4.0 PROJECT MANAGEMENT IMPLEMENTATION

4.1 Project Management

Project Scope

Many decisions concerning the management structure and task breakdown for a home insulation project depend on the scope of the project. A project to insulate a small number of homes could be managed by a small staff. Homeowners could deal directly with contractors and supervision could be provided by a local government or consulting agency. At the other end of the scale is the large project geared toward modifying several hundred homes per year for many years. This type of project usually requires a team of technical consultants, real estate experts, contracts specialists, and support staff. Among the factors to be considered in determining the scope of the project are:

- Number of impacted, eligible dwellings;
- Availability of funds and other resources;
- Completion of the overall project in a reasonable time span;
- Obtaining economies of scale in ordering materials;
- Having sufficiently large orders to command priority in obtaining specialized materials(i.e., acoustical windows);
- Having jobs large enough to attract competent construction contractors in what is, locally, a seller's market.

Using a Pilot Study

Ordinarily, large home sound insulation projects are conducted in phases with a pilot insulation project as Phase I. A pilot study consists of analyzing and modifying a limited number of representative homes before the entire community is treated. The pilot is, in effect, a complete version of the home insulation project from start to finish, but on a much smaller scale. This enables managers to develop and test implementation schemes and reliable cost estimates for the entire project by using results from actual installed modifications. The number of houses chosen for the pilot varies depending, again, on budgetary constraints. Twenty homes is a manageable number for a study and several airports have found that to be sufficient.

Management Structure

Although a wide variety of management structures is possible to implement such a program, they all fall into one of three general categories:

- The program can be managed entirely by the sponsoring agency, by organizing and staffing its own program office to carry out all the necessary functions (the "in-house" option);
- The program can be managed entirely by a single external entity, such as a consultant or some other governmental agency under contract to the sponsoring group, with that entity organizing and staffing its own local office to carry out the necessary functions (the "turnkey option");
- The program may be a mixture of these two extremes, with the sponsoring organization carrying out certain of the functions, and the external entity (or entities) carrying out the remaining functions (the "hybrid option"). In this case, the external entities could be the homeowners themselves.

With any of these options the sponsoring agency will be responsible for budgeting and any necessary legislative action. The agency will also be involved in setting design objectives, determining dwelling eligibility, selecting the dwellings, and negotiating with the homeowners. It is assumed the agency will want to audit the project, evaluate the results, and carry out public relations efforts. Beyond this minimal involvement, the choice of management options depends largely on staff availability and cost effectiveness.

The categories defined above are illustrated conceptually in Figure 4–1 along with a summary of the advantages and disadvantages of each option.

In-House Option

The "in-house" option provides the most direct control for the sponsoring agency. This structure, along with the "turnkey" structure, has the potential of being most efficient, since a single entity is in charge.

The "in-house" structure does, however, demand the most in terms of agency staff and support (e.g., office space, equipment, supplies, etc.). It may also be difficult to implement

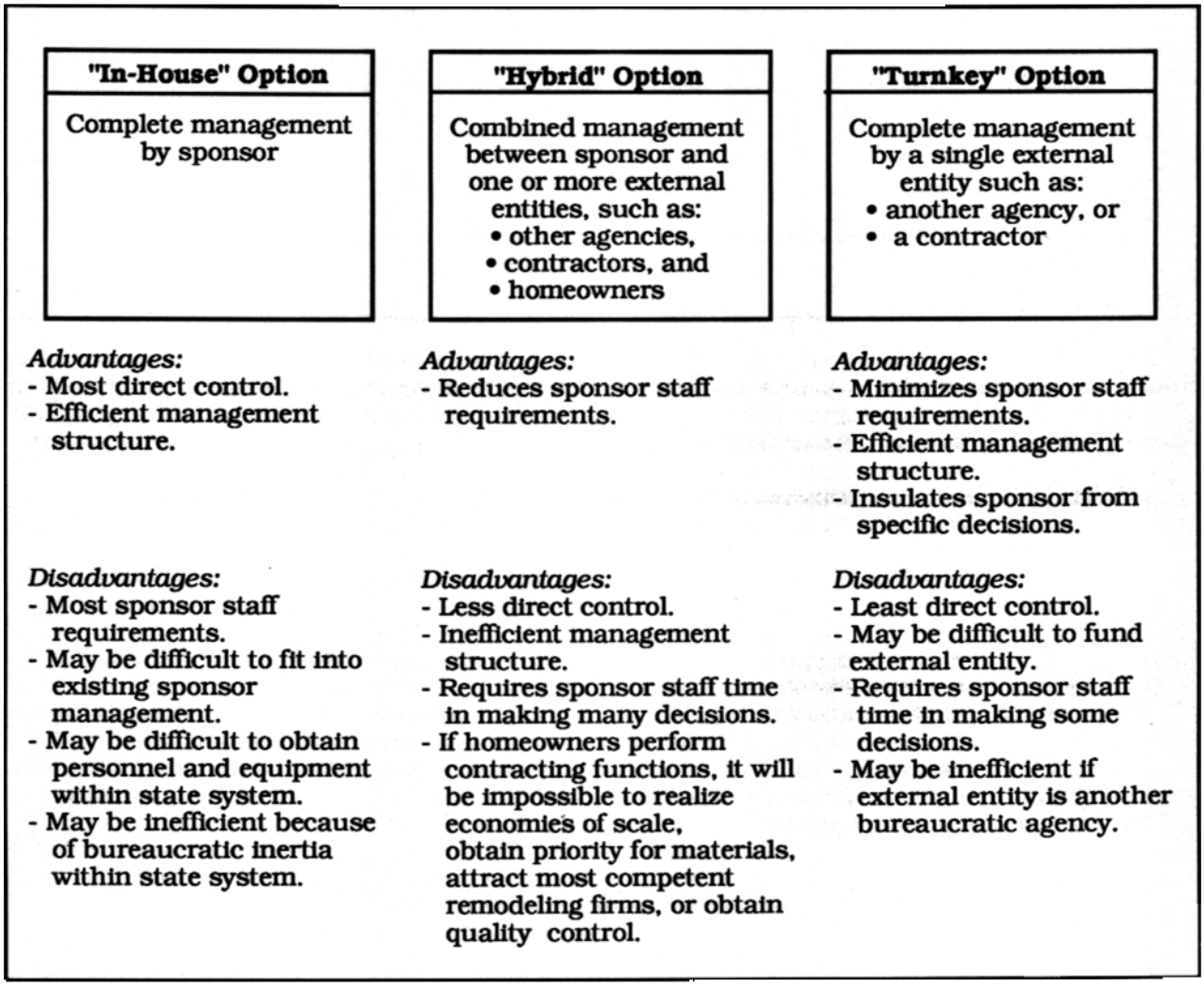


Figure 4-1. Possible Management Structures for Sound Insulation Program Office.

within the existing management structure, since the required functions may be far removed from those the sponsoring agency is normally responsible for. There may be problems associated with hiring new staff, transferring them from other programs, and releasing them after the program is finished. If the sponsoring agency is a government organization, there may be inefficiencies in procurement methods and day-to-day operations due to governmental requirements.

Turnkey Option

The "turnkey" option causes the least impact on the sponsoring agency and offers similar or better efficiency. In addition, this structure insulates the sponsoring agency from responsibility for many of the house-specific decisions that must be made continually. If the external entity is a private contractor, there will be maximum flexibility in staffing and responding to changing program directions and levels. On the other hand, this option removes most of the day-to-day control from the sponsoring agency, which will be acting primarily in an oversight capacity.

Hybrid Option

The least efficient option appears to be the "hybrid" structure. This option reduces the involvement of the sponsoring agency but may introduce inefficiencies and complications in coordinating the effort. For small projects with limited funding, however, this may be justified and workable. If this option is chosen it will be crucial to outline carefully the respective areas of responsibility and to develop efficient day-to-day lines of communication. Ensuring quality control and proper supervision of the construction work, particularly the acoustically sensitive tasks, will be much more difficult if the project office is not involved on a daily basis.

This option provides the maximum flexibility in balancing responsibility by assigning to each group the tasks they do best.

General Considerations

Regardless of the management structure chosen, it is advisable to set up a system for procuring materials in large enough lots to take advantage of preferential pricing and delivery schedules. Also, if all the homes are contracted together it is easier to get competitive bids from larger, more competent remodeling and construction companies. Unfortunately, many home remodeling companies do not have sufficient capital to purchase materials to do a large number of houses at once. These conflicting needs will have to be balanced in the program structure.

The various tasks involved in a home insulation project are discussed in the next section, Program Planning. This section identifies the factors bearing on deciding how large the project should be and which homes should be included. The managing agency's staff requirements can be estimated based on information provided here for per-home manhours. The last section, Detailed Cost Estimates, shows how to develop project cost estimates using the worksheets provided in Appendix A.

4.1.1 Program Planning

Program Function

Conducting a residential sound insulation project requires carrying out the following functions:

1. Developing and successfully sponsoring the necessary legislative and budgetary authority to undertake the program.
2. Soliciting applicants for participation in the program.
3. Determining eligibility and setting design objectives for the dwellings to be modified.
4. Selecting and prioritizing the specific dwellings to be modified.
5. Establishing work plan schedules.
6. Developing the design of the acoustical modifications for each dwelling.
7. Negotiating with the owners and lien holders of these dwellings in order to proceed with the modifications. This may include obtaining appropriate avigation easements or similar legal assurances from the owners.
8. Defining the specific modifications for each dwelling, based on both acoustical design objectives and owner preferences, and preparing the bid package.
9. Holding pre-bid briefings for prospective contractors, and responding to questions during the bid process.
10. Selecting and negotiating with a general contractor or contractors for the actual modifications.
11. Reviewing the general contractor's shop drawings and materials lists.

12. Inspecting the acoustical materials prior to the modifications.
13. Inspecting work in progress to ensure proper quality control and workmanship.
14. Managing change orders and unforeseen deviations from the initial contracts which arise during the modifications.
15. Evaluating acoustical effectiveness of and owner satisfaction with the modifications after completion.
16. Managing and documenting the progress, including continual community relations, and auditing of the completed program.

Selecting and Prioritizing Eligible Homes

As discussed in Section 4.1, the scope of the project is one of the primary variables. Deciding how many and which homes to include depends on factors such as: How many homes are impacted by the aircraft noise now? In five years? How much money is available to modify homes?

Mapped noise exposure contours provide a starting point for estimating the number of eligible dwellings. AICUZ or airport contours for current operations should be examined and any projected changes in the number or type of flights over the next five years should be taken into account. Priority should be given to homes which are in the highest noise zones. In addition, some homes are exposed to more intrusive noise than others within the same noise zone. Homes impacted by the noise from departures and reverse engine thrust on landings experience more disturbing noise than homes exposed to simple landings and should be given preference.

During the construction phase of the project it is much more efficient to modify homes which are grouped together geographically. This minimizes the time the work crews have to waste traveling and transporting equipment and materials from one site to another. Another way to enhance procurement and construction efficiency is to treat groups of homes with similar modification requirements. Project managers may decide to provide sound-insulating materials exceeding those required to meet the design goals in a few homes if ordering extra products will gain better pricing or delivery times.

Staffing Requirements and Program Growth

Staffing requirements depend on the scope of the project and the management structure chosen. While it is not possible to predict how many manhours any given project entails, some of the tasks consistently require more work than others regardless of the number of homes being modified. The following discussion provides information on the relative labor requirements of each of the functions outlined at the beginning of this section.

Most programs, whether large or small, start out treating a limited number of homes. Pilot studies of about 20 homes are typical of many recent residential insulation efforts. Then, if the ultimate goal involves a large number of homes, the project will build up to treating several hundred homes every year. The following discussion assumes a project treating 200 to 500 homes per year. Table 4–1 provides manhour projections broken down by task. The information presented here is based on actual experience conducting home insulation projects.

The team for the project in Table 4–1 is comprised of two senior technical staff members, seven junior technical people, six real estate specialists, and four secretary/typists. For projects of much smaller scope the division of labor will change considerably, but the relative number of hours devoted to each function should be about the same. For example, the acoustics consultant or architect will spend most of their time developing the acoustical design package and reviewing the working drawings the contractor submits. Similarly, obtaining easements will require a significant effort on the part of a real estate specialist and the support staff.

Task Emphasis

Several of the tasks in Table 4–1 should be emphasized, since their importance might not be recognized immediately. Selecting and prioritizing applicants, developing acoustical designs, obtaining easements, and preparing bid packages are all critical elements of the program. However, maintaining quality control by reviewing working drawings, inspecting materials and work in progress, and carrying out spot acoustical measurements are equally important tasks. Interviewing each homeowner after he or she has lived with the modifications for a while enables management to monitor the continuing success of the program.

It will not take very many negative reports of poor quality or inadequate noise reduction before the credibility of the whole program is questioned. Thus it is vital that extra effort be expended to maintain quality control. It is also important that

Table 4-1

Annual Manpower Estimates for
Residential Sound Insulation Program Office

TASK	HOURS PER HOME			
	Sr. Tech.	Jr. Tech.	Real Spec.	Sec/Typ.
Solicit Applicants				1.0
Determine Eligibility		0.50	0.50	0.50
Select & Prioritize				
Schedule Work Flow				
Inspect Homes		4.00		0.25
Develop Acoustical Designs	2.00	6.00		2.00
Obtain Easements			20.0	5.00
Develop Bid Package	1.00	4.00		2.00
Conduct Pre-Bid Briefing				
Review Bids / Make Award				
Review Working Drawings	2.00	4.00		
Inspect Materials		1.00		
Inspect Work in Progress		1.00		0.25
Handle Change Orders	2.00	2.00		1.00
Sign Off / Spot Measurements	1.00	1.00		0.25
Documentation	2.00	2.00		2.00
Homeowner Interviews			1.00	0.50
Sponsor Meetings / Public Relat'ns				
General Management				

KEY:
Sr. Tech. – Senior Technical Person
Jr. Tech. – Junior Technical Person
Real Spec. – Reality Specialist
Sec/Typ. – Secretary or Typist

positive homeowner responses be made known to the general public and the legislature. This will ensure a steady supply of applicants and continued legislative support. Negative homeowner responses should be responded to and the problems corrected, where possible, so that they turn into positive responses.

4.1.2 Detailed Cost Estimating

Project costs can be broken down into several categories. There will be preliminary costs associated with defining the project, starting up, and preparing the necessary plans and specifications. During the dwelling modification phase, there will be a series of readily identifiable construction-related expenses. Administrative and program management costs will spread over the length of the project. Being able to predict costs helps the project sponsor to formulate the project and prepare preapplications for funds. Recent residential sound insulation projects provide information on construction-related costs. For rough costing purposes, the following guidelines may be useful:

Contractor Profit and Overhead	20%
Contingency Fee	
New Construction	5%
Remodeled	20%
HVAC System, Complete	$5,000

To facilitate identifying and estimating these costs, a set of five sample worksheets is provided in Appendix A. Their form and use is explained below.

Preliminary Project Cost Estimates: Appendix worksheet A1 provides a framework for estimating project costs during the preapplication and project formulation stage. Principal factors include:

- Number of eligible dwellings anticipated;
- Noise reduction criteria to be used;
- Noise exposure levels;
- Dwelling categories identified;
- Average cost of implementing an expected modifications package;
- Additional cost factors.

In the block for dwelling modification breakdown, each noise zone is treated separately, since homes with similar noise exposures normally receive a similar package of treatments. Within these basic groupings the homes are further broken down by dwelling category types such as: siding with vented attic, or brick with vented attic and basement, etc. The worksheet provided in Section 2.6, Cost Estimation, can be used to predict an average insulation package cost to use in this worksheet.

Additional cost factors including design and development costs, contractor markup, noise measurement costs, avigation easement costs, and administrative costs are identified.

- Detailed Dwelling Unit Costs: Appendix worksheet A2 consists of a set of three worksheets to be used for preparing plans and specifications and for evaluating contractor bids. One of these worksheet sets is devoted to each individual dwelling in the project. The worksheet forms the basis for identifying costs for specific improvements to the house.

Basic information about the dwelling such as the address, the exterior noise exposure level, and the dwelling description or category should be included. Then, for each room the following information is detailed:

- Room type (living, dining, kitchen, bedroom, etc.);
- Shielding of outside walls due to orientation with respect to the flight track;
- Noise Level Reduction criteria used;
- Additional noise reduction required over sound insulation provided by existing condition;
- For each element type, the modifications and improvements along with their costs.

Treatments covering the entire house, or not specifically identified with any one room, are listed below this with their associated costs. These items include attic, underfloor or other vent baffles, insulation, costs for upgrading the heating, ventilation, and air-conditioning system, electrical systems, and other miscellaneous costs.

Sheet 2 provides additional space for specific room improvement notation and costs.

A simple floor plan should be developed on Sheet 3 and should show:

- Exterior cladding material;
- Type of roof or attic structure;
- Type of floor or foundation;

Number, use, and square footage of rooms;

- Number and type of windows and doors;
- Flight path orientation;
- Location of noise-sensitive rooms;
- Location of other noise-entry points (chimneys, vents, etc.);
- Existing insulation features;
- North arrow.

- Construction Cost Summary: Construction costs for the project are conveniently summarized on worksheet A3. It provides space for noting costs associated with each dwelling category, by noise zone. The dwelling category can either be a specific dwelling type such as siding or brick, or it can be used for geographic groupings of homes, whichever is most appropriate. Costs used here are guided by the modification packages and estimates developed in the Detailed Dwelling Unit Costs worksheets. These costs are broken down into materials and labor per dwelling so that any overtime labor premium can be shown. These figures can be multiplied by the number of dwellings in the given category and zone. Since contingency multipliers may vary depending on the geographic distribution or the modification package, this is also identified for each housing category. Then the last column shows the cost for each category.

  Whole project costs for demolition, cleanup, equipment, inspections, insurance, permits, fees, and other miscellaneous costs, are itemized below the dwelling inventory.

- Non-Construction Costs: Worksheet A4 summarizes all non-construction costs which include all expenses not directly related to the installation of modifications in the dwellings. These costs will be important in determining funding for the project as a whole. All pre-implementation costs, design, planning and specification costs, noise measurement costs, bid preparations, review and supervision costs, and administrative costs should be listed here. Many of these can be defined in terms of a cost per dwelling so columns are included for this as well as the number of dwellings affected. For example: relocation expenses depend on the number of families to be relocated and all other dwellings may require avigation easement expenditures. Some expenses, however, do not lend themselves to this format so the cost per dwelling column can be ignored for them.

- Total Project Costs: This last worksheet summarizes the costs identified in the other worksheets and relies on them for input.

4.2 Plans and Specifications

Purpose and Use

Plans and specifications are used in three ways. They document the implementation plan and form part of the grant application package when FAA or other funds are being sought. At another stage in the project they form the basis for soliciting bids from contractors to perform the construction work. Finally, local Building Departments use these plans to issue construction permits.

Generalized Specifications and Custom Designs

For large projects with a limited number of identifiable house types, program managers may choose to use generalized modification specifications rather than having designs developed for each home individually. Such a set of generalized specifications typically outlines requirements for changes to windows, doors, walls, roofs, and other structural elements of a dwelling depending on the noise exposure zone. The specifications should allow for variations in the type of structure and the presence of shielding from the flight path. Table 4–2 gives an example of a summary table of generalized specifications used in southern California.

In order for generalized specifications to be valid and useful, the homes must be similar enough that the modifications package is appropriate for each case it is applied to. In neighborhoods where the homes differ in ways which are acoustically significant, it may not be possible to use this type of modification package. In that event, each home is analyzed individually and the dwelling modifications are custom designed. Some projects may use a combination of generalized specifications with exceptions for dwellings requiring specialized designs.

Preparation of Architectural Plans

Architectural plans, in the form of drawings and a thorough description of the existing conditions, are prepared for each dwelling. Figure 4–2 illustrates such a plan. These are used in the acoustical analysis of the sound insulation requirements for the dwelling. Later,

Table 4-2

Example Summary of Sound Insulation Applications[1]
Based on Generalized Specifications

Element	Noise Exposure Zone, DNL (dB)					
	Greater than 75		70–75		65–70	
	Directly Exposed	Shielded	Directly Exposed	Shielded	Directly Exposed	Shielded
Window[2] STC (dB)	40	40	45	35	35[3]	30[3]
Door STC (dB)	40	36	40	36	36[4]	30[4]
Wall Modifications	Yes	No	No	No	No	No
Attic Insulation	R-21	---	R-19	---	(R-19)[5]	---
Crawlspace Vent Baffles	Yes	Yes	Yes	No	No	No
Kitchen Vent Ducting[6]	Yes	Yes	Yes	Yes	Yes	Yes
Secondary Sliding Glass Doors[7]	Yes	Yes	Yes	No	Yes	No

NOTES:

1 These are for detached dwellings with a wood frame/exterior stucco wall structure.

2 Applicable only to openable windows. Different specifications apply to fixed pane (unopenable) windows.

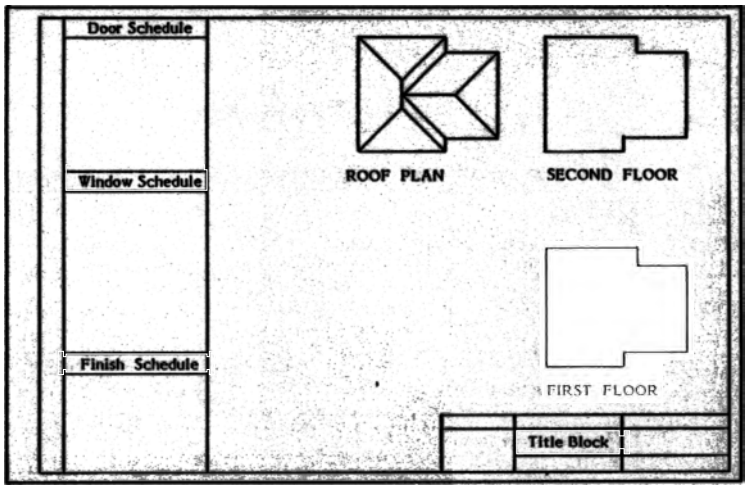
3 The quoted STC ratings are for replacement windows if the existing windows are more than 10 years old. Otherwise, the specifications require a second (storm) window, with an STC of at least 25 dB, to be added.

4 If the existing door is solid core, an additional storm door should be added rather than replacing the existing door.

5 Attic insulation is not required for acoustical purposes but is added to improve thermal insulation of the dwelling.

6 Fiberglass may not be used in the kitchen vents due to the fire hazard.

7 Sliding glass doors, being of relatively large area, are usually the weakest sound insulation path in a dwelling. Addition of a secondary door will not necessarily meet sound insulation objectives, but is preferable to substituting an opaque door with fill-in of the surrounding wall.



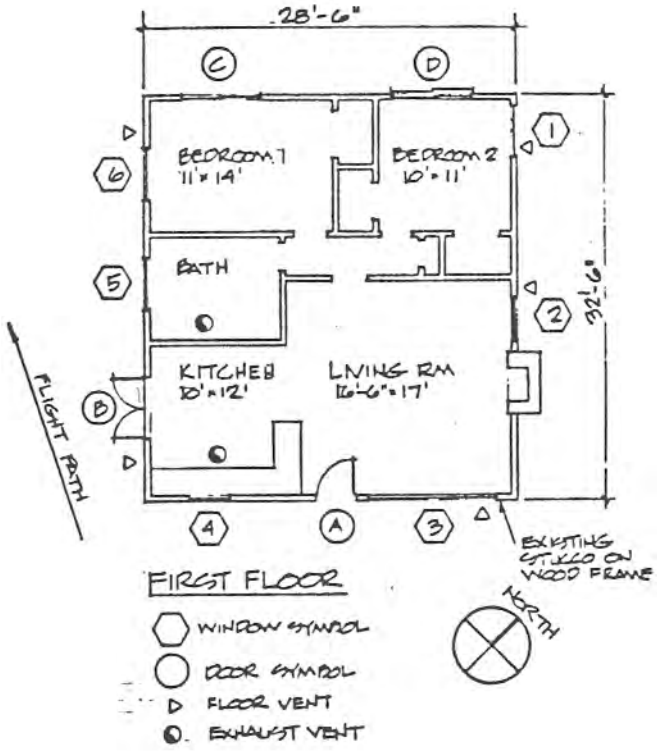


Figure 4-2. Architectural Plan Details.

they form the basis for specifying the dwelling modifications.

Floor plans are prepared in two stages. The first stage involves field-measuring each dwelling and gathering data which describes the existing physical features. Using this information, the floor plans, roof plans, window schedules, door schedules, and finish schedules are drawn. Later, the plans will be expanded to include the results of the Sound Insulation Specifications as well.

The specific items to be shown include:

1. Overall dimensions of each room except bathrooms, closets, and garage.
2. Overall dimensions of the dwelling.
3. Exterior materials and construction.
4. Swing of the exterior doors.
5. Arrangement of sash on horizontal sliding doors and windows.
6. Location of ventilating equipment (not grilles and registers).
7. Location of whole-house exhaust fans, wall-mount air conditioners, and kitchen exhaust vents.
8. Exterior elevations, on the window schedule, of each window type.
9. Location of underfloor vents (on the floor plan).
10. Location of attic vents (on roof plan).
11. Any other penetrations of the exterior envelope.
12. North arrow and orientation of aircraft flight path.
13. Schedules of existing doors, windows and rooms (Figure 4–3).

Definition of Sound Insulation Specifications

The specifications describe in detail the work, materials, and construction methods which the contractor(s) will use in modifying each home. Detailed window, door, and finish schedules, as shown in the example of Figure 4–3, will be completed to show the modifications for each element listed. Detail drawings of the installation of specialized acoustic products and modification techniques provide clear direction for implementing the insulation treatments.

Development of Implementation Plans and Schedules

Implementation schedules give more detailed information on the work to be performed on each dwelling in the program. The architectural plans and sound insulation specifications developed by the designer are normally included. The work requirements and material definitions are a part of these specifications. The shop drawings developed by the contractor are included in the project portfolio as well. They should also take into account the subdivision of work among the specialist subcontractors. The plans and specifications consist of:

- Plans
- Architectural schedules
- Specifications
- Shop drawings

The next two sections in this chapter discuss the last two topics in greater detail. Section 4.2.1 gives a detailed outline of the items to include in the statement of work requirements. Then, Section 4.2.2 tells how to develop the material definition specifications.

Submittal Review

Because the construction work must meet rigid standards in order to be effective, it is important for the acoustical consultant or architect to review the contractor's shop drawing submittal carefully. This is especially true at the beginning of the project and when the contractor lacks experience with acoustical remodeling. Contractors frequently underestimate the amount of time it takes for their submittals to be reviewed and approved. It may be necessary to stress these points at the contractor briefings and to remind the contractor(s) of the submittal guidelines and deadlines.

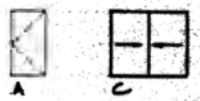
4.2.1 Work Requirements

The work requirements consist of specific technical descriptions of the work to be performed and form part of the overall Plans and Specifications package. This section discusses the work descriptions along with specifications of the codes to be complied with and the documentation to be provided. Each major building trade is addressed as well as the principal structural or acoustic elements involved in the modifications.

The subjects are presented in two parts: the General Specifications subsection identifies general requirements such as the scope of the work and required submittals. Then the Execution subsection outlines the topics which must be addressed in the technical directions for the work performance. The outline is presented here as a

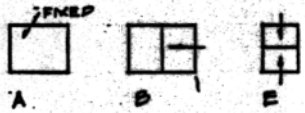
DOOR SCHEDULE

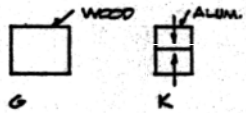
	Existing							Modification			
	Size (N)			Type	Material			Modification Notes	Min. STC	New Type	Detail
	W.	H.	T.		Door	Frame	Glass				
A	48	80	1-3/4	HC	Wd	Wd	No	Replace Door	35	A	G, G 1-4
B	36	80	1-3/4	SC	"	"	Cir	Replace Seals			H, G 1-4
C	72	80	--	SG	Al	Al	"	None			
D	72	80	--	SG	"	"	"	Add Sec. SG Door	--	C	I



WINDOW SCHEDULE

	Existing						Modification			
	Size (N)		Type	Material		Glass Type	Modification Notes	Min. STC	New Type	Detail
	W.	H.		Sash	Frame					
1	48	60	A	Wd	Wd	DS	Replace Window	35	G	A
2	48	60	A	"	"	"	Replace Window	35	G	A
3	48	60	A	"	"	"	None			
4	36	80	B	"	"	"	None			
5	36	80	B	"	"	"	None			
6	42	72	E	"	"	3/16	Replace Window	40	K	A
7	48	60	A	"	"	DS	Replace Window	40	G	A
8	48	54	A	"	"	"	None			





FINISH SCHEDULE

	Existing					Modification	
Room	Floor	Walls	Ceiling	Ht.	Modification Notes	Detail
LR	Carp.	GB	SP	8	None	
Entry	Carp	GB	Open	--	None	
Fam	Carp/Ct	GB	SP	8	Furred Wall	E, C-1
Kit	Res	GB	Lum	7'-6"	None	
Dining	Carp	GB	SP	8	None	
BR1	Carp	GB	SP	8	None	
BR2	Carp	GB	SP	8	Add 1 layer GB	C, C-1

Figure 4-3. Door, Window, and Finish Schedules.

guide for developing work requirements for any home sound insulation project.

4.2.1.1 *Summary of the Work*

1.0 General
- 1.1 Project/Work Summary
  - A. Scope and goals of the work
  - B. Occupied condition of dwellings – The work will be completed on an occupied dwelling and consideration will be made of the necessity for cleanup and proper material and tool storage.
  - C. Addresses of the dwellings
  - D. Provisions and limitations of the Contract Documents
    1. Existing site conditions and restrictions
    2. Pre-purchase of materials and equipment, inclusion in Contract Sum.
- 1.2 Pre-Negotiated Orders – The project sponsor may choose to purchase certain specialty items, such as acoustical windows and doors, and provide them to the contractor for installation.
- 1.3 Performance Requirements for Completed Work

4.2.1.2 *Special Provisions*

1.0 General
- 1.1 General and Special Requirements – required by program sponsor or granting agency
- 1.2 Scope of the Work
  - A. Identifies the services, equipment, and materials to be provided, and refers to satisfactory compliance with the Drawings and Specifications.
  - B. Responsibilities of the General Contractor regarding any special provisions of the procurement or installation of any part of the work.
  - C. Schedule coordination responsibilities between concerned parties.
- 1.3 Specification Section Titles – Section titles and paragraphs not to be taken as correct or complete aggregation of materials and labor.
- 1.4 Water, Power, and Light Facilities – Identification of provider and declaration of provider's responsibilities.
- 1.5 Permits – Delegation of responsibility for permits, fees, etc.
- 1.6 Approval of Substitutes – The contractor must get prior approval from the sponsor or project manager before substituting for any specified or quoted item (especially important for specialty acoustic windows and doors).
- 1.7 Salvage – Identifies which party gets first right to claim.
- 1.8 Furnishing, Floor and Window Covering
  - A. Declaration of responsibility for protecting, moving, and replacing.
  - B. Handling of existing custom-made window coverings such as shutters, blinds, curtains, and draperies.
- 1.9 Off-Site Storage.

4.2.1.3 *Insulation*

1.0 General
- 1.1 Work Included – specifies labor, materials, equipment, and services to be provided.
- 1.2 Submittals – defines how contractor will document materials to be used, number of copies required, etc.
- 1.3 Quality Assurance
  - A. Identifies experience level required of insulation manufacturer (i.e., 3 years consecutive manufacturing experience).
  - B. Documentation required of R-value certification, including method used to determine R-value.

2.0 Execution
- 2.1 Installation – conformity with manufacturer's recommendations.
- 2.2 Cleanup – How often site must be cleaned, acceptable performance of cleanup, etc.

4.2.1.4 *Acoustical Caulking*

1.0 General
- 1.1 Work Included – requirement to furnish all labor, materials, equipment, and services necessary to install acoustical caulking as shown in the Drawings.
- 1.2 Submittals – number of sets of catalog

data and product samples to be provided to acoustical consultant or architect.

2.0 Execution
- 2.1 Installation
  - A. Conformity with manufacturer's instructions.
  - B. Caulking placement as shown in Drawings.
  - C. Sealant application specifics.
- 2.2 Warranty – terms and conditions of warranty.

4.2.1.5 *Steel Acoustical Doors*

1.0 General
- 1.1 Work Included – specifies the labor, materials, equipment, and services to be provided in compliance with the Specifications and work orders.
  - A. Doors and frames.
  - B. Finish hardware.
  - C. Acoustical seals, weatherstripping, and drop seals.
- 1.2 Responsibility of the Acoustical Door Manufacturer
  - A. General survey of site.
  - B. Field measurement services.
- 1.3 Shop Drawings – defines type and number of copies for documentation of materials, STC ratings, etc.
- 1.4 Quality Assurance
  - A. Experience of manufacturer
  - B. Compliance with specific ANSI or other standards.
  - C. Affidavit documentation of acoustical performance.
- 1.5 Sound Transmission Loss Test
  - A. Documentation requirements, standards citation.
  - B. Testing conditions.
  - C. Statute of limitations for using test results – Tests for specified items must apply to the exact item quoted and must have been performed within the past five years (for example).
  - D. List of approved acoustical testing laboratories.
  - E. Conditions for accepting reports from other laboratories.
  - F. Rejection of reports from unrecognized laboratories.

2.0 Execution – defines acceptable standards for execution of each task identified.
- 2.1 Delivery and Storage
  - A. Provision of delivery and unloading.
  - B. Undamaged condition and protection during handling.
  - C. Inspection and repair.
  - D. Storage to prevent rust, warping, and other damage.
- 2.2 Inspection and Demolition
  - A. Inspection of existing condition.
  - B. Removal of existing doors and frames, salvage.
- 2.3 Installation
  - A. Compliance with shop drawings and manufacturer's specifications.
  - B. Alignment and anchoring.
  - C. Finish hardware.
  - D. Door and frame finish.
  - E. Threshold.
  - F. Acceptable paint products.
  - G. Final Adjustments.
- 2.4 Cleanup
- 2.5 Warranty

4.2.1.6 *Wood Acoustical Doors*

1.0 General
- 1.1 Work Included – specifies the labor, materials, equipment, and services to be provided in compliance with the Specifications and work orders.
  - A. Acoustical doors and frames.
  - B. Finish hardware.
  - C. Acoustical seals, weatherstripping, and drop seals.
- 1.2 Responsibility of the Acoustical Door Manufacturer
  - A. General survey of site.
  - B. Field measurement services.
- 1.3 Shop Drawings – defines type and number of copies for documentation of materials, installation, STC ratings, etc.
- 1.4 Quality Assurance
  - A. Experience of manufacturer.
  - B. Compliance with specific National Wood Window and Door Association or other standards.
  - C. Documentation requirements, Affidavit certification.
- 1.5 Sound Transmission Loss Test
  - A. Documentation requirements.
  - B. Testing conditions.
  - C. Statute of limitations for using test

results – Tests for specified items must apply to the exact item quoted and must have been performed within the past five years (for example).

D. List of approved acoustical testing laboratories.
E. Conditions for accepting reports from other laboratories.
F. Rejection of reports from unrecognized laboratories.

Execution – defines acceptable standards for execution of each task identified.

2.1 Delivery and Storage
- A. Provision of delivery and unloading services.
- B. Undamaged condition and protective packaging.
- C. Inspection for damage and warping; repairs.
- D. Storage to prevent damage and warping.

2.2 Inspection and Demolition
- A. Inspection of existing condition.
- B. Removal of existing doors and frames, salvage.

2.3 Installation
- A. Compliance with shop drawings and manufacturer's specifications.
- B. Re-use of existing subframe, molding, and trim.
- C. Alignment and anchoring.
- D. Latching and locking mechanisms.
- E. Threshold
- F. Finishing doors and frames
  1. Priming and final finish
  2. Application of sealer
- G. Approved paint manufacturers
- H. Finish carpentry standards
- I. Final operating inspection and adjustments

2.4 Cleanup
2.5 Warranty

4.2.1.7 *Sliding Glass Doors*

General

1.1 Work Included – specifies the labor, materials, equipment, and services required to be provided.
- A. Sliding glass doors
- B. Acoustical seals, weatherstripping, and sealants
- C. Door trim, molding, and casing materials

1.2 Submittals – defines the type of documentation required for the materials and installation methods.

1.3 Quality Assurance
- A. Experience of the manufacturer
- B. Affidavit certifying compliance with the specifications
- C. Compliance with applicable AAMA performance and fabrication standards.
- D. Compliance with applicable AAMA standards for air infiltration, water resistance, and load bearing.

2.0 Execution – specifies work performance requirements for all tasks involved in the work order.

2.1 Demolition

2.2 Installation
- A. Compliance with shop drawings and manufacturer's instructions
- B. Exterior sill and framing for secondary door
- C. Caulking, fillers, and gaskets
- D. Alignment, support, and anchoring
- E. Gaps and voids
- F. Exterior trim and molding
- G. Interior trim, molding, and casing
- H. Repair and patching of stucco, plaster, masonry, and drywall.

2.3 Cleanup
2.4 Warranty

4.2.1.8 *Aluminum Acoustical Windows*

1.0 General

1.1 Work Included
- A. Field measurement services
- B. Factory preglazed, assembled windows
- C. Seals and weatherstripping
- D. Storage and insurance
- E. Inspection services
- F. Repair and finish
- G. Preparation of window schedule

1.2 Shop Drawings
- A. Number of sets of shop drawings to be provided
- B. Dimensioning of windows

1.3 Quality Assurance
- A. Experience history of manufacturer
- B. Affidavit certifying compliance with window construction standards

1.4 Sound Transmission Loss Tests
- A. Documentation of test reports, testing methods used, and model

numbers of windows supplied.
B. Conductance in accordance with appropriate standards
C. Statute of limitations on STC rating tests for windows.
D. List of recognized testing laboratories.
E. Accreditation required of laboratories not on the list.
F. Conditions for rejection of reports from unrecognized laboratories.

1.5 Miscellaneous Tests
A. Documentation requirements (citing applicable standards)
1. Water resistance tests
2. Air infiltration tests
3. Condensation resistance factor tests
4. Overall heat transfer coefficient tests
5. Forced-entry resistance performance tests
6. Uniform load structural performance tests
B. Model number verification for applicability of test results.

1.6 Field Performance Tests
A. Specifications for number of rooms and dwellings to be tested, who should perform the tests, and conditions for accepting the test results.
B. Repair and replacement agreements in the event of field test failure.
C. Documentation requirements.

2.0 Execution
2.1 Responsibilities of the Acoustical Window Manufacturer
A. Project survey of window types needed.
B. Detailed survey of each residence for window dimensions.
C. Documentation via window schedule.
D. Allowable tolerance for window fit in wall openings.
E. Storage.
F. Liability and insurance.
G. On-site inspections.
H. Sash inspection and adjustment.
I. Specialized field testing.

2.2 General Contractor's Responsibilities
A. Demolition
B. Window Installation
1. Installation and match to existing conditions
2. Liners, furring, blocking, and shimming.
3. Back-sealing and fastening.
4. Caulking.
C. Repair and Finishes
1. Treatment of voids
2. Matching existing stucco
3. Matching wood and aluminum siding
4. Matching existing masonry.
5. Caulking, insulation, molding, blocking, trim, and accessories to maintain visual continuity.
6. Painting exterior.
7. Adjoining surfaces
8. Sound insulation performance of repairs and patching.
9. Acoustical batt insulation.
10. Acoustical caulking at frame perimeter.
11. Finish of interior surfaces.
12. Painting interior.

2.3 Cleanup

2.4 Warranties
A. Installation Warranty
B. General Contractor's Workmanship Warranty
C. Product Warranty
D. Supplementary Material Warranties – for materials not manufactured by the window manufacturer, such as sealants, etc.
E. Owner's Responsibility

4.2.1.9 *Glazing*

1.0 General
1.1 Work Included – specifies the labor, materials, equipment, and services to be provided.
1.2 Submittals–type and number of copies of documentation
1.3 Quality Assurance
A. Experience of company supplying laminated glass
B. Affidavit certification from manufacturer that materials meet specification requirements.
C. Compliance with applicable FGMA standards and other criteria.
1.4 Delivery, Storage, and Handling

2.0 Execution
- 2.1 Demolition – condition of exposed structural surfaces and adjacent wall surfaces.
- 2.2 New Laminated Glass
  - A. Framing, blocking, and attachment
    1. Protection from damage during handling and installation
    2. Avoiding impact, prohibition of use of pry bar.
  - B. Air infiltration limits for weatherstripping, sealants, and acoustical caulking.
    1. Application of sealant
    2. Elimination of sealant voids and surface bonding.
  - C. Matching existing interior trim.
- 2.3 Repair and Patching
- 2.4 Protection and Cleaning
  - A. Breakage protection and surface cleaning
  - B. Removal and replacement of broken glass.
  - C. Cleanliness of work area.
- 2.5 Warranty

4.2.1.10 *Gypsum Drywall*

1.0 General
- 1.1 Work Included
- 1.2 Submittals
  - A. Manufacturer's instructions to be provided to architect or engineer.
  - B. Product samples provided for approval
- 1.3 Quality Assurance
  - A. Manufacturer's experience
  - B. Fire-resistance rating compliance
  - C. Affidavit certification supplied by manufacturer regarding material compliance with specification requirements.
- 1.4 Delivery, Storage, and Handling
  - A. Packaging and labeling requirements
  - B. Storage and protection from exposure
  - C. Handling to prevent damage to edges, ends, and surfaces

2.0 Execution
- 2.1 Installation of Metal Studs
  - A. Dimensions, alignment, bracing, spacing, and plumb.
    1. Placement, fastening, reinforcement, and anchoring of studs used to frame openings.
    2. Horizontal intermediate bracing of studs.
    3. Installation, anchoring, and configuration of metal backing plates.
- 2.2 Sound Attenuation Blankets – fit and attachment requirements
- 2.3 Gypsum Wallboard Application and Finishing
  - A. ASTM standards to be met
  - B. Installation of imperfect, damaged, or damp boards prohibited
  - C. Positioning over supports, specified face out, abutment of edges, etc.
  - D. Attachment at openings and cutouts
  - E. Mounting of double layers
  - F. Sealing of perimeter and openings, treatment of expansion joints, sound flanking paths.
  - G. Fastener spacing.
  - H. Preparation for finishing and decoration
    1. Use of joint tape
    2. Use of joint compound
    3. Treatment of concealed drywall work
- 2.4 Cleanup
- 2.5 Warranty

4.2.1.11 *Painting*

1.0 General
- 1.1 Work Included
- 1.2 Submittals
- 1.3 Quality Assurance
- 1.4 Delivery, Storage, and Handling – packaging and labeling

2.0 Execution
- 2.1 Inspection
- 2.2 Surface Preparation
  - A. Cleaning and preparation procedures
  - B. Cleaning ferrous surfaces
  - C. Cleaning galvanized surfaces
  - D. Spackling and preparation of drywall
  - E. Filling cracks and preparing masonry walls
  - F. Miscellaneous surfaces
- 2.3 Application
  - A. Conformity with manufacturer's instructions.

B. Uniform coating of various surfaces.
C. Painting behind fixed and movable objects.
D. Painting inside ducts.
E. Painting back of access panels and hinged covers.
F. Finishing top, side, and bottom edges of doors.
G. Sanding
H. Surfaces which are shop-primed or touched up.
I. Matching existing color, texture and coverage.

2.4 Cleanup and Protection
A. Work areas
B. Window glass and other paint-spattered surfaces
C. Cleaning and repairing damaged work of other trades
D. Restoring painted surfaces damaged by other trades

2.5 Extra Stock
A. Volume to be provided
B. Labeling

2.6 Warranty

4.2.1.12 *Air Conditioning, Heating and Ventilation*

1.0 General
1.1 Work Included
A. Services, equipment and materials to be provided
1. Providing fresh air ventilation capability.
2. Installation of fan, ductwork, and fresh air ventilation capability.
3. Installation of central forced-air cooling.
4. Installation of central forced-air heating and cooling system
5. Responsibility for inspection and meeting HVAC goals.
B. Protection, replacement, and repair of adjacent areas.

1.2 Submittals
A. Number of copies and content of required documentation
B. Content of shop drawings
C. Required engineering calculations

1.3 Quality Assurance
A. Experience of HVAC system manufacturer
B. Requirements for Affidavit certifying compliance with specifications
C. Compliance with local building codes and energy conservation requirements.

2.0 Execution
2.1 General – meeting applicable codes and ordinances
2.2 Ductwork and Equipment
A. Construction and erection in accordance with drawings
1. Exterior condensing unit
2. Cooling, heating, and ventilation system equipment
3. Ductwork
4. Thermostat
5. Electrical work
6. Accessories (diffusers, vibration, and noise control elements, condenser pads, etc.)

2.3 Central HVAC Systems
A. Installation, location, and mounting
1. Ventilation in accordance with applicable local building codes
2. Modification of existing forced-air system
3. New exterior wall penetrations
4. Thermostat compliance with applicable local building codes
5. Mounting and location of exterior condenser unit or heat pump
6. Rain hood

2.4 Cleanup
2.5 Warranty

4.2.1.13 *Electrical*

1.0 General
1.1 Work Included
A. Services, equipment and materials to be provided
1. Connection and control of air-handling units
2. Supplementing the equipment provided by unit manufacturers
3. Installations and relocations required by drywall work
4. Low-voltage control wiring
5. Final test for operation
B. Protection and repair of adjacent surfaces and areas.
C. Compliance with local building codes.

2.0 Execution
- 2.1 General – Verification and upgrade of system capability
- 2.2 Wiring and Equipment
- 2.3 Relocating Switches and Outlets
- 2.4 Testing
- 2.5 Cleanup
- 2.6 Warranty

4.2.2 Materials Definition

Clear, comprehensive definitions of the materials used in the construction provide contractors with direction in how the work is to be performed. It enables them to respond more accurately to the bid request. The material definitions are also a valuable tool for the managers to use in evaluating contractor's bid proposals. They form an important part of the overall Plans and Specifications package.

The contractor should submit data for approval which substantiates the compliance of the proposed materials with the specifications and plans. Submittals normally include product catalog data, independent test laboratory reports, and other certified documentation.

Acoustically sensitive material, such as windows and doors, must be approved by the acoustical consultant before the order is placed with the manufacturer. The order, once approved, will be based on detailed architectural measurements from each dwelling. These items must be custom fit to be effective. In addition, they must be inspected for correspondence to the approved submittals as soon as they are delivered to the work site.

Sections 4.2.2.1 through 4.2.2.11 give an outline of the topics and details which must be addressed in defining the materials required to complete the work. Each of the major building elements and trades is presented with the products broken down into components. This outline is provided as a starting point and checklist for developing the materials definition part of the bid package.

4.2.2.1 *Insulation*

1.0 General
2.0 Insulation
- 2.1 Type of materials to be used.
- 2.2 Use of vapor barrier.
- 2.3 Method to be used to achieve specified R-value (i.e., thickness).

4.2.2.2 *Acoustical Caulking*

1.0 General
2.0 Products – specifies compound composition

4.2.2.3 *Steel Acoustical Doors*

1.0 General
2.0 Products – specifies acceptable ratings, dimensions, mounting, and other characteristics.
- 2.1 Steel Acoustical Doors
  - A. Composition and Construction
  - B. Specification of exterior use
  - C. STC rating required
- 2.2 Steel Acoustical Door Frames
  - A. Frame composition and construction
  - B. Compatibility with field-installed seals
  - C. Anchoring and clips
  - D. Threshold
- 2.3 Seals and Weatherstripping
  - A. Type and performance of seals
  - B. Type and performance of weatherstripping
- 2.4 Finish Hardware – compatibility with door
- 2.5 Vision Panels – construction and installation

4.2.2.4 *Wood Acoustical Doors*

1.0 General
2.0 Products – specifies acceptable ratings, dimensions, mounting and other characteristics.
- 2.1 Wood Acoustical Doors
  - A. Composition and construction
  - B. Warranted for exterior use
  - C. STC rating required of assembly
- 2.2 Wood Acoustical Door Frames
  - A. Composition and construction
  - B. Compatibility with field-installed seals
  - C. Anchoring and attachment
  - D. Threshold
- 2.3 Seals and Weatherstripping
  - A. Field-installation seals and drop seal

B. Weatherstripping type and performance
2.4 Finish Hardware
2.5 Vision Panels

4.2.2.5 *Sliding Glass Doors*

1.0 General
2.0 Products – specifies the characteristics and performance standards with which the materials and workmanship must comply.
2.1 Sliding Glass Doors
A. Construction and configuration
1. Tracking, connections, and joints
2. Secondary door configuration
2.2 Lumber Trim
2.3 Compliance with specifications and standards
2.4 Hardware – closing and locking devices
2.5 Weatherstripping
A. Composition and configuration
B. Sliding weatherstripping for operable panels
C. Compliance with applicable AAMA standards
2.6 Glass and Glazing Materials – reference applicable standards
2.7 Finishes

4.2.2.6 *Aluminum Acoustical Windows*

1.0 General
2.0 Products
2.1 General Product Requirements
A. Configuration
B. Ease of cleaning and replacement.
C. Identification and STC labeling.
2.2 Product Material
A. Type of material to be used in framing and fixtures.
B. Screws and fasteners
C. Hardware for fabrication and installation
D. Weatherstripping
E. Sealant and gasket materials
F. Window screen mesh
G. Sealant performance
H. Lumber trim
2.3 Window Construction
A. Construction design facilitating replacement or repair
B. Joints, anchoring, and sealing
1. Frame sills – weep system, etc.
2. Locking mechanisms
3. Thermal barriers between frames
4. Fit within wall
C. Sash assemblies
1. Joints and anchoring
2. Sealing and securing of sash corners
3. Interlocking of interior and exterior sashes when closed
4. Removability for cleaning
5. Prohibition of metal-to-metal contact
D. Configuration and characteristics of frame connections, functions.
1. Thermal barrier
2. Air and water infiltration
3. Shielding thermal barrier from exposure
E. Glazing
1. Factory pre-glazing
2. Glazing channels
3. Tempering
F. Locking mechanisms for removable sashes
G. Insect screens
1. Dimensions and mesh
2. Removability
H. Finish coatings
2.4 Window Performance
A. Documentation of window style and STC ratings
B. Testing conditions
C. Compliance with appropriate standards (referencing standards where indicated)
1. Transmission Loss requirements for each one-third octave band
2. Water resistance penetration performance
3. Air infiltration performance
4. Condensation resistance factor
5. Overall heat transfer coefficient
6. Forced-entry resistance
7. Uniform load structural performance

4.2.2.7 *Glazing*

1.0 General
2.0 Products
2.1 Laminated Glass
A. Compliance with required thickness and STC ratings.
B. Color and construction
2.2 Glazing Sealant

4.2.2.8 *Gypsum Wallboard and Sound-Deadening Board*

1.0 General
2.0 Products
- 2.1 Gypsum Wallboard – conformity to the Drawings and to ASTM or other standards.
- 2.2 Sound-Deadening Board – required dimensions, thickness
- 2.3 Metal Studs – gauge and configuration
- 2.4 Trim Accessories – composition and configuration
- 2.5 Joint Treatment Materials – conformity to ASTM or other standards, compliance with manufacturer's recommendations
  - A. Joint tape
  - B. Joint compound
- 2.6 Miscellaneous Materials
  - A. Auxiliary materials meeting manufacturer's recommendation
    1. Wallboard screws' compliance to applicable ASTM standards
    2. Concealed acoustical sealant composition and performance
    3. Exposed acoustical sealant composition and performance
    4. Sound-attenuation blankets specifications and density

4.2.2.9 *Painting*

1.0 General
2.0 Products
- 2.1 Colors and Finishes
- 2.2 Color Pigments
- 2.3 Paint Coordination – compatibility with primer and other substrates.
- 2.4 Materials
  - A. Quality
    1. Substitution of products of equivalent quality
    2. Undercoat compatibility, use of thinners
  - B. Paint products considered acceptable
    1. For exterior concrete, stucco, and masonry.
    2. For exterior concrete masonry units
    3. For exterior ferrous metals
    4. For exterior zinc-coated metals
    5. For interior drywall
    6. For interior galvanized ferrous metals.
    7. For interior zinc-coated metals.

4.2.2.10 *Air Conditioning, Heating, and Ventilation*

1.0 General
2.0 Products
- 2.1 Oil-Fired Split System Gas Furnace
  - A. List of acceptable manufacturers
  - B. Mounting and installation
  - C. Casing construction
  - D. Compressors
  - E. Coil construction
  - F. Indoor air fan – type and drive
  - G. Heat exchanger and burner construction and venting
  - H. Cooling section controls and electric supply safety features
  - I. Gas train heating controls
  - J. Filters
  - K. Thermostat and fan selection switch
  - L. Functioning and control of components provided by thermostat
- 2.2 Split System, Cooling
  - A. Air-cooled condenser
  - B. Condenser coil
  - C. Condenser fan and motor
  - D. Compressors
  - E. Safety devices
  - F. Casing
  - G. Liquid line, suction line, and power supply
  - H. Mounting
  - I. Refrigerant piping
- 2.3 Air-Handling Unit
  - A. Type of air-handling unit required
  - B. Cooling coil assembly
  - C. Evaporator fan
  - D. Casing
  - E. Mounting and optional fan relocation
  - F. Filters
  - G. Thermostat
- 2.4 Split System, Heat Pump
  - A. List of approved manufacturers
  - B. Assembly
  - C. Condenser coil
  - D. Condenser fan and motor
  - E. Compressors
  - F. Safety devices
  - G. Casing
  - H. Liquid line, suction line, and power line
  - I. Mounting
  - J. Refrigerant piping

Indoor Heat Pump Air-Handling Unit
A. Type of air-handling unit required
B. Cooling coil assembly
C. Evaporator
D. Casing
E. Mounting and optional fan relocation for vertical discharge
F. Heater electric service
G. Filters
H. Thermostat
I. Refrigerant piping

2.6 Ventilation System
A. List of approved manufacturers
B. Air-handling unit performance and vibration isolation
C. Duct connectors and vibration isolation
D. Appearance
E. Filters and grilles
F. Thermostat
G. Rain cap

2.7 Noise and Vibration Control
A. Mechanical equipment
B. Sound rating of exterior-located heat pumps and condensing units
C. Vibration isolation of fans and compressors
D. Flexible ductwork connections
E. Design of air grilles, diffusers, and registers
F. Noise levels for fans, ducts, and registers
G. Insertion loss around new penetrations of exterior walls

2.8 Sheetmetal ductwork

2.9 Flexible Ductwork
A. Fire hazard rating
B. Lengths supplied and galvanizing of ends
C. Insulation
D. Physical characteristics
1. Temperature range
2. Maximum working pressure
3. Bursting pressure
4. Maximum vacuum
5. Crush to failure pressure
6. Bending radius

Air Distribution System
A. List of approved manufacturers
B. Finish

4.2.2.11 *Electrical*

1.0 General
2.0 Products
2.1 General
A. Compliance with codes
1. NBFU
2. NEMA
3. NEPA
4. U.L.
5. ANSI
6. All local governing codes

4.3 Advertising For Bids

After the plans and specifications are finished, contractors are invited to submit competitive bids for the work. The package of bid documents usually includes the Advertisement or Invitation to Bid, Instructions to Bidders, the bid form, other sample bidding and contract forms, and the proposed Contract Documents including any Addenda issued prior to receipt of bids. The Contract Documents proposed for the Work consist of the Conditions of the Contract (General, Supplementary, and other Conditions), the Drawings, the Specifications, and all Addenda issued prior to and all Modifications issued after execution of the Contract.

Bid responses in other home sound insulation projects have shown that most contractors who are suited to the type of work involved are not experienced with some of the specialized products and services required. They may underestimate or overestimate the detailed workmanship involved in installing acoustical windows and doors, for example. Also, few contractors are familiar with the stringent bid documentation requirements for a project operating under a federal grant. For these reasons, a pre-bid conference with potential contractors is strongly recommended. The briefing should cover the basic work requirements, material specifications, and contract compliance, and should include visits to the prospective dwellings. Naturally, all bidders should visit the sites as a group to minimize the intrusion on the homeowners.

4.4 Contractor Selection and Approval

Once bids have been received they must be analyzed carefully to ensure that the contractor has understood and responded to the project requirements and specifications. Experience shows that the number of bids received is often smaller than anticipated due to some aspects of the project such as purchasing large quantities of specialized products and construction time constraints.

For most home insulation projects a General Contractor will be chosen who will be responsible for obtaining and managing all of the subcontract trades involved. This simplifies organizing the construction phase and the coordination of the various tasks. If the project is too limited for a General Contractor, the organizing agency can execute contracts with the individual trade contractors. This second approach will require that the funding agency provide the necessary construction management so that scheduling and performance are closely supervised. The trades involved are:

1. Carpentry – Installs drywall, windows, wood doors, sliding glass doors, vent baffles, and wood trim. The carpenter usually installs the specialized acoustic windows and doors under the supervision of the manufacturer's local representative.
2. Electrical.
3. Insulation – Installs attic and underfloor insulation.
4. Air Conditioning and Ventilation
5. Fireplace Damper – This service can be provided by specialists in the trade.
6. Painting
7. Drapery and Window Coverings – Removes and reinstalls specialized window coverings.

Because most contractors have limited experience with sound insulation work they often include a high construction cost contingency on the actual work required. This is common practice in the construction trades and ensures that the contractor realizes an adequate profit for the work undertaken. Typically, cost contingencies and profit combined represent about 30 percent of the total cost.

Construction costs are also dependent on the level of construction activity in the community. A healthy market will always generate higher bids than if the market is depressed.

Another possible source of disagreement between predicted costs and bid proposals is the difference between standard cost estimate methods and estimates based on experience gained from previous dwelling insulation projects. Generally, most contractors use construction cost data tabulated in Means Construction Costs guidebook as the basis for their estimates. Data contained in these guidebooks are taken from actual construction projects and are broken down by work item and trade. Means guidebooks are a commonly accepted standard in the construction industry for determining project construction costs.

Means costs generally do not take into account the inherent inefficiencies (e.g., dealing with homeowners, cleaning up daily, missed appointments) of residential remodeling. There is also a considerable cost increase, roughly 10 percent, if the dwellings are spread apart and travel time between them is significant. It is more accurate to base cost estimates on modifications of Means estimates which are based on experience with residential sound insulation programs.

4.5 Scheduling

A proposed construction schedule should be organized to make sure the tasks of the various construction trades are coordinated to mesh efficiently. The schedule must show the expected delivery times of specialty items such as acoustic windows and doors. These items typically require long delivery times – up to four months. The project manager should review the schedule for compatibility with project objectives and for minimum inconvenience to the homeowners.

Timely submittals to local building authorities should be taken into consideration. Normally, the general contractor takes responsibility for submitting copies of the plans and specifications and securing the required building permits from the local building department.

Overall Project Schedule

There are a number of tasks to be scheduled (or considered) for the overall program. Table 4–3 lists them in a general chronological order. The entries are self-explanatory. Many of them will be performed concurrently. Figure 4–4 shows these same items in the form of a flowchart with some entries grouped together if they are likely to be performed within the same timeframe. The flowchart entries are abbreviated, but the item numbers correspond to the table entries for easy reference.

Several of the schedule items may not apply to all projects, depending on the specific project structure and funding. For example, not every dwelling insulation project will involve a pilot study. Similarly, the schedule entries for FAA funding applications stages can be ignored if FAA funds are not being used.

Table 4-3

Chronological List of Project Schedule Items

1. Initial conceptual planning
   - identify possible funding sources
   - estimate total number of eligible homes
   - get list of acoustical consultants, architects, and mechanical/electrical engineers
   - attend informational seminars
2. Pre-application to FAA
3. Conduct housing survey
4. Decide whether or not to do a pilot project
5. Design pilot, determine number of houses, funds available
6. Apply to FAA for project approval and funding.
7. Decide whether or not to use an outside consultants
8. Put out RFP for consultant services
9. Set up some sort of office and develop plans for office staff
10. Hire (or acquire) office staff and hire consultant(s).
11. Advertise program to the public
    - hold public meetings
    - get newspaper and TV coverage
12. Solicit participants (homeowners)
13. Review applicants for dwelling insulation
14. Select dwellings and alternates, and prioritize
15. Inspect homes to see if acceptable for pilot study
16. Perform noise measurements
17. Pre-modification survey
18. Determine sound insulation improvements required for each house.
19. Prepare plans and specifications for each house
20. Prepare work requirements and material definitions
21. Develop overall project schedule
22. Prepare bid package
23. Submit bid package to local building department for review and approval
24. Advertise for bids
25. Pre-bid briefings and site visits
26. Review bids and select winning contractor(s)
27. Give project construction seminar to winning contractor
28. Place order for specialized materials, if necessary
29. Inspect delivered materials before installation
30. Install modifications
31. Inspect work during construction
32. Post-modification final inspection
33. Post-modification sound measurements
34. Post-modification opinion survey
35. Assess program
36. Plan for continuing program, if appropriate

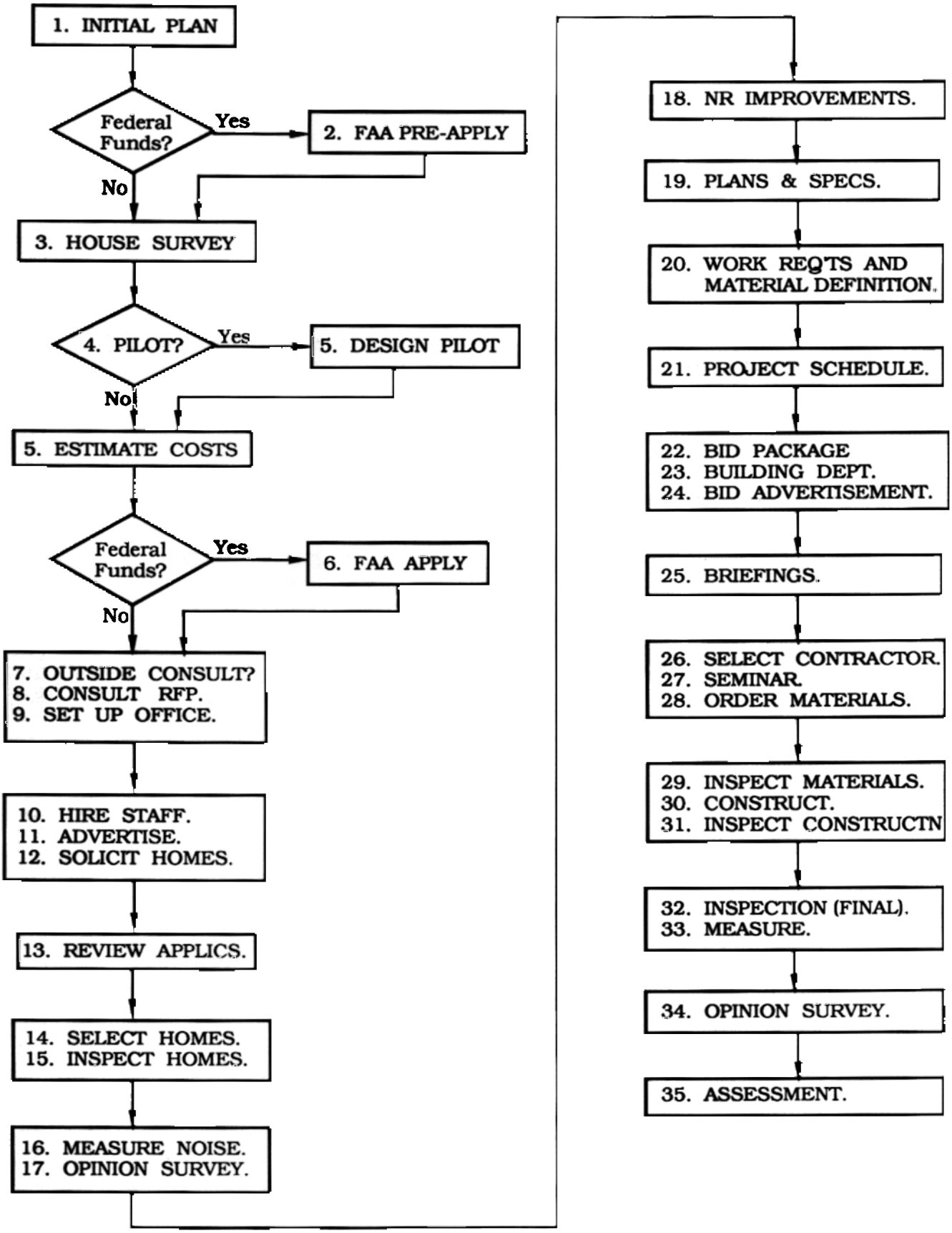


Figure 4-4. Program Schedule Flowchart

Construction Schedule

The flowchart in Figure 4–5 shows the six basic stages of modifying a dwelling. These stages are:

- ordering, receiving and inspecting building elements;
- pre-demolition;
- demolition;
- construction;
- cleanup; and
- post-construction.

In order to minimize the length of time taken to finish the dwelling modifications, the work should not start until all the special-order items, such as acoustical windows and doors, are delivered, inspected, and approved. Past experience shows that, when construction commences on part of the work while waiting for these products, the project often gets interrupted and delayed for many weeks. This should be avoided whenever possible.

The coordinated work of a number of different building trades will be required to implement the full dwelling modifications package. These tasks need to be scheduled within the construction stage to facilitate efficient work performance. The treatments which might be required in the modification design include:

- HVAC
- attic/ceiling
- roof
- underfloor
- windows
- doors
- exterior walls
- interior walls

Of these construction tasks there are only two – HVAC and interior wall modifications – that should be given a particular place in the construction sequence. If the HVAC system modifications require changing or installing ductwork, this must be done before installing insulation or other attic treatments. It is best to schedule the HVAC work first in the construction schedule.

Conversely, the interior wall modifications should be scheduled last. This is because the window and door openings cannot be framed and trimmed until the new windows and doors are in place. The final window and door interior trim can be performed when the wall is finished.

Other than these considerations, the order of the remaining construction tasks can be left up to the general contractor or scheduled according to constraints that are specific to the project in question.

4.6 Construction Inspections

4.6.1 Work Supervision

Supervising the construction phase of the project is important to the accomplishment of the program goals. The supervisor should monitor the soundproofing efforts closely to ensure that the modifications are being done in accordance with the plans and specifications and also to minimize the intrusion on the homeowners. A technically knowledgeable project manager, the architect, or the acoustics consultant are the best choices for this assignment.

The success of the sound insulation project depends on the correct execution of the specified modifications. Acoustically superior products, such as specialized windows and doors, must be installed properly if their benefits are to be realized. The importance of this cannot be overstressed. Similarly, secondary wall and ceiling treatments need to be applied exactly as instructed with proper resilient mounting and edge sealing in order to be fully effective. Since many contractors have little or no experience with these items and methods, supervision of the work in progress ensures proper work performance and avoids unnecessary delays.

Cleaning up at the end of each day and minimizing the inconvenience to the residents should be given a high priority. If the work crews are unaccustomed to working in occupied houses it may be necessary for the supervisor to remind them of the importance of this. The supervisor should also deal with unforeseen conditions as soon as they are discovered. The project manager and general contractor should prenegotiate terms and conditions for handling the costs associated with unforeseen conditions requiring a change order to complete such work. As an example, wood framing around a window may be rotted and need replacement to support the weight of the new acoustic window. This would have probably been an unforeseen condition when the general

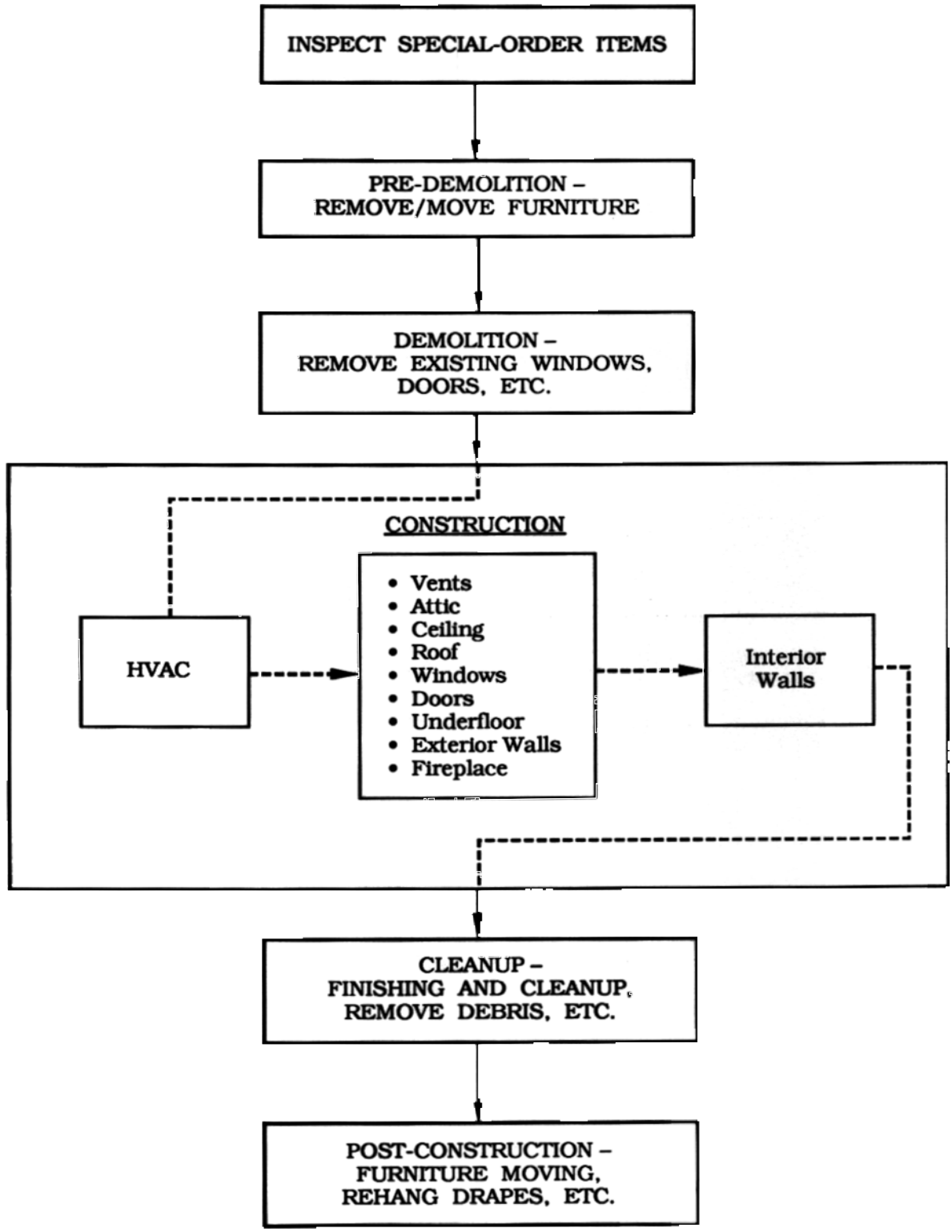


Figure 4-5. Construction Schedule Flowchart.

contractor prepared his bid. This will help shorten or eliminate delays that would further inconvenience homeowners and increase project costs as well.

4.6.2 Inspections

Inspection Tasks and Documentation

There are a number of inspection tasks for the project management to be concerned with. Inspections are needed prior to starting the construction phase, during construction, and after the modifications are completed. The contractor should be responsible for meeting local building code requirements and inspections are the responsibility of the local building department. Beyond this, regular field inspections and consistent documentation will ensure quality control and uncover problems as they develop. The tasks involved include the following:

- Review and process all submittals and shop drawings that are required by the Specifications.
- Inspect all materials before they are installed to ensure that they comply with approved submittals. This is particularly important for specialty products such as acoustical windows and doors.
- Inspect all work covered by shop drawings to ensure that it complies with approved shop drawings.
- Observe all work in progress to verify that it meets the requirements and intent of the Contract Documents.
- Issue a report to the General Contractor, in writing, of any part of the work in progress that does not conform to approved submittals, shop drawings, or Contract Documents.
- Prepare and issue to the General Contractor any clarification or interpretation of the Contract Documents.
- Consider and evaluate the Contractor's suggestions for modifications to the Contract Documents.
- Take photographs of the work in progress and the completed project.
- Review applications for payment to ensure that they agree with the work actually done and materials actually received.
- Prepare punch lists* at the appropriate time for each unit, distribute the lists to the General Contractor for execution, verify that punch list items are complete, and then certify the General Contractor's final invoice for payment.
- Visually inspect each unit before expiration of the guarantee/warranty period and issue a report describing all elements that are found to be in non-conformance, the reasons for their non-conformance, and a determination of the causes.

Obviously, conducting inspections is a significant part of the overall work effort. Such inspections are, however, vitally important to the success of the program and should not be neglected. A typical pilot study of up to 50 homes requires a staff of two or three knowledgeable persons just to conduct ongoing inspections.

Construction Phases

The field inspector should allocate time among the residences being modified according to the major phases of construction and material inspection, namely:

1. Inspection of Materials – before installation.
2. Pre-Demolition – Removal/moving of furniture, etc.
3. Demolition – Removal of existing windows, doors, etc., and enlargement or reduction of openings to accept new elements.
4. Construction – Installation of new elements.
5. Cleanup – Finishing and cleanup. Removal of debris,etc.
6. Post-Construction – Furniture moving, etc.
7. Final Inspection and Punch List

A Home Inspection Punch List is provided in Appendix C as an inspection aid. It consists of a detailed list of items to be checked concerning proper installation and operation of all modified items.

4.7 Post-Construction Noise Monitoring

After construction is completed, measuring the exterior and interior noise levels during aircraft flyovers will indicate the noise reduction improvement. All measurements should be conducted according to the methods described in Section 2.4. If noise measurements were performed prior to the modifications, the post-construction measurements should be conducted under the same conditions. Setup details which need to be duplicated include:

- The same houses should be remeasured.
- Weather conditions should be similar.
- The microphones should all be in the same places.
- There should be the same furniture in the room.
- All windows and doors should be tightly closed.
- Any noisy appliances such as refrigerators and ticking clocks, which were disabled, should be disabled again.
- A comparable number of flight events should be successfully recorded so there are similar number of samples in the average noise reduction calculation.
- Before and after measurements should compare takeoffs to takeoffs and landings to landings.

Post-modification measurements can indicate which rooms received the most improvement, which may point toward the effectiveness of specific modifications. Assess this cautiously, however, since the cause-and-effect relationship may not be a simple one.

4.8 Community Surveys

Soliciting the opinions of the residents who participate in the sound insulation project is a very effective means of assessing the success of the sound insulation efforts. A pre-modification survey shows the problems people have with noise in their homes and a post-modification survey indicates how well they feel their problems have been addressed. Sample survey questionnaires have been provided in Appendix F. Such surveys are easy to conduct and have proven worthwhile. The forms can be mailed to participants and the percentage of responses is generally high. Pre-modification opinions can be collected anytime before construction begins. Post-modification responses should be solicited about three months after the modifications are completed. One of the most important uses of such a survey is as a beneficial community relations tool for documenting the success of the program and encouraging other homeowners to participate.

REFERENCES

1 "Guidelines for Considering Noise in Land-Use Planning and Control", Federal Interagency Committee on Urban Noise, June 1980.

2. Title 14, Code of Federal Regulations, Part 150, "Airport Noise Compatibility Planning", revised as of 1 January 1987.

3. Sharp, B.H., Kohli, V.K., and Stusnick, E., "A Study of Soundproofing Requirements for Residences Adjacent to Commercial Airports", Wyle Research Report WR 81-39, prepared for the U.S. Environmental Protection Agency, August 1981.

4. Mange, G.E., Skale, S.R., and Sutherland, L.C., "Background Report on Outdoor–Indoor Noise Reduction Calculation Procedures Employing the Exterior Wall Noise Rating (EWR) Method", U.S. Department of Transportation Report FHWA-TS-77-220, prepared by Wyle Research, March 1978.

APPENDIX A1

Preliminary Project Cost Estimates

Preliminary Project Cost Estimates

Project: _____
Number of Dwellings: _____
Noise Reduction Criteria: _____

I. DWELLING MODIFICATIONS:

Noise Zone	Dwelling Category	Number Dwell	Avg Cost per Dwel	Cost
	1 2 3 4 5 6			
	1 2 3 4 5 6			
	1 2 3 4 5 6			
			SUBTOTAL:	

II.	Contractor Contingency Mark-up.....	
III.	Architectural/Engineering Design.....	
IV.	Preparation and Review of Plans & Specifications....	
V.	Noise Measurements (pre and post-modification).....	
VI.	Avigation Easement Costs.....	
VII.	Project Management Costs.....	
VIII.	Permits, Fees, Insurance, Bonds, etc.....	
IX.	Miscellaneous Costs	
	TOTAL:	

APPENDIX A2

Detailed Dwelling Unit Costs

DETAILED DWELLING UNIT COSTS - Sheet

Project: _____
Address: _____
Exterior Noise Level: _____
Square Foot Area: _____
Description/Dwelling Type: _____

I. LIST OF MODIFICATIONS:

Room Type	Shld	Criteria	Additn'l NR Req'd	Element	Description	Cost
Living Room				Windows Doors Walls Ceiling _____		
Dining Room				Windows Doors Walls Ceiling _____		
Kitchen				Windows Doors Ceiling _____		
Bedroom #1				Windows Walls Ceiling _____		
Bedroom #2				Windows Walls Ceiling _____		

SUBTOTAL: _____

II. Baffles..... _____
III. HVAC..... _____
IV. Insulation..... _____
V. Electrical System..... _____
VI. Contingency..... _____
VII. Permits, Fees, etc..... _____
VIII. Miscellaneous..... _____
IX. Subtotal from additional sheets.... _____

TOTAL: _____

COST PER SQUARE FOOT: _____

DETAILED DWELLING UNIT COSTS - Sheet 2

Project: _____

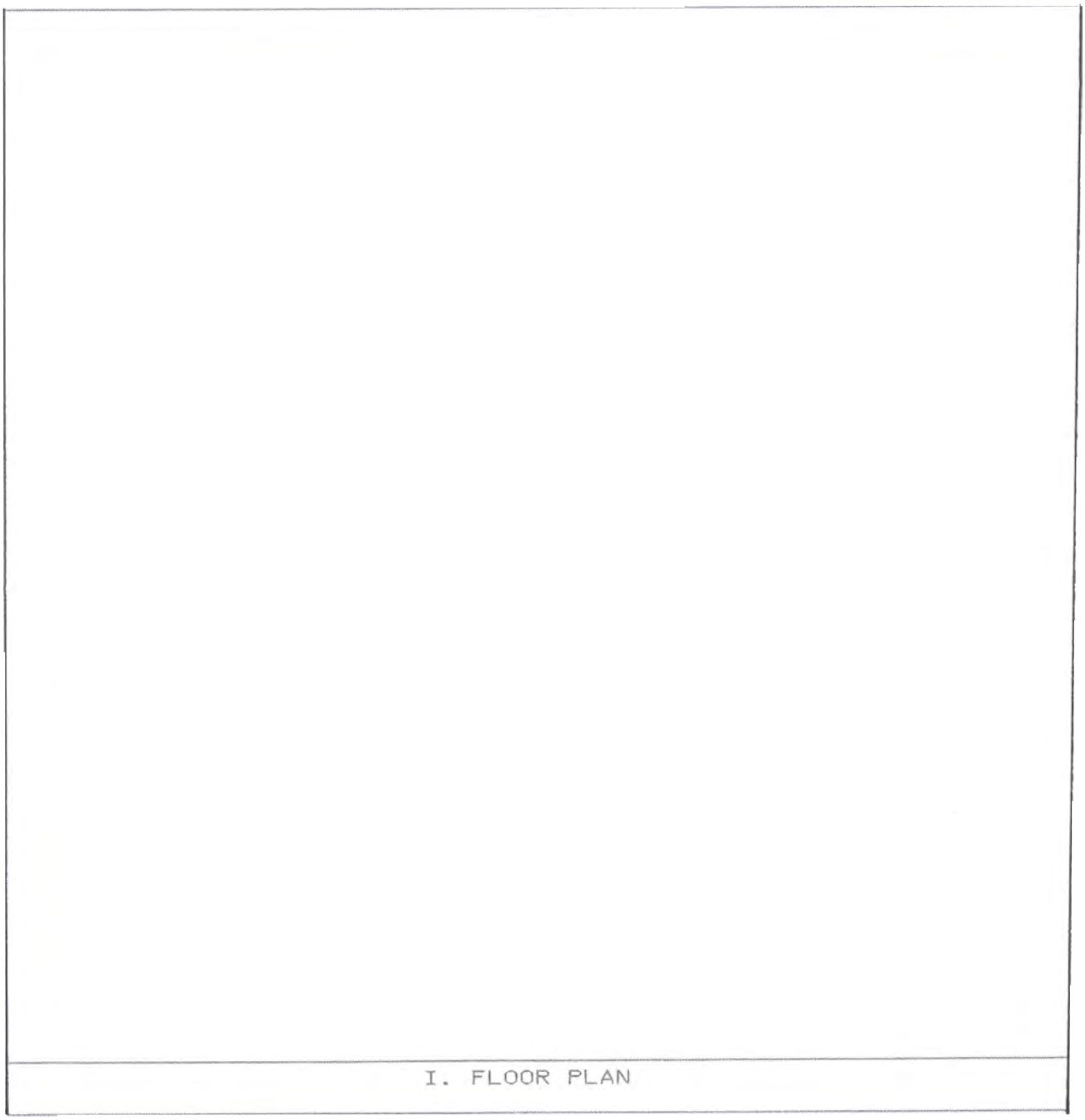
I. CONTINUED LIST OF MODIFICATIONS:

Room Type	Shld	Criteria	Additn'l NR Req'd	Element	Description	Cost

SUBTOTAL:

DETAILED DWELLING UNIT COSTS - Sheet 3

Project: _____



I. FLOOR PLAN

II. Address _____

III. Description: Type - _____

Exterior Cladding - _____

Roof - _____

Foundation - _____

Square Footage - _____

APPENDIX A3

Construction Cost Summary

CONSTRUCTION COST SUMMARY

Project: _____

Noise Reduction Criteria: _____

Contractor(s): _____

I DWELLING INVENTORY:

	Category	Noise Zone	Mat'ls per	Labor per	Labor Mult	Number Dwell	Conting Mult	Cost
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

SUBTOTAL: _____

II. Demolition..... _____

III. Clean-up..... _____

IV. Equipment..... _____

V. Inspections..... _____

VI. Insurance..... _____

VII. Permits, Fees, etc..... _____

VIII. Miscellaneous Costs ..... _____

TOTAL: _____

$$\text{Cost} = \left\{ \left(\begin{matrix}\text{Mat'ls}\\ \text{per}\end{matrix} \right) + \left[\left(\begin{matrix}\text{Labor}\\ \text{per}\end{matrix} \right) \times \left(\begin{matrix}\text{Labor}\\ \text{Mult}\end{matrix} \right) \right] \right\} \times \left(\begin{matrix}\text{Number}\\ \text{Dwell}\end{matrix} \right) \times \left(\begin{matrix}\text{Contg}\\ \text{Mult}\end{matrix} \right)$$

APPENDIX A4

Non-Construction Costs

NON-CONSTRUCTION COSTS

Project: _____
Number of Dwellings: _____
Noise Reduction Criteria: _____

Item	Cost per Dwell	Number Dwells	Cost
1. Modification Designs: 65-70 dB			
71-75 dB			
76+ dB			
2. Prepare & Review Plans & Specs			
3. Prepare Bid Documents			
4. Pre-bid Conference Costs			
5. Real Estate Consultant			
6. Architect/Engineer Consultant			
7 Noise Measurements			
8. Inspection Fees			
9. Relocation Expenses			
Administrative Expenses			
Avigation Easements			
12. Contingencies			
13. Insurance			
14. Bond Expenses			
15. Miscellaneous Expenses			
		TOTAL:	

APPENDIX A5

Total Project Costs

TOTAL PROJECT COSTS

Project: _____

Number of Dwellings: _____

Noise Reduction Criteria: _____

I.	Construction Costs	
II.	Non-Construction Costs	_____
III.	Miscellaneous	_____
	TOTAL:	_____
	COST PER DWELLING:	_____

APPENDIX B

Bibliography

APPENDIX B

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Knudsen, V.O., Harris, C.M., *Acoustical Designing in Architecture*, John Wiley & Sons, Inc., New York, 1950.

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APPENDIX C

Home Inspection Punch List

Home Inspection Punch List

HOMEOWNER: _____

ADDRESS: _____

INSPECTION DATE(S): INSPECTOR: _____

1. _____ 2. _____ 3. _____ DATE REQUESTED: _____

(NOTE TO INSPECTOR: Before starting punch list review, delete all items not applicable to this project by checking "N/A".)

****

I. ACOUSTICAL WINDOWS

PART A

	YES	NO	N/A
1. Were all required primary acoustical windows installed?			
2. How many? Primary ___STC 45 ___STC 40 ___STC 35 ___STC 30 ___Other			
3. Have STC test reports and rating from a recognized acoustical laboratory been provided for each window type?			
4. Are units cleanly and properly installed?			
5. Are all cracks and screw holes caulked?			
6. Is overall caulking job a clean one?			
7. Is the gap between the secondary and primary frame correct?			
8. Are there weep holes at the bottom of the frame?			
9. Are weep holes clear?			
10. Do all units operate properly?			
11. Do all locks and latches operate properly?			
12. Is there proper clearance for operation of all units?			
13. Is glazing correct for required STC rating, location, or application?			
14. Is finish required color?			
15. Is metal work clear of any defects?			
16. Were all windows cleaned?			
17. Where non-glass glazing is used, has Owner received cleaning instructions and information?			
18. Have screens been provided where required?			
19. Have sills been lowered or window openings enlarged where required?			
20. Has all trim and sill work been replaced to match existing?			

PART B

21. Other _____

_____

Explain any "NO" answers above _____

_____

_____

_____

_____

****

II. DOORS

PART A

YES NO N/A

1. Were all required doors installed?
2. How many?
   ___STC( ) ___STC( ) ___STC( ) ___Storm ___Sliding Glass
3. Have STC test reports and rating from a recognized acoustical laboratory been provided for each door type?
4. Are units cleanly and properly installed with a good tight fit all around?
5. Have new doors been installed with all hinges, seals, gaskets, thresholds, weatherstripping, etc., required to achieve required STC rating and complete installation?
6. Do all doors operate properly?
7. Do all locks, deadbolts operate properly?
8. Is there proper clearance for operation of all doors and parts without binding or causing damage to adjacent surfaces?
9. Have door stops been installed where required?
10. Is glazing correct for required STC rating, location, or application?
11. Have existing doors been weatherstripped where required?
12. Were all doors cleaned?
13. Has all trim work been replaced to match existing?
14. Have new doors been weatherproofed and painted?
15. Are storm doors weathertight?
16. Has closer, safety chain, and locking latch been installed on storm doors?

PART B

17. Other _____

_____

Explain any "NO" answers above _____

_____

_____

****

III. WALLS AND CEILINGS

PART A

YES NO N/A

1. Did Contractor request inspection of wall/ceiling components?
2. Was gypsum drywall installation acceptable?
3. Were all seams taped and wall perimeters caulked?
4. Is clearance between existing and new furred-out walls acceptable?
5. If not, were defects corrected and a second inspection completed and accepted?
6. Were all switches, outlets, grilles, vents, lights, etc., relocated with wall modification and are they operational?
7. Is gypsum drywall painting acceptable?
8. Was surface redecorated in a similar manner and style to previous surface?
9. Was all trim, siding, etc., replaced or installed to match previous or adjacent surfaces?

PART B

10. Other _____

_____

Explain any "NO" answers above _____

_____

****

IV. INSULATION

PART A YES NO N/A

1. Is all insulation required type, R-value, or thickness?
   - Attic
   - Crawlspace
   - Walls
   - Airducts
2. Is insulation installed per manufacturer's recommendations?
3. For rolled insulation, is vapor barrier facing toward the heated living area?
4. Are all recessed heat-producing fixtures baffled and clear?
5. Are all soffit/eave vents baffled and clear? (2½ inches)
6. Are all chimneys/flues baffled and clear? (3 inches)
7. Are all ducts insulated properly?
8. Is ventilation in the attic adequate?
9. Is the access hatch framed properly and does it fit tightly in place?

PART B

10. Other _____

_____

Explain any "NO" answers above _____

_____

_____

_____

****

V. LOUVERS (ACOUSTICAL OR VENT)

PART A YES NO N/A

1. Do acoustic louvers meet minimum sound transmission loss requirements?
2. Have louvers been recessed into exterior wall or installed so as to avoid injury to persons or damage to the louver?
3. Is color correct?
4. Are all finishes undamaged?
5. Is required insect screening provided?
6. All joints filled tightly with sealants and fillers?

PART B

7. Other _____

_____

Explain any "NO" answers above _____

_____

_____

_____

****

VI. FIREPLACE/CHIMNEY MODIFICATIONS

PART A

	YES	NO	N/A
1. Was manual operable damper modified or new installed?			
2. Does damper close tightly against frame?			

PART B

3. Other _____

Explain any "NO" answers above _____

****

VII. KITCHEN EXHAUST VENTILATION

PART A

	YES	NO	N/A
1. Was noise control duct added to existing kitchen ceiling fan?			
2. Was noise control baffle including insect screen added to existing kitchen wall fan?			
3. Does combustion air grille or duct draw true outside air?			

PART B

4. Other _____

Explain any "NO" answers above _____

****

VIII. VENTILATION (NEW OR MODIFIED HVAC SYSTEM)

PART A

	YES	NO	N/A
1. Have all permits been acquired and installation been approved by governing agencies?			
2. Has equipment been installed properly, per approved shop or diagrammatic sketches?			
3. Have all ducts been insulated and sound reduction elements been installed as required?			
4. Has all patching of surfaces disturbed for installation of equipment been completed?			
5. Has fresh-air intake and exhaust been provided?			
6. Has damper been installed in fresh air duct intake and exhaust?			
7. Are exterior condensing units level and mounted on concrete pads?			
8. Has control system been modified to permit operation of fan system(s) independent of heating or cooling functions?			
9. Have all the supply and return registers been installed in each room?			
10. Has vibration isolation been installed where required?			
11. Has perimeter of outside air intake and exhaust been caulked?			
12. Has drainage been provided for cooling coil condensation?			
13. Has system been tested and approved?			
14. Is air flow evident at each supply and return register?			
15. For gas-fired furnaces, has the bottom plenum been sealed to minimize combustion by products entering the dwelling? (Applicable only to some manufacturers' products.)			

VIII. VENTILATION (Continued)

PART B

16. Other _____

_____

Explain any "NO" answers above _____

_____

_____

_____

****

IX. GENERAL

PART A

	YES	NO	N/A
1. Was the work area left clean and in good order?			
2. Were demolition materials properly disposed?			
3. Was work completed in a timely manner?			
4. Was sponsor contacted to make progress inspections?			
5. Has Owner been instructed on use of any new equipment or materials, e.g., HVAC system, thermostats, windows, doors, etc.?			
6. Were all operation manuals and warranties left with the Owner?			
HVAC system			
Windows			
Doors			
Other			

_____

_____

_____

PART B

COMMENTS: _____

_____

_____

****

Contractor must correct items listed in Part B of each item of work before requesting a second verification.

****

All discrepancies as indicated above have been corrected as of _____ (date)

Contractor's Firm _____

Contractor's Representative's Signature _____

****

Discrepancies have been corrected and work is accepted by _____

on this day _____. Please deliver completed copies of the following:

1. Subcontractor/Supplier Disclosure Form (Contractor).
2. Affidavit of Wages Paid (Contractor and Subcontractors).
3. Other _____.

APPENDIX D

Housing Survey Form (Windshield Survey)

HOUSING INVENTORY WORKSHEET

City:_____ Observer:_____ Date:_____

Community:_____ Ldn Zone: < 60 65 70 75

Street:_____ Side: N S E W

CATEGORY								COUNT
Type	Wall	Roof	Wndw	Floor	Size	Storms?	Chim?	

HOUSE TYPE:
- One Story: 1S
- Two Stories: 2S
- Three Stories: 3S
- Split Level: SL
- Duplex (or row end): DU
- Row, Townhouse: TH

WALL:
- Alum. or Wood Siding: SD
- Brick Veneer: BR
- Brick Veneer + Siding: BS
- Stucco: ST
- Block: BL
- Poured Concrete: CN

ROOF:
- Vented Attic: VA
- Single Joist, Light: SJL
- Single Joist, Heavy: SJH
- Exposed Ceiling, Light: ECL

WINDOW:
- Wood Frame: WD
- Alum. Frame: AL
- Jalousie: JA
- Casement: CA

FLOOR:
- Basement: BA
- Crawlspace: CR
- Concrete Slab: CO

SIZE:
- Small: 0K
- Medium: 1K
- Large: 2K

STORMS:
- All: ✓
- Some: S
- None: –

CHIMNEY:
- Yes: ✓
- No: –

APPENDIX E

Glossary

APPENDIX E

Glossary of Acoustical Terminology

Absorption Coefficient – The sound-absorbing ability of a material, defined as the ratio of the incident sound energy absorbed or otherwise not reflected by the material to the incident sound energy at the surface of the material. Unless otherwise specified, a diffuse sound field is assumed. Values of absorption coefficient are a function of the frequency of the incident sound. The values of sound absorption coefficients usually range from about 0.01 (for hard smooth surfaces) to about 1.0 (for thick absorptive fiberglass).

Acoustical Treatment – The application of design principles in architectural acoustics to reduce noise or vibration and to correct acoustical faults in spaces.

Acoustics – The science of sound, including the generation, transmission, and effects of sound waves, both audible and inaudible.

Aerodynamic Noise – Noise generated in moving air by turbulent flow conditions. Aerodynamic noise in a high-velocity HVAC system can be generated at abrupt turns, dampers, flow constrictions, and room diffusers.

Airborne Sound – Sound radiated initially into and transmitted through air rather than through solids or the structure of the building.

Ambient Noise Level – The level of noise that is all-encompassing within a given environment for which a single source cannot be determined. It is usually a composite of sounds from many and varied sources near to and far from the receiver.

American National Standards Institute (ANSI) – A voluntary federation of organizations concerned with developing standards covering a broad spectrum of topics.

American Society of Heating, Refrigeration, and Air-Conditioning Engineers, Inc. (ASHRAE) – A professional organization which identifies and publishes specifications and standard practices relating to all aspects of heating, ventilation, refrigeration, and air conditioning.

American Society for Testing and Materials (ASTM) – An organization which develops and publishes recommended practices and standards for a broad range of testing and material properties issues.

Architectural Acoustics – The science of sound, including its production, transmission, control, and effects within buildings.

Arithmetic Average Sound Pressure Level – The sum of a series of sound pressure levels divided by the number of levels included in the sum.

Attenuation – The reduction of the energy or amplitude of a sound source.

A-Weighted Sound Level – A quantity, in decibels, read from a standard sound level meter with A-weighting circuitry. The A-weighting scale discriminates against the lower frequencies below 1000 hertz according to a relationship approximating the auditory sensitivity of the human ear. The A-weighted sound level is approximately related to the relative "noisiness" or "annoyance" of many common sounds.

Background Noise – Ambient noise from all sources unrelated to a particular sound that is the object of interest. Background noise may include airborne, structureborne, and instrument noise.

Balanced Design – A noise control design in which all important noise paths transmit the same amount of acoustic energy into the space, with the sum of these path contributions resulting in an acceptable noise level.

Building Officials and Code Administrators International, Inc. (BOCA) – A non-profit service organization which administers and enforces building design and construction codes in order to protect public safety, health, and welfare.

Coincidence – When the wavelength of the incidence sound wave projected onto a window, wall, door, or other architectural construction matches the bending wavelength of the partition or panel resulting in a decrease in the transmission loss at that frequency.

Composite Sound Transmission Loss – A measure of a complex built construction's assembly to reduce sound passing through it. A complex assembly contains two or more elements which exhibit different individual sound transmission loss properties. Expressed in decibels, it is 10 times the logarithm to the base 10 of the reciprocal of the sum of the sound transmission coefficients of the building elements. Unless otherwise specified, the sound fields on both sides of the complex built construction are assumed to be diffuse.

Critical Frequency – Lowest frequency where coincidence occurs. Critical frequency is raised for thinner and less stiff surfaces exposed to the sound field.

Dampen – To cause a loss or dissipation of the oscillatory or vibrational energy of an acoustical, electrical, or mechanical system.

Day-Night Average Sound Level (DNL or L_{dn}) – The day-night average sound level is a measure of the annual average noise environment over a 24-hour day. It is the 24-hour energy-averaged A-weighted sound level with a 10 dB penalty applied to the nighttime levels which occur between 10:00 p.m. to 7:00 a.m.

Decibel (dB) – The term used to identify 10 times the common logarithm of two like quantities proportional to power, such as sound power or sound pressure squared, commonly used to define the level produced by a sound source.

Design Criteria – Design goals used in acoustical and noise control design of buildings. Design criteria are usually stated as maximum allowable noise levels permitted inside buildings or as noise reduction values required for certain types of buildings or room occupancies.

Diffraction – Ability of a sound to bend or pass around a barrier or obstruction. Low-frequency sounds can diffract around obstacles more easily than high-frequency sounds because of their longer wavelength.

Diffuse Sound Field – A sound field due to the presence of many reflected waves in a room, arising from repeated reflections of sound from the various room surfaces in numerous directions, which results in constant sound level at different positions within the sound field.

Direct Sound – Sound which is transmitted from a source to a receiver in the shortest possible time relative to other sound paths with no reflections from room surfaces.

DNL – See Day-Night Average Sound Level.

Echo – Reflected sound which is loud enough and received long enough after the direct sound to be heard as a distinct entity from the source.

Energy-Averaged Sound Pressure Level – Ten times the common logarithm of the arithmetic average of the squared pressure ratios from which the individual levels were derived.

Environmental Noise – Unwanted sound from various outdoor sources which produce noise. Environmental noise sources include aircraft, cars, trucks, buses, railways, industrial plants, construction activities, etc.

Equivalent Sound Level (Leq) – The level of a constant sound which, in the given situation and time period, has the same average sound energy as does a time-varying sound. Specifically, equivalent sound level is the energy-averaged sound pressure level of the individual A-weighted sound pressure levels occurring during the time interval. The time interval over which the measurement is taken should always be specified.

Field Sound Transmission Class (FSTC) – A single-number rating derived from measured values of field transmission loss in accordance with ASTM Classification E413, "Determination of Sound Transmission Class". It provides an estimate of the performance of the built construction against sounds of speech, radio, television, etc.

Field Transmission Loss (FTL) – The radio, expressed on the decibel scale, of the airborne sound power incident on the built construction to the sound power transmitted by the built construction and radiated on the other side.

Flanking Transmission – Transmission of sound from the source to a receiver by a path other than that under consideration.

Free Sound Field – A sound field free from the effects of boundaries or in which the effects of boundaries are negligible over the frequency range of interest.

Frequency – The number of oscillations per second completed by a vibrating object.

Hertz – The unit used to designate frequency. Specifically, the number of cycles per second.

Impulse Noise – Noise of short duration (typically less than one second) with abrupt onset and rapid decay. Impulse noise is characteristically associated with such sources as explosions, impacts, discharge of firearms, sonic booms, etc.

International Electrotechnical Commission (IEC) – An organization comprised of national committees from member countries, concerned with standards for electrical technology.

International Organization for Standardization (ISO) – An organization which is responsible for developing worldwide technological standards, except for electrical technology (see IEC).

Loudness – The attribute of an auditory sensation, in terms of which sounds may be ordered on a scale extending from soft to loud. Loudness depends primarily upon the sound pressure of the source, but it also depends upon the frequency and wave form of the source.

Masking – The ability of one sound to inhibit the perception of another sound. Also, the use of an unobtrusive background noise to cover some other specific intruding sound.

Noise – Any sound which is undesirable because it interferes with speech and hearing, or is intense enough to damage hearing, or is otherwise annoying.

Noise Contours – Continuous lines of equal noise

level usually drawn around a noise source. The lines are generally drawn in 5-decibel increments so that they resemble elevation contours found in topographic maps except that they represent contours of equal noise level. Noise contours are generally used in depicting the noise exposure around airports, highways, and industrial plants.

Noise Criterion (NC) Curves – Any of several versions (NC, NCA, PNC, RC) of criteria used for rating the acceptability of continuous indoor noise levels, such as produced by HVAC systems.

Noise Exposure – The cumulative acoustic stimulation reaching the ear of a person over a specified period of time (e.g., a work shift, a day, a working life, or a lifetime).

Noise Isolation Class (NIC) – A single-number rating derived from the measured values of noise reduction, as though they were values of transmission loss, in accordance with ASTM Classification E413, "Determination of Sound Transmission Class". It provides an evaluation of the sound isolation between two enclosed spaces that are acoustically connected by one or more paths.

Noise Reduction (NR) – The numerical difference, in decibels, of the average sound pressure levels in two adjacent areas or rooms. A measurement of noise reduction combines the effect of the transmission loss performance of the built construction separating the two areas or rooms, plus the effect of acoustic absorption present in the receiving room.

Noise Reduction Coefficient (NRC) – The arithmetic average of the sound absorption coefficients of a material at 250, 500, 1000, and 2000 Hz.

Normalized Level Difference – Difference in decibels between sound levels in rooms on opposite sides of a built construction which has been corrected for a standard amount of absorption representative of normal furnished conditions in the receiving room.

Octave – The interval between two sound frequencies having a ratio of 2.

Octave Band – A frequency range which is one octave wide. Standard octave bands are designed by their center frequency.

Octave Band Center Frequency – The geometric mean of the upper and lower frequencies of the octave. Standard octave band center frequencies in the audible range are 31.5, 63, 125, 250, 500, 1000, 2000, 4000, 8000, and 16,000 hertz.

Pink Noise – Noise with a continuous frequency spectrum and with equal power per constant percentage bandwidth. For example, equal power in any one-third octave band.

Receiver – The listener or measuring microphone which detects the sound transmitted by the source.

Receiving Room – In architectural acoustical measurements, the room in which the sound transmitted from the source room is measured.

Reflected Sound – Reflected sound in a room is that sound which has undergone one or more reflections from room surfaces prior to arriving at the location of a receiver.

Resonance – The natural vibration of an area of material at a particular frequency as a result of excitation by a sound at that frequency.

Reverberant Sound Level – The level of the sum of all of the sound energy within the room which has undergone many reflections from the surfaces in the room.

Reverberation – The persistence of sound in an enclosed space, as a result of multiple reflections, after the sound source has stopped.

Reverberation Time – The time in seconds taken for the sound pressure level (or sound intensity) to decrease to one-millionth (60 dB) of its steady-state value when the source of sound is suddenly interrupted.

Shielding – The sound level reduction at various elevations of the building due to the relative orientation of the elevations to the sound source.

Society of Automotive Engineers (SAE) – Issues reports and standards concerning a wide range of topics on the design and operation of automobiles, engines, aircraft, spacecraft, and construction, and agricultural equipment.

Sound Absorption – The conversion of incident acoustic energy to heat or another form of energy within the structure of sound-absorbing materials.

Sound Exposure Level (SEL) – A time-integrated metric (i.e., continuously summed over a time period) which quantifies the total energy in the A-weighted sound level measured during a transient noise event. The time period for this measurement is generally taken to be that between the moments when the A-weighted sound level is 10 dB below the maximum (i.e., the 10-dB-down points).

Sound Insulation – Reducing the sound level inside a building through the installation of specific building construction materials, and component assemblies which provide increased noise reduction characteristics.

Sound Isolation – A quantity usually expressed in decibels which defines the amount of sound reduction between a sound source and a

receiver; the reduction in level or intensity of unwanted noise through specific building component selection and construction techniques.

Sound Power Level – A measure in decibels of the rate at which sound energy radiates from a sound source. Specifically, it is the total energy per second produced by a sound source, and expressed in decibels, equal to 10 times the logarithm to the base 10 of the ratio of the power of a sound to the reference power of 10^{-12} watts.

Sound Pressure Level – A measure in decibels of the magnitude of the sound. Specifically, the sound pressure level of a sound, in decibels, is 10 times the logarithm to the base 10 of the ratio of the squared pressure of this sound to the squared reference pressure. The reference pressure is usually taken to be 20 micropascals.

Sound Transmission Class (STC) – A single-number rating derived from measured values of transmission loss, in accordance with ASTM Classification E413, "Determination of Sound Transmission Class". It provides an evaluation of the sound-isolating properties of built construction against sounds of speech, radio, television, etc.

Sound Transmission Coefficient – The fraction of the airborne sound power incident on the built construction to that transmitted by the built construction and radiated on the other side.

Sound Transmission Loss (TL) – A measure of a built construction's ability to reduce sound passing through it. Expressed in decibels, it is 10 times the logarithm to the base 10 of the reciprocal of the sound transmission coefficient of the building component. Unless otherwise specified, the sound fields on both sides of the built construction are assumed to be diffuse.

Source – The object which generates the sound.

Source Room – In architectural acoustical measurements, the room that contains the noise source or sources.

Spectral Characteristics – The frequency content of the noise produced by the source.

Structureborne Sound – Sound energy transmitted through a solid medium such as the building structure.

Thermal Insulation – A material or assembly of materials used primarily to provide resistance to heat flow.

TL – See Sound Transmission Loss.

Unified Building Code (UBC) – A comprehensive building code published by the International Conference of Building Officials covering the fire, life, and structural safety aspects of all buildings and related structures.

Unit – A precisely specified quantity in terms of which the magnitudes of other quantities of the same kind can be stated.

Vibration Isolation – A reduction, attained by the use of a resilient coupling, interposed between the vibrating source and the mounting structure.

Wavelength – The physical distance between identical points on successive waves.

Weighting – An additive (or subtractive) factor by which the sound pressure level at certain frequencies in an acoustic measurement is increased (or reduced) in order for that measurement to be more representative of certain simulated conditions.

White Noise – Noise with a continuous frequency spectrum and with equal power per unit bandwidth. For example, equal power in any band of 100 Hz width.

APPENDIX F

Homeowner Questionnaire

Pre-Modification Survey

Address: _____

Respondent's Name: _____

Residential Status: (Check One) Homeowner _____ Renter

Family Member _____ Guest

Question No.

1. How many years have you lived at this address? years

2. As of your last birthday, how old are you?

   Less than 20 years old ____ 40 to 50 years old

   20 to 30 years old ____ 50 to 60 years old

   30 to 40 years old ____ More than 60 years old

3. How would you rate your health?

   Very Good ____ Good ___ Fair Poor Very Poor

4. How much difficulty does aircraft noise cause you (inside your home) in terms of:

	Very Much	Much	Some	Very Little	None
Speech Communication (Conversation):					
Sleep Onset (Falling Asleep):					
Sleep Disturbance (Being Awakened):					
Concentration (Reading, Studying, etc.):					
Relaxation:					
Listening to TV or Radio:					
Telephone Use:					
Other (Please specify):					
_____		____	____	____	____
_____		____	____	____	____

FOR OFFICE USE ONLY

Date Sent: **Date Returned:** **Dwelling No.**

Question
No.

5. Have you considered moving from your home because of aircraft noise?

Yes _____ No _____

6. During the past five years, did you ever complain to BWI Airport or other officials about aircraft noise?

Yes _____ No _____

7. How would you rate the present thermal insulation of your home:

Very Good ____ Good ____ Fair ____ Not Good ____ Very Poor

Please add any comments, criticisms, or advice you may have regarding this and future similar sound insulation projects:

_____

_____

_____

_____

_____

_____

Thanks again. We will advise you of the statistical results of this opinion survey and of the acoustical results in your home.

WYLE LABORATORIES

Post-Modification Survey

Address: _____

Respondent's Name: _____

Residential Status: (Check One) Homeowner ___ Renter
Family Member Guest

Question No.

1. How many residents (including yourself) currently live at this address?

2. Of the current residents, how many are?

Less than 5 years old	____	31 to 40 years old	
6 to 12 years old	____	41 to 50 years old	
13 to 19 years old	____	51 to 60 years old	
20 to 30 years old	____	Over 60 years old	

3. How many years have you lived at this address? years

4. As of your last birthday, how old are you?

Less than 20 years old	____	41 to 50 years old	
20 to 30 years old	____	51 to 60 years old	
31 to 40 years old	____	Over 60 years old	

5. How would you rate your health?

Very Good ____ Good ____ Fair ____ Poor Very Poor ____

6. Since sound insulation was applied to your home, how would you describe the changes in the living environment (inside your home) in terms of:

	Much Improved	Improved	Slightly Improved	No Change	Worse
Speech Communication (Conversation):					
Sleep Onset (Falling Asleep):					
Sleep Disturbance (Being Awakened):					
Concentration (Reading, Studying, etc.):					
Relaxation:					
Listening to TV or Radio:					
Telephone Use:					
Other (specify):					
_____		____	____	____	____
_____		____	____	____	____

FOR OFFICE USE ONLY

Date Interviewed: **Dwelling No.**

Question No.

7. For each major room in your home, how would you rate the aircraft noise intrusion?

	Much Improved	Improved	Slightly Improved	No Change	Worse
Living Room:					
Kitchen:					
Bedroom in which you sleep:					
Bedrooms used by others in your household (e.g., children):					
Bedrooms not commonly used (e.g., guest room):					
Other (specify): _____					

8. In your opinion, how much has the overall sound insulation of your home been improved as a result of changes to the following:

	Much Improved	Improved	Slightly Improved	No Change	Don't Know
Ventilation System:					
Doors:					
Windows:					
Attic Insulation:					
Walls (if modified):					
Underfloor Vent Baffles (if modified):					
Chimney Damper (if modified):					
Kitchen & Bathroom Vent Ducting (if modified):					

9. How would you rate the overall exterior and interior appearance of your home following the application of sound insulation?

	Much Improved	Improved	Slightly Improved	No Change	Worse
General Exterior Appearance is:					
General Interior Appearance is:					

Question No.

10. How would you rate the quality and appearance of each of the following specific changes to your home:

	Very Good	Good	Fair	Poor	Very Poor
Windows:					
Doors:					
Walls:					
Ventilation:					

11. Is the ventilation system installed as part of the sound insulation:

Adequate: ____ Inadequate: ____ No Opinion: ____

No Ventilation Installed: ____

How would you rate the present thermal insulation of your home:

Very Good ____ Good ____ Fair ____ Poor ____ Very Poor

If the sound insulation for your home had been limited to only four (4) rooms, which rooms would you have chosen and in what order of priority (e.g., 1st priority, Child's Bedroom; 2nd priority, Family Room/Den; 3rd priority, Guest Room, etc.)

1st Priority: _____

2nd Priority: _____

3rd Priority: _____

4th Priority: _____

14. Do you think your home has increased in market value because of the sound insulation?

Yes _____ No _____ Don't Know _____

15. Now that your home has been sound insulated, would you consider moving because of aircraft noise?

Yes _____ No _____

16. In retrospect, was installing the sound insulation a good idea or not?

Good Idea _____ Can't Tell Yet _____

Not a Good Idea _____ No Opinion _____

Question No.

17. If sound insulation was made available to other homeowners in your immediate neighborhood, would you recommend it to your neighbors?

Yes _____ No _____

16. With your knowledge, now, of the work involved in sound-insulating your home and of the long-term changes to your living environment, which of the following options would you recommend for other homes (or for your home if you could start again):

	More Sound Insulation	Less Sound Insulation	Same As Installed
Living Room			
Kitchen			
Bedroom (where you sleep)			
Other Bedrooms (where others in your home sleep)			
Other Rooms (Guest Room, Den, etc.)			

APPENDIX G

Organizational Addresses

APPENDIX G

Organizational Addresses

Acoustical Society of America
335 East 45th Street
New York, NY 10017

American National Standards Institute
1430 Broadway
New York, NY 10018

American Society for Testing and Materials
1916 Race Street
Philadelphia, Pennsylvania 19103

American Society of Heating, Refrigeration, and Air-Conditioning Engineers, Inc.
345 East 47th Street
New York, NY 10017

Building Officials and Code Administrators International, Inc.
17926 South Halstead Street
Homewood, IL 60430

International Conference of Building Officials
5360 South Workman Mill Road
Whittier, CA 90601

International Electrotechnical Commission
1-3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Noise Control Foundation
P.O. Box 3469
Poughkeepsie, NY 12603

Society of Automotive Engineers
400 Commonwealth Drive
Warrendale, PA 15096