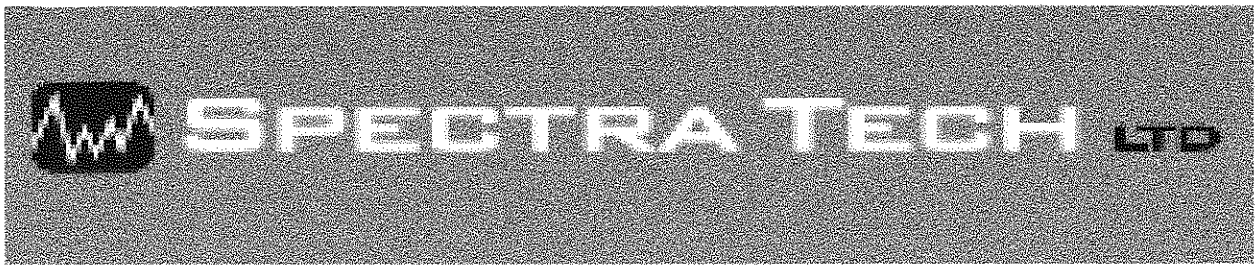

RT60 REVERBERATION / ACOUSTICS

OPTIMIZATION PROGRAM

(Proprietary)

V10.3

USER GUIDE

Program & User Guide
Copyright by Richard J. Lemker

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GENERAL OVERVIEW

The RT60 program has been created to allow for an acoustical designer to make calculations necessary to develop the optimum acoustical design for any room.

The program has been written to make use of both Sabine calculations and the more sophisticated 3 dimensional Fitzroy calculations. Using a common absorption data base, it is possible to develop a room design which satisfies the requirements of both formulas, theoretically providing optimum acoustical absorption in all three of the room's geometric axis

While the program is simple to operate, a working knowledge of acoustical design theory is necessary to use the information successfully. Richard J. Lemker & Associates assumes no responsibility for the accuracy of information generated by the program; it is the user's responsibility to enter all room data, and verify the accuracy of such information.

The user is guided through every step by a series of menus, and data input sequences. No knowledge of computer command codes or programming experience is required to use the program.

The total program includes over 6000 lines of program code, and might process over 500,000 equations during a typical room analysis. Imagine doing all that work by hand!!

The program has several major sub-sections, each of which has a particular function. Major sub-sections are as follows:

- FILE RETRIEVAL
- PROJECT SETUP
- GEOMETRIC CALCULATIONS
- MATERIALS TAKEOFF
- DATA EDITING
- RT60 CALCULATIONS
- HARDCOPY PRINTOUT
- SAVE FILE
- ONSITE TEST JUSTIFICATION
- ANALYSIS OF TREATMENT OPTIONS

Each of the major sub-sections will be discussed in detail, in the section which follow.

FILE RETRIEVAL

When the program is first started, the user is given the option of creating a new project, or retrieving an existing project from a disk drive.

To retrieve an existing file, follow the screen prompts to identify the file you want. You may specify a disk drive other than the default drive, if you wish.

The program will search a series of files or all files, and list or print the Project Name and brief description for each file on the specified disk and subdirectory, as well as the DOS filename. When you have located the file you wish to load, type the 8 character file name. The file names contain a 4 digit number, plus RT60 (XXXXRT60). The program will then display a complete summary of the project which you have specified; you may continue, or go back to select a different file.

When you have retrieved a file, the program will immediately proceed to the main menu, to allow for editing, printing, or analysis.

PROJECT SETUP

To create a new project, simply select this option on the first menu screen. The program will prompt you for pertinent project information, which may be edited later if you wish before printing hardcopy.

You must also determine the optimum reverberation time for the subject room. The program can automatically calculate optimum values for various situations, using the Knudsen formulas, or you may enter the optimum RT60 of your choice. Once set, the optimum RT60 cannot be changed during the project analysis, since all calculations are referenced to this performance requirement. If you wish to consider 2 or more scenarios for the same room, you must reenter the data and create new project files.

Once the project description has been entered, the program will proceed to the geometric calculation subroutines.

GEOMETRIC CALCULATIONS

The program allows for calculation of a room's volume (cubic feet) and surface area (square feet), and also computes the amount of surface area for each of the room's 3 geometric axis. The three dimensional information is needed in order to use the Fitzroy RT60 formulas later on. This process may be simple (e.g., rectangular room) or may be complex (multiple room areas of various shapes), depending on the project.

The process involves dividing the room into various recognizable areas, the volumes of which may be computed separately. After dividing the room into these areas, the first step is to compute basic room sections; when these calculations are complete, you can proceed to calculation of roof vaults.

Consider the example of a rectangular church building, with a triangular/peaked roof. Select the "room/section" option from the first menu. Compute the lower rectangular area below the roof. The program will ask if you wish to specify additional room/sections. Answer no. You will then be asked if you wish to enter ceiling vault sections. Answer yes. Select the triangular roof section from the menu. Enter the requested information. You will be asked to enter the square footage for the area where the two room sections intersect. Enter the square footage for the theoretical area at the top of the rectangle, where it meets the triangular roof section (same as floor area). Specify the intersection to be in the "floor/ceiling" axis. You will be asked if you wish to enter additional roof sections. Answer no. The program will add the rectangular volumes and surface areas, and compensate for the specified situation, to determine how much of each area is assignable to each room axis. (You will see that the floor/ceiling surface area is actually reduced by adding the triangular roof section, since part of the roof surfaces are assigned automatically to the side wall axis.) The program will then proceed to the absorptive materials data input subroutine.

For more complex projects, involving complex combinations of geometric shapes, you may add or subtract various combinations to arrive at the final totals. You will have to simply experiment with various techniques, and gain an understanding of how this complex process works.

MATERIALS TAKEOFF

After the geometry of the space has been calculated, the program will prompt you to enter the square footages for all materials and surface areas. The screen will display the square footage for each of the 3 room axis which remains to be specified. This feature is intended to preclude the possibility of a data entry error during takeoff, and speed up the process.

When entering the various surface information, you must first specify which axis the material is located in (front/back, side walls, or floor/ceiling axis).

Consider the example of entering the data for a typical building's side walls. First enter the area for windows. Enter the total square footage, or use the program's calculator feature to determine the square footage. If the remaining side wall area is all drywall, read the quantity remaining to be specified and enter this figure for square footage; the program will have subtracted the area you specified for the windows from the remaining total. You do not have to scale off the remaining drywall area, since the program has taken care of it for you.

The program will allow you to specify any of the approximately 100 types of surfaces resident in the program's data base, or you may enter a description and absorption coefficients for a different material of your choice.

The program does not allow for addition of objects (e.g. people) per se; rather these must be entered as surface areas, since the 3 dimensional information is required in order to use the Fitzroy formulas.

The program does not currently allow for the user to create or edit information in the permanent absorptive materials data base.

You may specify more or less surface area than the program has determined to exist in the room. When you are satisfied that you have entered all surface area data, you may select "RT60 Calculations" from the main menu.

You will also note that the effect of air absorption in the room has automatically been computed, and appears automatically as the last line on every data table.

DATA EDITING

To edit an existing project data table, simply select this option from the main menu. Specify the data table line number you wish to edit. The program will display the information for the line which you have selected, and prompt you the re-enter all data for that line. Enter the data the same as you would for a new line entry. The program will automatically remove the original line, and substitute the new line in it's place on the data table.

The air absorption line cannot be edited.

RT60 CALCULATIONS

After all data has been completed, the program will run an extensive series of calculations based on the Sabine and Fitzroy formulas. The program requires that you have entered some absorption for each of the 3 geometric axis, or else a "divide by zero" program error will occur. To execute the calculations, press the enter key. Results will be displayed in subsequent screens; this information can be printed later under the printer routines section. Unless your room has been designed "perfectly", you will see that there is an uneven distribution of absorption in the room among the 3 geometric axis, resulting in a discrepancy between the Sabine and Fitzroy RT60 predictions.

The fact that the two equations produce different answers is the basis for arriving at a final design which will produce an even distribution of the absorptive materials in the space. The Sabine formula is probably more accurate in predicting the "actual" RT60 which might be measured if the room existed. However, the Fitzroy formulas allow for an analysis of the distribution of the absorptive materials in the space. Often, optimum acoustics can be obtained by re-arranging the amounts and placement of various absorptive elements within the 3 axis, thus resulting in a much more consistent RT60 throughout the room. In fact, the program's Sabine and Fitzroy formulas can arrive at the same RT60 prediction, if the absorptive materials are evenly distributed throughout the space. (The Fitzroy calculations have been modified to use the Sabine absorption units in the program.) The "Analysis of Treatment Options" section of the program is intended to assist you in reaching this optimum design condition.

You may also notice that the printout indicates that certain RT60 calculations are not valid. This notation is the result of the program's analysis of the room using the criteria developed by BB&N concerning 4 ranges of acoustical activity.

HARDCOPY PRINTOUT

Once the RT60 calculations are complete, you may obtain a printout of all room data. You will be asked whether you want to re-enter project data; if you answer yes to any of the questions, you may type in the new information; otherwise, the program will retain the previously entered data. The final three input statements ask you to enter any notes pertinent to the printout (e.g. "windows are per spec") The 3 note entries do not carry over from printout to printout.

The program will automatically assign the next sequential number to each printout. This is to positively identify that particular printout from all others, since some data may have changed.

Whenever you obtain a hardcopy printout, it is recommended that you save the file to disk, so that you will have the opportunity to call it up again later. If the same project is called up again later and printed again, the program will assign a new number to the second printout, even if no data has been changed. (The original file and number remain on the disk.)

SAVING FILES

The program will allow you to save a file to disk only after you have obtained a printout.

Select the "Save File to Disk" option from the menu. The program will display the file number assigned when the file was printed. Enter the 4 digit number plus "RT60" (XXXXRT60).

The program stores all geometric data and the absorptive data table in the file; RT60 calculations are not stored, but may be run again if the file is retrieved.

You will have another opportunity to save the project file to disk, after running the "Analyze Treatment" routine.

ONSITE TEST JUSTIFICATION

The program may be used in conjunction with onsite test results, in order to determine the optimum acoustical treatment requirements for an existing facility.

The process involves entering geometric data and absorptive materials data in much the same manner as for a non-existing room. After data entry has been performed, run the standard RT60 calculations for the room, based on the data you have collected. It is common to find that the onsite test results do not match exactly with the programs predictions. This is due to differences between data table information for a specific material and properties for the material as constructed. In order to more accurately predict the effect of absorptive treatment, it is possible to correct the discrepancies before proceeding with the analysis of treatment options, by using this special program feature.

Select the "Justify Onsite Test Results" option from the menu after printing out the initial calculations. the program will prompt you to enter the actual test RT60 values for various frequency ranges. You will have several options for justification of the results with the calculations. Use common sense in selecting the justification process, and in determining which surfaces require the most justification. (e.g., if the floor is concrete, chances are the program's absorption data file values are nearly the same as for the field material; on the other hand, actual absorption of complex seating arrangements and construction details are more difficult to define, and are probably candidates for justification.) When you have answered all of the program's questions, the program will automatically compute the amount of change necessary to justify the information, and create new data table lines with the justification values. If the results of the process you have selected do not produce satisfactory results, run the justification process again using a different rationale.

Once you are satisfied with the justification results, print out the new information, save the file, and analyze the treatment options as usual.

ANALYSIS OF TREATMENT OPTIONS

Based on the information obtained using the Sabine and Fitzroy calculations, it is now possible to compute the optimum modifications for various room surfaces necessary to achieve the optimum RT60 (for the selected frequency band). The program routines are written to allow for identification of treatment options which will result in agreement of the Sabine and Fitzroy RT60 calculation predictions (an optimum condition).

The program will print the Fitzroy-based calculations for each room axis on the screen. You will be asked to identify certain surface areas which might be available for acoustical treatment. For example, on a typical wall, the doors and windows cannot be modified, but the remaining drywall surfaces might be treatable. Select at least 1, and no more than 5 line items from the data chart for consideration. If more than one type of material is involved in the selections (e.g. drywall plus paneling, the program will calculate the average absorption value of the combined surface areas). The screen will display a guideline as to how much surface area might need to be modified. Once the line items have been specified, you will be asked to select an alternate material, which might be used to "treat" the specified surfaces. The computer will analyze the proposed treatment material, and if the amount of change afforded by the particular material is adequate to satisfy the Fitzroy parameters, the optimum square footage to be replaced will be displayed and printed. If the amount of change is not adequate, the computer will display the % of required treatment that the proposed material will provide.

You will have the opportunity to specify different combinations of surfaces, and consider any number of possible treatment materials for each axis.

When analyzing the floor/ceiling axis in particular, you will frequently find that the total floor/ceiling axis absorption as shown on the design already exceeds the Fitzroy absorption requirements. (This frequently occurs when lots of people, acoustical ceilings, or heavy carpeting are present.) This is an accurate indication that there is in fact too much absorption in that particular axis, and absorption should therefore be reduced. To handle this situation, for example when an acoustical ceiling is present, simply select a less absorptive material for consideration (e.g. drywall).

If you have been able to develop options which satisfy the Fitzroy criteria for each of the three room axis, the resulting design with any of the recommended treatment options will result in achievement of the optimum specified RT60 (for the selected frequency band), and this can be verified using the both the Sabine & Fitzroy formulas. You may edit the absorption data tables to reflect the selected modifications if you wish to prove the point, but this is not necessary.

OTHER COMMENTS

As stated at the beginning of this manual, a complete understanding of acoustical design theory and practice is essential in order to make effective use of information developed by the program.

The program is intended to relieve the experienced designer of the tedious chore of calculating needed information by hand. It is assumed that the user knows what information he is looking for, and how to use it along with other design tools and techniques in finalizing his design recommendations to his client.