middle, we understand that this would not be possible on account of the spectrum being occupied by the Department of Space.



2. We believe that ideally the Government should make this entire band available for IMT services and then auction it as per the ITU Option 1 given above. This can be done in the following manner:

   a. This band in India at present is allocated for Mobile Satellite Services, Broadcast Satellite Services and LMDS/MMDS applications. Since there are limited LMDS/MMDS systems existing at present in different parts of the country, we believe that 40 MHz of spectrum earmarked for these systems can be easily re-farmed.

   b. It is further suggested that the INSAT operations in this band should be restricted as per Radio Regulations and from now on no future allocations in this band should be made for INSAT systems.

   c. We believe MSS band presently with Department of Space meant for usage by Defence may be vacated through employment of necessary measures – like alternate network, appropriate compensation, etc.

3. We suggest that the Authority examines the feasibility of getting the spectrum vacated by Department of Space in the short term to allow for the auction of this spectrum as per the ITU Option 1 Band Plan.

4. In the alternative, we suggest that the residual portion in this band be auctioned in TDD mode as per Band Plan 41. There are eight networks launched and there are 768 devices available in this band as per the GSA Report.

5. For both 2300 MHz band and 2500 MHz (if auctioned in TDD mode), majority of our members feel that a block of 20 MHz would be suitable, however, few members feel that a block of 10 MHz would be suitable.

Q6. Considering the fact that one more sub-1 GHz band (i.e. 700 MHz band) is being put to auction, is there a need to modify the provisions of spectrum cap within a band?

Q7. Is there any need to specify a separate spectrum cap exclusively for the spectrum in 700 MHz band?

Q8. Should a cap on the spectrum holding within all bands in sub-1 GHz frequencies be specified? And in such a case, should the existing provision of band specific cap (50% of total spectrum assigned in a band) be done away with?

COAI Response

1. TRAI, in section C on Spectrum Cap (Chapter – II) of its consultation paper, has acknowledged that the spectrum caps are typically designed and enforced to prevent spectrum concentrations in one or two operators' hand. The Industry concurs with TRAI views and also endorses that appropriate intra-band caps are essential to prevent potential spectrum grabbing or monopolization of the spectrum in a specific band by any single operator. Any spectrum cap should facilitate an outcome where all mobile operators may

reasonably be able to claim necessary spectrum holdings in a particular band to deliver viable mobile communication services.

2. However, the Industry is deeply concerned over the proposal of a new spectrum cap, which once enforced, will promote the spectrum concentration in a specific band with a single operator. It will seriously affect the level playing field and deprive many operators to acquire spectrum in a particular Sub-1 GHz band. Therefore, this question should not be considered by the Authority for the reasons stated as under:

a. The current intra-band cap of 50% has effectively served the interest of consumer, competition and the Industry. It not only avoids spectrum concentration in a particular band with a single operator but also enables others to acquire adequate/proportionate spectrum in the same band. On the contrary, the proposal of a separate cap for Sub-1 GHz bands in a market of 10-13 operators may empower a single operator to acquire an excessive/disproportionate amount of spectrum in a particular Sub-1 GHz band, thereby creating its monopoly/dominance over the spectrum in a specific band.

b. The Sub-1 GHz band is considered more efficient since all spectrum bands (700, 800 and 900MHz) have better propagation characteristics. However, these spectrum bands are not directly substitutable at present, due to distinct ecosystem and propagation characteristics. These spectrum bands are presently used for offering distinctive technologies viz. 700MHz for LTE (not for 2G and 3G services), 800MHz for CDMA and LTE (not for GSM services) and 900MHz for 2G and 3G services. Therefore, operators would most likely require spectrum in every Sub-GHz band for offering various services/technologies.

c. The new spectrum caps tantamount to changing the rules midway. During the last few spectrum auctions when a substantial amount of spectrum in 900MHz and 800MHz band was assigned, the operators were subject to band specific cap rule. Had the new spectrum cap been implemented during the past spectrum auctions, operators' spectrum cap limits for 900MHz and 800MHz would have been different and they would have placed their bids accordingly.

d. Currently, 800MHz and 900MHz are held by 3-4 operators due to intra-band cap, and no operator has any monopoly over these bands. On the contrary, the proposed Sub-1 GHz bands cap may allow one operator to acquire a disproportionate amount of spectrum in the 700MHz or consolidate spectrum in the 800MHz band which is underutilized to a great extent, thereby creating a possible monopoly over one spectrum band/technology. This is a serious concern, especially in a market like India where the spectrum holding per operator is abysmally low as compared to other countries and only a small quantity of spectrum is offered in each auction/band.

e. To illustrate, presently 12.5- 16.25 MHz of the spectrum in 800 MHz band has been assigned in various circles and intra-band spectrum cap of 50% restricts any operator to hold more than 6.25 – 8.125 MHz. Any proposal of replacing the intra band cap of 50% with a sub 1GHz cap will allow the operator to hold all spectrum in the premium 800 MHz band. Any such move, on top of existing special dispensation of 10MHz cap prescribed in M&A policy, which increases intra-band cap to 65-80% instead of 50% prescribed in

NIA/policy, will further skew the market, for example, in favour of operators holding 800MHz band spectrum.

3. The goal of TRAI for prescribing band wise spectrum cap has been to ensure a level playing field for operators and to provide equal opportunity for acquiring spectrum in each band. The majority of the industry strongly believes that the proposal of a limited number of operators who may accumulate disproportionate holdings in a particular Sub-1 GHz band, for example, 800MHz or 700MHz band and therefore, will defeat the very purpose of prescribing the intra-band spectrum cap.

4. The spectrum caps need to increase with time. To promote consolidation in the telecom sector, the Government released the merger & acquisition guidelines under which mergers are allowed until the market share (subscriber and revenue) of merged entity is up to 50%. However, the present spectrum cap of only allows operators to hold up to 25% of the total spectrum. Currently, some operators have more than 30% market share and continue to grow. An overall spectrum cap of 25% is stifling the growth of operators, although such growth is not considered as anti-competitive or market concentration from the competitive perspective. The objective of placing this restriction is to ensure that a minimum of four mobile operators continues to operate in the cellular market. It is highly unlikely and impractical to assume that all operators would have equal spectrum holdings. Therefore, an overall spectrum cap of 25% will result in either the spectrum remaining unsold or being fragmented among a large number of operators.

Q9. Should 2300 MHz and 2500 MHz bands be treated as same band for the purpose of imposing intra-band Spectrum Cap?

Please support your suggestions for Q6 to Q9 with proper justifications.

COAI Response

1. We believe that 2300 MHz and 2500 MHz should be treated separately for imposing intra-band Spectrum Cap for the reasons listed below:

   a. Two bands have a completely different device eco system and therefore, treating 2300 MHz and 2500 MHz bands as one band for intra-band cap may result in one operator acquiring a disproportionate amount of the spectrum in one of the bands viz. 2300 MHz/ 2500 MHz or consolidate spectrum in the 2300 MHz band, which will create one operator's monopoly over that particular spectrum band.

   b. Although spectrum in 900 MHz and 1800 MHz are considered inter-changeable historically and been used for offering same services/technology in overlapped network and are subjected to common rollout obligations, but these are still treated as different spectrum bands for spectrum cap.

2. Therefore, we find no rationale for treating 2300 MHz and 2500 MHz as a common band for intra-band spectrum cap.

3. The goal of TRAI for prescribing band wise spectrum cap has been to ensure a level playing field for operators and to provide equal opportunity for acquiring spectrum in each band. The majority of the industry strongly believes that the proposal of separate sub-GHz cap and treating 2300 MHz & 2500 MHz as one band for intra-band cap will defeat the very purpose of prescribing the intra-band spectrum cap.

4. We recommend that the present intra-band spectrum caps of 50% in a particular band should be continued and should be applied for 700 MHz band and 2500 MHz band in the larger interest of consumers, competition and the Industry.

Q12. In the auction held in March 2015, specific roll-out obligations were mandated for the successful bidders in 800 MHz, 900 MHz, 1800 MHz and 2100 MHz spectrum bands. Stakeholders are requested to suggest:
(a) How the roll-out obligations be modified to enhance mobile coverage in the villages? Which of the approaches discussed in para 2.58 should be used?
(b) Should there be any roll out obligation for the existing service providers who are already operating their services in these bands.

Please support your answer with justification.

Q13. In the auction held in 2010, specific roll-out obligations were mandated for the successful bidders in 2300 MHz spectrum band. Same were made applicable to the licensee having spectrum in 2500 MHz band. Stakeholders are requested to suggest:
(a) Should the same roll-out obligations which were specified during the 2010 auctions for BWA spectrum be retained for the upcoming auctions in the 2300 MHz and 2500 MHz bands? Should both these bands be treated as same band for the purpose of roll-out obligations?
(b) In case existing service providers who are already operating their services in 2300 MHz band acquire additional block of spectrum in 2300 or 2500 MHz band, should there be any additional roll out obligation imposed on them?

COAI Response

1. We believe that once the full market value for spectrum has been extracted by the Government through an open market (auction), there is no justification for any roll out obligations. Therefore, no roll out obligations should be specified and the market forces should determine the rollout.

2. We would however like to submit that as once rollout obligations are being prescribed as a condition of auction, it is incorrect for the Government continues to collect levy on account of Universal Service Obligations (USO), the prime objective of which is to fund for services in the rural areas. Therefore, such levy tantamount to double whammy wherein the operator is not only being asked to contribute towards the USO fund for provision of services in rural areas but is also being asked to provide services in those areas, that too after paying for spectrum at market determined price. Government should use the 'scheme of incentive' for rural rollout rather than mandating rollout with lengthy documentary verification processes.

3. Moreover, India in terms of mobile telephony is a mature market now, hence there is no need to prescribe roll out obligations. Furthermore, there should be no need to prescribe roll-out obligations for a TSP who acquires spectrum in the auction if that TSP has already fulfilled the prescribed roll-out obligations once as the present obligations are quite comprehensive.

4. However, it has been the practice followed thus far of attaching rollout obligations to the spectrum being auctioned and therefore this approach can be continued with for the forthcoming auctions as well.

5. We therefore suggest that the same rollout obligations that were prescribed in 2015 auctions should be continued with in respect of 800/900/1800 and 2100MHz bands.

   In respect of 2300MHz and 2500MHz, we suggest that the rollout obligations kept akin to those specified for 800 MHz and 900/1800 MHz bands.

6. We submit that no additional rollout obligations be mandated on an existing licensee acquiring additional spectrum in any band.

7. We note that the Authority in its recommendations dated 06.01.2015 had noted that the high USOF levy has not achieved the stated purpose of filling the investment gap in the development of telecom services in underserved areas and that the time is ripe for a regulatory reappraisal of the LF regime to stimulate further investments in the sector for its growth and the spillover effects on the rest of the economy. Accordingly, the Authority had recommended that the component of USO levy should be reduced from the present 5% to 1% of AGR for all licences with effect from 1st April 2015.

8. In view of our submissions and the Authority's own view as above, we urge that the Government should consider a phased reduction in the USO levy. This can be also by way of incentivizing TSPs to achieve pre-defined milestones and faster rollout of services in uncovered areas. The Government at one stage had approved reduction in license fee by 2% in case operators cover more than 95% of the block headquarters. 90% of on-road coverage shall be treated as sufficient for considering a block headquarter as covered. These incentives will encourage operators to rollout services in uncovered area and also meet the universal service objectives. Therefore, it is suggested that license fee may be reduced by 2% if they cover 95% of the block headquarters in a service area.

9. We would also like to bring to the notice of the Authority the issue of testing fees being charged by the operators for roll out testing requirement. We would like to submit that since the operators are acquiring spectrum through a market determined auction price, the roll out testing fees should be recovered from the proceeds of the auction and it should not be an additional financial burden on the operators.

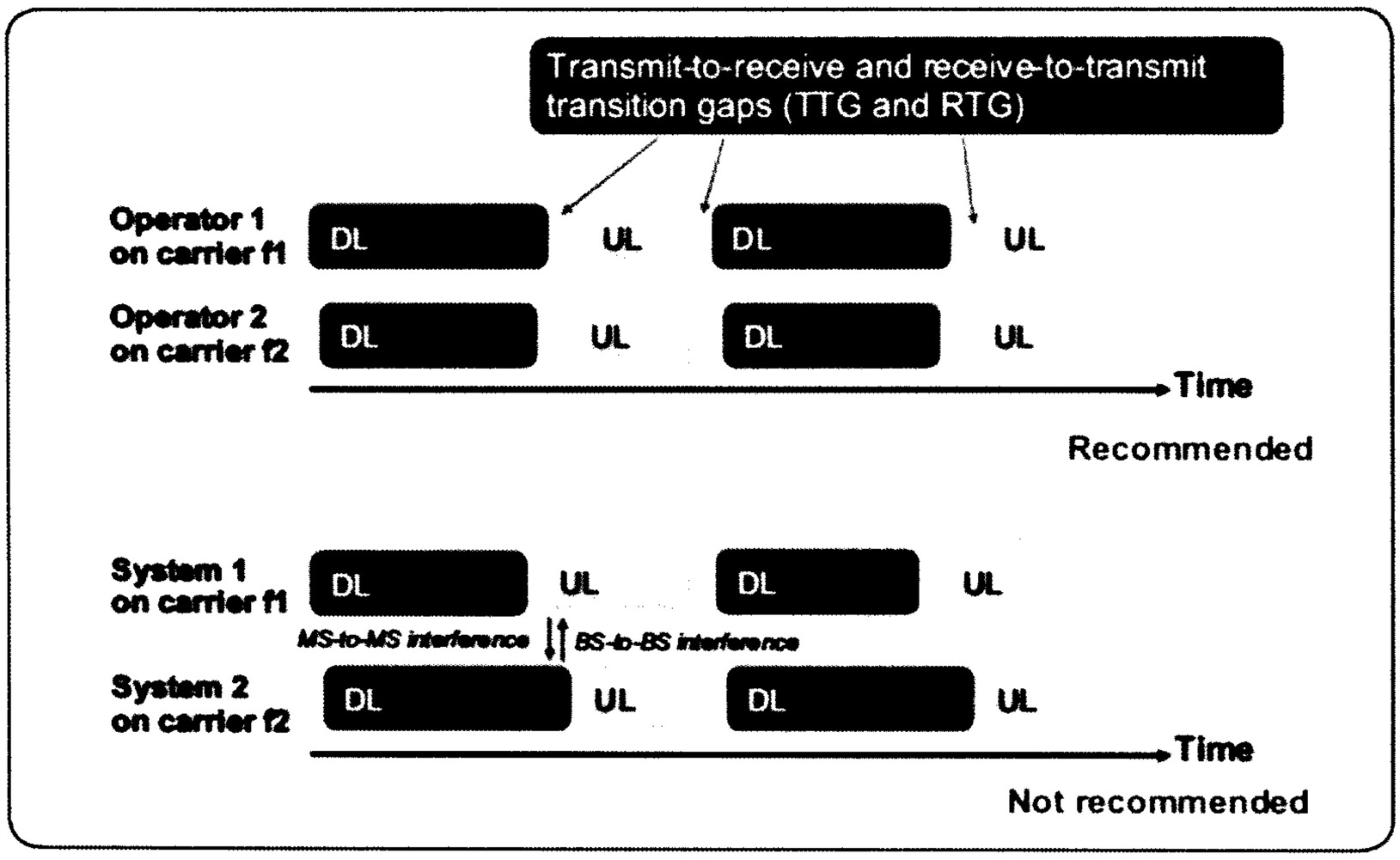
Q14. Keeping sufficient guard band or synchronization of TDD networks using adjacent spectrum blocks are the two possible approaches for interference management. Considering that guard band between adjacent spectrum blocks in 2300 MHz band is only 2.5 MHz in a number of LSAs, should the network synchronization amongst TSPs be mandated or should it be left to the TSPs for the interference free operation in this band? Please support your suggestion with proper justifications.

Q15. In case, synchronization of the TDD networks is to be dealt by the regulator/licensor, what are the parameters that the regulator/licensor should specify? What methodology should be adopted to decide the values of the frame synchronization parameters?

Q16. If synchronization of the TDD networks is ensured, is there a need for any guard band at all? If no guard band is required, how best the spectrum left as inter-operator guard band be utilised?

COAI Response

1. Deploying two TDD LTE cellular systems in the same coverage area on adjacent carriers require synchronization of the networks and alignment of the DL and UL sub frames of the transmitted radio frames. TDD switch point & sub frame configuration needs to be coordinated among the neighbor operators to avoid interference as well as to save the guard band requirement between the adjacent channel allocations. In case the eNBs of two different operators are uncoordinated, there is distinct possibility of interference across both BS-BS and UE- UE.



2. In order to ensure the coexistence of two adjacent carriers & TDD operation, it is important that:

   a. Both the TDD LTE networks are synchronized with either GPS or 1588v2 standards and maintain the Frequency Sync requirement of +/- 50 parts per billion with BTS sync recovery to keep an accuracy of +/-15ppb (to guarantee +/-50ppb in the radio interface) and Phase Sync requirement of +/- 1.5us.

   b. Operators should use the same TDD DL & UL configuration.

3. **We recommend that network synchronization among TSPs and same configuration must be mandated for the interference-free operation in these bands.**

4. The Network synchronization should be recommended along with the following:
   a) Before putting up fresh spectrum for auction, spectrum harmonization should be carried out across India for existing allocations whereby same spectrum block is allocated in all circles for each operator;

   b) Minimum 20 MHz guard band is required from the Wi-Fi band. The ISM band (Wi-Fi) devices have filter characteristics with roll-off around 2380 MHz.

5. Since, the spectrum in 2300 MHz and 2500 MHz is to be used largely for broadband applications/ data where asymmetric capacities are required with downlink data speeds greater than uplink data speeds, **TDD configuration of 3:1 & GPS based synchronization is best suited and should be mandated.**

Q17. Whether the ISP category 'A' licensee should be permitted to acquire the spectrum in 2300 and 2500 MHz bands or the same eligibility criteria that has been made applicable for other bands viz. 800 MHz, 900 MHz, 1800 MHz and 2100 MHz band should be made applicable for 2300 MHz and 2500 MHz bands also?

COAI Response

1. Te eligibility criteria for all the bands should remain the same, and it should be the same as was for the last auction (March 2015), i.e., any licensee who holds a UAS/ CMTS/ UL(AS)/UL with authorization for Access Services for that Service Area; alternatively, any licensee who fulfils the eligibility for obtaining a Unified License with authorization for Access Services; alternatively, any entity that gives an undertaking to obtain a Unified License for access service authorization through a New Entrant Nominee as per DoT guidelines/licence was eligible to bid for the Spectrum in 800 MHz, 900 MHz, 1800 MHz and 2100 MHz band, subject to other provisions of the NIA.

Q18. Stakeholder are requested to comment on
(a) Whether the guidelines for liberalisation of administratively allotted spectrum in 900 MHz band should be similar to what has been spelt out by the DoT for 800 and 1800 MHz band? In case of any disagreement, detailed justifications may be provided.
(b) Should the liberalization of spectrum in 800, 900 and 1800 MHz be made mandatory?

COAI Response

1. Yes, there is a need for liberalization guidelines for 900 MHz band and it should be along the same lines as applicable to other bands.

2. There is no need to mandate liberalization of the spectrum as depending on the needs of the operators, they will approach the Government from time to time for liberalization of their spectrum holding.

Q19. Can the prices revealed in the March 2015 auction for 800/900/1800/2100 MHz spectrum be taken as the value of spectrum in the respective band for the forthcoming auction in the individual LSA? If yes, would it be appropriate to index it for the time gap (even if this is less than one year) between the auction held in March 2015 and the next round of auction and what rate should be adopted for indexation?
&
Q30. Should the realized prices in the recent March 2015 auction for 800/900/1800/2100 MHz spectrum bands be taken as the reserve price in respective spectrum bands for the forthcoming auction? If yes, would it be appropriate to index it for the time gap (even if less than one year) between the auction held in March 2015 and the forthcoming auction? If yes, then at which rate the indexation should be done?

COAI Response

1. Less than nine months have passed since the successful conduct of the auction in March 2015. Nothing much has changed both in terms of the economic activity as well as the outlook for the telecom sector during the last nine months that would significantly impact the value of the spectrum.

2. The fresh valuation and estimating Reserve Price of the spectrum will not yield valuations that are significantly different from the TRAI's Recommendations of October 2014, since the variables and inputs used in different approaches for valuation of spectrum have not changed radically.

3. Thus, we believe that value/market price of the spectrum discovered in March 2015 auctions can be taken as the value of 800/900/1800/2100 MHz spectrum for the forthcoming auction in the respective LSA if the recommendations are issued by the Authority within a year, i.e. until March 2016.

4. There is no need to index the value of the spectrum for the time gap between the auction held in March 2015 and forthcoming auction.

5. Further, in circles where the spectrum remained unsold in 800/900/1800/2100 MHz, the valuation should be set at 50% of reserve price of the auction held in March 2015.

Q20. If the answer to Q.19 is negative, should the valuation for respective bands be estimated on the basis of various valuation approaches/methodologies adopted by the Authority (as given in Annexure 3.1) in its Recommendations issued since 2013 including those bands (in a LSA) for which no bids were received or spectrum was not offered for auction?

COAI Response

NA

Q24. Should the value of May 2010 auction determined prices be used as one possible valuation for 2300 MHz spectrum in the next round of auction? If yes, then how? And, if not, then why not?

Q25. Should the value of the 2300 MHz spectrum be derived on the basis of the value of any other spectrum band using the technical efficiency factor? If yes, please indicate the spectrum band and technical efficiency factor with 2300 MHz spectrum along with supporting documents.

COAI Response

1. We believe that the auction-determined prices obtained in the May 2010 auction provide an appropriate basis for the valuation of the 2300 MHz band. The reasons are as follows:

   a. **No significant development of the eco-system of 2300 MHz band:** The eco-system for 2300 MHz has not evolved much between May 2010 and now and roll-out of services are still in the nascent stage. As there has been no significant development in the 2300 MHz eco system, the auction-determined prices obtained in the May 2010 auction can be used as a valuation for the forthcoming auctions.

   b. **Deteriorating financial performance of the Indian telecom sector since 2010:** Since 2010, the industry financial parameters have worsened due to higher debt levels, declining profitability and a sharp slowdown in revenue growth. The industry is reeling under a debt burden of INR 3.5 lakh crores, and the industry's net debt to EBITDA multiples have risen to 5.2x due to significant funding needed by operators in order to afford spectrum as well as network expansion. This compares to a general acceptance of a 3x debt to EBITDA margin, representing an acceptable debt exposure to lenders. The majority of spectrum investments made by operators have been funded through debt. In the current debt-burdened scenario, it will be increasingly difficult for operators to raise further debt for acquiring spectrum, and this factor points against ambitious or high reserve prices.

2. Thus, we agree that the value of May 2010 auction determined prices should be used as valuation for 2300 MHz spectrum in the next round of auction.

3. There is no need to index the value of the spectrum for the time gap between the auction held in May 2010 and forthcoming auction.

Q26. Should the valuation of the 2500 MHz spectrum be equal to the valuation arrived at for the 2300 MHz spectrum? If no, then why not? Please support your comments with supporting documents/ literature.

COAI Response

1. The spectrum in the 2500 MHz band would be put to auction for the very first time in the country. However, the eco-system is still developing and is lagging behind 2300 MHz. As per the latest GSA Report, 2300 MHz had 19 networks and 1021 devices in comparison to 8 networks and 768 devices in 2500MHz (Band 41).

2. Further, the propagation characteristic of 2500 MHz band is poorer than 2300 MHz.

3. Hence, the valuation for 2500 MHz should be fixed 70-80% of valuation for 2300 MHz.

Q27. Is there any other method/approach than discussed above that could be used for arriving at the valuation of 700/800/900/1800/2100/2300/2500 MHz spectrum bands or any international auction experience/ approach that could be used for valuation of any of these bands? Please support your suggestions with detailed methodology and related assumptions.

COAI Response

NA

Q28. As was adopted by the Authority in September 2013 and subsequent Recommendations and adopting the same basic principle of equal-probability of occurrence of each valuation, should the average valuation of the spectrum band be taken as the simple mean of the valuations obtained from the different approaches/methods attempted for that spectrum band? If no, please suggest with justification that which single approach under each spectrum band, should be adopted to value that spectrum band.

COAI Response

1. As stated earlier, the market price of the spectrum discovered in March 2015 auctions can be taken as the value of 800/900/1800/2100 MHz spectrum.

2. For 2300 MHz the value of May 2010 auction determined prices should be used as valuation for 2300 MHz spectrum in the next round of auction. For 2500 MHz, the average valuation of the spectrum band should be fixed 80% of valuation for 2300 MHz.

Q29. What should be the ratio adopted between the reserve price for the auction and the valuation of the spectrum in different spectrum bands and why?

COAI Response

1. Auctions are useful when there is uncertainty about the value of the good for sale. As far as setting the reserve prices is concerned, the following are the objectives, in order of preference.

    a. Ensure sale
    b. Induce participation
    c. Determine optimal value
    d. Avoid collusion

2. Setting reserve prices is typically a conundrum, because if the reserve price is set too high it increases the probability of auction failure, whereas if set too low frivolous bidders can enter the auction. Every failed auction results in missed opportunity for the economy, lower investor interest in the industry, revenue loss to the exchequer and inefficient allocation of spectrum and therefore sensible reserve prices are important.

3. The reserve price across numerous auctions in other countries in the recent past has been set at a ratio of around 0.4-0.5 to the final auction-determined values. In the past, TRAI has fixed reserve price at 80% of valuation.

4. Thus, as per practice adopted so far, we suggest the reserve price of the spectrum in bands that have been auctioned recently be fixed at 80% of valuation.

5. In case of the new bands – 700, 2300 & 2500 MHz, we recommend a more conservative approach and suggest a ratio of not more than 70% of estimated valuation, to ensure active participation in the auction.

ADDITIONAL COMMENTS

1. DoT, vide the Circular No. 800-15/2010-VAS (Pt) dated April 10, 2012 has introduced strong regulation on EMF (1/10th of ICNIRP levels) to ensure that radiation is kept well within the permissible limits.

2. It is pertinent to note that 2G/3G/4G technologies are all operating at different frequency bands and the free space losses are totally different in different frequency bands but the transmit power regulation is common to all.

3. In 3G especially, the pilot power transmitted is at a very low power level and the operators should be allowed to report the transmit power based on pilot power. Technology wise 3G has only one carrier and every site uses only one carrier, accordingly interference is not a concern. The limit of 20W leads to an unsatisfactory user experience, hence power of upto 60W should be permitted in 3G as compared to 2G which has multiple carriers and 20W.

4. 3G is a wide-band technology and hence power transmitted is distributed across the wider channel bandwidth. That is to say, that 20W cannot be compared to the power transmitted in GSM across 200Khz bandwidth & CDMA across 1.25MHz bandwidth, Similar is the case with LTE where the channel bandwidth can be from 5MHz to 20MHz.

5. 3G & LTE have new technologies such as MIMO, where power is transmitted in two to four Tx paths. This needs the norms of Transmit power per sector to be revised with the single criteria of EMF levels to be complied by the operators.

6. The DoT norms on EMF directly govern the transmit power set at the base stations to ensure EMF compliance. This creates dual condition of compliance for the operators as in some technologies, like 3G, this transmit power will have to be changed based on pilot power. There is a need to review this in terms of EMF exposure and interference issues requirements and align both requirements.

7. The EMF guidelines also require that the transmit power be measured at the antenna port and that clearly nullifies the necessity of regulated transmit power settings at the Base station, as long as both EMF exposure and interference are being complied with.

8. Operators now have networks in various technology bands, as compared to the scenario back in the early days, hence, there is a need to review the transmit power regulation.

9. In summary, limit of 20W as transmit output of the BTS is outdated and should be reviewed. It is constraining TSPs to enhance coverage & capacity of the sites and hence providing better user experience to their subscribers. It is therefore submitted that TSPs should be allowed to configure higher transmit power (upto 60W per carrier per port) while maintaining compliance to the defined EMF norms by DoT. The detailed submission for the same is enclosed for your perusal. A detailed proposal in this regard is enclosed as Annexure – 1.

RSM/COAI/2015/133
July 20, 2015

Shri. P.K. Mittal
DDG (AS-I), DoT
Department of Telecommunications
Sanchar Bhawan, 20, Ashoka Road
New Delhi 110001

SUBJECT: Enhancement of BTS transmit power & EIRP limits subject to EMF compliance

Dear Sir

1. This is with reference to the discussion during the meeting chaired by Member (T) on call drops in mobile networks held on July 17, 2014 regarding BTS Transmit power guidelines for the mobile networks.

2. In this regard, it is submitted that the radiated power from BTSs is already being governed via the EMF guidelines. DoT, vide its Letter No. 800-15/2010-VAS (Pt) dated April 10, 2012 has introduced strong regulation on EMF (1/10th of ICNIRP levels) to ensure that radiation is kept well within the permissible limits.

3. Further, while seeking allocation of spectrum in 900 MHz/ 1800 MHz/ 2100 MHz/ 2300 MHz bands, our member operators have sought for allowing upto 60 Watts of power (per carrier at the antenna port) to be radiated from the BTS. However, despite our submissions, the allocation letters still mentions 20 Watts which limits the capabilty of operators to provide adequate coverage & capacity from the base station.

4. It is submited that 2G/3G/4G technologies are all operating at different frequency bands and the free space losses are different in respective frequency bands but the allowed transmit power has been limited to 20 Watts in respect of all bands & technologies.

5. Further, in broadband technologies such as 3G & LTE, pilot or reference power transmitted is only fraction of the total power in the sector, and hence operators should be allowed to report the transmit power based on pilot / reference power. In addition, these broadband technologies use wider spectrum bandwidth (minimum 5MHz channel size), typically with single carrier per sector, resulting in significantly lower EMF levels. LTE, in addition has channel bandwidths ranging from 5MHz to 20MHz, also has MIMO, where power is transmitted in two to four Tx paths.

6. Limitation of 20W leads to limited coverage & capacity and hence unsatisfactory user experience. It is therefore the need of the hour that the norms of Transmit power per sector be revised which will provide operators capability to optimize the network for better experience with lower congestion & mitigate the problems currently being faced on call drops. It is also to be noted that going forward this will also facilitate the Digital India and Smart Cities objectives of the Government.

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7. DoT norms on EMF directly govern transmit power set at the base stations to ensure EMF compliance. Defining maximum transmit power at the base station creates dual condition of compliance for the operators.

8. The EMF guidelines also require that transmit power be measured at the antenna port and that clearly nullifies the necessity of regulated transmit power settings at the Base station, as long as both EMF exposure and interference are being complied with.

Our submissions:

In summary, limit of 20W as transmit output of the BTS is outdated and should be reviewed. It is constraining TSPs to enhance coverage & capacity of the sites and hence providing better user experience to their subscribers. It is therefore submitted that TSPs should be allowed to configure higher transmit power (upto 60W per carrier per port) while maintaining compliance to the defined EMF norms by DoT. The detailed submission for the same is enclosed for your perusal.

Regards

Rajan S. Mathews
Director General

CC: **Shri S.S Sirohi, Member T, DoT**
Shri A.K Mittal, Sr. DDG, TEC

A. Executive Summary

1. Background

BTS Transmit power guidelines for the mobile networks were introduced in 1995 when GSM was the most common network, since then newer technologies have evolved. However, transmit power regulation have not been reviewed and the same norms are being followed for all new technologies such as 3G and LTE. Current guidelines of RF power from DoT on transmit power (RF) from the BTS is 20W at the output of the BTS port. This is common guideline for all type of technologies deployed in the network like GSM, CDMA, WCDMA, and LTE (reference DoT letter number L-14035/08/2010-BWA, dated 15th Sep 2010).

In addition, more stringent EMF level regulations (1/10th of ICNIRP values) have been mandated for compliance by TSPs to ensure radiations from the base stations are kept under limit. These guidelines also govern the transmit power of the base station, thus creating dual condition of compliance,

Given that the new broadband technologies introduced beyond 2010 are having different characteristics like frequency band, MIMO, wide band spectrum usage; it is pertinent for these regulations to be revised by DoT.

2. Objective

Aim of this paper is to review the 20W at the output of the BTS port and allow higher suitable transmit power & EIRP limits for 3G & 4G Base stations as they operates on wider carrier bandwidth & discontinuous transmission modes and at the same time EMF (EIRP/EIRPth) from 3G & 4G BTS is much lower than GSM technology as described through medium of this paper.

3. Highlights

i. There are significant differences between GSM (narrowband technology) and 3G / LTE technologies (broadband technologies) which necessitate different treatment of RF Power related to these technologies:

   a) Power in GSM is across a narrow 200KHz channel vs. 3G/LTE which is in wideband say 5MHz, 10MHz or 20MHz

   b) GSM has continuous power transmission irrespective of the traffic in the BTS, while 3G / LTE-FDD / LTE-TDD have variable/discontinuous power transmission owing to following aspects

      I. Pilot power, which is typically 10% of the total transmit power of Node-B in 3G network, is continuous and total power is based on the amount of voice & data traffic in the Node-B,

      II. Power transmission is only in fraction of time in case of LTE-TDD deployments

      III. Continuous power transmission in LTE-FDD networks is only transmitted on some RE (Resource Elements)

   c) MIMO is mandatory in LTE and optional in 3G which is not applicable for 2G networks

ii. 3G and LTE are wideband technologies; they need higher transmit power for coverage & capacity. Global deployments in US, Europe, China and APAC markets for 3G & LTE are using 40W to 80W of transmit power in the BTS irrespective of bands (3G in 900 and 2100, LTE-FDD in 1800, 800, 2100, 900 band, LTE-TDD in 2300, 2600 band) to take care of growth in mobile broadband traffic.

iii. 3G & LTE emission mask ensures that the out of band emissions are same even if the transmit power of the BTS is >20W. These emission masks are defined by 3GPP standards in 3GPP TS 25.104 section 6.6.3.1.1.1 and 6.6.2.2.1 for 3G / UMTS, and TS36.104 for LTE base stations.

iv. Power density (RF power per MHz) in 3G & LTE is lower than GSM even with BTS RF Power is 60W and 80W respectively as shown in the table below:

Table -1

	Units	GSM	UMTS(3G)		UMTS (3G)		LTE-TDD		LTE-FDD		LTE-FDD		LTE-FDD	
BTS Transmit Power	Watt	20	20		40		40		40		40		40	
Carrier BW	MHz	0.2	5		5		20		5		10		20	
Power/MHz	dBm	50	36		39		33		39		36		33	
MIMO		No	Optional		Optional		Mandatory		Mandatory		Mandatory		Mandatory	
TDD Ratio	No	No	No		No		Yes(3:1)		No		No		No	
Total Max Transmit Power /MHz (with MIMO & TDD as	dBm	50 dbm @ 20 Watt	20	36	20	36	20	36	20	36	20	36	20	36
			40	39	40	39	40	39	40	39	40	39	40	39
			60	41	60	41	80	42	80	42	80	42	80	42
Pilot Power	dBm	43	30 - 33		30 - 36		36 - 38		36 - 38		36 - 38		36 - 38	
Frequency Band	MHz	900, 1800	900, 2100		900, 2100		2300, 2600		1800, 900, 2100, 800					

v. EIRP and EIRP/$EIRP_{th}$ for 3G / LTE is significantly lower than that of GSM (using peak power in each of the respective technologies), as defined in the table below:

Calculated Value for Worst Case (at 100% loaded case):

Table -2 (refer annexure for calculation details)

Technology	Power(W)	EMF Scenario 1 (At Ground) – EIRPt/$EIRP_{th}$	EMF Scenario2 (At Adjacent Bldg.) – EIRP/$EIRP_{th}$
GSM900 (4/4/4)	20W/Carrier	0.06092	0.01896
GSM1800 (4/4/4)	20W/Carrier	0.03147	0.00979
UMTS	60W/Carrier	0.02445	0.007607
LTE	80W/Carrier	0.03644	0.01134
Total EIRP/ $EIRP_{th}$		**0.15327**	**0.04769**

vi. EIRP/EIRP$_{th}$ for usage of UMTS and LTE (irrespective of bands 800, 900, 2100, 1800, 2300, 2600) will be significantly lower considering only pilot channel or reference symbols in the LTE. Due to spread spectrum nature of the 3G and LTE technologies, irrespective of the bands and the channel bandwidth, the EIRP/EIRP$_{th}$ for 3G & LTE will be lower and compliant with the required levels for EMF exposure.

Measured values at heavily loaded sites:

Table -3

Technology	No. of Operators	EMF Scenario 1 (At Ground) – EIRPt/EIRP$_{th}$	EMF Scenario2 (At Adjacent Bldg.) – EIRP/EIRP$_{th}$
GSM900 (4/4/4)	2	0.00065	0.00010
GSM1800 (4/4/4)	2	0.00072	0.00118
UMTS (2100MHz) – 60W	2	**0.00036**	**0.00023**
LTE-TDD (2300MHz) – 80W	1	**0.00003**	**0.00002**
Total EIRP/ EIRP$_{th}$		**0.00176**	**0.00153**

Also, it shall be noted that in a typical network, not all the 100% resources are always used and transmitted. Thus the above values with traffic are on the higher side. In practice typically not more than 30-40% of the resources (whether codes or PRB) are used and the TTI (Transmit Time Intervals) of not more than 40-50% are used.

4. Inference & Recommendations

i. From the calculated method and field measurement results shown above for a heavily loaded site, it is clear that the EIRP/EIRPth values for 60W/80W power of 3G and LTE are well within the limits of EMF exposure guidelines described by DoT.

ii. Transmit power per MHz (power density) for 3G & LTE base station (having transmit power of 60W & 80W respectively) is lower than that of a GSM base station,

iii. $EIRP/EIRP_{th}$ for 3G and LTE base station is lower than that of GSM base station. This is pertinent to 3G deployment in 2100MHz or 900MHz band and LTE deployment in 2300MHz or 1800MHz band,

iv. 3GPP specifications ensure same out of band emission norms for 3G and LTE base station with transmit power of 43dBm (20W) or higher,

v. 3G and LTE base stations with transmit power of 60W & 80W respectively, comply to the 3GPP specifications and are within emission levels as per EMF regulations,

vi. Suggested modifications for EIRP value in case of 3G, LTE-FDD, LTE-TDD deployments by taking average transmit power during a frame. This is mandatory as LTE technology (FDD&TDD) consistent power is only transmitted during specific Resource Elements. Additionally in LTE-TDD base stations are transmitting power only during specific intervals of time (downlink sub-frames), while at other time intervals its only in the receiving mode with no transmitting power (uplink sub-frames). Similarly in 3G only the CPICH is

vii. transmitted as full power (30-33dBm) , only when users are scheduled the further additional delta power is required

viii. Given the above facts, the limit of 20W at the output of the BTS port is outdated and should be reviewed and TSPs should be allowed to configure transmit power in 3G and LTE base stations beyond 20W, maintaining compliance to the EMF norms.

ix. Increasing the power will not have any interference impact on adjacent carrier so far operator is complying with the 3GPP mentioned ACLR and SEM requirements

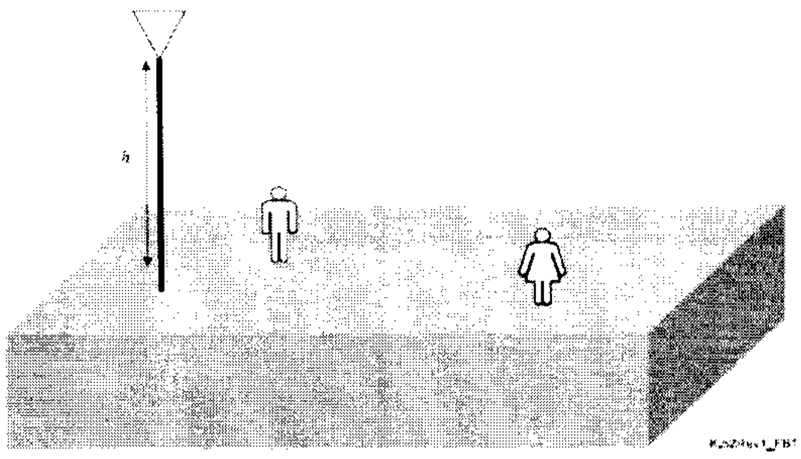
ANNEXURE I

B. Introduction

EMF measurement scenario described below as per guidelines

Calculation Scenario 1:

The calculations are done on roads at the ground level.



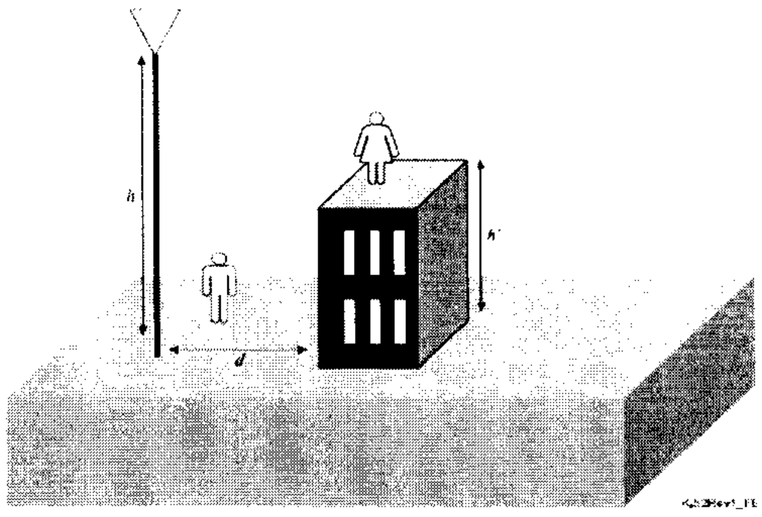
For 400 MHz < f < 2000 MHz,

$EIRP_{th}$ = {(f*∏)/ (2000*Asl)}*(h-2)^2

For f > 2000 MHz,

$EIRP_{th}$ = (∏/Asl)*(h-2)^2

Calculation Scenario 2:
The calculations are done on the adjacent building roof top.



For 400 MHz < f < 2000 MHz,

EIRPth = {[(f∏)/ 2000*Asl)}*((d^2+(h-h')^2)/d))^2

For f > 2000 MHz,

$EIRP_{th}$ = (∏/Asl)*((d^2+(h-h')^2)/d))^2

1. 3G NodeB Transmit Power & Spatial Emission Mask (as per Standard)

i. 3G BTS Transmit Power

Power Scenario	Band	BTS Transmit Power	BTS Transmit Power @ different loading		
			0%(pilot)	50%	100%
Scenario-1	2100/900	20Watt	33 dBm	40 dBm	43 dBm
Scenario-2	2100/900	40 Watt	36 dBm	43 dBm	46 dBm
Scenario-3	2100/900	60 Watt	36 dBm	44.7 dBm	47.7 dBm

ii. 3G BTS Out of Band Emission (Spatial Emission Mask as per Std.)

SEM Requirement
SEM requirement for UTRAN/FDD systems as defined in 3GPP TS 25.104 section 6.6.3.1.1.1 has been reproduced for reference. Spectrum emission mask values, BS maximum output power **P ≥ 43 dBm**

Band	Maximum level	Measurement Bandwidth
9kHz - 150kHz	-13 dBm	1 kHz
150kHz - 30MHz		10 kHz
30MHz - 1GHz		100 kHz
1GHz - 12.75 GHz		1 MHz

Filter ACLR Requirement
Minimum ACLR requirement defined by 3GPP TS 25.104 section 6.6.2.2.1 for an offset of 5 MHz from the edge frequency is **45 dB** and that from an offset of 10 MHz is **50 dB** to meet above mentioned OOB emission requirement

iii. 3G BTS EIRP

EIRP = TX Power – Combiner Loss – (Cable Length x Unit Loss) + Antenna Gain (dBm)
Typical Assumption: Combiner Loss: 1 dB, Cable Loss: 1 dB, Antenna Gain (18 dBi)

Note: EIRP (T) is same as EIRP, as only one 3G carrier is assigned

Power Scenario	Band	Transmit Power @ BTS Port in Watts	EIRP in dBm		
			0%(pilot)	50%	100%
Scenario-1	2100 / 900	20	49	56	59
Scenario-2	2100 / 900	40	52	59	62
Scenario-3	2100 / 900	60	52	60.7	63.7

iv. 3G BTS $EIRP_{th}$

Calculation Scenario 1:
$EIRP_{th}$ = (∏/Asl)*(h-2)^2

Typical Assumption: f=2149, Asl =-18, h=24

Note: $EIRP_{th}$ is same for all loading and power configuration

Power Scenario	Band	Transmit Power @ BTS Port	$EIRP_{th}$ (in Watts)
Scenario-1	2100	20Watt	95890.4
Scenario-1	900	20Watt	44828.7

Calculation Scenario 2:
$EIRP_{th}$ = (∏/Asl)*((d^2+(h-h')^2)/d))^2

Typical Assumption: f=2149, Asl =-18, h=24, h'=5, d=25

Note: $EIRP_{th}$ is same for all loading and power configuration

Power Scenario	Band	Transmit Power @ BTS Port	EIRPth (in Watts)
Scenario-2	2100	20Watt	308179.3
Scenario-2	900	20Watt	144073.8

v. 3G BTS EIRP/ $EIRP_{th}$

Calculation Scenario 1:

Power Scenario	Band	EIRP/ EIRPth- Scenario 1		
		0%(pilot)	50%	100%
Scenario-1	2100	0.0008	0.0042	0.0083
Scenario-2	2100	0.0017	0.0083	0.0165
Scenario-3	2100	0.0017	0.0123	0.0244

Power Scenario	Band	EIRP/ EIRPth- Scenario 1		
		0%(pilot)	50%	100%
Scenario-1	900	0.0018	0.0089	0.0177
Scenario-2	900	0.0035	0.0177	0.0354
Scenario-3	900	0.0035	0.0262	0.0523

Calculation Scenario 2:

Power Scenario	Band	EIRP/ EIRPth- Scenario 2		
		0%(pilot)	50%	100%
Scenario-1	2100	0.0003	0.0013	0.0026
Scenario-2	2100	0.0005	0.0026	0.0051
Scenario-3	2100	0.0005	0.0038	0.0076

Power Scenario	Band	EIRP/ EIRPth- Scenario 2		
		0%(pilot)	50%	100%
Scenario-1	900	0.0006	0.0028	0.0055
Scenario-2	900	0.0011	0.0055	0.011
Scenario-3	900	0.0011	0.0082	0.0163

2. 4G eNodeB Transmit Power & Spatial Emission Mask (as per Standard)

i. 4G BTS Transmit Power

Ir-respective of the band the transmit power in 4G will be as follows

Power Scenario	Band	Transmit Power @ BTS (2x2 MIMO) in Watts	BTS Transmit Power (2x2) @ different loading in dBm		
			0%(pilot)	50%	100%
Scenario-1	2300 / 1800 / 900 /2100 / 2600	20	33.00	40.00	43.00
Scenario-2	2300 / 1800 / 900 /2100 / 2600	40	36.00	43.00	46.00
Scenario-3	2300 / 1800 / 900 /2100 / 2600	80	39.00	46.00	49.00

ii. 4G BTS Out of Band Emission (Spatial Emission Mask as per Std.)

SEM Requirement

SEM requirement for 5, 10, 15 and 20 MHz channel bandwidth (E-UTRA bands >1GHz) for Category A as defined in 3GPP TS 36.104 has been reproduced for reference

Frequency offset of measurement filter -3dB point, Δf	Frequency offset of measurement filter centre frequency, f_offset	Minimum requirement (Note 1, 2)	Measurement bandwidth (Note 5)
0 MHz ≤ Δf < 5 MHz	0.05 MHz ≤ f_offset < 5.05 MHz	$-7dBm - \frac{7}{5} \cdot \left(\frac{f\_offset}{MHz} - 0.05 \right) dB$	100 kHz

5 MHz ≤ Δf < min(10 MHz, Δfmax)	5.05 MHz ≤ f_offset < min(10.05 MHz, f_offsetmax)	-14 dBm	100 kHz
10 MHz ≤ Δf ≤ Δfmax	10.5 MHz ≤ f_offset < f_offsetmax	-13 dBm (Note 7)	1MHz

Filter ACLR Requirement
Minimum ACLR requirement defined by 3GPP TS 36.104 for an offset of 2.5 MHz from the edge frequency is **45 dB** to meet above mentioned OOB emission requirement

iii. 4G BTS EIRP

EIRP = TX Power – Combiner Loss – (Cable Length x Unit Loss) + Antenna Gain (dBm)
Typical Assumption: Combiner Loss: 1 dB, Cable Loss: 1 dB, Antenna Gain (18 dBi)
Note: EIRP (T) is same as EIRP, as only one 4G carrier is assigned

Power Scenario	Band	EIRP in dBm		
		0%(pilot)	50%	100%
Scenario-1	2300 / 1800 / 900 /2100 / 2600	49.0	56.0	59.0
Scenario-2	2300 / 1800 / 900 /2100 / 2600	52.0	59.0	62.0
Scenario-3	2300 / 1800 / 900 /2100 / 2600	55.0	62.0	65.0

iv. 4G BTS EIRPth

Calculation Scenario 1:
$EIRP_{th}$ = (∏/Asl)*(h-2) ^2

Typical Assumption: f=2337.5, Asl=-18, h=24

Note: $EIRP_{th}$ is same for all loading and power configuration

Power Scenario	Band	Transmit Power Per sector	$EIRP_{th}$(in Watts)
Scenario-1	2300/1800/900/2100/2600	20/40/80 Watt	95890.37

Calculation Scenario 2:

$EIRP_{th}$ = (∏/Asl)*((d^2+(h-h')^2)/d))^2

Typical Assumption: f= 2337.5, ASL=-18, h=24, h'=5, d=25

Note: $EIRP_{th}$ is same for all loading and power configuration

Power Scenario	Band	Transmit Power Per sector	$EIRP_{th}$(in Watts)
Scenario-1	2300/1800/900/2100/2600	20/40/60 Watt	308179.30

v. 4G BTS EIRP/$EIRP_{th}$

Calculation Scenario 1:

Power Scenario	Band	Transmit Power @ BTS(2x2 MIMO) in Watts	EIRP/ EIRPth- Scenario 1		
			0%(pilot)	50%	100%
Scenario-1	2300 / 1800 / 900 /2100 / 2600	20	0.0008	0.0042	0.0083
Scenario-2	2300 / 1800 / 900 /2100 / 2600	40	0.0017	0.0083	0.0165
Scenario-3	2300 / 1800 / 900 /2100 / 2600	80	0.0033	0.0165	0.0330

Calculation Scenario 2:

Power Scenario	Band	Transmit Power @ BTS(2x2 MIMO) in Watts	EIRP/ EIRPth- Scenario 2		
			0%(pilot)	50%	100%
Scenario-1	2300 / 1800 / 900 /2100 / 2600	20	0.0003	0.0013	0.0026
Scenario-2	2300 / 1800 / 900 /2100 / 2600	40	0.0005	0.0026	0.0051
Scenario-3	2300 / 1800 / 900 /2100 / 2600	80	0.0010	0.0051	0.0103

3. GSM Transmit Power & Spatial Emission Mask (as per Standard)

i. 2G BTS Transmit Power

Power Scenario	Band	Transmit Power per carrier	BTS Transmit Power
Scenario-1	900/1800	20Watt	43

ii. 2G BTS Out of Band Emission (Spatial Emission Mask as per Std.)

SEM Requirement
SEM requirement for GSM/EDGE systems as defined in 3GPP TS 45.005 has been reproduced for reference

Band	Frequency offset outside relevant transmit band	All BTS except multicarrier BTS	Multicarrier BTS
		Maximum power limit	Maximum power limit
9 kHz to 1 GHz			Wide Area
	≥ 2MHz	-36 dBm	-25 dBm
	≥ 5MHz	-36 dBm	-20-4,2*
			(Δf - 5) dBm
			(Note)
	≥ 10MHz	-36 dBm	-36 dBm
1 GHz to 12.75 GHz	≥ 2MHz	-30 dBm	-25 dBm
	≥ 5MHz	-30 dBm	-20-3*
			(Δf - 5) dBm (Note)
	≥ 10MHz	-30 dBm	-30 dBm

Filter ACLR Requirement
Minimum ACLR requirement for GSM/EDGE systems as defined in 3GPP TS 45.005 mentions that at a channel band width of 200 KHz and frequency offset value of 400 KHz allowable ACLR value should be >=60 dB for class II base stations

iii. 2G BTS EIRP

EIRP = TX Power – Combiner Loss – (Cable Length x Unit Loss) + Antenna Gain (dBm)

Typical Assumption: Combiner Loss: 1 dB, Cable Loss: 1 dB, Antenna Gain (18 dBi)

Power Scenario	Band	Transmit Power per carrier	EIRP (dBm)
Scenario-1	900/1800	20Watt	59

iv. 2G BTS EIRP (T)

EIRP (T) = EIRP (BCCH) watts + (EIRP (BCCH) watts x 0.9 x 0.9 x (Carrier Per sector-1)

Typical Assumption: 4/4/4 BTS configuration

Power	Band	Transmit Power per	EIRP (T) (dBm)

Scenario		carrier	
Scenario-1	900/1800	20Watt / 4TRX	64.36

v. 2G BTS EIRPth

Calculation Scenario 1:

$EIRP_{th}$ = {(f*⌈⌉)/ (2000*Asl)}*(h-2)^2

Typical Assumption: f= 935, 1810.2, Asl=-18, h=5

Note: EIRPth is same for all loading and power configuration

Power Scenario	Band	Transmit Power @ BTS Port	EIRPth (in Watts)
Scenario-1	900	20Watt 4 TRX	44828.75
Scenario-2	1800	20Watt 4 TRX	86790.38

Calculation Scenario 2:

$EIRP_{th}$ = {[(f⌈⌉)/ 2000*Asl)}*((d^2+(h-h')^2)/d))^2

Typical Assumption: f= 935, 1810.2, Asl=-18, h=24, h'=5, d=25

Note: $EIRP_{th}$ is same for all loading and power configuration

Power Scenario	Band	Transmit Power @ BTS Port	$EIRP_{th}$ (in Watts)
Scenario-1	900	20Watt/4 TRX	144073.8
Scenario-2	1800	20Watt/ 4 TRX	278933.1

vi. 2G BTS EIRP (T)/$EIRP_{th}$

Calculation Scenario 1:

Power Scenario	Band	Transmit Power per carrier	EIRP(T)/$EIRP_{th}$
Scenario-1	900	20Watt 4 TRX	0.06092
Scenario-2	1800	20Watt 4 TRX	0.03147

Calculation Scenario 2:

Power Scenario	Band	Transmit Power per carrier	EIRP(T) /EIRP$_{th}$
Scenario-1	900	20Watt 4 TRX	0.0190
Scenario-2	1800	20Watt 4 TRX	0.0098

4. Total EIRP/EIRP$_{th}$ for different Site configurations

Calculation Scenario 1:

The following tables summaries the EIRP/EIRPth for different frequencies at different transmit power at BTS port and BTS Transmit Power per Port at different loading values.

Height of the antenna is considered as 16m.

Technology	Power (W)	0%	50%	100%
GSM 900	20	0.06092	0.06092	0.06092
GSM 1800	20	0.03147	0.03147	0.03147
UMTS-900	20	0.00177	0.00888	0.01772
UMTS-2100	20	0.00083	0.00415	0.00828
LTE-900	20	0.00177	0.00888	0.01772
LTE-1800	20	0.00092	0.00459	0.00915
LTE-2100	20	0.00083	0.00415	0.00828
LTE-2300	20	0.00062	0.00308	0.00615

Technology	Power (W)	0%	50%	100%
GSM 900	20	0.06092	0.06092	0.06092
GSM 1800	20	0.03147	0.03147	0.03147
UMTS-900	40	0.00354	0.01772	0.03535
UMTS-2100	40	0.00165	0.00828	0.01653
LTE-900	40	0.00354	0.01772	0.03535
LTE-1800	40	0.00183	0.00915	0.01826
LTE-2100	40	0.00165	0.00828	0.01653
LTE-2300	40	0.00123	0.00615	0.01228

Technology	Power (W)	0%	50%	100%
GSM 900	20	0.06092	0.06092	0.06092
GSM 1800	20	0.03147	0.03147	0.03147
UMTS-900	60	0.00354	0.02621	0.05229
UMTS-2100	60	0.00165	0.01225	0.02445
LTE-900	80	0.00705	0.03535	0.07054
LTE-1800	80	0.00364	0.01826	0.03644

LTE-2100	80	0.00330	0.01653	0.03298
LTE-2300	80	0.00245	0.01228	0.02450

Measured value:

An isotropic antenna was set-up at ground level and the value of EIRP/EIRPth was measured using the spectrum analyzer.

Technology	Power(W)	EIRP/EIRPth	
		Peak (d=25m)	Average (d=25m)
GSM900 4 TRX	20	0.00136	0.00065
GSM1800 4 TRX	20	0.00186	0.00072
UMTS	40	0.00106	0.00036
LTE	40	0.00003	0.00002

Calculation Scenario 2:

The following tables summaries the EIRP/EIRPth for different frequencies at different transmit power at BTS port and BTS Transmit Power per Port at different loading values.

Height of the antenna is considered as 16m. The distance between the antenna and the user is considered as 25m and the height at which the user is present is considered as 6m.

Technology	Power (W)	0%	50%	100%
GSM 900	20	0.01896	0.01896	0.01896
GSM 1800	20	0.00979	0.00979	0.00979
UMTS-900	20	0.00055	0.00276	0.00551
UMTS-2100	20	0.00026	0.00129	0.00258
LTE-900	20	0.00055	0.00276	0.00551
LTE-1800	20	0.00028	0.00143	0.00285
LTE-2100	20	0.00026	0.00129	0.00258
LTE-2300	20	0.00019	0.00096	0.00192

Technology	Power (W)	0%	50%	100%
GSM 900	20	0.01896	0.01896	0.01896
GSM 1800	20	0.00979	0.00979	0.00979
UMTS-900	40	0.00110	0.00551	0.01100
UMTS-2100	40	0.00051	0.00258	0.00514
LTE-900	40	0.00110	0.00551	0.01100

LTE-1800	40	0.00057	0.00285	0.00568
LTE-2100	40	0.00051	0.00258	0.00514
LTE-2300	40	0.00038	0.00192	0.00382

Technology	Power (W)	0%	50%	100%
GSM 900	20	0.01896	0.01896	0.01896
GSM 1800	20	0.00979	0.00979	0.00979
UMTS-900	60	0.00110	0.00815	0.01627
UMTS-2100	60	0.00051	0.00381	0.00761
LTE-900	80	0.00219	0.01100	0.02195
LTE-1800	80	0.00113	0.00568	0.01134
LTE-2100	80	0.00103	0.00514	0.01026
LTE-2300	80	0.00076	0.00382	0.00762

Measured value:

The isotropic antenna was set-up at a distance of 25m from the antenna and 5m above ground level and value of EIRP/EIRPth was measured.

Technology	Power(W)	EIRP/EIRPth	
		Peak (d=25m)	Average (d=25m)
GSM900 4 TRX	20	0.00019	0.00010
GSM1800 4 TRX	20	0.00357	0.00118
UMTS	40	0.00073	0.00023
LTE	40	0.00004	0.00002

ANNEXURE II

(BTS Power used by operators across the globe)

S.No.	Top Global Operators	Region	Technology	BTS Configuration (1T/2R, 2T/2R, 4T4R, 8T8R etc)	Max. BTS Transmit Pwr used	Pwr Distribution - across network
1	T Mobile	US	UMTS	2T2R	2x20W,2x40W and 2x60W	2x20W in most sites. 2x40W and 2x60W in some
		Germany	UMTS	2T2R	2x40W & 2x60 W	2x40W in most sites 2x60W in some
2	Telefonica	Europe	GSM, UMTS, LTE	GSM: 1T2R, UMTS: 1T2R, LTE: 2T2R	GSM: 10W/TRX; 20W/TRX; 40W/TRX UMTS: 20W/C; 40W/C LTE: 20W/TxPort and 40W/TxPort	
3	Vodafone	UK	UMTS	1T2R	40W	Mainly 40W
		Germany	UMTS	1T2R	20W,40W	40W
4	France Telecomm	D.R.Congo	GSM, UMTS, LTE-TDD	GSM: 1T2R, UMTS: 1T2R, LTE: 2T2R	GSM: 15W/ TRX UMTS: 20W/ Carrier LTE: 40W/ Carrier	GSM 100% 60W (S444) UMTS 100% 40W (S222) LTE 100% 40W (S111)
5	Optus	Australia	UMTS	2T2R	2x40W and 2x60W	
6	TeliaSonera	Europe	UMTS	2T2R	2x60W	
7	LTC	Laos	UMTS	1T2R	20W,30W,60W	30%-20W, 30%-30W, 40%- 60W
8	AIS	Thailand	UMTS	1T2R	20W and 40W	40W in suburban
9	O2	Germany	UMTS	1T2R	40W	Mainly 40W