American Pipe Organ Construction Standards and Guidelines for Building, Rebuilding, Repair and Tuning

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Introduction

The wind-blown pipe organ is the king of musical instruments, a distinction recognized for hundreds of years.

American pipe organs are the standard for overall quality, tonal specification, mechanical and electrical engineering, world-class tonal specification and literally thousands of distinguished and artistic visual designs. The United States has some of the finest examples of the art and craft of pipe organ building in the world. American pipe organ builders in the last 200 years have provided the research and development that has improved the building standard of the industry worldwide.

Building a pipe organ, refurbishment of existing pipe organs, additions to existing pipe organs, pipe organ maintenance, and pipe organ tuning comprises a profession that can require the expertise of 13 trades, and many associated occupations and specialties.

A pipe organ builder must sell, engineer, build and install custom built instruments that the customer cannot see, hear, inspect or evaluate until the organ is completed. Pipe organ refurbishment, additions, maintenance and tuning requires expertise, qualifications and, in most cases, the same due diligence of a pipe organ builder.

Individual or firms advertising or stating that they are a pipe organ builder, rebuilder, service company or pipe organ tuner should meet or exceed the requirements as outlined in this document. Installation of wind-blown organ pipes as part of an analog or digital electronic organ is also covered under these standards and guidelines.

These standards and guidelines are the essential elements necessary for the profession to meet the business requirements, legal requirements, code requirements, artistic standards, material specifications, manufacturing requirements and component listing requirements.

Use of this Document

This document is the intellectual property of the author and is copyrighted. The intent of this document is to provide a reference document, a source of common industry standards and basic standard business practices.

This document is a work in progress and is subject to revision by the author. These standards should not be viewed as a complete, all inclusive, exhaustive document in the building of pipe organs or those working within the pipe organ field.

It is not the intent of the author that this document be used in evaluating the work of other pipe organ companies, firms or individuals.

The standards contained within this document are currently in use by a number of pipe organ builders. Others may feel free to adopt these standards, or to use them as a starting point for developing their own. It is our hope that standards will be adopted within the pipe organ industry to provide our customers with the highest quality pipe organ building and services.

The author assumes no liability whatsoever in the use and application of this document. The author furthermore does not guarantee that use of this document will result in quality organ building, repairs, or fitness of work in any associated application.

About the Author

These standards and guidelines for the construction, rebuilding and repair of pipe organs were written and edited by Arthur E. Schlueter, Jr., Founder and CEO of A. E. Schlueter Pipe Organ Company, in consultation with industry experts. Arthur has extensive experience writing and developing standards, guidelines and codes. He was the Associate Executive Director of the Southern Association of Colleges and Schools responsible for developing, writing and editing standards for higher education. Since 1990 he has served as a committee member of the National Electrical Code Panel 12, and was the principal submitter of Code 650 - Pipe Organs, and Code 640, which includes code related to electronic organs. He is licensed in multiple states as a low-voltage electrician, has earned B.A., M.Ed., and Sp.Ed. degrees and is a doctoral candidate.

Section A—Business

This section is applicable to any technician, firm or pipe organ building company that sells, engineers, manufactures, and installs pipe organs. Pipe organ tuners are also included under this general section.

1. Legal Requirements and Business Considerations

a. Business License, Taxes, and State Registration

Individuals or firms operating within a state or jurisdiction must be registered to operate a business. Registration requirements vary from state to state, but generally includes registration with the Secretary of State and the state Department of Revenue for taxation of sales and use tax, income tax and, in some states, a city and county tax as well as city or county licenses.

The United States Federal Government requires that any "for profit" business register and obtain a Federal ID number.

Taxes on sales or services are to be collected by the pipe organ builder, technician or company, and forwarded to the appropriate jurisdiction.

Full disclosure to the customer of the tax on parts or services should be made available to the client. In all cases, the responsibility to collect any tax is the burden of the pipe organ technicians, company or firm.

b. Multi-State Operations

Individuals and firms operating outside the state of home registration are to be legally licensed in every state in which business is conducted following the above criteria.

Securing registration prior to contract signing or starting work, is generally the legal requirement of all states.

c. Insurance Requirements

Businesses or individuals registered to do business are required by state law to have specific insurance.

State by state requirements can vary depending on the number of employees, size of the business and, in some cases, type and class of business.

General business insurance should be secured to cover the value of personal property of

the business or individual, business property insurance, business vehicle insurance, as well as adequate liability insurance.

Based on the general scope of business, a **minimum** of a two million dollar general liability insurance policy is highly recommended. Liability coverage is important, especially in building a pipe organ with exposed pipe work, and cantilevered organ chest(s) over people. Pipe organ tuners are subject to liability while working in the pipe organ, as well as, in some cases, around stained glass windows and church furniture. State licensed pipe organ manufacturers and builders should also have product liability insurance.

The manufacturer or service technician should realize that liability does not end when the organ is installed. The pipe organ builder or rebuilder can be held liable and financially responsible, if there is a structural failure of the organ.

d. Workman's Compensation Insurance

Pipe organ builders, rebuilders, service and tuning/maintenance companies **must** be covered with a comprehensive Workman's Compensation policy. Requirements vary state by state, and individuals or firms working in multi-state jurisdictions must have endorsements for each state in which the firm or individual works.

Builders, tuners and organ maintenance personnel who are **not** covered with Workmen's Compensation insurance must provide a written release of liability to the customer.

Some states and jurisdictions do not allow a written release of liability, and Workman's Compensation insurance is a requirement even if it is written on an individual. The individual or firm is responsible for assessing the individual jurisdictional requirements.

e. Additional Insurance Riders

Property of others under the care, custody and control of the organ builder should be separately covered under a special insurance rider. Pipe organs and organ parts to be incorporated into a new or rebuilding project that are the property of a client, should be insured for replacement value. Parts of organs or completed organs belonging to a client should also be photo documented, inventoried, listed and declared to the insurance company.

Pipe organ parts under production should be covered with insurance to the value of completed goods or should be scheduled based upon level of completion.

New or refurbished pipe organs in transit should be insured for replacement value. Pipe organ parts that are a component of an organ contract should be adequately insured.

Pipe Organ installers and builders who install must have installation insurance that adequately covers the exposure of builder, as well as the organ that is being installed.

Unless otherwise stated in the signed contract, usually the value of the organ pipes, chest(s), console and related parts remain the liability of the organ builder or installer until installed or attached to the church. Any damage to an uncompleted organ can be the financial responsibility of the builder or installer, if not covered by insurance.

Pipe organ parts of a new or refurbished pipe organ being installed should be covered by the organ builder for the total replacement value until completely installed.

Also, pipe organ parts in the possession of subcontractors must be covered by insurance against damage at the subcontractors site, or in transit.

f. Honest Bond Insurance

Pipe organ builders, service personnel and tuners should also be covered by Honest Bond insurance, for protection in the event that the client files a claim for the loss of property that is declared missing while personnel are working on site.

g. Financial Health

It is extremely important that a client is aware of the financial health and stability of a pipe organ builder/manufacturer, rebuilder, or company making additions to an existing organ, or providing any pipe organ service.

The financial health and stability can be provided by disclosure of the following:

- number of years in business,
- recent letter(s) of recommendation,
- statements concerning reputation in the business community from outside sources,
- history with the firms primary financial institution.

Financial health documentation may also include one, or more, of the following:

- annual financial statement,
- letter of credit from banking institutions,
- credit report from credit rating services,
- report from Dun and Bradstreet.

h. Personnel Insurance

Pipe organ companies that employ more than a single individual should protect their staff by providing adequate life and health insurance, as well as long-term and short-term disability insurance.

Employee life and health insurance can provide financial stability to personnel working in the construction of pipe organs or pipe organ related occupations. Customers assume stability of the company that could be compromised if employees are not insured.

Pipe organ companies as well as sole proprietary firms should also have in place a succession plan to assure clients of the continuation of the business to cover the terms of the contract warranty.

Business owners should maintain life insurance equal to or exceeding the liability of projects under contract.

i. Electrical Requirements

Pipe organs generally incorporate low voltage DC signal and power circuits.
State law requires such wiring conform to the National Electrical Code (NEC) Article 650.

Most states, counties and cities require low-voltage licensing of any pipe organ service technicians or pipe organ installers. Pipe organ builders/manufacturers and pipe organ service persons working in multi-state jurisdictions must be licensed for each state.

Pipe organ builders/manufacturers, depending on state jurisdiction, may be required by the city and/or county to obtain a permit prior to installation of any low voltage electrical circuits for a pipe organ. Pipe organ low voltage wiring may also be subject to city and/or county inspections.

All pipe organ wiring must be in compliance with NEC Article 650, and all other codes, as applicable. Installation of audio speakers and digital sound sources within a pipe organ, associated wiring, and electronics, is to be in compliance the NEC Article 640.

Electrical wiring details may be found in Section B, paragraph 4.

2. Contractual Document

a. Scope

All proposed work that is in excess of $2,000.00 requires a formal contract and obligates the pipe organ builder or service company to specific performance parameters, time schedule, firm price and warranty provisions.

Key components of the formal contract include:

- descriptive narrative of what is covered in the contract,
- tonal specification,
- elevation drawings,
- construction details,
- and certification that the organ will be built according to customer-approved engineered blue prints, and all of the above-mentioned contractual details.

Pipe organ building standards, such as this document, should be referenced to assure the customer of the quality of the new pipe organ, refurbished organ, or organ addition.

Tuning agreements or contracts for service should be in written form, with details as to what is being provided, calendar constraints, other considerations, cost and warranty.

b. Performance Bond

When the customer requires a Performance Bond, that should be documented within the contract. The church or customer can, for a fee, purchase a performance bond; the cost of such bond is borne by the church and is based on the agreed cost of the project. Generally, the cost of a performance bond is 3% to 4% of the project cost, plus possible associated fees. Rarely are bonds required, as the cost of the bond will increase the cost of the organ.

Satisfaction by the customer with Section A, paragraph 1g (Financial Health, described above) should alleviate any concerns about the company's performance. Customers should exercise due diligence to verify the financial stability of any firm with which they are contracting.

c. Design, Engineering, and Structural Certification

Pipe organ design and engineering requires certification of fitness for the application, as design certification relates to life safety issues in public assembly buildings (churches, schools, colleges, etc). The persons responsible for the design and engineering, their qualifications, and the blueprints being provided with the certifications required within the state of manufacture, should be clearly documented in the contract.

d. Electrical License and Code Compliance

The contract should reference all applicable electrical codes to be complied with and licensing requirements (see Section A, paragraph 1i). It should document the person responsible for the electrical wiring and their licensing state and number which fulfills the requirements for the state in which the installation will take place.

e. Materials Used in Construction

All material used in the building, rebuilding or repairing of a pipe organ should be of the highest quality available, and this may be documented within the contract by including or referencing the set of standards and guidelines (such as this document) which details the type of materials to be used.

3. Tonal Philosophy and Design

The majestic tonal effect of the pipe organ can be thrilling and emotionally affect the soul of the listener, so it should be no surprise that there is no other topic related to pipe organ building that elicits so many opinions and strong feelings as the tonal direction of a pipe organ.

The sound of a well-designed pipe organ is uplifting and inspiring, providing a unique experience that surrounds the listeners, and can be felt as well as heard. Studies have shown that pipe organ sound can have an uplifting effect on the human physiology as well.

In worship, the primary purpose of the pipe organ is to set the tone for the message. In addition to worship, the pipe organ must be able to support ensembles and soloists, and the vast array of pipe organ literature. To accomplish this goal, the pipe organ must be able to lead and support congregation singing and to do this at all dynamic levels. The success of a pipe organ is generally based on how well it performs in this role.

The American pipe organ should be designed to lead and support all worship styles, including contemporary worship as well as traditional and liturgical worship styles.

"Tonal Philosophy" refers to the body of thought held by the pipe organ builder that guides the development of the tonal design for a pipe organ. Since every pipe organ is custom-built, the tonal specification and design will vary with each instrument. Because each American church and congregation is different, the tonal design for a pipe organ has to meet the musical challenges unique to each church and congregation, encompassing both current and future needs. Pipe organ builders must embrace a modern pipe organ tonal philosophy which is forward-thinking; a pipe organ

should be able to adapt to the worship needs at least 50 years into the future.

A pipe organ builder should maintain their own tonal standards, reflected in both their tonal philosophy and tonal designs, which serve as benchmarks of the success of their pipe organ installations. The tonal design resulting from the application of that tonal philosophy should in all cases meet the expectations of the end user. The builder should be able to explain their philosophy and document those guidelines which they apply as a standard in their tonal designs.

Pipe organ builders are reminded that they are not building the organ for themselves, and should not have an agenda in promoting or endorsing a particular tonal direction or philosophy. Unfortunately, some pipe organ builders maintain the unjustified position that this aspect of the pipe organ is their domain, exclusively, and that the customer should blindly accept the end result. The pipe organ builder that is truly interested in providing the best possible instrument for the client will incorporate into their tonal planning the needs and desires of the client, organization, and/or their representatives, as well as knowledge about current denominational music trends.

It is not adequate for a builder to say that they are copying another builders, or group of builders, philosophies, or that they are building organs of a specific era. To say that a builder is copying a previous builders tonal philosophy would require that the new organ be built as a replication, including the physical building within which it is housed. All aspects of the construction of the organ would have to be the same: the stop list, the scaling, console placement, organ location, wood used in construction, metal content of the pipes, winding system, action type, expression mechanisms, etc. At best, a builder could try for a close approximation of the application of another builders tonal designs.

In the development of the tonal design, the following elements should be considered:

- Expectations of the organist and congregation, or client,
- visual aspects of placement within the sanctuary,
- tonal specification,
- pipe scaling,
- pipe making,
- division expression,
- optimum chest design and pipe placement,
- wind pressures,
- meticulous voicing,
- and tonal finishing.

In order to gauge a builders tonal philosophy, it would be best to listen to a number of organs from that builder.
Some organizations will bring in consultants to advise them. Consultants should not try to advance their own personal preferences, but should assist the client to determine in a

broad sense what tonal considerations are important to the successful design of their pipe organ.

The success of “the King of Instruments” depends on the knowledge and experience of the pipe organ builder and the staff of artisans who contribute their knowledge and skills, working in conjunction with the musicians and other principals for whom they are building the organ, in order to produce world-class pipe organs.

Section B—Pipe Organ Building

This section deals with the specifics of individual systems incorporated in the building of a fine pipe organ.

1. Structural Design and Engineering

New pipe organs, and pipe organ additions to an existing pipe organ, require complete blueprints documenting construction details, specifications, front, side, and section elevations, and floor plans, including floor loading requirements.

Organ structure or scaffolding, case work, and support structure of exposed pipe work necessitates that the organ builder's blueprints or drawings be reviewed, inspected, and certified by a state licensed engineer.

Structural certification must be approved within the state of manufacture **prior to** construction. Signed and sealed structural prints should be delivered to the client prior to commencing the installation, and approved by the client.

When a new organ is to be installed in an existing building or in new building construction, verification by the church architects should be secured to determine the structural integrity of the building where the pipe organ is to be installed.

2. Materials Used

a. General

All material used in the building, rebuilding or repairing of a pipe organ should be of the highest quality available.

Material used should be verified for the application intended. Documentation of material source and intended use should be recorded for each project.

Parts should not be used with known limited life expectancy. Generally, time-honored materials and supplies have well served the pipe organ builder.

Solid Woods – Solid woods must be carefully chosen and fully seasoned. This is very necessary because of frequent wide temperature and humidity variations caused by the use of air conditioning and central heating systems in modern buildings. Non-seasoned woods that have been strictly air dried for a short period of time should be used cautiously, especially in small parts, wood pipes, or thinly milled panels, due to the probability of deformation.

Fiberboards – Fiberboards such as MDF (Medium Density Fiberboard), particle boards that consist of a high ratio of resins to wood solids, or composition boards such as Masonite, should not be used for structural applications such as support beams and windchest frames. These materials may find application in more appropriate non-structural areas.

Laminates – Laminated solid woods of appropriate type, or plywood, with minimum voids in both the face and body, may, if appropriate to the design, be substituted for solid woods. This may be especially necessary in situations where a solid panel might be prone to splitting or warping, such as a rack board. All plies must be glued with non-water soluble glues.

Leathers – Use of leathers in the organ for pneumatic mechanisms, gaskets, hinging or corners should be of the appropriate type, graded specifically for use in pipe organs, and purchased from a recognized, reputable supplier of this type leather. Tanning procedures of supplier-purchased leathers should be of such type as to give a reasonable service life under normal conditions of temperature, humidity, and air quality.

Other Materials – Other materials used in the building of pipe organs but not specifically addressed in this section should be of proven longevity and reliability, and used in a manner appropriate to their individual characteristics.

b. Imported Parts

American pipe organ builders build the finest pipe organs in the world, and though some imported parts may be used in the manufacture of their pipe organs, generally this is limited to a few custom items of high quality which are competitively priced because of mass production.

Any imported pipes, parts, motors, electronics or associated organ building supplies, should meet the same standards of manufacture as their domestically produced counterparts. Imported parts that are incorporated into pipe organs should be warranted by the builder the same as domestic parts.

There is no advantage to purchasing imported pipes, other than cost in some instances, as pipe built by domestic pipe builders are the finest in the world. It is recommended that the use of imported pipes in American built pipe organs should be fully disclosed to the customer.

3. Structures

Building frames for the organ structure may be constructed of solid wood or steel, depending on the individual design criteria. Wooden frames should be made of sound, structural grade wood, and be finished with at least two coats of lacquer or equivalent. A load analysis should be conducted and approved by a licensed structural engineer, who will

then recommend to the company the proper material to be used to support the loads generated by the individual design. All loads should have direct vertical support as the primary load-bearing structure, with such support rated to carry twice the anticipated load (a 100% safety factor). Should direct vertical support not be possible, secondary supports should be provided to ensure the 100% safety factor. A floor frame is mandatory to distribute high load points.

Either bolts, screws, or other positive tensioning devices should be used to assemble the building frames. The frames should also be well braced to limit any sway movement and provide complete stability. For certain areas with high probability of earthquake activity, particular attention should be given to the requirements of local building codes. Design of internal bracing and general load factors for bearing surfaces should be carefully considered. Certification by a structural engineer should also be included.

4. Electrical

All new electrical or electronic systems, or subsystems, in a pipe organ must conform to the National Electrical Code (NEC), at a minimum. Where a jurisdiction has adopted a stricter standard, then that is the code which must be applied to any pipe organ manufactured for installation within that area.

The installation of low-voltage (0-50 volts) DC requires installation by, or oversight of installation by an appropriately licensed electrician. To do wiring without the required license is in violation of the law, and in case of a fire loss, insurance will not cover or pay a claim if the work was not completed in compliance with the NEC code and done in accordance with licensing requirements.

Installation of pipe organs in public assembly buildings (i.e. churches, colleges, schools) may require permits in addition to licensing.

Permits and licensing requirements can vary with each installation location. It is the responsibility of the organ builder to be aware of compliance issues.
Blowers, rectifiers and accessories which are installed as part of a pipe organ installation, should conform to rating and listing agencies, such as Underwriters Laboratories (UL), National Electrical Manufacturers Association, and the International Electrotechnical Commission.

Pipe organ builders should reference the National Electric Code (NEC) Article 650-Pipe Organs. For pipe organs that incorporate digital or analog sampled sound technology, reference also NEC Article 640 concerning the installation of audio equipment and speaker systems.

Repair of old pipe organ installations built prior to 1990 may require the rewiring of pipe organ electrical systems. Wiring that does not meet the current code, and is modified or

altered, requires replacement. The pipe organ builder or technician assumes the potential product liability if the wiring is a safety issue, or is a hazard to life, limb or property.

See also Section A, paragraph 2d.

5. Console and Action

a. Dimensions

Console dimensions and arrangement of controls should conform specifically to recommendations published by the American Guild of Organists (AGO). Some possible exceptions are:

- an instrument built as a strict reproduction of a specific historical model;
- a complete restoration of an historic instrument, where the client desires that the original console arrangement and dimensioning are to be preserved;
- an instrument replicating a general historical style.

For consistency in manual/pedal relationship, manual D27 should be located above pedal D15, where keyboard compasses are other than 61/32, e.g. 58/30. The organist should feel comfortable playing the console regardless of the console design.

b. Materials

Keyboards should have clear wood bodies, either solid or laminated, and multiple keyboards should be designed and built to AGO specifications. Playing surfaces may be fabricated from bone, hardwood, or durable plastic, at customer's discretion. Stop controls should be made of materials chosen by the client and should be complementary to the playing surfaces. All moving parts should have good tactile feel, be of proper mass, and adequately bushed with felt for precise movement under normal climate conditions for the installation's locale.

Old ivory keys may be refurbished and reused in a new or rebuilt console. Their suitability for reuse should be determined by pipe organ technicians. The use of new ivory or other materials originating from endangered species is prohibited by law.

c. Controls

All controls should be clearly identified by engraving, style chosen by customer, as to their function per normal AGO nomenclature. The stop controls and couplers should be of the drawknob, tilting tablet, or stop tab type, whichever is preferred by the customer. The drawknob type should have the stop knobs and intra-manual couplers set in vertical jambs at each side of the manuals. They should move in horizontal line and should be insulated from the stop jamb by a felt bushing. The inter-manual coupler controls may be of the tilting tablet type and placed above the top manual in the name board, or of the

draw knob type placed in vertical jambs. The movement of the knobs and tilting tablets past center in both directions should be accentuated by toggle spring or similar device with the stop motion cushioned by heavy felt.

The combination movements should visibly operate the stop controls and couplers and should be set from the console. Visible operation may be either by physical movement or illumination of a light.

The pedalboard assembly should be a self-contained, removable unit securely attached to the console framing.

The balanced expression shoes should be mounted on a steel shaft by machined bronze life-lubricated bearings with tension adjustment screws for adjusting resistance of movement. They should operate smoothly and freely.

All metal fittings in the console should be treated against corrosion. The console frame should be built of solid wood with the exterior finished to match sample approved by purchaser.

d. Operation

All action types, whether mechanical, electrical or electro-pneumatic, should provide a positive touch from the keyboard, with repetitive response capable of meeting the needs of the most demanding player, with reliable and precise response of the corresponding pipe valves. Tracker touch on the keyboards may be specified as a customer option. Stop actions selected from the console should operate quickly and as noiselessly as possible whether the action is slider, electro-pneumatic, electro-mechanical or mechanical.

e. Electrical controls

Contacts of all electrical controls should be of either the striking or wiping, self-cleaning type with redundant contacts provided for technician use in case of partial failure. All contacting surfaces should be fabricated from silver alloy or should be gold-plated for longevity. All contact devices should be rated with a minimum of 100% current-carrying overcapacity.
Electrical or electronic devices, all solid-state control systems including circuit boards, solenoids, relays, motors and switches should be new, of high quality and proven reliability, and also have demonstrated design overcapacity.

6. Wind Chests

a. General

Windchests should be constructed and finished such that the final visible product will appear to the casual lay observer as professional in craftsmanship as the normally visible parts of the organ, i.e., furniture-grade finishing.

Windchests should be designed so as to be constructed for good structural fit and totally airtight. The side and end frames should be designed to support the weight of the chest itself, the weight of all pipework and racking, and the weight of service personnel who may need to stand on the chest during organ installation or normal service. Chest frames should engage their supporting bearers by positive location such that all loads have direct vertical support or sufficient secondary support to ensure a minimum of a 100% safety factor.

Windchest frames should be made of solid wood appropriate load carrying characteristics, such as poplar. All joints in any frame side member should be made using accepted joinery techniques such as mortise and tenon, and glued with a non-water soluble glue. Veneer-core or lumber-core plywood may be used for bungs and rackboards.

Removable panels, normally identified as bottom boards, should be provided at all places where access to working parts is necessary for post-installation serviceability. Such panels should be gasketed with cork or leather to ensure airtightness, and securely fastened to the frame. These panels are completely non-structural and provide airtightness only. Their removal should have no effect on the structural integrity of the windchest itself.

Electrical cables within the windchests should be neatly routed to keep the wiring away from moving parts. Cable clamps or straps should secure the cables in place and cable loops used to provide strain relief.

Windchest action parts, both internal and external, should be precisely made, and sealed with clear lacquer or other sealer that defeats moisture absorption under normal climatic conditions for the place of installation.

The pneumatic action magnets used in the primaries, offset chests, stop actions, and shade actions should be of hairpin, or horseshoe, two-pole “outside” type, having a combined resistance or two poles of not less than 200 ohms. The cores should be soft non-magnetic iron. The windings should be no finer than No. 38 nor heavier than No. 34 B and S gauge, coated copper wire. Soldered, stranded terminal wires should be tied to the core. Coils should be slipped into the cores after they are bent and should have a

protective covering. The base should be a seamless die casting with cores pressed into a firm fit. The cap or valve seat in regulating exhaust screw should be of machined aluminum, or similar metal.

b. Slider Windchests

The channel grid of the slider windchest should be made with a solid wood external frame and solid wood internal structural dividers. Non-structural dividers may be made of solid wood or plywood. After assembly, the channel grid should be machined flat to ensure no inter-channel air leakage after the top and bottom tables are glued in place. The top and bottom tables of the grid should be fabricated from clear solid wood.

Since cross-sectional areas of the individual note channels will vary, pallet sizes and pallet boxes should be of adequate size and be determined during the engineering design phase with reference to the pipe scaling, mouth widths, wind pressure and subsequent voicing techniques regularly used by the builder.

Pallets should be of kiln-dried fine-grain solid wood for dimensional stability, and fitted with corrosion-resistant springs. Pallets should be gasketed with either felt and leather, or leather alone. Actuation should be by means of a suitable electro-mechanical device.

Sliders should be made of dimensionally stable, reinforced plastic or suitable composition board, and be of sufficient thickness to avoid any deformation under high usage. Self-compensating slider seals and rings of high durability should be used to avoid the development of leakage or pressure variation between channels. Slider actuation should be by electromagnetic, or pneumatic slider motors with controllers receiving signal voltage from the relay system. The slider action should be limited positively in travel and be quiet in operation.

c. Electro-pneumatic Windchests

The windchests should be of the individual pneumatic valve type. Each group of pipe valves should be removable in sections of not more than one half of the compass of the manual wind chests, so that one person may handle the section.

Pipe valves should be designed so they can be removed from the bottom of the wind chest without removing the pipes. Expansion springs should be used under all screw heads holding parts which join air passages. A separate valve should be provided for each pipe and all pouches should be made of best quality leather or other approved material. The pouch seat controlling the air to the pipe should be built up of the best grade of wool felt and leather. All air channels and borings throughout the air chest should be sealed by an approved sealer against moisture. The wind channels to the pipes should be sealed to prevent any loose cuttings or foreign matter working into the pipes.

The windchest valves should be equipped with centered corrosion-resistant springs. Toeboard expansion chambers may be used where necessary to aid the pipe speech. The primary magnets should be of proper power and capacity for the wind pressure.

d. Electro-mechanical Windchests

The electro-mechanical action can be effective in the construction of unit organs, organs requiring extra close spacing of pipe work, chests constructed in unique shapes or designs such a circles and triangles.

Electro-mechanical is a generic term for the electric pipe organ action developed by the Wicks pipe organ company. Wicks refers to their electric action as Direct Electric®. Since the Wicks patent expired, a number of look-alike electro-mechanical actions have been developed.

Electric action can be of several styles, the action does not use leather or pneumatic to open the pallet that supplies wind to organ pipes. DC current energizes a solenoid, which is attached to a pallet; when organ keys are played air is directed into the pipe.

Spring loaded pallets attached to leaves, or arms, are pulled down when the magnet is energized. Other styles may incorporate an open coil of wire with a spring loaded arm.

Electro-mechanical wind chests should be designed and constructed to accommodate the additional weight of the action magnets, which adds a considerably to the total weight of the organ chest.

Toe boards should be sufficient in thickness, or an expansion chamber should be incorporated, to assist in good pipe speech and tone characteristics. The preferred construction design of electro-mechanical action chests is to use expansion chambers that are channeled and offset from the toe holes.

Electro-mechanical action steel frame parts should be of the highest quality, and frames should be plated to resist corrosion. The pallet material should be of quality leather and felt, mounted to fiberboard or leather disks.

Wiring of the action magnets shall include a pig tail to minimize the effects of vibration of the wiring attached to the coil of the magnet. The return wire should be separately installed, independent from the chest cable.

Electro-mechanical chests should incorporate a service loop within the chest to allow for the removal of the toe board for repair or maintenance.

7. Pipe Work

a. General

All pipework should be manufactured of appropriate materials related to the tonal characteristics desired by the customer. The highest quality of construction, whether the pipes be of metal or wood, should be strictly observed.

All pipes should be firmly supported as necessary, longer pipes requiring more positive support along the body of the pipe. Such additional support is required to preclude the danger of falling, bending, or breaking. Upright racks should be provided in addition to rack boards for pipes more than 4-5 feet in length, or for pipes of delicate construction (such as thin-scaled strings or reeds). Upright racks, especially for exposed pipes, should be firmly secured to the basic structure of the organ framework to avoid the possibility of collapse or detachment from the pipes.

Large pipes with miters, made necessary due to height limitations in the chamber, should be specially racked and secured to the rack with ties reducing the chance of deformation or collapse. All miters should include bracing integral to the pipe structure to ensure stability and eliminate the presence of any sympathetic vibration.

Any previously used pipework to be incorporated in a new, rebuilt or enlarged organ, whether from a customer's previous instrument or from the builders pipe stock, either in original or altered form, should be repaired and/or reworked in order to function as well and last as long as new pipes. All old pipes should be clearly described as such in the contract specifications.

b. Metal Flue Pipes

Metal pipes may be made of a lead-antimony alloy, various tin-lead alloys, zinc, copper, brass, or aluminum, with securely soldered, welded, or brazed seams. Plain zinc, and all façade pipes, regardless of metal type, should be given a protective coating to prevent oxidation and retain the original brilliance. Scaling, cut-up, mouth widths, and type of tuning devices should be determined by the pipe organ builder, commensurate with the tonal results desired. Open-toed pipe work is generally to be avoided, due to lack of ability to easily regulate voicing of the individual pipe.

Various types of tuning devices such as scrolls or sleeves (tuning slides) may be employed on the pipes. If tuning scrolls are used, especially those made of zinc or copper, they should be felted to prevent vibration and noise.

When tuning sleeves (or slides) used to vary the overall resonating length of the pipe, they should be made of tin or aluminum of adequate gauge and overlapping cylindrical

form to securely grip the pipe body without excessive looseness, but neither should they be so tight as to deform the pipe body. Larger sleeves may be fitted with coil spring tensioners. Tuning slides on larger pipes are preferred to tuning scrolls because of increased longevity of the tuning device.

Pipework that is built with the intent of being cone-tuned is not recommended for any environment that does not maintain an absolutely constant temperature. Fluctuating temperatures require more frequent tunings, which ultimately damage the pipes, when tuned regularly with a "cone."

c. Wood Flue Pipes

Wooden pipes should be made of a solid, clear, knot-free wood, species, type and thickness determined to be suitable for use in that particular pipe voice. All seams should have a waterproof glue applied to both inside and outside surfaces to render each pipe airtight and, in addition, the pipes should have sealer applied to both inside and outside surfaces. Mitered pipes should be provided with external bracing, as deemed necessary by the pipe organ builder, to prevent opening of miter joints over time. The blocks (languids) of all larger wood pipes should have their exposed surfaces end-grain sealed to prevent deformation over time due to high humidity conditions. Stoppers, as opposed to caps or flaps, where fitted on stopped pipes, should be made of solid wood, and made of an exacting size with an airtight covering such that expansion and contraction will not split the seams of the pipe body. Packing for the stoppers should be airtight, and fashioned from leather made specifically for that use. Reused stoppered wood pipes should have their stoppers releathered to ensure longevity for tuning stability.

Open pipes may be provided with felted tuning slides, flaps, gates in the toe of the pipe, or other accepted methods of tuning adjustment.

Old or reused pipes should be carefully checked for soundness of all joints, cracks in the materials, and stability of tuning devices. Tuning devices should adhere to the standards documented above.

d. Reed Pipes

Reed pipes should be constructed from materials and methods similar to those of metal or wood flue pipes, as documented in their respective paragraphs above. Reed pipes may be constructed of either metal or wood, such as a Holz Posaune, a large pedal reed of wood, signified by the German adjective "Holz." Special attention should be given to the fitting of the resonator into the block so there is no possibility for opening of the joint between the two major parts of the reed pipe, should the resonators move out of vertical alignment for any reason. Resonators may be fitted with various tuning devices

or cut to length. In the reed block, wedges should be carefully fitted to hold reed tongues securely in place. All reed pipes should be tested for initial voicing and stability on a voicing machine.

Racking should be carefully constructed, in the case of reed pipes because of their particular construction, to eliminate any chance of the problem referred to in the previous paragraph. The resonators of pipes more than 3 feet in length, or 5 feet in the case of pipes of French double-block construction, should be provided with upright racks. These racks may be of the full-circle, partial-circle, scallop, or straight variety. Hooks, twill tape or other ties should be provided, if the rack itself cannot restrain movement of the resonator out of the vertical in all axes.

Old pipes being reused should be thoroughly reconditioned and checked for condition of materials and joints, wedges and tongues replaced, corrosion on shallots and tuning wires corrected, and stability of tuning devices verified on a voicing machine. After these pipes have been refitted, they should be tested for initial voicing and stability on a voicing machine.

8. Winding System

a. Blowers

Since the winding system is of major importance to the tonal stability of the pipe organ, electric blower(s) employed to supply air pressure for the pipes should be of sufficient capacity to provide an adequate supply for both pipework and mechanisms under normal playing conditions and assuming minimal leakage from supply lines. Size of the blower should be nominally determined by reference to the blower size chart provided by the American Institute of Organbuilders (AIO).

Blowers and controls should be installed in an enclosure with silencing devices and static regulators. The enclosure must provide maintenance access for service technicians.

The blower should be located as close to the organ as possible. In the case of a new building, close cooperation between the pipe organ builder design team and the building architect should be provided to effect an ideal location for the blower. The blower should draw air directly from the organ area, or from the room in which the organ is housed, to minimize temperature differences which will affect tuning of the organ. It is the responsibility of the customer to provide this space.

b. Reservoirs

Reservoirs may be of ribbed, floating lid, or diaphragm (schwimmer) type, at the

discretion of the pipe organ design engineers, and should be of such size as to supply the full demand of air required under normal playing conditions, including full organ at sustained operation.

All reservoirs should be made of the best lumber finished with two coats of lacquer or equivalent finish. They should be leathered at the hinges and gussets with the best grade of alum-tanned leather, or other approved and tested material.

All reservoirs should be provided with a valve of appropriate type (curtain, pallet, etc.) attached to the floating top, to regulate the flow of air from the main reservoir. The reservoir should be fitted with springs to provide suitable tension resulting in an initial pressure value, and additional weights to be added, resulting in a higher pressure if determined to be necessary to maintain a stable overall pressure.

Removable panels should be provided for maintenance access by a qualified service technician, and should be gasketed with cork or leather. All joints should be sealed on the inside to prevent leakage from usage of ambient air of differing temperatures and humidity levels during the year, resulting in drying and shrinkage of the materials over the service life of the unit.

c. Tremulants

Tremulants may be of the exhaust, pressure, inertial, or fan type. Actuation of the tremulant is controlled from the organ console, providing an electrical signal to actuate the tremulant mechanism.

Tremulants should provide an even pulse frequency within the wind supply under normal playing conditions. Speed of tremulation and amplitude of pulsation should be adjustable over a wide range to suit the taste of the customer. The tremulant mechanism itself should be placed to provide optimal noiseless operation.

d. Wind Conductors

Wind conductors should be designed with sufficient cross-sectional area to allow good wind flow without significant pressure drop or resonance waves under normal playing conditions.

Solid wind conductors may be made of soldered galvanized metal, plywood, solid wood, preformed PVC plastic containing UV inhibitors to retard deterioration, or any combination of the above. Each run may be provided with a flexible section to reduce transmission of vibration, as well as to accommodate normal expansion and contraction of materials, thereby maintaining an airtight system.

Flexible wind conductors may use rubberized fabric or leather sleeves, paper-foil hose, or rubber hose with reinforcing metal coils. The use of thin plastic hose ("dryer hose") should not be permitted. All flexible lines should be kept as short as possible to prevent unsteadiness and turbulence within the system and should be adequately supported to prevent movement.

Wood trunks should be fitted with framed hardwood collars, properly packed, and firmly screwed in place to be airtight. Metal conductors should be fitted with heavy metal and felt collars, and firmly screwed into place, airtight. For a professional looking installation, metal conductors should be painted a color harmonizing with the woodwork of the organ.

Wind conductor runs should be as direct as possible for good flow characteristics, allowing for design layout, and routed neatly so as to allow good access within the organ. All runs should be covered where necessary to prevent damage due to normal passage of personnel through the organ during installation and maintenance.

9. Expression

The expression shades should be built to sufficient thickness to assure adequate expression, normally 1½" high-density material. The edges of each shade should overlap the next and be surfaced with ⅛" felt to assure a tight fit. The shades should be activated by an electro-pneumatic action and provide 90 degrees of operation, unless artificially limited by design to focus tonal egress in a certain direction. Expression shades should operate with ease and be as noiseless as possible. Hardware used should include low-friction bearings.

Expression boxes should also be constructed of 1½" high-density material and all panels of the box painted inside and out with two coats of lacquer, black is recommended as it "disappears" in the chamber when viewed through pipework. A framework of hardwood or steel provides the structural elements of each expression box. Each expression box should be provided with a ceiling and floor which are unique to that expression box, to prevent transfer of vibrations from one organ division to another.

10. Installations

a. General

The pipe organ builder should accept full responsibility for the installation of the pipe organ as required per the specifications approved by the customer. It is therefore best practice for the pipe organ builder to provide a professional installation at the customer's site by employees of the pipe organ builder. An installation supervisor should be on site to direct the installation team.

All instruments should have been set up at the organ builder's facility, and all wind lines, connections, and wiring pre-tested to ensure the most rapid and accurate installation at the installation site.

All parts should be carefully packed by pipe organ technicians and suitably protected. All pipes should be wrapped and packed in pipe trays for shipping. Pipes of exceptional length which cannot be packed in pipe trays should be individually wrapped and protected.

b. On Site

On site installation by pipe organ personnel should be conducted during normal business hours. The customer is obligated to provide storage space for organ parts, to be used as needed. The organ site should be maintained in a serviceable condition for normal services, as required by contract.

11. Tonal Considerations

a. General

By their very nature, pipe organs are individual creations whose character is a direct result of the training and experience of the pipe organ builder and interaction with each client to understand their tonal concept.

The tonal design of the organ should be such that the organ will function properly for its intended artistic purpose. A stop list with four or more stops should include at least one temperament tuning stop, normally a 4' Principal rank.

b. Winding

Wind pressures should be reasonably stable when the keys are initially depressed, and as they remain depressed. There should be no adverse pressure drop in the course of normal playing when additional keys are depressed on the same manual, in order to ensure that the pipe organ may be tuned in a satisfactory manner.

c. Pipe Placement

Pipe placement on the windchest, or in an offset location, should be such that there is space for the pipes to speak properly and that there is enough room for tuning access. Walkboards should be provided for this purpose. Each pipe should be fitted so that it sits firmly in its toe hole and can be turned freely at all times, except for larger pipes held in place by a pin.

If the caps of stopped pipes are soldered or otherwise fixed in place during final tonal finishing, the tuning ears should be positioned as close as possible to 90 degrees in relation to the mouth after final regulation and tuning have been completed.

d. Scaling and Voicing

Design of the pipe scales should result in individual voices of distinctive tone color which should combine into controlled, natural ensembles.

Voicing should be done in a careful manner using accepted techniques to achieve the desired tonal concept agreed upon by the pipe organ builder and the customer. Flue pipes, in general, should be regulated for proper speech, neither unduly slow nor fast, to suit the attack characteristic of the windchest valve. Mixtures should have the breaks scaled and voiced for smooth transition; there should be no breaks greater than one octave. Reeds should have no slow, fast, or after speech. When resonators go from fractional to full length, or have multiple breaks in length or shape, the transition in speech and color should be as smooth as possible.

Each organ should be tonally finished by qualified personnel in its final location after mechanical installation is complete. Since each room is unique and each organ custom designed by the pipe organ builder for the client, several voicing sessions may be scheduled over a period of months for refinement, in order to achieve the best result possible given the room and the design.

The pipes of each individual stop should be meticulously regulated for uniformity of character, strength and attack. The stops, and then the divisions, should be balanced with each other in the context of the room acoustics, from the perspective of the average listener. The full ensemble should provide satisfying sound pressure levels within the listening area without any distortion, especially from electronically generated voices.

In church instruments, particular attention should be given to the role of the organ in the accompaniment of congregational singing, choral ensembles, and solo vocalists.
All aspects of tonal design and execution should result in a distinctive and musical sound which will invite the listener to emotionally and intellectually participate in the musical performance.

Section C—Services

1. General

Pipe organ tuners and service companies should meet all of the business and insurance requirements outlined in Section A.

Pipe organ tuners and service personnel are responsible for inspecting the organ during each visit to ensure continuing structural integrity of the instrument. Generally, the last technician that services the pipe organ could be held responsible for structural integrity of the exposed façade, and should check that exposed pipe work is securely and physically attached to support structures.

2. Pipe Organ Tuning

Pipe organ tuning should be performed according to a contract that spells out the details, which may include:

- scope of tuning and service work to be performed,
- authorized agent to approve tuning,
- tuning cost and terms,
- tuning warranty,
- and cancellation of contract.

Each tuning visit should also include a "mechanical systems" check of the entire organ, the purpose of which is to ascertain the current condition of the organ and notify the client of any potential repairs and maintenance that will require attention in the near future. The list of equipment and controls to check for proper maintenance and operation should include:

- all stops in the console,
- pistons,
- toe studs,
- spoons,
- expression shoes,
- couplers,
- manual keys and pedal keys,
- tremulants,
- chimes,
- blower lubrication.

The importance of accuracy and a thorough organ tuning cannot be overstated. A full, or complete tuning entails retuning the entire organ, at it's current pitch, given normal operating temperature. The pitch of every pipe should be verified and corrected as needed, including bass octaves, celeste ranks, mixtures, speaking exposed pipes, 16' and 32' pipes as well. A complete tuning is very time-consuming, and may require several days to tune a

large pipe organ.

It may also be quite expensive to completely tune an organ with much exposed pipework that requires ladders and/or scaffolding to access.

A touch-up tuning involves tuning of pipework that is noticeably out of tune. This type of tuning is quite subjective and open to interpretation by either the tuner, or the organist. Frequently the organist may provide a list of notes or stops that specifically require tuning. Generally the treble pipework and the unison pipework is checked, all reed stops tuned, and touch-up tuning of any other notes that stand out.

Pipe organs should be fully tuned at least once a year if the quality of the organ tone is not to be compromised.

A written report should be issued to the customer summarizing the type of tuning done and any mechanical problems encountered.

Usually the pipe organ is tuned to the general pitch of the organ within the normal operating temperature of the room. If the organ pitch is extremely sharp or flat, the organ may need to be re-pitched. This requires additional time, since every single pipe must be re-tuned without exception, and the reeds may require re-regulation as well. Re-pitching the organ is not usually undertaken as part of a full tuning, or touch-up tuning. Since additional time is required for re-pitching, and additional cost, usually the need for re-pitching the organ is documented, approved by the client, and specially scheduled to allow the appropriate block of time. Frequently the cost of re-pitching the organ is charged on a time and material basis.

3. Pipe Organ Maintenance

this section under development