ASSUMPTIONS

		Pres	Eng	F&A	Mkt	Total
1	Compensation - Headquarters					
	Executive #	1	1	1	1	4
	Executive $	125	90	75	75	365
	Staff #	1	2	3	2	8
	Staff $	30	125	120	80	355
	Total	155	215	195	155	720
	Compensation - Control Center					
	Staff #	0	4	0	0	4
	Satff $	0	250	0	0	250
2	In-orbit Insurance - % of annual installments		2%			

CD RADIO, INC.
Balance Sheet
(in millions)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Cash	2.25	11.03	7.81	3.89	36.00	83.73	124.42	167.37	215.12	267.53	326.17
Other Current Assets	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Current Assets	2.25	11.03	7.81	3.89	36.00	83.73	124.42	167.37	215.12	267.53	326.17
Communications Equipment	0.20	0.60	31.50	130.50	289.50	354.50	384.50	384.50	384.50	384.50	384.50
Accumulated Depreciation	-0.02	-0.07	-2.69	-13.57	-37.69	-67.23	-99.28	-131.32	-163.36	-195.40	-227.44
Organization Costs	0.50	1.00	1.50	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Accumulated Amortization	0.00	0.00	0.00	0.00	-0.40	-0.80	-1.20	-1.60	-2.00	-2.00	-2.00
Total Fixed Assets	0.68	1.53	30.31	118.93	253.41	288.47	286.03	253.58	221.14	189.10	157.06
TOTAL ASSETS	2.93	12.56	38.12	122.82	289.40	372.19	410.44	420.95	436.26	456.63	483.23
Accounts Payable	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Current Liabilities	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Current Liabilities	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Senior Debt	0.20	0.60	31.50	129.07	286.64	350.21	323.86	267.50	211.14	154.79	99.86
Subordinated Debt	0.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Working Capital Line	0.00	0.00	0.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Total Long-Term Liabilites	0.20	10.60	41.50	144.07	301.64	365.21	338.86	282.50	226.14	169.79	114.86
Total Liabilities	0.20	10.60	41.50	144.07	301.64	365.21	338.86	282.50	226.14	169.79	114.86

Common Stock	2.75	2.75	2.75	2.75	2.75	2.75	2.75	2.75	2.75	2.75	2.75
Retained Earnings	-0.02	-0.79	-6.13	-24.00	-14.99	4.23	68.83	135.70	207.37	284.10	365.62
Total Equity	2.73	1.96	-3.38	-21.25	-12.24	6.98	71.58	138.45	210.12	286.85	368.37
TOTAL LIABILITIES & EQUITY	2.93	12.56	38.12	122.82	289.40	372.19	410.44	420.95	436.26	456.63	483.23

	2001	2002	2003	2004	2005	2006
Cash	389.45	457.37	584.84	711.42	835.10	954.15
Other Current Assets	0.00	0.00	0.00	0.00	0.00	0.00
Total Current Assets	389.45	457.37	584.84	711.42	835.10	954.15
Communications Equipment	384.50	384.50	384.50	384.50	384.50	384.50
Accumulated Depreciation	-259.48	-291.51	-323.50	-352.92	-374.08	-382.00
Organization Costs	2.00	2.00	2.00	2.00	2.00	2.00
Accumulated Amortization	-2.00	-2.00	-2.00	-2.00	-2.00	-2.00
Total Fixed Assets	125.02	92.99	61.00	31.58	10.42	2.50
TOTAL ASSETS	514.47	550.36	645.84	743.00	845.52	956.65
Accounts Payable	0.00	0.00	0.00	0.00	0.00	0.00
Other Current Liabilities	0.00	0.00	0.00	0.00	0.00	0.00
Total Current Liabilities	0.00	0.00	0.00	0.00	0.00	0.00
Senior Debt	44.93	-10.00	-10.00	-10.00	-10.00	-10.00
Subordinated Debt	10.00	10.00	10.00	10.00	10.00	10.00
Working Capital Line	5.00	5.00	5.00	5.00	5.00	5.00
Total Long-Term liabilites	59.93	5.00	5.00	5.00	5.00	5.00
Total Liabilities	59.93	5.00	5.00	5.00	5.00	5.00

Common Stock	2.75	2.75	2.75	2.75	2.75	2.75
Retained Earnings	451.79	542.61	638.09	735.25	837.77	948.90
Total Equity	454.54	545.36	640.84	738.00	840.52	951.65
TOTAL LIABILITIES & EQUITY	514.47	550.36	645.84	743.00	845.52	956.65

Satellite CD Radio, Inc.
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Appendix 2

FCC Form 430
Common Carrier and Satellite Radio
Licensee Qualification Report

FCC 430

FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

Approved by OMB
3060-0105
Expires 3/31/90

COMMON CARRIER AND SATELLITE RADIO LICENSEE QUALIFICATION REPORT

See reverse side for information regarding public burden statement.

INSTRUCTIONS

A. The "Filer" of this report is defined to include: (1) An applicant, where this report is submitted in connection with applications for common carrier and satellite radio authority as required for such applications; or (2) A licensee or permittee, where this report is required by the Commission's Rules to be submitted on an annual basis.

B. Submit an original and one copy (sign original only) to the Federal Communications Commission, Washington, DC 20554. If more than one radio service is listed in Item 6, submit an additional copy for each such additional service. If this report is being submitted in connection with an application for radio authority, attach it to that application.

C. Do not submit a fee with this report.

1. Business Name and Address (Number, Street, State and ZIP Code) of Filer's Principal Office:

Satellite CD Radio, Inc.
TechWorld Plaza, Suite 750
Washington, D.C. 20001-8000

2. (Area Code) Telephone Number:
(202) 408-0080

3. If this report supercedes a previously filed report, specify its date:
N/A

4. Filer is (check one):
☐ Individual ☐ Partnership ☒ Corporation
☐ Other (Specify):

5. Under the laws of what State (or other jurisdiction) is the Filer organized?
Delaware

6. List the common carrier and satellite radio services in which Filer has applied or is a current licensee or permittee:

Private Satellite Carrier

7(a) Has the Filer or any party to this application had any FCC station license or permit revoked or had any application for permit, license or renewal denied by this Commission? *If "YES", attach as Exhibit I a statement giving call sign and file number of license or permit revoked and relating circumstances.* ☐ Yes ☒ No

(b) Has any court finally adjudged the Filer, or any person directly or indirectly controlling the Filer, guilty of unlawfully monopolizing or attempting unlawfully to monopolize radio communication, directly or indirectly, through control of manufacture or sale of radio apparatus, exclusive traffic arrangement, or other means of unfair methods of competition? *If "YES", attach as Exhibit II a statement relating the facts.* ☐ Yes ☒ No

(c) Has the Filer, or any party to this application, or any person directly or indirectly controlling the Filer ever been convicted of a felony by any state or Federal Court? *If "YES", attach as Exhibit III a statement relating the facts.* ☐ Yes ☒ No

(d) Is the Filer, or any person directly or indirectly controlling the Filer, presently a party in any matter referred to items 7(b) and 7(c)? *If "YES", attach as Exhibit IV a statement relating the facts.* ☐ Yes ☒ No

8. Is the Filer, directly or indirectly, through stock ownership, contract or otherwise, currently interested in the ownership or control of any other radio stations licensed by this Commission? *If "YES", submit as Exhibit V the name of each such licensee and the licensee's relation to the Filer.* See Exhibit V. ☒ Yes ☐ No

If Filer is an individual (sole proprietorship) or partnership, answer the following and Item 11:

9(a) Full Legal Name and Residential Address (Number, Street, State and ZIP Code) of Individual or Partners:

(b) Is individual or each member of a partnership a citizen of the United States? ☐ Yes ☐ No

(c) Is individual or any member of a partnership a representative of an alien or of a foreign government? ☐ Yes ☐ No

If Filer is a corporation, answer the following and Item 11:

10(a) Attach as Exhibit VI the names, addresses, and citizenship of those stockholders owning of record and/or voting 10 percent or more of the Filer's voting stock and the percentages so held. In the case of fiduciary control, indicate the beneficiary(ies) or class of beneficiaries.

See Exhibit VI.

(b) List below, or attach as Exhibit VII the names and addresses of the officers and directors of the Filer.

See Exhibit VII.

(c) Is the Filer directly or indirectly controlled by any other corporation? ☒ Yes ☐ No

If "YES", attach as Exhibit VIII a statement (including organizational diagrams where appropriate) which fully and completely identifies the nature and extent of control. Include the following: (1) the address and primary business of the controlling corporation and any intermediate subsidiaries; (2) the names, addresses, and citizenship of those stockholders holding 10 percent or more of the controlling corporation's voting stock; (3) the approximate percentage of total voting stock held by each such stockholder; and (4) the names and addresses of the president and directors of the controlling corporation.

See Exhibit VIII.

(d) Is any officer or director of the Filer an alien? ☐ Yes ☒ No

(e) Is more than one-fifth of the capital stock of the Filer owned of record or voted by aliens or their representatives, or by a foreign government or representative(s) thereof, or by a corporation organized under the laws of a foreign country? ☒ Yes ☐ No

(f) Is the Filer directly or indirectly controlled: (1) by any other corporation of which any officer or more than one-fourth of the directors are aliens, or (2) by any foreign corporation or corporation of which more than one-fourth of the capital stock is owned or voted by aliens or their representatives, or by a foreign government or representatives thereof. ☒ Yes ☐ No

(g) If any answer to questions (d), (e) or (f) is "YES", attach as Exhibit IX a statement identifying the aliens or foreign entities, their nationality, their relationship to the Filer, and the percentage of stock they own or vote. See Exhibit IX.

11. CERTIFICATION

This report constitutes a material part of any application which cross-references it, and all statements made in the attached exhibits are a material part thereof. The ownership information contained in this report does not constitute an application for, or Commission approval of, any transfer of control or assignment of radio facilities. The undersigned, individually and for the Filer, hereby certifies that the statements made herein are true, complete and correct to the best of Filer's knowledge and belief, and are made in good faith.

WILLFUL FALSE STATEMENTS MADE ON THIS APPLICATION ARE PUNISHABLE BY FINE AND IMPRISONMENT (U.S. Code, Title 18, Section 1001) and/or REVOCATION OF ANY STATION LICENSE OR CONSTRUCTION PERMIT (U.S. Code, Title 47, Section 312(a)(1)).	Date	Filer *(Must correspond with that shown in Item 1)*	Typed or Printed Name
	5/18/90	Satellite CD Radio, Inc.	Peter Dolan
	Signature		Title
			President

NOTICE TO INDIVIDUALS REQUIRED BY THE PRIVACY ACT OF 1974 AND THE PAPERWORK REDUCTION ACT OF 1980

The solicitation of personal information requested in this form is to determine if you are qualified to become or remain a licensee in a common carrier or satellite radio service pursuant to the Communications Act of 1934, as amended. No authorization can be granted unless all information requested is provided. Your response is required to obtain the requested authorization or retain an authorization.

Public reporting burden for this collection of information is estimated to average 2 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Federal Communications Commission, Office of Managing Director, Washington, DC 20554, and to Office of Management and Budget, Paperwork Reduction Project (3060-0105), Washington, DC 20503.

EXHIBIT V
OTHER RADIO STATION INTERESTS

Martin A. Rothblatt, who owns 100 percent of the stock of MARCOR which, in turn, owns 50 percent of the stock of Satellite CD Radio, Inc., owns stock in Geostar Corporation, a licensee in the Radiodetermination Satellite Service.

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EXHIBIT VI
STOCKHOLDERS OWNING OF RECORD AND/OR VOTING
10 PERCENT OR MORE OF THE FILER'S VOTING STOCK

Name and Address	Percentage of Stock Ownership	Percentage of Stock Voted
MARCOR Techworld Plaza 800 K Street, N.W. Suite 750 Washington, D.C. 20001	50%	50%
New Era Corp. c/o Kevin MacCarthy Associates 444 Madison Avenue New York, N.Y. 10022	50%	50%

EXHIBIT VII
OFFICERS AND DIRECTORS OF SATELLITE CD RADIO, INC.

OFFICERS*

Name and Title	Address
Martin A. Rothblatt Chairman of the Board & Chief Executive Officer	MARCOR Techworld Plaza 800 K Street, N.W. Suite 750 Washington, D.C. 20001
Peter Dolan President & Chief Financial Officer	MARCOR Techworld Plaza 800 K Street, N.W. Suite 750 Washington, D.C. 20001
Thomas J. Dougherty, Jr. Secretary & Treasurer	Fletcher, Heald & Hildreth 1225 Connecticut Ave., N.W. Suite 400 Washington, D.C. 20036

* Satellite CD Radio, Inc. was incorporated on May 17, 1990. The principals of the corporation have agreed that the individuals listed in this exhibit should be officers and these individuals have agreed to serve as officers, but they have not been elected as of the date hereof.

DIRECTORS*

Name	Address
Martin A. Rothblatt Chairman of the Board	MARCOR Techworld Plaza 800 K Street, N.W. Suite 750 Washington, D.C. 20001
Kevin MacCarthy	Kevin MacCarthy Associates 444 Madison Avenue New York, N.Y. 10022
Michael S. Alpert	Alpert & Associates 2000 L Street, N.W. Suite 702 Washington, D.C. 20036
Yovette Mumford	System Builders, Inc. 1 Vande Graaff Drive Burlington, MA 01803
Robert Mounty	301 East 62nd Street New York, N.Y. 10021
Sharad Tak	Tak Communications 1577 Spring Hill Road Vienna, VA 22180
Thomas J. Dougherty, Sr.	7308 Burdette Court Bethesda, MD 20817

* Except for Martin A. Rothblatt, who has been elected as a director by the incorporator, the principals of the corporation have agreed that the individuals listed in this exhibit should be directors and these individuals have agreed to serve as directors, but they have not been elected as of the date hereof.

EXHIBIT VIII
NATURE AND EXTENT OF CONTROL BY OTHER CORPORATIONS

Satellite CD Radio, Inc. is 50 percent owned by MARCOR, a District of Columbia corporation engaged primarily in the communications consulting business, and 50 percent owned by New Era Corp., a Maryland corporation engaged primarily in the business of technology development. The address of MARCOR is Techworld Plaza, 800 K Street, N.W., Suite 750, Washington, D.C. 20001. The address of New Era Corp. is c/o Kevin MacCarthy Associates, 444 Madison Avenue, New York, N.Y. 10022.

100 percent of the voting stock of MARCOR is owned by Martin A. Rothblatt, who is a U.S. citizen. His address is c/o MARCOR at the address indicated above. Martin A. Rothblatt is the president and a director of MARCOR. The other directors are Bina Rothblatt and Eleanor Leung. The address of each director is c/o MARCOR at the address indicated above.

100 percent of the voting stock of New Era Corp. is owned by Jean-Jacques Poutrel, who is a citizen of France. His address is c/o Ingenico, Compagnie Industrielle et Financiere d'Ingenierie, 9 Qual de Dion Bouton, 92800 Puteaux, France. Mr. Poutrel is also a director of New Era Corp. Kevin MacCarthy is the president and a director of New Era Corp. His address is 444 Madison Avenue, New York, N.Y. 10022.

EXHIBIT IX

RELATIONSHIP OF JEAN-JACQUES POUTREL TO CD RADIO, INC.

New Era Corp. owns 50 percent of the voting stock of Satellite CD Radio, Inc. 100 percent of the voting stock of New Era Corp. is owned by Jean-Jacques Poutrel, who is a citizen of France. His address is c/o Ingenico, Compagnie Industrielle et Financiere d'Ingenierie, 9 Qual de Dion Bouton, 92800 Puteaux, France. Mr. Poutrel is also a director of New Era Corp.

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Appendix 3

Development Plan

DEVELOPMENT PLAN

CD Radio, Inc. (CDR), has initiated the regulatory process in which it will request an allocation of the most favorable frequencies for satellite broadcasting currently available on the radio spectrum. As an early approval by the FCC will greatly enhance the company's position in pioneering the satellite digital radio broadcasting industry, it will request approval to be granted within twelve months pursuant to the "new technologies" amendment to the Communications Act.

Once FCC approval has been granted, the Company will construct terrestrial DAB systems in two cities to demonstrate the viability of the service. Major metropolitan areas such as New York and Los Angeles will be chosen to generate maximum exposure. Selected high-profile radio stations operating in the metropolitan areas will be provided the opportunity to broadcast their program material over the digitally based terrestrial system. The programming studio will be connected to the network of ground repeaters via fiber optic links. The test broadcast will be tuned-in by listeners provided with CD radio receivers currently under development.

To spur consumer interest of CD radio, it will be necessary to make high-quality, low-cost receivers available to the general public. In this regard, the Company has enlisted the support of Stanford Telecommunications to develop the Application Specific Integrated Circuits (ASIC) crucial to the production of a low-cost CD radio receiver. The Company envisions acquiring a patentable interest in the ASIC development and will seek to license its interest to electronics manufacturers producing CD radio receivers. Based on early production cost estimates from Stanford Telecommunications, the Company believes that an initial receiver will retail for approximately $200, with prices declining correspondingly to ascending sales levels experienced by equipment manufacturers.

The CD radio will be enclosed in the same housing as the AM/FM receiver avoiding the duplication of boxes purchased by the consumer. Exclusive tuners will be made available to existing equipment owners. The CD receiver will feature digital tuning which

allows simplified program selection as compared to the frequency dialing required by AM/FM receivers. Each CD receiver will permit the selection of any of the 100 available channels of satellite delivered programs.

One of the most dramatic improvements in sound quality reception will be realized in automobiles. Current radio signals are subject to fade-ins and -outs within a defined coverage area. Coupled with the congestion and interference problems continually experienced with AM/FM bands, mobile radio reception is clearly inadequate.

The CDR system will provide the transient audience with the clearest and most consistent signal ever heard. DAB radio signals are not subject to signal breakups caused by tunnels, underpasses, bridges and so forth which plague AM/FM broadcasts. Moreover, since the CDR system is national and international in extent, no disruption of program reception will be experienced as the mobile audience commutes between the various existing radio signal ranges.

After the test market exercise has been successfully concluded, the Company will aggressively market the available satellite channels to potential users. In this regard, the Company had identified the following institutions as potential users:

- Large radio stations
- Radio networks
- Television networks
- Cable companies
- Publishing houses

The Company proposes to offer transponders on its satellite system on a non-common carrier basis and according to specialized customer requirements. Consequently, transponders will be sold or leased outright with all incidents of ownership passing to end users. In addition, other methods of conveyance will be entertained where such methods better suit the user's needs. Prior to the construction of the satellite system, CDR will enter into to "pre-sales agreements" with users to guarantee the economic foundation of the service.

The pre sales agreements will be used as collateral to secure project financing for full system construction and launch.The Company will issue request for proposals from satellites and

support equipment construction from the most sophisticated manufacturers in the industry to ensure quality assets at a reasonable price.

CDR is committed to strictly adhering to the development plan according to the following timetable.

May 1990	FCC filing.
October 1990	Construct test market
June 1991	Preliminary FCC approval. Secure project financing. Finalize service contracts
1992	Final FCC approval. Negotiate satellite system construction and launch contracts.
1994	Begin launch schedule.

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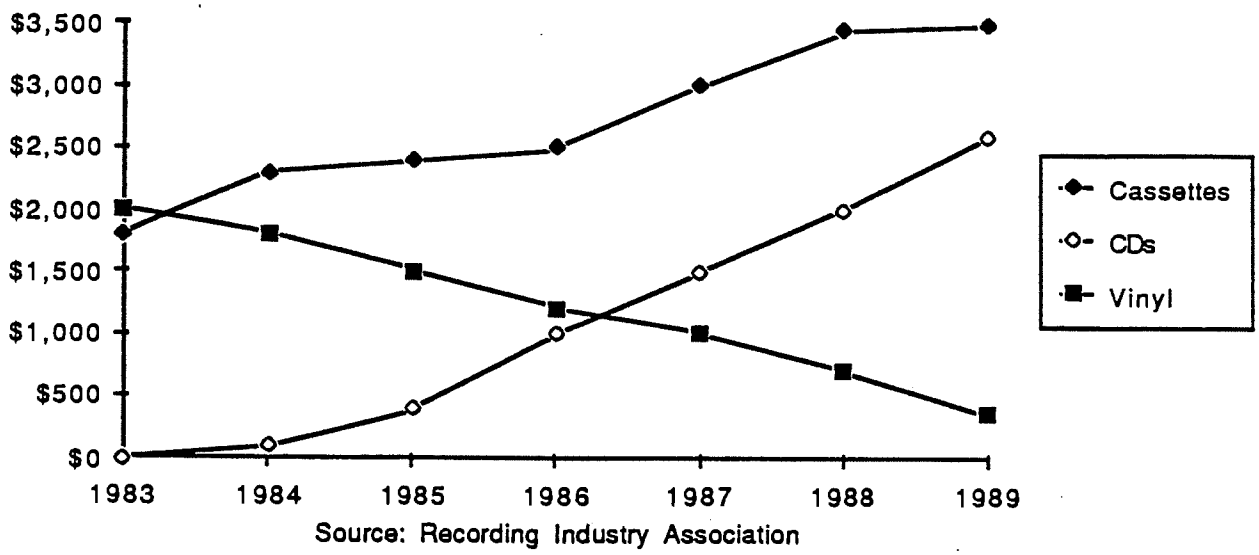
Appendix 4

Business Overview

THE INDUSTRY

With the advent of compact discs, the listening public has become acutely aware of the audio benefits of digital sound. Since compact discs were introduced, its sales have practically eclipsed the existence of vinyl records. The following chart graphically demonstrates the impact of CD's on the recording industry:

RECORDING INDUSTRY SALES
Annual Sales (In millions)

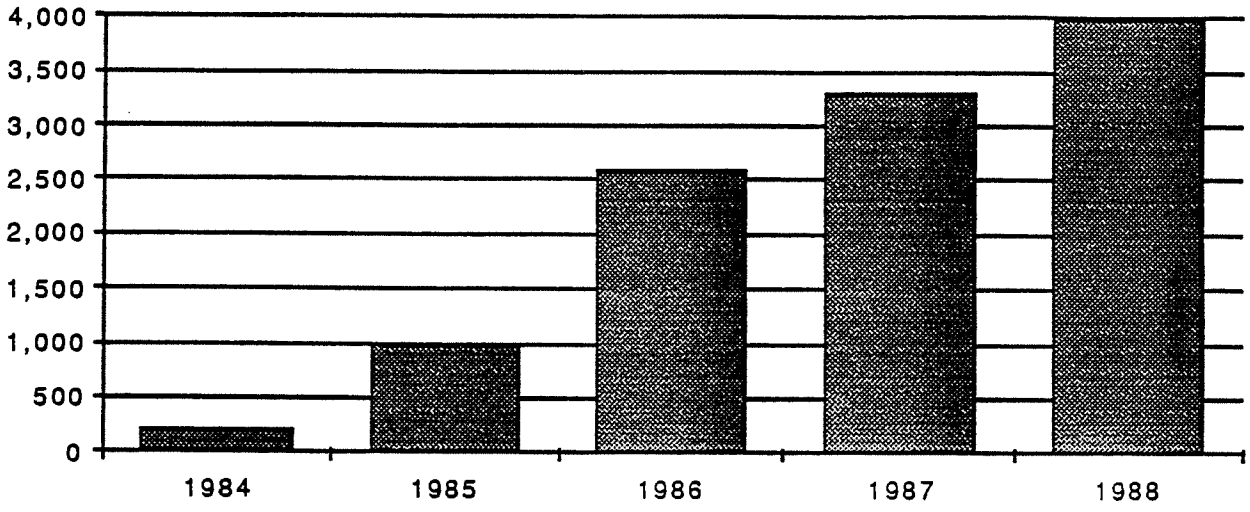


Source: Recording Industry Association

Cassette tape sales have leveled off in recent years and vinyl record sales have declined dramatically over the six year period. Only CD sales have sustained continued growth. Consumers have demonstrated their preference for high quality sound by paying as much as $15 for a compact disc when the same material is available on vinyl album or cassette tape for as little as $7. As CD prices continue to fall, an increasing number of buyers are opting for its superior listening quality.

The increase in CD sales is the direct result of the tremendous acceptance of CD players in consumer homes. Compact Disc players now inhabit 19% of U.S. homes with penetration increasing on declining unit prices. The following chart displays the historical growth of compact disc players:

COMPACT DISC PLAYER SALES (ESTIMATED)
(In thousands)



Source: Consumer Electronics Report

One of the reasons cassette tapes have remained a popular medium is because it has the capability of being played and recorded on. Once the copyright problems surrounding the introduction of Digital Audio Tape (DAT) recorders have been solved, it is widely anticipated that cassette tapes will suffer the same destiny of vinyl records and be replaced by a digital device.

Listening audiences are demanding the same type of high quality sound from the radio broadcasting industry. However, due to the inherent limitations of existing radio transmitting means, broadcasters are ill-equipped to respond to the demand of their audiences. AM and FM bands are plagued with congestion and interference. Normal FM radio transmission is an analog process which is limited to 15 KHz audio bandwidth and subject to noise and

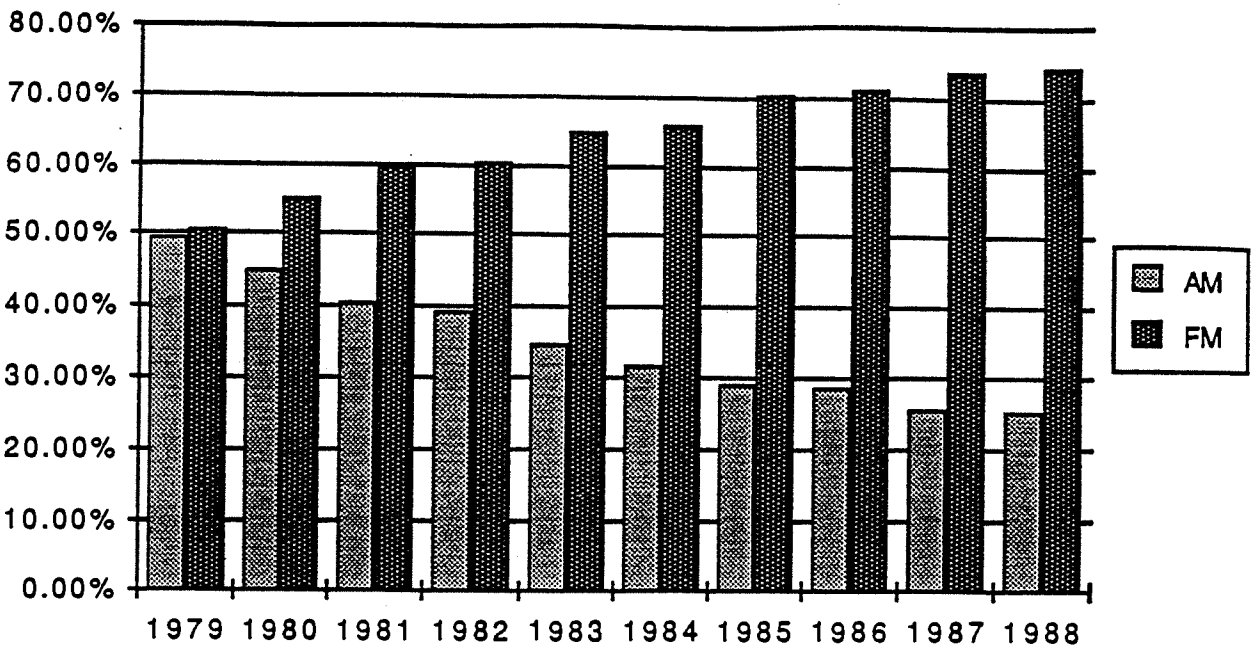
distortion caused by atmospherics, signal processing and multipath reception effects. Good stereo reception is practically impossible in cars where reception suffers dramatically from multipath propagation.

The demand for and unavailability of CD quality radio has been recognized by the cable industry. Three companies are now offering digital radio systems which will provide cable customers with high quality, commercial-free music delivered to their home stereo systems. The service will cost between $8 and $10 per month. The companies involved are:

Company	***Service***
International Cablecasting	*CD/8*
General Instrument	*Digital Cable Radio*
Digital Radio Lab	*Digital Radio Channel*

According to a National Association of Broadcasters document, the companies expect to reach a 10% penetration of the 52 million cable households within the next 2 to 3 years. Research conducted by A.C. Nielsen suggests that about 14% of cable households surveyed are "very likely" to subscribe to the Digital Radio Channel service at $7.50 per month. Digital Radio Labs is affiliated with HBO and Viacom which indicative of broad support for the service. In addition to the monthly service fee, the DRC system costs about $2,000 to add a cable headend which the customer will have to purchase or lease.

The radio industry itself has established a precedent for the acceptance of advanced sound quality. With the introduction of FM radio, AM broadcasters have progressively attracted smaller audiences. The FM radio band is located in a higher frequency band than its AM counterpart and is therefore less susceptible to static, fading and background overlapping than AM transmissions. The following chart demonstrates the relative AM and FM audience shares over the past 16 years:



Source: R&R Magazine

It is therefore clear that listening audiences understand and respond to the quality of digital sound. When it first became available in the form of compact discs, they were prepared to purchase another component for their home stereo systems and pay roughly twice the price of vinyl records for the compact discs themselves. Focusing on radio, consumers are paying a service fee to cable operators for digital sound as an alternative to the free analog transmission provided by current broadcasting means. Radio broadcasters are thus finding it increasingly difficult to contest in today's competitive marketplace with yesterday's technology.

CD Radio, Inc. (CDR) can provide the bridge between the listening public's demand for greater sound quality and the radio broadcaster's inability to deliver it. A revolutionary technology has recently been developed which will allow radio listeners to receive compact disc quality sound at home and in their cars. The technology is called Digital Audio Broadcast and has been successfully demonstrated both in Europe and the United States. CDR is laying the foundation to bring DAB to commercial application.

THE MARKET

The CD Radio system essentially provides the radio broadcaster with two dramatically innovative features:

- o *the ability to broadcast radio programming with compact disc quality sound,*
- o *the ability to reach a national or international audiences with the superior signal.*

To the listener, the attraction of compact disc quality radio is obvious. It has already been demonstrated that consumers are willing to extend themselves for high quality sound and the CDR system is the next logical step in meeting their requirements. The attraction of a national radio broadcast may not be as obvious, but it is certainly one with precedent.

System Users

National television broadcasting is a time-honored enterprise in the United States. National networks have long dominated the delivery of television programs to the American public. Radio stations have been incapable of reaching national audiences because of technological limitations and consequently have had to forfeit significant revenues related to national ad campaigns.

By utilizing the CDR system, a radio broadcaster realizes economies of scale not available to the typical local station. In reaching a national audience, the system user will be able to spread programming costs over a significantly larger base which in turn will allow the broadcaster to increase its station's programming budget. The national broadcaster will be able to present such programs as concert appearances by famous rock musicians, sporting events such as the Super Bowl or World Series, and radio "name" personalities like Larry King which until now have been out of the reach of local station operators. In addition, with a national infrastructure, the broadcaster will be able bring immediate news, financial and political developments directly to its audiences. With this type of high profile programming, the radio broadcaster will be

able to garner the same type national recognition as television studios through its own particular format.

The broadcaster will realize other significant operating efficiencies in addition to programming. The following schedule presents a comparison of typical operating results for radio stations operating in large and small markets, respectively:

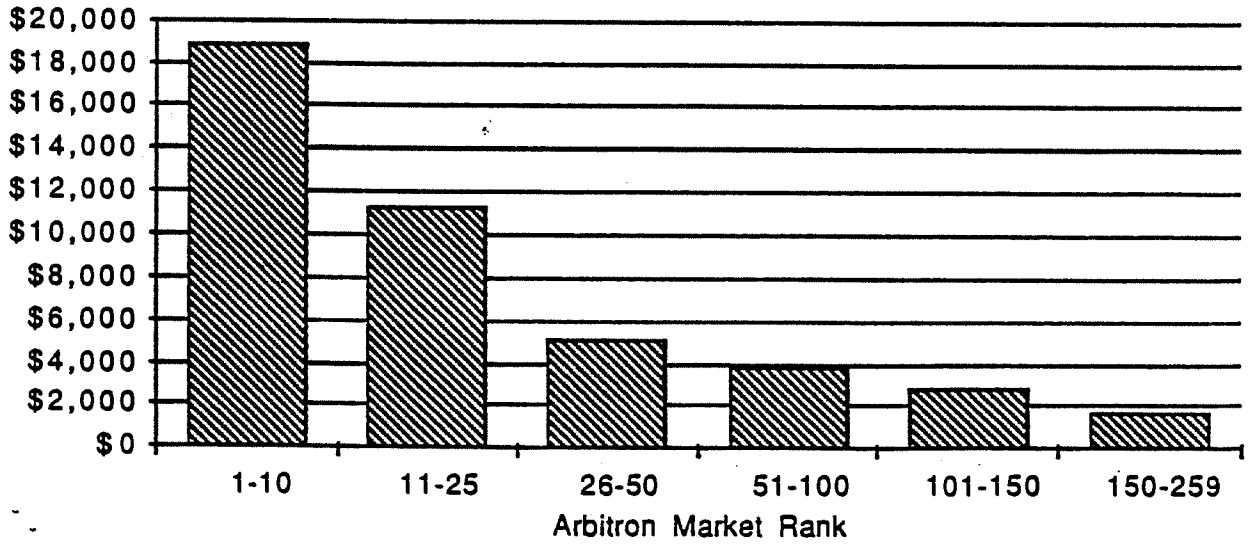
	Radio Station in Market with Population Over 2.5 Million *(in thousands)*	***Radio Station in Market with Population Between 500,000 and 1,000,000*** *(in thousands)*
Revenues:		
Network	225	23
National/Regional	2,667	485
Local	8,095	1,601
Total Time Sales	10,987	2,109
Net Revenues	9,406	1,841
Expenses:		
Technical	444	85
Programming/Production	1,747	342
News	460	65
Sales	1,373	398
Advertising/Promotion	1,076	186
General /Administrative	1,229	400
Total Operating Expenses	6,329	1,476
Operating Profit	3,077	365
Profit Margin	32.71%	19.83%

Source: Broadcast Investment Analysts, Inc.

Operating margins are highest in larger markets due to the fact that radio broadcasting is generally regarded as a fixed-cost enterprise with sales commissions normally being the only material variable cost. Because of the high ratio of fixed to variable cost, stations operating in the largest markets and generating the highest revenues will consequently experience the highest margins. This factor makes the CD Radio system a very attractive vehicle for potential broadcasters by covering national or international populations.

Acquisition prices of radio station are closely related to the size of the population they serve and the economic activity of the area. These factors determine the size of the potential listening audience and the advertising revenues that support the local station. Radio stations in larger markets are generally more profitable or have more upside potential than stations in smaller markets. Thus, prices paid for stations in larger markets are typically higher than those for comparable stations in smaller markets. The following chart illustrates average prices for stand-alone FM facility sales during the period from 1986-1987:

Average Sales Price for FM Radio Stations,1986-1987
(In thousands)



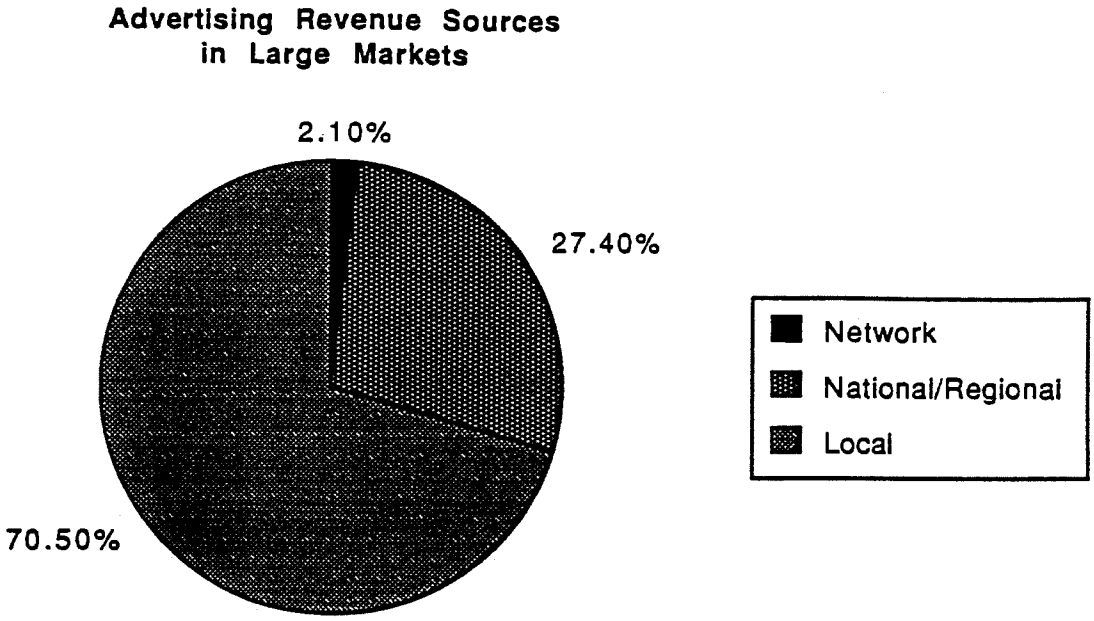
Source: Broadcast Investment Analysts, Inc.

As the chart demonstrates, the value of radio stations is closely related to the size of the market in which it is located. As the CDR system has the capacity of delivering a national or international audience, only a little imagination is required to comprehend the resulting value to a well managed programming entity.

The potential users of the CDR system are numerous. First and foremost will be local stations seeking to become national "superstations". Television networks and cable companies with programming experience are also likely candidates. In essence, almost any media distribution company, including newspaper and magazine publishers could emerge as national broadcasters on a very profitable basis.

Advertisers

Commercial radio stations earn the majority of their revenues from the sale of airtime to advertisers. There are generally two classifications of advertising revenues: national and local. Historically, local advertising has comprised the majority of a stations overall revenues. The following diagram displays the various components of a typical radio station's advertising revenues operating in a large market:



Source: National Association of Broadcasters

Companies seeking to market products and services through mass communication mediums have concentrated on television as a means of reaching potential customers. Radio broadcasters have never gained the full attention of national advertisers primarily as a result of technological and logistical problems. Radio is unquestionably the most fragmented of all mediums in the broadcast industry. Today there are approximately 9,000 commercial radio stations operating throughout the country. Attempting to coordinate a national ad campaign among the vast number of stations has proven to be an overwhelming exercise.

In placing radio commercials on individual stations, national advertisers have normally utilized the services of large advertising agencies. The advertising firm will purchase "spot time" from the stations to air the commercials. It is the responsibility of the advertising firm to place the commercial on particular stations which will most effectively reach the client's target market. For this service, the firm will receive a commission from the radio station for selling the air time and also a fee from the advertiser

for placing the ad which serves to significantly increase overall marketing costs.

Verifying performance of radio ads is cumbersome and uncertain at best. For the most part, verification is in the form of signed affidavits which creates a tremendous clerical burden in tracking paperwork. In addition, as the advertising firm is responsible for placing the ad on local stations across the country, effectiveness and therefore cost justification is difficult to determine.

A national broadcaster using the CDR system will solve a multitude of problems previously experienced by national radio advertisers:

- by centralizing radio advertising with one national station, an advertiser will greatly reduce the logistical inefficiencies of verification,

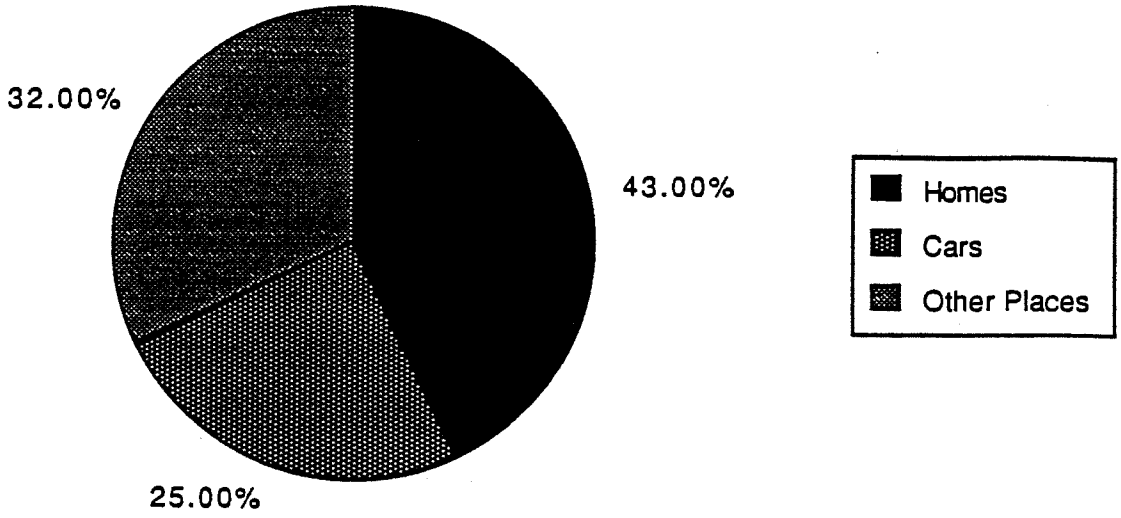
- consumer response to radio advertising will be far easier to monitor by focusing on one station rather than numerous independent stations,

- a national advertiser's in-house marketing staff will for the first time be able to contract with a single broadcaster for commercial time. As a result, significant efficiencies will be realized in eliminating the advertising firm's fees for placing radio ads thereby reducing overall marketing costs. Lower marketing costs will in turn attract additional advertisers serving to expand the national radio advertising revenue base.

A national radio broadcaster can provide an advertiser with an effective alternative to television. The comparable cost of television advertising greatly exceeds that of radio. With the technological and logistical drawbacks of national radio advertising being solved, companies are sure to rethink their commercial delivery strategies.

Radio advertising will offer marketing benefits which television cannot duplicated. Radio broadcasting delivers audiences largely unreachable by television such as individuals in cars and outside their homes. According to the National Association of Broadcasters, current FM audiences can be segregated as follows:

FM Audiences



As the diagram indicates, approximately 57% of FM audiences listen to radio away from home where the overwhelming majority of television viewing takes place. A broadcaster on the CDR system will provide the national advertiser with an effective means of reaching these audiences.

A company advertising on television can incur excess marketing costs as a result of most TV programming being directed towards the public at large, some of which may be out of the advertisers specific target market. Consequently, the advertiser is paying a premium to reach an unresponsive portion of the audience. With up to 100 channels of CDR system programming available in markets throughout the world, an advertiser will be able to identify effectively and economically the audience its wishes to reach through a process in radio broadcasting known as narrowcasting. In narrowcasting, programming is geared to the specific tastes of a homogeneous groups with similar interests. These groups can be identified in age, gender or ethnic segments. Examples of segments would be Hispanic communities, elderly, financial/business audiences, etc.. There are an average of six television stations per market operating throughout the country. For the most part, television stations offer little diversity in overall programming to

viewers of various backgrounds because they must appeal to a much broader audience. With 100 channels of CD Radio available in every market, certain national broadcasters will have the flexibility to tailor their program material specifically to the preferences of their target audiences. Narrowcasting on a national basis could enable the broadcaster to reach massive audiences with high quality program material not available on a local level and also allow the advertiser to efficiently manage its marketing budget.

Quantitative Analysis

While national advertisers certainly have not fully utilized radio in their marketing strategies, they have not ignored it either. According to the Radio Advertising Bureau, national advertisers have spent well over a billion dollars in radio advertising in each of the past three years:

1989	$1,530,000,000
1988	$1,402,000,000
1987	$1,315,000,000

Multiplying the 1989 total by the average annual increase of approximately 8%, the current year national advertising total should be in the $1.65 billion range. Based on the revolutionary capabilities provided by the CD Radio system as discussed in this document, it is reasonable to conclude that future national radio advertising revenues will reach historic levels. The following schedule approximates future revenues for users of the CD Radio system:

Approximte existing national radio advertising	1,600,000,000
Estimated growth factor	150%
Estimated anuual national advertising	2,400,000,000
CD Radio Penetration	50%
Available revenues	800,000,000
Number of CD Radio channels	200
Revenue per channel	4,000,000

The potential future revenues available to the CD Radio system users can be even greater. As already pointed out, the advantages of a national radio broadcast will cause businesses marketing their products and services country wide to review overall marketing strategies. This situation will surely expand radio advertising revenues making national radio broadcasting a very profitable venture.

BEFORE THE

Federal Communications Commission

WASHINGTON, D.C. 20554

In the Matter of the Application of	)	
SATELLITE CD RADIO, INC.	)	File No.
For Authority to Construct, Launch and Operate a Space Station in the Satellite Sound Broadcasting Service at 103° West Longitude	)	

APPLICATION OF SATELLITE CD RADIO, INC.
FOR A PRIVATE DIGITAL
SATELLITE SOUND BROADCASTING SYSTEM

Pursuant to Section 308, 309 and 319 of the Communications Act of 1934, as amended, 47 U.S.C. §§ 308, 309 and 319, Satellite CD Radio, Inc. (hereinafter referred to as CD Radio, Inc.) requests authority to construct, launch and operate a space station in the satellite sound broadcasting service at 103° West Longitude.

The technical information supporting this application is contained in the attached technical showing.

CD Radio, Inc.'s legal and financial qualifications are demonstrated in the Satellite System Proposal preceding this application. CD Radio, Inc. hereby incorporates by reference the legal and financial showings made therein.

WAIVER PURSUANT TO SECTION 304 OF THE COMMUNICATIONS ACT OF 1934

Pursuant to Section 304 of the Communications Act of 1934, CD Radio, Inc. waives any claim to the use of any particular frequency or of the electromagnetic spectrum as against the regulatory power of the United States because of the previous use of the same, whether by license or otherwise, and requests the grant of construction, launch and operating authority in accordance with this application.

REQUEST FOR WAIVER OF SECTION 319(d) OF THE COMMUNICATIONS ACT

CD Radio, Inc. hereby requests a waiver of Section 319(d) of the Communications Act, as amended, with respect to the above-referenced application in order to proceed immediately with the construction of the system proposed therein. As set forth below, CD Radio, Inc. believes that the requested modifications are in the public interest, and it is prepared to accept the risk of initiating the proposed service pending final action by the Commission on its application.

CD Radio, Inc. is a pioneer in proposing a private, digital satellite sound broadcasting system. Concurrent with the above-referenced application, CD Radio, Inc. is filing a petition for rulemaking requesting the Commission to initiate a rulemaking proceeding to amend its Table of Frequency Allocations to allocate frequencies for the proposed satellite sound broadcasting system.

As demonstrated in its Petition for Rulemaking, there is currently an unfulfilled demand for high-quality radio service and for radio stations with nationwide coverage. That demand can be satisfied by CD Radio, Inc. using its proposed system. Early construction, launch and operation of the satellite sound broadcast system will maximize efficient use of the spectrum by permitting early initiation of the service and further refinement in light of practical experience derived from the system's

operation. Interim service is critical to demonstrate the commercial viability of the system and to bring competition to the broadcast and developing cable radio markets. Rapid introduction of the satellite sound broadcast service would help ensure effective competition to the emerging provision by cable systems of radio services by providing a high-quality radio alternative. Thus, the Commission's goal of diversifying sources of radio programming would be promoted.

For these reasons, CD Radio, Inc. requests that the Commission grant a waiver of Section 319(d) of the Communications Act to permit construction to begin as soon as possible. CD Radio recognizes that any expenditures made pursuant to this waiver will be at CD Radio's risk and that the grant of this waiver will not prejudice the Commission's final decision regarding the merits of CD Radio's application.

CERTIFICATION

The undersigned, individually and for the applicant, hereby certifies that the statements made in this application are true, complete, and correct to the best of his knowledge and belief, and are made in good faith.

Respectfully submitted,

SATELLITE CD RADIO, INC.

By: _____
Peter Dolan
President

May 18, 1990

Technical Appendix

1. Introduction.

CD Radio, Inc. is applying for authority to operate a domestic sound broadcasting-satellite system with downlinks in the L-band and feeder links in the Ka-band, pursuant to Sections 308, 309 and 319 of the Communications Act as amended. The complete CD Radio, Inc. system will consist of two operational satellites, a multiplicity of terrestrial repeaters primarily serving permanent urban areas of the country, and an earth station which provides feeder links to the satellites, and performs the functions of tracking, telemetry and control of the spacecraft.

A newly developed audio processing technique will contribute to the high spectrum efficiency and cost-effectiveness of the overall system.

This transmission format Offset Quadrature Phase Shift Keying ("OQPSK") at a bit rate of 256 kb/s, will be used for satellite transmissions, for terrestrial repeaters of those transmissions, and by independent terrestrial broadcasting stations that will be operating in an adjacent frequency band. Therefore, the home, portable and vehicular radio sets to be used with this new broadcasting service will be able to pick up 100 satellite and terrestrial broadcasting channels of CD-

quality, stereophonic nationwide, regional and local programming throughout the United States.

2. General Description.

The two satellites in the CD Radio, Inc. system will be spaced 18 degrees apart at 103° and 121° west longitude to provide undiminished service from one satellite at all times during eclipse periods. On-board batteries will enable the satellite to carry a substantial number of its 99 channels throughout its period of eclipse.

To provide CD-quality audio programming throughout the continental United States, the country will be divided into three regions, designated Eastern, Central and Western. Each satellite will have three antenna beams of approximately three degrees each, providing coverage of those regions, as shown in Figure 1.

Each satellite will provide a total of 99 channels, 33 channels in Eastern, Western and Central Beams. Thus, the two satellites together will provide a total of 66 channels to the Eastern, Western and Central Regions of the U.S. The transponders connected to the Central Beam will have nominal e.i.r.p. of 46.1 dBW, while the transponders connected to the

Eastern and Western Beams will each have a nominal e.i.r.p. of 46.4 dBW. The slightly higher e.i.r.p. in the Eastern and Western Beams is intended to compensate for higher signal attenuation in those regions of the country with heavier foliage.

Each of the three transmitting beams will have a beam width of approximately three degrees, and hence, a gain of about 34.8 dBi. However, careful beam shaping (as shown in Figure 1) and power weighting will be employed both to confine the transmitted power to the desired more or less rectangular service areas, and to hold the difference in power between beam center and beam edge to about 1.5 dB (a difference which would otherwise be 3 dB).

The satellites will employ a reflector-type antenna with a multiplicity of feeds to generate the shaped coverage patterns mentioned above. This arrangement provides for the addition "in space" of the power from individual, moderate-size solid-state power amplifiers.

Satellites will be procured from spacecraft manufacturers responding to a Request for Proposal (RFP) that will set forth overall performance specifications, rather than detailed design specifications. In that way, CD Radio, Inc.'s system can

4. Communication Subsystem.

4.1. GENERAL. The design of CD Radio, Inc.'s communication subsystem is based on the latest digital audio technology. The features of this design include:

- Stereo compact disk audio quality directly to the listener by the use of a spectrum-efficient, digital sound encoding technique developed by Dolby Laboratories.

- A system design that permits the production of a series of receivers whose cost and complexity depend only on the type of environment in which the receiver is intended to operate.

- A system design that does not constrain all consumer receivers to be of high complexity and cost.

- The use of adaptive equalization in vehicular receivers to simultaneously mitigate the effects of delay spread and to optimally utilize the signal power that does exist in the delay spread multipath signal.

- The use of quad-spatial diversity in vehicular receivers to mitigate the effects of multipath fading.

- The use of high power terrestrial repeaters to ensure the availability of uncompromised, high quality CD radio service in heavily shadowed urban areas.

- Efficient use of the spectrum through the paired use of frequencies assigned to specific satellite beams for terrestrial repeaters.

- A design that permits program channels to be added to the satellite as service providers are added to the system. This leads to the efficient use of the spectrum and of satellite transmitter power if programming and sponsors are only available for a fewer number of channels. This is in contrast to alternative system designs in which channels must be added in blocks of 8 or 16. For example, if all channels in existing blocks were assigned, then to add

an additional channel would require the addition of a new block and the power and bandwidth to transmit all 8 or 16 channels.

4.2 DOWNLINK BUDGET. A downlink budget for the satellite-based links of the CD Radio, Inc. system serving the contiguous 48 states (Conus) is given in Table 1. There will be two satellites in the geostationary orbit transmitting at 1500 MHz and using Offset Quadrature Phase Shift Keyed (OQPSK) modulation with a bit rate of 256 kbps per stereo program channel. Channel coding, in the form of a rate 1/2, constraint length 7 convolutional code, will be applied to each program channel as a means to mitigate the effects of shadowing and multipath and to efficiently use the satellite transmitter power [1], [2]. The use of convolutional coding will double the symbol rate of the OQPSK carrier to 256 ksps.

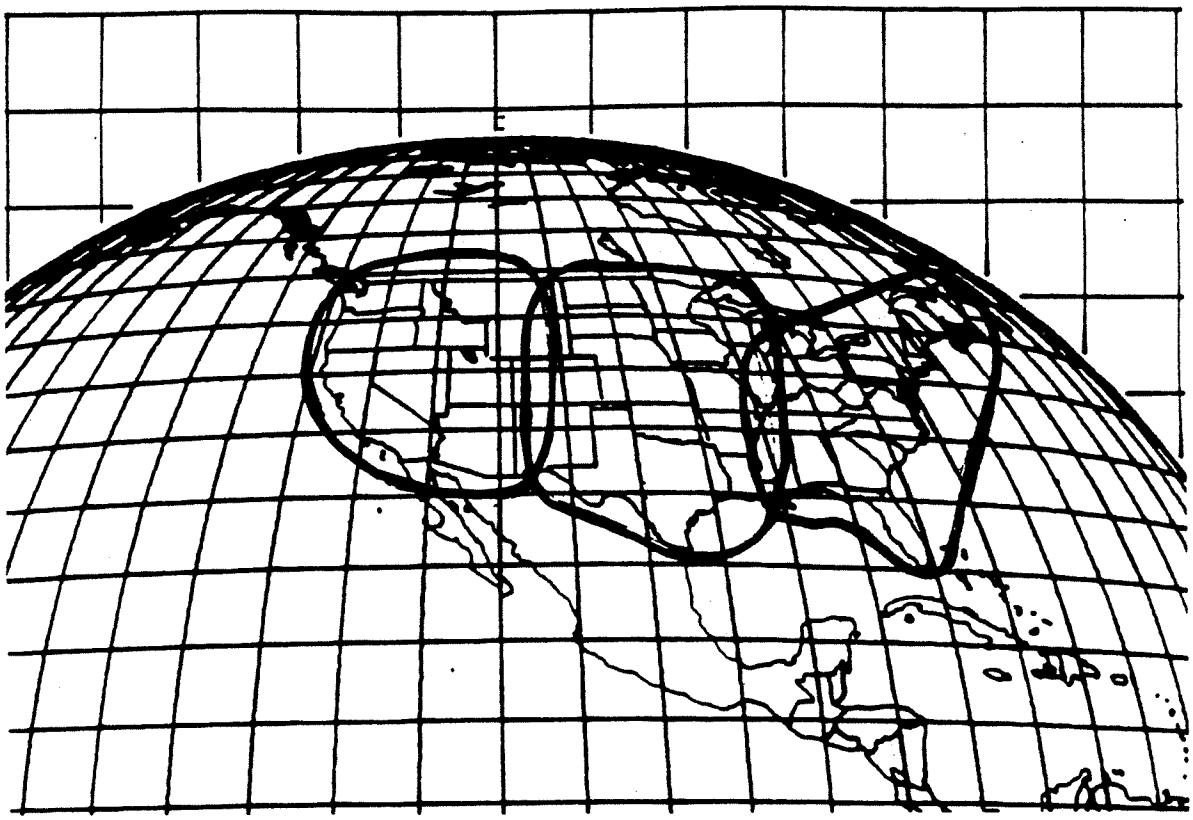
4.3 SYSTEM COVERAGE. As shown in Figure 1, Conus coverage will be provided by three shaped satellite transmitting antenna beams to cover three major geographical areas: one of each of the beams will cover the eastern, central, and western portions of the US. As indicated by the entries in Table 1, somewhat less power will be apportioned to serve the central part of the US since the amount of foliage, and thus shadow loss, in this area of the US is less than in other areas.

The two satellites will be located at 103° and 121° West longitude. Each satellite will provide 33 channels in the Eastern, Western and Central Beams, for a total of 66 channels in each beam area provided via satellite. Another 34 channels in each beam area will be provided by high-power terrestrial transmitters to provide coverage in "urban canyons," that is, in heavily populated areas where buildings may block line-of-sight from the satellites.

Table 1: CD-Radio link budget

Parameter	Units	Central Beam	East and West Beam
Transmitter Power	(Watts)	16.0	17.0
	(dBW)	12.0	12.3
Filter, cable and VSWR loss	(dB)	-0.7	-0.7
Transmitting antenna diameter	(m)	4.7	4.7
Transmitting antenna gain	(dBic)	34.8	34.8
Antenna 3 dB beamwidth	(Deg)	3.0	3.0
E.i.r.p.	(dBW)	46.1	46.4
Power variation within shaped beam	(dB)	-1.5	-1.5
Path loss	(dB)	-187.7	-187.7
Spectral pfd	(dBW/m^2 4kHz)	-131.6	-131.4
Polarization loss	(dB)	-0.5	-0.5
Receiving antenna gain	(dBic)	5.0	5.0
Receiver noise temperature	(K)	100.0	100.0
Elevation angle	(deg)	30.0	30.0
Antenna noise temperature	(K)	50.0	50.0
Receiving system temperature	(K)	150.0	150.0
Adjacent channel interference	(dB)	-0.5	-0.5
Demodulator loss	(dB)	-0.5	-0.5
Mean received Eb/No	(dB)	14.2	14.5
Theoretical Eb/No (BER=10^{-6})	(dB)	7.0	7.0
Required Eb/No (BER=10^{-6})	(dB)	8.0	8.0
Margin (For any excess path loss and all other factors)	(dB)	6.2	6.5

Figure 1: Satellite coverage areas.



With the satellites positioned at 103° and 121° West longitude, the minimum elevation angle will be on the order of 30°. The link budget in Table 1 shows that within the coverage area there will be a minimum link margin in excess of 6 dB to account for such factors as excess path loss due to shadowing.

4.4 TYPES OF SERVICES. CD Radio, Inc. system is designed to provide 66 compact disk-quality stereo broadcast channels to the general population while in their homes or places of business, while engaged in outdoor activities, or while in their vehicles. It is intended to be a totally new and ubiquitous service.

The system incorporates a high-quality audio transform encoding technique developed by Dolby Laboratories that is known as the Dolby AC-2 audio coding process. At 128 kbps per monaural channel (256 k samples/sec for stereo), which is one-sixth the bit rate of 48 k samples/sec 16-bit PCM, it produces a virtually transparent signal fidelity even when operating with a bit error ratio as high as 10^{-5} [ref. 3]. The salient performance characteristics of the CD coding process are summarized in Table 2 [ref. 4].

Table 2: Characteristics of the Dolby AC-2 digital audio coders/decoders.

Response	20 Hz to 15 kHz ±0.2 dB
Distortion	Less than 0.1% at 1 kHz Less than 0.4%, 20 Hz - 15 kHz
Dynamic Range	Greater than 90 dB
Crosstalk	Less than -80 dB
Level Stability	Better than 0.2 dB
Coding Method	Dolby AC-2
Audio Sampling Rate	48 k samples/second
Data Clock	256 kHz ±25 ppm
Error Correction	Reed-Solomon
Time Delay	45 ms, encode-decode, including formatting delay

A 1200 bps auxiliary data channel is also provided by the Dolby AC-2 digital audio coder/decoder; use of this channel has no effect on the performance of the main audio channels.

4.5 MODULATION PARAMETERS. The CD Radio, Inc. system uses a spectrum-efficient, power-efficient, constant-envelope, single carrier per stereo channel modulation method. The 256 kbps binary data stream from the output of the Dolby AC-2 encoder is encoded using a rate 1/2, constraint length 7, convolution code. The output, which is at a serial data rate of 512 kbps, is fed to a modulator which generates an offset quadrature phase shift keyed signal (OQPSK) with a symbol rate of 256 ksps. The advantage of OQPSK, in comparison with QPSK (i.e., 4-Phase PSK), is less regeneration of the "tails" of the RF spectrum of the signal after amplification in a non-linear amplifier, such as solid-state power amplifiers (SSPA) and traveling wave tubes (TWT), which exhibit AM to AM and AM to PM distortion [5]. Minimizing the energy in the spectral "tails" promotes efficient use of the spectrum and reduces the amount of adjacent channel interference.

5. Consumer Receiver Parameters.

5.1 GENERAL. The philosophy employed in the design of the CD Radio, Inc. system permits a range of receivers to be marketed, whose cost and performance reflect the environment in which the receivers are intended to operate. All receivers will be capable of being tuned over the frequency bands assigned to the satellite channels, terrestrial repeaters, and the ter-

restrial broadcast channels. There will be complex receivers that are intended to operate in the most severe propagation environment - the heavily shadowed, delay-dispersive urban environment. Unlike alternative satellite sound broadcasting system designs that are described in [6], the CD Radio, Inc. system also permits the marketing of simple receivers intended to operate in the least harsh environment. A minimum of four different types of consumer receivers are presently envisaged for use with the CD Radio, Inc. system. The characteristics of these receivers are summarized in Table 3.

Table 3: Receiver characteristics

TYPE	CHARACTERISTICS
- Home, fixed	- Single outdoor antenna
	- Single-channel receiver
	- Simple convolutional code decoder
- Portable, for signal level urban areas	- Single antenna (no space use in high-diversity)
	- Single-channel delay equalizer
	- Simple convolutional code decoder
- Portable, for signal level urban areas	- Dual antenna (dual space use in low-diversity)
	- Dual-channel delay equalizer
	- Viterbi maximum likelihood decoder
- Vehicular	- Quad antenna (quad space diversity)
	- Four-channel delay equalizer
	- Viterbi maximum likelihood decoder

The home receiver intended for fixed operation with an attic or outdoor antenna is the least expensive. It features a single antenna of moderate gain (e.g., 10 dBic) pointed towards either the satellite or the local terrestrial repeater. The receiver uses a single RF channel, since space diversity is not used. The receiver also employs a simple, majority-logic convolutional decoder, since the coding gain afforded by the use of a Viterbi maximum likelihood decoder is not needed.

The portable receiver for use in high-signal level urban areas will have some of the same features as the home receiver. Specifically, since the receiver will be operating in high-signal level environment, a single antenna and single RF channel receiver will suffice. However, because of the delay-spread of the signals in an urban environment, the receiver would contain an adaptive delay equalizer capable of accommodating multipath signals with delays up to 40 usec. This is to be contrasted with alternative system designs described in CCIR Report 955-1 (MOD F) [2] which can only accommodate delays up to 16 usec.

The next level of complexity is characterized by the portable receiver intended for operation in a low-signal level urban environment. This type of receiver uses dual space diversity to minimize fading and a Viterbi maximum likelihood decoder to realize a coding gain of about 5 dB at a BER of

10^{-6} . Space diversity requires a two-channel receiver with dual diversity antennas.

The vehicular receiver will be the most complex since it will operate in the most harsh propagation environment: the multipath fading, low-signal level, delay dispersive urban environment. This receiver uses quad-space diversity with maximal ratio combining, a four-channel adaptive delay equalizer, and Viterbi maximum likelihood decoder.

The technology for these receivers is well in hand. Viterbi maximum likelihood decoders are available from several sources, including Stanford Telecommunications [7]. A receiving system featuring triple-space diversity, maximal ratio combining, and adaptive equalization has been demonstrated by Stanford Telecommunications [8]. The measured performance of the receiver in a severe frequency-selective fading environment as shown in Figure 2, dramatically illustrates the performance gain achieved by using adaptive equalizers.