INTRODUCTION TO AMERICAN MAGNETICS, INC.

American Magnetics, Inc. (AMI) was founded in 1968 as a spin-off from the Fusion Energy Division of the Oak Ridge National Laboratory. It was founded with the objective of designing and manufacturing superconducting magnets, scientific instrumentation and cryogenic accessories. Since then, AMI has become a leading supplier of superconducting magnet systems and cryogenic liquid level instrumentation. AMI has established a reputation for excellence in superconducting magnetic technology, cryogenics and instrumentation by supplying hundreds of magnet systems to leading universities, government laboratories, and private industry throughout the world.

AMI remains a private company and currently qualifies as a small business as defined by US Federal and State legislation with under 500 employees.

CAPABILITIES

All product design and most fabrication and testing activities are performed at AMI. In-house machining, welding, and winding machines are available. State of the art commercial and proprietary computer programs are used for design activities. AMI capabilities include electronic and mechanical engineering design, solid modeling computer-aided design, product assembly and testing, cryogenic testing, magnet analysis, magnetic field intensity and homogeneity measurements.

All electronics engineering and design functions are performed in-house. State-of-the-art printed circuit board (PCB) layout and routing programs are used to speed the design process and generate the most efficient designs possible. AMI's extensive experience with cryogenics has allowed it to provide unique designs that are robust and accurate even under such harsh conditions.

Through its continuing activity in custom design for a wide variety of applications, AMI has maintained its position at the leading edge of superconducting magnet and cryogenics technology. AMI has a proven track record of delivering innovative high quality products and services. Some of AMI's achievements include:

- Leading US manufacture of superconducting research magnet systems
- One of the earliest manufacturers of MRI magnet systems
- Pioneer in cryogenic liquid level measurement
- World’s leading supplier of liquid helium level instruments/sensors
- Leading US manufacturer of industry standard helium vapor cooled current leads
- Reputation for quality, value and integrity

SUPERCONDUCTING MAGNET DESIGN AND MANUFACTURING

Quality and dependability in magnet design and manufacturing summarizes AMI's reputation among users of custom magnet systems throughout the world. The successful design and delivery of multiple whole body MRI systems up to 1 Tesla in the 1980s gave AMI significant experience

with large systems. These projects helped increase AMI's understanding of issues that set MRI, NMR and ICR applications apart from other superconducting magnet systems.

Recent developments in superconducting magnet design include an ever increasing number of Cryogen Free magnets which are operated in a vacuum space. These systems conductively cool the magnet using a mechanical refrigeration system (cryocooler) requiring no cryogenic liquids. AMI has provided many such magnets and has an outstanding record for quality and reliability in this area.

While the majority of AMI magnet systems have been custom designed, AMI welcomes the opportunity for establishing OEM supply relationships. The following is an indicative sampling of applications for which AMI has supplied custom designed and fabricated magnets and/or systems:

- Cryogen Free Magnet Systems
- STM Magnet Systems
- 2 and 3-Axis Magnet Systems
- Magnetic Resonance Imaging Systems
- Particle Beam Magnets
- Dipole and Quadrupole Racetracks
- Ion Cyclotron Magnets
- Nuclear Physics Experiment Systems
- Plasma Physics Experimental Systems
- Levitation Systems
- Materials Analysis Systems
- Energy Storage Magnets
- Solid State NMR Systems
- Magneto Hydro Dynamic Systems
- Gyrotron Magnet Systems
- Bubble Chamber Magnets
- Neutron Diffraction Systems
- X-Ray Diffraction Systems
- Electron Spin Resonance Systems
- Adiabatic Demagnetization Systems
- High Gradient and Gradient Product Systems
- Multi-axis Optical systems
- Cast Field Imaging Systems
- Mossbauer Magnets
- Systems for Solid State Physics

LIQUID HELIUM LEVEL INSTRUMENTATION MANUFACTURING

AMI has been manufacturing cryogenic liquid level instrumentation for over 35 years. During this time, many of the unique problems associated with these types of level measurement have been encountered and overcome. AMI offers a wide range of cryogenic liquid level instrumentation as part of the standard product line in addition to the custom products produced for various OEM customers. The Model 110A is a proven, reliable, and inexpensive analog instrument for displaying LHe levels. The 13X series (Models 135, 135-2K, 136, and 137) are microcontroller based sample and hold instruments with digital readouts. The 13X series are all capable of interfacing to computers via RS-232 or IEEE-488 and can be custom configured to operate with National Instruments LabView™ Virtual Instrumentation software via AMI developed and furnished drivers. All of these helium instruments are designed to work with standard or custom designed superconducting sensors to meet each individual application.

CRYOGENIC LABORATORY AND INDUSTRIAL LEVEL INSTRUMENTATION

Capacitance-based sensors are used by AMI to measure a wide range of liquids such as Oxygen, CO_2, Hydrogen, Argon, etc. The Models 185, 186, 286, and 187 are also microcontroller-based devices that display a digital readout and provide analog outputs, remote computer control and many advanced features. AMI offers standard and custom cryogenic liquid auto-filling systems for a wide range of applications.

The growing line of industrial liquid level instruments includes the Model 175 transmitter with the HART™ industrial process control protocol. These units have been proven useful in general industry, aerospace applications, and laboratory environments.

VAPOR COOLED CURRENT LEAD MANUFACTURING

AMI has manufactured thousands of pairs of standard and custom vapor cooled current leads and has set the industry standard for quality, reliability, and value. AMI's former President, Dr. Kenneth R. Efferson, invented the AMI type vapor cooled current lead in 1967 while working at the Oak Ridge National Laboratory. This basic lead design has been perfected and expanded to become the industry standard in performance and reliability for such devices. Current leads rated up to 75,000 amperes have been produced. Custom configurations have included integrated lead clusters, AC operated leads, nitrogen gas cooled leads, retractable/breakaway leads, automatic lead retraction systems, high voltage isolation systems, voltage taps, etc. In addition to current leads, AMI also manufactures superconducting bus bar extensions using a laminate Cu/Nb_3Sn/Cu arrangement. AMI has produced these bus bars up to an 80,000 ampere rating. Various available configurations include bent or curved shapes, gold plated contact areas, etc. These bus bar extensions are specifically designed to operate with AMI's vapor cooled leads to provide the most robust design possible while minimizing helium consumption. Just a few of AMI's vapor cooled current lead projects include:

Customer	Description
• Samsung Institute of Technology	50 KA KSTAR leads
• Applied Superconductivity Center - U. of Wisc.	75 KA SMES leads
• Westinghouse STC/ NHMFL	50 KA SMES leads, 80 KA bus bars
• Samsung Institute of Technology	6 KA KSTAR Hybrid HTS leads
• Lawrence Berkeley National Lab	120A LHC Corrector Coil Leads – 40 pair
	600A LHC Corrector Coil Leads – 56 pair
• Fermi National Laboratory	5 KA Accelerator leads - 74 pair
	2 KA Quadropole leads - 18 pair
• Martin Marietta Astronautics Group	1 KA SSC Corrector Element lead

SPECIALTY CONTRACT MANUFACTURING SERVICES

On a selective basis AMI does offer complete turnkey manufacturing services to companies looking for a high quality outsourcing option. AMI specializes in low to medium volume items requiring a mixture of process expertise. Services can include engineering design, material procurement, process definition, PCB and electro-mechanical assembly, final test and field repair services.

PRODUCT DESIGN/TESTING

AMI has experience in both designing and testing to worldwide Electro-Magnetic Compatibility (EMC) standards. Power supplies have been designed and successfully tested in systems to Class B radiated and conducted EMC emission levels. Products have been designed and successfully tested to meet the various IEC 1000-4-X specifications for EMC immunity. Most current AMI products meet the European Community CE-marking requirements. Product design verification testing includes the use of an environmental test chamber to stress instruments under a wide range of conditions.

EMBEDDED SOFTWARE DEVELOPMENT

AMI has extensive experience in the area of embedded software development using the C/C++ programming language. AMI designs and manufactures embedded instrumentation utilizing the MC68HC05, MC68HC11 and 80x86 microprocessor architectures. The software development experience within AMI includes cross-compilation and emulation for these microprocessors, as well as PC-hosted compilation and remote debugging kernels targeted for 80x86 processors that are monitored through an RS-232 interface.

AMI also has experience with *object-oriented development techniques* for both embedded applications and higher-level Graphical User Interface (GUI) development. AMI has knowledge and experience with the ANSI C, C++, Objective C, and Object Pascal programming languages. Object-oriented techniques reduce the design complexity and recurring maintenance requirements as compared to purely procedural-based techniques.

UNIX SYSTEM ADMINISTRATION AND SOFTWARE DEVELOPMENT

AMI has experience in Unix system administration and software development. This experience includes configuration and maintenance of several System V and BSD versions of Unix. Unix system administration experience includes managing FTP, Telnet, SMTP email, NFS, X-Windows, and HTTP services. Past projects of current AMI employees have included comprehensive computational and GUI code development in a Unix environment for a real-time application.

In addition to Unix GUI development, AMI is experienced in developing applications in a Microsoft Windows™ environment.

CAD/CAM CAPABILITIES

The AMI engineering and manufacturing departments are organized to design and manufacture utilizing CAD/CAM processes to speed development and ensure accuracy. AMI also makes use of the latest in solid modeling programs, which include the use of finite element analysis (FEA). A local area network (LAN) allows various departments to access up-to-date data and provides for the level of document control the AMI quality program requires. Mechanical drawings are generated with AutoCAD 2-D and Solid Works 3-D. Schematic capture is performed with Protel or OrCAD. PCB layouts are performed with Protel.

Several manufacturing and test processes are computer controlled. Dedicated computers are utilized to control mechanical and environmental manufacturing processes. Electrical test processes are controlled by National Instruments LabView virtual instrumentation software or custom software utilizing data acquisition hardware.

QUALITY ASSURANCE

AMI has a thorough Quality Assurance Program to ensure consistent product quality every time a product is designed, manufactured and shipped to a customer. The Program is implemented in every step of the manufacturing process, from location of raw materials to customer service after product delivery. The framework of the program includes and addresses most major components of the ISO9002 standards.

The engineering and production staffs are experienced in regulatory agency approval. AMI is currently manufacturing electronic products certified to comply with Underwriters Laboratories (UL), Canadian-UL (cUL), Canadian Standards Association (CSA), Factory Mutual (FM), British Standards Institute, and International Electrotechnical Commission (IEC) standards.

FACILITIES

AMI's corporate offices and manufacturing facilities are housed in a modern company owned 16,700 ft^2 building located in Oak Ridge, Tennessee. A new 7000 ft^2 building was added in 1999 to accommodate business growth.

AMI's products are sold in North America through the main office in Oak Ridge and regional sales offices. Sales agents are used in many other countries to provide our global customer base with easy access to sales and service of all AMI products. A current list of agents can be found on the company web site.

CUSTOMERS

Many repeat customers have emerged over the years. Customers include all major US government laboratories such as Argonne National Lab, Fermi National Accelerator Lab, Oak Ridge National Lab, Los Alamos National Lab, Lawrence Berkeley National Lab, NIST, etc. Other customers include NASA, AT&T Bell Laboratories, Babcock & Wilcox, CERN, General Dynamics, IBM, Lockheed-Martin, Ford, Westinghouse, MIT, Cal Tech, Cornell University, Florida State University, Harvard University, and The University of California, just to name a few. Excellent working relationships have developed in both the scientific and industrial community through AMI's cooperative efforts to help customers solve difficult problems.

Magnets and magnet systems manufactured by AMI are designed and fabricated to the demanding standards required for experimental research and medical applications. Cryogenic instrumentation including helium level monitors, liquid level controllers, sensors, magnet system control electronics, as well as vapor cooled current leads and other accessories are routinely manufactured and maintained in inventory for fast delivery.

QUALIFICATIONS OF KEY PERSONNEL

The AMI management team has a genuine interest in providing the customer with the best possible system at an affordable price. The team includes Engineers and Manufacturing Specialists from a wide variety of disciplines with a wealth of experience. This team of personnel with outstanding qualifications is the primary reason AMI can bring successful completion and timely delivery to the most difficult and demanding projects.