Height Above Average Terrain (HAAT). Height of the center of the radiating element of the antenna above the average terrain. See § 90.309(a)(4) for calculation method.

Personal Communications Services (PCS). A very broadly defined and flexible radio service that encompasses a wide array of mobile and ancillary fixed communications on frequencies in the 901-902 MHz, 930-931 MHz, 940-941 MHz, 1850-1895 MHz, and 1930-1975 MHz bands. This includes all types of voice or data services to be provided to all segments of the U. S. economy.

Subpart B - Applications and Licenses

§ 99.11 Scope.

This subpart contains procedures and requirements for filing applications for licenses to operate radio facilities in the Personal Communications Services. Part 1 of the Commission's rules contain additional applicable rules governing forms (§ 1.922), fees (§ 1.1102), processing procedures (§ 1.953), special temporary authority (§ 1.925), assignment or transfer of control (§ 1.924), and environmental impact (§ 1.1301). Unlicensed PCS devices are governed by Part 15 of the Commission's rules. Part 17 contains applicable rules regarding tower lighting (§ 17.7 - 17.17)

§ 99.13 Eligibility.

Any entity, excluding a foreign government or a representative of a foreign government, is eligible to hold a license under this part. No wireline common carrier is eligible to be licensed in this Part to provide PCS in the same geographic area in which it provides local exchange telephone service. No Cellular Radio Service licensee is eligible to be licensed in this Part to provide PCS in the same geographic area in which it or any affiliate provides cellular service.

§ 99.15 License Term.

Licenses for PCS stations will normally be issued for a term of ten years from the date of original issuance, modification, or renewal.

Subpart C - Technical and Operating Requirements

§ 99.401 Scope.

This subpart sets forth the technical requirements for use of the spectrum and equipment in the radio services governed by this part. Such requirements include frequency channelizations and

standards for equipment authorization, transmitter power, antenna height, and signal strength. Included in this subpart are interference criteria for co-channel operations, including other services authorized for the same spectrum.

§ 99.403 Equipment authorization.

Each transmitter utilized for operation under this part and each transmitter marketed as set forth in § 2.803 of Part 2 must be of a type that is included in the Commission's current Radio Equipment List as authorized under the type acceptance procedure for use under this part; or, of a type that has been authorized by the Commission for use under this part in accordance with the procedures in paragraph (b) of this section.

(a) The Commission periodically publishes a list of equipment entitled "Radio Equipment List, Equipment Accepted for Licensing." Copies of this list are available for public reference at the Commission's offices in Washington, D. C., and at each of its field offices.

(b) Any manufacturer of radio transmitting equipment to be used in these services may request equipment authorization following the procedures set forth in Subpart J of Part 2 of this chapter. Equipment authorization for an individual transmitter may be requested by an applicant for a station authorization by following the procedure set forth in Part 2. Such equipment if approved or accepted will not normally be included in the Commission's Radio Equipment List but will be individually enumerated on the station authorization.

§ 99.405 Frequencies.

Licensed personal communications radio services will be authorized in the 901-902 MHz, 930-931 MHz, 940-941 MHz, 1850-1895 MHz, and 1930-1975 MHz bands. Licenses under this part will be issued based on the following channelizations:

(a) <u>Block I</u>
1850-1865 MHz (base stations)
1930-1945 MHz (mobile/portable stations)

(b) <u>Block II</u>
1865-1880 MHz (base stations)
1945-1960 MHz (mobile/portable stations)

(c) <u>Block III</u>
1880-1895 MHz (base stations)
1960-1975 MHz (mobile/portable stations)

(d) Block IV
901-902/940-941 MHz
(subdivided into 50 kHz spectrum blocks for narrowband operations using various channel bandwidths)

(e) Block V
930-931 MHz
(subdivided into 50 kHz spectrum blocks for narrowband operations using various channel bandwidths)

§ 99.407 Power/antenna height limits.

Power and antenna height limits are specified for the various frequency bands as follows:

(a) 1850-1895, 1930-1975 MHz:

[See text at paragraphs 115 and 116 for power and antenna height limits options.]

(b) 901-902, 930-931, and 940-941 MHz nationwide operations:

Base stations - 3500 watts (ERP); no antenna height limit.

Mobile/portable stations - maximum 7 watts (ERP); mobile/portable equipment must have built-in capability to automatically limit radiated power to the minimum necessary for successful communication with the associated base station.

(c) 901-902, 930-931, and 940-941 MHz regional operations:

Base stations - No greater than 1000 watts (ERP) and 305 m (1000 ft) above average terrain (AAT), or the equivalent thereof determined from the following table:

Antenna Height Above Average Terrain in meters (feet)	Effective Radiated Power (ERP) (watts)
Above 1372 (4500)	65
Above 1220 (4000) to 1372 (4500)	70
Above 1067 (3500) to 1220 (4000)	75
Above 915 (3000) to 1067 (3500)	100
Above 762 (2500) to 915 (3000)	140
Above 610 (2000) to 762 (2500)	200
Above 457 (1500) to 610 (2000)	350
Above 305 (1000) to 457 (1500)	600
305 (1000) and below	1000

For AAT's between the values listed in the table, linear interpolation should be used. For reliable service area requirements less than 32 km (20 mi.) see Section 90.635(c), Table 4.

Mobile/portable stations - maximum 7 watts (ERP); mobile/portable equipment must have built-in capability to automatically limit radiated power to the minimum necessary for successful communication with the associated base station.

§ 99.409 Field strength limits for the 1850-1895 MHz and 1930-1975 MHz bands.

Each licensee of a personal communications system shall operate its system in such a way as to limit:

(a) The field strength at its service area boundary to a median value of 47 dBu,

(b) The total PCS power available at the receiver terminals of any OFS station to that specified in Section 94.63 of this Chapter, unless there is prior agreement with the affected OFS licensee. The determination of the PCS power at the OFS receiver must include the sum of the power from all transmitters authorized to operate on the licensee's personal communications system. PCS applicants must demonstrate compliance with this criteria with regards to OFS stations within the coordination distance set forth in Table 1.

Table 1

Coordination Distances In Kilometers (Miles)

EIRP	PCS Antenna Height in Meters (Feet)				
(Watts)	90(295)	120(394)	150(492)	300(984)	600(1969)
10	201(125)	206(128)	211(131)	225(140)	246(153)
20	228(142)	233(145)	237(147)	251(156)	274(170)
50	262(163)	267(166)	272(169)	286(178)	309(192)
100	290(180)	294(183)	298(185)	314(195)	336(209)
200	315(196)	320(199)	325(202)	339(211)	364(226)
500	351(218)	356(221)	359(223)	375(233)	399(248)
1000	377(234)	381(237)	386(240)	402(250)	425(264)

§ 99.411 Emission limits for the 901-902 MHz, 930-931 MHz, and 940-941 MHz bands.

(a) The power of any emission shall be attenuated below the unmodulated carrier power (P) in accordance with the following schedule:

(1) On any frequency in the authorized bandwidth and removed from the edge of the authorized bandwidth by a displacement frequency (f_d in kHz) of 0 kHz to 5 kHz: at least 83 Log_{10} ((10-f_d)/ 5) decibels;

(2) On any frequency outside the authorized bandwidth and removed from the edge of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 0 kHz up to and including 200 percent of the authorized bandwidth: at least 116 Log_{10} ((f_d + 10)/6.1) decibels or 50 plus 10 Log_{10} (P) decibels or 70 decibels, whichever is the lesser attenuation;

(3) On any frequency outside the authorized bandwidth and removed from the edge of the authorized bandwidth by more than 200 percent of the authorized bandwidth: at least 43 plus 10 Log_{10} (output power in watts) decibels or 80 decibels, whichever is the lesser attenuation.

Note: The measurements of emission power can be expressed in peak or average values provided they are expressed in the same parameters as the unmodulated transmitter carrier power.

(b) When an emission outside of the authorized bandwidth causes harmful interference, the Commission may, at its discretion, require greater attenuation than specified in this section.

§ 99.413 Emission limits for the 1850-1895 MHz and 1930-1975 MHz bands.

(a) On any frequency outside of these frequency bands, the power of any emission shall be attenuated below the unmodulated carrier power (P) by at least 43 plus 10 log_{10}(P) decibels or 80 decibels, whichever is the lesser attenuation.

Note: The measurements of emission power can be expressed in peak or average values provided they are expressed in the same parameters as the unmodulated transmitter carrier power.

(b) When an emission outside of the authorized bandwidth causes harmful interference, the Commission may, at its discretion, require greater attenuation than specified in this section.

§ 99.415 Service areas.

[See service area proposals in paragraph 60.]

§ 99.417 Co-channel separation criteria for regional channels in the 901-902, 930-931, and 940-941 MHz bands.

Based on the reliable service area in Section 99.413, the minimum distance separation between regional base stations in these bands is 112 km (70 mi.).

§ 99.419 Frequency stability requirements for the 901-902, 930-931, and 940-941 MHz bands.

The frequency stability of the transmitter shall be maintained within ± 0.0001 percent of the center frequency over a temperature variation of -30 degrees to +50 degrees C at normal supply voltage, and over a variation in the primary supply voltage of 85% to 115% of the rated supply voltage at a temperature of 20 degrees C.

(1) For battery operated equipment, the equipment tests shall be performed using a new battery without any further requirement to vary supply voltage.

(2) It is acceptable for a transmitter to cease functioning outside of a narrower temperature range as long as it complies with the frequency stability requirements within the temperature range over which it operates.

§ 99.421 Frequency stability requirement for 1850-1895 MHz and 1930-1975 MHz bands.

The frequency stability shall be sufficient to ensure that the fundamental emission stays within the band of operation.

Appendix B: Companies Holding A PCS Experimental License

ADELPHIA CABLE COMMUNICATIONS
ADVANCED CORDLESS TECHNOLOGIES
ADVANCED MOBILECOM TECHNOLOGIES, INC.
ADVANCED WIRELESS COMMUNICATIONS, INC.
ALLTEL SERVICE CORPORATION
AMERICAN PERSONAL COMMUNICATIONS, INC.
AMERICAN PORTABLE TELECOMMUNICATIONS, INC.
AMERICAN TELEPHONE & TELEGRAPH CO
AMERICAN TELEZONE
AMERITECH DIRECT COMMUNICATIONS, INC.
ASSOCIATED PCN CORPORATION
ATLANTIC COMMUNICATIONS ENTERPRISES
ATLANTIC CELLULAR CO., LP
BARDEN COMMUNICATIONS, INC.
BELL ATLANTIC MOBILE SYSTEMS, INC.
BELLSOUTH SERVICES, INC.
BELLSOUTH ENTERPRISES, INC.
BISHOP CLARKSON MEMORIAL HOSPITAL
BNR, INC.
BUCKEYE CABLEVISION, INC.
CABLE TV OF EAST PROVIDENCE, INC.
CABLE USA, INC.
CABLEVISION
CAPITOL NETWORK SYSTEM, INC.
CASCO CABLE TELEVISION, INC.
CELLULAR 21 INC.
CELLULAR DATA, INC.
CELLULAR GENERAL INC.
CELLULAR SERVICES, INC.
CENCOM CABLE ASSOCIATES, INC.
CENTURY PERSONAL ACCESS NETWORK, INC.
CHRONICLE CABLEVISION OF HAWAII
CINCINNATI BELL TELEPHONE CO
CITIZENS UTILITIES CO. OF CA
CITY SIGNALS INC.
COMCAST PCS COMMUNICATIONS, INC.
CONCORD TV CABLE
CONDOR COMMUNICATIONS, INC
CONTINENTAL CABLEVISION OF CALIFORNIA, INC.
CONTINENTAL CABLEVISION OF JACKSONVILLE, INC.
CONTINENTAL CABLEVISION OF MASSACHUSETTS, INC.
COX ENTERPRISES, INC.
CYLINK CORPORATION
DIAL PAGE, LP
DIGITAL SPREAD SPECTRUM TECHNOLOGIES, INC.
EASYPHONE, INC.
ELECTRIC LIGHTWAVE, INC.
ERICSSON PAGING SYSTEMS, INC.
ESSEX COMMUNICATIONS PARTNERS
FREEMAN ENGINEERING ASSOCIATES, INC.

GENERAL INSTRUMENT CORP.
GEORGIA INSTITUTE OF TECHNOLOGY
GOEKEN CUSTOM COMMUNICATIONS, INC.
GTE MOBILE COMMUNICATIONS
HEWLETT PACKARD COMPANY
INLAND VALLEY CABLEVISION
INTERMEDIA COMMUNICATIONS OF FLORIDA, INC.
JONES LIGHTWAVE, LTD.
LAS CRUCES TV CABLE
LDH INTERNATIONAL, INC.
LINKATEL COMMUNICATIONS, INC.
LITEL TELECOMMUNICATIONS CORP.
MATRIX PERSONAL COMMUNICATIONS, INC.
MCCAW CELLULAR COMMUNICATIONS, INC.
MEDIA GENERAL CABLE OF FAIRFAX COUNTY, INC.
METROPOLITAN FIBER SYSTEMS OF BALTIMORE
METROPOLITAN FIBER SYSTEMS OF CHICAGO, INC.
METROPOLITAN FIBER SYSTEMS/MCCOURT, INC.
METROPOLITAN FIBER SYSTEMS OF SAN FRANCISCO
MICRONET, INC.
MONTEREY PENINSULA TV CABLE
MOTOROLA, INC.
MTEL PCN, INC.
NAC, INC.
NEW CHANNELS CORPORATION
NEW YORK STOCK EXCHANGE
NOVATEL COMMUNICATIONS, INC.
NYNEX SCIENCE AND TECHNOLOGY
OMNI-POINT DATA COMPANY, INC.
ONE WORLD TELECOMMUNICATIONS, INC.
PATHFINDER VENTURES, INC.
PCN AMERICA, INC.
PCN COMMUNICATIONS, INC.
PCS NETWORK, INC.
PERSONAL COMMUNICATIONS NETWORK SERVICES OF NEW YORK, INC.
PERTEL, INC.
PRIME II MANAGEMENT, INC.
QUALCOMM, INC.
RESEARCH RESOURCES INTERNATIONAL, INC.
RIM COM CORP.
ROLM SYSTEMS
SAN MARCOS TELEPHONE CO, INC
SATCOM, INC.
SCS MOBILECOM, INC.
SHARECOM-AUSTIN, LP
SOUTHWESTERN BELL PERSONAL COMMUNICATIONS, INC.
SUBURBAN CABLEVISION, INC.
TEL/LOGIC INC.
TELE-FINANCING CORP., INC.
TELECABLE CORPORATION
TELEPOINT PERSONAL COMMUNICATIONS, INC
TELESIS TECHNOLOGIES LABORATORY, INC.

THE ZN GROUP, INC.
TIME WARNER CABLE GROUP
TIMEX COMMUNICATIONS CORP.
UNICELL CORPORATION
UNITED ARTISTS CABLE CORPORATION
USA MOBILE COMMUNICATIONS, INC. II
US WEST COMMUNICATIONS, INC.
VANGUARD CELLULAR SYSTEMS, INC.
VENTURA COUNTY CABLEVISION
VIACOM INTERNATIONAL INC.
VISTA-UNITED TELECOMMUNICATIONS
WESTERN TV CABLE
WOMETCO CABLE TV OF GA, INC
YORK CABLE TELEVISION, INC.

Appendix C: 900 MHz Pioneer's Preference Proposals In Docket 92-100

Petitioner	Total Requested Spectrum	Individual Channel Bandwidth	Number of Providers/ Spectrum per Licensee	Service Applications
Dial Page	75 kHz	25 kHz	3 regional 25 kHz/licensee	1-way acknowledgment-paging; 2 watt units
Echo	300 kHz	5 kHz	3 nationwide 3 local 50 kHz (10 chnls) per licensee	2-way data; emergency radiolocation & tracking; medical & environmental emergency, handicapped, personal & other commercial
Freeman	*	150 kHz fwd 56 kHz back	*	2-way; tone alert, digital readout, voice, alpha-numeric, extended text messaging
Global	150 kHz	25 kHz	3 regional 3 nationwide 25 kHz/licensee	1-way; facsimile, tone-only, numeric, alphanumeric, text
Metriplex	1 MHz	25 kHz 50 kHz pairs	*	1-way; tone only, numeric, alphanumeric, data & paging with acknowledgement
MobileComm	*	50 kHz	nationwide 50 kHz/licensee	verified transmission of messages, E-mail, and other data without full 2-way capabilities at high data rates
Montauk	100 kHz	25 kHz	2 nationwide 1 or more local 25 kHz/licensee	1-way facsimile-broadcasting; messages, news, stock reports, traffic conditions, etc.
Mtel	150 kHz	50 kHz	2-3 nationwide 50 kHz/licensee	2-way data & messaging; also includes 1-way & acknowledgment paging

*** not specified**

900 MHz Pioneer's Preference Proposals (continued)

Petitioner	Total Requested Spectrum	Individual Channel Bandwidth	Number of Providers/ Spectrum per Licensee	Service Applications
PacTel (advanced architecture paging)	*	25-50 kHz	*	1-way; digitized voice, lengthy alphanumeric messages, E-mail, video, facsimile, low & high resolution graphics
PacTel (ground-to-air paging)	75 kHz	25 kHz	nationwide 25 kHz/licensee	1-way; complements air-to-ground radiotelephone services
PageMart	800 kHz	25 kHz	2 nationwide 2 local 10 chnls/licensee 6 chnls/licensee	2-way messaging service; digitized voice & data (respectively)
Paging Network	1 MHz	25 kHz	2 nationwide 2 local 250 kHz/licensee	1-way voice paging; pager contains message storage capability
Skycell	25-50 kHz	25 kHz	1 or 2 nationwide 25 kHz/licensee	control & management for CT-2/Telepoint

*** not specified**

APPENDIX D: ANALYSIS OF ALTERNATIVE LICENSING PROCEDURES

This appendix briefly describes and compares comparative hearings, lotteries and competitive bidding .[118]

Description

Comparative Hearings. Until 1982, administrative hearings were the Commission's primary way of selecting among competing applicants. Depending on the level of review, either an administrative law judge, the Review Board or the full Commission would evaluate applicants under comparative criteria.

Two major problems with the comparative hearings process are cost and delay. It is not uncommon for litigation to take years, with participants incurring huge legal bills. These long litigation periods harm both the applicant ultimately selected and the public. The new licensee loses an income stream; the public is without an additional service. But because delay favors existing licensees, they have strong incentives to file petitions to deny or otherwise utilize the administrative process as a means of retarding competitors' entry.

There is also considerable doubt as to whether using comparative hearings for non-broadcasting services furthers the public interest. It has proved difficult to agree on what the comparative criteria should be and how they should be weighted. Moreover, if licenses are freely transferable, the ultimate licensee may not be the party that the Commission has deemed the most worthy.

Lotteries. In 1982 Congress authorized award of licenses by random selection. The private sector was quick to respond to the new selection procedure. "Application mills" soon offered a standard completed application at modest cost. Because application costs were low and the licenses valuable, the FCC received large numbers of speculative applications, imposing a major administrative cost. Moreover, the number of applications has continued to increase. For example, in 1984 there were over 5,000 applications filed for cellular licenses in metropolitan markets 91-120 (ranked by size). Despite the FCC tightening application requirements in hopes of reducing speculation, there were approximately 92,000 applications filed in 1986 for cellular

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[118]This section draws extensively from Evan Kwerel and Alex Felker, "Using Auctions to Select FCC Licensees," Legal Times, September 22, 1986, p. 14, and Evan Kwerel and Alex Felker, Using Auctions to Select FCC Licensees, FCC, Office of Plans and Policy, Working Paper 16, May 1985.

licenses in metropolitan markets 121-305. Between July 1988 and January 1989 the Commission received about 288,000 applications for 428 rural markets.

In subsequent lotteries the Commission has taken several measures to reduce the number of speculative applications. For example, in May 1991, when proposing the use of a lottery to select land mobile licenses in the 220 MHz band, the Private Radio Bureau: (1) opened the filing window two days after notice appeared in the Federal Register; (2) considered applications to be mutually exclusive only if received on the same day;[119] (3) set filing fees at $35 for local licenses, $12,250 for 5-channel national blocks, and $24,500 for 10-channel national blocks; and (4) limited resale. Despite these provisions, the Commission received over 59,000 applications. One firm filed over ten thousand of these applications, and approximately sixty percent of all applications were submitted by just ten firms. It would not have been possible to file so many applications in such a short period if application mills had not widely advertised and made prior arrangements with their clients to submit applications as soon as the filing window opened.

Competitive Bidding. A third possible selection method is a competitive bidding system, whereby licenses are awarded to those users willing to pay the most for them. Competitive bidding has been used to award spectrum licenses in New Zealand and the United Kingdom. Although it has never been used to award FCC licenses, federal government experience with competitive bidding is longstanding and extensive. For example, the U.S. Department of the Interior has been using competitive bidding since 1953 to award leases on oil and natural gas tracts in the Outer Continental Shelf.

In 1989, New Zealand passed an Act of Parliament that provides for awarding radio spectrum licenses by competitive bidding. Licenses that have been awarded by competitive bidding include (1) seven national and several regional UHF TV channels; (2) three nationwide licenses in cellular telephone bands; (3) various local AM and FM broadcast channels; (4) 12 MDS channels for video distribution services.[120]

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[119]This had the effect of inducing the vast majority of applicants to file on the first day the Commission opened the filing window.

[120]Shafi, Milner, Barry, Gardenier, "Experience with Spectrum Tendering in New Zealand," IEEE, 1991, pp. 725-729.

Comparison Of Selection Procedures

Effect On Ownership. The initial selection method will generally have little effect on the ultimate distribution of license ownership if unrestricted resale of licenses is permitted. Currently, there are relatively few restrictions on resale and there has been considerable trading of licenses. Thus in the long run, the ownership distributions would be about the same under all three methods of selecting licensees. One implication of this conclusion is that the potential for monopolizing the spectrum would be no greater under competitive bidding than under the current selection methods.

Delay In Making Assignments. Delays in choosing licensees deprives the public of communications services. Comparative hearings are likely to have the greatest delays. Even the streamlined hearings used to grant cellular radio licenses in the top 30 markets averaged 18 months. Delays have also been experienced in selecting licensees through lotteries because of the large numbers of applicants. Processing delays are estimated to average 12 months. On the other hand, competitive bidding will attract fewer applicants than lotteries because the winner of a competive bidding must pay for the license. Thus, administrative delays are likely to be shorter under competitive bidding once operational.

Private And Social Application Costs. With free entry and full information, the total private expenditures made in an effort to acquire a license would be approximately equal to the value of the license. (For example, if a license were worth $100 and it cost each applicant $10 to prepare and file a lottery application, there would be 10 applicants. If there were fewer applicants, the expected gain of applying would exceed the cost and more would apply.) So from the private perspective the total expenditures will be about the same under all three selection systems. But from the social perspective the costs of competitive bidding will be less. Under comparative hearings or lotteries applicants must use real resources to increase their probability of winning a license -- primarily the time of lawyers, and engineers in preparing "better" or more applications. Under competitive bidding, however, applicants must be willing only to transfer more resources (in the form of a higher bid) in order to increase their chance of winning. Thus, competitive bidding would reduce the real resources used in applying for a license by approximately the amount of the winning bid.

FCC cost of administering selections. Government administrative costs are a small component of total social costs of selecting licensees. Comparative hearings are likely to be most costly, competitive bidding least costly.

Constraints on the ability of the Commission to hire additional staff to expedite licensing could increase the social costs, especially if comparative hearings are used. With a fixed budget, conducting comparative hearings would either take a long time, or could significantly divert resources from other FCC activities, thereby delaying the benefits to the public of improved regulation in other areas of telecommunications.

Other Considerations. Competitive bidding has additional benefits. It would generate information on the value of spectrum in alternative uses that the Commission could use in future spectrum allocation proceedings. In addition, competitve bidding would give taxpayers a return for the value conferred in a license. On the other hand, some argue that competitive bidding would make it more difficult for smaller firms to obtain licenses. This would depend upon the ease with which financing could be obtained in the capital markets.

This analysis suggests that competitive bidding is superior or equivalent to lotteries and comparative hearings in all respects. All methods would ultimately assign a license to the user who values it most, but competitive bidding would do so more quickly. It would reduce the FCC's cost of administering selections, and most importantly would reduce the real private resources expended in seeking licenses.

APPENDIX E: ISSUES IN IMPLEMENTING COMPETITIVE BIDDING

If Congress were to authorize use of competitive bidding to select licensees, in implementing this authority we necessarily would have to address the following issues that relate to the design of the competitive bidding procedure.

Bidding Method. One option would be to award licenses by sealed bids. The high bidder (who meets all qualifications) would be awarded the license and pay the amount bid. Another option would be oral bidding.

Sealed bidding is simple to administer and less subject to manipulation by bidders than oral bidding. The most serious form of manipulation takes place when parties get together before the bidding and agree on who will win. Such collusion reduces the return to the seller since the party designated to win could submit a bid well below the value of the item without risk of being outbid.

Collusion is more difficult under sealed bidding for two reasons. First, under sealed bidding colluding parties run a greater risk of an unknown competitor outbidding them. If such a party were to show up at an oral bidding, the colluding parties would be able to respond by raising their bids and thereby avoid losing. Second, the colluders run the risk of losing the bidding to a firm reneging on its agreement. The breach of agreement would not be discovered until the bidding was closed. Punishment of such a firm would need to either take place outside of the bidding process or wait until the next bidding.

Another advantage of sealed bidding is that it will generally provide a greater return to the Government if there is only a single bidder. In an oral bidding, a party will know whether he is the only bidder and if so, he could win the bidding by submitting the minimum permitted bid. On the other hand, in a sealed bidding, a party cannot be sure of being the only bidder, so the applicant is more likely to submit a bid closer to the party's value of the item.

Oral bidding, however, has several advantages over the standard sealed bid procedure. First, oral bidding may be more likely to assign a license to the party who values it the most. Assuming bidders do not collude, the party most willing to pay would ultimately outbid all other parties in an oral bidding. The price the party would pay would be approximately the value placed on the item by the bidder with the second highest willingness to pay. In a standard sealed bid procedure, the price paid is the high bid. Parties may shade their bids below the maximum amount they are willing to pay in order to avoid paying more than necessary to win the bidding. In other words, the winner desires its bid to be only slightly more than the next highest bid. Since

in a sealed bidding procedure bidders do not know precisely how much other parties will bid, it is possible that the bidder with the highest willingness to pay may not submit the highest bid. If this occurred, either the license would remain with a party who does not value it the most or additional transaction costs would be incurred in reselling the license. The second advantage of oral bidding is that it may have lower private costs than sealed bidding because it does not require estimation of the value other bidders place on the item.

Sequence of Bidding. Competitive bidding could be used to determine whether to issue regional or national licenses. One way to achieve this would be through a two step process. For the 2 GHz spectrum, for example, we could first offer blocks of spectrum in the 2 GHz bands for regional licenses, with the winning bids announced for each block before proceeding to the next block. Then we could offer some of the blocks for nationwide bids. If the winning nationwide bid on a block is greater than the total of the winning regional bids for that block, a nationwide license would be awarded. The high bid for the first nationwide block would be announced before putting other blocks up for nationwide bids.

For the bidding on regional licenses within each block, we could allow parties to place simultaneous independent bids on several licenses. We could also allow them to specify a limit on their aggregate bid to avoid winning more licenses than they can finance.

Another option is sequential bidding for each regional license within each block. Under sequential bidding, whether oral or by sealed bid, the amount bid in later rounds can reflect what licenses have been acquired in earlier rounds. This is likely to be better than simultaneous independent bidding in allowing bidders to express the dependence of a license's value on what other licenses are held. Sequential bidding, however, does not necessarily assure that groups of licenses are assigned to their highest valued use.[121] For example, with sequential bidding a firm's bid in the early rounds would not be able to reflect whether the firm was able to acquire contiguous licenses in later rounds. The main drawback of sequential bidding is the delay if used to award large numbers of licenses by sealed bid.

Another option is to permit applicants to make simultaneous contingent bids for as many regional licenses as they wish. Each buyer could submit bids for each subset of licenses. This would provide bidders with flexibility in defining the scope of the territory they desire to serve. Such a bidding, however, would

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[121]John Riley and William Samuelson, "Optimal Auctions," American Economic Review, (June 1981), p. 389.

require the FCC to develop a complex rule for determining who wins which licenses and at what price. Such a system would be extremely complex to administer.

Another option is to allow bidding on a limited number of additional groupings per block. For example, one could first take bids on individual regional licenses, then on these grouped into larger regions, and finally on a nationwide license which is the aggregation of the regional licenses.

Minimum Bid Requirements. Setting a "reservation" price below which the license will not be awarded could increase the government's expected return by inducing some buyers to raise their bids.[122] The benefits of setting a reservation price are likely to be greatest when there are very few bidders. When competition is intense the benefits of setting a reservation price may not be worth the cost. Setting a refusal price would require estimating the value of the license, which may be difficult and time consuming. Developing and implementing a procedure to use this estimate in calculating the minimum bid could further delay the initial bidding date. Moreover, if no bids exceeded the minimum bid, the Commission must wait some interval before it could put the license up for bids a second time. Meanwhile, the public would lose the benefits of the services that could be provided with the spectrum.

Payment Method. There are various methods of receiving payment from winning bidders. One option would be to allow payment over a three year period. Allowing installment payments is equivalent to extending credit to the winner. This would reduce the amount of financing needed by a prospective licensee. It has been argued that this would allow greater participation in bidding by small businesses. Another option would be to require the winner to pay the entire amount of the bid in one payment. This would leave financing to the private sector, and for the smaller business perhaps to private credit backed by a government agency.

A third option would be a combination of up-front payment and royalties. If the royalties are based on the output or revenues of the winning firm, they will act as a tax on incremental production and therefore tend to reduce output. This distortion must be weighed against the possible benefit of risk sharing with the government. If PCS is a highly risky business and the government (taxpayers) is (are) better able to bear risk than the firm (shareholders) there may be an advantage having some portion of the payment in the form of a royalty. A system of an up-front payment and royalties at a fixed rate is used by the Department of the Interior for outer continental shelf oil and gas leases.

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[122]See Riley and Samuelson, 1981.

Deposit And Other Requirements For Entering Bid. There are a number of methods to prevent frivolous bids. If the winning bidder is unable to pay, the license would need to be reissued, thus delaying service to the public. One option would be to require that a 25% deposit be submitted with each bid.[123] These deposits could be refunded to losing bidders, but forfeited by winning bidders who fail to comply with purchase terms. If bids on multiple licenses are submitted, the deposit could be 25% of the bidder's self specified aggregate bid limit. The deposit could be forfeited by winning bidders unable to make the first installment of the three payments.

License Renewal. Competitive bidding might be employed only for awarding initial licenses and we could establish the same renewal procedures and expectancy for PCS licenses as for cellular. If we were to use competitive bidding for license renewals, however, the renewal expectancy relative to that for most FCC licenses would be reduced. This could tend to discourage investment in equipment, training, and marketing that is tied to the license.[124]

Organization Conducting The Competitive Bidding. One option for conducting the competitive bidding process would be the FCC. Other options include contracting to another government agency with experience in the administration of a competitive bidding process, or to a private securities firm with such experience. We believe that the Commission would be able to conduct a simple sealed bid procedure on its own. However, if oral bidding is to be used, it may be desirable to contract with a private firm. Private firms might also be better able to publicize the bidding. This could increase the number of bidders, thereby increasing the likely revenues.

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[123]This would be the same as used in New Zealand's spectrum license auctions. See Shafi, Milner, Barry, Gardenier, "Experience with Spectrum Tendering in New Zealand," IEEE, 1991, p. 727.

[124]The source of this problem is the lack of certainty as to the identity of the licensee at the expiration of a given license. If, for example, licensee A knew that at the end of ten years his license would go to party B, it would be possible for A to negotiate with B before making investments tied to the license. But if the license is just put up for auction at the end of 10 years, there is no one for licensee A to negotiate with prior to investing. If he invests anyway, and then negotiates with the winner of the license, he will be in a very weak bargaining position since at that point his investment will have little or no value without the license.

Appendix F

PCS-Fixed Microwave Interference Calculations

We propose that the permissible non-desired signal level at each operational fixed microwave receiver be based on Section 94.63 of our rules and on procedures described in EIA/TIA Bulletin TSB10-E. Specifically, we propose to require each PCS licensee to calculate the total PCS power level from both co-channel and adjacent channel operations at each microwave receiver within 200 km (125 miles) of each proposed PCS base station by summing the contributions from each PCS base, mobile and portable unit.

Interference from a proposed PCS system to existing microwave receivers shall be calculated as follows:

Base Stations. For each microwave receiver to be considered, calculate the PCS signal level (in milliwatts) at the receiver's input from each PCS base station. Assuming straight power addition of the PCS signals, the total PCS power level from PCS base stations at the receiver input is the total of the contributions of each PCS base station. The methods employed to perform path loss calculations shall follow generally acceptable good engineering practices. Procedures developed by the Electronic Industries Association, as described in EIA/TIA Telecommunications Systems Bulletin TSB10-E, will be acceptable. We recognize that there is no general agreement on all aspects of these calculations; therefore we seek comment on these methods and on alternatives.

Mobile Stations. The contribution from the mobile stations is determined by first calculating an equivalent effective isotropic radiated power (EIRP) for the mobiles nominally associated with each base station. Assume straight power addition in making this calculation, 100 mobile units each with an EIRP of 0.1 watt, e.g., would be assumed to have an equivalent EIRP of 10 watts. Then using the equivalent EIRP and an antenna height of 5 feet, calculate a PCS mobile signal level for the cell associated with each base station at the receiver input of each microwave receiver. Find the total input signal level from the mobile stations at the microwave receiver by summing the signal level of all the cells, again assuming straight power addition.

In calculating path losses for the mobile units, an appropriate statistical propagation model shall be used instead of the point-to-point models used for the base station calculations. A statistical model is more appropriate for this purpose because path loss calculations are significantly affected by clutter in the vicinity of the low antenna--buildings, trees, etc., and even small variations in terrain elevation. The model used should at a minimum make allowance for the differences in path losses expected between urban and suburban areas.

Various models have been proposed by commenters in this proceeding. The Hata model,[125] based on the Okamura land mobile model,[126] has been suggested by some PCS experimenters. Others have questioned whether this model is appropriately accurate for these purposes, and several have proposed new models based on their own experimental data. Other models have being proposed in Europe, and the CCIR recently established a Task Group to study the issue. We seek comment concerning the appropriate model(s) for calculating propagation losses in urban and suburban built-up areas, especially those involving low antenna heights.

Portable Stations. The contribution from the portable stations should be determined using the same general procedures described for the mobile units. Calculate an equivalent EIRP for the portable units nominally associated with each base station. However, the equivalent portable EIRP should be weighted according to the estimated portion of portables associated with that cell expected to be operated inside buildings at any given time and the portion which could be expected to be operating from elevated locations, such as balconies or building rooftops. For example, in the case of a service intended for business use in an urban area, one might expect that perhaps 50% of the portables in use at any given time would be operating from within buildings and perhaps 5% might be operating from rooftops or balconies. In this case it would be assumed that the signals from those portables inside buildings would be subject to an additional 20 dB attenuation, while the contribution from those on rooftops and balconies or other exposed heights would be weighted upward by an amount based on the average building height. The equivalent EIRP for cells in suburban areas might involve different weighting criteria. Contributions to the EIRP from that portion of portables within a cell operating from inside single-family homes would be considered to be attenuated by 10 dB. We seek comment concerning the use of weighting factors as described above, and the possible use of weighting factors associated with the proportion of portables expected to be operating at any given time.

Once an equivalent EIRP is established for the portables, the same propagation model used for the mobile units shall be used to calculate the receiver input from each cell at the microwave receiver. Again all the inputs from each cell should be summed,

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[125] See Masaharu Hata, "Empirical Formula for Propagation Loss in the Land Mobile Radio Service," IEEE Transactions of Vehicular Technology, Vol. VT-29, No. 3, August 1980.

[126] See Yoshihisa Okumura, et.al., "Field Strength and Its Variability in VHF and UHF Land-Mobile Radio Services," Review of the Electrical Communications Laboratory, Vol. 16, Numbers 9-10, October 1968.

assuming straight power addition, to determine the total input at each microwave receiver from the portable stations.

To determine the total PCS input to the microwave receiver, the contributions from the base, mobile, and portable stations should be summed using straight power addition.

Separate Statement of
Commissioner James H. Quello

RE: Amendment of the Commission's Rules to Establish New Personal Communication Services.

Today's action is a significant step forward in the process of making personal communication services (PCS) available to the public. Although I support this action, there are some aspects of this Notice that need additional attention. I am asking that participants in this proceeding address the specific concerns listed below.

The Commission recognizes that PCS is likely to be a family of services with a potential for a wide variety of applications. Without defining PSC more specifically than a family of services, the Commission is moving forward with specific proposals on PCS market size and eligibility. Such proposals, however, may have the unintended effect of limiting the full potential of PCS applications. Consequently, the Commission may be moving to structure the PCS market prematurely. Nonetheless, I recognize the need to move forward, and I encourage participants not only to address the proposals in the Notice, but also to present alternative proposals on PCS market size and eligibility criteria.

The Notice proposes four options for PCS service areas. One option not included in the Notice is the 734 cellular licensing areas. Cellular licensing areas were recently used in determining markets for the Interactive Video and Data Services. (See 7 FCC Rcd 1630 (1992)) Since some PCS operators are likely to use microcellular technology, perhaps smaller service areas would be more appropriate. Furthermore, smaller service areas may facilitate delivery of PCS to rural areas in a timely manner. I encourage commenters to address the possible option of 734 PCS service areas.

This Notice is significant not only for what it proposes for PCS, but also for what it proposed to do to the cellular industry. In my opinion, the proposals affecting the cellular industry have the potential of radically changing the industry as we know it today. The net result of such proposals has the potential to allow telephone companies with cellular subsidiaries to do anything they choose with their 25 MHz cellular allocation. If there is an interest or need to restructure the cellular industry, then perhaps the Commission should consider issuing a separate proceeding in this matter.

Regarding licensing, the Notice proposes a 10 year license term for PCS. It appears that licensees' responsibilities depend on how licensees are selected. For example, if licensees are

selected under a lottery scheme, construction requirements may be imposed. Under the auction proposal, PCS licensees would have no requirements other than protecting existing 1.8-2.2 GHz licensees from interference. Since license terms are for 10 years, a decade could pass before the Commission reclaims a license granted under the auction proposal due to failure to construct. This approach is taking the flexible use of spectrum concept to new levels that may not necessarily be in the public interest. I look forward to commenters' views on this issue.

While on the subject of licensing, I encourage commenters to submit proposals designed to strengthen the lottery process. Construction requirements, financial showings and anti-trafficking provisions are just a few examples of how the lottery process can be improved. I believe sound lottery criteria will stem the tide of speculative applicants and the application mills.

Finally, regarding auctions or competitive bidding, I am not convinced that those with the deepest pockets always have the most innovative ideas, especially when it comes to technology. What effect do auctions have on those who create new spectrum efficient technologies, but are unable to afford to compete for spectrum? What will auctions do to America's entrepreneurs? Those favoring auctions argue that the dollar value of spectrum will flow directly to the national treasury. There is some truth in that statement. In the American economy, however, it is more likely that profits derived from private transactions would be reinvested in the private market, creating employment opportunities, thereby sustaining American industry. This economic scenario has the potential of serving broad segments of the public. Alternatively, the possibility of auctions coupled with the proposal for national licenses (as proposed in the Notice) suggests that winners will be interested in serving only the most lucrative markets. Is this trickle-down spectrum management? What happens to mid-sized and rural markets? Again, I am concerned about the ability of small businesses to compete for spectrum under an auction proposal. I am interested in commenters' views on the merits of auctions as well as the specific questions contained on how auctions should be structured, if Congress grants the Commission authority to test the auction concept.

July 16, 1992

STATEMENT OF
COMMISSIONER SHERRIE P. MARSHALL

Re: Amendment of the Commission's Rules to Establish New Personal Communications Services (GEN Docket No. 90-314 and ET Docket No. 92-100)

Today's decision is a milestone for U.S. manufacturers, entrepreneurs wishing to provide the public with new personal communications services (PCS) and the American consumer, who is always seeking newer, more efficient, and less expensive means of communicating. According to a recent demand study released by Telocator (the personal communications industry association), if the FCC licenses new PCS providers by 1994 there could be as many as 23.3 million new subscribers three years later. And the new services will be engineered to the individual, not to a car, house, desk or other similar physical location.

This Commission has learned from the costly delays and uneconomic licensing processes of the cellular experience. And I, for one, am determined not to repeat those mistakes again. We are striving to create a PCS marketplace that is open and competitive, where customers will be able to negotiate with multiple service providers to obtain the best rate and service possible.

Assuming there is sufficient spectrum, both new entrants and current telephone and cellular licensees should be able to provide PCS services. And, regardless of spectrum limits, we should ensure that incumbent cellular licensees have the flexibility to utilize their existing spectrum to offer PCS.

I am aware, of course, of the regulatory hurdles still facing the FCC. For example, I am especially interested in how we will classify this new service and how we can minimize the regulatory burdens on what promises to be a vigorously competitive wireless communications market. To assist the FCC in its task, I hope Congress will move swiftly to give the FCC auction authority for PCS spectrum. Our experience in the cellular arena confirms that, despite our best efforts to prevent speculators from "gaming" the process, abuses will occur.