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PROPERTY INSURANCE COMMITTEE

Prevention Specifications

Gas extinguishing installations

Specifications for spark detection, spark extinguishing and spark diversion systems –

Planning and Installation

CEA 4044: June 2004 (en)

(EFSAC endorsed)

Contents

1. General

1.1. Scope

These specifications give the requirements for planning and installation of spark detection, spark extinguishing and spark diversion systems.

These specifications describe minimum requirements.

In this document:

- "shall" indicates a mandatory requirement,
- "should" indicates a recommendation.

Permanently installed spark detection, spark extinguishing and spark diversion systems can be approved provided that the system meets the requirements of these specifications and the system uses approved components. Complete system approval is also required. Installation shall be by an approved installing company.

If, in individual cases, explicit regulations are missing, details have to be agreed upon with the responsible authority. All national regulations should/shall of course be observed.

1.2. Aims

Sparks occur when materials are processed or separated. Sparks together with combustible dust, chips, slices, flakes, etc. can cause fires in transport systems and connected plant areas. Primary ignition sources are sparks due to foreign bodies, blunt tools and hot surfaces but also frictional heat and overheating. Filters, bunkers, silos or other machinery connected to conveying systems are most at risk.

Spark detection, spark extinguishing and spark diversion systems provide reliable protection in closed systems such as conveyors, since they deal with the fire at source. General room fire extinguishing systems (e.g. ceiling mounted sprinklers) are not designed to react early enough and efficiently for such fires. However spark detection systems are only useful when backed-up with adequate protection measures.

Necessary additional protection measures depend on production methods and protection requirements.

1.3. Application

These requirements and recommendations apply to spark detection, extinguishing and diversion systems that are permanently installed in areas of plants where materials, e.g. fibres, dust, chips etc., are transported, and have the potential for causing fires and spreading fires.

1.4. References to standards, regulations, memorandums

CEA specifications for Sprinkler Systems, planning and installation

CEA specifications for fire detection systems, planning and installation

2. Definitions

Authority: Body having jurisdiction over aspects of the installation, e.g. insurer, fire brigade, government agencies.

Disable Device: Manually activated shut-off valve installed in the spark extinguishing water pipework. In normal operation the valve shall be fixed in the open position.

Alarm devices: Devices inside the plant for audible and visual alarm.

Trace Heating: Controlled electrical heating system installed along the length of a pipe to provide frost protection to the extinguishing water pipes and extinguishing nozzles.

Pressure controller: A device that monitors the operating pressure in the extinguishing device.

Pressure Booster System: A system that automatically supplies the required quantity of water at the required operating pressure.

Spark Diversion System: A system to automatically divert conveyed material containing sparks. Basically such a system consists of a spark detection and diversionpart.

Spark Diversion Part (e.g. damper/vent) (symbol: ⋄): Equipment designed to divert the discharged material containing sparks.

Spark Detection System: A system designed to automatically detect the flow of sparks. The system basically consists of spark detectors, spark control and indication equipment and an alarm device.

Spark Extinguishing System: A system to automatically detect and extinguish sparks in conveyed material. The system basically consists of spark detection and extinguishing parts. A spark extinguishing system is able to protect one or several areas at risk.

Spark Extinguishing Area (SEA): Area within a production line that is controlled by spark detectors which can activate one or more spark extinguishing parts.

Dependent Spark Extinguishing Areas: Two or more spark extinguishing areas that can be triggered by sparks from the same upstream location. Spark extinguishing areas which are likely to be triggered simultaneously by a single source of sparks are called compulsory.

Independent Spark Extinguishing areas: Two or more spark extinguishing areas that can not be triggered by sparks from the same upstream location.

Spark Extinguishing Part (symbol: ▽): Extinguishing device that is automatically triggered by a spark detection system.

Spark Detector (symbol: F): The detector of a spark detection system that recognises changes in intensity within certain spectral ranges depending upon its type.

Spark control and indication equipment: This part of the spark detection system serves for:

- receiving of signals given by the connected detectors, giving visual and audible indication of these signals, receiving the location of the spark flight and recording messages if necessary.

- triggering the extinguishing or spark diversion parts

- monitoring system and giving visual and audible fault indication (e.g. wire breakage, short circuit or others)

Installation certificate: A form in accordance with appendix A 1 stating information concerning the specific system.

Extinguishing injection: Injection of extinguishing agent for a pre-determined time.

Extinguishing action: Activation of the spark extinguishing system leading to extinguishing agent injection.

Extinguishing water control: To monitor whether extinguishing function operates correctly or not.

Solenoid valve: This valve is part of the spark extinguishing part and is triggered by the spark detection system to release the extinguishing agent.

Strainer: A strainer to prevent unwanted material from reaching the spark extinguishing equipment.

Quick action damper/vent: A shut-off element installed within pneumatic transport ducts for diverting the flow of material.

Extinguishing nozzles: Special nozzles belonging to the spark extinguishing part. They perform the water injection into transport ducts.

Flow switch: A monitoring device to ensure water flow inside the pipe of the spark extinguishing equipment.

3. Spark Detection System

3.1. Description

The task of the spark detection system is to detect, sufficiently early, sparks and ember build-up which can be created in production and transport ducts. This system shall activate an alarm indication and adequate control processes (such as a machinery stop) as well as to automatically activate spark extinguishing and/or spark diversion. Automatic machinery shut-down shall be carried out when several spark detectors (detections) at different sections of the conveyor system operate simultaneously.

The spark detection system consists of spark detectors, spark control and indication equipment and electrical cables. The electrical part of the system, including all other connected control cables (e.g. solenoid valve) of the system, shall conform to relevant national and international guidelines (e.g. EN54, CEA specifications for fire detection systems) and remain operative even in case of power failure.

Battery back-up to supply the required power for a stand-by time of only four hours is considered acceptable. The main electrical power supply shall be a separate circuit with the corresponding fuse uniquely labelled.

3.2. Spark Detectors

Spark detectors react to infrared radiation. They immediately transmit an electrical signal to the spark control and indication equipment. Two types of detectors are available: light-sensitive detectors and detectors insensitive to daylight.

Light-sensitive detectors shall only be installed in dark and closed systems where no undesired radiation can deceive the spark detector. This does not apply to detectors insensitive to daylight because their sensitivity has to be adapted to the ambient conditions.

Automatic cleaning units such as air purge devices are recommended when the detector lens could be inadmissibly covered by the material conveyed.

3.3. Positioning of Detector

Taking into consideration detector parameters and local conditions, the spark detectors shall be installed in such a way that the whole cross section area of the conveying line is safely monitored even at maximum obstruction by material. Depending on the cross section area of the conveying duct, it might become necessary to stagger the detectors not only around the circumference but also along the duct.

The spark detectors should be preferably installed downstream from fans as seen in flow direction.

Any cross section area to be monitored shall be equipped with at least two detectors. Depending on the geometry of the conveying duct the lenses shall be installed such that they monitor the whole cross section area but cannot be obscured by the material. Therefore detectors shall not be mounted on the bottom of ducts.

3.4. Spark control and indication equipment

The following system states shall be visible at the spark control and indication equipment:

- Alarm call

- Operating readiness of system

- Power failure

- Battery failure

- Failure of additional heating system (e.g. trace heating)

- Wire break and short circuit of electrical cables and their connections.

In some cases, a spark counting unit with optical indication is advisable.

3.5. Alarm

Every spark message and every fault message shall result in an audible and visual indication at the spark control and indication equipment. Additional alarm devices with signals different from other plant signals shall be installed in areas at risk in order to allow early intervention by the security or plant personnel. Successful alarm device transmission to plant personnel and/or to a personnel in permanently occupied places (e.g. gate-keeper, company's fire brigade) is essential.

4. Spark Extinguishing System

4.1. Description

A spark extinguishing system mainly consists of parts for spark detection and spark extinguishing. It may include several spark extinguishing areas. The task of a spark extinguishing system is to detect sparks and embers nests which may occur during production and/or transport of combustible dust, chips or fibres and to extinguish those sparks as early as possible to prevent fire and explosion in connected plant areas. An explosion that has already started cannot be suppressed by spark extinguishing systems. Spark extinguishing systems extinguish automatically and, after an extinguishing action, they shall immediately be ready for operation again.

4.2. Extinguishing agents

The spark extinguishing systems referred to in these specifications use water, without any additives, as the extinguishing agent. If other extinguishing agents are utilized their effectiveness and practicability shall be tested and proved.

4.3. Extinguishing Action

Upon activation of the system an extinguishing injection of mist water is sprayed into the conveying duct for a pre-determined period of time.

The extinguishing action is affected by the: diameter of the duct; type of material conveyed; material density and feeding velocity. The extinguishing action depends on the duration of spark flight and it might consist of several water injections. Water input shall extend spark detection by at least 5 seconds.

In case of continuous water injection, i.e. more than three times the minimum pre-determined extinguishing time, or in case of a fault in the spark extinguishing parts, control measures shall be activated, e.g. alerting operating personnel, automatic shut-down of machines and fans or activation of additional plant extinguishing equipment. Automatic shut-down of plant machinery shall take place whenever sparks are detected in several areas at the same time or when a long spark flight of more than 15 seconds occurs. Premature shut-down of machinery is also advisable when a certain number of sparks per time period are exceeded.

4.4. Spark Extinguishing Parts

The spark extinguishing part of a spark extinguishing system consists of:

- Water supply
- Flow switch, pressure switch
- Strainer (DN 25 minimum)
- Extinguishing nozzles
- Solenoid valve
- Pipes
- Disable devices (safeguarded)
- Trace heating, if necessary.

4.5. Distance between Spark Detectors and Extinguishing Nozzles

For installation, it is necessary to have a certain distance between spark detectors and extinguishing nozzles. The distance depends on transport velocity of material conveyed and total delay time of the system.

The total delay time includes:

a) Reaction time of electrical equipment

b) Time of mechanical opening of solenoid valve

c) Creation of an effective extinguishing water mist

d) Buffer time (30% of sum of a), b) and c)).

When planning a spark extinguishing system it shall be assumed that sparks move with the same velocity through the transport system as the material conveyed does. If the material conveyed is obstructed by built-in components, e.g. block catchers or sieves, water shall be sprayed on those built-in parts too.

Example:

Transport velocity: v = 20 m/s
Total delay time: t_{DT} (incl. 30 % buffer time) = 0.3 s.

Distance between spark detectors and extinguishing nozzles: a
with $a = v \times t_{DT}$
therefore: a = 20 m/s x 0.3 s = 6.0 m

4.6. Water Supply

The water supply is affected by many factors, e.g. transport velocity, minimum pressure at the most disadvantaged nozzle, dimension of water inlet pipe, number of extinguishing parts and diameter of conveying duct. Therefore, the actual water requirement can only be determined by a hydraulic calculation.

Stored extinguishing water shall be sufficient for a continuous extinguishing of 60 s at the extinguishing area requiring the highest water supply. If the spark extinguishing system has more than one extinguishing area, 50 % additional water shall be added. For the calculation of the highest possible water demand, all those fire protection systems (e.g. a water deluge system in a filter) shall be taken into account that might be supplied simultaneously in case of activation.

Extinguishing water shall be available at the necessary minimum flow pressure. Flow pressure of 7 bar at the inlet pipe is normally sufficient.

fig. 4/01

Minimum number of extinguishing water injections that shall be possible from the water supply of the pressure tank.

	Minimum number of extinguishing water injections		
Number of spark extinguishing areas (SEA) with a common water supply	independent SEAs	dependent SEAs	System with both, independent and dependent SEAs
1 - 3	2	4	3
4 - 6	3	5	4
7 - 10	5	7	6
11 – 20	6	8	7
> 20	Individual determination		

Note: Normally, an approximate water requirement of 10 l can be assumed for each extinguishing injection.

4.6.1. Connection to Existing Water Extinguishing Network

Spark extinguishing systems can be connected to an existing water extinguishing network provided the requirements of clause 4.5 are met.

4.6.2. Connection to a Sprinkler System

If the minimum water supply operating pressure is 7 bar, the spark extinguishing system can be connected before the alarm valve in the water supply of a sprinkler system with a pressure tank. The pressure tank shall be automatically re-filled with water.

4.5.3. Connection to Pressure Booster System

A pressure booster system normally consists of a membrane pressure tank and a pump system.

The water taken from the pressure tank shall be automatically re-filled.

The re-fill pump shall be designed in such a way that the extinguishing water demand is provided for as described in clause 4.5.

The effective content of the pressure tank shall be at least 25 l of extinguishing water, and in addition, it shall meet the requirement of fig. 4/01.

The design of the pressure tank depends on total water injections resulting from fig. 4/01.

With spark extinguishing systems consisting of both dependent and independent extinguishing areas, the sum of these extinguishing areas shall be used. The number of extinguishing injections can be determined by means of column 4 of fig. 4/01.

4.7. Pipes

Minimum nominal pipe wall thickness shall be DN 20. Only galvanized pipes according to DIN 2440 or copper pipes according to DIN 1786 are permitted. Every water connection of the spark extinguishing areas shall have a separate disable device and shall be protected against undesired closing. The pipes shall be of adequate size preventing flow velocities exceeding 5 m/s in fittings and 10 m/s in pipes (higher velocities may be found in the solenoid valve).

4.8. Extinguishing Nozzles

The nozzles shall be installed in such a way that coverage of the entire conveying cross section area by an efficient water mist is guaranteed.

The extinguishing nozzles shall not be contaminated or clogged by the material conveyed. The appropriate spray pattern shall be created at each extinguishing action.

The extinguishing nozzles shall be easily accessible.

4.9. Frost Protection

All pipes for the water supply and the storage tank shall be protected against freezing.

If it is not possible to route the pipes to the nozzles in frost free areas, an electrical heating system (e.g. trace heating) shall be installed and the pipework shall be lagged with non- combustible insulation .

The heating shall be effective along the entire pipe length. The heating conductor shall be controlled by two separate temperature detectors.

The following events shall result in visual and audible fault alarms:

- Power failure

- Lower temperature

Design and energy supply of fault indication devices shall to comply with clause 3.

It may also be necessary to include the nozzles in the frost protection measures.

The frost protection shall not be achieved by adding glycol mixtures to the water.

5. Spark Diversion System

5.1. Description

The main assemblies of spark diversion systems consist of fine-tuned parts for spark detection and spark diversion. The task of spark diversion systems is to detect sparks and embers nests which may occur during production and/or transport of combustible dust, chips or fibres and to divert the spark together with some material, from the conveyed material to prevent fire and explosion. An explosion that has already started cannot be suppressed by spark diversion systems.

The reset of spark diversion systems can be automatic or manual.

Material discharge shall be collected in such a way that additional fire risk is avoided.

5.2. Spark Diversion Part

The diversion part normally consists of a control system and devices for diverting the flow of material, e.g. quick action damper/vent.

The duration of the diversion process in combination with an automatic reset depends on the transport duct cross section area, type of material conveyed, density of material conveyed and transport velocity. It is usually up to 10 s. The diversion process shall exceed the time of spark detection by at least 5 s.

Shut-down of machines and fans is required

- for systems with manual reset

- for systems with automatic reset when the preset minimum abort time to accomplish diversion is exceeded three times.

During material discharge further transfer of sparks shall be prevented[1]. The receptacle for the material discharged shall be of non- combustible material.

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[1]This can be achieved by closed systems, receptacles outside buildings, or also installation of an automatic fire fighting system.

5.3. Distance between Spark Detector and Spark Diversion Part

Spark detector and spark diversion part shall be installed with sufficient distance between them. The distance is determined by feeding velocity of the material conveyed and total delay time of the system.

The total delay time consists of:

a) Reaction time of the electrical part

b) Duration of mechanical action

c) Buffer time (30% of the sum of a) and b))

When planning a spark diversion system it shall be assumed that sparks move through the transport system at the same velocity as the material conveyed.

Example:

Transport velocity: v = 20 m/s
Total delay time: t_{DT} (incl. 30 % buffer time) = 0.3 s

Distance between spark detectors and spark diversion part: a
with $a = v \times t_{DT}$
therefore: a = 20 m/s x 0.3 s = 6.0 m

6. Additional Measures

Plant machinery normally does not need to be shut off when spark diversion or spark extinguishing systems are installed. It shall be individually evaluated whether shut-down is necessary or not.

Automatic shut-down is necessary, for example, in case of:

- Spark detection without spark diversion or extinguishing

- Manual reset of spark diversion (depending on system)

- Continuous spark flight

- Functional problems at spark diversion and/or extinguishing parts.

Automatic shut-down is required when spark alarms come from several detection areas/zones at the same time.

Depending on local conditions, e.g. system and plant design, it may be necessary to verify the success of spark diversion or extinguishing with a spark detection part installed downstream.

Depending on the local conditions, it may also be necessary to install a further spark extinguishing or diversion part or to shut down the transportation system.

7. Maintenance and Operating Requirements

Spark detection, spark extinguishing and spark diversion systems shall be periodically examined and maintained by an approved installation company. Any defect shall be immediately corrected.

Maintenance shall be at least half-yearly.Shorter maintenance intervals may be required due to local ambient conditions and after experience gained from operation, and shift operation.

Tests of the electrical components shall be performed according to relevant national regulations (EN54, CEA specifications for fire detection systems).

The function of detectors shall be tested by easy-to-handle devices. This likewise applies to tests during plant operation.

A system diagram shall be attached to every spark control and indication equipment showing function and protection areas/zones.

The operator shall be trained by the installer.

The operator shall record all system events in an operator's log (see appendix C), such as:

- Operation start-up

- Alarms

- Technical examination

- Maintenance

- Service work

- Defects

- Technical modifications and changes

Automatic print-out recorder units can also be utilized to compliment, but not replace, the operator's log book.

In detail, the following controls shall be carried out and registered in the operator's log (by an employee of the operator, who is responsible for the care of the spark extinguishing system, or his representative):

1 Daily visual checks
On working days the operating condition and the water pressure shall be checked.

2 Weekly checks
The following shall be checked weekly:
- function of the detectors
- cleanness of the detectors
- cleanness of the extinguishing nozzles
- water storage
- reading of the spark counter device, if existing

3 Monthly checks
The following shall be checked monthly:
- function of the whole system, including release
- cleanness of the dirt catcher
- function of perhaps existing
    - ∗ trace heating
    - ∗ alarm devices
    - ∗ triggering of fire protection devices

4 Other controls
Furthermore, the responsible employee as well as his representative shall care for the keeping of the operating and maintenance instructions from the manufacturer of the system.

8. Protection of Areas of Special Character and Utilisation

If pneumatic transport ducts pass through fire walls/complex partition walls or walls for partition of fire sections, quick action dampers/vents shall be built in the ducts and if possible, in the walls in order to prevent the spread of fire. This parameter also applies to conveying ducts outside buildings. In pneumatic transport ducts protected by a spark extinguishing system, the quick-action dampers/vents shall be installed behind the extinguishing system. Quick-action dampers/vents shall be activated by spark detectors (e.g. fail-safe detection). Shut-off dampers/vents required at other places are not affected by this requirement.

A detailed description for several special risks is given in appendix A.

9. Documentation

The installer shall submit technical documentation which shall give sufficient information to be able to estimate the hazard and effectiveness of the spark detection, extinguishing, and diversion system.

The approved installation company shall establish, for every system, an installation certification according to appendix A 1 as well as a schematic drawing showing the function and protection area *). Where spark extinguishing systems are concerned, the type of the extinguishing agent supply and the hydraulic calculation shall be indicated. These documents shall be submitted to the relevant authority when the customer applies for an approval of his system.

*) The following symbols shall be used:
Spark detector: 

Spark extinguishing part: 

Spark diversion part:

10. Approvals

The installation shall be designed, installed and maintained by an approved installer in accordance with these specifications, using approved, compatible components. Approval is given by the appropriate authority (accepted by insurers).

The installation shall comprise only components approved by the appropriate authority (accepted by insurers). The appropriate compatibility of the components shall be certified by a system approval.

An approval inspection shall be carried out by an inspector accepted by the insurers. to check that the installation is in accordance with these specifications.

Should several companies be involved in the installation of a spark detection, extinguishing or diversion system, only the approved installation company for spark extinguishing systems is responsible for the complete system.

If electrical installations and/or connections to the water mains cannot be carried out by the approved installation company due to local regulations, the approved installation company shall inform the contractor in writing about the applicable regulations.

The installation and protected risk shall be inspected at least once a year by an inspector accepted by the insurers.

APPENDIX A 1

Installation Certification

No.	**Installation certification for ❒ spark detection, ❒ spark extinguishing and ❒ spark diversion systems (FULA)**														
1	Owner Resp. Insuree	Name address													
2	Location of building	address													
3	Protection area		Detection area No.	Pipe diamenter Mm	Air velocity m/sec	minimum water amount per m³ transport volume g	minimum pressure at ext. part bar	minimum flowrate at ext. part l/min	design pressure bar	total delay time sec	Distance Fum Lö nominal value ① actual value ② m	Water supply ③Sprinkler ④ DEA	Number of Fum Typ of Fum	Number + type of Lö Number + type of nozzles	K-Faktor ext. part

Fum = Spark detector
Lö = Extinguishing part
DEA = Pressure booster
①, ②, ③, ④ = Please fill out the field concerned

Fum N = Normal spark detector
Fum L = Glass fibre detector

Signature of responsible specialist _____

Sheet no.

APPENDIX A 2

Particleboard Industry

When chipping, drying or milling wood chips, as well as during edge-trimming or sanding, sparks and emberbuild-up can be caused by foreign bodies, blunt tools, frictional heat or overheating of material. Filters, bunkers and silos that are connected to the conveying units are especially vulnerable.

To prevent fire and explosion caused by sparks inside those systems, it is necessary to install spark extinguishing system using water as the extinguishing agent.

A 2.1 Extent of Protection

The protection described below is based on the production line in a particleboard plant (see fig. A2/01). In plant configurations different from the one shown this concept is to be used accordingly.

Spark detection and extinguishing is required in the following areas:

(1) In the dryer transfer chute between discharge and the following conveyor

If sparks are detected for more than 15 s, the discharge screw shall be reversed until the material with sparks is cleared.

(2) In the exhaust duct between dryer and cyclone group

(3) After the conveyor screw - fine dust discharge

(4) In the circulating air conduit between cyclone group and combustion chamber

If the spark extinguishing system is triggered the connecting conveyor screw shall be automatically reversed in detection areas (1) and (3) until the material comprised in the conveyor screw at the time of detection is completely discharged.

Fire and explosion risk after material discharge should be reduced by providing fire extinguishing devices to spray the discharged material with water.

(5) Behind sieve sifter fine chip discharge between fan and cyclone (surface layer silo)

(6) Behind the sieve sifter coarse chip discharge

(7) The sieve sifter requires an extinguishing device which is only activated when spark alarms come from detection areas (5) and (6) at the same time.

(8) Behind the wind sifter fine chip discharge between fan and cyclone (core layer silo)

(9) Behind the wind sifter coarse chip discharge

(10) The wind sifter requires an extinguishing device which is only activated when spark alarms come from detection areas (8) and (9) at the same time.

(11) Behind the mill between fan and cyclone

(12) The mill entry requires an extinguishing device which is only activated when a spark alarm comes from detection area (11).

(13) In the exhaust ducts (main ducts) of the trim saws

(14) In the exhaust ducts (main ducts) between sander and filter

Identical protection shall be provided for pneumatic transport ducts (exhaust, return air) in production areas which are not included in the system diagram.

This applies to, for example:

- Exhaust ducts (main duct) of cut-to-size saw

- Return air from spreading bunker/filter.

A 2.2 Supplementary Protection

Depending on the extent of production facilities the above-mentioned fire protection concept shall be complemented by stationary fire extinguishing systems (sprinkler and/or water spray systems) and occasionally by further measures.

A 2.3 Safety Measures

With respect to a comprehensive protection concept for particleboard production equipment, further safety devices are advisable, for example:

- Magnetic separator and heavy material separator

- Conveying flow meter (discharge flow meter/belt scale)

- Temperature control in dryer incl. burner shut-down

- Extinguishing device in dryer

- Fire protection in bunkers and silos

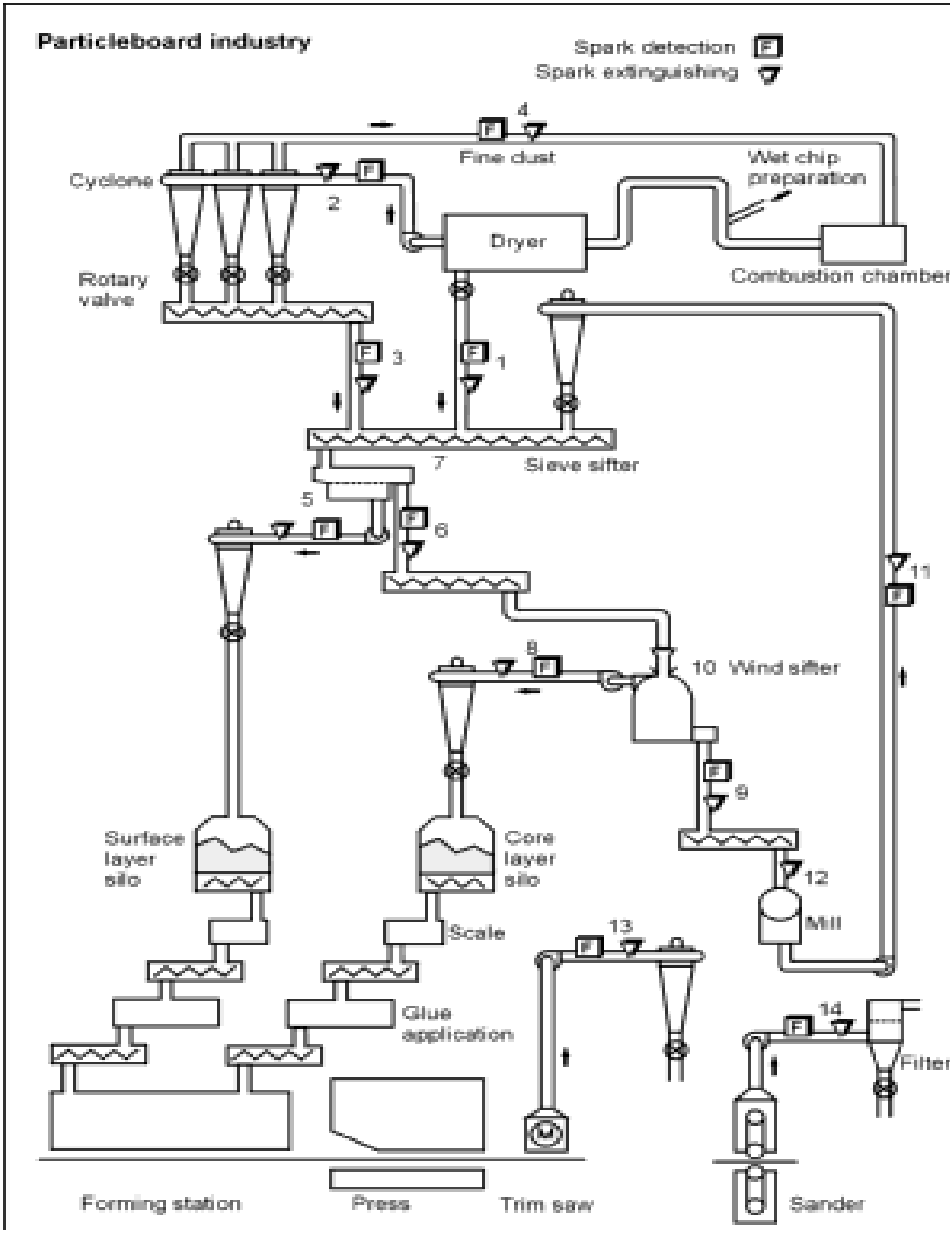
- Rotary valve

- Revolution counter

- Electrical interlocking.

Furthermore, explosion protection measures (e.g. pressure-proof construction, pressure relief vents) might also become necessary.

Fig. A 2/01: System Diagram Particleboard Plant



APPENDIX A 3

Wood Fibreboard Industry
(Medium Density Fibreboard)

When drying or milling fibres, as well as during edge-trimming or sanding, sparks and ember build-up can be caused by foreign bodies, blunt tools, frictional heat or overheating of material. All production machinery connected to the conveying system is constantly at risk. Reliable basic protection against fires is ensured by spark extinguishing systems using water as the extinguishing agent.

A 3.1 Extent of protection

The extent of protection described below is based on the course of manufacture in a fibreboard plant (see example fig. A3/01).

In plant configurations different from the one shown this concept is to be used accordingly

Spark detection and extinguishing is required in the areas listed below:

(1) In the dryer before the first separator (cyclone)

(2) Behind the separator (cyclone), between rotary valve and reversing belt/belt scale

Upon activation of the spark extinguishing system the material flow shall be reversed until all of the affected material is discharged.

(3) Behind the sifter before the separator group (cyclones)

(4) In the return air conduit between cyclones and sifter

(5) In the return air conduit between cyclones and filter

(6) Behind the fan of the separator group (cyclones)

(7) Behind the fibre discharge and between rotary valve and surge bunker

(8) In the conveying screw from surge bunker to dosing bunker

(9) In the pneumatic exhaust duct of the pre-press (main duct)

(10) In the pneumatic exhaust duct of mat reject

(11) In the return air conduit before the cyclone between cutter cylinder and spreading machine

(12) In the exhaust duct (main duct) between sander and filter

Identical protection shall be provided for pneumatic transport ducts (exhaust, return air) in production areas which are not included in the system diagram.

This applies to, for example:

- Chipping before the dryer

- Exhaust ducts (main duct) of trim saw

- Return air from spreading bunker/filter

A 3.2 Supplementary Protection

The fire protection concept shall be complemented by water spray extinguishing systems in the below-mentioned areas and the spark extinguishing part shall be replaced in belt scales, screws etc.

Above the belt scale

Upon activation of the spark detection with spark counting, a water spray system shall be automatically activated if the alarm threshold is reached and the belt scale shall also be reversed at the same time.

Separator groups
Surge and dosing bunkers

Upon activation of spark detectors with spark counting in areas (2), (6) respectively (8) the water spray extinguishers installed in those areas shall be automatically activated if the alarm threshold is reached. The water spray extinguishers in surge

and dosing bunkers can also be activated by differential-thermo detector.

Depending on production machinery, the above-mentioned fire protection concept shall be complemented by stationary fire extinguishing systems (sprinkler systems) and occasionally by further measures.

A 3.3 Safety Measures

With respect to a comprehensive protection concept for fibreboard production equipment, further safety devices are advisable, for example:

- Magnetic separator and heavy material separator

- Temperature control in dryer incl. burner shut-down

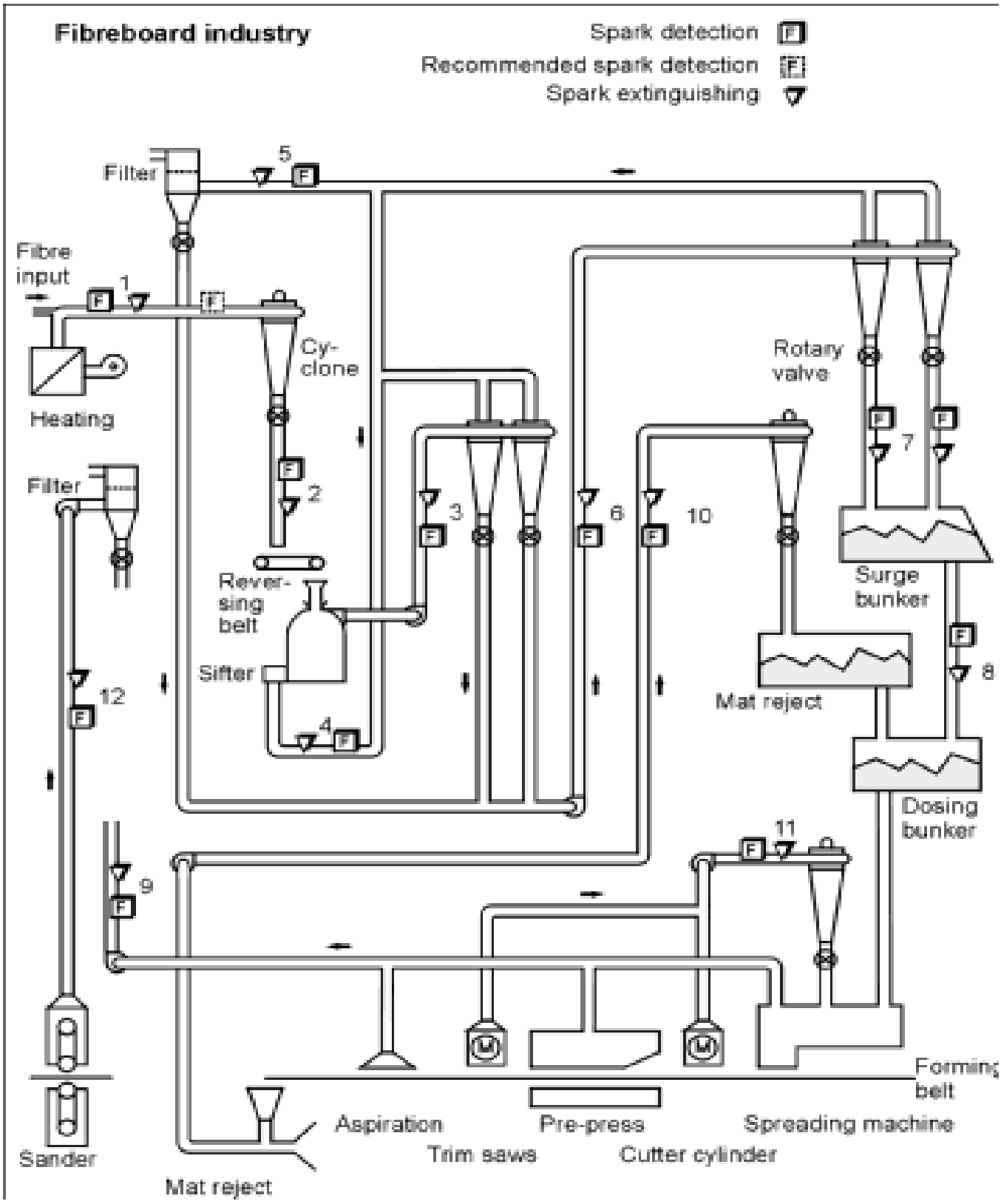
- Rotary valve

- Revolution control

- Level control in fibre cyclones.

Furthermore, explosion protection measures (e.g. pressure-proof construction, pressure relief vents, explosion suppression) might also become necessary.

Fig. A 3/01: System Diagram Fibreboard Production (MDF: Medium Density Fibreboard)



APPENDIX A 4

Sugar Industry

In pulp drying and pelletizing, fires can be caused by overdrying and frictional heat.

All machines including exhaust systems connected to conveying systems are at risk. Damage due to fire can be reduced by installing spark detection and extinguishing systems in combination with material discharge channels.

A 4.1 Extent of protection for pulp drying and pelletizing

The extent of protection described below is based on an example production line, see fig. A4/01).

In plant configurations different from the one shown this concept is to be used accordingly.

Spark detection is required in the areas listed below:

(1) In the crude gas duct: directly behind discharge chute leading to cyclone outlet

(2) In pulp transport section behind the discharge chute of the drum

(3) Between cyclone outlet and dust screw

(4) At the elevator head, before magnetic separator

(5) Between pellet press and slide sieve

(6) In the exhaust air of the pellet cooler, before the filter

(7) Between cyclone discharge (rotary valve) and dust return screw

(8) In the dust return duct, behind the filter

(9) In the material discharge of the pellet cooler

A 4.2 Supplementary Protection

The protection concept shall be complemented by installing spark extinguishing systems

- before every hose filter

- in the dust transport section (except of vapour transport).

Upon activation of spark detectors in areas (3), (6), (7), (8) the additional spark extinguishing systems shall be automatically activated.

In the course of spark discharge (emergency path) a fire extinguishing system shall be provided for. Further extinguishing systems are recommended, e.g. water spray extinguisher for drums including discharge chutes, cooler, hose filter.

A 4.3 Safety Measures

With respect to a comprehensive protection concept for sugar production equipment, further safety devices are advisable, for example:

- Magnetic, metal and heavy material separator

- Electric interlocking

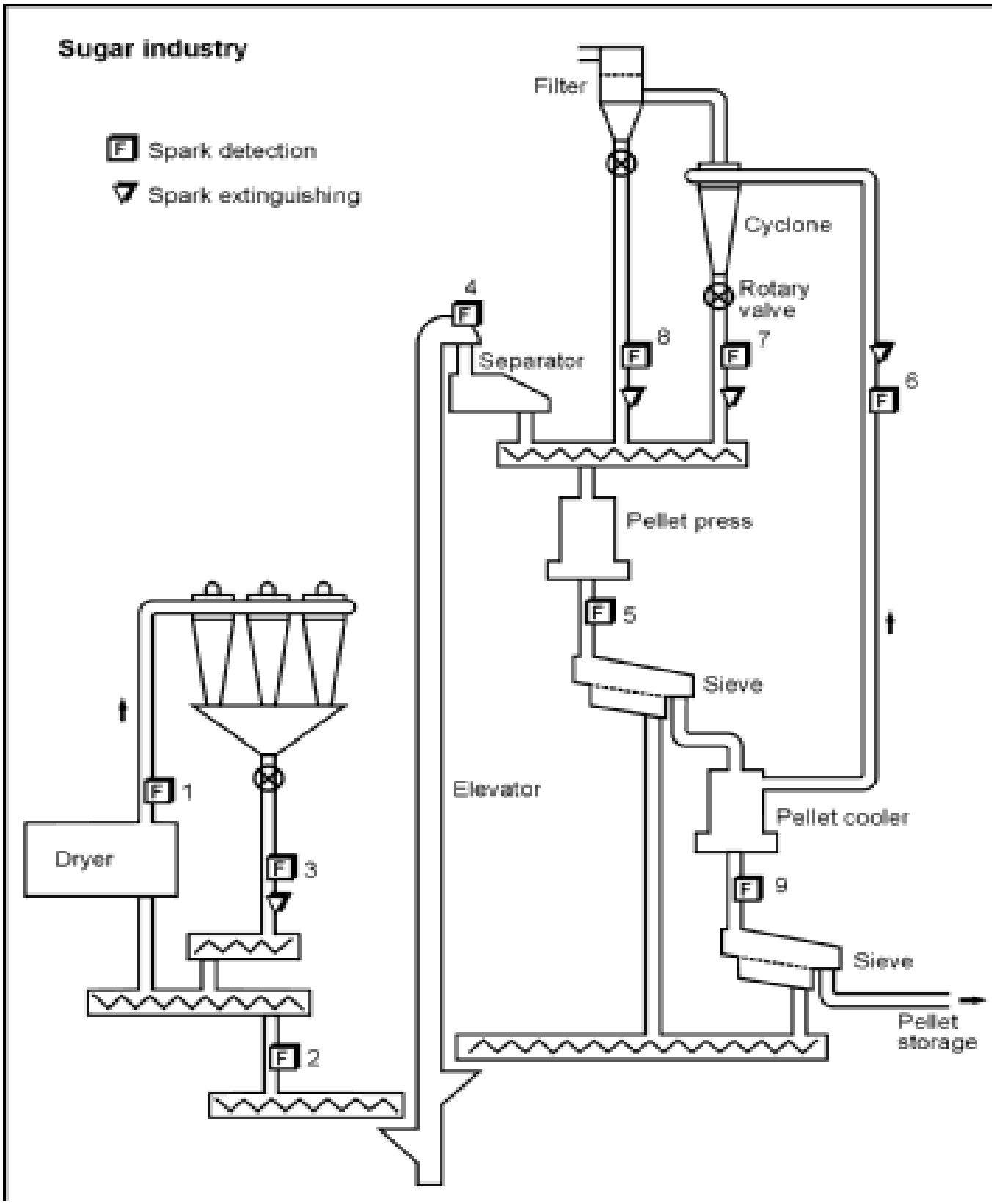
- Revolution control

- Temperature control

- Tracking security

- Emergency paths

Fig. A 4/01: System Diagram Pulp drying and pelletizing



APPENDIX A 5

Textile Industry

When processing textile fibres, sparks and ember build-up can be caused by foreign bodies, frictional heat or loosened machine parts. As a result all machines connected to pneumatic or mechanical conveyors, as well as fibre discharge or air conditioning systems, are at risk.

The expected rapid spreading of a fire requires the installation of spark detection including diversion or extinguishing.

A 5.1 Extent of Protection

The extent of protection described below is based on an example production line in a material preparation section, see fig. A5/01. Analogue protection equipment is to be installed when the plant configuration differs from the one shown.

Spark extinguishing or diversion is to be provided behind every spark detection point. Machine lines, multiple duct systems as well as dense machine arrangement allow for several spark detectors to be combined to a group. Every detector group shall activate the downstream spark extinguishing or diversion parts.

Spark detector grouping requires automatic shut-down of production lines upon activation of a spark detector (see clause 6).

Some production conditions require the installation of quick-action dampers/vents as an alternative provided that installation locations are the same as with spark extinguishing or diversion systems. However, it shall be possible to remove the conveyed material in the duct before the quick-action damper/vent without any difficulty.

Spark detection is required:

(1) Between bale opening machine and mixer opening

(2) In the exhaust air duct between mixer opening and step cleaner

(3) In the material transport duct between mixer opening and the roller cleaner sometimes behind infeed of recycling fibres

(4) In the waste transport duct between mixer opening and roller cleaner

(5) In the material transport duct between the roller cleaner and step cleaner

(6) In the connection duct between the roller cleaner and waste transport duct

(7) In the connection duct between step cleaner and exhaust duct

(8) In the material transport duct between step cleaner and industrial cleaner

(9) In the connection duct between step cleaner and waste transport duct

(10) In the connection duct between industrial cleaner and exhaust duct

(11) In the material transport duct between industrial cleaner and feed machine

(12) In the connection duct between industrial cleaner and waste transport duct

(13) In the connection duct between feed machine and exhaust duct

(14) In the connection duct between feed machine and exhaust duct

(15) In the material transport duct between feed machine and card feeder

(16) In the connection duct between feed machine and waste transport duct (filling chute)

(17) In the connection duct between card feeder waste transport duct

(18) In the exhaust duct between feed machine and and filter

(19) In the waste transport duct between card feeder and filter

Upon activation of spark detectors with spark counters in areas (18) and (19) the production facilities in the preparation plant shall be automatically shut down.

Spark detectors shall always be installed downstream of the fans.

If pneumatic transport ducts (disposal/air conditioning) are present in production areas which are not included in the system diagram identical protection shall be provided

This applies to, for example:

- Exhaust air collection duct of individual spinning boxes, out-end area, before the filter

- Conveying duct to air conditioner, behind machine fan

- Collection duct of stationary floor sweep

- Return recycling fibre, waste stock.

A 5.2 Supplementary Protection

With respect to a comprehensive protection concept for production equipment in textile industry, further safety devices are advisable, e.g. sprinkler systems for room protection, water spray extinguishers to protect central exhaust air flow channels or CO_2 systems for protection of

- Mixer openings and cleaner lines

- Intermediate material stocks in the machine lines where the material remains for a relatively long time. They should be additionally monitored by thermo-differential detectors and protected using a manually activated fire extinguishing system.

A 5.3 Safety Measures

To avoid the generation of sparks, the following conveying ducts require magnetic and heavy material separators, as well as metal detectors installed:

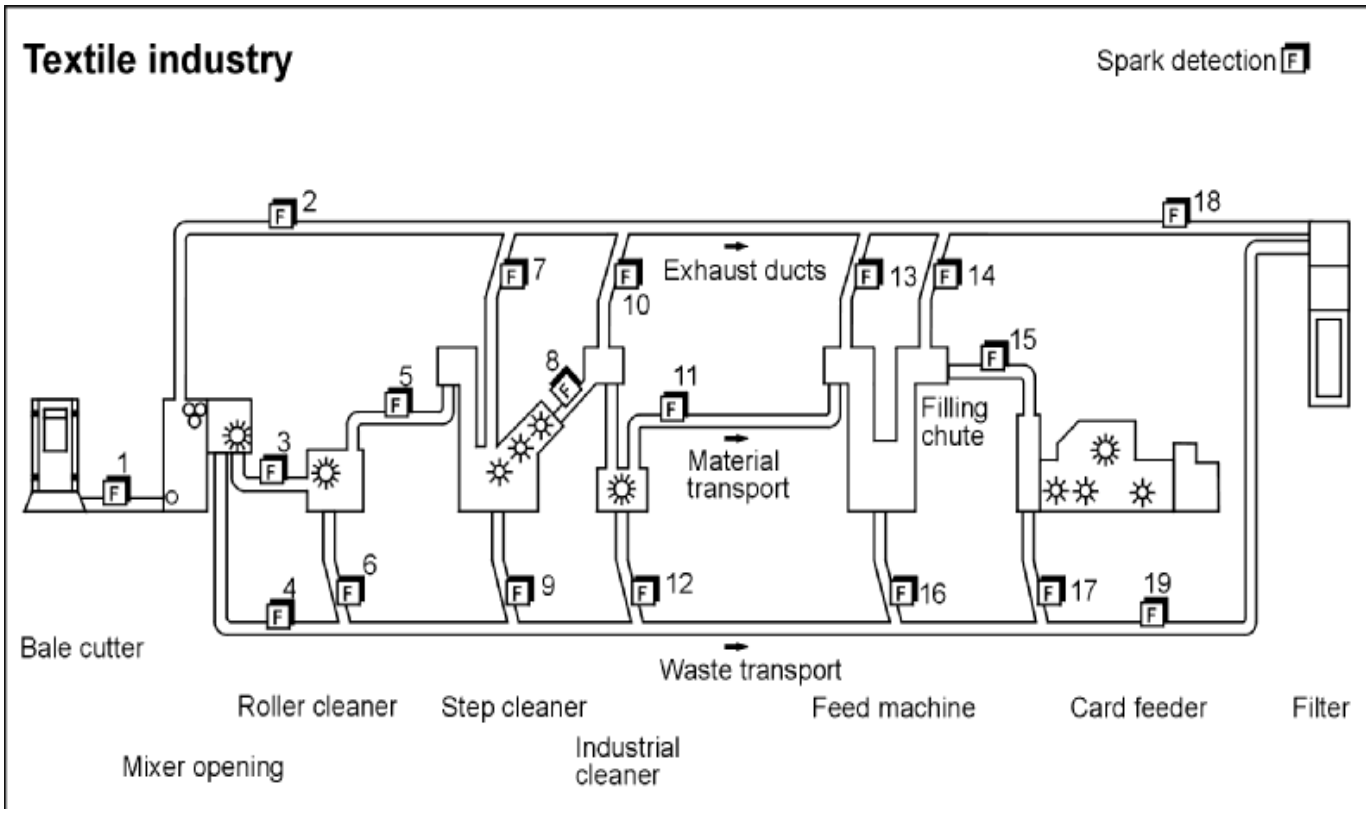
- between bale cutter and mixer opening

- behind the roller cleaner

- in or behind every recycling feeder

Material shall be discharged upon every detection of metal.

Fig. A 5/01: System Diagram Preparation Plant (material preparation)



APPENDIX A 6

Wood Working Industry

Processing of wood, dust and chip transport systems are extremely vulnerable to sparks and emberbuild-up caused by foreign bodies, blunt tools, frictional heat or hot surfaces.

A 6.1 Extent of protection

The extent of protection described below is based on an example production line of a furniture manufacturer (see fig. A6/01). In plant configurations different from the one shown this concept is to be used accordingly.

To protect filters and silos all feeding units shall be equipped with spark extinguishing systems.

Spark detection and extinguishing is required at least:

(1) In the pneumatic dust exhaust ducts (main duct) of the wood working machine

(2) In the pneumatic chip exhaust ducts (main duct) of the wood working machines

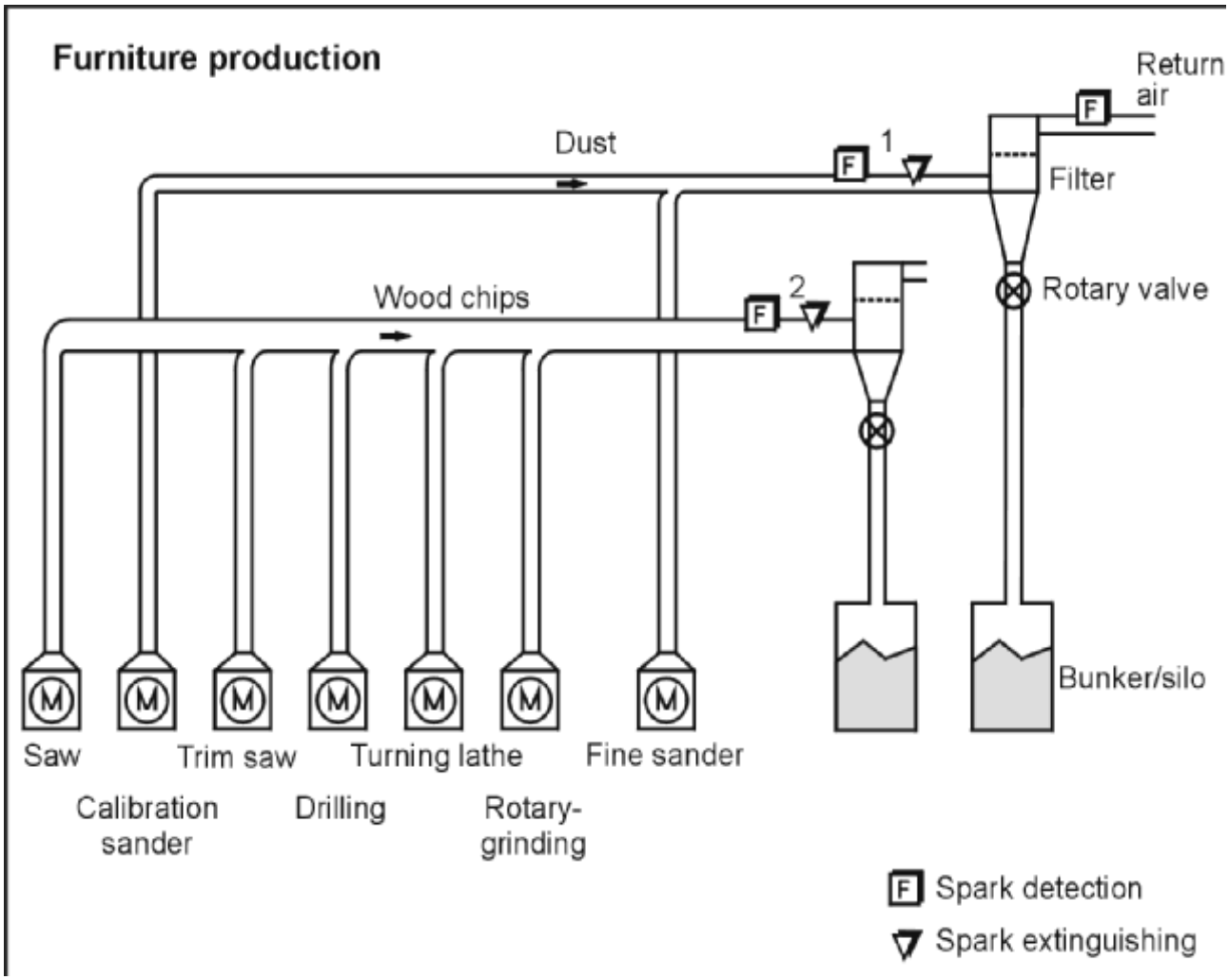
In production plants with return air, the return air ducts shall be equipped with detectors that activate quick action dampers/vents.

Remote plant machinery requires additional spark detection and extinguishing units to be installed in every manifold of a machine line.

A 6.2 Supplementary Protection

Depending on the extent of production machinery (filter, bunkers, etc.), the above-mentioned fire protection concept shall be complemented by stationary fire extinguishing systems (sprinkler and/or water spray systems) and if necessary by further protection measures.

Fig. A 6/01: System Diagram Wood working industry



APPENDIX C: Operator's log

In this operating book all events with importance for the availability of the
Spark extinguishing system
are to be registered. The care for the system und the keeping of the operating book is done by a specially named employee or his representative.

Responsible institutions

Fire brigade address/telephone

Installer approval no.

Company	protected facility(ies) / area(s)	

Technical inspection service	*address*	*phone number*
Authority (e.g. building supervision)		
Fire insurance / contents		
Fire insurance / buildings		
Receiving place of the fire detection		