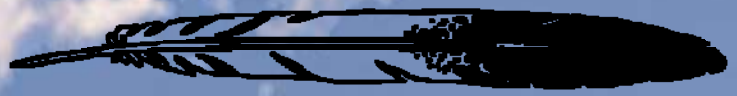
LEE SOUND DESIGN



CONSULTING ENGINEERS
Audio, Acoustics, and Video

Acoustic and Electro-Acoustic Measurement Workshop

Speech Intelligibility

The Audio Engineering Society – Atlanta Section
Saturday, February 19, 2011

D. Wayne Lee, PE

DEFINITION OF SPEECH INTELLIGIBILITY
Can You Hear Me Now?

Potential Client: I can't hear anything when I'm sitting in the back row.

You: Well is the system loud enough?

Potential Client: Yea it's plenty loud.

You: Oh so you can't understand what's being said?

Potential Client: Well yea I can't hear a thing.

DEFINITION OF SPEECH INTELLIGIBILITY
Can You Hear Me Now?

Loudness and “being able to hear” is different from intelligibility and “being able to understand.” It can be loud enough but unintelligible, especially in a reverberant space.

It’s not audibility – allowing sounds to be heard among other sounds

It’s not clarity – freedom of sound from distortions of all kind

DEFINITION OF SPEECH INTELLIGIBILITY

Noun 1. speech intelligibility - the intelligibility of speech (usually measured in the presence of noise or distortion)
intelligibility - the quality of language that is comprehensible

(in'tel ? j?'bil ?d e)
(communications) The percentage of speech units understood correctly by a listener in a communications system; customarily used for regular messages where the context aids the listener, in distinction to articulation. Also known as speech intelligibility.

WHAT ARE WE MEASURING AND WHY?

* Potential intelligibility of a particular system?

* Intelligibility of speech with the aid (or hindrance) of a sound system?

Remember we are usually measuring a system.

We can't always control what goes into the sound system.

WHAT ARE WE MEASURING AND WHY?

* To verify a sound system meets a particular level of speech intelligibility as a design target.

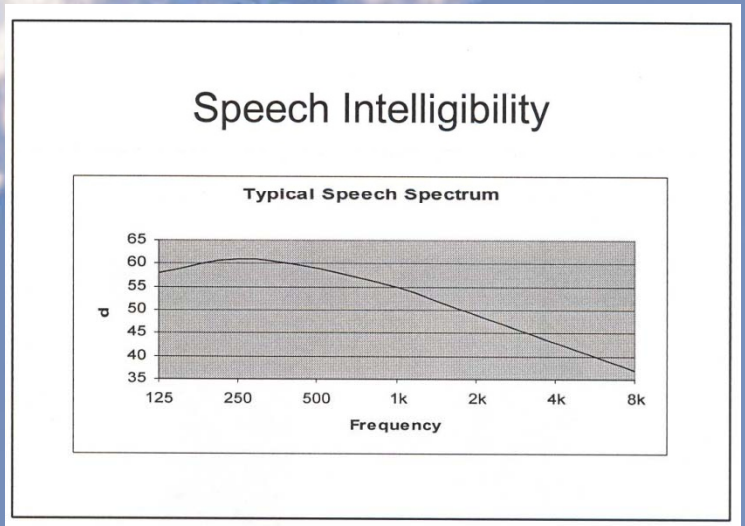
* To verify a sound system meets a particular contractual criterion.

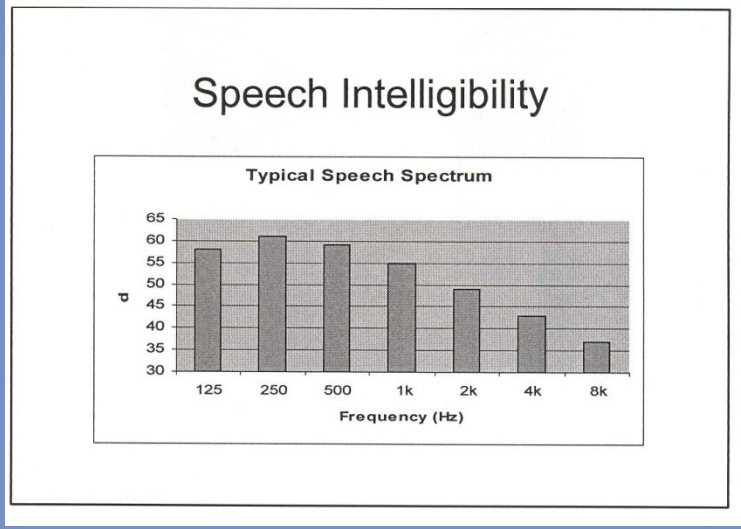
* To ascertain why a sound system is not as intelligible as it should be.

SPEECH AND FREQUENCY RELATIONSHIPS

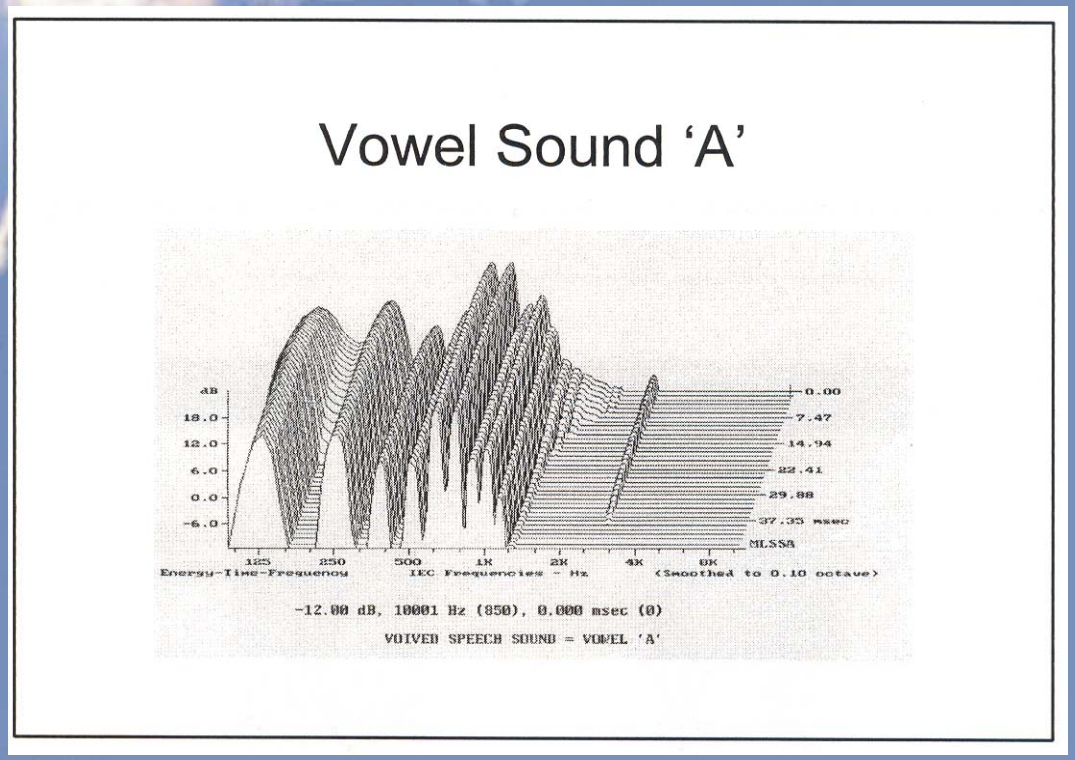
* The mid band frequencies are the most important for voice and most pre-programmed music. Vocal power is concentrated around the 500Hz and 1000 Hz octaves with articulation and presence at 2000 Hz to 4000 Hz octaves. Low frequency voice energy is around the 200 Hz to 500 Hz octave and consists of the chest diaphragm sounds, more often found in male talkers. Good intelligibility requires a little of all of this.

SPEECH AND FREQUENCY RELATIONSHIPS

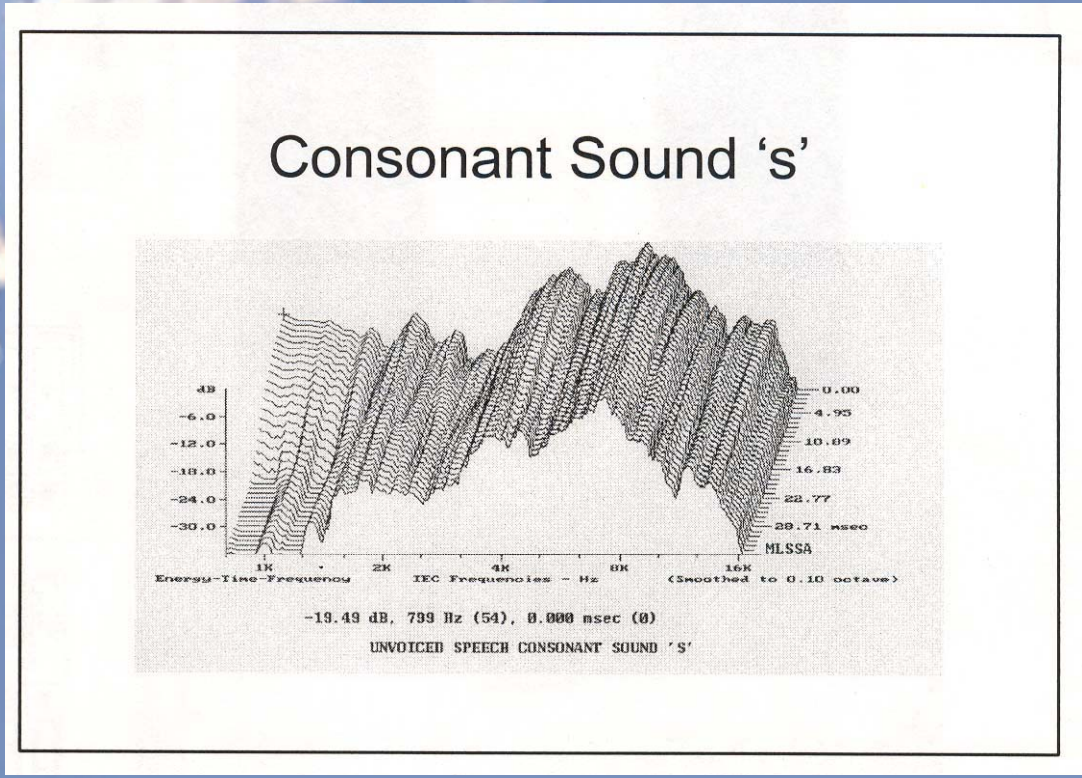




SPEECH AND FREQUENCY RELATIONSHIPS



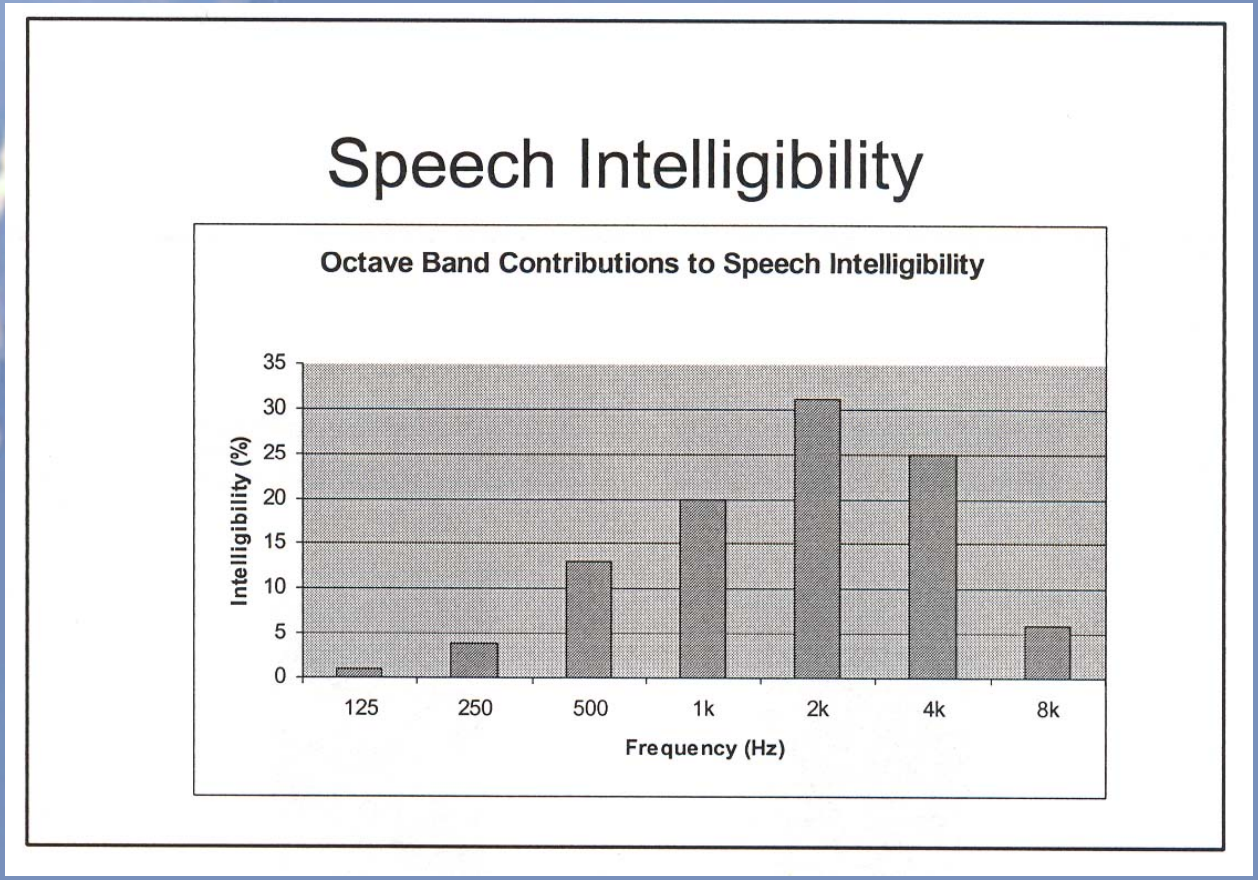
SPEECH AND FREQUENCY RELATIONSHIPS



SPEECH AND FREQUENCY RELATIONSHIPS

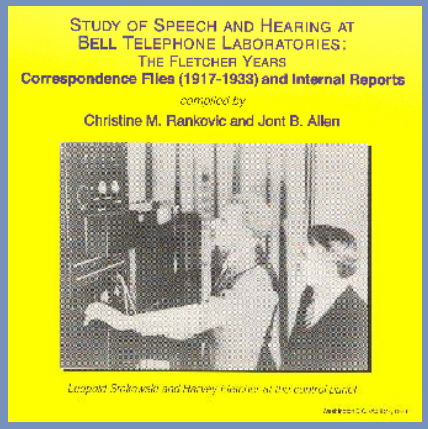
* The majority of the speech intelligibility resides in the three middle octaves of 500 Hz, 1000 Hz and 2000 Hz. The contribution is approximately 16% at 500 Hz, 25% at 1000 Hz and 34% at 2000 Hz. The remaining contribution is distributed throughout the other octaves. Our analysis usually concentrates on these octaves.

HISTORY OF MEASURING (AND STUDYING) SPEECH INTELLIGIBILITY



Bell Labs The Fletcher Years 1917 -1933

* Research for improving quality of telephone speech
* Fletcher was the first president of the ASA
* Historical and technical review of these years - JASA, 1996, April, pp1825-1839, Jont Allen
* Documents discovered at ATT Archives, Warren, NJ late 1990's
* 1953 seminal book - Speech and Hearing in Communications



ARTICULATION TESTING - WORD LISTS

* 1940's - Professors J. P. Egan and S. S. Stevens, Psycho-Acoustic Lab, Harvard University - The *R Lists*

* Lists of random sentences, words or syllables to measure percentage correctly recognized by a listener

* Evaluate effect of ambient noise, long delayed reflections, echoes

ARTICULATION TESTING - WORD LISTS

* Lists of phonetically balanced words or rhymes

* Articulation Index (AI): Covered by ANSI S3.5 (1969)

* Phonetically Balanced Word Scores: Covered by ANSI S3.2 (1989)

* Still the only acceptable method of testing in some jurisdictions

ARTICULATION TESTING - WORD LISTS

PB Wordlist

Phonetically balanced speech intelligibility test

Line No.	*Column*					
	A	B	C	D	E	F
1	bat	bad	back	bass	ban	bath
2	been	beach	beat	beam	bead	beak
3	bun	bus	but	buff	buck	bug
4	came	cape	cane	cake	cave	case
5	cut	cub	cuff	cup	cud	cuss
6	dig	dip	did	dim	dill	din
7	duck	dud	dung	dub	dug	dun
8	fill	fig	fin	fizz	fib	fit
9	hear	heath	heal	heave	heat	heap
10	kick	king	kid	kit	kin	kill
11	late	lake	lay	lace	lane	lame
12	map	mat	math	man	mass	mad
13	page	pane	pace	pay	pale	pave
14	pass	pat	pack	pad	path	pan
15	peace	peas	peak	peal	peat	peach
16	pill	pick	pip	pig	pin	pit
17	pun	puff	pup	puck	pus	pub
18	rave	rake	race	rate	raze	ray
19	sake	sale	save	sane	safe	same
20	sad	sass	sag	sack	sap	sat
21	seep	seen	seethe	seed	seem	seek
22	sing	sit	sin	sip	sick	sill
23	sud	sum	sub	sun	sup	sung
24	tab	tan	tam	tang	tack	tap
25	teach	tear	tease	teal	team	teak
26	led	shed	red	bed	fed	wed
27	sold	told	hold	fold	gold	cold
28	dig	wig	big	rig	pig	fig
29	kick	lick	sick	pick	wick	tick
30	book	took	shook	cook	hook	look
31	hark	dark	mark	lark	park	bark
32	gale	male	tale	bale	sale	pale
33	peel	reel	feel	heel	keel	eel
34	will	hill	kill	till	fill	bill
35	foil	coil	boil	oil	toil	soil

/continued over page

KLARK TEKNIK
The first name with sound system designers

LEE SOUND DESIGN, Inc.

SIGNAL-TO-NOISE RATIO

* Lochner and Burger 1961 introduction of early energy fraction and weighting factor

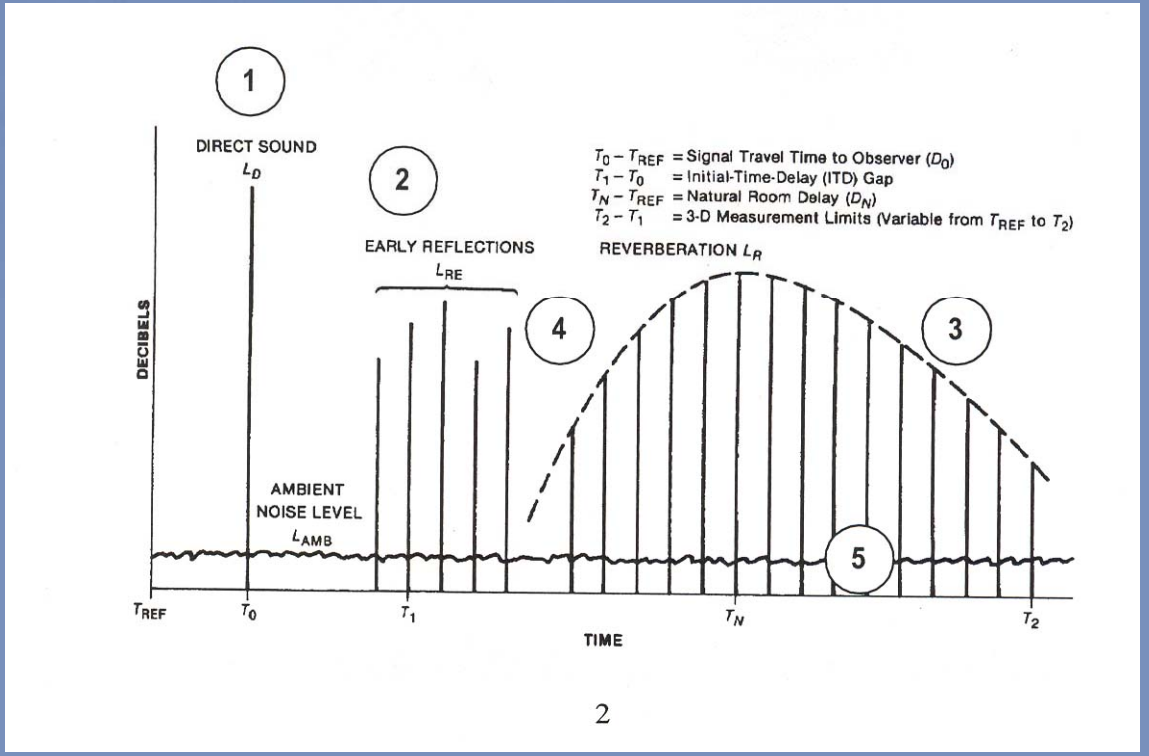
* 1964 Journal of Sound and Vibration paper, “Influence of Reflections on Auditorium Acoustics”

* Useful energy in sound reflections within first 50 ms to 92 ms of direct sound

* Brains integration of sound energy within this region

SIGNAL-TO-NOISE RATIO

1 – Direct Sound
2 – Early Reflections
3 – Reverberation
4 – Energy Ratio Separation
5 – Ambient Noise



PERCENTAGE ARTICULATION LOSS OF CONSONANTS - %ALcons

* 1971 V.M.A. Peutz publishes equation for %ALcons in speech

* $$\%ALcons = \frac{656D_2^2RT_{60}(N)}{VQM}$$

* Most people must understand at least 85% of the articulation of consonants for speech to be intelligible

* We can tolerate a loss of 15% of the articulation of consonants.

PERCENTAGE ARTICULATION LOSS OF CONSONANTS - %ALcons

Percentage loss of consonants (% Alcons)

$D_2 < 3.16DC \quad \%\ Alcons = \frac{200(D_2)^2(RT_{60})^2(n+1)}{VQm}$

$D_2 > 3.16DC \quad \%\ Alcons = 9RT_{60}(+k)$

k = zero correction factor. For a good listener k = 1.5%

Maximum distance (LS to listener) for 15% Alcons

$$\text{Max } D_2(15\%) = \sqrt{\frac{15VQm}{200(RT_{60})^2(n+1)}}$$

$$\text{Max } RT_{60} \text{ for } 15\%\ Alcons = \sqrt{\frac{15VQm}{200(D_2)^2(n+1)}}$$

$$\text{Min Q for } 15\%\ Alcons = \frac{200(D_2)^2(RT_{60})^2(n+1)}{15Vm}$$

$$DC = \text{Critical distance} = 0.141\sqrt{QS\bar{\alpha}} \qquad DC \text{ also} = 0.141\sqrt{\frac{QRm}{n+1}}$$

Note % Alcons may also be expressed as

$$\%\ Alcons = \frac{200(D)^2(RT)^2}{V+k}$$

V = Volume of space in m^3
D_2 = Distance in metres between loudspeaker and listener
Q = Axial directivity factor
(n+1) = Total number of loudspeaker groups contributing to the reverberant field ('1' represents that group that also contributes direct sound to the measuring point)
m = The critical distance modifier
$m = (1-\bar{\alpha})/(1-\bar{\alpha}c)$
$\bar{\alpha}$ = Average absorption coefficient
$\bar{\alpha}c$ = Average absorption coefficient of surface covered by loudspeaker(s)
For imperial calculations in feet change 200 to 641.81

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PERCENTAGE ARTICULATION LOSS OF CONSONANTS - %ALcons

* Figure of merit is the percentage of loss of articulation in consonants or abbreviated %Alcons

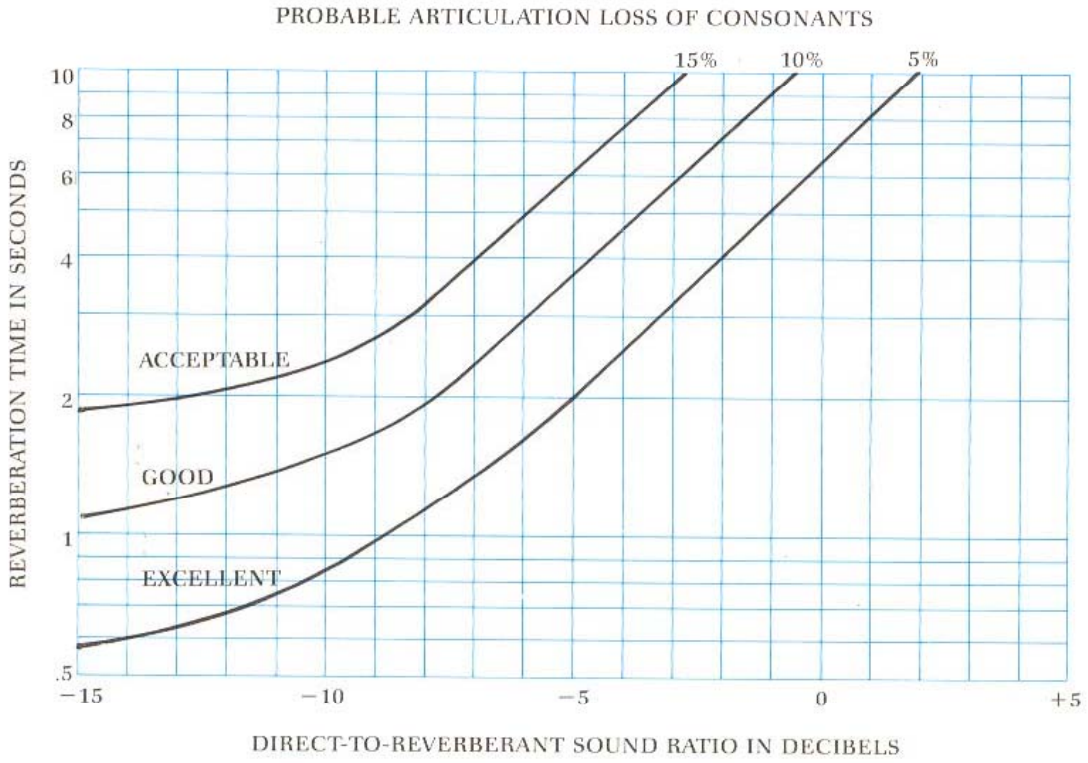
* In critical listening situations such as worship spaces and auditoriums, most people find 8% to 10% ALcons provides a more realistic limit. Listening can be comfortable and not strained.

* In paging sound system applications, often all that is required for the verbal communication, is understanding your name. These systems can often measure slightly greater than 15% ALcons.

PERCENTAGE ARTICULATION LOSS OF CONSONANTS - %ALcons

Probable intelligibility

as a function of reverberation time and direct-to-reverberant sound ratio



PERCENTAGE ARTICULATION LOSS OF CONSONANTS - %ALcons

* Syn-Aud-Con Speech Intelligibility Workshop - St. Charles, IL, Sept 23-26,1986

* Verified and quantified of the TEF 12, %Alcons, B&K RASTI measurement systems

* Direct correlation of the role of loudspeaker directivity vs. speech ineligibility scores

* Role of ear/brain integration time in speech intelligibility

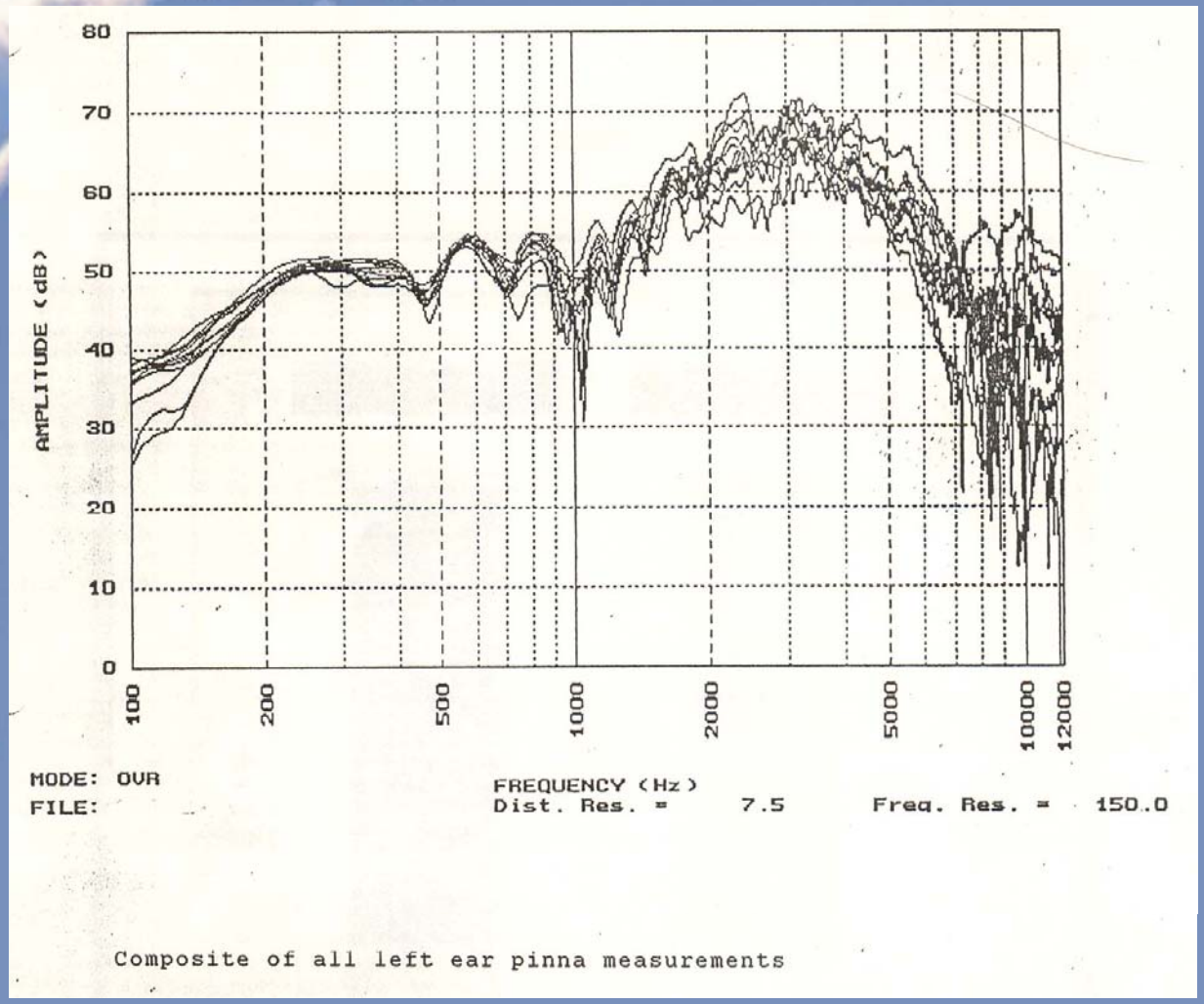
PERCENTAGE ARTICULATION LOSS OF CONSONANTS - %ALcons

* Syn-Aud-Con Speech Intelligibility Workshop II, Indiana Univ - October 7-9, 1990

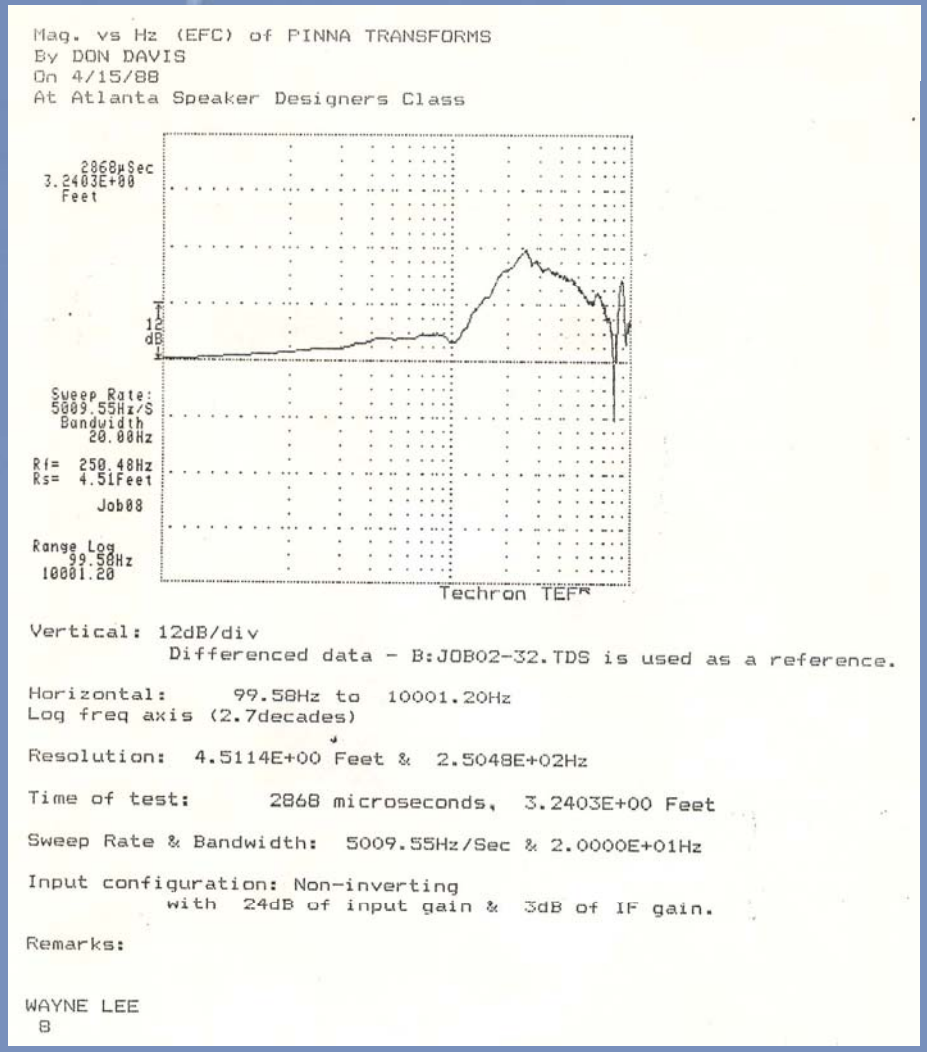
* Role of pinnae and ear canal. Speech intelligibility centers on 2 kHz octave as does the peaked response at the listeners eardrum

* Learned people with high pinnae response in 2500 Hz region, but poor overall freq resp scored higher on word tests

PERCENTAGE ARTICULATION LOSS OF CONSONANTS - %ALcons



PERCENTAGE ARTICULATION LOSS OF CONSONANTS - %ALcons



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PERCENTAGE ARTICULATION LOSS OF CONSONANTS - %ALcons

* Syn-Aud-Con Speech Intelligibility Workshop II, Indiana Univ - October 7-9, 1990

* DAT recordings of various %Alcons using live listeners, TEF analysis and In-The-Ear measurements

* Learned the role of high level specular room reflections particularly from side walls

DIRECT TO REVERBERANT ENERGY RATIOS

* C50 and C35 - Often used in Europe as a measure of speech intelligibility

* Split time is the ratio of Direct and Reverberant Energy - 35 ms or 50 ms after the direct sound

* Ideally C50 is >0 dB and roughly equivalent to 10% Alcons

* No formalized scale, measurements purely within the 1 kHz octave, do not take into consideration background noise or masking

MODULATION TRANSFER FUNCTION - MTF

* 1980's Houtgast and Steeneken, TNO Human Factors published their MTF adaptation first used in optics, into Speech Transmission Index (STI)

* 1971 Acustica, “Evaluation of Speech Transmission Channels using Artificial Signals”

* Relies on concept that speech intelligibility is based on the slow modulation of the strength of the sound pressure acting as a carrier

MODULATION TRANSFER FUNCTION – MTF

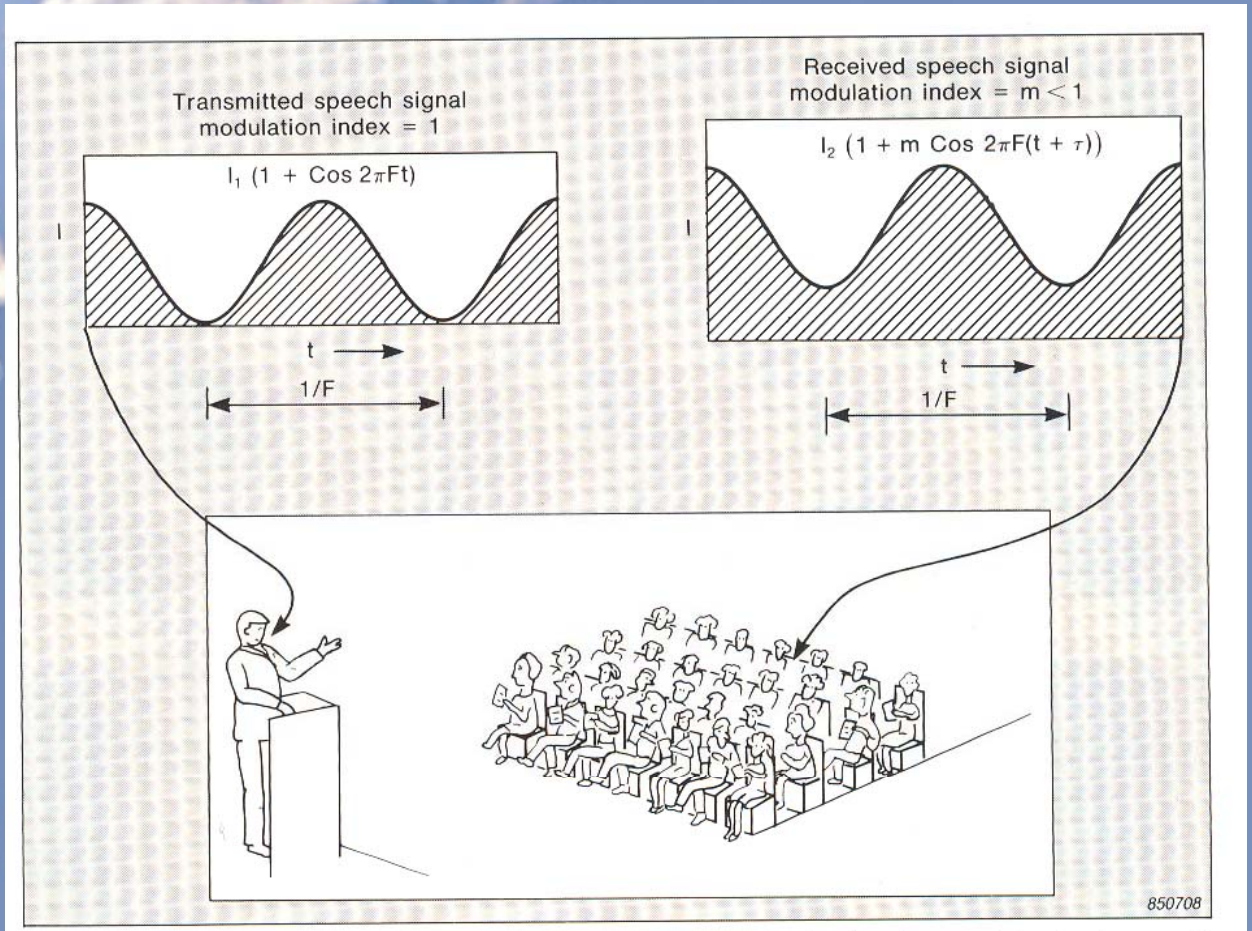
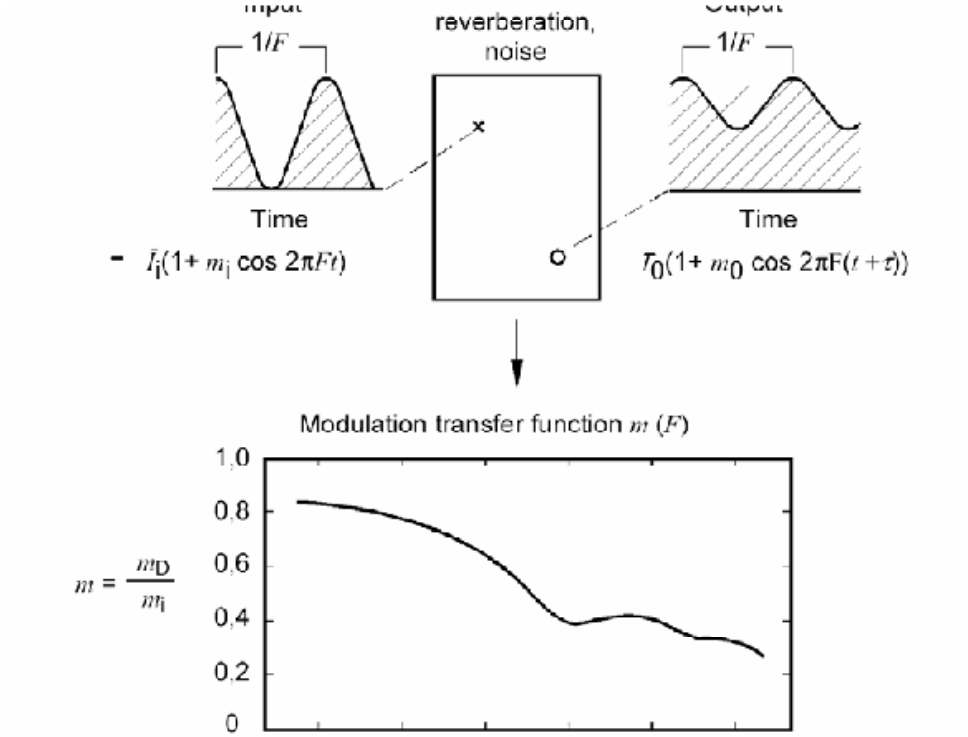


Fig. 3 Illustration of the reduction in modulation of a speech signal caused by background noise and reverberation

MODULATION TRANSFER FUNCTION – MTF

rength
re
rrier.



SPEECH TRANSMISSION INDEX - STI

* Test signal with speech like characteristics following the concept that speech can be described as a fundamental waveform modulated by low frequency signals

* The depth of the modulation of the measured/received signal is compared to the test signal

* Reductions in modulation depth are reductions in speech intelligibility

SPEECH TRANSMISSION INDEX - STI

* Carrier - 7 Octave bands, 125 Hz to 8 kHz, gaussian noise

* Modulation - 14 frequencies from 0.63 Hz to 12.5 Hz

* Each of the 98 combinations is measured in 10 seconds for a total of 16 minutes total measurement time

SPEECH TRANSMISSION INDEX - STI

* Noise may be added as part of the measurement

* Computationally difficult in it's early days

* Go-no-go type analysis with no additional information about the results

* STI Covered by IEC Standard 60268-16

RAPID SPEECH TRANSMISSION INDEX– RASTI

* Developed in 1979 by TNO, Human Factors as a simplified measurement

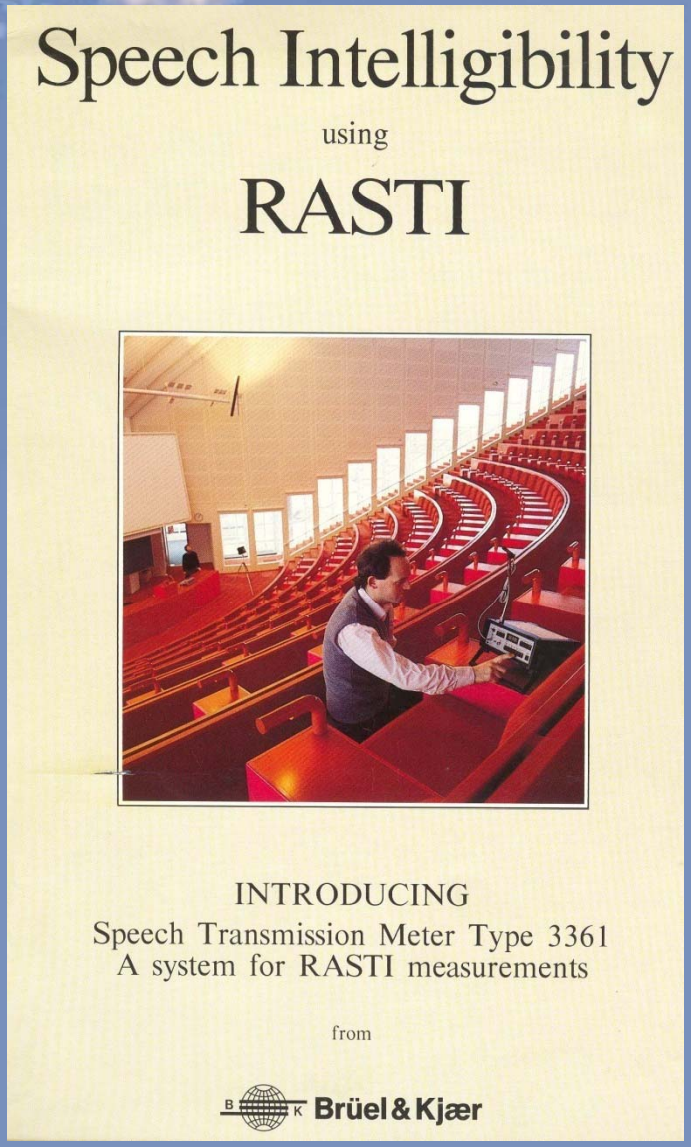
* Method only considers the two octave bands of 500 Hz and 2 kHz

* Each band modulated with four and five frequencies, respectfully, in 9 total combinations

* Typical measurement time was 10 to 15 seconds

* Limitations on accuracy where the sound system is strongly non-linear or has limited bandwidth

RAPID SPEECH TRANSMISSION INDEX-RASTI



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RAPID SPEECH TRANSMISSION INDEX-RASTI

Brüel & Kjær

product data
type 3361

Speech Transmission Meter Type 3361
Consisting of Transmitter Type 4225
and Receiver Type 4419

RASTI (Rapid Speech Transmission Index) is a method of measuring objectively, how good an acoustic communication channel is with respect to speech intelligibility. It is based on measurement of the reduction in signal modulation between the speaker and listener positions and offers many advantages over traditional methods.

Speech Transmission Meter Type 3361 measures RASTI values directly using two instruments: Transmitter Type 4225 which sends out a special test signal, and Receiver Type 4419 which analyses the signal and calculates the RASTI value. The instruments are battery powered and fully portable, enabling rapid and objective measurement of the quality of speech intelligibility and provide further information of diagnostic value.

4419


4225

FEATURES

- Measures Speech Transmission Index according to RASTI method
- Speech transmission index given for two octave bands of carrier signal
- Measures 9 points on Modulation Transfer Function
- Estimates equiv. Early Decay and equiv. S/N
- Conforms to IEC Draft Pub. 268, Part 16
- RASTI index can be directly compared with results from theoretical models.
- Built-in loudspeaker for output of test signal
- Selectable measuring times of 8, 16, and 32 s
- Provision for entry of a noise floor to simulate background noise
- Easily calibrated
- Serial data interface
- Rugged, portable, battery powered instruments

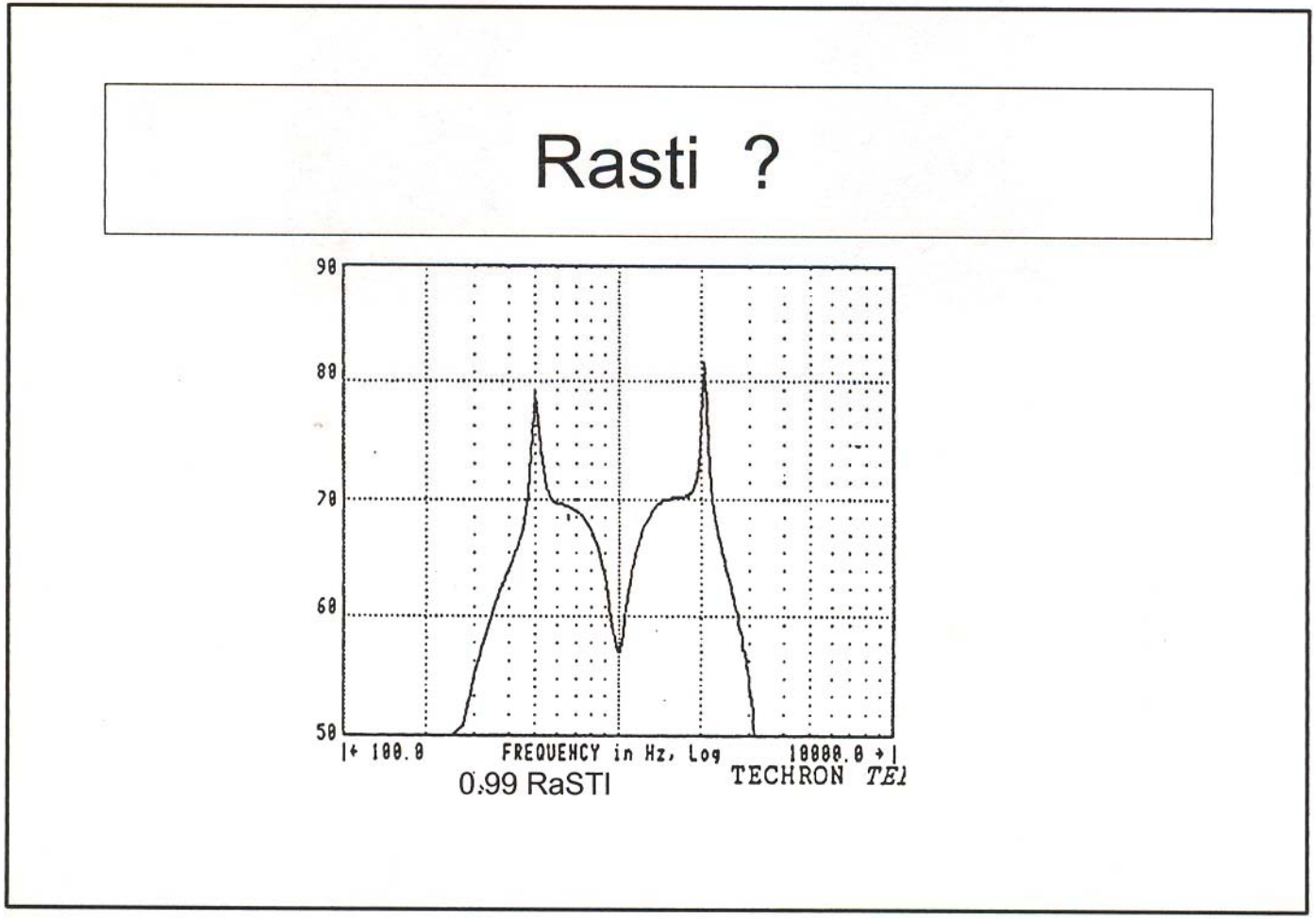
USES

- Objective assessment of speech intelligibility in: Auditoria, Theatres, Conference rooms, Schools, Industry, Aircraft, Motor Vehicles, Vessels.
- Optimizing speech reinforcement systems.
- Assessment of public address systems: in Railway stations, Airports, also Emergency Public Address Systems.
- As a diagnostic tool for investigating means of improving speech intelligibility
- Investigation of acoustical privacy

BP 0435-12

LEE SOUND DESIGN, Inc.

RAPID SPEECH TRANSMISSION INDEX-RASTI



RAPID SPEECH TRANSMISSION INDEX-RASTI

Converting RASTI measurements to % Alcons
After Becker

	RASTI	% Alcons
	0.20	57.7
	0.22	51.8
Bad	0.24	46.5
	0.26	41.7
	0.28	37.4
	0.30	33.6
	0.32	30.1
	0.34	27.0
Poor	0.36	24.2
	0.38	21.8
	0.40	19.5
	0.42	17.5
	0.44	15.7
	0.46	14.1
	0.48	12.7
	0.50	11.4
Fair	0.52	10.2
	0.54	9.1
	0.56	8.2
	0.58	7.4
	0.60	6.6
	0.64	5.3
Good	0.66	4.8
	0.68	4.3
	0.70	3.8
	0.72	3.4
	0.74	3.1
	0.76	2.8
	0.78	2.5
	0.80	2.2
	0.82	2.0
	0.84	1.8
	0.86	1.6
Excellent	0.88	1.4
	0.90	1.3
	0.92	1.2
	0.94	1.0
	0.96	0.9
	0.98	0.8
	1.00	0.0

STI-Pa and CIS

* Computational speed increase allows advances

* Developed to improve accuracy in assessment of PA sound systems

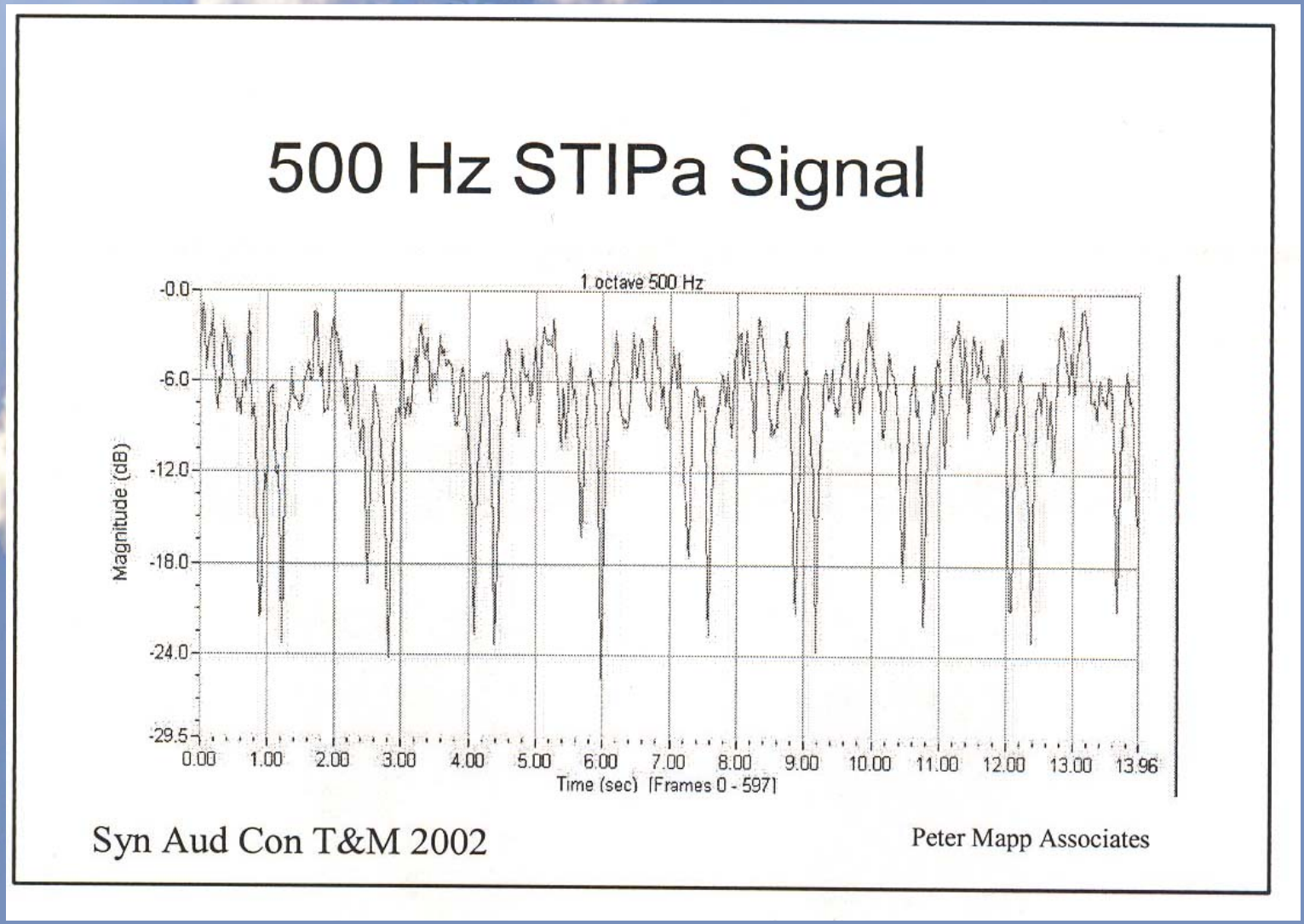
* Handles effects due to reverberation and sound system distortions

* Uses all 7 octave bands from full STI and 12 modulation indices

STI-Pa and CIS

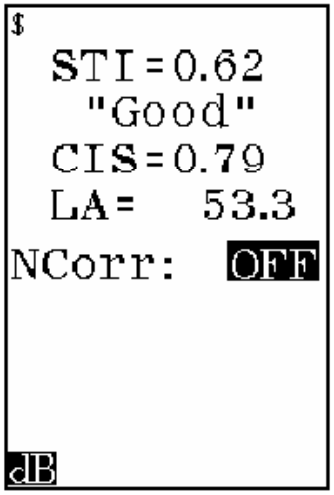
* CD provided with test signals
* Typical measurement time was 10 to 15 seconds
* Common Intelligibility Scale (CIS) common in US
* Peter Mapp & Associates

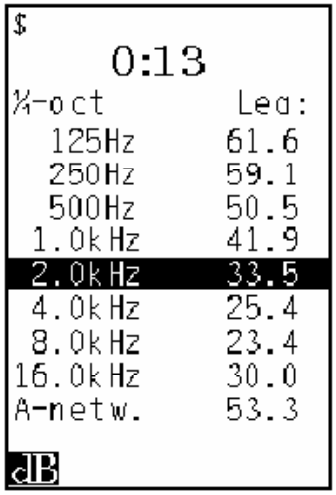
STI-Pa and CIS



STI-Pa and CIS

- The rating is displayed after the measurement and may be stored with the octave spectrum.





KEY PARAMETERS AFFECTING SPEECH INTELLIGIBILITY

* Oversimplified version - Low RT or high Q loudspeaker or short D2

* Age, physical conditions, mental condition, and mood will affect understanding speech

* Hearing sensitivity, ear configurations, differences in ear type and training will cause variations in speech intelligibility scores

* Reverberation time - especially difference of direct and reverberant level

KEY PARAMETERS AFFECTING SPEECH INTELLIGIBILITY

* Signal-To-Noise Ratio (SNR) – Masking
* Distance from loudspeaker
* Source misalignments, especially short ones
* Reflections under 1 ft of path length difference
* Reflections late in time (100 + ms) and higher in level than surrounding energy

SECONDARY FACTORS AFFECTING SPEECH INTELLIGIBILITY

* Talker Type - male/female/accent
* System distortion
* System Equalization
* Uniformity of acoustic coverage
* Reflections, focusing, echoes
* Localization - direction of arrivals
* Vocabulary and context of the speech information

SPEECH INTELLIGIBILITY MEASUREMENT TOOLS

* Groups of listeners, a talker and a sound system
* Smaart from JBL, EAW, Rational Acoustics
* EASE SysTune from AFMG or Renkus-Heinz
* TEF 25 from GoldLine
* EASRA from AFMG or Renkus-Heinz
* SIM System from Meyer Sound
* STIPA Meter from Norsonic

SPEECH INTELLIGIBILITY MEASUREMENT TOOLS

* Verifier STI-PA Meter from Quest Technologies

* Model DSP30 with STI-CIS™ Intelligibility Option from GoldLine with conversion to Common Intelligibility Scale (CIS)

* STI-PA Software for Ivie Technologies IE-35 Analyzer

* NTI Acoustic Analyzer AL1 with STI-PA

* Measured IR's and wave editor software, Audacity, Sound Forge

SPEECH INTELLIGIBILITY MEASUREMENT TOOLS

DSP2B / DSP2BP

- Portable *digital* Speech Intelligibility/Privacy Meter.
- Displays results in CIS, STI or PI formats.
- Measurements conform to IEC60268-16.
- Factors in the effects of room acoustics and background noise.
- RS232 computer interface.

U.S. Patent 6,792,404

The following standard features are supplied.

- Model MK8A - 600 ohm omni-directional electret condenser instrument microphone.
- DSP2B - OPT STICis™ firmware.
- DSP2B - CIS and STI Intelligibility measurement modes.
- DSP2BP - OPT STICis™ and OPT PI firmware.
- DSP2BP - CIS, STI and PI, Intelligibility and Privacy measurement modes.
- STI-PA Test Tone CD.
- SPL mode.
- Serial Port.
- Rugged Carrying Case.

SPECIFICATIONS

Measurement Range:

LEE SOUND DESIGN, Inc.

SPEECH INTELLIGIBILITY MEASUREMENT TOOLS

LEE SOUND DESIGN, Inc.

SPEECH INTELLIGIBILITY MEASUREMENT TOOLS

Less noise • More sound

STI-PA Fact Sheet

Why speech intelligibility measurements?

In case of emergency, public address systems in buildings like airports, railway stations, shopping centers or concert halls have legal requirements to (clearly) inform persons in danger about escape information and directions. However if such announcements are misunderstood due to poor system quality, tragic consequences may result. Therefore, it is essential to design, install and verify sound reinforcement systems properly for intelligibility. In addition, a variety of other applications such as legal and medical applications may require intelligibility verification.

The IEC 60849 and other national standards shown in the table below require electro acoustic sound systems for emergency purposes to be verified under realistic circumstances, in order to ascertain a minimum level of speech intelligibility in case of an actual emergency.

Thereby, speech intelligibility from a regulatory view is not a subjective measurement, but can be verified with several, more or less complex methods that have been standardized in IEC 60268-16.

Other national or local regulatory bodies implement recommendations or requirements to conduct these measurements for maintaining minimum speech intelligibility.

Various local to national jurisdictions also then define whether or not it is mandatory to conduct the intelligibility measurements. These by-laws may vary depending on the type of business or venue, and the national or regional regulations, although the trend is certainly in the direction to require this testing.

How does STI-PA compare to STI and RASTI

STI measured in public address systems has been very time consuming, as the complete set of 98 measurements of modulation transfer functions (MTF) have to be obtained and summed. Due to the complex nature and the time required almost no really useful STI measurement systems were available for years.

With the appearance of MLS based systems, STI was more often obtained, as it can be calculated out of the transfer function, as long as the entire system is strictly linear and synchronous. But this means there must be no non-linear processing or conditions, including compressors or limiters, which is a rather rare situation. So STI-PA has been developed specifically to cope with the heavily non-linear processing environment common to advanced sound systems, and to reduce the measurement time required to a practical level.

STI-PA Measurements with the NTI Acoustilyzer AL1

National Standards	
IEC 60849	Sound systems for emergency purposes
NFPA 72	National Fire Alarm Code 2002 (2002 edition, section 7.4.1.4)
BS 5839-8	Fire detection and alarm systems for buildings. Code of practice for the design, installation and servicing of voice alarm systems

protected, BOSE of America has been recently granted the US-Patent 6,782,404B2 for the idea to implement STI or STI-PA onto a hand held analyzer. NTI maintains a license agreement with BOSE for this patent and is therefore able to market the STI-PA implementation available for the Acoustilyzer.

Can I buy STI-PA for my AL1?

Yes, STI-PA is an optional function for the Acoustilyzer AL1. Any AL1 user may obtain a STI-PA license. With the key of the license he may request the activation key for his Acoustilyzer AL1 and full functionality is then activated.

Minilyzer ML1, can be upgraded to STI-PA functionality

I have an ML1. Can I run STI-PA as well?

NTI offers a cross grade package that converts the functionality of the Minilyzer into an AL1 Acoustilyzer with 100% compatibility in functionality and specification. This functional extension, including the STI-PA option, is then available as with any other regular Acoustilyzer AL1.

What is a TalkBox, and do I need a TalkBox for STI-PA measurements?

The TalkBox is NTI's calibrated acoustical sound source with built in digital solid state signal generator.

No you don't necessarily need a TalkBox. If you are testing only the portion of the system beyond the microphone.

But the use of a Talk as a speaker simulation is advisable if:

- Regulations require a complete end-to-end system check including the microphone. This is the most realistic system check in any event.
- No electrical input is available to induct the electrical test signal.
- The level of the test signal is not clearly defined
- The characteristics of the speakers acoustical environment are not negligible and flat.

NTI TalkBox

- The characteristics, sensitivity and frequency response of the speaker's microphone is not known but needs to be considered.
- As above, if for any other reason it is desirable to test the entire signal chain under real conditions.

The TalkBox is also capable of delivering white and pink noise and other special signals, and so is a very useful overall tool for system tuning and testing.

For further information please visit: www.nti-instruments.com

LEE SOUND DESIGN, Inc.

AFTERNOON SESSION:

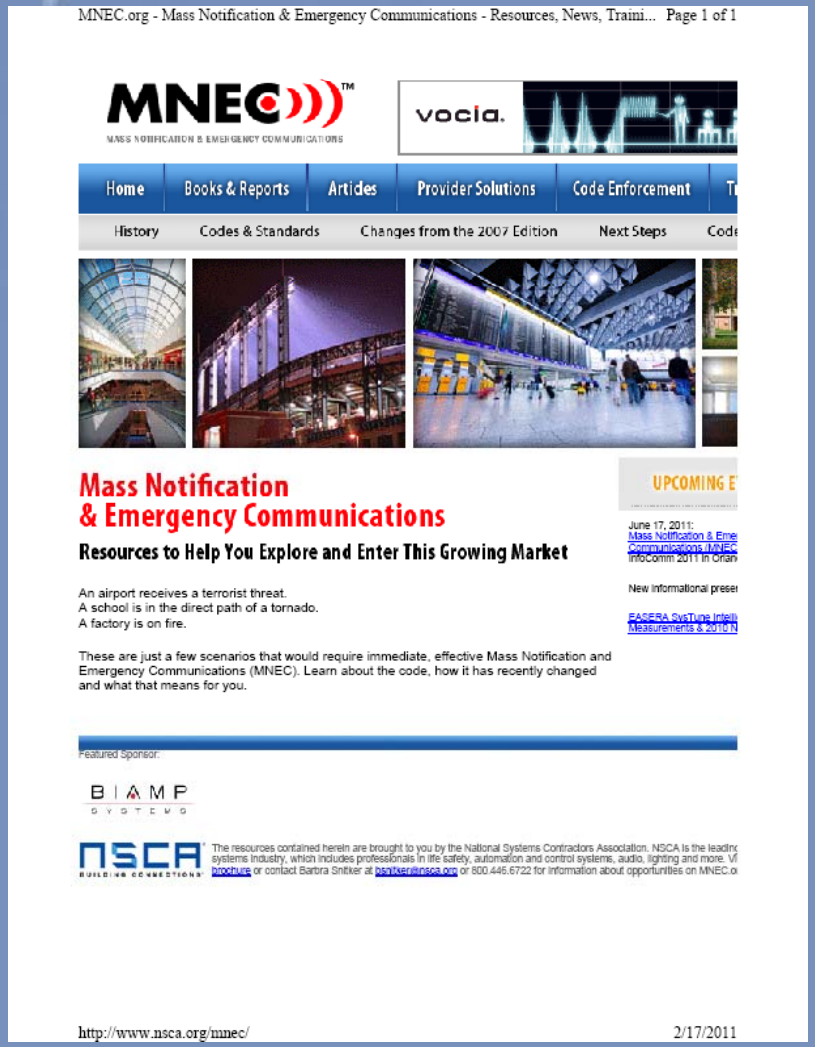
MEASURING SPEECH INTELLIGIBILITY IN REAL LIFE

* Using Rhyme Tests
* Measuring %ALCons
* Measuring RASTI
* Measuring STI
* Measuring with an STI-Pa Meter

SPEECH INTELLIGIBILITY MEASUREMENT OPPORTUNITIES - OR HOW CAN I MAKE MONEY AT THIS?

* Fire alarm system testing , commissioning and troubleshooting – NFPA 72
* Emergency Evacuation Systems
* Mass Notification Systems - www.mnec.org
* Sound system analysis and reports
* Sound system testing and commissioning

SPEECH INTELLIGIBILITY MEASUREMENT OPPORTUNITIES - OR HOW CAN I MAKE MONEY AT THIS?



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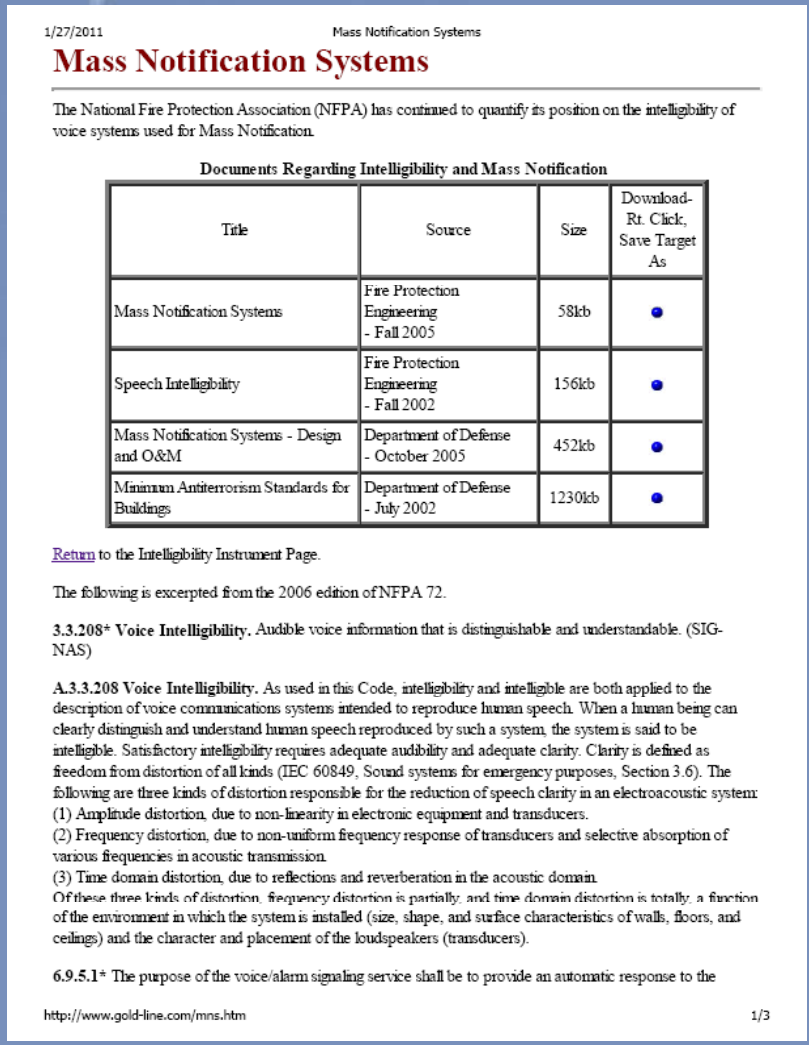

1/27/2011 Mass Notification Systems

Mass Notification Systems

The National Fire Protection Association (NFPA) has continued to quantify its position on the intelligibility of voice systems used for Mass Notification.

Documents Regarding Intelligibility and Mass Notification

Title	Source	Size	Download- Rt. Click, Save Target As
Mass Notification Systems	Fire Protection Engineering - Fall 2005	58kb	●
Speech Intelligibility	Fire Protection Engineering - Fall 2002	156kb	●
Mass Notification Systems - Design and O&M	Department of Defense - October 2005	452kb	●
Minimum Antiterrorism Standards for Buildings	Department of Defense - July 2002	1230kb	●

Return to the Intelligibility Instrument Page.

The following is excerpted from the 2006 edition of NFPA 72.

3.3.208* Voice Intelligibility. Audible voice information that is distinguishable and understandable. (SIG-NAS)

A.3.3.208 Voice Intelligibility. As used in this Code, intelligibility and intelligible are both applied to the description of voice communications systems intended to reproduce human speech. When a human being can clearly distinguish and understand human speech reproduced by such a system, the system is said to be intelligible. Satisfactory intelligibility requires adequate audibility and adequate clarity. Clarity is defined as freedom from distortion of all kinds (IEC 60849, Sound systems for emergency purposes, Section 3.6). The following are three kinds of distortion responsible for the reduction of speech clarity in an electroacoustic system:
(1) Amplitude distortion, due to non-linearity in electronic equipment and transducers.
(2) Frequency distortion, due to non-uniform frequency response of transducers and selective absorption of various frequencies in acoustic transmission.
(3) Time domain distortion, due to reflections and reverberation in the acoustic domain.
Of these three kinds of distortion, frequency distortion is partially, and time domain distortion is totally, a function of the environment in which the system is installed (size, shape, and surface characteristics of walls, floors, and ceilings) and the character and placement of the loudspeakers (transducers).

6.9.5.1* The purpose of the voice/alarm signaling service shall be to provide an automatic response to the

http://www.gold-line.com/mns.htm 1/3

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