Waterbased Coating - Sheetfed Drying v1.1

Modern sheetfed press drying systems have become sophisticated in their components and operational software to help aid in achieving optimum drying of inks and waterbased coatings. As press speeds and production demands increase, and job turn-around times from press to finishing to delivery decrease, the importance of achieving the most efficient and effective drying of ink and coating films is more important than ever. Thorough understanding of the drying process of conventional sheetfed printing inks and waterbased coatings, and how to use the tools available with the press drying system are critical to ensuring predictable and repeatable success. The goal of drying both inks and waterbased coating in-line at high press speeds requires proper individual and collective use of the press drying system components in conjunction with the availability of a powder-spray device. Together, these tools can help to achieve adequate ink/coating film setting within the drying tunnel and continued drying in the press-load prior to second-side printing or finishing processes.

Waterbased Coating Drying Principle

Drying Principle	Waterbased coatings in a wet state generally contain 60 - 70% water, which serves the purpose of maintaining all coating ingredients in a homogeneous state during storage, and the distribution of these ingredients throughout the coating circuit, over transfer surfaces and ultimately on the printing substrate in a wet film. Once the application process has been completed, the water component along with additional diluents are removed from the wet coating film by evaporation and possibly absorption if the substrate allows. The remaining coating components will coalesce into the final dried coating film which will exhibit the intended characteristics of the coating product. Ingredients such as ammonia and isopropyl alcohol that can be used to improve coating performance will also be removed by evaporation during the drying process. Influences which can determine the rate and distribution of water-loss from the wet coating film by evaporation or absorption: - Substrate - Drying System - Ambient Conditions
Substrate Influence	The amount of evaporative drying that is required by the wet coating film can be determined by the absorbency of the substrate and beneath ink film layers. High-absorbency paper and paperboard substrates can require less evaporation drying due to the ability of water to be quickly absorbed by paper fibers. Low-absorbency paper and paperboard substrates, high density wet ink layers, or dry-trap applications over dry/cured ink layers or primer coating can require more evaporative drying due to the inability of water to be quickly absorbed; this can be due to the construction of the paper or condition of beneath ink film/primer coating layers. Non-absorbent substrates will exclusively require evaporative drying as no water can be absorbed which may require special waterbased coating formulations.
Drying System Influence	High performance press drying systems that are in good operational condition can promote efficient and effective evaporative drying, which can reduce the amount of absorption required to set and dry the applied wet coating film quickly and completely. In cases where the press drying system lacks capacity or is in poor operational condition, the heavy reliance on absorptive drying may be required due to ineffective evaporation being achieved. In cases where the drying system capabilities are limited, special waterbased coating formulations may be required to enhance the evaporative drying characteristics of the coating product.

Waterbased Coating Drying Principle - *continued*

Ambient Conditions	Air can be described as a "sponge" as it relates to moisture absorption, and like a sponge, the drier the sponge, the more moisture can be absorbed; the warmer/drier the air, the greater the capacity for moisture absorption. The condition of ambient air for temperature and humidity within the press area can greatly influence the ability of moisture to be effectively evaporated from the applied wet coating film. Conditions in the press-room that are high in ambient temperature and relative humidity can impair evaporation and require increased substrate absorption for setting and drying, or result in extended drying times if the absorption of the substrate is limited. Conditions that are high in temperature and low in relative humidity can improve evaporation and reduce the amount of necessary substrate absorption.
Waterbased Coating - Film Setting	Coating film 'setting' is achieved during drying system exposure in which diluents are removed from the wet/applied film by absorption and/or evaporation. The coating film will begin to coalesce into a final/continuous film on the substrate/ink surface and the migration of slip agents to the film surface will provide short-term protection for scratch/burnishment and picking/set-off. In this state, the Operator will observe the coating film to be tack-free on press pull-sheets, and pull-sheets can be handled without smearing/transferring underlying ink films. While the 'set' state of the coating film provides initial protection as sheets enter the press delivery-pile, within the delivery-pile, and on press pull-sheets, the drying process is not complete and will continue to progress over several hours/days. The set state coating film will not exhibit the complete/intended characteristics of the coating film in terms of rub/burnish resistance, COF and block resistance. The set speed of the coating film can be influenced by variables such as coating product formulation, drying system capabilities/operation, substrate absorbency, ink film thickness/condition and ambient conditions.
Waterbased Coating - Film Drying	Complete loss of diluents from the applied coating film will allow the polymers to coalesce and harden into a final/continuous film on the substrate/ink surface. Complete migration of the slip agent to the coating film surface will establish the intended rub and block resistance as well as AOS/COF. At this point, the coating film will exhibit the intended product characteristics.

Conventional Sheetfed Ink Drying Principle

Absorption/ Evaporation - Prior to Drying Tunnel	Absorption and evaporation begin immediately after the ink film is applied to the substrate during the printing process and prior to the printed sheet reaching the press drying tunnel. Colorant and resin binder contained in the applied ink film will permeate the substrate surface while fountain solution contained in the applied ink film will be evaporated or absorbed for removal from the ink film. Process variables such as substrate absorbency, ink/dampening emulsification, ink density/over-printing ink films,fountain solution formulation and ambient conditions will all be determining factors in the amount of absorption and evaporation that takes place prior to the printed sheet reaching the drying tunnel.
Absorption/ Evaporation - Drying Tunnel Exposure	Drying system exposure will heat the ink film and promote absorption and evaporation by momentarily lowering the ink film viscosity which will increase substrate permeation while enhancing the release of contained fountain solution and diluents for absorption/evaporation. Once substrate absorption and moisture removal for the applied ink film has been completed upon exiting the drying tunnel, the ink viscosity will increase and the film will transition from a liquid to a solid and be considered "set". Any contained waxes formulated into the ink will migrate to the film surface creating a protective layer for rub/burnish resistance. At this point, the ink is not considered "dry", however, printed sheets do exhibit rub protection and can enter into the press delivery-pile without creating defects of scuffing, marking or ink-transfer/set-off. Printed sheets can be handled upon removal from the press delivery without significant smearing of the applied ink films.

REV 04/20_v1.1

Conventional Sheetfed Ink Drying Principle - *continued*

Oxidation	Within the delivery-pile and press-load, drying oils contained in the ink film begin to react with oxygen trapped between the printed sheets to begin a polymerization process causing the ink film to harden. This process will transition the ink film from a “set” state to a “dry” state. Additional ink drying stimulators can be added to ink or fountain solution to help increase the rate of oxidation/polymerization and reduce the ink overall drying time.
Non-Absorbent Substrates	Ink and fountain solution selection for non-absorbent or low-absorbency substrates must be tailored to achieve suitable ink film setting and drying without the benefit of ink components or fountain solution from penetrating into the substrate. Fountain solution selection and dosing must be such that the substrate surface does not become saturated with dampening in non-image areas which may contribute to poor ink transfer/condition on subsequent printing units. Ink/dampening emulsion stability must be excellent and the overall applied ink films must be minimized to avoid excessive ink/dampening sitting on top of the substrate surface. Special “high-solid” ink formulations are recommended which contain higher colorant loads and reduced resin varnish to enable achieving color at a thinner applied film thickness without compromising adhesion on the non-absorbent substrate.

Sheetfed Press Drying Equipment

Modern sheetfed press drying systems utilize a combination of heat generation in the ink/coating films and forced-air applied to the substrate surface as it passes through the drying tunnel to facilitate absorption and evaporate of any moisture/diluents from the applied ink/coating films. In addition, air-extraction is used to exhaust high-humidity air from the drying tunnel that is created by evaporation during the drying process. As printing press speeds have continued to increase, modern drying systems have been adapted to be more efficient in the ability to properly set and dry a variety of ink and coating formulations applied over a wide-range of substrate types. Increased length of the drying tunnel in modern sheetfed presses creates an “extended” delivery which can incorporate more drying system components. Drying systems can employ redundancy of drying system components to achieve progressive drying for optimized performance, particularly at high press speeds. Modern printing presses that are equipped with coating units to apply waterbased coatings utilize the following drying system components to achieve proper setting/drying of both conventional ink and waterbased coating films:

- Infrared Lamp(IR)
- Hot-Air Knife(HAK)
- Air-Extraction(EXT)
- Powder-Spray Device

Infrared Bulb(IR)	Infrared wavelength emitters housed on quartz tube “bulbs” are used as an energy source to generate heat in the substrate and applied ink/coating films. IR energy is an effective source due to the high absorption rate by ink and waterbased coating films, which results in accelerated temperature generation of the contained diluents in a very short dwell time compared to using a forced hot-air source alone. A drying system that exclusively uses forced hot-air will typically approach the necessary temperature for applied ink/coating films near the end of an extended drying tunnel, whereas the use of infrared emitters as an energy source will cause ink/coating films to reach an effective temperature almost immediately after being exposed. Redundancy of IR emitter bulbs in a drying system provides the most exposure of the printed/coated sheet to infrared energy even at high press speeds. Variability in infrared emitter output enables “as needed” adjustment based upon changes in printing conditions and individual job requirements. Adjustments to IR energy output will bring the most immediate and drastic change to sheet surface and captive press-load temperatures. Modern sheetfed press drying systems allow for the automatic adjustment of IR output based on the actual measured sheet surface temperature as it relates to a desired temperature target.

REV 04/20_v1.1

Sheetfed Press Drying Equipment - *continued*

Infrared Bulb(IR) *(continued)*	The most effective spectral range of infrared output for generating heat in lithographic ink and waterbased coating films is the short to medium, 0.7 - 10.0 micrometer wavelengths. The combined use of short and medium wavelength IR emitters optimizes the efficiency of the drying system by utilizing the advantages of each spectral range for impacting the substrate, ink, coating and ambient drying tunnel temperatures. Due to individual and collective advantages of both spectral output ranges, it is common for a combination of both short and medium wavelength emitters to be used in modern drying systems. The impact of using infrared emitters: - Lowers ink film viscosity to promote substrate absorption and release of diluents - Lowers coating film viscosity to promote substrate moisture absorption and film flow-out/leveling - Vaporizes fount and diluents in the wet ink film for removal to promote film setting - Vaporizes water and diluents in the wet coating film for removal to promote film setting - Stimulates drying additives in the ink film to promote oxidation
Infrared Bulb(IR) Longevity	The useful life expectancy of an infrared emitter for effective use on a sheetfed press is considered to be ~5000 operational hours. Despite continuing to produce visible light, a loss of efficiency in the infrared spectrum will cause the setting/drying capabilities for ink/coating films to become diminished. Additionally, the condition of the quartz tube and care of maintenance can determine the long-term efficiency of the bulb, as contamination with spray powder and paper dust that can become burned into the bulb surface can diminish the capabilities. Regular cleaning of the emitter bulb and reflector is recommended to maintain overall performance. The drying system should be maintained per the Manufacturer's recommendations to avoid performance issues that may contribute to poor ink/coating film setting/drying and quality issues.
Hot-Air Knife(HAK)	Forced hot-air is used to impinge the substrate surface as well as warm the laminate air above the sheet after IR exposure to absorb waterbased coating vapors for removal by the air-extraction system. Heated-air is required due to the greater capability to absorb moisture and therefore most effectively remove a larger volume of moisture-laden air created by waterbased coating from the press drying tunnel. Air blowers and heating elements are used in combination to create forced hot-air in the drying tunnel which is directed at the substrate surface through openings(hot-air knives) in the HAK cassette after sheet exposure to the infrared bulbs. With most modern drying systems, the desired temperature and volume of HAK is variable and can be individually adjusted to achieve the best results for drying of waterbased coating. Care should be taken to ensure that the amount of hot-air blown onto the sheet surface does not create turbulence and disrupt sheet travel. Disruption of sheet travel creating waves/ripples in the sheet can cause an uneven distribution of spray powder as the sheet passes beneath the spray-powder nozzles creating quality issues in the press-load.
Air-Extraction(EXT)	In order to continue the drying process of inks/coating on subsequent printed sheets, the humid/moisture-laden air that has been produced by evaporation in the drying tunnel must be removed and replenished with dry air supplied by the HAK. Air-blowers connected to drying tunnel exhaust outlets allow for moisture-laden air to be efficiently removed without negatively impacting sheet travel or spray powder application. If presses do not have integrated extraction within the drying tunnel, exhaust hoods can be added above the press delivery for humid air removal. Without adequate air removal from the drying tunnel, an excessive amount of moisture/humidity will accumulate and negatively impact the evaporation process for additional printed/coated sheets. Results can be sheets within the press-load that do not exhibit proper drying of both ink/coating films. In order to successfully remove the necessary amount of moisture-laden air from the drying tunnel, the extraction air volume needs to be greater than the supplied HAK air volume, typically by 50%. For sheetfed applications, an exhaust volume of 1400 - 1600 cfm is recommended using a large vent; air volume is most important and should not be confused with velocity.

REV 04/20_v1.1

Sheetfed Press Drying Equipment - *continued*

Spray Powder Device

For continued drying of ink/coating films in the press-load, proper spray powder selection and application volume is important. Spray powder application to the printed/coated sheet helps to create space between the sheet surfaces in the press-load preventing wet ink/coating films from contacting the sheet above; this is particularly important on two-sided applications. The space created between the sheets will trap air and allow for ventilation of the press-load to avoid heat retention and facilitate continued drying of inks/coating on captive sheets. The use of spray powder is particularly important on non-absorbent substrates, where oxidation of ink and evaporation of coating films are the only means for drying. In addition, the smooth and non-porous surface of plastics can cause a "glassing" effect where it is not possible for air to enter/exit the delivery-pile, therefore slowing the drying process and retaining heat from the drying tunnel exposure. Spray powder type and granule size can be selected based on the specific application, with volume of the applied spray powder being adjustable by the Operator based on job conditions.

Drying System Capabilities

The drying capacity/capability of a press is determined by the drying tunnel configuration in regards to length, number of cassettes, and availability/redundancy of IR/HAK/EXT components. Drying tunnel length can determine the number of available cassettes containing IR/HAK/EXT capabilities and the amount of dwell that the printed/coated sheet has available beneath these cassettes. The available drying capacity and tunnel length will ultimately determine the effectiveness of the drying system to be able to dry both inks/coating at high press speeds. Limitations in system components and/or drying tunnel length can cause for the operation of the drying system at near maximum capacity and/or reduced printing speeds to achieve adequate drying results. Limitations in drying system capabilities can contribute to problems of:

- Reduced press speeds
- Insufficient measured sheet surface and delivery-pile/captive-load temperature
- Sheet distortion; curl/embossing
- Quality issues in delivery-pile; ink-transfer/set-off, picking, scuffing, ink-balling
- Quality issues during second-side printing; sticking, blocking, picking, ink-transfer/set-off
- Quality issues during finishing
- Variance in coating film Gloss, COF/AOS, Rub resistance
- Odor issues on printed materials after packaging

Non-functioning drying system components should be replaced/fixed immediately to ensure that no performance and quality issues are encountered. Existing drying system components should always be maintained per manufacturer's recommendations/specifications to ensure that optimum system performance is achieved contributing to predictable drying results. For drying systems with limitations in capabilities/capacity due to system configuration and/or condition, special considerations should be made when selecting inks, fountain chemistry, coating and spray powder to ensure that adequate drying can be achieved to avoid quality issues. Substrate limitations may exist due to drying system capabilities/condition.

Drying Fundamentals

Progressive Drying

In order to efficiently and effectively promote the setting/drying of inks/coating films, redundancy of drying system components can be employed in modern printing presses to create "progressive drying." Long drying tunnels utilizing multiple cassettes that contain redundant IR/HAK/EXT components allow for the ink/coating films to achieve the highest degree of drying prior to the sheet reaching the delivery-pile, particularly at high press speeds. Sheet exposure to multiple drying cassettes containing IR/HAK/EXT enable the ink/coating films to become "drier and drier" as the sheet moves through the drying

REV 04/20_v1.1

Drying Fundamentals - *continued*

Progressive Drying *(continued)*	tunnel by continuous absorption/evaporation and removal of humid/moisture-laden air. Additionally, progressive drying through drying system redundancy allows for each component to be operated at a reduced output to protect the integrity of the substrate while achieving the desired drying results. Despite the redundancy of drying system components, component removal or the inability of any of the IR/HAK/EXT components to function properly will negatively impact the drying capabilities of the system and can lead to problems associated to insufficient setting/drying of ink/coating films.
Effective Short-Term Drying, “Setting”	The degree of drying achieved in the drying tunnel, or “short term” drying or “setting”, sets the stage for the effectiveness of continued “long term” drying that is experienced by captive sheets in the press-load. The goal in drying system operation is to remove as much moisture from the wet ink/coating films during drying system exposure to progress all wet films to semi-dry/”set” films prior to sheet delivery. Effective short-term drying will achieve the protective set-state qualities of the ink/coating films to help avoid quality issues upon sheet delivery and allow for the most effective continued drying to be achieved in the press-load. In-effective short-term drying can result in prolonged drying times for ink and/or coating films and quality issues in the press-load.
Delivery-Pile Temperature	Measuring the temperature of captive sheets in the delivery-pile using a stem thermometer is a valid means of determining adequate heat exposure of the sheet in the drying tunnel. A measured delivery-pile temperature of 95-100°F can help to ensure that adequate heat exposure by ink/coating films is achieved in the drying tunnel, as well as confirm adequate drying system performance and consistency. While this temperature indicator is a helpful reference for drying system condition/settings, it does not ensure success, and the condition of the drying ink/coating films need to be evaluated on the sheet. A balance between IR/HAK/EXT must be achieved to ensure that short-term setting of ink/coating films has progressed prior to the sheet being delivered Once the sheet has been delivered, the previous exposure in the drying tunnel as well as spray powder application will determine the efficiency and effectiveness of continued drying in the press-load.
Sheet Surface Temperature	Most modern press drying systems use pyrometers located in the press delivery to measure the sheet surface temperature as sheets enter the delivery-pile. Additionally, hand-held pyrometers can be used to measure the temperature of the sheet as it enters the press delivery. While the use of pyrometers can be a good indicator of sheet temperature, the use of a stem thermometer in the delivery-pile is recommended to confirm the actual delivery-pile temperature as it relates to the continued drying of inks/coating. Press drying system and hand-held pyrometers measure the printed/coated sheet as it enters the delivery-pile, in which the sheet is still losing heat from the drying system exposure. A noticeable difference of 5-10°F can be detected when using a thermometer in the delivery-pile compared to a pyrometer upon sheet entry into the delivery. It is a good idea when using the drying system pyrometer to measure and control drying system settings in an “automatic” mode, to correlate the desired drying system sheet surface temperature with the captive delivery-pile temperature using a stem thermometer. In most cases, a sheet surface temperature of ~105°F is necessary to achieve a captive delivery-pile temperature of 95-100°F. Keep in mind that the center of the delivery-pile and press-load will generally have a higher measured temperature than perimeter edges due to ventilation contributing to heat loss. In addition, ink and ink-free areas will typically measure differently for sheet surface temperature, with saturated ink areas measuring highest.
Drying Tunnel Temperature - Non-Production	Most modern drying systems use a function of IR or HAK to maintain drying tunnel temperature during periods of press idle/non-production. This feature is important to ensure that first sheets receive sufficient drying and to avoid drastic increases in IR/HAK output during production starts and output fluctuations for extended periods when operated in an “automatic” mode.

REV 04/20_v1.1

Drying Fundamentals - *continued*

Spray Powder Selection

Proper powder type and size is important based upon several factors:
- Substrate type/quality/absorbency
- Single vs two-sided printing
- Ink type/characteristics
- Ink density/coverage
- Coating formulation
- Drying system configuration/capability
- Additional surface applications; foil, film, UV coating

Powder sizes ranging from 15 to 80 microns are available in organic and inorganic materials for use on a broad range of stock thicknesses from label to heavy paperboard. Thicker/heavier substrates used for single-sided printing and stocks with inconsistent sheet caliper creating “high and low” areas may require larger micron-sized particles distributed in a high concentration to ensure that necessary separation is created between the sheets in the press-load. Thinner stocks used for two-sided printing will require smaller micron-sizes with minimal distribution to the sheet to avoid printing blanket contamination during second-side printing. High quality spray powders are necessary to ensure that the particle size and shape are consistent to provide even distribution and effective separation of the printed/coated sheets. As a practice, apply the least amount of powder to promote the most effective press-load drying for ink/coating films. Natural starch powders are the most common powder type used in the printing industry and are most desirable for their soft-round shape and non-abrasive nature. Starch powders are available in coated and uncoated versions depending on the application. In-organic powder types such as calcium-carbonate are available and have advantages due to the particle weight and the fact that they due not clump or stick together, however, they are very abrasive and not suitable for two-sided applications.

Coated Spray Powder

These powders are specially treated with a coating to make the powder particles resistant to absorbing water and hydrophobic/non-soluble in water. Insolubility will allow the powder particles to retain their original shape and dimensional stability when being distributed over the surface of a wet/semi-dry waterbased coating film after the drying tunnel. This allows for optimum sheet separation in the press-load to be achieved to promote continued oxidative and evaporative drying of ink/coating films by air-exchange/ventilation. Coated powders are less likely to stick together and clump in the powder system or storage container, particularly in high-humidity pressroom conditions. It is recommended to use coated powders in conditions where the “short-term” drying of waterbased coating is not effective or when evaporation is the only means of drying on non-absorbent substrates. Additionally, coated powders are best suited in situations where additional slip is required for finishing applications.

Uncoated Spray Powder

These powders are untreated and are hydrophillic/water-soluble, and will absorb water when in contact. Due to water absorption, uncoated powder will have a tendency to break-down when coming into contact with wet or semi-dry films of waterbased coating in the drying tunnel. As the powder particle absorbs water and dissolves/breaks-down, the ability to create necessary space between the printed/coated sheets in the press-load to provide ventilation for continued oxidative/evaporative drying of inks/coating will be greatly reduced. Uncoated powders are only recommended when very good short-term drying can be achieved in the drying tunnel prior to sheet delivery, or with substrates with high absorbency where evaporative drying can be reduced.

Calcium Spray Powder

These powders tend to be more uniform in size as they are easier to sort, and a higher percentage of distributed powder can make it to the sheet surface due to the increased particle weight compared to starch powders. However, these powders are very abrasive and can contribute to scratching of the printed surface and contamination and degradation of printing plates during two-sided applications.

REV 04/20_v1.1

Drying System Operation

Automated Mode

- Locate drying system pyrometer above press delivery-pile; pyrometer measures sheet surface temperature of incoming sheets to the delivery-pile.
- Ensure that drying system pyrometer is clean; observe manufacturer's recommendations for cleaning.
- Determine desired drying system temperature value; drying system value of 100-105°F will typically achieve a delivery-pile temperature of 95-100°F measured with a stem thermometer.
- Ensure that all drying system components are enabled/operational.
- If applicable, input correct IR format for sheet width.
- If applicable, input system parameters for upper/lower limits for IR and HAK ouput to create a window of operation that will minimize output fluctuation while achieving the desired drying system temperature; this may require experience by operating the drying system in a “manual mode” to determine optimum system settings based on the variables of press speed, substrate, ink/coating coverage.
- During production, confirm that the drying system actual temperature achieves the desired temperature value; observe stability of the actual temperature as well as consistency/fluxuation of drying system IR/HAK output.
- Correlate the actual drying system temperature with a hand-held pyrometer and/or stem thermometer to confirm accuracy; delivery-pile temperature measured using probe thermometer should be 95-100°F. The surface temperature of incoming sheets into the delivery-pile can typically measure 5-10°F higher than the captive delivery-pile temperature when a using hand-held pyrometer.
- During production, observe drying system output of IR/HAK components and compare to the actual drying system temperature. In cases where upper/lower limit parameters are not available for IR/HAK output, large fluctuations in system settings in an attempt to achieve the desired temperature value can result in sheets being produced with varying degrees of drying. This can result in areas within a single press-load exhibiting different degrees of drying for inks/coating. In cases where drying system output is erratic for IR/HAK, operation of the drying system in a “manual mode” may be required to ensure that all sheets are produced with a sufficient amount of drying system exposure. A press-load that exhibits different areas of sheet jogging quality is an indication of changes in drying system settings in an automated mode that results in varying degrees of drying exposure.
- Observe that printed/coated sheet exhibit good drying at existing drying system settings.
- Based on drying performance observations, make necessary adjustments to the drying system desired temperature value and upper/lower limit settings to optimize drying system performance while minimizing system output fluctuation to achieve a measured delivery-pile temperature of 95-100°F.

Manual Mode

- Determine the temperature measurement method for monitoring drying system operation: drying system pyrometer, hand-held pyrometer and/or probe thermometer; drying system pyrometer measures incoming sheet surface temperature only, hand-helf pyrometer can measure incoming sheet surface temperature and delivery-pile/captive-load temperature, probe thermometer will measure delivery-pile/captive-load temperature only.
- Determine the desired target temperature to achieve adequate drying performance of ink/coating films. An incoming sheet temperature of 100-105°F and delivery-pile temperature of 95-100°F is considered a good temperature target. If measuring both incoming sheet temperature and delivery-pile temperature, it is always recommended to correlate both measurements to achieve a common delivery-pile temperature of 95-100°F to make both measurements interchangeable while maintaining the desired temperature results.
- Ensure that all drying system components are enabled/operational.
- If applicable, input correct IR format for sheet width.
- Preset all drying system components to an output that will closely reflect the desired temperature target based on the variables of press speed, substrate and ink/coating coverage.

REV 04/20_v1.1

Drying System Operation - *continued*

Manual Mode *(continued)*	- During production, tmke temperature measurements and note results. Observe drying performance of ink/coating films on the sheet. - Based on temperature measurement observations/trends, make necessary adjustments to IR/HAK output to target the desired delivery-pile temperature. - Continue making temperature measurements and necessary adjustments until the desired temperature is achieved. Always observe drying performance of ink/coating films to ensure successful drying results.
System Check-List	- IR bulbs are functioning - IR bulbs and reflectors are cleaned - IR bulbs have <5000 hours operational hours - IR bulb wavelength output has been confirmed; short, medium, combination short-medium - HAK are functioning - HAK heating elements are functioning - HAK supply hoses have no defects such has holes, kinks, restrictions - HAK slots/nozzles are open and clear - HAK incoming air filters are clean - Air-Extraction is functioning - Air-Extraction hoses have no defects such as holes, kinks, restrictions - Air-Extraction volume is sufficient - Powder device is functioning - Powder device hoses and nozzles are clean - Powder device supply air pump filter is clean - Test powder device; print full-size sheet with complete black ink coverage with powder applied and observe sheet surface for complete powder coverage by side-illumination, OR, place full-size sheet printed complete with black ink beneath powder device nozzles and enable “test mode” to distribute powder over the sheet surface and observe for individual nozzle performance.

REV 04/20_v1.1