Speech Intelligibility Analyser User's Guide

DSP2 Dedicated Speech Intelligibility Meter Measures Sound Pressure Level and Speech Intelligibility Index in CIS or STI formats using the OPTion STICis™ Software.

Warning Systems

STI-CIS System User's Guide

Introduction

This publication describes how to use the STI-CIS (Speech Transmission Index-Common Intelligibility Scale) Analyser with Talkbox and STI-PA (Speech Transmission Index - Public Address) Test Tone CD (STI-CIS System) to measure the speech intelligibility of a sound system for emergency purposes. Speech intelligibility is the measure of a listener's ability to understand a spoken message.

Anything that is between the talker and the listener can affect speech intelligibility. Intelligibility degradation – whatever the source – causes the masking of the speech signal or a reduction of the voice modulations. The STI-CIS Analyser factors in the effects of the sound system for emergency purposes (warning system), room acoustics (reverberation and echoes) and background noise to measure overall speech intelligibility (see Figure 1). The STI-CIS Analyser uses the STI-PA measurement method (a variant of the full STI method) that is detailed in the IEC (International Electrotechnical Commission) Standard IEC 60268-16. Testing to this standard complies with AS 1670.4, Section A-4.3.1.5. The STI-CIS Analyser displays the measurement method result in Common Intelligibility Scale (CIS) units or Speech Transmission Index (STI). CIS is the internationally recognised measurement unit defined in the IEC standard.

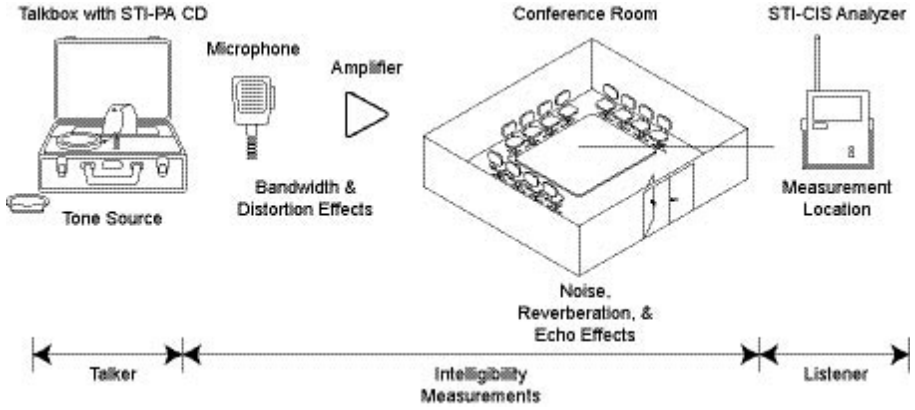

Figure 1. Components of Speech Intelligibility Measurements

To measure speech intelligibility, the STI-CIS Analyser uses STI-PA test tones from the Talkbox to simulate speech patterns. The test tones don't sound at all like human speech; however, the entire range of speech is simulated by these tones.

In This Publication

This Manual discusses the following topics:

Inspecting Contents of Shipment

DO NOT USE THIS PRODUCT IF IT APPEARS DAMAGED
Upon unpacking your STI-CIS Analyser, inspect the contents of the carton for shipping damage. If damage is apparent, immediately file a claim with the carrier and notify your supplier.

ELECTRICAL HAZARD - Disconnect electrical power when making any internal adjustments or repairs. Servicing should be performed by the manufacturer (Gold Line) or authorised repairer.

Limited One-Year Warranty

The manufacturer makes the following limited warranties. These limited Warranties extend to the original retail purchaser only and to no other purchaser or transferee. The manufacturer warrants this product and parts thereof against defects in materials or workmanship for a period of one year after the date of original purchase. During this period, the manufacturer will repair a defective product or part without charge to you as long as you deliver the entire product to your supplier.

User's Guide

You should read this User's Guide thoroughly before operating this product.

Owner's Responsibility

The above warranties are subject to the following conditions.

1. You must retain your Bill of Sale or other Proof of Purchase.
2. You must notify your supplier within 30 days after you discover a defective part.
3. All warranty servicing of this product must be made by the Gold Line authorised repair facility.
4. The warranties do not extend to any product or parts which have been subjected to misuse, neglect, accident, improper installation, or improper maintenance or use in violation of instructions furnished by use, or to units which have been altered, modified, or repaired without authorisation from Tyco Safety Products - Fire Detection, or to products or parts thereof which have had the serial number removed, altered, replaced, defaced, or rendered illegible.

To Obtain Warranty Servicing

1. Contact your supplier within 30 days after a defective product or part is discovered.
2. Arrange for the delivery of the product to the authorised repairer nominated by Tyco Safety Products - Fire Detection. The product must be insured and properly packed (preferably in original shipping carton) and a letter explaining the defect & also a copy of the Proof of Purchase must be enclosed. All transportation & insurance charge must be prepaid by you.
3. If you have any questions about service, please contact Tyco Safety Products Customer Service +61 3 9538 7220.

Equipment Required to Measure Speech Intelligibility

Introduction

This section of the manual lists the equipment needed to measure speech intelligibility.

Required Equipment

To measure speech intelligibility, you need the following equipment (see Figure 2):

- Talkbox (includes speaker, CD Player, and microphone holder)
- STI-CIS DSP2 Analyser* (includes microphone, AC Adapter, STI-PA Test Tone CD, serial port DB-9P and software). Batteries are not included.

* Manufactured under licence from Bose Corporation. Covered by Bose patents issued and/or pending

Figure 2. Equipment required to Measure Speech Intelligibility

Required Personnel

Note: in order to carry out Sound Pressure Level Calibration and Evacuation Speaker Zone selections in a timely manner, 2 people may be required, using 2 way communication devices (2-way radio, mobile phone, etc). The warden intercom may be able to be used.

STI-CIS Analyser Description

Introduction

The STI-CIS Analyser measures the speech intelligibility of a sound system for emergency purposes. To measure overall speech intelligibility, the STI-CIS Analyser uses the STI-PA measurement method to factor in the effects of the sound system for emergency purposes (warning systems), room acoustics (reverberations and echoes) and background noise.

Equipment Description

The STI-CIS Analyser (Figure 3) comes equipped with its own microphone and LED display and has buttons to activate dB(A) and CIS[1] measurements. There is provision for a PC interface (RS-232) for use with the STI-CIS Noise Effect Correction Software Tool.

Figure 3. STI-CIS DSP2 Analyser

Power Sources

You can provide power for the STI-CIS Analyser by using the supplied AC adapter (see Figure 3) or by using 8 AA NiCad rechargeable, NiMH rechargeable, or alkaline batteries (not supplied). To install the batteries:

1. Loosen the four screws on the removable plate at the rear of STI-CIS Analyser and slide the plate to the right before removing it.
2. Load eight AA NiCad, NiMH, or alkaline batteries into the compartment. Then set the Battery Type Switch to NiCad (for NiCad or NiMH batteries) or alkaline according to the type of batteries that you just loaded.
3. Replace plate and tighten down the four screws previously loosened. DO NOT OVERTIGHTEN SCREWS.

Note 1. CIS stands for Common Intelligibility Scale. This allows the many different speech intelligibility methods to be compared. See Appendix A and B. The DSP2 analyser uses the STI-PA method but can display the measurement as either STI, RASTI or CIS. Use the Mode Select button, before or after a test, to select the desired display.

General Battery Note

NEVER ATTEMPT TO TAKE MEASUREMENTS WHEN THE ANALYSER DISPLAYS A LOW BATTERY MESSAGE (DISPLAYED AS "BAT"). Inaccurate measurements may result.

NiCad and NiMH Battery Notes

NiCad and NiMH batteries can be recharged in six hours as long as they have been correctly loaded into the analyser and the Battery Type inside the battery compartment has been set for NiCad before the recharging begins. Also be sure that the STI-CIS Analyser's power switch (see Figure 3) is OFF when recharging the NiCad or NiMH batteries inside the battery compartment. Do not let the NiCad or NiMH batteries fully discharge before charging them. The LED display will read "BAT" when it's time to recharge the batteries. Most analysers run for 3 hours on standard NiCads before they need to be recharged while the Talkbox runs for 3.5 hours before needing recharging. As for fully-charged NiMH batteries, a set of 1500 mAH batteries usually runs an analyser for 8 hours and a Talkbox for 18 hours. The rating of the NiMH battery determines run time.

Do not run a constant charge over long period time such as a week or two. An overnight charge of six hours returns the analyser to a fully-charged state.

Alkaline Battery Notes

BE SURE THAT YOU NEVER ATTEMPT TO RECHARGE ALKALINE BATTERIES IN THE ANALYSER SINCE YOU RISK SERIOUS INJURY OR EQUIPMENT DAMAGE DUE TO THE EXPLOSIVE RELEASE OF GASES. It's important to use alkaline batteries in the analyser instead of standard batteries because the standard batteries discharge too quickly.

A fresh set of AA alkaline batteries usually runs an analyser for 8 hours and a Talkbox for 18 hours.

Talkbox Description

Introduction

The Talkbox is used to send the STI-PA test tone into the sound system for emergency purposes (warning system). It interfaces with the system through its microphone input. A line-level output is also available for systems with direct line inputs.

Equipment Description

The Talkbox (Figure 4) comes equipped with its own CD player and speaker. The CD player has controls to Play, Rewind, and Fast Forward the CD with STI-PA test tone (supplied). However, pressing Play on the CD player is all that is required to play the test tone once you insert the STI-PA Test Tone CD into the CD player. Power is supplied to the Talkbox through a DC power supply (connected to the Ext. Power socket) or batteries. The Talkbox operates a minimum of 18 hours on eight double AA alkaline batteries.

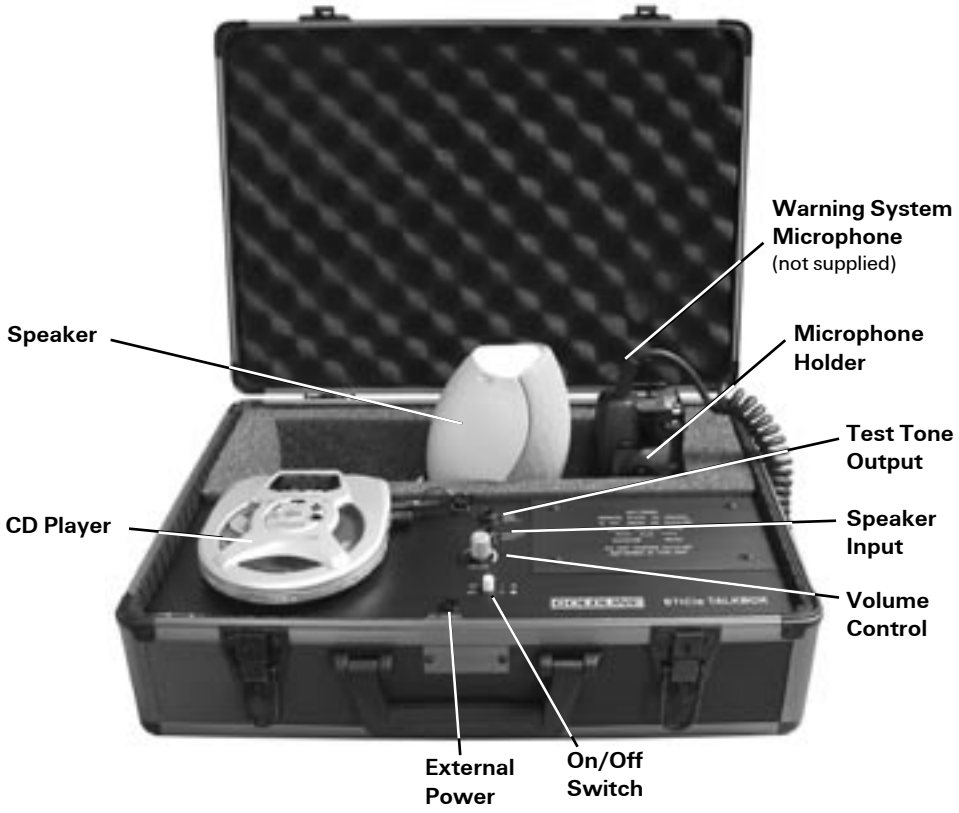

Figure 4. Talkbox

Sixty minutes of STI-PA test tone is recorded on the CD that is shipped with the analyser. To prevent damage to the CD player while transporting the Talkbox, it's important to remove the CD from the player before you close up the Talkbox.

To set up the microphone, insert the microphone upside down into the holder with the front of the microphone facing the speaker. Press the clamps to activate the microphone's push-to-talk switch (to release the microphone, press the button on the side of the mount). Move the speaker so that it is approximately 20mm from the microphone.

Verification of Proper Equipment Operation

Objective

You must verify proper operation of the STI-CIS System (Talkbox & STI-CIS Analyser). This should be done before a session of use, typically at the beginning of a days work.

Step by Step Procedure

Follow the step-by-step procedure below to verify proper operation of the Talkbox with the STI-CIS Analyser.

1. Insert the STI-PA Test Tone CD into the CD player.
2. Apply power to the Talkbox before pressing Play on the CD player.
3. Turn on the STI-CIS Analyser and hold it so that its microphone is approximately 20mm directly in front of the Talkbox speaker.
   - Ensure that you remove and retain the cap on the analyser's microphone before you proceed any further. When you are done with the analyser, place the cap back on the microphone.
   - Ensure that the date on the analyser's calibration label is valid. If the date is invalid, send the analyser for calibration. Calibration is required every 24 months by a NATA accredited facility.
4. Press the dBA button.
5. Adjust the speaker's volume so that the STI-CIS Analyser's dB reading is approximately 92; allow the reading to stabilise.
6. Press the Test button on the analyser and record the CIS reading once it appears.
7. Repeat steps 4 and 6 two more times to ensure the reading is consistent and not affected by nearby noise.
   - The equipment is working properly if the average of the three CIS readings is greater than 0.96. If the analyser fails to read greater than 0.96, you must do the following:
     - Ensure that the batteries are in good condition.
     - Be sure that no one is talking during the measurement.
     - Check for excessive background noise.
8. Remove the STI-PA Test Tone CD from the CD player before closing up the Talkbox.

STI-PA Sound Level Calibration Procedure

Objective

You must match the sound pressure level produced by the warning system in at least one emergency speaker zone using the Talkbox, with the sound pressure level of the actual voice message coming from the system.

Step by Step Procedure

It is assumed that the whole warning system has been set up to meet the tone audibility requirements of the relevant installation Standard and that the voice message is at a level that appears to be acceptable on a subjective basis. Note that the voice message can be up to 10dB below that of the tone. This may require the tone to be higher in order to achieve a voice signal to background noise ratio is at least 6dB or better.

Follow the step-by-step procedure below to calibrate the Talkbox with the actual voice message.

Notes:

i. Two people will be needed to perform the Calibration Procedure. One person needs to be present at the Talkbox that is attached to the warning system while the other person needs to operate the STI-CIS Analyser at the selected location. Before you begin using the analyser, ensure that the calibration label has a valid date.

ii. The microphone on the STI-CIS Analyser needs to be handled carefully to avoid damage. Do not bump it on anything when you transport or use it.

iii. When holding the STI-CIS Analyser, position it so that the analyser's microphone is at ear level (approximately 1.5m from the floor).

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1. Place the STI-CIS Analyser in a representative location of the building.
2. Apply power to the STI-CIS Analyser.
3. Press the dBA button on the STI-CIS Analyser.
4. Activate the voice message from the warning system.
   - Decibel reading at the STI-CIS Analyser is erratic due to the nature of speech signals.
5. Note the highest dB reading while the voice message is played.
   - Do not move the STI-CIS Analyser from the position in the building. You will take another reading from this position later in this procedure.
   - If the warning system does not have pre-recorded voice messages (or one that can be used), then speak into the microphone at a distance of approximately 20 mm using a normal voice or as one would in an emergency.
6. Turn off the voice message at the warning system.
7. Mount warning system microphone in Talkbox by turning it upside down inside the microphone holder and then pushing in the clamps to activate the push-to-talk switch.
8. Adjust the Talkbox speaker so that it lines up with the microphone and so that it is approximately 20mm away from the microphone. See Figure 4.
9. Insert STI-PA Test Tone CD (with STI-PA tone signal) into CD player. Press Play on the CD player to play the tone.
   - You will now need to have two people for the rest of the procedure. One person needs to be at the Talkbox while the other person needs to be at the STI-CIS Analyser.
   - If you encounter feedback when using the panel microphone, disable the speakers that are causing the feedback.

10. From the same position where your reading was noted on the STI-CIS Analyser in Step 5, the person at the STI-CIS Analyser needs to press the dBA button. This person then waits for the reading to stabilise within one or two decibels.
11. Now the other person at the Talkbox needs to adjust the volume level up or down on the Talkbox's speaker so that the person at the STI-CIS Analyser gets the same peak reading as when the system voice message played in Step 5.

Now you need to read the Measurement Guide section before performing the **test procedure**.

Measurement Guide

Introduction

Before you proceed to the Test Procedure and begin taking measurements, it's important to carefully plan ahead to determine the **acoustically distinguishable areas** (a.d.a.) to be measured and the number of measurements required in each a.d.a.

Note: Alternative procedures may be issued from time to time in accordance with Australian Standards, ISO Standards or In-House guidelines.

General Guidelines

In general, each room should be considered a different a.d.a. Examples of rooms are office spaces, hotel rooms, conference rooms, cafeterias, food preparation areas and restrooms. Hallways and stairways should also be considered different rooms.

It may be possible to measure representative rooms in a building and so avoid having to test each like room.

This technique can be used as long as the representative rooms have common speaker locations, power settings, room dimensions, furnishings and background noise.

Sometimes one room can have more than one a.d.a. that needs to be considered separately. If the ceiling height changes by more than 20%, or if the architecture creates alcoves within a larger room, these parts should be treated separately.

Once the a.d.a. (measurement zones) have been established, you need to determine the number of measurements to be made in the a.d.a. -

i. For each measurement location, if the CIS reading is >0.75, one measurement is sufficient.

ii. If the reading is <0.75, take a minimum of two CIS measurements.

iii. If the two measurements differ by more than 0.03 CIS, take a third measurement.

Retain the two measurements that are closest in score, taking an average of the two readings to determine the final CIS score for that location.

General Guidelines

The intelligibility for an entire a.d.a. is calculated from the average of all measurements in the a.d.a. minus one standard deviation. For more information, refer to the paragraph below from AS 1670.4-2004 Appendix A3 which states:

> The measurements shall be made at a sufficient number (*n*) of representative points, which shall be detailed in the system specification, in each area of coverage. The arithmetical average I_{av} of the intelligibility values on the CIS, and the standard deviation σ of the results, shall be calculated. The quantity $I_{av} - \sigma$ shall exceed the limit value specified in 4.3.6. If the result is within $\pm\sigma$ of the limit, the measurements should be repeated, preferably at a larger number of points. The mean value of intelligibility, and its 95 % confidence interval, over the whole area of coverage shall be calculated, taking into account the shape of the statistical distribution of the results of the measurements.

The CIS result determined for each a.d.a must not be less than 0.7 in locations specified in AS 1670.4.

When measuring the CIS in **occupied areas** (while occupied with typical background noise and therefore more accurate) a simplified approach is to calculate a.d.a. CIS readings as the average of all point readings (using the average of 2 readings at each point if necessary). Provided no single point has a CIS of less than 0.65, the standard deviation need not be calculated.

When it is necessary to measure intelligibility while the **areas is unoccupied** - the STICVO.exe software can be used to yield an effective CIS reading by mathematically combining the occupied noise with the unoccupied CIS reading. This procedure can be time consuming.

If, however, the STI-PA test tone signal to noise ratio is better than 10 dB (in the worst location), then the true occupied reading may be only slightly worse or slightly better than the unoccupied CIS reading. Assuming that the occupied reading is slightly worse than the unoccupied reading and the unoccupied reading is significantly better than required, a quicker method can be used. Subtract the correction factors in Table 1 according to the signal to noise ratio (S/N voice) from the meter reading to obtain an effective but conservative CIS reading at each measuring point. If the corrected value is better than 0.7 on the CIS scale, use this to record the location average.

All procedures, corrections and assumptions that are used must be documented and included with the results so that they may be repeated in the same way at a later stage.

Table 1 STI-PA Test Tone Signal to Noise CIS correction

STI-PA Tone S/N	Correction factor	Example CIS	Effective CIS
20 dB	0.00	0.8	0.8
16 dB	0.02	0.8	0.78
14 dB	0.04	0.8	0.76
12 dB	0.06	0.8	0.74
10 dB	0.08	0.8	0.72

General Guidelines

We recommend taking measurements on a 6 metre grid but with no measurement location more than 12 metres apart. Refer to Table 2 for a guide to the number of locations to be measured.

Table 2 Minimum number of measurement points

acoustically distinguishable area (m^2)	Minimum no. of measurement points
Less than 25	1
25 to less than 100	3
100 to less than 500	6
500 to less than 1500	10
1500 to less than 2500	15
Greater than 2500	15 per 2500 m^2

Normally unoccupied edges and corners of rooms do not need to be measured, but there shall be at least a set of measurements no further than 6 metres from the walls. Avoid measuring in locations directly under loudspeakers; otherwise, artificially high intelligibility readings will result.

Seams between two a.d.a. within a single room should be measured by using the 6 metre rule of thumb, as if there was a wall at the seam.

Measure any area that has noticeably poor sonic quality, such as in stairwells or high-noise equipment rooms.

Test Procedure for Occupied Buildings

Objective

You must determine the intelligibility of the warning system while the building is occupied.

Follow the step-by-step procedure below to test the speech intelligibility of the system voice message in occupied buildings. Ensure that the STI-PA sound level calibration procedure (refer to page 11) has been carried out.

Step by Step Procedure

Do not alter the volume of the Talkbox during the test of the whole system, even if it is necessary to adjust individual speakers or the emergency loudspeaker zone amplifier gain. If the individual pre-amp gains of either the tones, pre-recorded message or microphone channels are altered to meet requirements, a sound level calibration may have to be performed again.

1. At the warning system equipment, eg sound system for emergency purposes, plug power into the Talkbox (or operate on battery power) and switch it on.
   - This action powers the CD player and the speaker.
2. To activate the microphone, clamp it into the Talkbox.
3. Maintain the speaker-to-microphone distance at 20mm, the same as during the sound level calibration check.
4. Turn on the CD player to play sound in the system and select the emergency loudspeaker zone to be tested.
   - Once sound is playing in the system, take the STI-CIS Analyser to the first emergency loudspeaker zone location within the selected a.d.a., ready for the intelligibility test.
5. Apply power to the STI-CIS Analyser.
   - As the STI-CIS Analyser measures the sound pressure level in the room, let the reading stabilise within 1 or 2 dB. The STI-CIS Analyser must have a stable sound pressure level reading before you can perform the test.
6. Press the Test Button on the STI-CIS Analyser.
   - Do not talk after pressing the Test Button, otherwise, E.RR (Error Message) will appear.
   - Hold microphone at ear level of occupants: approximately 1.5m when standing and 1m when seated, for example in theatres and auditoriums.
   - A reading appears and the light is illuminated above the CIS label and below the actual reading. (An example of a CIS reading is 0.76.) Note the analyser can display the result in CIS, STI or RASTI. Use the mode selector to ensure that CIS is the figure displayed.
7. Repeat Steps 5 through 6 for additional measurement locations in each a.d.a.
8. Repeat for each emergency loudspeaker zone.
9. Stop and remove the STI-PA Test Tone CD from the CD player before closing up the Talkbox.

Test Procedure for Unoccupied Buildings

Objective

You must determine the intelligibility of the warning system based on the STI-PA measurements taken while the building is unoccupied.

About the Test Procedure

Unlike the previous test procedure for measuring STI-CIS that assumes that the testing is conducted when the building is occupied, with its normal background noise, this test procedure covers testing that's done in unoccupied buildings. While occupied testing is the **preferred method**, it may be impractical. The STI-PA test tones used are intrusive, and obtaining permission to play the tones during normal business hours may be difficult.

When 'occupied' testing is not acceptable, there is a computer based method that combines the unoccupied noise and STI-PA measurement (displayed as CIS) with the occupied noise to obtain an overall CIS for the occupied situation.

Limitations

Unoccupied measurements are valid only if the reverberation of the room doesn't change significantly. For instance, it would be invalid to test a room before the furnishings have been installed because an artificially low CIS score would result. However, if the result meets the requirements, the area will be satisfactory as it will improve when furnished.

Reverberations also change dramatically in areas of high occupancy such as cafeterias and auditoriums. Because the CIS passing score of 0.70 is required for all occupancies, it would be safe to assume that audibility requirements met during occupation as well as intelligibility requirements met during empty conditions would combine to meet all audibility and intelligibility requirements.

Computer Based Measurement Method

The computer based method uses the Windows PC programme STICVO.exe. When installed on a PC connected to the data port on the analyser the following three measurements will be logged and used to determine the occupied CIS for each location:

1. Background noise when occupied
2. Background noise when unoccupied
3. CIS (using the STI-PA tone) when unoccupied

When the occupied noise measurement is taken, the noise is broken into its constituent frequency bands and saved to a file. The noise is later recalled to calculate the effect the noise would have on the intelligibility, as if the measurement had been taken with the noise present. This technique also requires a background noise measurement taken at the same time as the STI-CIS measurement. The background noise figure is used to compensate for noise that is present at all times - such as HVAC noise - so that the noise isn't counted twice when the final CIS score is calculated.

If it is not possible to even take background noise measurements when the building is occupied (for instance if a new building is not yet occupied), you may load pre-calibrated noise typical of the expected noise into the program and run the intelligibility test. The noise files shipped with the system represent speech noise (babble), generalised HVAC noise and pink noise. Once the noise is loaded into the program, it is possible to adjust the dBA level of the noise to match the expected noise when occupied.

Step-by-Step Procedure for Computer-Based Measurement Method

The STICVO programme stores occupied background noise, empty background noise and STI-CIS test data in a single data file (with the .CIS extension) per location. The sequence of measurement is not important - you can perform the STI-CIS test before the occupied noise tests or vice versa.

The STICVO programme operates on the minimum configuration required for Windows 95/98/NT/2000/XP and requires approximately 1MB of disk space. To install it, run the install.exe file from the supplied media. Follow the step-by-step procedure below to test the speech intelligibility of the system in occupied buildings.

Measuring Occupied Background Noise

1. Locate the analyser and computer in an area to be measured during normal occupancy.

2. Connect the analyser to the serial port on the PC with the supplied 25-pin to 9-pin cable before turning on the analyser.

3. Start the STICVO programme.

The following screen appears:

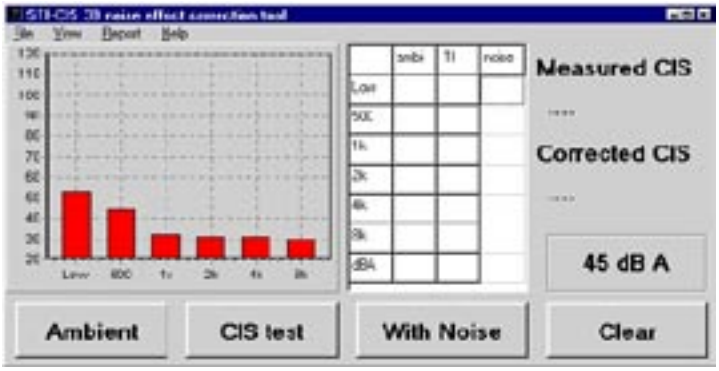

Figure 5. STI-CIS Main Screen

4. If this is the first measurement, click the Clear button to set all readings to zero; otherwise, click on the "With Noise" button.

The following screen appears:

Figure 6. STI-CIS After clicking With Noise button

5. Click the "Measure" button to take a measurement.

   - A measurement takes about 10 seconds. This measurement provides both dBA measurements (to be used for audibility requirements) and octave band analysis that will be used later in the procedure.

6. Click the "With Noise" button.

The following screen appears:

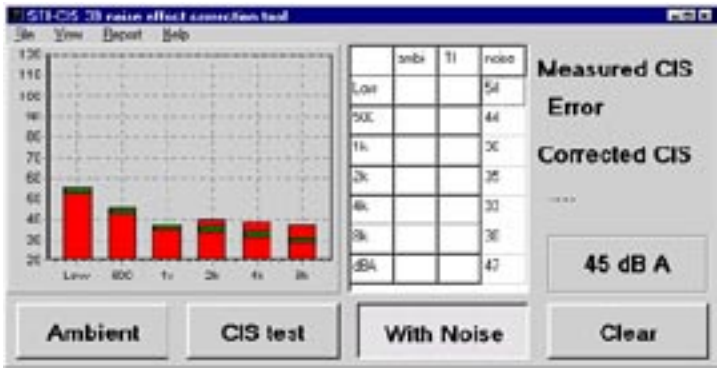

Figure 7. STI-CIS After completing With Noise measurement

The green bars indicate the stored dB readings of the background noise in the octave bands (listed numerically in the "noise" column of the table). The red bars continue to change to show the current readings.

7. Once the noise readings have been taken, the data must be saved to a file. Click the "File" menu and select Save (keyboard shortcut is Ctrl+S).

The standard file save dialogue appears:

Figure 8. Saving the Occupied Noise Data

Step-by-Step Procedure for Computer-Based Measurement Method

8. Enter a name descriptive for the location being tested.

9. Click the "Save" button to complete the operation.

Measuring Ambient Noise and CIS

These two measurements can be taken sequentially using the STI-PA Test Tone CD. The following procedure assumes that the occupied noise measurement has been completed and saved to disk.

10. Calibrate the level of the STI-PA signal as described in the Calibration Procedure that appeared earlier in this publication.

11. Play the STI-PA Test Tone CD through the warning system.

12. At the test location, open the file (Menus File and then Open or Ctrl+O) that contains the previously saved occupied noise measurements for that location.

13. Press the Pause button on the CD player before clicking the "Empty" button.

The following screen appears:

Figure 9. STI-CIS After clicking Empty button

14. Click the "Measure" button to begin a measurement. This measurement takes about 15 seconds to complete.

The following screen appears:

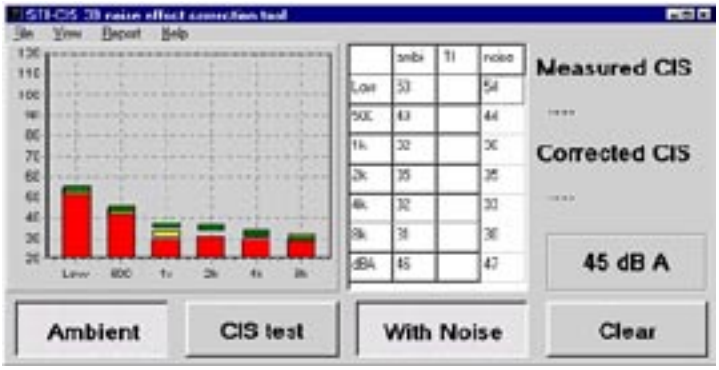

Figure 10. Ambient noise measurement

15. Click the "CIS" test button.

The following screen appears:

Figure 11. STI-CIS After clicking CIS test button

16. Press the "Play" button on the CD player, then click the "Measure" button to perform the CIS test. The measurement takes about 15 seconds to complete.

When the measurement is complete, the following screen appears (Figure 12) to show the corrected CIS test score that's result of the three tests being combined to create a single score.

17. Once the CIS readings have been taken, the data must be saved to a file. Click the "File" menu and select Save (keyboard shortcut is Ctrl+S).

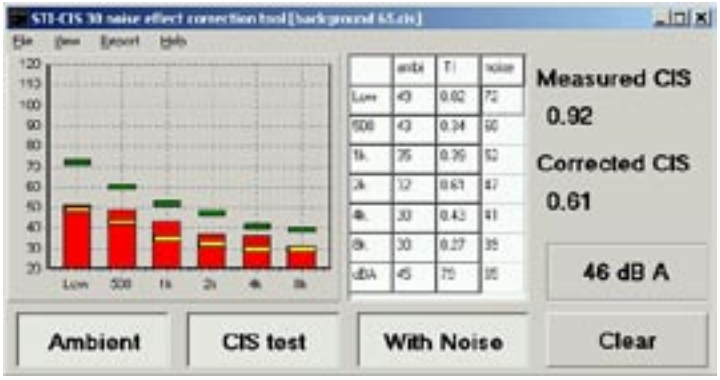

Figure 12. Corrected CIS Score

The standard file save dialogue appears:

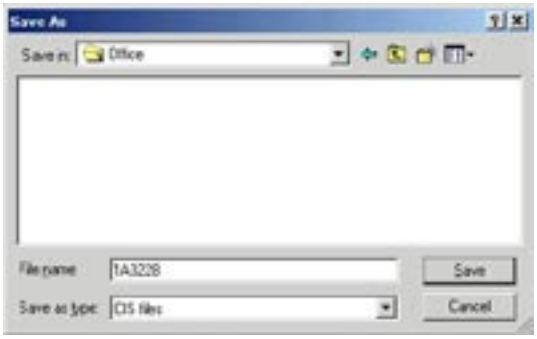

Figure 13. Saving the CIS Data

18. Enter a name descriptive of the location being tested or select the previously saved file for the occupied background noise.

19. Click the "Save" button to complete the operation.

Interpretation of Test Data

General

The CIS score for any a.d.a. (room) is the average of all of the readings for the room (I_{av}), minus 1 standard deviation ($_s$) or $I_{av\text{-}s}$. The standard deviation is a measurement of the variability within the readings. (The standard deviation of a collection of numbers (X) is the square root of the difference between the mean of the squares of the numbers and the square of the mean of the numbers.) Many programs, such as Microsoft Excel, have a built-in standard deviation function to simplify the analysis of the data.

We recommend taking a minimum of two readings per location. If the two readings differ by more than 0.03 CIS, then take a third reading and discard the measurement that differs the most in the set of readings. The location's CIS score is the average of the readings at that location.

Consider the following example of measurement and CIS score calculation.

Measurement Example

Measurement Zone (a.d.a.) Specifications:

- 30m x 30m room
- Tile Floors
- Sheetrock walls
- Wall-Mounted speakers

It was determined that measurements were to be taken at the recommended 6m grid pattern. Eight measurement locations were selected spaced evenly throughout the room and 6m away from any wall to avoid artificially high readings that would result from measurements near the speakers.

The STI-PA test tone calibration location was chosen near the centre of the room at location B2 (see Figure 14 below).

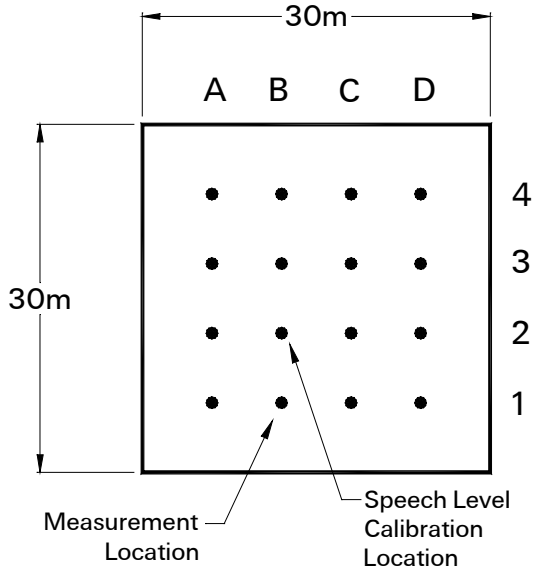

Figure 14. Example Test Locations

Measurement Example

A tally sheet used to collect the data was prepared in Microsoft Excel with the measurement locations matching a map of the room.

Example CIS Measurement Data Entry Form								
Project	*Example Measurements*		**Building**			**Sheet**	**1**	
Date	*11 Nov 05*		**a.d.a.**	**Cafeteria**		**of Zone**	**1**	
By	*TSP-Mel*							
REF	**Location**	**Background Noise Level dBA (A/R)**	**STI Tone Level (dBA)**	**CIS1**	**CIS 2**	**CIS 3 (A/R)**	**Location Average**	**Notes**
	A1							
	A2							
	A3							
	A4							
	B1							
	B2 (Cal Location)							
	B3							
	B4							
	C1							
	C2							
	C3							
	C4							
	D1							
	D2							
	D3							
	D4							

Figure 15. Form Prepared for Data Collection

At the time of the test:

1. The warning system is put into a test mode and the proper authorities are notified.

2. The emergency loudspeaker zone for the test area is activated and a (pre-recorded) voice message is activated at the warning system, such as the warning system test message.

3. The peak dB(A) level is measured and recorded at location B2.

4. The Talkbox is set up at the warning system control and indicating equipment and the STI-PA test tone volume is adjusted to match the peak level of the voice message.

5. Room measurements begin; the STI-PA tone level and CIS scores are recorded at each location.

Interpretation of Test Data

Measurement Example

At the completion of the test, the data are entered into the spreadsheet and analysed to determine the final overall CIS score.

Example CIS Measurement Data Entry Form								
Project	*Example Measurements*		**Building**			**Sheet**	**1**	
Date	*11 Nov 05*		**a.d.a.**	**Cafeteria**		**of Zone**	**1**	
By	*TSP-Mel*							
REF	**Location**	**Background Noise Level dBA (A/R)**	**STI Tone Level (dBA)**	**CIS1**	**CIS 2**	**CIS 3 (A/R)**	**Location Average**	**Notes**
	A1		*78*	*0.75*	*0.69*	*0.73*	*0.74*	
	A2		*78*	*0.72*	*0.73*		*0.73*	
	A3		*78*	*0.73*	*0.72*		*0.73*	
	A4		*78*	*0.72*	*0.71*		*0.72*	
	B1		*75*	*0.7*	*0.63*	*0.71*	*0.71*	
	B2		*76*	*0.76*	*0.75*		*0.76*	
	B3		*76*	*0.72*	*0.7*		*0.71*	
	B4		*75*	*0.75*	*0.74*		*0.75*	
	C1		*78*	*0.79*	*0.72*	*0.74*	*0.73*	
	C2		*76*	*0.74*	*0.75*		*0.75*	
	C3		*76*	*0.74*	*0.74*		*0.74*	
	C4		*78*	*0.79*	*0.77*		*0.78*	
	D1		*78*	*0.78*	*0.76*		*0.77*	
	D2		*78*	*0.76*	*0.75*		*0.76*	
	D3		*78*	*0.75*	*0.72*	*0.72*	*0.72*	
	D4		*78*	*0.79*	*0.76*		*0.78*	
						a.d.a. Average	*0.74*	
						Standard Deviation (or minimum of all CIS readings)	*0.023*	
						a.d.a. CIS (Average -1 SD), (or Average if CIS min.>0.65)	*0.72*	

Figure 16. CIS Measurement Test Data

CIS Measurement Data Entry Form

Project			**Building**			**Sheet**			
Date			**a.d.a.**			**of Zone**			
By									
REF	**Location**	**Background Noise Level dBA (A/R)**	**STI Tone Level (dBA)**	**CIS1**	**CIS 2**	**CIS 3 (A/R)**	**Location Average**	**Notes**	
			a.d.a. Average						
			Standard Deviation (or minimum of all CIS readings)						
			a.d.a. CIS (Average -1 SD), (or Average if CIS min.>0.65)						

Appendix A - CIS to STI, RASTI and AL_{cons} Conversion Table

The STI-CIS Analyser displays the intelligibility measurements in CIS units, an abbreviation for Common Intelligibility Scale. The CIS scale is defined in the International Electrotechnical Committee publication IEC 60849 "Sound Systems for Emergency Purposes Second Edition" and relates the existing intelligibility scales to a single, internationally recognised common scale.

Figure 17 shows correlation between CIS, STI, RASTI (Rapid Acoustics Speech Transmission Index) and $\%AL_{cons}$. (percent Articulation Loss of Consonants).

Figure 17. Correlation between CIS, STI, RASTI and AL_{cons} Scores

The STI-PA method used in the STI-CIS Analyser uses a subset of the octave band modulations used in the full STI measurement. TNO in the Netherlands has verified the correlation of the STI-PA method to the full STI to within ±0.03 CIS[1]. The results are presented in Figure 18 below. A copy of the report is available at www.gold-line.com. The following is taken directly from the report.

Instrument testing

Prototypes of the meter [8] (analyser) were tested to ensure that they behaved according to theory and met our goals for accuracy, portability, and simplicity. STI values obtained on the meter were compared to STI values obtained using the full 98 combinations of modulated noise as calculated on a reference system at TNO. A number of representative test conditions were used, including different bandpass conditions, noise levels, non-linear effects, reverberation and echo profiles. The results are shown in Figure 18. The data show conclusively that the prototype meter is accurate in a wide range of conditions typical of public address systems.

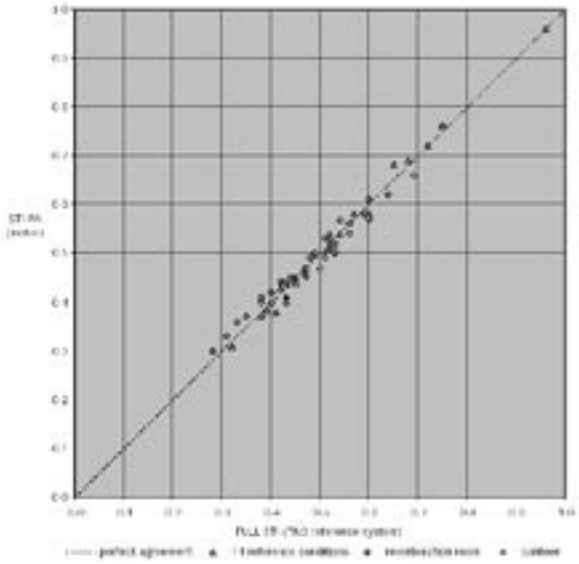

Figure 18. STI-PA to Full STI Correlation

Figure 18. For a variety of conditions, STI values from the prototype meter are compared to values obtained on an STI reference system at TNO that uses the full 98 combinations of modulated noise. The test conditions are:

1. Fourteen reference conditions which use a mixture of band pass limiting, noise, peak clipping, and echoes.[9]

2. Measurements made in a TNO reverberation room using different numbers of absorbers in order to vary the reverberation time (0, 1, 2, 4, 8 and 16 absorbers resulting in a reverberation time range of 0.2 - 4.0 seconds), different bandwidths (500Hz - 4 kHz and 1-4kHz) and different noise conditions (no noise and 50 dBA of speech babble), all using an artificial talker as a source producing 50 dBA at one meter.

3. Measurements from the TNO canteen, with either a PA system or an artificial talker as a source and at two locations (5 and 15 metres from the artificial talker). Most data are within ± 0.02 and the worst case error is only ± 0.03. The results show that the meter is very accurate over a broad range of conditions common in public address systems.

[8] Gold Line DSP30 with STI-CIS™ module.

[9] The fourteen conditions used are described in H. J. M. Steeneken, "On Measuring and Predicting Speech Intelligibility," Ph.D. thesis, University of Amsterdam, pp. 143-144, (1992). The abbreviations for the fourteen conditions used here are:

BP01 - BP1 + SNR inf; BP04 - BP1 + N2 + SNR = 0; BP08 - BP1 + N4 + SNR = 3;

BP17 - BP2 + N4 + SNR = 6; NL01 - PC1 + BP1 + SNR = inf; NL04 - PC1 + BP1 + N4 + SNR = 9;

NL08 - PC1 + BP2 + N1 + NSR = 6; NL14 - CC2 + BP1 + N4 + SNR = inf;

E01 - E1 + BP1 + SNR = inf; E04 - E2 + BP1 + SNR = inf; E06 - E2 + BP1 + N4 + SNR = 6;

E07 - E3 + BP1 + SNR = inf; E08 - E3 + BP1 + N4 + SNR = 12; E09 - E3 + BP1 + N4 + SNR = 6.

References

[1]Development of an Accurate, Handheld, Simple-to-use Meter for the Prediction of Speech Intelligibility

Dr. Herman Steeneken
Senior Research Scientist, TNO Human Factors

Jan Verhave
Research Scientist, TNO Human Factors

Steve McManus
Senior Engineer, Gold Line® Corporation

Kenneth Jacob
Chief Engineer, Bose® Professional Systems Division

STI-CIS Analysers

Model STI-CIS DSP2

Included Equipment	• STI-CIS DSP2 analyser • Calibrated microphone • DC power supply • STI-PA test tone CD • STICVO application program (compatible with Windows 95/98/NT/2000/XP) • Carrying case
Communications Port	RS-232C, DB-9S connector (DCE equipment)
Application Program	STICVO program is compatible with Windows 95/98/NT/2000/XP

Common Specifications for Models STI-CIS DSP2 and DSP2B Analysers

Microphone	Top left side of case has XLR socket. Analyser has Gold Line microphone (-18.7dB sensitivity). Analyser provides 12-volt phantom power. Calibration is traceable to NIST.
SPL Measurement Range	27 dB to 125 dB
Weighting	IEC A
Power	• 12 volts @ 250 mA dc via eight AA batteries of type alkaline, NiCad, or NiMH
- OR-	
	• AC adapter at 500 mA supplying 12 Vdc tip positive
STI-PA Test Tone CD	60 minutes of CD audio
Low Battery Monitor	Displays BAT when batteries need to be recharged/replaced
CIS Measurement-Error Checking	Displays E.RR when octave band analysis is unable to correctly interpret the STI-PA test tone
Calibration Interval	One year
Weight	
Analyser only	0.16 kg
Analyser in carrying case	0.52 kg
Size	
DSP2 Analyser only	410 x 250 x 70 mm (HWD) with microphone assembled
Analyser in carrying case	340 x 470 x 180 mm (HWD) with microphone disassembled
Temperature Range	
Ambient	0°C to 50°C
Storage	-20°C to 60°C

Appendix C - Specifications

Talkbox	Included Equipment	CD player with manual specific to the player
		Speaker with levelling bracket
		Microphone holder
		DC power supply with connector
		Battery compartment
		On/Off switch
		Volume adjustment
		Speaker input jack
		Test tone output jack
		Carrying case (padded and lockable)
		Carrying case strap
		Set of two keys
		Serialised label with date of calibration and calibration due date
	Power	12 volts @ 190 mA dc (92 dBA STI-PA tone out) via eight AA batteries of type alkaline, NiCad, or NiMH
	- OR -	
		AC adapter at 500 mA supplying 12 Vdc tip positive
	SPL Output	0 dB to 100 dBA (STI-PA test tone)
	Weight	0.52 kg
	Size	470 mm x 360 x 180 mm (HWD)
	Temperature Range	
	Operating	0°C to 50°C
	Storage	-20°C to 60°C

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