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Responsible: Einar Friðgeir Björnsson
Editor: Rafn Magnús Jónsson

05-Mechanic
Dust Collection System

Doc. no.: NA-05-STS001

Table of contents

1 Responsibility

This Standard Technical Specification (STS) is of responsibility of the owner. The revision and date of issue are on the front page.

All deviations from the specifications must be approved in writing by the Owner

2 Scope and Field of Application

2.1 Scope Definition

This Standard Technical Specification details the minimum technical requirements including but not limited to: Design engineering, material quality and workmanship, installation, testing, inspection and identification for dust collection system equipment and components. As such, the Standard Technical Specification establishes the minimum requirements.

The provision of this Standard Technical Specification for dust collection systems applies to the production area of Norðurál aluminum smelter.

Excluded from the scope are Gas Treatment Centers (Fume Treatment Plants)

2.2 Document Conflicts

Eventual conflicts between the referenced documents shall be reported, without delay, to the Owner in writing for resolution.

3 References and Definitions

3.1 References

All equipment, materials, workmanship, design calculation and tests shall be performed in compliance and read in conjunction with the Standard Technical Specification: NA-00-STS001, General Technical Standard and other relevant standards.

The relevance order of standards shall be according to NA-00-STS001. All materials intended for use at Norðurál shall be approved by the Owner.

The following referenced documents should be considered for the application of this document. For dated references, only the edition cited applies. For all references, dated and undated, the latest edition of the referenced document (including any amendments) applies.

Table 3.1 -References/Standards

Standard Nr.	Subject/Name
Directive: 2006/42/EC	The Machine Directive
Directive: 94/9/EC	Directive On Equipment and Protective Systems Intended for use in Potentially Explosive Atmospheres (ATEX)
Directive: 2004/108 EC	The EMC Directive
ÍST EN ISO 1037:1995	Safety of machinery – Prevention of unexpected start-up
ÍST EN ISO 12100:2010	Safety of machinery – General principles for design, risk assessment and risk reduction
ÍST EN ISO 13849-2:2008	Safety of machinery – Safety-related parts of control systems – Part 2: Validation
ISO 14119	Safety of machinery -- Interlocking devices associated with guards -- Principles for design and selection
ISO 14120	Safety of machinery -- Guards -- General requirements for the design and construction of fixed and movable guards

3.2 Abbreviations

- AKS Aluminum Kennzeichen System
- EN European Norm (CEN)
- HMI Human Machine Interface
- IEC International Electro technical Commission (CENELEC)
- ÍST Prefix for Icelandic Standards

4 Air Handling Equipment Design Requirements

4.1 General

In general the requirements specified in Norðuráls Standard Technical Specification NA-00-STS001 shall be laid down as basis for design, mechanical requirements, access, accessibility and safety of equipment.

Airborne dust will be captured from silos, hoppers, belt conveyors feed and discharge points, bucket elevators and other process and materials handling equipment. Dust emissions will be minimized by maintaining certain parts of these systems under vacuum, and filtering the collected dust-laden air in a bag houses prior to release to atmosphere.

Design, materials and construction shall conform to Manufacturer's standards and practices. All parts and accessories shall be interchangeable as much as possible from a practical standpoint. All equipment and accessories shall be designed to required minimum maintenance and spare parts.

4.2 CE Marking

The supplied equipment and its accessories shall be designed considering inherent safety aspects in operation and maintenance in accordance with European code: 2006/42/EC Machinery Directive.

4.3 Accessibility and Safety

Equipment drive mechanisms shall be fitted with protective guards designed for easy dismantling in accordance with:

- ISO 14119: Safety of machinery -- Interlocking devices associated with guards -- Principles for design and selection
- ISO 14120: Safety of machinery -- Guards -- General requirements for the design and construction of fixed and movable guards

Equipment access doors and hatches shall be fitted with locking devices to prevent start-up of the machine, all in accordance with NA-06-STS002, Specification for LOTOV.

Equipment shall be supplied with an inspection door (locked without key) for visual inspection and maintenance purposes.

4.3.1 ATEX

Refer to: NA-00-STS001, General Technical Standard

4.4 Soundproofing

The sound level measured in any place and at a distance of 1 meter from the noise source shall not exceed 85 dB(A) for continuous or intermittent exposure of eight hours per day (machine Directive 2006/42/EC)

For further requirements, refer to: NA-00-STS001, General Technical Standard

4.5 Recommended Manufacturers for Plant

All materials intended for use at Norðurál shall be approved by the Owner.

The components and materials used in the manufacture of plant equipment shall comply with the requirement of Norðuráls Standard Technical Specification: NA-00-STS010, Recommended Manufacturers for Plant.

4.6 System Design Requirements

Calculations shall be prepared by Vendor to support the design of each dust collection system, and submitted to Owner for approval. Such approval by Owner shall not relieve the Vendor of responsibility for proper performance of the system as installed.

Bag houses that are not provided with hoppers will be installed directly on the equipment to be de-dusted. Collected dust will be discharged directly to silos, belt conveyors, bins, containers, etc.

For applications representing an explosion hazard, relief doors are to be provided accordingly to protect the system. Relief doors should be positioned so that a blast will not be directed towards personnel or any other structure which may burn, harmed or damaged.

Depending on criticality of the system and the accuracy of available exhaust rate data for the various parts of the system, exhaust systems shall be designed using Method “A”, Balance Without Dampers (Blast Gates), or Method “B”, Balance Using Dampers,.

Method “B” is the preferred method and shall be used for systems requiring flexibility for future changes or additions, or where required exhaust volumes are not accurately known.

Method “A” shall be used in all cases where potentially explosive dusts are being handled, or where tampering with blast gates may create hazardous working conditions in areas served by the system.

To prevent build-up of static electrical charges, the entire system should be thoroughly grounded, including the machine generating the dust, conveying ductwork, dust collector, etc. Detailed guidelines are given in NFPA 77: Recommended Practice on Static Electricity.

Galvanic corrosion amongst different metals should be limited to outdoors 0,15V and inside to 0,25V, detailed guidelines are given in ÍST EN ISO 9224

Sample and test points are to be incorporated into the design to allow for monitoring and sampling in order to satisfy occupational health and environmental issues, where applicable. A “Higher than Operational Limit” warning (type to be agreed) shall be integrated in the design accordingly.

Air bleeds shall be incorporated into systems designed in accordance with Method “A” in order to achieve final balance. Fan and dust collector volumetric capacity shall be selected to allow for anticipated air bleed volume. Dust collection baghouse and ducts shall withstand maximum blower vacuum accordingly.

4.7 Supports, Platforms and Ladders

Maintenance access and monitoring platforms shall be included in the scope of work. ÍST EN ISO 14122: Safety of machinery – Permanent means of access to machinery shall be laid down as basis for design requirements for platforms, stairs and ladders.

Ladders and stairs shall extend to grade. Due care shall be given to slopes of ladders as per ÍST EN ISO 14122-3, Chapter 7.2.

Cross bracing shall be minimized to avoid interference with the materials handling system and facilitate cleaning (floor sweeping).

Each solenoid valves, diaphragms, bags, and cages on top of the bag house (when required) shall have a dedicated access platform.

4.8 Protectors/Guards

Refer to: NA-00-STS001, General Technical Standard

5 Ducts

5.1 General

Ducts larger than DN1000, shall be made of mild steel; S235JRG2 (St37 2) or stainless steel 316L. Mild steel ducts shall be of minimum 3 mm thickness and shall be corrosion protected as specified in: NA-03-STS001 - Surface Treatment and Painting. Stainless steel may be 2 mm or thicker.

Flanges and nominal dimensions shall be according to DIN 24154.

5.2 Rectangular Ducts

Design and selection of rectangular ducts shall be based on ÍST EN 1505 for dimensions and ÍST EN 1507 for strength and tightness. Rectangular ducts shall only be used for low velocity (< 12 m/sec) and low negative and positive pressure applications.

The following table depicts minimum requirements for duct thicknesses.

Table 5.2.1-Rectangular Duct Material Thicknesses as a Function of Gas Speed

Side Length (L) [mm]	L < 250 mm	250 ≤ L < 500 mm	L ≥ 500
Wall Thickness (t) [mm]	t = 0,5	t = 0,6	t = 0,9

5.3 Circular Ducts

Design and selection of circular ducts shall be based on ÍST EN 1506 for dimensions and ÍST EN 12237 for strength and tightness:

The following table shall be laid down as basis for material thicknesses of circular ducts as a function of velocity

Table 5.3.1 - Circular Duct Material Thicknesses as a Function of Gas Speed

Diameter (D) [mm]	Range of Velocity [m/sec]	D < 400	400 ≤ D < 800	800 ≤ D < 1000	D ≥ 1000
Wall Thickness (t) [mm] Lower Speeds	12,5 < V_t < 20,0	t = 0,75	t = 0,9	t = 1,0	t=3,0 (S235JRG2) t = 2,0 (316L)
Wall Thickness (t) [mm] Higher Speeds	20,0 ≤ V_t < 25	t = 1,00	t = 1,25	t = 1,5	t=3,0 (S235JRG2) 2,0 (316L)

Ducting shall be circular with smooth internal finish. Transition sections shall be used to connect to rectangular equipment connections. Transition sections shall have tapers no greater than 12° included angle.

If blue colored boxes are used as a design reference, buckling calculation are strictly requested by the Owner.

Cleanouts shall be provided at the beginning of each horizontal section. Cleanouts shall not be attached to elbows. Inspection doors should be provided and located at frequent intervals,

especially after changes in direction or branch junction two branches shall not enter a main opposite each other. A branch shall never enter the bottom of a main, nor shall one enter an elbow.

Branches shall enter a main at no greater angle than 45°, 30° is preferred. A branch shall enter a main on the larger end of a transition piece, not ahead of the transition. Throat radii of bends should be as large as practicable. 90° elbows up to 200 mm diameter shall be fabricated in 5 sections, form 210 mm to 460 mm diameter in 7 sections and over 460 mm diameter in 9 sections. Other angles shall be proportional, rounded up to the next whole number. Elbows shall be 2 times the diameter radius unless otherwise shown on drawings.

Elbows shall not be attached directly to fan intake connections. A straight section of duct of at least 3 times the diameter in length shall be used between elbow and fan inlet.

Dampers (Blast gates), if used in branch lines, shall be installed close to the entrance to the main. They shall not immediately follow a hood.

Ducting should be rigidly supported every 3-4 meters, depending on site conditions.

Heavy duty flexible connections/supports are to be integrated in the system to prevent transmission of vibration.

The stack shall be designed and installed to facilitate for the exhaust air to escape the building/structure envelope and provide sufficient dispersion so that the plume does not cause an unacceptable situation when it reaches the ground. A good stack velocity is 15 m/s, however this is to be confirmed depending on the type of dust and location of the installation. Rain caps shall not be used.

After installation, system shall be leak tested at the maximum expected static pressure.

Leakage should be no more than 1% of the design volume.

The following table indicates the nominal thicknesses of square and spiral would ducts.

5.4 Transport Velocity Requirements

Transport velocities in ducts shall be adequate to carry the particulate matter picked up in the hoods. Velocities shall be in the range as show in the following table:

Table 5.4.1- Transport Velocities

Dust Type	Transport velocity, V_t [m/s]
Fine to medium density	$12,5 < V_t \leq 20,0$
High-density coarse dust containing moisture and some large particles	$20,0 < V_t < 25,0$
Normal range for carbon dust and alumina dusts	$15 < V_t < 20$

All dust generating processes and equipment shall be adequately exhausted to prevent release of dust into the work area or atmosphere.

6 Dust Collectors (Bag Houses)

6.1 General

Dust collectors shall be the automatic self-cleaning type (reverse air or pulse jet) as dictated by the application as best type. Pulse-jet type is preferred, using compressed air to clean the filter bags. The Vendor must specify the required air pressure (typical plant air is available at nominal 6-8 bar, and supply all pressure regulators and filters required for the operation of the bag houses.

The bag filter housing shall be designed with dust hopper 100% filled up with dust. The unit shall be provided with internal baffle plates for even distribution of air and one airtight inspection door (min. size 600 mm x 600 mm).

6.2 Design Requirements

The Dust Collectors (Bag Houses) shall be supplied complete with the following:

- Lifting lugs to permit easy handling
- Flanged gas inlet and outlet connections; and
- Hopper discharge flange

The cleaning frequency shall be controlled by a solid-state sequential timer. The arrangement of the components shall permit easy assembly, installation, replacement of defective parts and easy access for inspection, troubleshooting, cleaning and repair.

In addition to a timer, cleaning using differential pressure across the filter sheet may be required as specified by the Owner and/or tender documents.

Dust collectors shall provide convenient access for maintenance of filter bags and bag cleaning mechanisms from the clean air side. A walk-in plenum shall be provided on all units of 17.000 Nm^3/h capacities and larger. Gasketed access doors and internal walkways shall be provided. Door gaskets shall be suitable for both positive and negative pressure.

Bag replacement shall be carried out from the clean side on top if bag houses.

All necessary controls shall be provided for operation of the dust collector and fan, including start/stop push buttons and emergency stop button to be approved with the Owner.

Structural steel support legs shall be provided, designed for the weight of the collector and hopper, including a full dust load. The minimum hopper valley angle shall be 60°.

All dust collectors shall have metric manometers permanently connected. Dust collectors having 50 m^2 or more of filter area shall be equipped with a differential pressure gauge with contacts for remote high level indication and alarm.

Bolts exposed to elements shall be made of stainless steel or other corrosion resistant metals.

6.3 Air to Cloth Ratio and Velocity between bags

Air to cloth ratio for each application shall be derived from the performance requirements for each application.

Clean air discharge shall contain no more than 5 mg/Nm^3 of particulates as average over sampling period.

The maximum average vertical gas velocity between the bags, can velocity, for each application shall be derived from the performance requirements for each application.

The Vendor shall indicate acceptance of the specified air to cloth ratio and velocity between bags, can velocity.

6.4 Filter Bag material and assembly

The bag assembly shall include:

- Filter bag
- Plugs for approximately 10%. These will be used to plug the venturi of a leaking bag until a replacement can be installed

- Bag support cages shall be constructed as a single piece from minimum 3 mm galvanized steel wires. Venturi (if applicable) shall be integral to the cage. Cage bottom shall be closed with galvanized steel cap welded to wire cage. The wire cage shall have minimum 8 vertical wires and horizontal rings spaced at maximum 200 mm
- Bag cage coated with 75µ epoxy to protect against corrosion
- Facilitate bag removal
- Venturi (if required)
- Stainless steel fastening devises
- Seal gasket

The bottom of each bag shall be sufficiently cuffed to provide a wear contact surface between bags.

For standardization purposes, bags materials and dimensions shall be approved by the Owner.

The clamping devices shall permit bag replacement without entering inside the dirty side of the dust filter. For smaller dust filters of less than 1.5 m wide, the maintenance shall be made through side access doors on one or two sides. For larger dust collectors, bag replacement shall be made from the exterior of the dirty side, on the top.

Online cleaning shall be used and no more than 10% of the bags shall be cleaned at any time.

6.4.1 Clamping device for Bag Assemblies

The bag assemblies shall be firmly clamped to the tube sheet by a positive locking, which will not loosen or slacken with time and vibrations. All tools required for operation of the clamping mechanism shall be provided. Clamping devices shall be easily and rapidly removable.

The reverse pulse jet bag cleaning system shall include.

Solenoid and diaphragm valves shall be prewired; build into IP 65 enclosures and shall permit easy removal of the valves. The solenoid valves shall be rated for operation at 24 V DC.

Blow tubes shall be easily removable and provided with quick release couplings and plug on the bottom of opposite end of the header from the air inlet for blow down. An air pressure gauge with isolating valve shall also be provided.

The compressed air header, solenoid valves, diaphragm valves, tubing and fittings shall be shop assembled and shipped for easy field mounting on the dust collector. This assembly shall be pressure tested at shop before delivery. The pulse-jet system shall be designed such that the solenoid and diaphragm valves and blow pipes are easily removable.

The solenoids shall be pre-wired into a maximum of two connection boxes.

Static differential pressure across filter shall not exceed 1500 Pa maximum and negative pressure shall not be more than 4500 Pa

The tubing between the diaphragm valves and solenoids shall be stainless steel and shall come complete with fittings.

Isolating manual shut-off valves between compressed air header and each diaphragm valve shall be provided.

The compressed air header shall be equipped with a plugged drain at its lowest point and a pressure gauge with shut-off valve.

6.5 Hopper/ Housing

The dust collector shall have a pyramid type hopper and designed to withstand a vacuum.

Hoppers shall be provided with level switch according to NA-00-STS010, Recommended Manufacturers for Mechanical Equipment.

Bag catch screens with approximately 100 mm openings shall be provided to capture loose bags. The screen shall be strong enough to support a man and shall be located below the access door.

6.6 Rotary Airlock Valves

A rotary airlock shall have the following features:

- Cast iron body
- Outboard mounted dust-sealed, anti-friction bearings
- All lubrication points shall be provided with metric button head grease fittings
- Minimum bearing B10 life of 30.000 hours
- Chain driven, complete with chain, sprockets, safety guard and shear pin. Belt drives are not acceptable
- The valve shall be a square plan configuration with minimum opening size of 250 mm by 250 mm
- Flanged and drilled inlet and discharge flange
- Independent drive and motor
- Maximum rotational speed of 30 rpm
- Flexible polyurethane adjustable and replaceable rotor tips
- Air purge connection (plug)
- Completely factory assembled

Rotary feeder shall dispose of the dust from the hopper and shall be designed to start even though the hopper is filled with dust. Where a rotary feeder is used after a screw feeder, the capacity of the rotary feeder shall be at least 30% more than the screw feeder.

6.7 Walk-In Plenum

A walk-in plenum design that requires splitting of the bag cage is not acceptable. The plenum shall be equipped with an airtight access door. Minimum size shall not be less than 600 mm by 1000 mm. Refer to: NA-00-STS001, General Technical Standard, for further design requirement.

If installed outdoors, the walk-in plenum shall have a sloped roof.

7 Fans

Fans shall be manufacturer’s normal design for the service specified. Standard replacement parts shall be readily available. Motors for fans in hot gas service shall be rated for “cold start”.

Fan dampers shall be multi-blade type with linkage suitable for manual or automatic control as specified for the application. Dampers shall be independent of the fan housing.

Larger units shall have separately mounted fans. Fans shall generally discharge through a vertical steel stack to a point clear of building structures or work areas.

Fans shall be designed for continuous operational duty.

Impellers and shafts shall be statically and dynamically balanced per ISO standards. The preferred method of achieving balance is by grinding or milling. If this is not possible, drilling is preferred over adding weights. Where adding weights is utilized, the balance weights shall have rounded corners and be securely welded to the impeller and do not contact the casing. The fan shall be designed so that the first critical speed is at least 1.25 times the maximum fan speed. The fan wheel assembly shall be statically and dynamically balanced.

The fan casing shall be adequately stiffened and supported to avoid vibration of panels.

7.1 Fan Housing

Fan housing shall be provided with a threaded drain connection with plug, on the bottom of the scroll. An inspection door bolted and with gasket, shall be provided on the fan housing. If required inspection doors shall be fitted with locking devices to prevent start-up of the machine, all in accordance with NA-06-STS002, Specification for LOTOV

Lower portion of housing shall be provided with a plug type drainage fitting.

7.2 Bearings

Shaft of all fans shall be supported on two bearings. Impellers directly attached to electrical motors are not acceptable (flanges motors).

Lubrication and cooling of bearings shall be described in data sheets. Unless indicated otherwise, bearings shall be located outside fan gas flow. Bearings shall be chosen for a useful life of 100.000 hours, based on B10 evaluation method.

7.3 Fan Drive

For detailed requirements refer to: NA-00-STS001, General Technical Standard.

Each drive mechanism, whatever the type specified, shall be designed with a safety factor of 1.5 to required motor capacity and taking service factor into consideration.

Fixed diameter pulley drives shall be multiple V groove type. Pulleys shall be installed on quick disassembly hub. Pulleys shall be keyed to motor and fan shafts. Maximum motor/fan speed ratio shall be 3:1. V-belts shall be supplied in assorted sets (2 belts minimum) and shall be clearly identified as such.

Fan supports for motors equipped with belt and pulley drive mechanisms shall be adjustable type to maintain proper belt tension.
Whenever required, anti-vibration devices shall be provided between fan and steel base or steel base and floor.

8 Equipment Painting

Refer to: NA-03-TS001 Surface treatment and painting.

9 Cartridge Type Dust Collectors

The Vendor may suggest cartridge filters when the following conditions apply. However, cartridge filters shall need express approval of the Owner.

- If the contamination is lower than 100 ppm that is to say with contamination levels lower than 0.01% in weight cartridge filters shall be considered as an alternative to bag filters
- Cartridge filter may be of the surface or depth-type filter implying that depth-type filters capture particles and contaminant through the total thickness of the medium, while in surface filters particles are blocked on the surface of the filter
- If selected, cartridge filters shall be of the disposable type

Cartridge type dust collectors shall provide convenient access for maintenance of cartridges from the clean air side. A walk-in plenum shall be provided on all units of 17.000 Nm^3/h capacities and larger. Gasketed access doors and internal walkways shall be provided. Door gaskets shall be suitable for both positive and negative pressure.

The following table may be used as a guideline for selection between cartridge and bag filters

Table 9.1 – Selection Criteria for Cartridge Filters

Cartridge Filters may be suggested	Bag filters shall be considered as first choice for
Application requiring filtration rate from 0,1 to 500 microns	Applications requiring filtration rate from 1 to 1000 microns
Compressed air filtering	Dust removal in the plants industrial environment:
Atmospheric dust, smoke, fumes, solid contaminants in the system.	
As final filter	
As 2nd filter after bag filters	