The Economic Impact of the Medical Imaging Technology Industry in Pennsylvania

Prepared for

Medical Imaging and Technology Alliance

By

John Dunham & Associates

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Executive Summary

The medical imaging technology industry is a significant contributor to Pennsylvania's economy. Pennsylvania is home to 45 major medical imaging technology companies.[1] The activities performed at these sites, along with the use of medical imaging equipment and technology at over 1,421 hospitals, urgent care facilities and other major medical clinics and offices located throughout the state, provide over 12,261 full-time equivalent jobs. In addition, suppliers and other companies directly related to the medical imaging industry generate an additional 23,967 full time equivalent positions.

Summary of Economic Impact of the Medical Imaging Sector in Pennsylvania

Direct Economic Impact	Jobs	Wages	Output
Device Manufacturing	4,183	$555,541,800	$4,517,715,900
Hospitals and Medical Facilities	8,078	$644,067,200	$1,254,152,100
Total Direct Impact	12,261	$1,199,609,000	$5,771,868,000
Supplier Economic Impact	10,676	$915,849,900	$2,286,560,900
Induced Economic Impact	13,291	$662,722,400	$1,928,081,000
Total Economic Impact	36,228	$2,778,181,300	$9,986,509,900

The Industry Generates High Paying Jobs. All told, the medical imaging sector provides an estimated 36,228 jobs in Pennsylvania, from hospital technicians to assembly workers, and from metal and glass suppliers, to accountants, retail workers and administrators. Pennsylvania workers received approximately $2.78 billion in total wages and benefits due to industry operations in the state.

The jobs directly created by the industry have average wages and benefits of over $97,800 while those supplying goods and services have average wages of roughly $85,800 per year.

Medical Imaging Technology Is Important to Pennsylvania. The medical imaging sector generates about $9.99 billion in total economic activity in the state both through its direct production and through its linkages.

This is larger than the direct output of all of the hotels and motels in the state, and in total equates to about 1.3 percent of Pennsylvania's total state product.

In addition, the people and firms involved in the industry provide about $988.63 million in revenues to the federal, state and local governments, of which about $288.11 million go to state and local governments in Pennsylvania. This is equal to nearly $8,000 per employee.

These Figures Are Based on Standard Models and Analysis. The analysis used data provided by Infogroup, industry sources and the state government, and utilizes a commonly used economic modeling framework known as IMPLAN, which is based on the national income accounts generated by the US Department of Commerce.

[1] In this analysis the term companies represents individual facilities.

Introduction

The Medical Imaging and Technology Alliance (MITA), a division of the National Electrical Manufacturers Association (NEMA), is the leading organization and collective voice of medical imaging equipment, radiation therapy and radiopharmaceutical manufacturers, innovators and product developers. It represents companies whose sales comprise more than 90 percent of the global market for medical imaging technology including those that produce:

- Medical X-ray equipment
- Computed tomography (CT) scanners
- Ultrasound
- Nuclear imaging
- Radiopharmaceuticals
- Radiation therapy equipment
- Magnetic resonance imaging (MRI)
- Imaging information systems

Medical imaging technology is manufactured by hundreds of companies with operations located throughout the United States, and is utilized in tens of thousands of hospitals, clinics, urgent care centers and physicians' and dentists' offices. One state where the manufacturing of high technology equipment like medical imaging equipment is particularly important is Pennsylvania. This study examines the role of medical imaging equipment in the Pennsylvania economy and quantifies its "economic footprint."

Findings

Pennsylvania is home to 45 medical imaging technology facilities. The activities performed at these sites, along with the use of medical imaging equipment and technology at over 1,421 hospitals, urgent care facilities and other major medical clinics and offices located throughout the state, provide over 12,261 full-time equivalent jobs in Pennsylvania. In addition, suppliers and other companies directly related to the medical imaging industry generate an additional 23,967 full time equivalent positions.

Table 1
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This includes jobs such as hospital technicians, assembly workers, accountants, administrators and retail workers. All told, the medical imaging sector supports roughly 36,228 jobs in

Pennsylvania, paying workers an estimated $2.78 billion in wages and benefits. Table 1 outlines the overall economic impact of the medical imaging sector in Pennsylvania as of 2019.

The medical imaging sector generates about $5.77 billion in total economic activity in the state both through its direct production and through its linkages. This is more than the direct output of all motels and hotels in the state, and in total equates to about 1.3 percent of Pennsylvania' total gross state product.[2]

In addition, the people and firms involved in the industry provide about $988.63 million in revenues to the federal, state and local governments, of which about $288.11 million go to state and local governments in Pennsylvania. This is equal to nearly $8,000 per employee.

Direct Economic Impact

The direct impacts of the industry consist of the manufacturing of medical imaging technology and equipment and other corporate activities related to that process.[3] Based on data from NEMA and Infogroup, there are 45 operations involved in these activities in the state of Pennsylvania. They directly employ about 4,183 FTE.[4] Figure 1 on the following page shows the location of the medical manufacturing facilities throughout Pennsylvania.[5]

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2 Based on 2018 GSP of $576.567 billion. Bureau of Economic Analysis. Gross Domestic Product by State, Third Quarter 2018. Table 3 – Current-Dollar Gross Domestic Product (GDP) by State and Region, 2017:Q1-2018:Q3. Published February 26, 2019. Available: https://www.bea.gov/system/files/2019-02/qgdpstate0219.pdf

3 This includes medical X-ray equipment, computed tomography (CT) scanners, ultrasound equipment, nuclear imaging equipment, radiation therapy equipment, magnetic resonance imaging (MRI) and certain imaging information systems.

4 Throughout this report, jobs and people are used to describe full-time equivalent jobs.

5 Throughout this study, the term "firms" actually refers to physical locations. One company may have facilities in dozens of locations.

Figure 1
Medical Imaging Device Industry Facilities

In addition, there are approximately 1,421 hospitals and similar facilities in the state. Based on the share of hospital output (a general indicator of overall revenues) attributable to medical imaging, another 8,078 FTE jobs in medical facilities are dependent on the use of this equipment.[6] Figure 2 maps the locations of hospitals and medical facilities used in the study.

Figure 2
Hospitals and Medical Facilities Included in the Analysis

[6] These percentages come from the state IMPLAN tables, and are discussed further in the methodology section of the report.

Supplier Economic Impact

Other firms are related to the imaging technology industry as suppliers. These firms produce and sell a broad range of items including machinery, tools, parts, molds, forms, and other materials needed to produce medical imaging equipment, or to use it in a hospital setting. In addition, supplier firms provide a broad range of services, including personnel services, financial services, advertising services, consulting services and transportation services. Finally, a number of people are employed in government enterprises responsible for the regulation of the industry. All told, we estimate that the industry is responsible for about 10,676 supplier jobs in Pennsylvania alone. These firms generate an estimated $2.29 billion in economic activity.

Induced Economic Impact

This economic analysis takes account of additional linkages as well. The spending by employees of the industry, and those of supplier firms whose jobs are directly dependent on the industry, are typically included in economic impact calculations. This spending on everything from housing, to food, to educational services and medical care makes up what is traditionally called the "induced impact" or multiplier effect of the medical imaging equipment industry. In other words, this spending, and the jobs it creates are induced by the manufacturing and distribution of medical imaging technology and to the use of this equipment in Pennsylvania medical facilities. The induced impact of the industry generates over 13,291 jobs and approximately $1.93 billion billion in economic impact.

Fiscal Impact

Another facet of the contribution of the industry is its impact on the public finances of the country. In the case of the state's medical imaging technology industry, the traditional direct taxes paid by the firms and their employees provide an estimated $988.63 million in revenues to the federal, state and local governments. Of this revenue, about $288.11 million accrues to state and local governments in Pennsylvania. Table 2 outlines the fiscal impact to the state and its localities.

Table 2
Summary of State and Local Tax Revenues

	Amount	Percent of Total
Taxes on Profits and Dividends	$33,678,200	11.7%
Licenses and Fees	$11,908,500	4.1%
Property Taxes	$78,954,900	27.4%
Severance Taxes	$0	0.0%
Social Insurance Taxes	$1,411,000	0.5%
Sales Taxes	$86,640,300	30.1%
Other Taxes	$75,514,900	26.2%
Total State and Local Taxes	$288,107,800	100.0%

Impact of Pennsylvania Medical Imaging Industry across the U.S.

About half of the U.S.-produced supplies and services used in medical technology equipment manufactured or used in Pennsylvania comes from in-state sources. The rest comes from other states. Because of this, and because workers located in Pennsylvania purchase goods or services from other states, about 52.4 percent of the induced impact attributable to the medical imaging technology industry in the state are generated in other parts of the country. About 7,520 jobs in other parts of the United States are dedicated to supplying goods and services to the medical imaging equipment manufacturers in Pennsylvania and to the hospitals and technicians involved in imaging in the state. An additional 11,260 induced jobs are created elsewhere in the U.S. Table 3 below outlines the supplier and induced impacts of the production and use of medical imaging technology in Pennsylvania compared to the rest of the country.

The national importance of Pennsylvania' medical imaging technology industry is further detailed in Table 4, which outlines the percentage of inputs attributable to in-state and out of state producers. As the table shows, for example, roughly 90.7 percent of the agricultural inputs, 80.6 percent of the manufactured inputs, and about 36.2 of the finance related inputs come from outside the Pennsylvania economy.[7]

7 Note that these are aggregated sectors. Products like cotton or wood are included in agriculture, and manufactured products can include anything from steel and glass to integrated circuitry.

Table 3
National Economic Impact of the Pennsylvania Based Medical Imaging Sector

	Jobs	Wages	Output
Total Direct Impact	**12,261**	**$1,199,609,000**	**$5,771,868,000**
Device Manufacturing	4,183	$555,541,800	$4,517,715,900
Hospitals and Medical Facilities	8,078	$644,067,200	$1,254,152,100
National Supplier Economic Impact	**18,193**	**$1,445,615,300**	**$4,409,358,100**
Pennsylvania	10,676	$915,849,900	$2,286,560,900
Other States	7,517	$529,765,400	$2,122,797,200
National Induced Economic Impact	**24,547**	**$1,275,092,300**	**$4,050,865,000**
Pennsylvania	13,291	$662,722,400	$1,928,081,000
Other States	11,256	$612,369,900	$2,122,784,000
Total Economic Impact	**55,001**	**$3,920,316,600**	**$14,232,091,100**

While Pennsylvania producers and medical imaging technology users rely on suppliers from throughout the economy, the same can be said of the industry itself, which provides goods and services to hospitals and patients located throughout the Unites States.

Table 4
Supplier Impact of the Pennsylvania Based Medical Imaging Sector

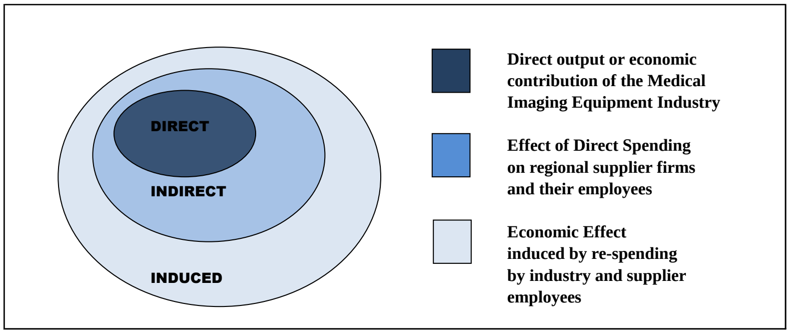
	Jobs			Output		
Supplier Industry Sector	United States	Pennsylvania	PA Percent	United States	Pennsylvania	PA Percent
Agriculture	268	25	9.3%	30,972,800	$1,851,100	6.0%
Mining	141	17	12.1%	44,433,900	$6,465,100	14.5%
Construction	249	154	61.8%	39,283,100	$24,953,800	63.5%
Manufacturing	2,427	471	19.4%	1,365,752,200	$222,837,500	16.3%
Transport & Comm	1,610	909	56.5%	525,209,300	$327,131,200	62.3%
Wholesale	1,777	1,273	71.6%	437,830,600	$316,066,800	72.2%
Retail	158	87	55.2%	13,416,700	$6,655,900	49.6%
FIRE	1,866	1,191	63.8%	502,301,500	$318,638,600	63.4%
Travel & Entertainment	925	543	58.7%	62,460,800	$31,741,800	50.8%
Business & Personal Services	8,554	5,882	68.8%	1,339,200,600	$1,008,358,000	75.3%
Government	218	124	56.8%	48,496,600	$21,861,100	45.1%
Total	18,193	10,676	58.7%	$4,409,358,100	$2,286,560,900	51.9%

Methodology

The study begins with an accounting of the direct employment involved in the manufacture of medical imaging equipment and technology in Pennsylvania. The data come from Infogroup, National Electrical Manufacturers Association, and primary research by John Dunham & Associates.

It is sometimes mistakenly thought that initial spending accounts for all of the impact of an economic activity or a product. For example, at first glance it may appear that consumer expenditures for a product are the sum total of the impact on the local economy. However, one economic activity always leads to a ripple effect whereby other sectors and industries benefit from this initial spending. This inter-industry effect of an economic activity can be assessed using multipliers from regional input-output modeling.

Figure 3
Outline of Economic Impact Structure



The economic activities of events are linked to other industries in the state and national economies. The activities required to manufacture medical imaging technology generate the direct effects on the economy. Regional (or indirect) impacts occur when these activities require purchases of goods and services such as machinery or electricity from local or regional suppliers. Additional induced impacts occur when workers involved in direct and indirect activities spend their wages. The ratio between induced jobs and direct jobs is termed the multiplier. Figure 3 outlines how these linkages are related.

This method of analysis allows the impact of local production activities to be quantified in terms of final demand, earnings, and employment in the states and the nation as a whole.

Once the direct impact of the industry has been calculated, the input-output methodology discussed below is used to calculate the contribution of the supplier sector and of the re-spending in the economy by employees in the industry and its suppliers. This induced impact is the most controversial part of economic impact studies and is often quite inflated. In the case of this model, only the most conservative estimate of the induced impact has been used.

This analysis is based on data provided by Infogroup, NEMA and the state government. The analysis utilizes the IMPLAN Model in order to quantify the economic impact of the industry on the economy of Pennsylvania and of the United States.[8] The model adopts an accounting framework through which the relationships between different inputs and outputs across industries and sectors are computed. This model can show the impact of a given economic decision – such as a factory opening or operating a sports facility – on a pre-defined, geographic region. It is based on the national income accounts generated by the US Department of Commerce, Bureau of Economic Analysis (BEA).[9]

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[8] The model uses 2016 input/output accounts.

[9] RIMS II is a product developed by the U.S. Department of Commerce, Bureau of Economic Analysis as a policy and economic decision analysis tool. IMPLAN was originally developed by the US Forest Service, the Federal Emergency Management Agency and the Bureau of Land Management. It was converted to a user-friendly model by the Minnesota IMPLAN Group in 1993.

Every economic impact analysis begins with a description of the industry being examined. In the case of this model, the medical imaging technology industry is defined as the manufacturing and production related activities for a wide range of products.[10] The company operations extracted from the Infogroup data were verified by JDA staff, and where direct employment numbers were not available the missing data were replaced by the median figure from the other company operations. These data were then mapped to their physical locations in the state.

In the case of technology and equipment usage, data on hospitals and ambulatory care centers and clinics was gathered from Infogroup. The data was combined and cleaned to remove duplicates, non-operational facilities, and facilities that would not generally considered to be hospitals, urgent care centers or large medical clinics. Once the cleaning process was finished, a total of about 490 facilities remained. Where employment data were available from Infogroup, they were tied to each facility. For others, they were estimated based either on the average number of employees per dollar of revenue, or using the average for similar facilities. The final list was divided into hospitals, urgent care centers and other medical facilities. Since the entire employment base of a hospital or medical facility is not totally dependent on the use of imaging technology, only those jobs directly tied to the operation of the equipment were used for this analysis. This is a very small subset of overall employment and was estimated based on the percentage of cost for imaging equipment per dollar of hospital or clinic billing. In this case, the cost of imaging equipment represents just 2.5 percent of total hospital billing and only 2.4 percent for clinics.[11] These percentages were applied to the actual jobs in each facility to calculate the direct medical imaging jobs. Again, all of the facilities were mapped to their physical locations within the state.

The IMPLAN model is designed to run based on the input of specific direct economic factors. It uses a detailed methodology (see IMPLAN Methodology section) to generate estimates of the other direct impacts, tax impacts and supplier and induced impacts based on these entries. In the case of this model, direct employment is a base starting point for the analysis. Direct employment (as calculated above) represents data as of February 2019 from Infogroup. This data is gathered at the facility level; therefore, a company with a manufacturing plant, warehouse and sales office would have three facilities, each with separate employment counts. Since the Infogroup data are adjusted on a continual basis, staff from John Dunham & Associates scanned the data for discrepancies.

Once the initial direct employment figures have been established, they are entered into a model linked to the IMPLAN database. The IMPLAN data are used to generate estimates of direct wages and output. Wages are derived from data from the U.S. Department of Labor's ES-202 reports that are used by IMPLAN to provide annual average wage and salary establishment counts, employment counts and payrolls at the county level. Since this data only covers payroll employees, it is modified to add information on independent workers, agricultural employees, construction workers, and certain government employees. Data are then adjusted to account for counties where non-disclosure rules apply. Wage data include not only cash wages, but health and life insurance payments, retirement payments and other non-cash compensation. It includes all income paid to workers by employers.

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[10] See Note 2

[11] Based on Pennsylvania use tables for 2016 from IMPLAN, Inc.

Total output is the value of production by industry in a given state. It is estimated by IMPLAN from sources similar to those used by the BEA in its RIMS II series. Where no Census or government surveys are available, IMPLAN uses models such as the Bureau of Labor Statistics' growth model to estimate the missing output.

The model also includes information on income received by the Federal, state and local governments, and produces estimates for the following taxes at the Federal level: Corporate income; payroll, personal income, estate and gift, and excise taxes, customs duties; and fines, fees, etc. State and local tax revenues include estimates of: Corporate profits, property, sales, severance, estate and gift and personal income taxes; licenses and fees and certain payroll taxes.

While IMPLAN is used to calculate the state level impacts, Infogroup data provide the basis for Congressional and state legislative district level estimates. Publicly available data at the county and Congressional district level is limited by disclosure restrictions, especially for smaller sectors of the economy. This model therefore uses actual physical location data provided by Infogroup in order to allocate jobs – and the resulting economic activity – by physical address or when that is not available, zip code. For zips entirely contained in a single district, jobs are allocated based on the percentage of total sector jobs in each zip. For zips that are broken by districts, allocations are based on the percentage of total jobs physically located in each segment of the zip. Physical locations are based on either actual address of the facility, or the zip code of the facility, with facilities placed randomly throughout the zip code area. All supplier and indirect jobs are allocated based on the percentage of a state's employment in that sector in each of the districts. Again, these percentages are based on Infogroup data.

Appendix 1: IMPLAN Methodology[12]

Francoise Quesnay one of the fathers of modern economics, first developed the analytical concept of inter-industry relationships in 1758. The concept was actualized into input-output analysis by Wassily Leontief during the Second World War, an accomplishment for which he received the 1973 Nobel Prize in Economics.

Input-Output analysis is an econometric technique used to examine the relationships within an economy.

It captures all monetary market transactions for consumption in a given period and for a specific geography. The IMPLAN model uses data from many different sources – as published government data series, unpublished data, sets of relationships, ratios, or as estimates. IMPLAN gathers this data, converts it into a consistent format, and estimates the missing components.

There are three different levels of data generally available in the United States: Federal, state and county. Most of the detailed data are available at the county level, but there are many issues with disclosure – especially in the case of smaller industries. IMPLAN overcomes these disclosure problems by combining a large number of datasets and by estimating those variables that are not found from any of them. The data is then converted into national input-output matrices (Use, Make, By-products, Absorption and Market Shares) as well as national tables for deflators, regional purchase coefficients and margins.

The IMPLAN Make matrix represents the production of commodities by industry. The Bureau of Economic Analysis (BEA) Benchmark I/O Study of the US Make Table forms the bases of the IMPLAN model. The Benchmark Make Table is updated to current year prices, and rearranged into the IMPLAN sector format. The IMPLAN Use matrix is based on estimates of final demand, value-added by sector and total industry and commodity output data as provided by government statistics or estimated by IMPLAN. The BEA Benchmark Use Table is then bridged to the IMPLAN sectors. Once the re-sectoring is complete, the Use Tables can be updated based on the other data and model calculations of interstate and international trade.

In the IMPLAN model, as with any input-output framework, all expenditures are in terms of producer prices. This allocates all expenditures to the industries that produce goods and services. As a result, all data not received in producer prices is converted using margins which are derived from the BEA Input-Output model. Margins represent the difference between producer and consumer prices. As such, the margins for any good add to one. If, for example, 10 percent of the consumer price of an ultrasound machine is from the purchase of aluminum, then the aluminum margin would be 0.1.

Deflators, which account for relative price changes during different time periods, are derived from the Bureau of Labor Statistics (BLS) Growth Model. The 224 sector BLS model is mapped to the 432 sectors of the IMPLAN model. Where data are missing, deflators from BEA's Survey of Current Businesses are used. Finally, the Regional Purchase Coefficients (RPCs) – essential to the IMPLAN model – must be derived.

[12] This section is paraphrased from IMPLAN Professional: Users Guide, Analysis Guide, Data Guide, Version 2.0, MIG, Inc., June 2000.

IMPLAN is derived from a national model, which represents the "average" condition for a particular industry. Since national production functions do not necessarily represent particular regional differences, adjustments need to be made. Regional trade flows are estimated based on the Multi-Regional Input-Output Accounts, a cross-sectional database with consistent cross interstate trade flows developed in 1977. These data are updated and bridged to the 432 sector IMPLAN model.

Once the databases and matrices are created, they go through an extensive validation process. IMPLAN builds separate state and county models and evaluates them, checking to ensure that no ratios are outside of recognized bounds. The final datasets and matrices are not released before extensive testing takes place.

Appendix 2: Manufacturing Facilities Included in This Analysis

Company Name	City	State	Zip
Avid Radiopharmaceuticals	Philadelphia	PA	19104
Bayer	Saxonburg	PA	16056
Bayer Corp	Pittsburgh	PA	15238
Bayer HealthCare Indianola	Indianola	PA	15051
Bayer Radiology and Interventional	Warrendale	PA	15086
Best Nomos	Pittsburgh	PA	15202
BK Ultrasound - Sound Technology	State College	PA	16803
Blatek Inc	State College	PA	16801
Canon Medical Systems	Glen Mills	PA	19342
Capintec Instruments Inc	Pittsburgh	PA	15238
Cdl Nuclear Technologies Inc	Wexford	PA	15090
Covidien	King Of Prussia	PA	19406
Curvebeam, LLC	Warrington	PA	18976
DGH Technology Inc	Exton	PA	19341
E V PRODUCTS	Saxonburg	PA	16056
Eli Lilly & Co	Chadds Ford	PA	19317
eV Products, Inc.	Zelienople	PA	16063
GE Healthcare	Feasterville Trevose	PA	19053
GENDEX CORP.	Hatfield	PA	19440
IMAGING SCIENCES INTERNATIONAL LLC	Hatfield	PA	19440
Integrated Modular Systems Inc	Havertown	PA	19083
Longport Inc	Chadds Ford	PA	19317
Longport Inc	Glen Mills	PA	19342
Mac Kay Life Sciences	Philadelphia	PA	19103
Philips	Philadelphia	PA	19104
Philips	Monroeville	PA	15146
Philips	Reedsville	PA	17084
Philips	Murrysville	PA	15668
Philips	New Kensington	PA	15068
Philips	Pittsburgh	PA	15206
Philips	Tarrs	PA	15697
Philips	Youngwood	PA	19087
Real-Time Tomography LLC	Villanova	PA	19085
Siemens Health Svc	Berwyn	PA	19312
Siemens Health Svc	Hollidaysburg	PA	16648
Siemens Healthcare	Malvern	PA	19355
Siemens Healthcare	Plymouth Meeting	PA	19462
Siemens Healthcare	Plymouth Meeting	PA	19462
Siemens Healthcare Customer Solutions	MALVERN	PA	19355
Siemens Healthcare Customer Solutions - Office	GREENTREE	PA	15220
Siemens Healthcare Customer Solutions - Office	MALVERN	PA	19355
Siemens Healthcare Imaging & Therapy Systems	MALVERN	PA	19355
Siemens Healthineers USA	Malvern	PA	19355
Siemens Medical Solutions USA	Williamsport	PA	17701
Sonomed Escalon	Wayne	PA	19087