Safety Requirements for Paper Machine Drying Sections

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Contents

Scope

This Practice Note applies to all Mondi paper mills. All mills are to assess their associated risks and develop plans to implement the requirements listed in this Practice Note. The paper machine drying section is defined from the press section to pope including hood and steam system and equipment located under the hood but excluding calendar, Clupak and sizing press.

Objective

The objective of this Practice Note is to standardize the minimum safety requirements during operations on paper machine drying sections across all Mondi operations.
All operations are to adhere to the minimum requirements within five years (end 2026). The relevant Business Unit (BU) CEO and/or COO on advice from the BU and Group Safety and Health (SH) Managers shall approve any exceptions to the requirements as listed in this Practice Note.

Tasks and Hazards

Tasks Conducted in the Drying Section of Paper Machines

The following are typical tasks, which are conducted in the paper machine drying section whilst the machine is in running mode:

Drying Section

Machine in Operation

- Walkover and inspection of equipment of drying section
- Tail threading
- Greasing
- Bearing monitoring
- Broke removal, operational level 1 and 2
- Edge controllers for driving unit- condition inspection
- Continuous fabric cleaning (high pressure cleaning) (edge paddles, guiding units, felt tensioning)
- Measuring temperature curve
- Fabric tension measurement
- Dust cleaning
- Visual inspection of joints and valves (steam leakage) (thermo-camera)
- Temperature measurement (inlet and outlets) steam joints
- Infrared dryer inspection
- Infrared dryer cleaning
- Inspection of moisture-risers

Maintenance

- Drying cylinder (drying can) replacement
- Drying cylinder pressure testing
- Inspection of cylinders through manhole

- Doctor blade changes
- Rope changing
- Fabric changing
- Dust cleaning (while machine is stopped for maintenance tasks)
- Cleaning of rolls and cylinders from dirt contamination (scraper, high-pressure water)
- Broke removal (while machine is stopped for maintenance tasks)
- Cutting threading ropes off journals of rolls
- Removal and replacement of cylinders, rolls, doctor holders, machine components including run-ability components (e.g. blow boxes, pocket ventilation boxes
- Bearing inspection
- Rope pulley change
- Edge paddles, guiding units, felt tensioning condition checks
- Inspection of equipment for fabric cleaning
- Service activities on machine clothing in the area of drying fabrics
- Operations during industrial safety expert review
- Lighting
- Lubrication and compressed air piping and accessories

Hood

Machine in Operation

- Opening and closing doors

Maintenance

- Dust cleaning (compressed air and hoses or where this is prohibited cleaning by vacuum cleaners, mops, water is poured on sides of hood)
- Repair and adjustment of hood elements, fixations, replacement of elements
- Adjustment and inspection of drying hood ventilation elements
- Drying felts from press part on top of hood

Main Hazards in the Drying Section of Paper Machines

The main hazards that exist in paper machine drying section include the following:

Falling Objects

- Drying cylinders, ropes, rope pulleys, other machine components, felt, doctor blades, broke, building material
- Falling tools and compressed air and water hoses

Nip and Pinch Points

- Between felt and rolls
- Between rolls
- Between rolls and doctor blades
- Between rotating parts and cross beams
- Between rotating parts and structures
- Between pulleys and ropes

- Between tensioning mechanisms, felts and ropes
- Between drying fabric guiding mechanism
- Between drive systems and structures
- Moving parts of drying hood shutter

Rotating Parts

- Drying cylinders
- Rolls and pulleys
- Broke conveyors
- Rotating felt
- Threading conveyors
- Threading knives (tail cutting)

Fire Risks and Combustible Materials

- Paper
- Grease and oil (leakages)
- Lubrication and hydraulic stations
- Dust (fibres)
- Wires
- Hot surfaces
- Static electricity
- Friction (incl. bearings, felt)
- Electric Material (JBs, cables, etc.)

Cut Hazards

- Doctor blades
- Cutting tools (broke jam removal)
- Cut tools (felt installation)
- Rope cutting knife (fishbone knife)
- Paper web
- Ropes
- Felt

Hot Surfaces and Environment

- Hot drying cylinders
- Steam conveyances (pipes, manifolds, valves etc.)
- Hood interior
- Area above drying section
- Area in drying section cellar
- Pipes (system) for condensate removal

Falling from Height

- Working at ground level - fall to cellar (pits, service platforms under the hood)
- Working on upper levels - falling to ground level or cellar

- Working on top of the hood or in hood ceiling - falling to ground level or cellar
- Going up and down the stairs, from platforms

Slip and Fall

- Slip on water, lubricants, chemicals, paper(broke), on felt
- Tripping on paper (broke), uneven floor, ropes, sewer channels, hoses, pipes, equipment etc.

Confined Spaces

- Drying cylinders
- Yankee cylinders
- Separator
- Condensate collector

Exposure to Hazardous Substances

- Venting or leaking steam
- Unplanned steam release (including catastrophic release - explosion)
- Condensate leakage and drainage
- Hydraulic oil or lubricant oil leakage
- Compressed air leakage

Manual Handling Hazards (Strains etc.)

- Manual tail threading
- Doctor blade handling
- Broke cutting
- Broke removal
- Rope installation
- During inspections

Other Hazards

- Noise
- Vibration
- Dust
- Environmental heat
- Humidity
- Very intense or insufficient lighting

Minimum Requirements

Trigger for minimum requirements: The following requirements are based on four of the five elements of the hierarchy of controls, being substitution, engineering controls, administrative controls, personal protective clothing and equipment, and safety culture.

Elimination

See good practices below.

Substitution

The risk shall be substituted as follows:

- Installation of a rope less tail threading system if:
  - Other measures considered do not reduce the risk to an acceptable level, and;
  - It is technically possible (e.g. machine speed higher than 300 m/min, depending on paper grade, basis weight, moisture, machine components).
- Installation of an automatic greasing system (central lubrication system).
- Installation of automatic bearing monitoring system. Units (outside hood) that allow offline measurement.

Engineering Controls

In order to reduce the risk levels to an acceptable level, the following should be installed to provide a safer operational environment:

- Lifeline systems protecting workers that are exposed to falling hazards or work at height.
- Guarding of all the nip points and rotating parts (including cardan shafts), including fencing or barriers that prevent exposure of hands, arms and full body to moving and rotating machinery.

  Guarding on both the operator and drive side to comply with local machine guarding norms and standards (for example: EN 1034 - Safety of machinery - Safety requirements for the design and construction of paper making and finishing machines; EU Machinery Directive 2006/42/EC; EN ISO 12100-1 Safety of machinery - Basic concepts, general principles for design etc.) and Mondi Practice Note “Machine Guarding”.

Examples of drying section paper machine guarding

- Solid fencing/barriers (no chains or plastic barriers) to prevent falling into the cellar from the operating level.

Fall prevention barriers

- Where relevant, system to support the widening of sheet from last drying-cylinder to the pope to create tail stability - for example: Swiecie has pull down doctor beams from Runtech.
- Tail threading - Rope threading used at machines with indirect manual interaction (compressed air, wooden/hockey type sticks) to place paper tail for threading.
- Greasing - remote tube greasing system.
- Bearing monitoring - Online systems to replace direct measurements that are still taken at some PM and in some areas when the machine is running without paper once hood is opened.
- Broke and broke jam removal at drying cylinders, including Yankee cylinders and associated doctor blades and doctor blade holders. Compressed air used to blow broke out of level 1, removal from level 2 with machine stopped and old fabrics placed on cross beams. Long fingers and hooks to be used.
- Edge controller condition inspection - installing limit switches for felts to ensure the groups stop as the felt leaves its operating parameters. Can also be inspected from walkways out of the drop zone while in operation or done during shut down.
- Fabric tension measurement - automatic measurement were feasible including extensive trialing before installation and roll out.
- Dust cleaning - usually done during shuts with air blowers, mobile vacuum cleaning, installed vacuum cleaning to replace manual cleaning with brooms (Minimum once per year during shut, under hood during regular shut once a month or as determined by the paper machine manager).
- Inspections of integrity steam joints and valves at regular, risk based, intervals.
- Infrared dryer inspection - interlock installed.
- Rope system pneumatic adjustment and tensioning - adjusted while machine is running, DCS system adjusts automatically. Some systems are locally adjusted at local control panels. Rope tension measurement tool to be used by operators.
- Drying cylinder Hood Standard - automatic hood opening system (DCS controlled) when a break occurs and manual closing following tail threading; Closing the doors of hood is done manually at some PM's by operator (pressing a button).
- Yankee cylinder hood Standard.
- Hood roof access: Hood roof panels integrity confirmed to be able to support personnel accessing the hood roof, alternatively a railed hood roof walkway installed with lifeline or harness attachment points for work on the hood roof.

In order to reduce the risk levels to an acceptable level, the following should be in place to provide a safer maintenance environment:

- Cylinder replacement - LOTO, safe lifting equipment including cranes.
- Cylinder inspection through manhole -- LOTO, cooling.
- Pressure vessels - (pressure test on drying cylinders and relevant valves) - frequency of integrity checks of drying cylinders determined by site procedures and local requirements and including drying cylinder wall thickness once per annual shut on 10% of cylinders per annual shut (10 years - minimum). Steam supply can be locked out and blank-flanged.
- Doctor blade changes - done by technologist and supported by maintenance, covered storage boxes, mechanized equipment used to cut and dispose old doctor blades, pulling devices to be used.

Doctor blade disposal device

- Fabric changing - walkways are required (not possible on older machines), safety ropes and attachment points in place to support safe work at height.
- Cutting threading ropes off journals - manual cutting of ropes with the group stopped (using certified cutting tools). SCP eliminated this hazard by using automatic tail threading.

Administrative Controls

Although implementing administrative controls does not necessarily reduce the risk levels, sites shall provide necessary information of the risks and provide safe tools, equipment and warnings that enable operators to conduct the tasks safely, these include:

Operational

- Displaying suitable labelling - signs indicating hazard warnings and no authorized entry warnings at moving and rotating machinery and equipment, hazardous area access points and hazardous substance conveying (steam/condensate etc.) equipment.
- Developing safe operating procedures for:
  - Tail threading - where rope threading is used with manual interaction to place paper tail in thread - safe operating procedure (SOP) (tools - compressed air hoses and wooden sticks) Steti PM1 Rope threading inside drying section and training team members.

- Greasing - SOP that describes safe manual greasing including adequate cooling periods in areas where an occupational risk assessment demonstrates that personnel are exposed to heat stress.
- Bearing monitoring - SOP that requires cooling periods.
- Broke and broke jam removal at drying cylinders, including Yankee cylinders and associated doctor blades and doctor blade holders. - SOP's that include:
  - Stopping the drying section or Yankee cylinder, stopping doctor blade holder movement motors, applying LOTO.
  - The SOP has to define that this task is done by an experienced operator.
  - Removing broke or broke jams using tools (compressed air, long fingers, rod with scraper, hooks, wooden sticks) for this task.
  - Rest periods to defined in SOP.
  - Safe manual removal using hands needs to be clearly described in the SOP including the use of Class 5 cut resistant gloves.

➢ In case paper jams at doctor blades or doctor blade holders cannot be removed the SOP has to require that doctor blades will be pulled or doctor blade holders removed by maintenance or trained operators.

- Removing paper jam under doctor blade - SOP that includes stopping the dryer section, LOTO, safe removal of doctor blade and returning to it positions. Safety knives and hooks to be used with class 5 gloves and lower arm protectors to cut and pull broke out of the jam.

Hook to remove broke (SCP example)

- Edge controller condition inspection - during operating conditions - done using an SOP (persons in no go area - machine rotating at full speed).
- (Example: Swiecie does this activity in two steps - first after clothing change during the shutdown and then fine setting during crawling. Clothing have to crawl to go on track first and then adjustment of the edge switches may be done. In some positions like on PM7 we have solution which allows us to correct it on the run).
- Measuring temperature curve - Contractors use special equipment and SOP to measure the temperature curve (open hood to go inside - use special PPE, air-cooled).

- Example: Steti and Stambolijski opens hood doors and uses a contact temperature probe (1.5m length, no special PPE, done by technologist). SCP uses thermo-camera to check the temperature.
- Rope system adjustment - Rope change requires that groups have to be stopped. A detailed SOP describing safe execution of this activity, including use of crawl speed (10m/min for rope adjustment is advised) has to be in place (see references).
- Fabric tension measurement - where automatic measurement is not possible, defining safe manual measurement can be made without exposing personnel to moving and rotating machinery or felt failure .
- Infrared dryer inspection - Only during shut, prevent water contact, LOTO.
- Inspection of moisturizers - Only during the monthly shut, (when out of the drop zone inspection can be done).
- Manual rope change - requires an SOP.
- Hood Standard - an SOP describing the safe operation of the hood.
- Hood access - an SOP defining safe hood access and or access prohibitions.

Maintenance

- Removing and replacing of cylinders - planned process as part of annual shut or as required (a number of other services be dismantled) - such activities need specific safe work methods and requiring a PtW, LOTO, safe lifting of equipment including cranes.
- Cylinder inspection through manhole - confined space PtW and SOP (defines the safe opening due to condensate, hot substances/steam pressure, adequate cooling time allowed to achieve a 320C wet-bulb room temperature), rescue equipment (special evacuation stretcher) (example - SCP cooling of cylinder metal at atmosphere).
- Doctor blade changes - done by technologist and supported by maintenance based on SOP (addressing safe work method, PPE requirements and safe handling and disposal based on the Mondi Practice Note Doctor Blade Safe Handling).
- Fabric changing - an SOP is required that describes safe work at height (use of lifelines, full body harnesses used and attached), removal of old fabric and installation of new fabric.
- Cutting threading ropes of journals - an SOP is required for manual cutting of ropes with the group stopped, describing safe work around hot surfaces, PPE requirements(heat protective sleeves, no cooling time, small incidents occur and safe tool use.
- Dust cleaning - usually done at shut by either employees or contractors (air blowers, mobile vacuum cleaning, installed vacuum cleaning, manual cleaning with brooms).

Personal Protective Clothing and Equipment (PPE)

Suitable personal protective clothing and equipment shall be issued in addition to the administration controls listed above and/or as required in the site-specific task based risk assessments and safe operating procedures. These include, but are not limited to the following:

- Hearing protection.
- Foot protection with steel or composite toe caps.
- Head protection (bump caps or helmets):
  - Some sites require helmets, some sites bump caps during production
  - Helmets are required during shut or maintenance activities and in basement

- Helmets or bump caps not to be worn if inspecting or working on the operational machine (only operating and threading the machine)

- No long sleeved jackets due to risk of material being caught by rotating equipment. In cases were legislation requires long sleeved jackets for burn protection, these shall be buttoned up.

Tail Threading

- Safety glasses: (Steti and Stambolijski are not using safety glasses as these are fogging up - rope system threading may result in glasses fogging up - if this risk exists glasses not to be used; SCP's machines that have automatic threading require operators to use safety glasses).
- Safety gloves: Gloves are used for tail threading to protect against exposure to hot surfaces.
- Safety sleeves: Offer lower and upper arm protection against hot surfaces (Steti is testing protective sleeves). At some operations buttoned-up long sleeves of coats can be used.

Broke Removal Level 1 and 2

- Standard PPE as above, in case of cutting tool use or exposure to doctor blades, class 5 cut resistant gloves are to be used.

Paper Jam Removal

- cut resistant gloves (class 5) that also provide protection from heat.

Measuring Temperature Curve

- Heat protective gloves. External companies use air-cooled suite (SCP to share this practice - Voight - (picture or contact details - possible good practice). Felt suppliers also have this equipment TSF and Asten Johnson; "Stambolijski using a pocket thermo-camera to check heat sources - picture to be shared; Steti uses a contact thermometer and thermo-camera".

Doctor Blade Removal/Installation

- Class 5 cut resistant gloves.

Dust Cleaning During Shut Downs

- Dust protection mask.

Fabric Changing

- Fall protection harness used with correct lanyard attached to lifelines or suitably graded attachment points to prevent fall from height as defined in Fabric change SOP.

Drying Cylinder Inspection

- Extraction stretcher with training.

Rope Cutting

- Safety knife for cutting ropes and plastic wrapping; class 5 cut resistant gloves.

Cutting Threading Ropes of Journals

- Class 5 cut resistant glove and where relevant fall protection systems.
- Effective communication between control room and field operators, important during inspections, tail threading or other routine tasks, for example radios with speaker and headphones integrated in hear protection. Such equipment is also relevant for maintenance tasks and co-ordination.

Safety Culture

- Safety leadership programs for line managers and first line managers.
- Management risks focused auditing and first line manager critical task audits.
- Safety engagement program and board use.
- Interactive safety training concepts.

Additional Requirements and Good Practice

The following requirements are compulsory when designing and or purchasing new paper machines as well as during major rebuilds/modernization of paper machines or parts thereof. These controls are based on the top four of the five elements of the hierarchy of controls, being elimination, substitution, engineering and administration controls.

Elimination

- Rope less threading for all new paper machines (Dynäs PM5 speed up each drying group by 2 meters when starting tail threading and goes back when paper has full width); with broke conveyor where cellar construction supports this, including guard fencing to prevent access to the pulper opening.
- Web-break cutters between relevant groups to prevent broke jams for new machines.
- Platforms on the top position between stretcher and roll - with winding and unwinding station to pull the fabric through the machine with barriers to prevent personnel to fall.

Substitution

- Temperature curve soft sensor calculation systems.
- Online measurement system for vibration.
- Automatic lubrication/greasing systems (>500m/min).
- Drying cylinder inspection using borescopes or industrial endoscopic systems.
- Automatic threading in the area of paper web transfer into dryer and from dryer.

Engineering Controls

- To facilitate safe work at height, designing of safe access platforms or lifeline systems and their installation.
- Physical barriers for nip points that allows broke cleaning and cleaning of broke from beams (cleaning belt and rotating).
- Web-break cutters between relevant groups to prevent broke jams.
- Installation of Dryer Fabric Cleaning system (hot HP water + soap) to maintain fabrics in good operating condition, reducing need to manual cleaning.

Digital Maintenance Assistance Tools (Convergence Training)

- Dust removal: Vacuum systems for example SCP PM 18 central vacuum system.
- Control of equipment in drying section by industrial television method (video monitoring camera) in each section excluding the basement.
- Technical solutions to ease broke jam removal at Yankee cylinder and associated doctor-blades and doctor blade holders. Options include:
  - Narrower holders.
  - Lift-able doctor blades.
  - Two doctors instead of three to increase space.

PPE

- Cooling vests.

Culture

- Digital (augmented reality 3D concept) training of operators.
- Devices for communication using hands free and glasses with camera and image sharing capability (new ways of working).

References

- Mondi Practice Note “Machine Guarding”
- Mondi 9 Safety Rules to Live By
- Requirements for guarding are described in EN 1034 - Safety of machinery - Safety requirements for the design and construction of paper making and finishing machines
- ISO 12100:2010 Safety of machinery - General principles for design - Risk assessment and risk reduction
- Audit template for safe operation of paper machines
- Mondi Practice Note Doctor Blade Safe Handling
- https://www.valmet.com/board-and-paper/board-and-paper-machines/sustainable-performance/working-safety-and-usability/
- https://www.convergencetraining.com/paper-manufacturing-training.aspx
- EN 1034 1-2021 - defining crawl speed: The lowest practicable speed, no greater than 0,25 m/s (15 m/min). HSE Guide to Making Paper Safely (Part 6 of Guide to managing health and safety in paper mills) advises that a maximum crawl speed should be 10 m per minute: https://www.hse.gov.uk/pubns/web07.pdf

Appendix I - Images of Described Tools

Rope Tension Measurement

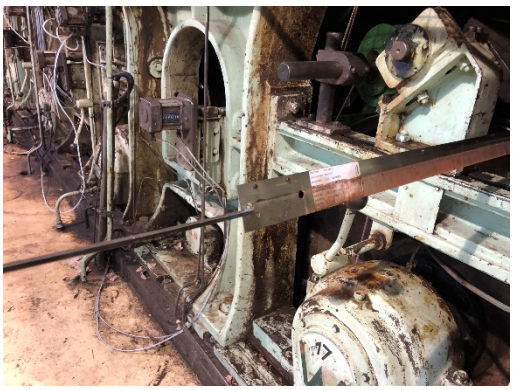
Example tool from Stambolijski:

Cut Hazards

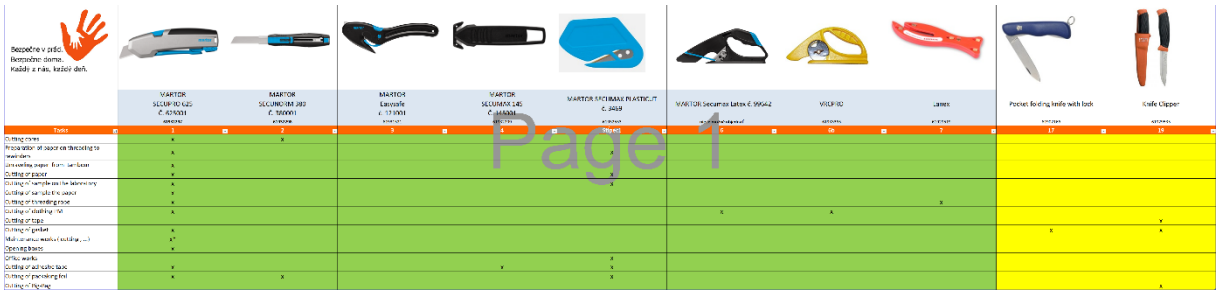
Doctor blade pulling tools, storage bin, destruction device for old blades and arm sleeves:







Example of SCP Approved Cutting Tool Catalogue:



Stambolijski example of safety knife for rope cutting:

Moving and Rotating Machinery Hazards

Long fingers to keep safe distance during broke removal

Beam Covers as Used in Steti

Hot Work Environment

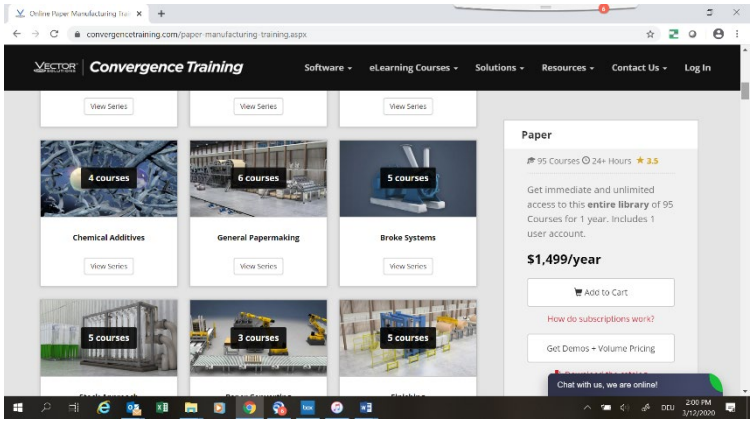
Frantschach example of a cooling vest for work in hot environments:

Example of arm sleeves that protect against contact with hot surfaces and objects:

Stambolijski thermo-camera tool:

SCP Temperature curve measuring PPE used by Voight:

Training



Example of digitalized paper machine training materials:
https://www.convergencetraining.com/paper-manufacturing-training.aspx

Drying Cylinder Rescue

Swiecie Rescue Stretcher

Good Practice exchange – Life line system mondi

Operation	**Paper machine №21**
Contact Person	**D. Sivtsev**

Description of Problem

- In order to conduct regular operations on replacement of PM-21 machine clothing, personnel had to conduct works at height where safe preconditions were not ensured sufficiently.
- There was risk of falling from height due to lack of anchoring points.

Details of Improvements

Pilot project was successfully implemented in 2019 on PM-21: 19 guard rail systems were mounted in total(6 guard rail systems at the machine press section and 12 guard rail systems at drying section). To mount these life line systems stationary protective-guard rail systems of Ez-line, AXIOS D, AXIOS M types were used, they allow 6 persons to be present and move unobstructed through intermediary anchoring points on section located at PM-21 bottom wire and up to 2 persons on other areas.

Guard rail systems can be operated under temperature up to +50 C.

Syktyvkar PM21 safe work at height lifelines

Document Control

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