

# ARROWHEAD PRODUCTS

## COMPANY OVERVIEW



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## **1.0 Company Overview**

Forming part of the Industrial Manufacturing Corporation, Arrowhead Products was founded in 1937 and is a global Leader in the Design, Manufacture and Test of State-of-the-Art Composite and Metallic Ducting Systems and Components for Aircraft and Aerospace Applications

With headquarters in Cleveland, Ohio, The Industrial Manufacturing Corporation has 30 plants located in the USA, China, and Europe employing 3500 highly trained personnel with a turnover in excess of \$400 Million.

### **1.1 Overview – Arrowhead Products**

With facilities located in the USA, Arrowhead Products employs approximately 560 staff with a turnover of \$77 Million in FY 08.

Our global reputation has resulted in an impressive customer base providing systems for both fixed wing and rotary wing aircraft across all market sectors for both commercial and military applications.

At Arrowhead Products we continue to invest in the development of new materials and product design, offering our customers the most efficient and cost effective systems possible providing continuous trouble free service.

An extensive in-house manufacturing capability has been established to support fabrication of both the nonmetallic and metallic aircraft low pressure and high pressure ducting.

### **1.2 Familiarity with Aerospace Industry Requirements**

Experience of integrating systems for aerospace is at the forefront of Arrowhead Products business plan and the content of this proposal is based on a clear understanding of the program, certification, performance, and engineering requirements generally defined in the information provided and those requirements resulting from referenced military, government, and non-government standards, specifications, and regulations.

## **2.0 Manufacturing Facilities & Capabilities**

The company's plant facilities cover 250,000 square feet, with approximately 200,000 square feet in fabrication and manufacturing facilities. The remaining area covers test laboratory areas, engineering and administrative office space. Manufacturing capability exists to fabricate all aspects of the system; Arrowhead can fabricate essentially all detail parts from raw material, perform final assembly, inspect, test and insulate the ducts in-house...

Arrowhead's facilities include a complete tool fabrication capability with machine shop equipment ranging from small tooling lathes and mills to a 60-inch vertical turret lathe, a complete jig and fixture assembly area that incorporates precision surface tables, ro-tabs, optical comparators, coordinate measuring machines, and a plaster, tool and die shop.

For the purpose of producing non-metallic rigid Composite ducting Arrowhead Products capabilities include autoclave and oven curing techniques and coupled with the manufacture of lightweight and ultra lightweight flexible tubing enables the company to produce and optimise in house all the parts required for a complete Low Pressure Air Distribution System.

### **3.0 Management Overview**

#### **3.1 Program Management**

To manage the integration of the design, development, and production activity within customer expectations and requirements, Arrowhead would assign a dedicated Program Manager. The Program Manager would provide a single point of contact for all program related activities. The Program Manager's team would consist of representatives from all required disciplines necessary for contractual performance. The Program Manager would have a direct line communication path to the company President and his staff to assure that the entire company's resources will be available.

#### **3.2 Engineering**

Product Design. Arrowhead Products' engineering department averages more than 30 years of aircraft air ducting, flexible joint, and insulation system design experience per person including the design and manufacture of composite ducting.

Departmental capabilities include the following:

- (a.) Ducting system and component design capability utilizing Autocad Mechanical Desktop V6 and CATIA V4.2 & V5 software.
- (b.) Ducting system analysis capability using customized finite-element analysis methodology for flexibility, deflections, loads and stress, modal and dynamic analysis.
- (c.) Flexible joint and component design utilizing Nastran finite element analysis.
- (d.) Ducting system and component pressure drop analysis.
- (e.) Material and process evaluation for non-metallic and metallic materials.
- (f.) Weight and balance analysis.
- (g.) Heat transfer analysis.
- (h.) Data import/export via ftp protocols, encryption capable.

Materials and Processes Laboratory. Arrowhead Products has a fully equipped metallurgical laboratory capable of all testing required to support its product line, including materials testing and monitoring of pertinent manufacturing process. This laboratory supports any failure analysis activities, metallurgical evaluations, and is involved in ongoing high and low cycle bellows fatigue testing.

### **3.2.1 Engineering Specialities**

Arrowhead Products specializes in solutions for ducting system applications. In providing these solutions, a core-competency has been developed, focused around the following specialties:

- (a.) System analysis utilizing the latest analysis tools. This enables an in-depth understanding of the behaviour of the system which allows for a more effective design approach.
- (b.) Bellows design capability. Design capabilities are based on years of testing correlated to empirically derived and modified design rules. The bellows element is a fundamental feature in any duct system.
- (c.) Flexible Joint design capability. Selection and design of gimbal joints, bellows ball joints, tie-rod type joints, compensators, and other types of joints is a specialty of Arrowhead Products.

There are no capabilities, requirements or specialties required for this program that are not in place at Arrowhead's Los Alamitos facility.

### **3.2.2 Design Approach**

The design approach with respect to trade studies and policies concerning new versus existing technology, methods and materials is to evaluate the benefits and costs of each new item, comparing against those existing, and weigh any benefit against risk to both the master program schedule and certification requirements. Arrowhead Products considers the master program schedule (MPS) to be "cast-in-stone" and any new item must offer minimal risk to qualification/certification and schedule to be considered.

### **3.2.3 Product Testing & Qualification**

Arrowhead Products has a 25,000 square foot, fully equipped test laboratory capable of conducting the following tests in support of product development, product qualification and certification:

- (a.) Static testing, pressure and temperature capable, instrumentation with load cells, strain gages, thermocouples and data acquisition systems.
- (b.) Low and high cycle fatigue testing.
- (c.) Vibration testing, sine, random, sine on random, gun-shot, and shock capabilities.

- (d.) Flow and pressure drop testing.
- (e.) Cryogenic to high temperature testing, loads and pressures.
- (f.) Helium leak testing.

For any test requirements beyond our in-house capabilities, Arrowhead has several local test laboratories readily available, including Wyle Laboratories (El Segundo, CA), Garwood Laboratories (Downey, CA) and National Technical Systems (NTS-Saugus, CA).

Support of the certification efforts has included both contracted and delegated conformity inspections, and support of contracted and customer Designated Engineering Representative witness of qualification test programs.

Arrowhead's participation in the certification process has consisted of preparation of hardware qualification test procedures and reports, and providing all necessary technical support to the delegated inspection and engineering representatives.

Arrowhead Products enjoys excellent relations with the local Manufacturing Inspection District Office of the Federal Aviation Administration, and a major audit performed within the last two years by that office was completed without findings requiring corrective action.

### **3.3 Manufacturing Engineering**

Manufacturing Engineering is responsible for developing and communicating the manufacturing plan through tool concepts and the manufacturing routing and process sheets. Their participation in the design process starts at the quote stage, identifying the most cost effective solution to the customer's application and continues through to approval of detail design drawings.

The engineering drawings are electronically prepared utilizing CATIA or Mechanical Desktop allowing Tool Design direct access to the electronic data sets, eliminating redundancy and minimizing the potential for translation errors. Tool design capability is available with vendors familiar with Arrowhead tool design conventions to provide emergency design capacity when required.

Tooling is fabricated both in-house and by several local shops familiar with Arrowhead tool design requirements, to provide complete flexibility of capacity and schedule. Tools are subjected to complete inspection to the tool design drawing or verified through first article tool try-out. Tool control is maintained through a computer database integrated with the MRP II business system. Bar-coded labelling of the tooling is being implemented to assure complete and accurate tool location and status, as well as integrate with periodic tool inspection schedules.

From the engineering drawing, process planners develop an indented bill of material and manufacturing routing that completely define the raw material, fabrication, tooling, processing, and assembly requirements from the detail level through the deliverable final assembly. The bill of material and routing is the backbone of the MRP II shop floor control system, generating purchasing requirements, and scheduling release of raw material, details, and assemblies in accordance with the customer needs. The system has been custom programmed to provide complete visibility of the product throughout the manufacturing cycle.

Processing of hardware is performed to engineering specifications and approved procedures specified by the manufacturing planning. Detailed description of the policies and procedures governing manufacturing requirements and process control are contained in sections eight and nine of the enclosed Quality Assurance Manual with reference to the implementing procedures.

Through extensive internal and external audits, this system of manufacturing, process control, and quality assurance has been proven to be satisfactory for man-rated space programs, NADCAP certification is held for Heat Treating, Welding, Non-Destructive testing and Chemical Processing.

Engineering change and configuration control policy is defined in Quality Assurance Manual section five, which references the implementing procedures SOP 2-102-1 and QCI-05-040. The configuration management procedures assure controlled release of approved drawings and specifications, customer approval of documentation when required, configuration status of hardware in work and stock, disposition of hardware affected by changes and implementation of engineering changes.

Arrowhead Products policies for first article inspection are defined in Quality Assurance Manual section ten, which references the implementing procedure QCI-10-004. All procedures can be provided upon request.

Arrowhead will fully support inspections and tests at customer premises, and provide complete support to analyze and correct failures or quality problems after installation in production aircraft.

### **3.4 Quality Procedures**

#### **3.4.1 Quality Manuals/Quality System**

Arrowhead Product's Quality Assurance Manual establishes the company quality policy. The Quality Assurance Department has the responsibility and authority for enforcement of the policy. Arrowhead Products is Certified to ISO9001:2000 and EN/JISQ AS9100:2004 by DNV valid thru January 13, 2010.

The detailed procedures necessary for implementation of the policy, and for assuring product quality at all phases of work from design, development and qualification testing, material procurement through receiving inspection, processing, fabrication, assembly, acceptance testing and shipping, are contained in sub-tier specifications to the manual called Quality Control Instructions and Quality Supplements.

The Quality Control Instructions are referenced in the appropriate section of the manual.

#### **3.4.2 Manufacturing Quality**

From the released engineering documentation, Manufacturing Engineering develops tooling, manufacturing planning and a bill of materials.

Quality Assurance verifies planning for the adequacy and sequencing of inspection operations, special measurement and testing requirements, and verification of customer requirements.

Quality Engineering initiates specialized quality planning in the form of Quality Supplements to document special techniques, processes, tooling and equipment necessary to assure quality.

Final inspection folders are prepared which include the customer Purchase Order, first article inspection records, and mandatory inspection characteristics.

Inspection and testing is performed in accordance with Drawing or Specification requirements.

### **3.4.3 Test Quality**

Arrowhead Product's Quality Assurance participates in the design and development process in accordance with SOP 2-102-1.

Preliminary quality planning begins at this phase with input on producibility, product integrity and inspectability.

Acceptance Test Procedures, Process Specifications and Qualification Test Procedures generally require Quality Assurance approval prior to production release.

Quality Assurance personnel monitor qualification testing and assure conformance to customer and Arrowhead requirements.

Quality Assurance verifies acceptable completion of product acceptance tests prior to shipment of hardware.

### **3.4.4 Quality Control of Sub-Contractors**

Arrowhead Products Quality Assurance maintains a list of approved suppliers and monitors their performance on an ongoing basis.

When warranted by poor quality performance, supplier corrective is requested and verified for effectiveness.

New suppliers are evaluated for the criticality of their supplies, and a site survey is performed if warranted. Otherwise new suppliers are put on a limited approval status and their performance closely monitored through the initial shipments.

Customer approved sources are used for any special hardware requiring the use of special processes.

Where the customer has not specified the use of their approved sources, NADCAP special process certification is recognized.

### **3.4.5 Purchased Material Quality**

From the bill of material, Production Control issues requisitions for procurement of raw material and components and routes them to Quality Assurance.

Quality Assurance verifies the accuracy of the requisition and identifies the quality requirements for the purchase order, including certifications, test data, source inspection, control of age sensitive items, and use of customer approved sources.

After Purchasing has written the purchase order, it is returned to Quality Assurance for approval and verification of placement with an approved source.

All materials procured for use in contract deliverable products are subjected to receiving inspection and/or test to verify conformance to specification requirements.

Accepted material is identified and placed in controlled stores.

Traceability of the accepted material is maintained after release from stores through the build cycle to shipment.

### **3.4.6 Continuous Improvement**

Arrowhead Products began implementing Six Sigma and Lean methodology in 2002. To date a number of employees have received training in Quality Tools such as root cause analysis and waste elimination to enable them to focus on activities that will reduce scrap, increase productivity, cycle time reduction, reduce costs, automating data collection. Arrowhead Products currently has two certified Six Sigma Blacks.

Root cause analysis is applied during our problem solving activities for discrepant materials to prevent recurring defects. Lean Manufacturing activities improve quality and delivery while reducing costs.

### **3.5 Customer & Product Support**

The nature of the product designed and manufactured by Arrowhead Products has not justified establishment of a separate product support department, and support is provided directly by the engineering department.

Typically, most support issues and necessary modifications to a system are resolved during the design and development phase of a program. The company recognizes that engineering capability is a core competency, and critical to customer satisfaction. As such, the stability and longevity of the engineering department is highly valued and Arrowhead has established an excellent record in this regard.

As a result, the familiarity with customer and system requirements established during the design and development phase of a project is maintained throughout the life of the program.

### **3.6 Spares Policy & AOG Support**

Arrowhead is flexible to the needs of the customer in support of spares requirements but generally parts are procured and stocked by the customer. We do stock spares when requested by the customer.

An AOG hotline and internal processing procedure is in place. Arrowhead hold PMA on numerous part numbers for a variety of aircraft, but are flexible to the needs and desires of the customer on this issue.

### 3.7 Repair & Overhaul Service

An FAA certified Manufacturers Maintenance Facility is in place to support repair of in-service units for which we hold PMA, and we perform subcontract work to repair stations as necessary to support airline customer needs. FAA Repair Station Number OHTR662X

### 3.8 Technical Data & Technical Publications

In specific cases, Component Maintenance Manuals have been prepared, when requested by the customer.

They are prepared by Engineering in coordination with the customer, and would typically be updated after release only at the request of a customer, due to their limited need and use.

### 4.0 Previous Design & Program Experience

Arrowhead Products' ducting system design, manufacture and test experience is extensive.

The following table presents a listing of commercial, regional, and military programs, including where Arrowhead Products have been responsible for a mixture of HP & LP low pressure air distribution, engine and APU bleed air, environmental control, thermal anti-ice and pylon ducting and compressed air systems.

Customer	Programmes
Boeing	717, 727, 737, 747, 757, 767, 777
Boeing / MDC	DC-9, DC-10, MD-80, MD-90, MD-11
Bombardier Canadair	CL600/601/604, RJ200
Bombardier deHavilland	Dash 8 Q-100, Q-200, Q-300, Q-400
Embraer	ERJ-145, ERJ-170, ERJ-190
Lockheed	L-1011
Gulfstream	G-III, G-IV, G-V
Boeing	C-17, V-22, X32A (JSF), KC-135, E-3, A-4, F-4, F-15, KC-10, B-1
Lockheed Martin	X-35A (JSF), F-22, F-16, F-117, F-111, C-130, C-5, C-141, P-3, S-3, Trident
Northrop Grumman	F/A-18, A-6, A-7, A-10, E-2C, F-14, B-2, Jstars

For each of the above programmes Arrowhead Products have supported the following requirements to some degree in conjunction with the aircraft manufacturer and systems integrator:-

- Project definition
- Air distribution system design
- Test rig management including design and manufacture
- System test
- Qualification
- Test reports
- Project management
- Management of Sub-contractors