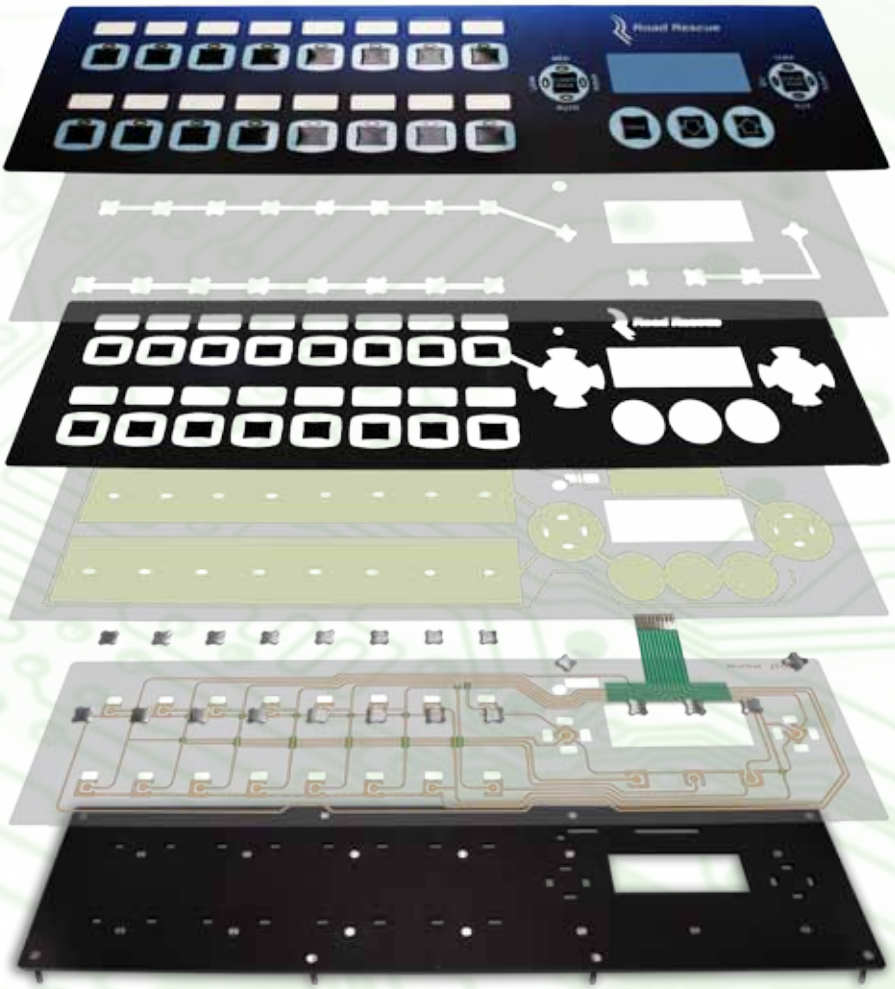
PANNAM IMAGING
advanced interface solutions



Membrane Switch Design Guide

ISO 9001: 2008 Certified

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Pannam Imaging

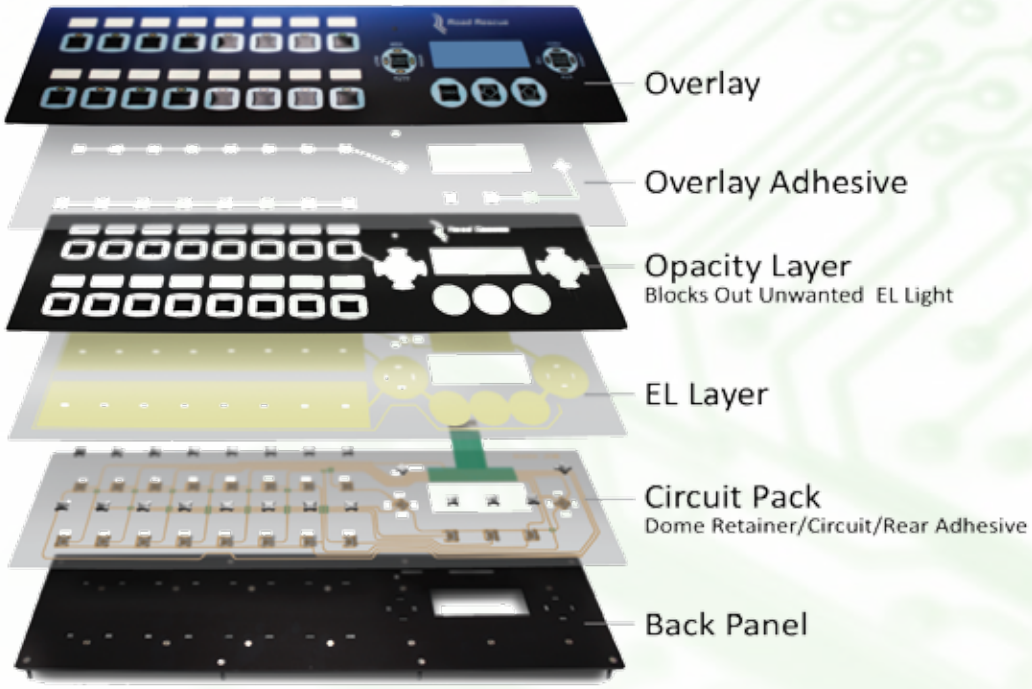
Pannam is an advanced interface solutions provider. We manufacture customized user interface membrane switches that demand the highest level of integration, execution and reliability. Our products serve many markets including medical, health and fitness, industrial controls, electronics and data communications.

Pannam has focused its competitive expertise on the high quality, high value-added end of the product-need spectrum. With our advanced fabrication capabilities and overseas operations, Pannam has the flexibility to manage low-volume jobs, high-volume runs, and everything in between, providing the highest quality membrane switch to meet your specific job requirements.

The Design Process

This design guide will inform you of the various components for consideration in designing a user interface membrane switch. You will also be advised about available options for certain components. Pannam utilizes a project management system that guides the process from prototype to production. Once you have determined the product requirements and identified features and options, our engineers will design a new switch as well as produce the actual prototype, including a complete set of drawings and specifications.

Membrane Switch Design Concept



Design

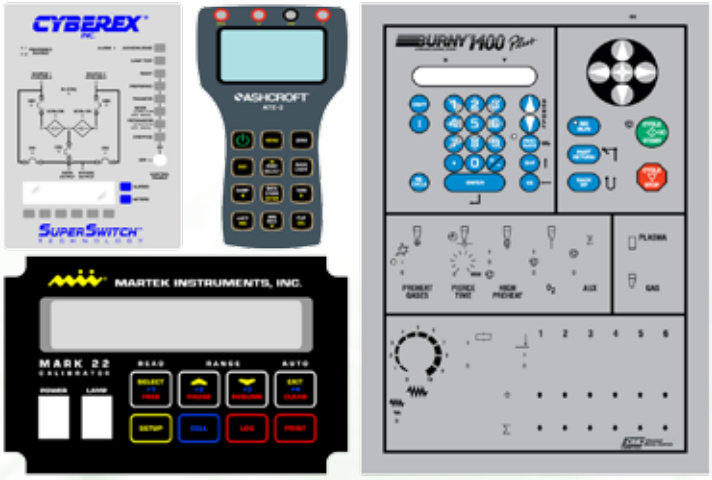
Production Drawings

During the design phase, Pannam consults with you to generate manufacturing drawings that meet your approval. These drawings accompany the job as it moves through production.

E-Files

Pannam supports files created in AutoCAD, SolidWorks, CorelDraw, Illustrator, and Inventor. To avoid font compatibility issues, we suggest converting all text to curves or outlines in your file before sending to Pannam. Also, no need to worry about complexity. We have worked with prints in all ranges of detail, including explicitly detailed prints, even sketches on napkins.

You can e-mail your file to sales@pannam.com.



Overlay

Achieving the Right Look

The overlay, the top layer of the membrane switch, is the graphic interface between user and machine. While the underlying layers house the electronic components, it is the overlay that most directly impresses your customer. To help create the desired look and feel of your overlay, we offer design assistance from simple color and overlay material selection, to complex design elements incorporating creative functionality. Pannam offers complete in-house graphics capabilities, enabling us to incorporate a wide variety of design elements such as CMYK process, color halftones and gradients, selective textures, transparent windows, screen tints, dead fronts and embossing.

During the design process, you will receive a color proof of your overlay to verify color placement. Exact color match swatches on the selected overlay material are available if required for approval. Pannam offers polyester and polycarbonate materials in many gloss and textured finishes.

Material Selection

Your overlay is what the user sees in the switch assembly. Its appearance and function are crucial to a successful switch solution. Contributing to overall function is overlay durability. It is essential to ensure that the overlay material chosen will last as long as your specific application requires. Polyester is the material of choice if your overlay is embossed, or for switches that require a large number of actuations (>25,000). Generally, life cycle tests show polyester keypads can be actuated over 1,000,000 times before showing any signs of wear. While polycarbonate offers more design options, it will not provide as many life-time actuations as polyester. Please note that the actual switch, without an overlay in place, can last over 5,000,000 cycles.

Choosing Thickness

For excellent tactile feedback in a switch with stainless steel dome construction, choose an overlay thickness between .006” and .008”. This thickness range will be durable enough to hold up to numerous switch cycles. A thicker overlay will significantly decrease tactile feedback, giving a heavier feel.

Color Matching

Pannam calibrates colors within the acceptable standards of Delta-E measurements using a computer color matching system and archive recipes of colors already matched for specific customer applications. We can match colors from the Pantone Color Selection Guide, Federal Standard Guide, European Standard Guide or a customer-supplied swatch, providing it is a minimum 2” square size.

Printing Colors

All the colors on the overlay are printed on the second surface (the reverse) of the overlay material using either a digital or screen printing process, or a combination of both. Utilizing digital imaging can result in reduced cost and lead time if many colors, special logos, or gradient background shading is required. The thickness of the overlay material protects the graphics from damage or wear by the operator or environment. Selective textures and window clearing agents are the only inks printed on the first surface of the overlay and are UV cured to produce a durable finish.

Finishes

Polyester and polycarbonate overlays are available with a variety of textures and hardcoats. While a gloss overlay can offer a high-end appearance, it is very susceptible to scratches with use over time. To minimize scratches, a velvet-textured overlay is recommended for most applications, particularly for industrial environments. Conversely, extended-use keypads should not have printed texture on them. Alternatively, the switch can be designed with glossy keypads and a textured background so that the texture ink is printed only around the actual pad that functions. In this manner, potential keypad degradation is eliminated, and an attractive design element is introduced that more clearly differentiates the keypad from the surrounding switch area.

LCD/LED Display Windows

An overlay may include windows of varying shapes and sizes. Windows may be clear, or printed with transparent color to help conceal the underlying lighting element when not illuminated. Additionally, printed textures and clearing agents may be applied. Pannam recommends that smaller LED windows retain the same texture as the background.

Embossing

Depending on design creativity, embossing can dramatically enhance the look of the overlay.

Pad

The entire shape of the keypad is raised.

Rail ***(Perimeter)***

A rim around the perimeter of the keypad is raised.

Dome

The entire keypad is raised to a spherical shape *(normally used in poly-dome constructions).*

Embossing can also be a great design enhancement to the function of a switch. For example, rail (perimeter) embossing can be used as a finger locator for a switch with many keypads, or a Braille pattern can be added to the overlay for the visually impaired. Depending on size and shape, custom logos and multi-level shapes can be embossed, as well.

There are certain limitations to be aware of:

Height - Typically, emboss height on polyester overlay should measure 1.5x the thickness of the base material. It is possible to emboss beyond 1.5x material thickness, but only at a cost to durability. Heavily used keypads that have been embossed will most certainly degrade more rapidly due to a thinner wall thickness at the point of stress.

Width - Recommended minimum emboss width is 8x the base material thickness. This will maintain strength and form of the overlay.

Radius - Recommended minimum corner radius is .032". Completely square corners are not possible because they will crack the overlay material.

Spacing - Typical minimum space between embossed areas is .125". Minimum recommended spacing from embossing to edge of overlay is .250".

Tolerances for Overlays and Circuits

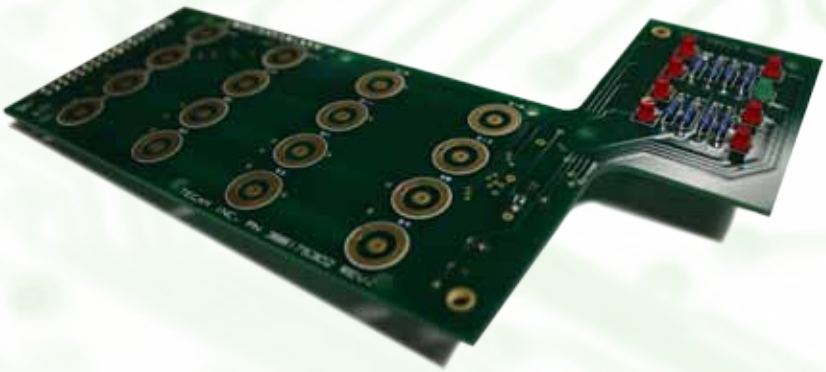
Imaging: +/- .015" copy to edge. Die-cutting (Hole and perimeter size): +/- .010" hole to edge

Circuits

Production

There are numerous methods for producing circuit layers depending on durability, power and system integration requirements. Pannam offers screen printed silver conductive ink circuits as its standard construction. We also supply copper-etched and PCB circuits depending on your design requirements.

The silver conductive ink circuit layer is typically printed on .005" thick polyester and is designed to minimize overall resistance. After printing, the circuit layer is fabricated to the proper shape to fit in the switch stack-up. A typical switch stack-up will range in thickness from .025" to .050".



Electrical Schematics

It is more cost-effective to allow Pannam to do the circuit design (unless you have done this before, specifically for membrane switches). Depending on the size and shape of the part, the complexity of the electrical schematic and keypad configuration, it is sometimes more difficult to fit all of the circuitry on a single layer. It may be necessary to use bridging, through-hole printing, or multiple circuit layers to accommodate the functionality required. Our experienced engineering team can make electrical schematic suggestions to limit the number of printed circuit passes, which will reduce the cost of the switch with no loss of performance.

Circuit Tail Length

The circuit tail is part of the circuit layer. The length of the circuit tail can be as long as required to terminate to other functioning parts of the system. The longer the circuit tail, the more base material and conductive ink will be used, which will increase the cost of the switch and the resistance. Pannam can also supply extension cables with or without connectors.

Circuit Tail Connectors

- Berg ®/FCI ® (Standard)
- Molex ®
- CrimpFlex ® (Standard)
- Solder tabs
- Amp ®
- ZIF ®
- Male or female connector pins

Lighting Options

Optical Fibers

Optical fibers are an ideal choice for backlighting, as they offer uniform lighting over a large area with less power consumption. In addition to their low profile, optical fibers are immune to EMI and RFI, offer long life (10,000 to 100,000 hours), and operate in a wide range of temperatures, moisture and humidity levels.

Electroluminescent (EL) Lamps

EL lamps provide even light distribution and are used frequently as a backlighting option. Their compactness offers additional design flexibility and may be more economical than optical fibers. EL lamps do not produce heat and have a half-life of approximately 3,000 to 8,000 hours. An important consideration is that once they reach their half-life, the brightness starts to fade rapidly.

Light Emitting Diodes (LEDs)

LEDs are considered the standard for indicator lamps in user interface membrane switches due to their brightness and robustness. Additional benefits include long life and low energy consumption. LEDs create bright spots. For this reason, Pannam discourages the use of LEDs as a backlighting option. LEDs may be surface-mounted to the circuit layer or placed on a separate LED layer.

Electrical Specifications

Switch Contact Rating	28V DC/30mA max
Loop Resistance	100 Ohms max (may be dependent on design)
Switch Configuration	SPST normally open
Surface-Mounted LED Specifications	Available upon request
Contact Bounce	<200 milli-seconds on break, <10 on make

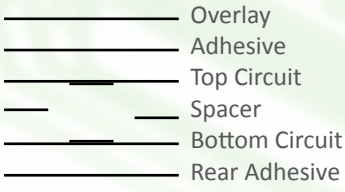
Actuation Force/Design

Examples of actuation choices for specific applications:

Light Force (3-6 oz.)	High-speed data entry
Medium Force (10-14 oz.)	Most applications fall in this range (medical devices, test equipment, etc.)
Heavy Force (16-20 oz.)	Manufacturing plant, where a machine operator may be wearing protective gloves; ensures activation is deliberate

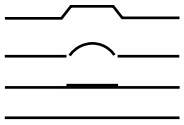
Non-Tactile

Non-tactile switches can be designed with a broad range of actuation forces starting at 3 oz. *Overall non-tactile switch thickness starts at .030".*



Actuation force is determined by the spacer thickness (layer between the top and bottom circuit layers) and the diameter of the spacer hole. For example, a switch with a thin spacer and large diameter spacer hole will have a light actuation force.

Tactile



Actuation force in a switch designed with tactile feedback does not have as much feel flexibility as a non-tactile switch. Using different sizes of stainless steel domes will vary the force to meet most requirements.

Choosing a Dome

Typically, Pannam makes a proper dome recommendation based on the size of the keypad. The 12.2mm dome is the most common and cost-effective choice for most applications.

Stainless Steel dome specifications:

Size	Force	Travel
8.5mm	9-11oz.	.015” - .019”
12.2mm	11-18 oz.	.020” - .024”
20mm	17-23 oz.	.047” - .055”

Force is for the stainless dome itself. Other aspects of construction design will affect actuation force or feel.

Shielding

Shielding is used to protect the switches from electrostatic discharge (ESD) and electromagnetic interference (EMI). Pannam can design a switch that incorporates the proper shielding layer for your specific application needs.

Types of Shields

Pannam uses three different basic shielding methods to protect switches:

Foil	Laminated aluminum foil and polyester.
Transparent Film	Shielding required over windows (more costly).
Printed	Screen printed with silver conductive ink in a grid, bus-bar or full-coating format. Typically, the grid format is chosen because it is very reliable and does not use as much silver conductive ink as does the full-coating format.

Shield Termination Methods

Tab	The preferred method for reliability. Can be attached to a stud or stand-off on a back panel or metal enclosure.
Connector	Shield layer can be terminated into a pin or pins on the circuit tail connector.
Wrap-Around	Shield layer can wrap completely around the membrane on all four sides to ground to a chassis. Although this method is very reliable, it is more costly than the other two methods due to the added labor and material necessary to execute.

User Interface Membrane Switch Backings

User interface membrane switches are typically flexible with a mounting adhesive or have a rigid aluminum backing. Pannam can recommend a mounting adhesive appropriate for the intended application surface. A smooth surface will readily accept an adhesive while a powder-coated or rough surface will require a thicker, more aggressive adhesive. Ideally, the mating surface for a flexible switch should be as flat as possible. A curved or convex surface may require stronger adhesive to prevent delamination of the membrane from the backer. Tactile switches are not recommended on concave surfaces, as the domes can be pushed past parallel, causing them to invert and fail prematurely.

Additionally, it is important to understand the durability and environmental requirements of the switch after it will be applied in a system to ensure the proper adhesive choice. Sample materials can be provided to the customer for testing in their environment, or a bezel may be sent to Pannam to allow for hands-on testing and recommendations by our engineers.

Pannam has full capabilities for shearing, bending, milling, punching and installing PEM inserts in aluminum back panels. Typical thicknesses range from .032” to .125”. They may be alodined to create a non-corrosive surface; or anodized to create a non-conductive, non-corrosive surface that can be colored. Although alodining is usually less expensive, anodizing is more durable.

Glossary

Actuation Force	The maximum force measured prior to or including the point at which keypad contact closure is achieved.
Alodine	A chemical conversion process that oxidizes aluminum to form a non-porous aluminum oxide. Less costly than anodizing.
Anodize	Electro-chemical oxidation of aluminum to form aluminum oxide with a porous nature. The anodized layer can be durably colored and is non-conductive, non-corrosive and resistant to abrasion.
Arcing	Discharge of electricity (a spark) that can occur when contacts are opened or closed. Arcing can degrade or burn contacts, reducing useful life.
Backlighting	A flexible layer within a membrane switch construction that illuminates select areas of the overlay, such as text or graphic symbols. (EL or optical fibers).
Circuit	Functioning component (sub-layer) of a membrane switch; typically made of a silver conductive ink printed on polyester. Also can be a flexible copper circuit, a PCB or polyester printed with other conductive materials.
Contact Bounce	Intermittent contact opening and contact closure that may occur after switch operation.
Contact Closure	Point at which specified resistance is achieved.
Contact Force	The force at contact closure.
Dead Front	Printing translucent ink in an area so that the graphic is visible only when backlit.
Density	Degree to which light transmits through a color or transparent window. The higher the density, the less light will be transmitted.
Dielectric Strength	Voltage that an insulating material can withstand before breakdown occurs, usually expressed as voltage gradient (such as volts per mil).
Digital Printing	Method of printing from a digital-based image directly to a variety of media or substrates.
EMI (also RFI)	Electromagnetic Interference (Radio Frequency Interference). Radiated energy from electrical devices, lightning and similar sources which interferes with the proper operation of electronic circuitry.
ESD	Electrostatic Discharge. Potential transfer of high electrical charge between objects by contact or through the air.
Gloss Level	The degree of shininess of a particular material, usually specified in percentages such as 75% gloss, 90% gloss, etc.
Halftone	Image made of a pattern of various size and shape dots (newspaper photograph) rather than continuous gray.
LED	Light Emitting Diode. Bright and robust. Most frequently used as an indicator lamp.
Membrane Switch	A momentary device in which at least one contact is made of a flexible substrate.
Non-Tactile Switch	A switch assembly that has a tactile ratio equal to zero.
Overlay	Top layer of a membrane switch (the graphic interface between a device and user) generally made of polyester or polycarbonate.
Pad Emboss	A raised area on an overlay, which defines a graphic feature (i.e. a keypad button or LED window).
Polyester Dome	A keypad on a membrane that has been dome-embossed on the overlay or top circuit layer to add tactile feedback when the switch is activated. The dome shape, which is usually formed by a hydro-forming process, can vary in size and shape to achieve a desired “force” and tactile “feedback” of the keypad.
Prototype Tooling	Method of fabricating prototype components without using steel rule dies (hard tooling) allowing changes before production runs without expensive tooling charges.
Rail Emboss	A raised area on an overlay which defines the perimeter of a graphic. (i.e. perimeter of a keypad or a border).
Screen Printing	Method of printing by forcing ink though a mesh selectively. This is done by closing parts of the mesh with a stencil.
Screen Tint	Area of image printed with dots so ink coverage is less than 100%, simulating shading or a lighter color.
Selective Texture	A transparent velvet finish printed on specific areas on an overlay to accentuate design elements such as windows, keypads or graphics.
Shield	A layer of polyester material that is either laminated with aluminum or printed with conductive ink to protect a switch from ESD or EMI.
SMD / SMT	Surface Mount Device / Surface Mount Technology
Specified Resistance	Maximum allowable resistance measured between two terminations whose internal switch contacts, when held closed, complete a circuit.
Sub-Surface Printing	Imaging on the reverse (second surface) of an overlay so the printed graphic is protected from wear by the material.
Tactile Ratio	A measure of tactile response.
Tactile Response	A sudden collapse or snapback of a membrane switch prior to contact closure or after contact opening.
Tactile Switch	A switch assembly that provides a tactile ratio greater than zero. Tactile switches give the user immediate physical feedback that the switch has been activated. Tactile feedback on a membrane switch can be achieved by using a stainless steel dome or a polydome construction.
Termination	How a switch is connected to the device it activates.
Translucent	Having the property of diffusing light; partially transparent.
Transparent	Having the property of transmitting light without appreciable scattering so that objects beneath are entirely visible.

Product Offering

- Membrane Switches
  - SimTouch™
  - SimScroll®
  - SimSlide™
- Elastomer Keypads
- Overlays
- Integrated Assemblies
  - Printed Circuit Boards
  - Touch Screens
  - Flexible Circuits
  - Plastic Consoles & Metal Back Panels
- Medical Electrodes
- Labels/Nameplates

Engineering Capability

- Electronic circuit design development
- Keypad designs
- Mechanical designs (sheet metal, brackets, etc.)
- Test Hardware Development (functional and parametric testing)
- Manufacturing tooling designs

Full-Service Facilities

- Artwork Generation
  - -AutoCad
  - -Adobe Illustrator
  - -Autodesk Inventor
  - -CorelDraw
- Electrical Testing
- Screen Manufacturing
- Laminating
- SMT Placement
- Dome Placement
- Connector Assembly
- Color Matching
- Digital UV Flatbed Printing
- Assembly
- Die Cutting/Fabricating/Slitting
- Punch Out – Weeding
- High-Speed State-of-the-Art Cutting Lasers

Quality System & Certifications

- Facility certification is to ISO 9001:2008
- Each employee is trained and certified to specific processes, and records are maintained for all activities

PANNAM IMAGING
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www.Pannam.com
18531 South Miles Road, Cleveland, Ohio 44128
800-524-4123
sales@pannam.com

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