Siemens Offers a Comprehensive Product Portfolio for Safety Lifecycle Management

Executive Overview ................................................................. 3

Business Issues and Drive towards Risk Reduction ....................... 4

A Complete Safety Portfolio ..................................................... 5

PROFIsafe Enables Single-Bus Safety ........................................ 14

Case Study: Rolf Janssen GmbH ............................................. 16

Recommendations .................................................................. 18
Safety Lifecycle Model

Levels of Integration with Control Systems
Executive Overview

Traditionally, safety protection referred to add-on components used to protect personnel working in or near hazardous manufacturing processes from injury or death. Today, however, safety solutions go far beyond this notion. Manufacturing plants are under pressure to contribute to their companies’ profitability by continuously improving the performance of their manufacturing operations. Increasingly, they recognize that the deployment of intelligent, integrated safety solutions can directly affect their bottom line.

Designing an inherently safe process is the best way to reduce risks in a manufacturing environment. However, inherent safety is rarely achievable in today’s manufacturing plants. Risks prevail wherever hazardous or toxic materials are stored, processed, or handled. These risks should be minimized in a layered manner, first by mechanical means, then by basic process control systems, and finally, by safety shutdown systems.

Interest in performing rigorous hazard and risk analysis and applying certified safety instrumented systems have increased significantly with the publication of the IEC 61508, IEC 61511, and ISA-84 safety standards. In addition to technical issues, these standards cover the planning, documentation and assessment of all activities required to manage safety throughout the entire life of a system.

Today, manufacturers are looking for suppliers that can offer a comprehensive set of products and services and complete support of their installed systems on a worldwide basis.

Siemens has been active in the safety protection business since 1980. For over 25 years, they have offered programmable safety systems for discrete and process industries. With the company’s Safety Integrated program and Global Process Safety Initiative, Siemens is now in a very good position to offer its comprehensive product portfolio for safety lifecycle solutions on a worldwide basis.

Developments in industrial networking technology are having a profound and positive effect on process safety. Profibus International, an industrial consortium of automation suppliers, has mated safety with industrial net-
working to create “networked safety” based on Profibus DP and PA, Profinet (industrial Ethernet), and wireless technology. End-users are now taking advantage of these solutions to unify their network architectures and eliminate the need for a second, parallel bus, while maintaining conformity with safety requirements up to SIL3. Benefits of networked safety include shortened start-up times, lower wiring costs and, in the long term, faster and more efficient maintenance.

Business Issues and Drive towards Risk Reduction

Safety, in the traditional sense, refers to add-on components that protect personnel working in or near hazardous manufacturing processes from injury or death. However, modern safety solutions go far beyond this notion. Many end users now recognize that the deployment of intelligent, integrated safety solutions can directly affect their bottom line.

Many end users now recognize that the deployment of intelligent, integrated safety solutions can directly affect their bottom line.

Manufacturing plants today are under pressure to contribute value to a company’s bottom line by continuously improving the performance of manufacturing assets. Today’s business drivers focus on metrics such as Return on Assets (ROA) and Overall Equipment Efficiency (OEE), both of which are critical contributors to the overall goal of achieving Operational Excellence (OpX). The nemesis of all manufacturers is unscheduled downtime – unexpected stoppage resulting from equipment failure, operator error, or nuisance trips. Safety solutions available today integrate directly into standard control architectures, helping to curtail downtime by allowing operators to diagnose hazardous conditions more intelligently, avoid nuisance trips, and – where necessary – quickly get production up and running again.

The Importance of Risk Reduction

Safety risk is usually defined as the combination of probability and the severity of an unplanned event. That is, what is the likelihood that something will happen and how bad are the consequences if it does. Examples of un-
planned events in manufacturing operations include equipment failure, a toxic spill, fire, or an explosion. Examples of associated risks include loss of life or limb, an environmental excursion, loss of capital equipment, or loss of production. For many manufacturers, damage to company image can also be a significant risk factor. Add to these issues the realities of increased environmental awareness, regulatory concerns, and threat of litigation and it is easy to see why risk reduction is becoming increasingly important to most manufacturers.

The best way to reduce risk in a manufacturing plant is to design inherently safe processes. However, inherent safety is rarely achievable in today’s manufacturing environments. Risks prevail wherever hazardous or toxic materials are stored, processed, or handled.

Since it is impossible to eliminate all risks, a manufacturer must decide upon the degree of risk that they can tolerate. After identifying the hazards, a hazard and risk study should be performed to evaluate each risk situation by considering its likelihood and severity. Site-specific conditions, such as population density, in-plant traffic patterns, and meteorological conditions should also be taken into consideration during risk evaluation.

Once the hazard and risk study has ascertained the risks, it can be determined whether they are below acceptable levels. Basic process control systems, along with process alarms and facilities for manual intervention, provide the first level of protection and reduce the risk in a manufacturing facility. Additional protection measures are needed when a basic control system does not reduce the risk to a tolerable level. Theses include safety-instrumented systems along with hardware interlocks, relief valves, and containment dikes. To be effective, each protection subsystem must act independently of all others.

**A Complete Safety Portfolio**

As users become more knowledgeable about safety issues, they are performing more comprehensive hazard and risk analysis to determine their needs. In order to reduce the cost of configuration, training, and support, users are seeking closer integration between their safety and control sys-
tems and closer integration with predictive maintenance for early detection of field device and processor failures. They are looking for flexible safety system architectures that may be configured according to the needed protection on a loop-by-loop basis. They are demanding integrated field devices and tools for safety lifecycle management and comprehensive one-stop support for their installed systems. They are also looking to safety fieldbus to reduce the cost of field wiring without sacrificing functional or data integrity.

Thus, an automation system supplier’s complete safety portfolio should include:

- Integrated control, safety, and predictive maintenance
- Flexible safety system architecture
- Safety field devices and transmitters
- Tools and support for safety lifecycle management
- Comprehensive support of installed systems

**Integrated Control and Safety**

In the recent past, many manufacturing companies kept their process control systems completely independent from their safety shutdown systems. In many cases, controllers used for safety-instrumented systems (SIS) came from specialized manufacturers that added extensive diagnostics to receive TÜV safety certification. Until recently, there was little choice other than to use completely different systems for control and safety. Some users even mandated control systems and SIS from different manufacturers.

There were and still are many other good reasons to put safety and control functions in different controllers. These include:

- Independent failures – minimizing the risk of simultaneous failure of a control system along with the SIS
- Security – preventing changes in a control system from causing any change or corruption in the associated SIS
- Different requirements for safety controllers – a safety system is normally designed to fail in a safe way, whereas a Basic Process Control System (BPCS) is usually designed for maximum availability. An SIS also has special features like extended diagnostics, special software error checking, protected data storage, and fault tolerance.
In the past, manufacturers that could not afford separate safety and control systems sometime integrated both safety and control functions in the same controller. However, the safety standards for process industry applications are somewhat ambiguous on the issue of separation, which is mandated only in nuclear power industry applications (IEC 61513).

Today, many users are finding logical reasons to justify using similar systems for control and safety functions. These include reducing the problems associated with different programming procedures, languages, installation requirements, and maintenance. There is always the risk that these different procedures might contribute to human error and possible safety problems.

The financial benefits of using similar systems are also clear: reduced hardware, configuration, training, and inventory costs result from the reduced range and quantity of equipment required. In addition, this approach removes the burden of servicing and supporting disparate systems.

### Benefits and Challenges: Integration of Safety and Control Systems

| Benefits: | | | |
|---|---|---|
| Common data mapping | | |
| Similar engineering tools | | |
| Significant reduction in integration efforts | | |
| Lower life-cycle cost | | |
| Challenges: | | |
| Putting hardware and software barriers between safety and control systems | | |
| Ensuring proper access protections | | |
| Ensuring visual differentiation between control and safety environments at workstation level | | |

The Three Levels of SIS Integration with Control Systems

Integration between control and safety systems can be categorized into three levels: interfaced, integrated, and common. Some control and SIS suppliers now offer similar systems for either function. These incorporate
similar HMI, configuration procedures, programming languages, and maintenance procedures. The key is to ensure that even though the two systems are separate, with different hardware and software, they have a common configuration, operation, and maintenance interface. This allows users to achieve the operational benefits of integration, while meeting the safety requirement for separation. The control and safety systems communicate transparently, but have adequate protection from corruption of one by the other.

Siemens has developed several different safety solutions to meet customers’ needs. Siemens’ Simatic S7 safety system can be configured to interface with Siemens process automation controllers to offer interfaced or integrated safety solutions. Additionally the Simatic S7 safety system can be configured for both control and safety functions. Thus, Siemens can offer any of the three levels of integration, depending on users’ preferences. TÜV has certified all three configurations for SIL 3 applications.

The new distributed safety concept from Siemens enables continuous function chart (CFC) or cause and effect diagram with Simatic Safety Matrix programming in the same graphical environment used for normal configuration. Thus, the safety functions can be designed, reviewed, commissioned, and locked in, while non-safety related code can be edited without restriction.

**Integrated Predictive Maintenance**

Plant Asset Management (PAM) systems are a combination of hardware, software, and services deployed to help the workforce predict and assess the health of plant assets by monitoring asset condition periodically or in real time to identify potential problems before they affect the process or lead to a catastrophic failure. Closer integration of PAM with control and safety systems facilitates early detection and notification of failures of field devices and processors.

A key driver behind PAM adoption is the critical need for the current workforce to be able to do more with less. By providing them with information at the right time and in the right context, workers work smarter. This provides maximum benefit to the enterprise. Success in today’s “Flat World,” where a plant’s assets and workforce are scattered across the globe, requires the availability of information 24 hours a day, seven days a week.
A key driver for PAM adoption is the critical need for the current workforce to be able to do more with less by providing them with information at the right time and in the right context.

For plant asset management applications, Siemens offers Process Device Manager (PDM). Simatic PDM is a universal, manufacturer-independent software tool for configuration, parameter assignment commissioning, and diagnostics and maintenance of intelligent process devices and automation components. The flexibility of Simatic PDM allows one software program to be used to configure a host of field devices from different manufacturers with a single user interface. Functionality includes changing process device data, checking plausibility, and simulating various modes of operation.

Using PDM from a central engineering station, users can parameterize and troubleshoot intelligent field devices remotely. PDM serves as the communications basis for the asset management system and is available integrated with Simatic PCS 7 or in standalone configurations.

Flexible Safety System Architecture

The installed base of SISs for critical control or safety shutdown consists largely of TMR (2oo3) and Duplex (1oo2D) systems. Other architectures increasingly offered by SIS suppliers include Quad (2oo4D), Pair and Spare, and Clustering configurations. Suppliers now also offer configuration flexibility, providing the user with the choice of putting together two or more safety PLCs to reduce failure rate and increase availability.

The Flexible Modular Redundancy (FMR) concept, introduced by Siemens, allows a system to be configured in many different ways, allowing the user to specify the amount of fault-tolerance required for each safety-instrumented function (SIF). This innovative approach saves cost by allowing the less-critical functions to be handled using lower-cost configurations, while providing high-availability for the most critical functions.

Siemens’ simplex S7-400F (“F” for fail-safe) controller, certified for SIL 3 applications, includes diverse software for checking failure conditions that go beyond the traditional 1oo2D architecture. For higher availability, Siemens also offers S7-400FH (“H” for high availability), which consists of a married pair of two S-400F controllers. In an evaluation carried out by an
independent third party, this configuration offered higher availability than conventional Duplex (1oo2D) or TMR (2oo3) systems. Another independent assessment of the system validated that the high-availability configurations meet, or exceed, the availability performance of traditional TMR or QMR systems.

Safety controllers are becoming more scalable. While high-end controllers continue to increase in both processing power and capacity, smaller controllers aimed at applications with limited I/O counts are being added to give better granularity. This is a boon to users as they no longer have to invest in large and expensive systems that are not needed for many of their applications.

Siemens range of S7 controllers for distributed safety applications includes IM-151, S7-315, S7-317, S7-412, S7-414, S7-416, and S7-417 CPUs. Because of their power and compactness, they can be scaled to users’ demands, from small- to large-sized applications.

**Safety Field Devices and Transmitters**

The main cause of an SIS failure is not the failure of logic solvers (controllers), but the failure of field devices. Even today’s advanced logic solvers with voting circuits and advanced diagnostics do not address over 90 percent of the causes for failures due to failed sensors and actuators.

Today, the overall design of a protective system should incorporate functionality for monitoring the health of field devices and I/O components.

Examples include:

- Sensor validation
- Environment condition monitoring, such as temperature and humidity that can cause sensor degradation
- Transmitter drift

Electronic components commonly fail due to environmental conditions. Many electronic devices fail when exposed to elevated humidity and temperature conditions, which need to be monitored closely. Sensor calibration is also becoming an integral part of an SIS. Use of open protocols, such as HART, Profisafe, and, in principle, Foundation Fieldbus, allows for remote monitoring, diagnostics and validation.
Certified smart sensors and final control elements that can report their health to the logic solver are now available. This increases uptime, as an unhealthy sensor can be replaced promptly or its input ignored for a voting strategy.

In safety applications, use of valve controllers that do not automatically diagnose the health of the valve assembly creates continual concern about the ability to trip on demand. Control valves are now being designed to have very low probability of stem seizure and packing failure and TÜV-certified actuators and controllers are now commercially available to test and diagnose their health.

The SIS design should include limited valve movement testing as an integral design feature. Partial stroke testing is also possible with a smart valve controller. This gives a much richer diagnostic and also stops exposing personnel to risk associated with manual field testing. Additionally, a valve need not be removed from the safety scheme while the test is carried out.

Siemens offers partial valve stroke testing function as a standard with their safety systems, which have been evaluated by an independent third party for SIL 2 and SIL 3 applications.

Tools and Support for Safety Lifecycle Management

Safety Lifecycle Management provides a way to specify, design, implement, and maintain safety systems to achieve overall safety in a well-documented and verified manner. With the publication of the safety standards, management of safety lifecycle has gained increased importance.

All major safety standards (ANSI/ISA-84-01-2004, IEC 61508, IEC 61511, etc.) have specified similar safety lifecycles, differing only in the details. A safety lifecycle shows a systematic, phased approach to safety, from an initial hazard and risk analysis, to safety system implementation, and ultimately, through system decommissioning.
The IEC 61511 standard specifies twelve steps in the safety lifecycle. These are segmented into four phases: Analysis, Realization, Maintenance, and Ongoing Functions.

**Analysis Phase**
The analysis phase includes the initial planning, identification, and specification of safety functions that are required for the safe operation of a manufacturing process, including documentation of the safety requirements. Specific activities include:

- Perform hazard and risk analysis
- Allocate safety functions to protection layers
- Specify requirements for safety system

**Realization Phase**
The realization phase includes design, installation, and testing of safety systems, plus the design, development, and installation of other effective methods of risk reduction, such as mechanical trips and barriers. Specific activities include:

- Design and engineer safety system
- Design and develop other means of risk reduction
- Install, commission, and validate the safety protections

**Maintenance Phase**
The maintenance phase begins at the startup of a process and continues until the safety system is decommissioned or redeployed. Specific activities include:

- Operate and maintain
- Modify and update
- Decommission safety system

**Ongoing Functions**
Certain functions are ongoing. Examples include managing functional safety, planning and structuring safety lifecycle, and performing periodic safety system verification and safety audits over the whole lifecycle. These are shown as vertical boxes in the diagram on page 2. Specific activities include:

- Manage functional safety, safety assessment, and safety audit
For realization and maintenance phases, Siemens offers Safety Matrix, which simplifies system engineering, commissioning, and maintenance, while also helping users fulfill the documentation, reporting, and change management requirements.

Activities for Analysis, Realization, and Maintenance phases are normally carried out consecutively, while Ongoing Functions run concurrently with the other phases. However, like all models, the safety lifecycle is an approximation. In reality, there are significant iterations between phases. Requirements of some of the functions, such as hazard and risk analysis, allocation of safety functions to protection layers, and designing and developing other means of risk reduction are not specified in any detail in the standard.

For the analysis phase, a user may use exida’s exSILentia tool. This provides fully customizable SIL selection options such as risk graph, hazard matrix, and frequency based targets. In addition, a complete SIF SRS template ensures completeness in requirements definition. exSILentia contains a comprehensive SIL verification program, SILver, allowing extensive Safety Instrumented Function definition, and an IEC 61508 approved calculation engine.

For the realization and maintenance phases, Siemens offers Safety Matrix, a set of TÜV-certified software tools that seamlessly imports data from exSILentia. Safety Matrix reduces human errors and engineering effort by automating the Cause & Effect (C&E) methodology to simplify SIS design.

The Safety Matrix greatly simplifies system engineering, commissioning, and maintenance while also helping users fulfill the documentation, reporting, and change management requirements of the IEC 61511 safety lifecycle. The integration of Safety Matrix with exSILentia allows users to automatically generate a cause and effect matrix directly from the results of their SIL verification efforts, reducing engineering hours, and the potential for human error.

**Comprehensive Support of Installed Systems**

Safety system users are looking for suppliers that can offer a single, comprehensive maintenance service contract for all their control, safety, and field devices. Multinational manufacturers require this comprehensive support on a worldwide basis. Both suppliers and customers benefit from
Users are looking for comprehensive single service contract for control, safety, and field devices.

comprehensive maintenance contracts that clearly define terms such as response time and parts availability.

Through appropriate maintenance services, a supplier can help its customers make better use of their resources and improve workload leveling. A supplier can deploy emergency personnel with special training on complex products at various customer sites as needed. This special training and flexible resource utilization can be very expensive and difficult for many customers to justify on their own. Suppliers can also achieve economies of scale by sharing the costs of specialized spare parts, tools, and test equipment across a number of companies. A supplier’s specialists can also gain important technical, regulatory, and legal knowledge by working at different customer sites.

Siemens offers comprehensive lifecycle services and worldwide support, which is closely aligned to their system business. The levels of support vary according to an end user’s needs. These include:

- Resolving technical issues over the Internet
- Direct communication with an expert over the phone
- On-site call from their service team
- Comprehensive service agreement
- Assignment of total responsibility for all service issues

In addition to qualified in-house expertise, Siemens can draw upon the expertise of a selected set of partners to meet the ever-increasing demands of the safety lifecycle management. These partner companies can offer advice and support for all safety aspects of clients’ automation projects. In selecting these partner companies, Siemens has placed great value on industrial skills, experience, and comprehensive know-how. The company keeps its partners updated with ongoing training courses to help ensure consistent skill levels. Additional partner companies across the globe are currently undergoing such qualification processes.

**PROFIsafe Enables Single-Bus Safety**

Thanks to recent developments in safety technology, modern automation philosophy now recognizes that it is no longer necessary to run two sepa-
rate fieldbuses for safety and non-safety data. This adds considerable value, since a two-bus architecture requires double the amount of training and network access hardware and makes start-up and troubleshooting tasks unnecessarily complex.

With the arrival of Profisafe, the safety protocol that is part of the communication protocols of both Profibus and Profinet, end-users can now eliminate the need for a separate safety fieldbus and reduce their network architectures to a single fieldbus. Profisafe extends the standard Profibus communications protocol to address special requirements for safety-related information necessary to conform to strict safety standards. For example, Profisafe adds elements, such as message numbering and data consistency checks, to rule out typical network messaging faults. This enables networked safety devices to meet the reliability requirements of Safety Integrity Levels (to SIL3) prescribed by international safety standards. Since Profisafe is built into the communications protocol, it can be used by devices connected to any Profibus medium, including Profibus DP and PA, as well as Profinet. This single-bus approach is especially useful in industries such as food & beverage and pharmaceutical, where machine safety plays an important role.

**Ring Redundancy for High Availability**

For applications requiring high availability, Profibus PA can be configured in a ring architecture that ensures communication, even if part of the network cable is disabled due to a short circuit or physical damage. A ring architecture uses “active field distributors” (AFD) to integrate field devices via four short-circuit-proof spur line connections in a Profibus PA ring with automatic bus termination. This ensures that, in the case of a break in the ring, the end of the remaining segment is terminated so that network communications can continue.

The ring is connected to two DP/PA couplers that can be operated on a single or redundant Profibus DP. Up to 8 AFDs and 31 Profibus PA devices can be configured per ring. Profibus PA also allows AFDs to be hot-swapped.
Case Study: Rolf Janssen GmbH

The backbone of Germany’s economy is made up of the *Mittelstand* – countless mid-sized companies, many of them family owned, that contribute to the enduring success of Germany’s engineering industries. Rolf Janssen GmbH Elektrotechnische Werke, founded in 1949, is a systems integrator in northern Germany that specializes in delivering and supporting turnkey systems ranging from power stations to food & beverage plants, hydrotechnology, applications, water treatment plants, and environment technology, ship building and building control.

In power stations, fuel is burned to heat water into steam, which turns a generator to produce electrical power. Rolf Janssen GmbH delivers the necessary subsystems that include burner control and boiler protection. The latter involves the monitoring of drum pressure, drum level, fresh air and flue gas flow. All of these tasks are critical to ensure uninterrupted operation of the power plant and the safety of personnel and equipment. Loss of control of just one variable due to equipment failure could result in a catastrophic explosion. For this reason, extensive and reliable safety functions are needed in addition to standard process control functions.

Rolf Janssen GmbH Elektrotechnische Werke is a Siemens Solution Partner and a specialist for safety applications using Siemens’ Simatic PCS 7 process control system. In power station applications, customers require a combination of high availability and functional safety, for which the PCS 7 processor S7-417FH is ideally suited (“H” stand for high availability and “F” for failsafe). These systems are “fault tolerant for safety”, meaning that one failure will not affect the system safety function. A typical configuration may include a single S7-400FH controller with all process control and safety functions implemented in a single system.

For smaller applications or for those not requiring high availability, the Simatic S7-300F is also used. These are also frequently used in “black box”
applications in which a subcontractor delivers part of a system such as a fail-safe burner management system. Multiple “black boxes” can then be integrated into a single system. In the past, fail-safe digital inputs and outputs were used to communicate between controllers, but now this is accomplished much more cost effectively with Profibus using the Profisafe protocol to ensure safe communication.

For boiler protection, field devices are deployed using Triple Modular Redundancy (TMR), meaning that three devices send their process variable independently for “2oo3” (two out of three) voting. The three input stages operate in parallel to decide which is the correct value to pass to the processor. For example, if one pressure transmitter fails, the system detects the dissenting signal and assumes that the values from the other two devices are correct. While 2oo3 voting is expensive to install, it is the easiest to maintain and monitor and provides the highest level of reliability for uninterrupted plant operation.

Depending on customer requirements, Rolf Janssen GmbH can configure the PCS 7 in a single or dual-redundant architecture for high availability. Dual redundancy offers the additional advantage of separating the processors physically to eliminate common cause failures. For example, should a fire or flood occur in a control room and disable one controller, the other controller in a remote location seamlessly takes over control of the process.

While other safety solutions are available, Rolf Janssen GmbH prefers the all-Siemens solution because of the seamless integration of standard control and safety functions.
Recommendations

- Re-evaluate the role that safety plays in your plant. Safety technology has evolved into a sophisticated set of technological solutions that can also help improve a manufacturer’s bottom line. A well thought out, intelligent safety strategy should not only protect humans, machines, and the environment, but also support business benefits such as increased productivity, improved machine efficiency, reduced downtime, and above all, lower Total Cost of Ownership (TCO).

- Adopt IEC 61511/ISA-84 as your safety implementation standard and perform rigorous standards-based hazard and risk analysis to decide on the right level of protection for your manufacturing plants.

- When evaluating Safety Instrumented Systems, choose a certified system that meets your highest SIL requirement, allows close integration with your new or existing control systems, offers integrated safety solution from sensor to actuator, offers state-of-the-art tools for safety lifecycle management, offers scalable solutions, and enjoys worldwide support.

- Consider a safety solution that takes advantage of modern fieldbus technology with support for safe communication, eliminating the need for a separate safety bus. In addition to safety, your fieldbus should also support legacy devices in your plant, such as existing HART field devices.

- Choose a supplier that offers a comprehensive set of products and services, which include integrated safety and control, flexible architecture, safety field devices and transmitters, tools for lifecycle management, and comprehensive support of your installed systems.
Founded in 1986, ARC Advisory Group has grown to become the Thought Leader in Manufacturing and Supply Chain solutions. For even your most complex business issues, our analysts have the expert industry knowledge and firsthand experience to help you find the best answer. We focus on simple, yet critical goals: improving your return on assets, operational performance, total cost of ownership, project time-to-benefit, and shareholder value.

All information in this report is proprietary to and copyrighted by ARC. No part of it may be reproduced without prior permission from ARC. This research has been sponsored in part by Siemens AG. However, the opinions expressed by ARC in this paper are based on ARC’s independent analysis.

You can take advantage of ARC’s extensive ongoing research plus experience of our staff members through our Advisory Services. ARC’s Advisory Services are specifically designed for executives responsible for developing strategies and directions for their organizations. For membership information, please call, fax, or write to:

ARC Advisory Group, Three Allied Drive, Dedham, MA 02026 USA
Tel: 781-471-1000, Fax: 781-471-1100, Email: info@arcweb.com
Visit our web pages at www.arcweb.com