AM Power Savings

NX Series MDCL -6 ORBAN XPN-AM

Agenda

- MDCL, Nautel, Orban: What's possible?
  - Savings, Sound, Coverage
- How it's done. What are the ingredients?
  - -NX
  - -MDCL -6
  - -Orban XPN-AM
- How these pieces work together
  - -Deeper dive into the results outcomes
- Still sound too good to be true?
- How to? Calculator?
- Q & A

Jeff Wilson
Nautel
Sales Manager - West USA

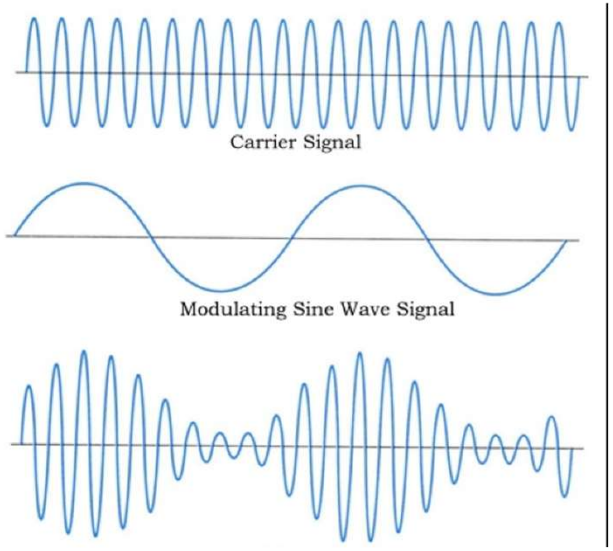
Mike Pappas, W9CN
Orban Labs, Inc.
Vice President – Business Development

MDCL, Nautel, Orban: What's this all about?

- Better sound
- Fill coverage holes
- Station punch
- Get out above the noise floor
- And by the way, you might save $60 k per year

AM Radio

- Outside of Spark-Gap and CW it's the oldest form of modulation
- Take a carrier and modulate it with audio!
- Simple and easy to implement and it's been on the air for 100 years



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AM Efficiency

- The downside to AM
  - Very inefficient to transmit
  - The AM carrier uses 66% of the transmitter power
    - Yet delivers no information!
    - Even with modern PWM AM transmitters the power consumption for a 50 kW AM station is substantial
  - So how do we make AM more efficient?
  - We modify transmitted waveform to reduce power without reducing received quality in receivers - MDCL

AM Efficiency

Forms of MDCL (also known as DCC – Dynamic Carrier Control) have been used for decades in ham radio.

DCC or variations have been used in European AM broadcast since the 1980s and have been available for Nautel transmitters since 1995.

At NAB2009, Nautel presented a white paper on MDCL.

In late 2010, Alaska Public Radio was granted experimental authorization to begin testing MDCL on several of its stations.

In September 2011, the FCC issued a Public Notice (DA 11-1535) approving the use of MDCL and leaving the specific algorithm up to the individual broadcasters.

Since then, several US broadcasters have implemented MDCL and have reported power savings of 20-40%

The Ingredients: Achieving exceptional power savings

NX Series AM Transmitters
Only NX Series transmitters have advanced digital modulation that permits high signal density, exceptional power savings, noise floor and loudness improvements.

-6 dB MDCL
Nautel has worked with broadcasters to develop Modulation Dependent Carrier Level (MDCL) parameters that result in significantly higher power savings.

Orban XPN-AM
The XPN's revolutionary limiter offers unprecedented loudness, cleanliness, crispness, speech intelligibility, and coverage. Greater density with lower distortion can significantly reduce power consumption.

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AM MDCL AMC

- Carrier and modulation together are decreased with increasing audio modulation
- The carrier is increased to full power during quiet periods when noise is most easily perceived
- As modulation density has substantially increased with modern audio processing AMC can generate greater efficiency
- Significant power savings

Orban XPN-AM

- Bob Orban pet project
- Ground up design
- Innovation:
  - Mod density without distortion
- Density permits aggressive carrier suppression
- Carrier suppression = $ savings

Field Testing

- Field testing:
  - determined the impact AMC at 3dB, 4dB, 5dB and 6 dB of carrier suppression at 100%, 125% and 150% peak positive modulation
- Townsquare Media KFXD in Boise ID was the test station
- Nautel NX5 Transmitter capable of MDCL @ 150%
- Power: 5.0 kilowatts (kW) Daytime on 630 kHz
- Format is “Sports Talk”
- FCC STA was obtained to run 150% peak positive modulation

FEDERAL COMMUNICATIONS COMMISSION
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Washington, DC 20554

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September 16, 2019

Howard M. Liberman, Esq.
Wilkinson Barker Knauer, LLP
1800 M Street, N.W.
Suite 800N
Washington, DC 20036

In re: Request for Experimental Authority
Townsquare Media Boise License, LLC
KFXD(AM), Boise, ID
Facility ID No. 63915

Dear Counsel:

The staff has under consideration the request received on September 6, 2019, for experimental authority to permit AM station KFXD, 830 kHz, to operate in a new MDCL mode, known as "Enhanced AMC". The experimental authority is requested for a duration of one week and will be limited to daylight hours. Testing is requested utilizing the authorized daytime antenna system and licensed nominal power of 5 kilowatts.

The experimental request states that KFXD proposes to evaluate MDCL technology at the station's site using its existing transmitter. The existing transmitter is an NX-5 model unit manufactured by Nautel Limited. This transmitter is capable of transmitting in several different MDCL modes. For the purposes of the proposed testing, the licensee intends to use the Enhanced AMC mode. In this mode the transmitter can reduce the carrier power up to 6 dB and an increase in peak power up to 1.76 dB. Station KFXD states that testing will be done in conjunction with Nautel (a transmitter manufacturer) and with Orban (an audio-processor manufacturer), which will be lending their expertise and support to this effort. Data collection will be in the form of occupied bandwidth measurements, field strength readings, audio recordings from the field, and real-time transmitter power-consumption data.

Operation in the Enhanced MDCL mode requires a waiver of 47 C.F.R. § 73.1570(b)(1), as KFXD wants to test positive-peak modulation levels up to 150%. According to Section 73.1570(b)(1) of the Commission's rules, in no case shall the amplitude modulation of the carrier wave exceed 100% on negative peaks of frequent recurrence, or 125% on positive peaks at any time.

A waiver of 47 C.F.R. § 73.1570(b)(1) is deemed warranted as the station will try to determine if Enhanced-AMC MDCL and high modulation levels can translate to an overall power savings for AM stations without sacrificing coverage area or quality. Accordingly, the requested experimental authority described above **IS HEREBY GRANTED**. This experimental authority will expire on **September 30, 2019**.

Sincerely,

Jerome J. Manarchuck
Audio Division
Media Bureau

cc: Howard M. Liberman, Esq. (via email only)

Field Testing

- Wanted field strength measurements and audio recordings
- Needed radio with audio bandwidth greater than 4.5 kHz
- C Crane Skywave radios have selectable bandwidths up to 6 KHz
- We ordered three of them for testing

Field Testing

- Needed to test the C Crane Skywave radios to determine their audio frequency response
- Needed a shielded enclosure to do the testing to minimize the RF noise floor and allow sufficient signal to noise ratio for accurate testing
- Home Depot to the rescue
  - 10-gallon galvanized garbage can provided the Faraday shielded enclosure for testing!

Home Depot Faraday Cage

Field Testing

- HP8920 A used to generate the AM carrier and audio modulation
- Calibrated by Amtronix Instruments, Inc. in 2018
- Measured all three of the C Crane Skywave radios and recorded the results
- John Kean of Cavell, Mertz & Associates, Inc. did the data work and compared against the National Radio Systems Committee (NRSC) 75 uS AM pre-emphasis curve (NRSC-1)


orban

Field Testing

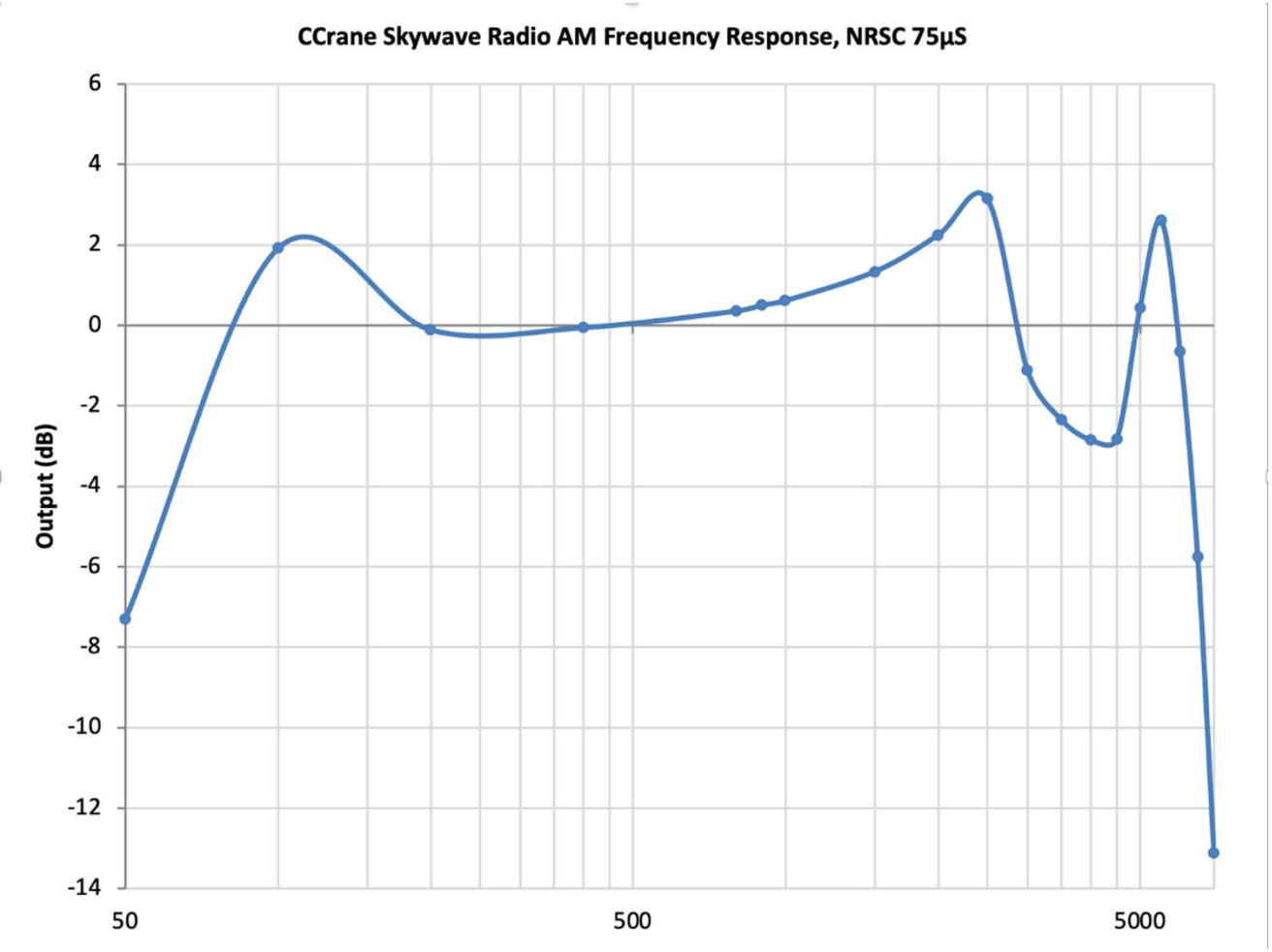
- 400 Hz was the “reference frequency” for the Skywave radio testing
  - Below the start of the 75 uS pre-emphasis
  - All three receivers were set to match output at 400 Hz and then tested
  - From 200 Hz to 7 kHz they were within 1.5 dB of each other.
  - Not bad for a relatively inexpensive radio.

Field Testing

	Radio #1	Radio #2	Radio #2					
	6 KHz Bandwidth	6 KHz Bandwidth	6 KHz Bandwidth					
Hz	dB 400Hz Ref	dB 400Hz Ref	dB 400Hz Ref	Min dB	Max dB	Variance dB	NRSC-1 Curve (dB)	Response to NRSC-1 (dB)
50	-7.3	-7.0	-7.1	-7.3	-7.0	-0.3	0	-7.30
100	1.9	-1.6	-2.0	-2.0	1.9	-3.9	0.01	1.91
200	-0.2	-0.1	-0.3	-0.3	-0.1	-0.2	0.08	-0.12
400	0.0	0.0	0.0	0.0	0.0	0.0	0.14	-0.06
800	-0.2	-0.1	0.0	-0.2	0.0	-0.2	0.55	0.35
900	-0.2	-0.1	0.0	-0.2	0.0	-0.2	0.7	0.50
1000	-0.2	-0.1	0.0	-0.2	0.0	-0.2	0.81	0.61
1500	-0.3	-0.2	0.0	-0.3	0.0	-0.3	1.63	1.33
2000	-0.3	-0.2	-0.1	-0.3	-0.1	-0.2	2.54	2.24
2500	-0.3	-0.2	-0.9	-0.9	-0.2	-0.7	3.44	3.14
3000	-5.4	-5.3	-5.1	-5.4	-5.1	-0.3	4.28	-1.12
3500	-7.4	-8.3	-8.2	-8.3	-7.4	-0.9	5.05	-2.35
4000	-8.6	-8.5	-8.4	-8.6	-8.4	-0.2	5.75	-2.85
4500	-9.2	-9.1	-8.1	-9.2	-8.1	-1.1	6.37	-2.83
5000	-6.5	-6.4	-5.2	-6.5	-5.2	-1.3	6.92	0.42
5500	-4.8	-4.7	-4.6	-4.8	-4.6	-0.2	7.41	2.61
6000	-8.5	-8.4	-8.2	-8.5	-8.2	-0.3	7.85	-0.65
6500	-14.0	-13.9	-13.8	-14.0	-13.8	-0.2	8.24	-5.76
7000	-21.7	-21.6	-21.4	-21.7	-21.4	-0.3	8.58	-13.12

AM Power Saving

Field Testing



AM Power Saving

Field Testing

- Needed a method to record the audio from the Skywave radios
- Tascam makes an inexpensive handheld digital recorder with line input capability
- Sourced 3 Tascam DR-05X recorders and the necessary cables from Broadcast Supply Worldwide to connect them to the Skywave radios and tested them
- And we purchased a ton of AA batteries!

Field Testing

Field Testing

- Field Team
  - Townsquare Media
    - Martin Stabbert DOE
    - Jordan Tomlinson Regional Chief Engineer
  - Nautel
    - Jeff Welton, Regional Sales Manager, Central U.S.
  - Broadcast Supply Worldwide
    - Tim Schwieger, President
    - Bryan Seeley, Director of Sales & Marketing

Field Testing

- Needed a field strength meter
- Rented a Potomac Instruments PI4100 field strength meter
  - Used that to check the two older Potomac Instruments FIM-41 that Townsquare had


PI Potomac Instruments
4100
48.0 dBuV/m
POWER
LPF
HOLD
MODE
SAVE
FREQ SET
AUDIO
FREQ PRESET
MENU
SELECT
DELETE

Field Testing

- Additionally Townsquare had a 3 phase power logging system that would allow us to measure transmitter power consumption and record it on a second by second basis

Field Testing

Time	V12	Unit	V23	Unit	V31	Unit	A1	Unit	A2	Unit	A3	Unit	P(SUM)	Unit	S(SUM)	Unit	Q(SUM)	Unit	PF(SUM)	PFH	WH	Unit
08:34:07	207.5	ACV	207.1	ACV	208.6	ACV	15.61	ACA	15.95	ACA	15.09	ACA	4.912	KW	5.59	KVA	2.669	KVAR	0.87	0.88	0.314	KWH
08:34:11	207.5	ACV	207	ACV	208.5	ACV	15.61	ACA	14.34	ACA	13.7	ACA	4.476	KW	5.089	KVA	2.421	KVAR	0.87	0.88	0.319	KWH
08:34:15	207.6	ACV	206.9	ACV	208.6	ACV	16.12	ACA	15.7	ACA	15.53	ACA	4.969	KW	5.676	KVA	2.742	KVAR	0.87	0.88	0.324	KWH
08:34:19	207.5	ACV	207	ACV	208.6	ACV	16.66	ACA	14.67	ACA	13.35	ACA	4.696	KW	5.356	KVA	2.575	KVAR	0.87	0.88	0.33	KWH
08:34:23	207.5	ACV	207.2	ACV	208.6	ACV	15.31	ACA	15.69	ACA	14.78	ACA	4.796	KW	5.488	KVA	2.666	KVAR	0.87	0.88	0.335	KWH
08:34:27	207.8	ACV	207.2	ACV	208.7	ACV	15.14	ACA	15.86	ACA	14.7	ACA	4.81	KW	5.482	KVA	2.628	KVAR	0.87	0.88	0.34	KWH
08:34:31	207.7	ACV	207.1	ACV	208.8	ACV	15.72	ACA	14.28	ACA	15.21	ACA	4.747	KW	5.423	KVA	2.623	KVAR	0.87	0.88	0.346	KWH
08:34:35	207.6	ACV	207.1	ACV	208.9	ACV	15.76	ACA	15.17	ACA	14.64	ACA	4.78	KW	5.469	KVA	2.657	KVAR	0.87	0.88	0.35	KWH
08:34:39	207.8	ACV	207.2	ACV	208.5	ACV	15.85	ACA	15.79	ACA	15.21	ACA	4.933	KW	5.614	KVA	2.681	KVAR	0.87	0.88	0.357	KWH
08:34:43	207.7	ACV	207.3	ACV	208.7	ACV	14.77	ACA	15.85	ACA	14.3	ACA	4.714	KW	5.389	KVA	2.611	KVAR	0.87	0.88	0.362	KWH
08:34:47	207.7	ACV	207.2	ACV	209.1	ACV	14.71	ACA	15.63	ACA	14.39	ACA	4.708	KW	5.372	KVA	2.588	KVAR	0.87	0.88	0.367	KWH

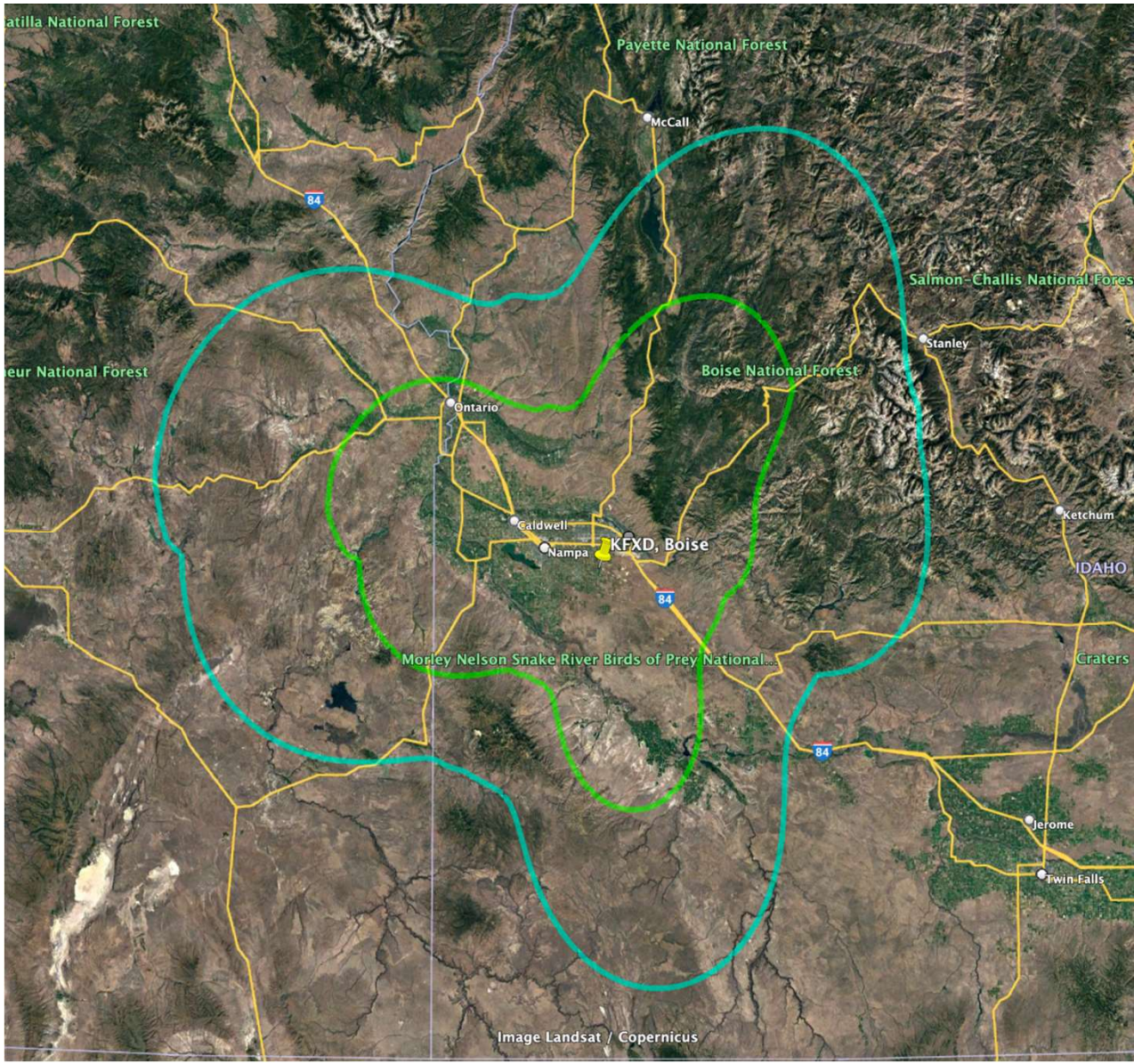

Rockwell
Collins 820E-1 AM Transmitter The Power Rock
Rockwell
SHURE

Field Testing

- Field testing at 2.0 mV/m and 0.5 mV/m
- Two sites for 2.0 mV/m manned by the Townsquare team
- The site for 0.5 mV/m was manned by the BSW folks and myself
- The 0.5 mV/m contour was over 60 miles from the transmitter site!
- In the 6 hours we were at the 0.5 mV/m location we didn’t see another vehicle!

Field Testing

KFDX FCC Contour:
2.0 mV/m (Light Green)
0.5 mV/m (Dark Green)



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Field Testing

- Testing Matrix
  - 100% symmetrical
  - 125% positive MDCL
    - 3 dB, 4 dB, 5 dB & 6 dB AMC
  - 150% positive MDCL
    - 3 dB, 4 dB, 5 dB & 6 dB AMC
  - 140% positive Enhanced MDCL
    - (1.76 dB power increase) 3 dB, 4 dB, 5 dB & 6 dB AMC
  - 150% positive Enhanced MDCL
    - (1.76 dB power increase) 3 dB, 4 dB, 5 dB & 6 dB AMC


KISS FM

Field Testing

- Ended up running the testing at lower than the licensed 5 kW
- There were concerns with how much power the antenna phaser and tuners could take without damage at 150% positive modulation and in Enhanced MDCL with an additional 1.76 dB of carrier power
- Didn’t want to “let the smoke” out of anything

Field Testing

AM 100% Symmetrical Field Strength uV/m	dBm	AC Power kW	MDCL AMC 125%	Field Strength uV/m	dBm	Delta dBm	AC Power kW	Delta AC kW	Reduction in power consumption
610	-51.28	5.26	3 dB	436	-54.20	-2.92	2.74	-2.52	-47.83%
			4 dB	386	-55.28	-4.00	2.21	-3.05	-57.98%
			5 dB	349	-56.13	-4.85	1.96	-3.30	-62.74%
			6 dB	325	-56.75	-5.47	1.18	-4.08	-77.51%

Field Testing

- Didn’t find any benefit to running Enhanced MDCL or greater than 125% positive modulation when we looked at:
- Technical challenges (power handling capability of the antenna system)
- Lack of transmitters capable of running Enhanced or 150% positive modulation
- Regulatory constraints (i.e. would the FCC actually issue licenses to run greater than 125% positive and/or Enhanced MDCL)

Bryan Seeley at the 0.5 uV/M location taking a measurement with the Potomac PI4100

Field Test Results

- Greater carrier suppression
  - Higher modulation density gives the MDCL system the ability to suppress the carrier to a much greater extent for longer periods of time
- 77% power reduction
  - At 6dB of AMC, 77% reduction in transmitter power consumption
- Slight degradation in fringe coverage at AMC levels > than 3 dB
- Zero listener complaints
  - Townsquare & Bonneville stations running 6 dB AMC on NX transmitters have significant power savings and zero listener complaints since 2020
  - **WEPN 1050 KHz, WINS 1010 KHz,WNYM 970 KHz,WCBS 880 KHz,WABC 770 KHz,WFAN 660 KHz all in New York City**

KSL AM
Salt Lake City

50 kW Tx
using
only 12 kW

AM Power Saving


C.CRANE
SKYWAVE
AM · FM · WX · AIR · SW
TASCAM
PUSH

What next?

- Calculator
- Leasing options
- Contact

AM Power Savings

Replacing legacy technology with a Nautel NX Series MW transmitter running MDCL could yield energy savings of up to $100,000 USD per year based on real world examples.

Calculate your energy savings with Nautel's MDCL technology

Enter values into the green cells to estimate your savings.

	Select Modulation Density		Mild		
	Current	NX Power 50	DCC MDCL	AMC 3dB MDCL	AMC 6dB MDCL
Cost per kW/h (US cents)	15	15	15	15	15
Power of Transmitter in kW	50	50	50	50	50
Rated Efficiency	73%	88%	88%	88%	88%
Modulation Factor	1.1	1.1	1.1	1.1	1.1
Consumption in kW/H	75.30	62.50	34.40	50.00	43.80
Hours of Operation / Day	24	24	24	24	24
Days of Operation / Year	365	365	365	365	365
Total Yearly					

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www.nautel.com/am-mdcl-savings/

AM Power Saving

Online Information

- **Nautel Waves Newsletter**
  https://www.nautel.com/newsletter/

  Webinars
  https://www.nautel.com/webinars/

  YouTube
  https://www.youtube.com/user/NautelLtd

- **MDCL Savings Calculator**
  www.nautel.com/am-mdcl-savings/

Thank You!

www.nautel.com


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