SD592.EXE PROGRAM MANUAL

These Notes correspond to software
REVISION SOUNDDESIGN v5.92

Email any program questions to sd592@yahoo.com

THIS PROGRAM IS BASED UPON VALCOM BRAND PRODUCTS

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SD592.EXE PROGRAM MANUAL

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Introduction

If it were possible to classify areas into one of a few dozen categories, the design of public address paging systems for those areas would be an easy task. Unfortunately, areas vary in terms of noise level, size, ceiling height, acoustics, content and shape. For this reason, there is not a "cookie cutter" approach that will satisfy all the areas that you may encounter. A professional sound engineer will draw upon personal experience, knowledge of sound's characteristics, trigonometry, knowledge of electronic circuits (to determine proper wire size and power losses), and the specific area's characteristics to come up with a working configuration. Notice that I use the term "a" as opposed to "the" working configuration. For any one environment, there may be multiple combinations of speakers and horns at various spacings and mounting heights that will provide adequate sound coverage. This is where personal experience comes in to play. The purpose of SD592.EXE is not to supersede experience, but to supplement it by performing the calculations involved in designing a public address paging system.

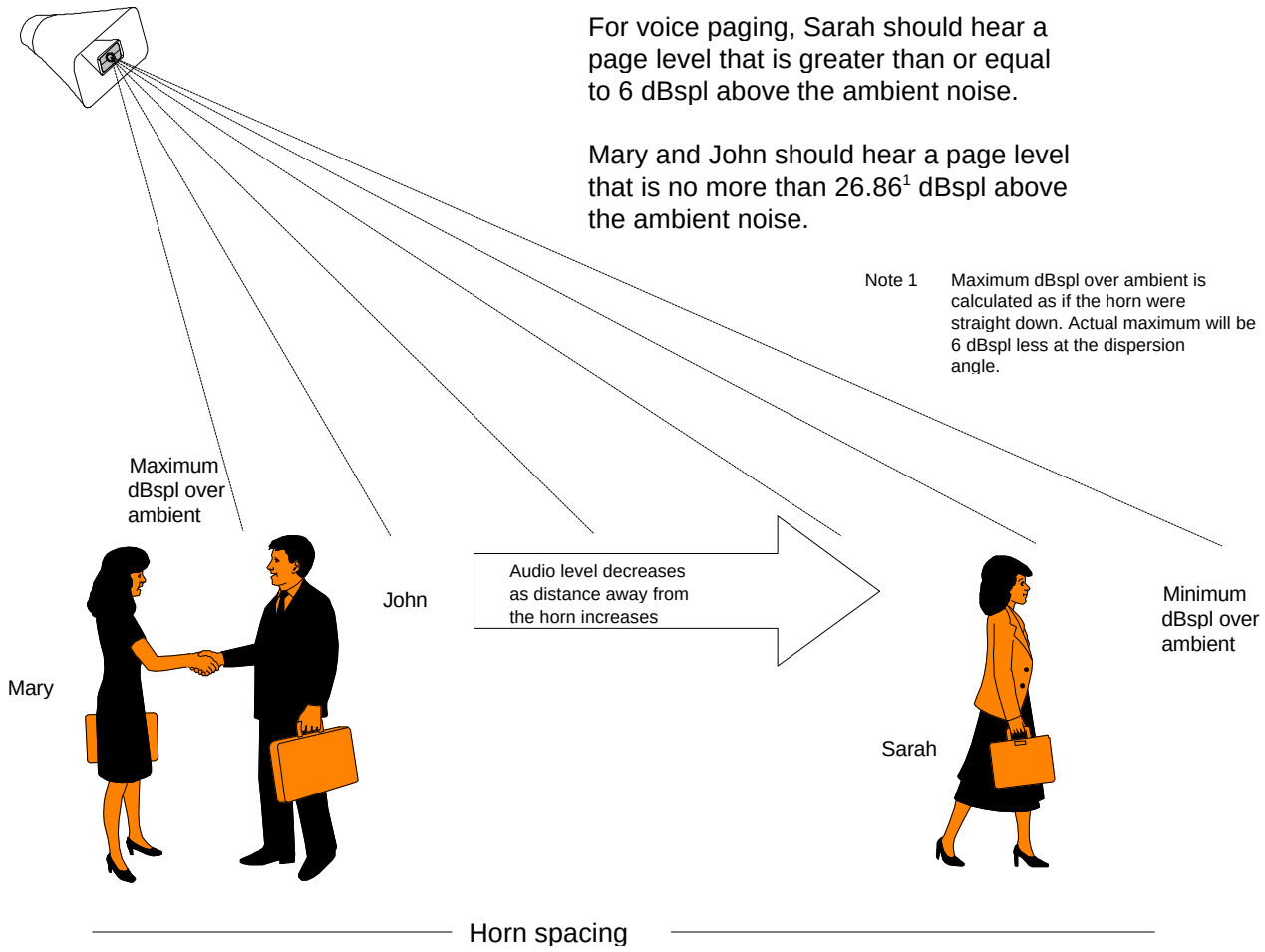
As with any software program, the best way to become acquainted with the capabilities of SD592.EXE is to use it. Please take time to work through some or all of the example problems in this manual. All of the examples have been documented in response to real user questions and, therefore, should guide you to a familiarization of many of the program's benefits to you.

PRESS A HOW MANY HORNS . . . ?

This option calculates the number of horns necessary for a square or rectangular area. These calculations are based upon a maximum acceptable horn sound level over the ambient noise[3], a minimum acceptable sound level over the ambient noise[3], the horn mounting height, the area's square footage **- or -** dimensions, and finally, the area's ambient noise level[3] value.

If possible, the program will automatically select a configuration that is within Valcom standard spacing guidelines, or within a user specified spacing. For extremely noisy areas, the program will offer information on spot paging distances.

Note - the user has the option of entering room size by length and width or total square footage. Specific spacing information is provided by the program only if the user provides area length and width.



Horn Paging Considerations

1) Horn volume should not be uncomfortably loud to individuals in close proximity to the horns. For voice page, page audio level should be >= 6 dBspl and <= 26.86[1] dBspl above the ambient noise[3]; for tones, audio level should be >= 3 dBspl and <= 26.86[1] dBspl above the ambient noise[3].

2) As horn mounting height is increased, horn volume can be increased without appearing excessively loud to individuals directly below. As a horn's volume is increased, the area covered by that horn is proportionally increased, however, the chance of reverberation problems also increases. *The horn layout program defaults to Valcom standard spacing and automatically limits the horn volume to an acceptable range for a non-reverberant indoor area.*

3) Outdoor areas are not generally reverberant and therefore can use less horns at a higher volume than an equivalent size indoor area. *There is a maximum spacing option in the horn layout program that displays the least number of horns for outdoor areas.*

4) As a general rule, horns in an area should all be mounted so that they disperse in a common direction. *The horn layout program automatically calculates horn spacing along each dimension and, if a difference in horn quantity occurs, selects the configuration that results in the least number of horns (using standard Valcom spacing when possible).*

5) For even sound coverage, side-by-side spacing of horns should be no more than front-to-back spacing.

Note 1: Maximum dBspl over ambient is calculated as if the horn were pointing straight down. Actual maximum dBspl over ambient will be less 6 dBspl at the dispersion angle.

Note 2: Spot paging is the practice of placing horns only by the people who need to hear the page (usually in extremely noisy areas)

Note 3: Ambient Noise Level is simply a numeric value (in terms of dBspl) which represents the level of background noise in an area. This value is determined through the use of a sound pressure level meter.

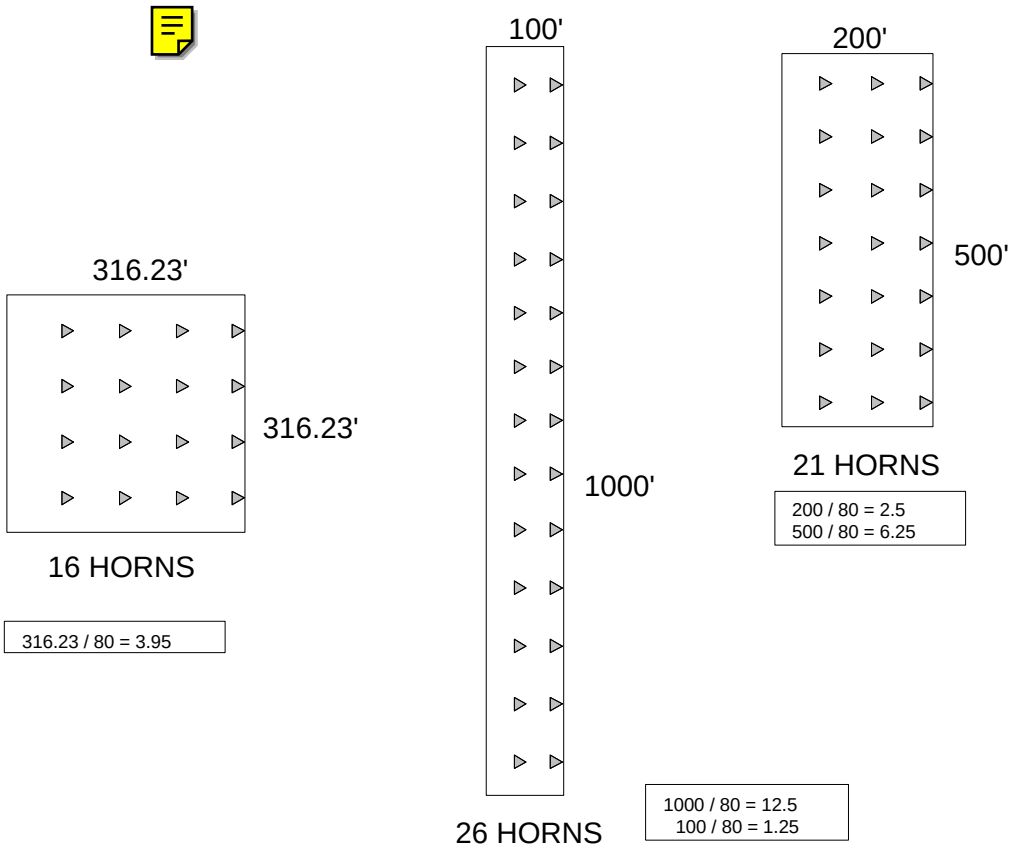
SAMPLE PROBLEM A1 [#/TYPE OF HORNS WHEN DIMENSIONS ARE KNOWN]

If an 85 dBspl area is 100' x 186' and voice page horns will be mounted @ 25' high, what horns can be used ? (ANSWER - 8 V-1030C)

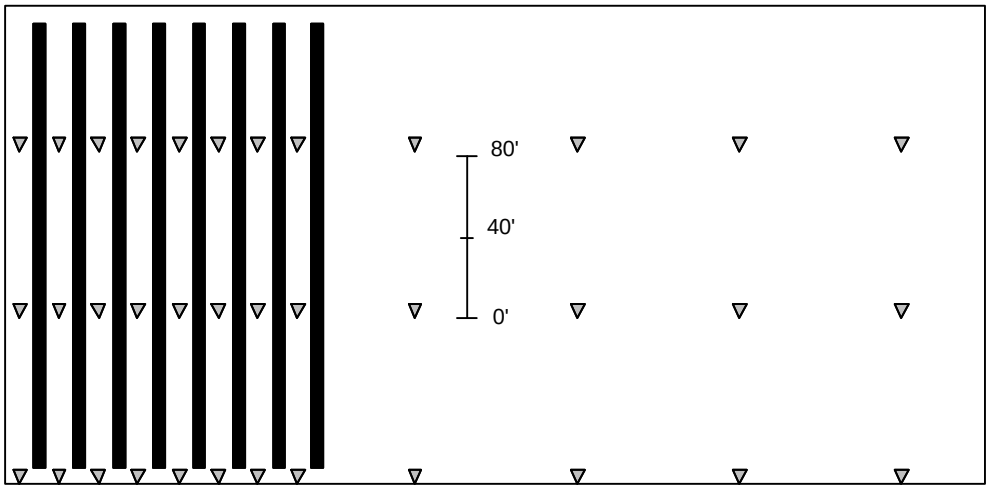
What actual row spacing will result ? (ANSWER - 50')

What actual side-by-side spacing will result ? (ANSWER - 46.5')

SQUARE FOOTAGE VS. ACTUAL DIMENSIONS



The drawing above illustrates the horn quantity variations that can occur in 3 different areas of the same square footage. Each area has been designed as a 79 dBspl area (80 foot maximum spacing). If all of the areas had been configured solely on square footage, 16 horns would be used in all cases; how would you space them without exceeding 80 feet ?



Ceiling high solid or densly stocked shelving

This area is designed for 80 foot horn spacing. Since the shelving will block the horizontal dispersion of the horns, one column of horns should be used per aisleway.

COMPENSATING FOR SOUND BLOCKING ROOM COMPONENTS

Room fixtures and/or components such as ceiling high solid shelving, large machinery or area dividers will block the dispersion of sound. Additional horns are generally necessary to compensate for these obstructions. The program suggests a horn spacing for the area with a quantity based upon an open area. Adjustments for actual room components is the user's responsibility.

PRESS A HOW MANY HORNS . . . ?
[CONTINUED]

SAMPLE PROBLEM A2 [#/TYPE OF HORNS WHEN SQUARE FOOTAGE IS KNOWN]

How many horns, and what type can be used to cover 300,000 square foot area for voice page:

a) @ 20 feet mounting height, 70 dBspl ambient noise - (ANSWER - 47 V-1030C)

b) @ 30 feet mounting height, 85 dBspl ambient noise - (ANSWER - 54 V-1036C)

c) @ 20 feet mounting height, 105 dBspl ambient noise - (ANSWER - 3183 V-1038)

1) If spot paging is to be used for this 105 dBspl area and 6 dBspl over ambient is desired (use option G "to view configuration/spot page details"):

What's the maximum line of sight distance away from listeners for:

5W horns ? [ANSWER - 7.11']
15W horns ? [ANSWER - 12.65']
30W horns ? [ANSWER - 17.87']

SAMPLE PROBLEM A3 [#/TYPE OF HORNS WITH USER DEFINED SPACING]

If a 93 dBspl area is 100' x 186' and voice page horns will be mounted @ 18' **on columns that are 45 feet apart**, how many horns and what type can be used ? (ANSWER - 15 V-1036C)

SD592.EXE HORN LAYOUT PROGRAM
Calculates number of horns based upon mounting height, ambient noise level, and dimensions or square footage.
Results accurate for any ambient noise level.
Can determine horn type required and quantity for a user defined spacing.
Provides spot paging information.
Provides specific spacing suggestions.

IMPORTANT

To increase intelligibility of voice page in reverberant areas, horns should be mounted closer to the people being paged, in effect, mounted at a lower height and closer together. Use the following guidelines:

	MOUNTING HEIGHT	HORN SPACING
REVERBERANT QUIET AREAS	10' to 15'	less than 70'
REVERBERANT MODERATE AREAS	10' to 15'	less than 55'
REVERBERANT NOISY AREAS	10' to 15'	less than 45'

PRESS <ENTER> TO CONTINUE OR 1 TO EXIT

There are several instances where the user may be advised to consider the reverberance of the area under consideration. The program does not know the difference between echoic and non-echoic areas . . . this is one instance where the user must use their own judgement.

The ability to define a desired spacing increment allows the user to configure a system for areas that have evenly spaced support posts or that should not use standard spacing due to acoustic issues.

DBSPL REFERENCES
VERY NOISY = 90 +
NOISY = 80 to 90 dBspl
MODERATE = 65 to 80 dBspl
QUIET = 50 to 65 dBspl

INITIAL CONFIGURATION WILL BE FOR VOICE PAGE

ENTER INFORMATION ABOUT THE SQUARE/RECTANGULAR AREA

PRESS <ENTER> IF LENGTH AND WIDTH ARE NOT KNOWN

What is the area's length ? 200
What is the area's width ? 300
How high will the horns be mounted ? 20
What is the ambient noise level (dBspl) of the area ? 88

This screen is where the user initially defines the area. If length or width are entered as zero, the program prompts for square footage. dBspl reference information is provided as a user reference.

Example Of Selected Configuration When
Length/Width Are Entered

INPUT DATA

L (200 FEET) X W (300 FEET) = 60000 FT²
MOUNTING HEIGHT = 20 FEET
AMBIENT DBSPL = 88 DBSPL
MAX DBSPL OVER AMBIENT ALLOWED/ADJUSTED = 26.86 / 20.15
MINIMUM DBSPL OVER AMBIENT ALLOWED = 6 DBSPL

SELECTED CONFIGURATION

HORN TYPE = 15 WATT ADJUSTED TO 119.63 DBSPL @ 4'
HORNS/ROW (4) X # ROWS (3) = 12 TOTAL HORNS
ROWS WILL BE ALONG THE 300 FOOT DISTANCE

PERTINENT DBSPL LEVELS - MAX SPACING ≈ 75 FEET

@ ROW SPACING (66.67 FEET) = 94.98 DBSPL
@ SIDE-BY-SIDE SPACING (75.00 FEET) = 94.00 DBSPL (REF)

This is the selected configuration. The program displays the data that was entered and the configuration that was selected to accommodate the input data. If square footage was entered, the row and side-by-side spacing is replaced by a maximum spacing value [see example below].

Example Of Selected Configuration When
Total Square Footage is Entered

INPUT DATA

SQUARE FOOTAGE = 60000 FT ²
MOUNTING HEIGHT = 20 FEET
AMBIENT DBSPL = 88 DBSPL
MAX DBSPL OVER AMBIENT ALLOWED/ADJUSTED = 26.86 / 20.15
MINIMUM DBSPL OVER AMBIENT ALLOWED = 6 DBSPL

SELECTED CONFIGURATION

HORN TYPE = 15 WATT ADJUSTED TO 119.63 DBSPL @ 4'
APPROXIMATE NUMBER OF HORNS = 11 TOTAL HORNS
COVERAGE PER HORN = 5454.545 FT²

MAXIMUM SUGGESTED HORN SPACING

THE MAX SPACING = 75.00'

PRESS A RESERVED FOR FUTURE USE

PRESS B TO CHANGE INPUT DATA

PRESS C TO CHANGE TO STANDARD SPACING (IF POSSIBLE)

PRESS D TO CHANGE TO MAXIMUM SPACING (NON ENCLOSED AREAS ONLY)

PRESS E TO RETURN TO THE INITIAL CONFIGURATION

PRESS F TO CHANGE TO A 'TONE ONLY' CONFIGURATION

PRESS G TO VIEW CONFIGURATION/SPOT PAGE DETAILS

PRESS H TO SWAP HORN ROWS AND COLUMNS

PRESS I TO PRINT THIS CONFIGURATION

PRESS Z TO START OVER OR X TO EXIT

After pressing <ENTER> the user is given more options:

Option B - allows the user to modify the input data (length, width, ambient dBspl, etc). OPTION B IS VERY USEFUL FOR EVALUATING CONFIGURATION CHANGES THAT OCCUR FROM VARIATIONS OF INPUT DATA (AMBIENT NOISE LEVEL, CEILING HEIGHT, ETC.)

Option C - Attempts to configure a system using standard spacing and the current input data.

Option D - Attempts to configure a system using maximum spacing and the current input data.

Option E - Returns the user to the initial configuration.

Option F - Allows the user to toggle between tone only and voice configurations.

Option G - Show additional detail about the configuration including the maximum spacing for minimum dBspl over ambient [without regard for maximum dBspl over ambient (for spot paging in extremely loud areas)].

Option H - The program automatically places the horns against the area dimension that provides the least number of horns (if there is a difference). This option reconfigures the spacing for rows against the opposing dimension.

Option I - Prints the current configuration.

QUESTION -

Why does the horn layout program (OPTION A) specify 4 five watt horns in a 50 dBspl area that is 50' x 50' when the mounting height is 8' and voice page is desired ?

Well, actually, this would be correct for the limits specified. An 8' mounting height is ridiculous (in this noise level anyway) and ridiculous input data yields ridiculous (but correct) answers.

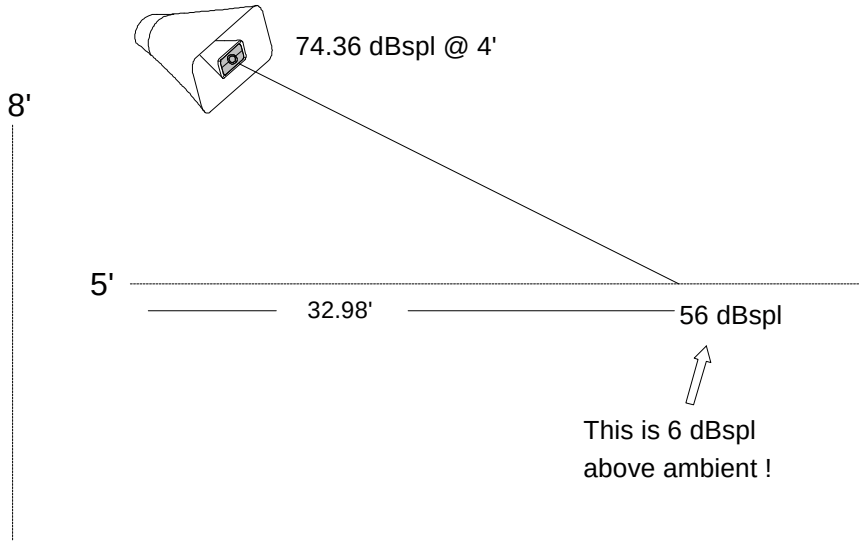
A maximum dBspl over ambient of 26.86[1] and a minimum dBspl over ambient of 6 is standard for voice page. This means that the horns can only be turned up to 74.36 dBspl @ 4'. If we use the standard people listening height of 5', this means listeners are only 3 feet away from the horn. By the Inverse Square Law . . .

$$74.36 \text{ dBspl} - 20 \text{ LOG } (3/4) = 76.86 \text{ dBspl}$$

So when a horn is turned up to 74.36 dBspl @ 4', the dBspl @ 3' away from the horn will be 76.86 dBspl . . . this is 26.86[1] dBspl above the ambient of 50 dBspl . . .

$$76.86 \text{ dBspl} - 50 \text{ dBspl} = 26.86 \text{ dBspl}$$

Well, since the horn can only be turned up to 74.36 dBspl @ 4', this means that the maximum spacing (the distance where 6 dBspl above ambient occurs) is 32.98. . . at this spacing 4 horns are required . . .



SAMPLE PROBLEM A4 [#/TYPE OF HORNS (PROGRAM SUGGESTS REDUCTION)]

An area is 1200' x 1200', 75 dBspl and voice page horns will be mounted at 20' high. If standard voice page spacing is to be observed (no more than 80' horn spacing, how many horns and what type will be necessary ?

Answer - 225 V-1030C 5 W horns

What if we are willing to accept approximately 86 foot horn spacing ?

Answer - 196 V-1030C 5 W horns

OPTIONS:

WITH THE HORN OUTPUT LEVEL AS DETERMINED BY 80 FOOT STANDARD SPACING . . .

THE SELECTED CONFIGURATION ACHIEVES THE REQUESTED MINIMUM DBSPL ABOVE AMBIENT OF 6 DBSPL BY USING 15 ROWS OF HORNS AND 80.0000' ROW SPACING.

14 ROWS (1 LESS) WOULD RESULT IN 85.7143' ROW SPACING.

THE SELECTED CONFIGURATION COMPLIES WITH THE GENERAL RULE THAT SIDE-BY-SIDE HORN SPACING SHOULD NOT EXCEED HORN REACH BY USING 15 HORNS PER ROW AND 80.0000' SPACING.

14 HORNS/ROW (1 LESS) WOULD RESULT IN 85.7143' HORN SIDE-BY-SIDE SPACING.

PRESS A (ALL) OR Y TO ACCEPT REDUCTIONS OR ANY KEY TO CONTINUE

After adjusting the horn output for standard or maximum spacing, if the program determines that one less row and/or one less horn per row will only reduce the minimum dBspl over ambient desired by 0.99 dBspl or less but will increase spacing over standard, the user is given the option of reducing the number of rows and/or number of horns per row. Horn output is automatically adjusted for the new spacing (if possible). The "All" option is for extreme cases where multiple reduction possibilities might exist.

SAMPLE OUTPUT SCREEN FOR SOUNDDESIGN V5.92 Option A "How many horns . . . . "

THE SELECTED CONFIGURATION IS BASED UPON THE FOLLOWING:

L (632 FEET) X W (251 FEET) = 158632 FT²	
MOUNTING HEIGHT = 20 FEET	Note 1
AMBIENT DBSPL = 88 DBSPL	
MAX DBSPL OVER AMBIENT ALLOWED/ADJUSTED = 26.86 / 20.15	Note 2
MINIMUM DBSPL OVER AMBIENT ALLOWED = 6 DBSPL	Note 3
SELECTED CONFIGURATION	Note 4
HORN TYPE = 15 WATT ADJUSTED TO 119.63 @ 4'	Note 5
# HORNS/ROW (4) X # ROWS (9) = 36 TOTAL HORNS	Note 6
ROWS WILL BE ALONG THE 251 FOOT DISTANCE	Note 7
PERTINENT DBSPL LEVELS - MAX SPACING = 75 FEET	Note 8
@ ROW SPACING (70.22 FEET) = 94.55 DBSPL	Note 9
@ SIDE-BY-SIDE SPACING (62.75 FEET) = 95.48 DBSPL (REF)	Note 10
PRESS +/- TO INCREASE/DECREASE MAX SPACING BY 1 FOOT	Note 11
ENTER AN OPTION LETTER, A NEW DESIRED HORN SPACING OR PRESS <ENTER>	Note 12

Note 1 - The first section is simply the information that you entered. This can be modified by pressing "B".

Note 2 - The maximum dBspl over ambient is the horn sound level that would be heard by individuals directly underneath a horn if it were pointing straight down. 20.86 dBspl is an acceptable limit. 26.86 dBspl is used to allow for the 6 dBspl dispersion angle loss. The adjusted value is the actual maximum associated with the actual horn spacing selected (i.e. MAX SPACING).

Note 3 - The minimum dBspl over ambient for good quality voice page is 6; for tone only systems 3 dBspl over the ambient noise is acceptable (press F to toggle between voice and tone only configurations).

Note 4 - The line reflects if the configuration was selected by the program "SELECTED CONFIGURATION"; altered by you "USER SELECTED CONFIGURATION" ; or the maximum possible spacing as determined by either the maximum output of a 30 watt horn *or* the maximum dBspl over ambient of 26.86 (whichever limit occurs first).

Note 5 - This is the horn type selected and the output necessary to achieve maximum spacing (see Note 8). Is anyone actually going to set the horn to this exact output ? Heck no, but knowing the required horn output tells you how close you are to the limits of the horn.

Note 6 - This is simply the resulting number of horns per row and number of rows.

Note 7 - The program selects one of the walls to place the rows against. You can swap this to the other dimension by pressing "H".

Note 8 - Based upon the mounting height, the ambient noise level and the maximum dBspl above the ambient noise, the program has determined the maximum horn spacing to achieve the minimum dBspl above ambient.

Notes 9 and 10 - This is the actual row and horn spacing that results from dividing the physical dimensions of the room by the number of horns per row and number of rows. This spacing defaults to a value less than or equal to maximum spacing (unless you have accepted horn reduction suggestions).

Note 11 - Pressing "+ " increases the maximum horn spacing by 1 foot; likewise, pressing "-" decreases the maximum spacing by one foot.

Note 12 - You can press the ENTER key to review options, you can simply press one of the option letters if you know them, or you can simply enter a different maximum horn spacing to evaluate.

PRESS B HOW MANY CEILING SPEAKERS . . . ?

This option calculates the number of ceiling speakers required for an area based solely upon square footage and mounting height. The program offers answers for "with background music" and "without background music" (25% reduction).

Note - the user has the option of entering room size by length and width or total square footage.

SD592.EXE CEILING SPEAKER LAYOUT PROGRAM
Calculates number of ceiling speakers based upon mounting height and dimensions or square footage.
Provides suggestion for area with background music and for area without background music.
Can evaluate user defined mounting height.
Can determine dBspl level available from speaker at 5' above the floor.
Provides specific spacing suggestions.

SAMPLE PROBLEM B1 [# CEILING SPEAKERS FROM DIMENSIONS]

If a 400' x 500' Superstore area has 25' ceilings, and pendant speakers will be mounted at a height of 20' (bottom of speaker), how many speakers will be required:

a) With BGM (ANSWER - 130)

b) Without BGM (ANSWER - 99)

SAMPLE PROBLEM B2 [ARE CEILING SPEAKERS LOUD ENOUGH ?]

If a 3,250 square foot open office area has 8' drop ceiling, how many ceiling speakers will be required:

a) With BGM (ANSWER - 13)

b) Without BGM (ANSWER - 10)

If the ceiling speaker can produce 96 dBspl @ 4', what is the maximum sound level that can be produced at 5' above the floor ? (ANSWER - 98.49 dBspl). This means that if the area's ambient dBspl level is 92.49 dBspl or less, the ceiling speaker can overcome the ambient by at least 6 dBspl.

SAMPLE PROBLEM B3 [# CEILING SPEAKERS FROM SQUARE FOOTAGE]

If a 120' x 100' open office area has 9' drop ceiling, how many ceiling speakers will be required:

a) With BGM (ANSWER - 42)

b) Without BGM (ANSWER - 30)

DATA FOR 8 FOOT MOUNTING HEIGHT, 3250 FT² AREA

WITH BACKGROUND MUSIC
THE SQUARE SPACING WILL BE 16 FEET
THE COVERAGE PER SPEAKER = 256 FEET²
IN ORDER TO EVENLY COVER THIS 3250 SQUARE FEET, USE 13 CEILING SPEAKERS

WITHOUT BACKGROUND MUSIC
THE SQUARE SPACING WILL BE 18.48 FEET
THE COVERAGE PER SPEAKER = 341.5104 FEET²
IN ORDER TO EVENLY COVER THIS 3250 SQUARE FEET, USE 10 CEILING SPEAKERS

PRESS A TO CHECK ANOTHER
PRESS B TO EVALUATE THE DBSPL AVAILABLE @ 5 FEET ABOVE THE FLOOR
PRESS C TO CHANGE MOUNTING HEIGHT
PRESS D TO EXIT

SAMPLE PROBLEM B2 RESULTS

PRESS C WHAT SIZE WIRE . . . HOW MANY SELF AMPLIFIED SPKRS ON WIRE SIZE ?

This option can be used to calculate the wire size required for a particular self amplified speaker/horn **power** wire run **- or -** may be used to calculate how many of these speakers may be spaced on a particular wire size (power pair). ***Be aware that you can always use a heavier gauge (smaller AWG number) wire than the program prescribes.***

All speaker wiring will inherently "drop" some voltage. This voltage drop is a product of the wire's resistance and the current being supplied to the speakers. The difference between the rated supply voltage and the minimum operating voltage is the acceptable voltage drop. For example, if a speaker is rated at 24 Vdc but will operate properly with as little as 20 Vdc, then the acceptable voltage drop across the wire will be the difference between 24 Vdc and 20 Vdc or 4 Vdc.

Very Important ! - By using properly placed remote power supplies, it is always possible to use standard 22 or 24 AWG twisted pair telephone wire for self amplified speaker connections. Figure 6 shows an example of this fact.

Valcom Distributed self amplified speakers and horns have amplifiers built-in. This technology offers great flexibility for telephone system integrated single or multiple zone paging, virtually unlimited system expansion and inherent reliability due to redundant amplifiers and low power/heat loss.

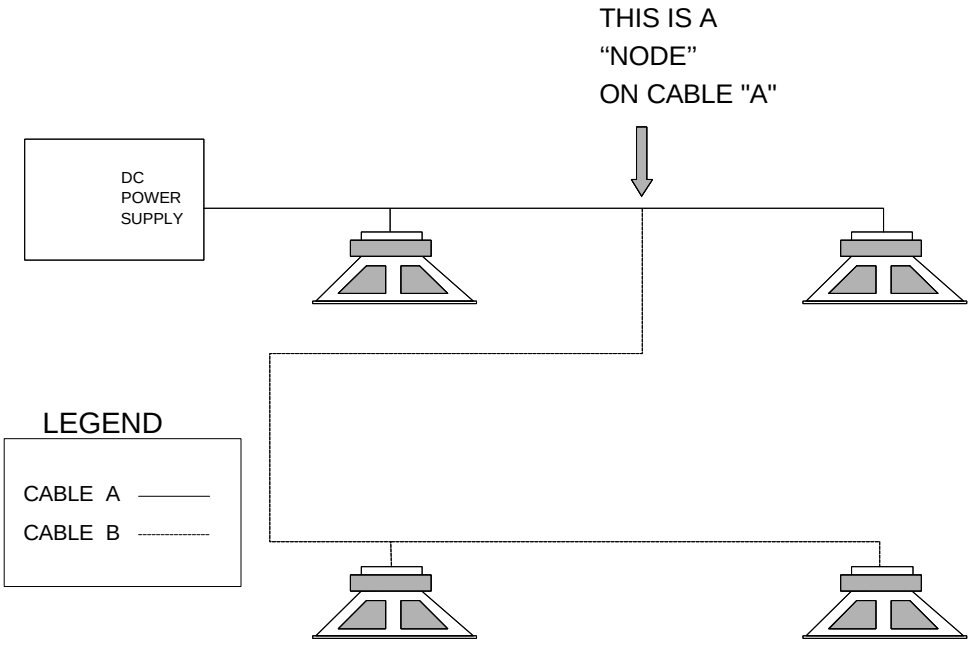
Due to the fact that each speaker or horn contains an integral amplifier, the audio wiring can usually be standard 24 AWG twisted pair telephone wire. Quite often, even existing spare pairs in telephone feeder cables can be used.

In some configurations, an advantageous way to power the DC inputs of these speakers is to locate power supplies near the speakers and horns that they are powering. Following this guideline will allow the use of the same 22 or 24 AWG twisted pair wire for both the audio and DC power connections.

Balancing a self amplified paging system simply involves adjusting the individual speaker/horn volume controls; expansion generally involves simply adding additional speakers/horns and DC power.

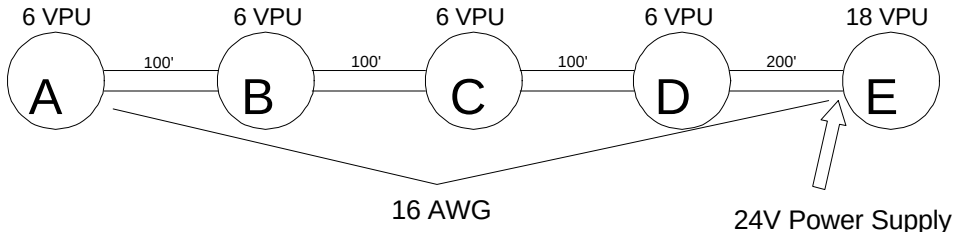
WHAT IS A NODE ?

A "node" is simply a point where one wirerun branches off of another



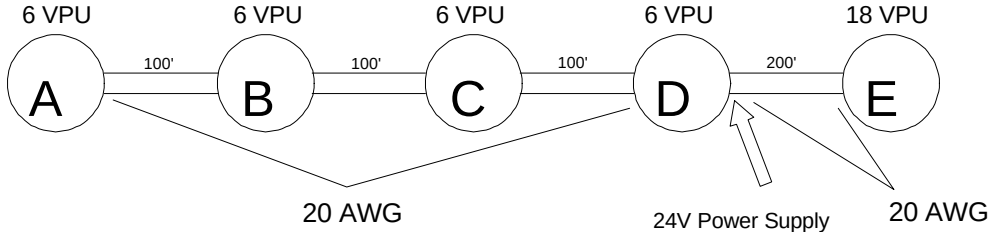
[All designed for a maximum 4 volt drop]

1)



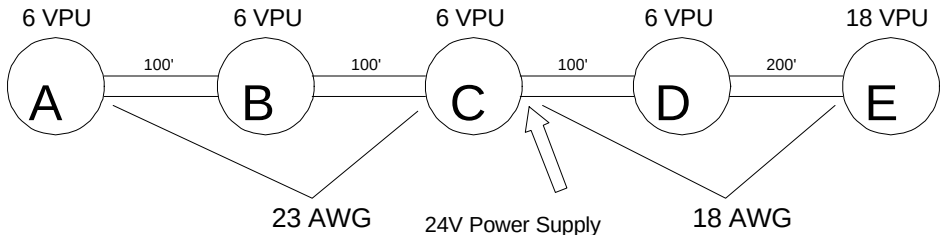
Power supply located next to horn "E"

2)



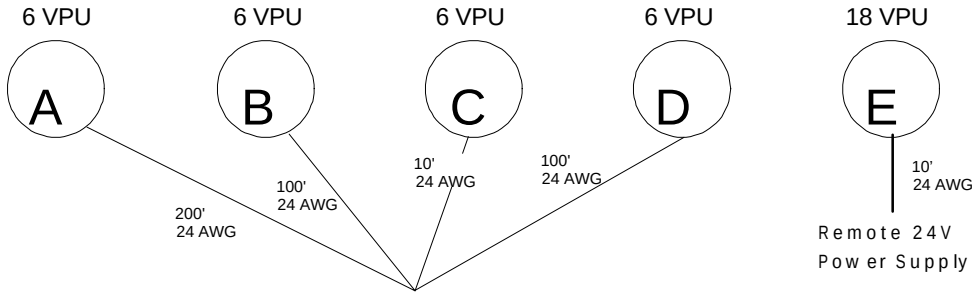
Power supply located next to horn "D"

3)



Power supply located next to horn "C"

4)



Power supply located next to horn "C" with all power wiring "home run" except for remotely powered horn "E".

When using self amplified type speakers, power supplies can be located near the speakers that they are powering. SD592.EXE allows you to determine the location and scheme that requires the smallest possible wire size.

Figure 6

SAMPLE PROBLEM C1 [MULTIPLE NODES] Refer to the figure on the next page

1) Enter the power supply voltage as "24"<ENTER>.
2) Enter the tolerable voltage drop as "4"<ENTER>.
3) Enter the data for the main wire run as follows:

Speaker #	Input	Feet
1	6<ENTER>	200<ENTER>
2	6<ENTER>	200<ENTER>
3*	37<ENTER>	100<ENTER>
4	1<ENTER>	100<ENTER>
5*	18<ENTER>	200<ENTER>
6	18<ENTER>	30<ENTER>
7	Press <ENTER><ENTER> to exit data entry	

** Nodes are simply added as if they were a single speaker*

4) The program calculates that 8 AWG is necessary for the main run (WIRE A).
5) Exit data entry and press 3 in order to determine the voltage at nodes 1 and 2.
6) Note that node 1's voltage is 21.45 V and node 2's voltage is 20.76 V.
7) Press <ENTER> then 9 to restart program.

To Determine the AWG necessary for WIRE B -

8) Enter the power supply voltage as NODE 1's voltage (21.45<ENTER>) voltage.
9) Enter the tolerable voltage drop (1.45<ENTER>).
10) Enter the data for the WIRE B as follows:

Speaker #	Input	Feet
1	18<ENTER>	100<ENTER>
2	18<ENTER>	100<ENTER>
3	1<ENTER>	1000<ENTER>
4	Press <ENTER><ENTER> to exit data entry	

11) The program calculates that 13 AWG is necessary for WIRE B.

To Determine the AWG necessary for WIRE C -

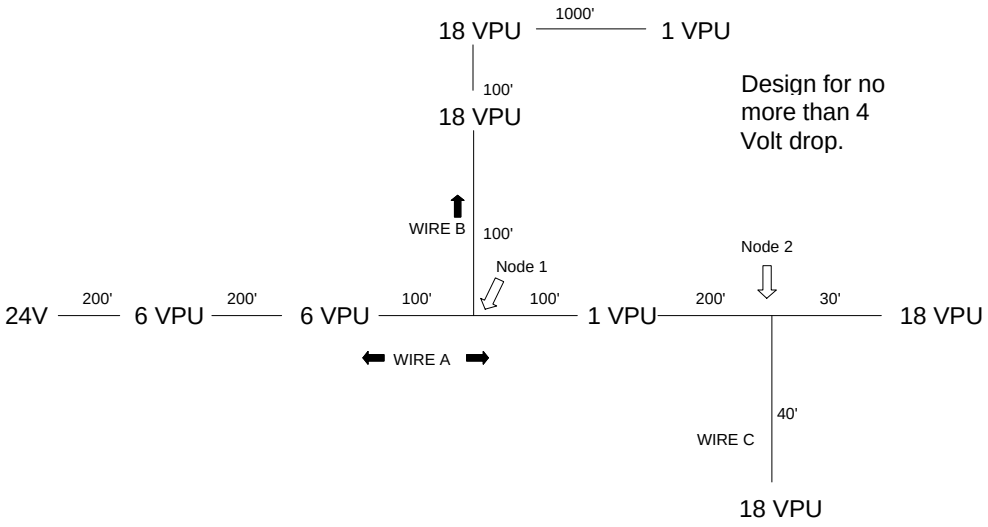
12) Press 7 to restart program.
13) Enter the power supply voltage as NODE 2's voltage (20.76<ENTER>) voltage.
14) Enter the tolerable voltage drop (.76<ENTER>).
15) Enter the data for the WIRE C as follows:

Speaker #	Input	Feet
1	18<ENTER>	40<ENTER>
2	Press <ENTER><ENTER> to exit data entry	

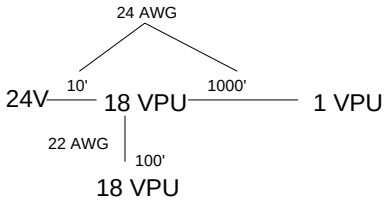
16) The program calculates that 20 AWG is necessary for WIRE C.

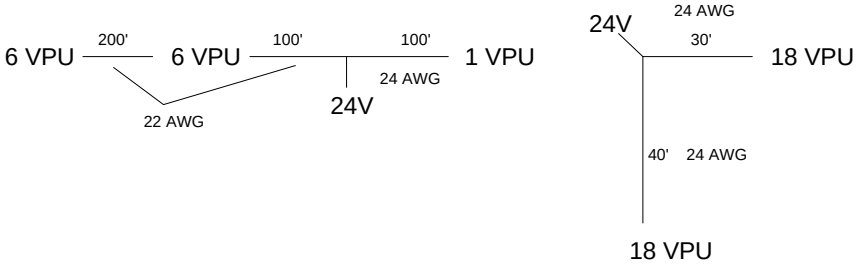
EXAMPLE SCENARIO

For sample problem C1



Now look what happens to the wire gauge required when 3 smaller remote power supplies are used. The wire could be 22 AWG in all cases.





Use the default of a maximum 4 volt drop for the following

SAMPLE PROBLEM C2 [HOW MANY HORNS ON WIRE SIZE vs. SPACING]

How many 24 Vdc/18 VPU horns can be connected on 24 AWG wire if they are spaced:

a) First horn 30' from the power supply, 40' spacing thereafter - (ANSWER - 1)

b) First horn 10' from the power supply, 30' spacing thereafter - (ANSWER - 2)

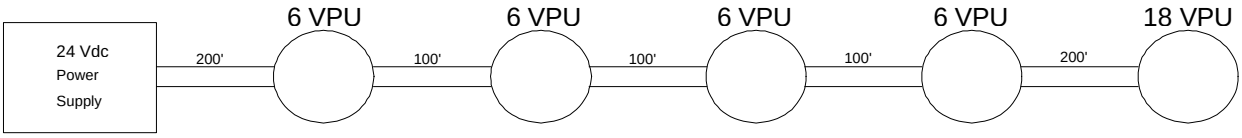
SAMPLE PROBLEM C3 [HOW MANY SPEAKERS ON WIRE SIZE vs. SPACING]

How many 24 Vdc/1 VPU speakers can be connected on 24 AWG wire if they are spaced first speaker 8' from the power supply and also 8' spacing thereafter ? (ANSWER - 19)

SAMPLE PROBLEM C4 [HOW MANY SPEAKERS ON WIRE SIZE vs. SPACING]

How many 24 Vdc/1 VPU speakers can be connected on 24 AWG wire if they are spaced first speaker 80' from the power supply and 8' spacing speaker to speaker thereafter ? (ANSWER - 12)

SAMPLE PROBLEM C5 [WHAT AWG WIRE IS NECESSARY ?]



Design for 4 volt maximum drop

Figure 3 - What gauge wire will be necessary ? [see figure 6 for other options]

(ANSWER - 12 AWG)

The DC POWER Pair wire size required is 12 AWG
The AUDIO Tip/Ring Pair wire size required is 24 AWG

RE-CONFIGURING WITH REMOTE POWER SUPPLIES LOCATED CLOSER TO THE SPEAKERS OR HORNS THAT THEY ARE POWERING WILL RESULT IS A SMALLER WIRE SIZE REQUIREMENT

5 SPKRS ENTERED SO FAR

E <ENTER> to EXIT PROGRAM
C <ENTER> to DISABLE constant check option
X <ENTER> to ENABLE entry review
A <ENTER> to enable AUTO ENTRY REPEAT
B + ENTRY # <ENTER> to BACK UP to previous entry

ENTER THE SPKR'S VPU VALUE
Input SPKR # 6

ACCEPTABILITY OF 22 & 24 AWG
24 AWG WIRE EXCEEDED
22 AWG WIRE EXCEEDED
12 AWG REQUIRED
(or 17 PAIRS OF 24 AWG)

Wirerun Data Input Screen For Option C

RE-CONFIGURING WITH REMOTE POWER SUPPLIES LOCATED CLOSER TO THE SPEAKERS OR HORNS THAT THEY ARE POWERING WILL RESULT IS A SMALLER WIRE SIZE REQUIREMENT

The DC POWER Pair wire size required is 12 AWG
The AUDIO Tip/Ring Pair wire size required is 24 AWG
12 AWG is equivalent to 17 pairs of 24 AWG twisted together
Total Voltage Drop = 3.3348
Wire AWG = 12 AWG Ohms per foot = 0.0031760
Circular Mils = 6530 Square millimeters = 3.31
The voltage at SPKR # 5 (last SPKR) = 20.665 volts

Press 1 for more options
Press 2 to list all AWGs/Voltage Drops
Press 3 to view current data
Press 4 to print current data
Press 5 to duplicate the last speaker
Press 6 to remove the last speaker
Press 7 to start over
Press 8 to end
Press 9 to evaluate twisting wire pairs

Option Screen 1

Tolerable Voltage Drop set to 4 - Power supply voltage set to 24 V

Wire AWG = 12 AWG Ohms per foot = 0.0031760

TOTAL VPUs = 42

Press 1 to return to previous menu
Press 2 to change the power supply voltage
Press 3 to change an entry
Press 4 to remove a speaker
Press 5 to mirror copy a speaker
Press 6 to change the tolerable voltage drop
Press 7 to evaluate a different wire AWG
Press 8 to end
Press 9 to start over

Option Screen 2

Option Screens Upon Completion Of Wirerun Data Input Section

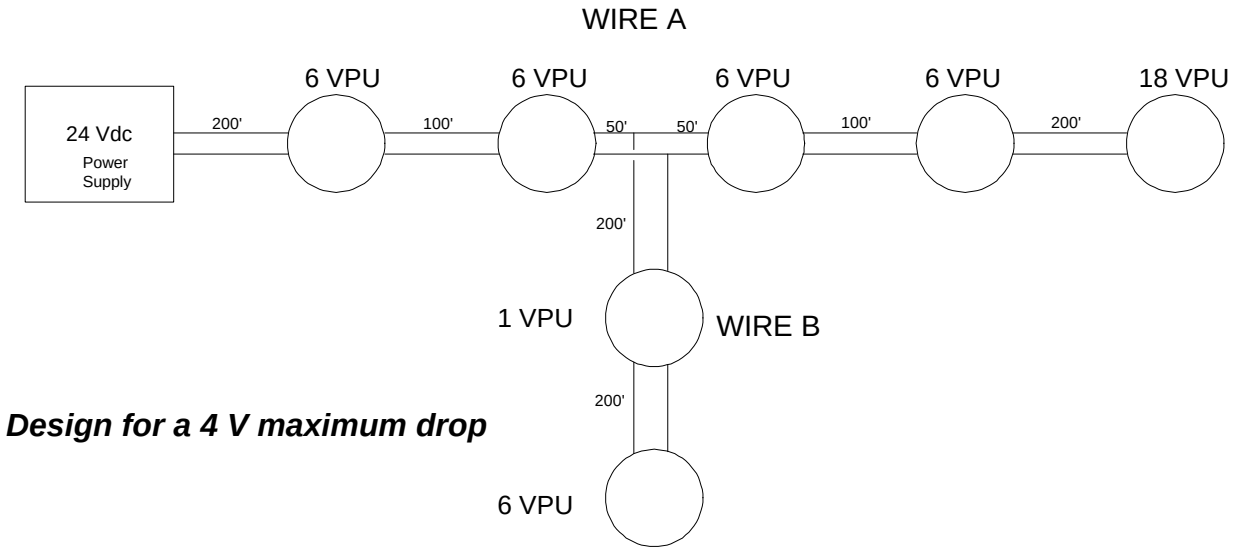
Result Of Pressing 3 On Option Screen 1 [Review Of Input Data]

```
SPKR #   1 = 6 VPU SPKR @   200'  SPKR Voltage = 22.666V  Space = 200 '
SPKR #   2 = 6 VPU SPKR @   300'  SPKR Voltage = 22.094V  Space = 100 '
SPKR #   3 = 6 VPU SPKR @   400'  SPKR Voltage = 21.618V  Space = 100 '
SPKR #   4 = 6 VPU SPKR @   500'  SPKR Voltage = 21.237V  Space = 100 '
SPKR #   5 = 18 VPU SPKR @   700'  SPKR Voltage = 20.665V  Space = 200 '

          <ENTER For More Or C To Continue>
```

Result Of Pressing 2 On Option Screen 1 [Review Of All Wire Sizes]

```
24 AWG WILL DROP   53.9070 Volts IMPOSSIBLE SCENARIO   LOSS > SUPPLY V
23 AWG WILL DROP   42.7560 Volts IMPOSSIBLE SCENARIO   LOSS > SUPPLY V
22 AWG WILL DROP   33.8940 Volts IMPOSSIBLE SCENARIO   LOSS > SUPPLY V
21 AWG WILL DROP   26.8800 Volts IMPOSSIBLE SCENARIO   LOSS > SUPPLY V
          20 AWG WILL DROP   21.3150 Volts
          19 AWG WILL DROP   16.9071 Volts
          18 AWG WILL DROP   13.4085 Volts
          17 AWG WILL DROP   10.6344 Volts
          16 AWG WILL DROP    8.4336 Volts
          15 AWG WILL DROP    6.6864 Volts
          14 AWG WILL DROP    5.3025 Volts
          13 AWG WILL DROP    4.2063 Volts
          12 AWG WILL DROP    3.3348 Volts
          11 AWG WILL DROP    2.6460 Volts
          10 AWG WILL DROP    2.0977 Volts

          <ENTER For More Or C To Continue>
```

SAMPLE PROBLEM C6 [DEMONSTRATES MULTIPLE SPEAKER NODE]



Design for a 4 V maximum drop

(ANSWER - WIRE A = 12 AWG WIRE B = 17 AWG)

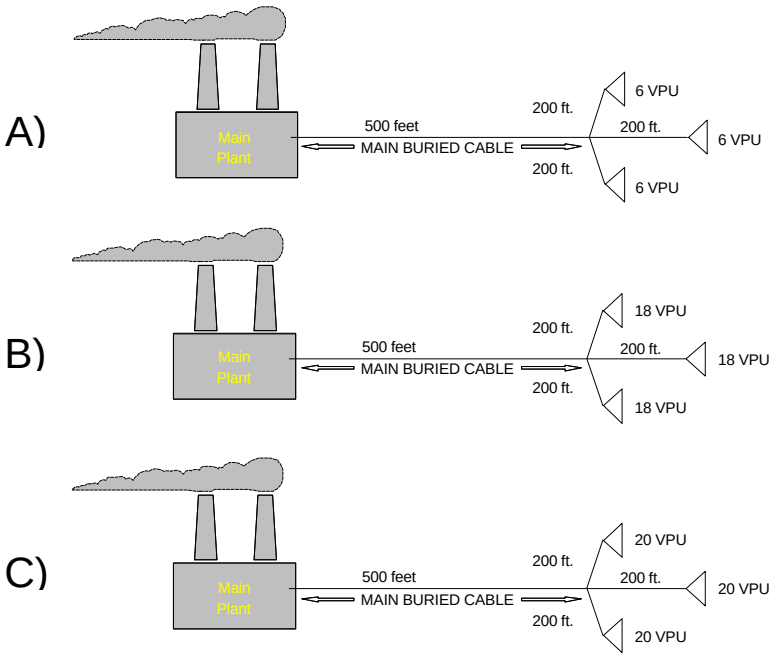
Hints:
To solve this problem calculate WIRE A separately from WIRE B starting with WIRE A:

1) As you're entering WIRE A, enter the point where WIRE B meets WIRE A as a 7 VPU speaker that is 50' from the second SPKR. (Note - the 4th speaker is then 50' from the NODE)
2) Solve for WIRE A (comprised of 5 SPKRS and one 7 VPU NODE)
3) Record the NODE's voltage. [21.467 V]
4) Restart the program using the NODE voltage as your power supply voltage and the NODE Voltage - 20V [1.466999 V] as the tolerable voltage drop (Note - this value is automatically calculated).
5) Solve for WIRE B.

What does this answer mean ?

If all of the speakers are using their rated VPUs and 12 AWG wire or larger is used for WIRE A and 17 AWG wire or larger is used for WIRE B, the minimum voltage at any speaker will be 20 Vdc.

SAMPLE PROBLEM C7 [WHAT AWG WIRE IS NECESSARY ?] Solve for the wire size for A, B, and C. Total Voltage drop across the wire should not exceed 4 Vdc.

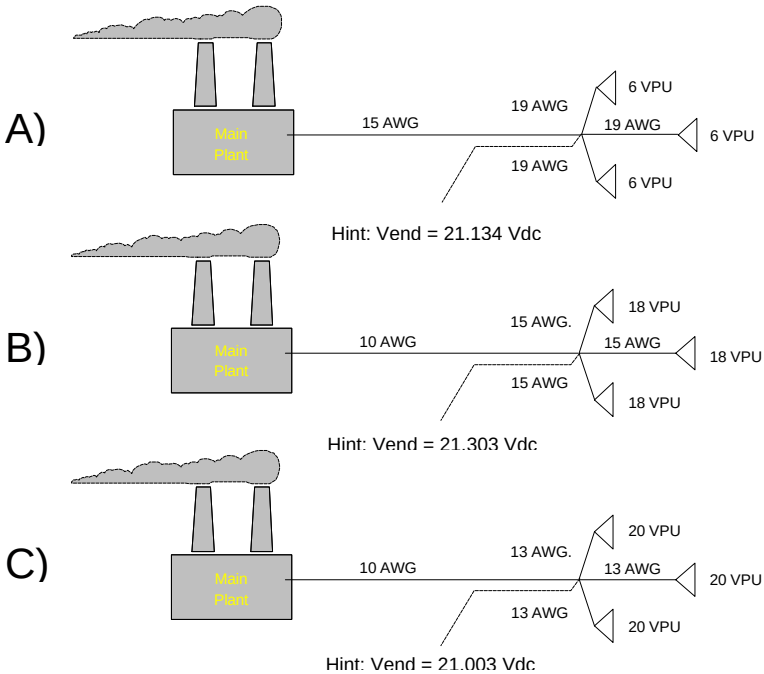


There are several ways to solve this, here is a suggested method:

1) Solve for the 500' main buried cable first using a 3 Vdc maximum voltage drop (this allows for 1 Vdc of drop available for each of the three individual horn runs). All of the current flows through this main run.

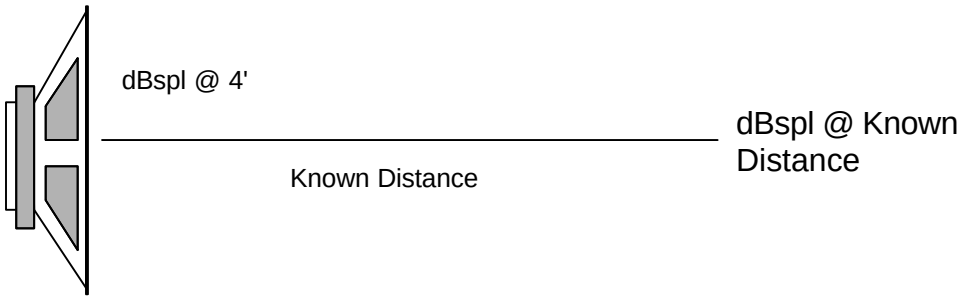
2) After step 1 is complete, note the voltage available at the end of the 500' wirerun (let's refer to it as V_{end}. Solve for the individual 200' wire runs using V_{end} as the power supply voltage and V_{end} - 20 Vdc as the acceptable voltage drop.

3) Done.



PRESS F WHAT'S THE DBSPL AT ___ FEET ? (INVERSE SQUARE LAW)

This option calculates the sound level that will result at a certain distance in front of a sound source based upon the source's reference dBspl.



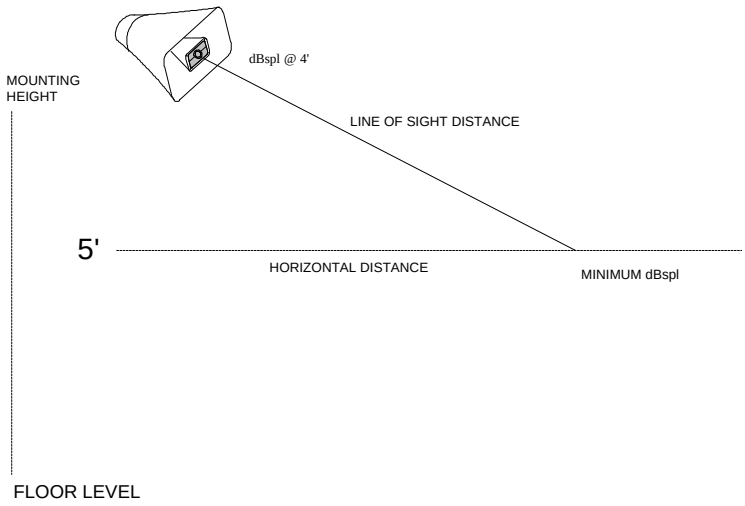
If the dBspl @ 4' and the desired dBspl are known, and distance is unknown, use Option I - HOW FAR IN FRONT OF THE SPEAKER/HORN WILL ___ DBSPL OCCUR ?

SAMPLE PROBLEM F1 [WHAT'S THE SOUND LEVEL 300' <u>DIRECTLY</u> IN FRONT OF A HORN]

If a horn's output is 121 dBspl @ 4', what sound level will be present at 300' in front of the horn (ideal conditions assumed) ? (Answer: 83.49 dBspl)

PRESS G WHAT'S THE DBSPL AT ___ FEET ? (WITH HORN ANGLE CONSIDERED)

This option calculates the sound level that will result at a certain horizontal distance in front of a sound source when the sound source is angled down from a particular height (like a horn). The program may also be used to calculate the distance in front of the source that will result in a certain sound level. This is based upon the source's reference dBspl and mounting height.



The program initially prompts the user for the dBspl @ 4' and mounting height of the horn speaker. Mounting height is automatically adjusted to reflect 5' above the floor (average listener distance). Listed below are the options offered after the user has provided the request information.

Option B provides the dBspl available at a particular horizontal distance.

Option A provides the horizontal distance that results in a particular minimum acceptable dBspl. Option A can also be used to determine the horizontal distance if you know the line-of-sight distance.

SAMPLE PROBLEM G1 [WHAT DISTANCE IN FRONT OF A HORN RESULTS IN 85 dBspl]

A 5 Watt horn is adjusted to 106 dBspl @ 4' and is mounted at a 20 foot height. How far in front of the horn will 85 dBspl occur (5' above the floor) ?
(ANSWER - 42.29')

SAMPLE PROBLEM G2 [WHAT dBspl WILL OCCUR AT 100 FEET IN FRONT OF A HORN]

A 5 Watt horn is adjusted to 114 dBspl @ 4' and is mounted at a 25 foot height. What dBspl level will occur @ 100 horizontal feet in front of the horn (5' above the floor) ?
(ANSWER - 85.87 dBspl)

SAMPLE PROBLEM G3 [WHAT dBspl EXISTS @ 200 DIRECT FEET IN FRONT OF HORN]

A 5 Watt horn is adjusted to 114 dBspl @ 4' and is mounted at a 25 foot height. What dBspl level will occur @ 200 line of sight feet in front of the horn ?
(ANSWER - 80.02 dBspl)

SAMPLE PROBLEM G4 [FINDING AN OPTIMAL HORN ANGLE]

Suppose you have determined the horn speaker spacing that you want to use, and now you want to describe how the speakers/horns should be angled. The horn layout program [Option A] provides this angle for the actual row spacing that results from the dimensions being divided by the desirable spacing. Option H also provides the optimal horn angle, but the program determines the horn spacing. If you have already determined the spacing then Option G is what you what to use. As an example, let's suppose you've decided on using a horn capable of producing 116 dBspl @ 4', spaced at 80 feet and mounted 25 feet high:

THIS PROGRAM DETERMINES THE HORIZONTAL DISTANCE FROM DIRECTLY BELOW A HORN TO A CERTAIN FLOOR LEVEL DISTANCE IN FRONT OF THAT HORN. IT ALSO DETERMINES THE OPTIMAL HORN ANGLE TO REACH THAT DISTANCE AND THE RESULTING DBSPL LEVEL. THE DBSPL LEVEL IS CALCULATED FROM THE ANGLED DISTANCE FROM THE HORN.

WHAT IS 4' REF DBSPL ? 116
WHAT IS THE MOUNTING HEIGHT OF THE HORN ? 25

FOR EVALUATION PURPOSES, MOUNTING HEIGHT HAS BEEN ADJUSTED TO 20 FEET.

Enter The Maximum Horn Output And Mounting Height

PRESS A TO FIND THE DISTANCE THAT MAY BE COVERED BY THE HORN

PRESS B TO FIND THE DBSPL AT A SPECIFIED DISTANCE

PRESS C TO EXIT

Then Select Option B

EVALUATING A HORN MOUNTED @ 25 FEET WITH A 116 DBSPL OUTPUT @ 4'

WHAT IS THE HORIZONTAL DISTANCE (FEET) TO BE COVERED BY THE HORN ? 80

Enter The Spacing Increment That You Are Interested In Evaluating (80 feet in this case)

EVALUATING A HORN MOUNTED @ 25 FEET WITH A 116 DBSPL OUTPUT @ 4'

WHAT IS THE HORIZONTAL DISTANCE (FEET) TO BE COVERED BY THE HORN ? 80

LINE OF SIGHT DISTANCE (HORN TO 5' ABOVE THE FLOOR) = 82.46211 FEET
THE HORN SHOULD BE ANGLED AT = 14.03626 ◦ FROM THE CEILING
DBSPL @ 82.46211 FEET (80 HORIZONTAL FEET) = 89.71611 DBSPL

PRESS 2 TO START OVER, <ENTER> TO EVALUATE ANOTHER DISTANCE OR 1 TO END

This is the resulting screen. Notice that the program tells you the horn angle (from the ceiling) that points the horn directly at the 80 foot target distance. The program also tells you the dBspl that will be available from the horn at that distance (based upon the 116 dBspl @ 4' that you entered).

PRESS H IF THE AREA IS ___ DBSPL, HOW FAR WILL A HORN'S SOUND REACH

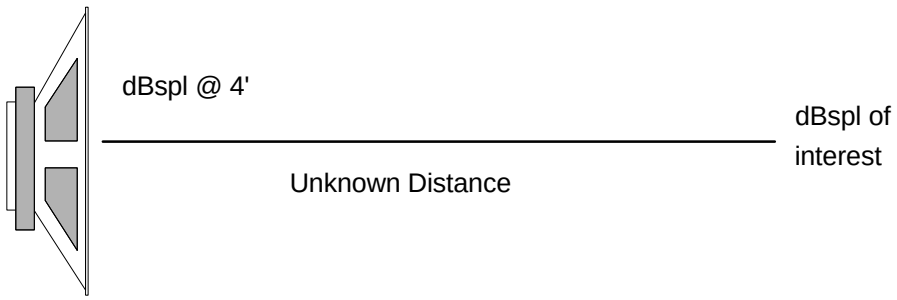
First, this option calculates the maximum sound level output that a horn can be allowed to produce based upon a maximum sound level over ambient and mounting height. Once this has been determined, the program determines the maximum distance that can be covered by the horn based upon the minimum sound level over ambient.

SAMPLE PROBLEM H1 [FIND MAXIMUM SPACING FOR A CERTAIN AMBIENT dBspl]

> If an area is 75 dBspl and horns (rated 100.66 dBspl @ 4') are to be used at a 15' mounting height, what is the maximum spacing for 6 dBspl above ambient ? (ANSWER - 37.14')

PRESS I HOW FAR IN FRONT OF A SOUND SOURCE WILL ___ DBSPL OCCUR ?

This option calculates the distance directly in front of a sound source that will result in a certain sound level. This is based upon the source's reference dBspl.



If the dBspl @ 4' and the distance are known, and the dBspl at the distance is unknown, use Option F - WHAT'S THE DBSPL AT ___ FEET ? (INVERSE SQUARE LAW).

SAMPLE PROBLEM I1 [<u>DIRECTLY</u> IN FRONT OF A 116 dBspl @ 4' HORN, FIND DISTANCE = 95 dBspl] If a horn's output is 116 dBspl @ 4', at what distance in front of the horn will 95 dBspl occur ? (Answer: 44.88')

PRESS J OHM'S LAW

This option calculates resistance, power, voltage or current when two of the values are known.

Notes - Current is expressed in terms of "Amps" [1 milliamp = 1/1000th of a amp]
Resistance is expressed in terms of "Ohms"
Power is expressed in terms of "Watts" [1 milliwatt = 1/1000th of a watt]
Voltage is expressed in terms of "Volts" [1 millivolt = 1/1000th of a volt]

SAMPLE PROBLEM J1 [DETERMINING THE WATTAGE OUTPUT OF A POWER SUPPLY]

If a 24 volt power supply has a 4 amp output, how many watts can it provide ? (ANSWER - 96 W)

SAMPLE PROBLEM J2 [DETERMINING THE CURRENT REQUIREMENT OF A POWER SUPPLY]

If a power supply's input requires 120 Vac and 90 watts, how much current will the power supply require from the 120 volt circuit ? (ANSWER - 0.75 amps)

SAMPLE PROBLEM J3 [DETERMINING THE WATTAGE REQUIREMENT OF A POWER SUPPLY]

If a power supply's input requires 120 Vac and 0.5 amps, how many watts will the power supply require from the 120 volt circuit ? (ANSWER - 60 W)

PRESS K HOW DOES POWER RATIO RELATE TO DBM ?

This option calculates the relationship between dBm and power

---

THIS PROGRAM CALCULATES THE RELATIONSHIP BETWEEN DBM AND POWER

PRESS A TO FIND THE DBM CHANGE BETWEEN 2 POWER LEVELS

PRESS B TO FIND THE POWER LEVEL THAT RESULTS FROM A DBM CHANGE

PRESS C TO EXPRESS A DBM LEVEL AS A POWER LOSS/GAIN

PRESS D TO EXIT

DBM Calculations Sub Menu

SAMPLE PROBLEM K1 [FIND THE DB GAIN THROUGH AN AMP] {SUB MENU OPTION A}

If an amplifier has a .001 Watt input and a 100 Watt output, what is the dBm gain ? (Answer: + 50 dBm)

SAMPLE PROBLEM K2 [FIND LOSS THROUGH ATTENUATOR] {SUB MENU OPTION A}

If an attenuator reduces 5 Watts of audio to a 1 Watt level, what dBm value represents this reduction ? (Answer: -6.9897 dBm)

SAMPLE PROBLEM K3 [FIND SPKR WATTAGE AFTER DB LOSS] {SUB MENU OPTION B}

If a 200 Watt speaker (driven at 200 Watts) sustains 3 dBm of loss, what is the new power level across the speaker ? (Answer: 100.2374 Watts)

SAMPLE PROBLEM K4 [FIND SPKR WATTAGE AFTER DB GAIN] {SUB MENU OPTION B}

If the power level across a speaker (initially driven at 10 Watts) is increased 2 dBm, what is the new power level across the speaker ? (Answer: 15.84893 Watts)

SAMPLE PROBLEM K5 [FIND POWER LOSS = DB LOSS] {SUB MENU OPTION C}

How much of a power loss is represented by -3 dBm ? (Answer: 49.88128 %)

SAMPLE PROBLEM K6 [FIND POWER GAIN = DB GAIN] {SUB MENU OPTION C}

How much of a power gain is represented by +4 dBm ? (Answer: 151.1886 %)

PRESS L WIRE PAIR CALCULATIONS

THIS OPTION PERFORMS A MYRIAD OF WIRE RESISTANCE CALCULATIONS . . .

THIS PROGRAM CALCULATES THE RESISTANCE OF LENGTHS OF WIRE

PRESS A TO FIND THE RESISTANCE OF A CERTAIN LENGTH OF WIRE

PRESS B TO FIND THE RESISTANCE OF A CERTAIN LENGTH OF ALL AWGS

PRESS C TO FIND THE WIRE DISTANCE ASSOCIATED WITH A VALUE OF RESISTANCE

PRESS D TO FIND MINIMUM AWG PAIR FROM RESISTANCE AND DISTANCE

PRESS E TO EVALUATE TWISTING MULTIPLE PAIRS OF WIRE TOGETHER

PRESS Z TO EXIT

Wire Calculations Sub Menu

SAMPLE PROBLEM L1 [FIND AWG FROM DISTANCE/OHMS] {SUB MENU OPTION D}

2000 feet of wire pair must not exceed 8 Ohms of resistance, what AWG wire can be used ? (ANSWER - 12 AWG)

SAMPLE PROBLEM L2 [FIND # FEET FROM AWG/OHMS] {SUB MENU OPTION C}

How many feet of 24 AWG wire pair results in 600 Ohms of resistance ? (ANSWER - 11,686)

SAMPLE PROBLEM L3 [FIND # PAIRS 26 AWG TO = 18 AWG] {SUB MENU OPTION E}

How many pairs of 26 AWG wire need to be twisted together to create the equivalent of 18 AWG ? (ANSWER - 7 PAIRS)

If we start with 2 pair of 24 AWG twisted together, how many additional pairs of 30 AWG need to be added to create the equivalent of 18 AWG ? (ANSWER - 9 PAIRS)

PRESS M UNIT OF MEASURE CONVERSIONS

This option allows conversion between a myriad of units of measure . . . .

THIS PROGRAM CONVERTS UNITS OF MEASURE

PRESS A - FEET TO METERS/METERS TO FEET
PRESS B - FEET TO KILOMETERS/KILOMETERS TO FEET
PRESS C - FEET TO MILES/MILES TO FEET
PRESS D - FEET TO YARDS/YARDS TO FEET
PRESS E - FEET² TO ACRES/ACRES TO FEET²
PRESS F - FEET² TO METERS²/METERS² TO FEET²
PRESS G - FEET² TO YARDS²/YARDS² TO FEET²
PRESS H - MILES TO KILOMETERS/KILOMETERS TO MILES
PRESS I - MILES² TO FEET²/FEET² TO MILES²
PRESS J - KILOMETERS² TO MILES²/MILES² TO KILOMETERS²
PRESS K - KILOMETERS² TO FEET²/FEET² TO KILOMETERS²
PRESS L - INCHES TO CENTIMETERS/CENTIMETERS TO INCHES
PRESS M - INCHES TO MILLIMETERS/MILLIMETERS TO INCHES
PRESS N - POUNDS TO KILOGRAMS/KILOGRAMS TO POUNDS
PRESS O - FARENHEIGHT TO CELSIUS/CELSIUS TO FARENHEIGHT
PRESS P - POUNDS TO GRAMS/GRAMS TO POUNDS
PRESS Q - OUNCES TO GRAMS/GRAMS TO OUNCES
PRESS R - FOR MORE CONVERSIONS
PRESS Z - TO EXIT

Main Unit Of Measure Window

PRESS N BASED ON THE SCALE, HOW MANY INCHES IS ___ FEET ? (BLUEPRINTS)

THIS OPTION CALCULATES INCHES VS. DISTANCE IN FEET FOR BLUEPRINTS

PRESS A TO ANSWER THE FOLLOWING TYPE OF QUESTION . . .

IF ___ INCHES = ___ FEET, HOW MANY INCHES = ___ FEET ?

Use this option if you know the scale of the drawing and want to determine how many inches represent a certain distance in feet.

SAMPLE PROBLEM N1 [HOW MANY INCHES = 50' IF THE SCALE IS 1" = 8']

IF THE SCALE OF A SET OF BLUEPRINTS IS 1" = 8', HOW MANY INCHES = 50' . . .? [ANSWER - 6 1/4"]

SAMPLE PROBLEM N3 [HOW MANY INCHES = 27 5/8' IF THE SCALE IS 1/16" = 2 3/8']

IF THE SCALE OF A SET OF BLUEPRINTS IS 1/16" = 2 3/8', HOW MANY INCHES = 27 5/8'? [ANSWER - USE STANDARD RULER INCREMENTS - REALLY CLOSE TO 23/32"]

PRESS B TO ANSWER THE FOLLOWING TYPE OF QUESTION . . .

IF ___ INCHES = ___ FEET, HOW MANY FEET DOES ___ INCHES REPRESENT ?

Use this option if you know the scale of the drawing and want to determine how many feet a measured distance in inches represents.

SAMPLE PROBLEM N2 [FIND FEET REPRESENTED BY MEASUREMENT]

IF THE SCALE OF A SET OF BLUEPRINTS IS 1" = 8', AND THE SIDE OF AN AREA MEASURES 3 3/32 INCHES, HOW MANY FEET IS THIS ? [ANSWER - 24.75 FEET]

SAMPLE PROBLEM N4 [FIND FEET REPRESENTED BY MEASUREMENT]

IF THE SCALE OF A SET OF BLUEPRINTS IS 1 1/16" = 15 3/8', HOW MANY FEET DOES 14 1/4" REPRESENT ? [ANSWER - 206.2']

PRESS O BASED ON THE SQUARE FOOTAGE, WHAT'S THE SCALE ? (BLUEPRINTS)

THIS OPTION DETERMINES A SCALE OF A BLUEPRINT, OR AN AREA OF A BLUEPRINT, WHEN ONLY THE SQUARE FOOTAGE IS KNOWN.

SAMPLE PROBLEM O1 [DETERMINE A SCALE FROM SQUARE FOOTAGE ONLY]

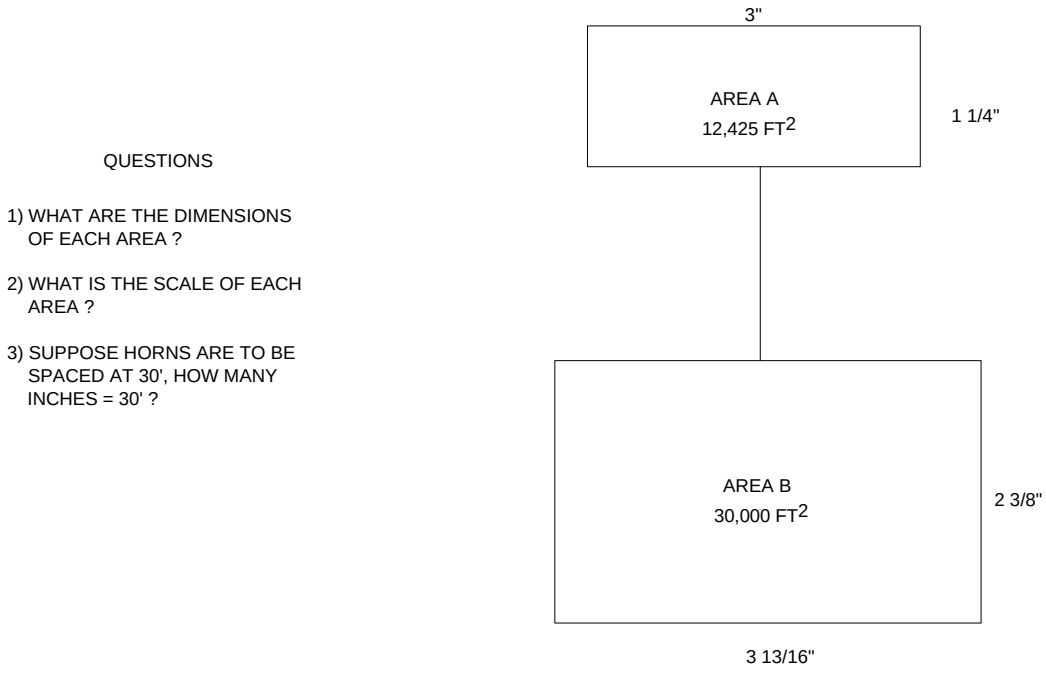


Figure 9 - NOTE - DRAWINGS NOT TO SCALE ! !

QUESTIONS 1 AND 2 MAY BE ANSWERED USING OPTION "O"

ANSWERS - AREA A = 172.68' x 71.95'
AREA B = 136.71' x 219.45'

THE SCALE IN BOTH CASES, 1" = 57.56'

QUESTION 3 MAY BE ANSWERED USING OPTION "N"

ANSWER - IN BOTH CASES, 30' EQUALS SLIGHTLY MORE THAN 1/2"