ASM LAB

TECHNICAL DOCUMENTATION

VERSION 2026.1.6

MINE VENTILATION DESIGN

Prepared by

ASM Lab

GITHUB.COM/RESPECT-MASITHULELA/ASM-LAB-RELEASES/RELEASES/LATEST

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About this document

Version 2026.1.6. The latest copy is published with every release at github.com/Respect-masithulela/ASM-Lab-Releases/releases/latest. Instructions for everyday use are in the ASM Lab User Guide.

1 Introduction

1.1 Purpose

ASM Lab is a desktop application for designing mine ventilation networks and simulating the airflow through them. It combines a 3D drawing environment with a network solver, so that airways, fans and regulators can be laid out, solved and reviewed in one place.

This document is the technical reference. It describes the data model, file formats, solver method, verification cases and troubleshooting. Step-by-step instructions are in the separate ASM Lab User Guide.

1.2 Scope

- Steady-state airflow in networks of airways, shafts, fans and regulators.
- Air density from pressure and temperature, including natural ventilation pressure.
- Optional thermal pass (Solve mode: aerodynamics and thermal).
- Context geometry: DXF drawings, 3D models and Datamine block models.

1.3 System requirements

Item	Requirement
Operating system	Windows 10 or Windows 11, 64-bit
Graphics	A graphics card or integrated GPU with WebGL 2 support
Network	Not required. ASM Lab works fully offline; internet is used only for update checks and bug reports.
Disk space	About 400 MB for the installed application

2 Installation and updates

2.1 Download

Installers are published at github.com/Respect-masithulela/ASM-Lab-Releases/releases/latest. Each release provides:

File	Use
ASM-Lab-Setup-<version>.exe	Installer. Recommended; receives automatic updates.
ASM-Lab-<version>-portable.exe	Runs without installation. Does not update itself.
ASM-Lab-Samples.zip	Sample projects and solver check cases.
ASM-Lab-User-Guide.pdf, ASM-Lab-Documentation.pdf	The user guide and this document.

2.2 Installing

- Run the Setup file. Windows SmartScreen may report an unknown publisher until the application is code-signed; choose More info, then Run anyway.
- Choose the installation folder (per-user installation, no administrator rights needed).
- Answer the prompt to create a desktop shortcut. A Start menu entry is always created.

2.3 Updates

- At start-up and every six hours, installed copies check the download page for a newer version.
- When one is found, a window shows the version and its release notes. Nothing is downloaded until the user chooses Update.
- The download runs in the background, with progress on the taskbar icon. The user then chooses Restart now, or the update is installed when ASM Lab closes.
- Projects are autosaved before restarting. The desktop shortcut is kept and refreshed.

2.4 Uninstalling

Use Windows Settings, Apps, ASM Lab, Uninstall. The desktop shortcut is removed with the application. Project files saved by the user are not touched.

3 User interface reference



Area	Contents
Menus	File, Edit, Mine and View. Every command is also in the command palette.
Ribbon	Tabs Home, Design, Network and Simulation. Home holds Create (draw tunnel, curved tunnel, shaft, fan, regulator, refuge bay), Edit (duplicate, merge, delete, split, fillet), Simulate (check, diagnostics, fan curves, go to fan, report, thermal), Solve, Navigate and Display.
Top right	Help (tutorials), Report bug, Settings, Open.
Left dock	Outliner (files, block models, collections), Drawing pen (profile and size of new airways), Colour (per network and per DXF layer), Clip (six cutting planes).
View tools	Drawing plane, fit, reset camera, wireframe, labels, flow arrows, flow animation, outliner, grid, flip, and two arrows that zoom, or set the animation speed while flow is animating.
Right panel	Inspect (properties of the selection), Dialogue, Network.
Bottom	Status bar and the solver log (iterations and residuals of the last solve).

4 Data model

4.1 Project structure

- A project contains collections. A collection is a level or area of the mine; the solver always runs on the whole project.
- Each collection holds nodes (junctions, with x, y and elevation) and airways (tunnels and shafts) that join two nodes.
- Fans and regulators are placed on airways. Refuge bays sit on a tunnel.
- Block models and imported solids are context: they are displayed and clipped, but are not part of the network.

4.2 Airway properties

Property	Meaning
Shape and size	Profile (e.g. rectangular or horseshoe), width and height; gives area A and perimeter P.
Length L	From the node coordinates, or stated.
Friction factor k	Atkinson friction factor [kg/m³]. Standards for drives and shafts can be set in Settings.
Resistance override	A stated resistance R [N·s²/m⁸] used instead of geometry and k.
Fan	A fan curve (library, quadratic, field test or blade geometry) and direction.
Regulator	Holds the airway at a set flow, or a set pressure drop.

4.3 Units

Quantity	Unit	Symbol
Air quantity	m^3/s	Q
Velocity	m/s	v
Pressure, pressure drop	Pa	p, Δp
Resistance	$N \cdot s^2/m^8$	R
Friction factor	kg/m^3	k
Density	kg/m^3	ρ
Temperature	°C (K in calculations)	T
Length, elevation	m	L, z

5 Files

5.1 Opening and importing

Format	Notes
ASM Lab project (.json)	Native format: network, settings and view. Samples use .asmlab.json.
DXF (.dxf)	Lines and polylines can be treated as tunnels (becoming a network) or kept as geology, orebody or other solids. Colours per layer.
Spreadsheet (.csv, .xlsx)	File, Import spreadsheet: nodes and airways from tables.
3D models (.glb, .gltf, .obj, .stl, .tri)	Displayed as solids for context.
Datamine block model (.dm)	Legacy double-precision .dm files. Coloured by any numeric field. DMX (compressed) files must first be converted to .dm with Datamine tools.

5.2 Saving and exporting

Command	Result
Save (Ctrl+S), Save As (Ctrl+Shift+S)	Project file (.json).
Save Copy	A copy, leaving the current file name unchanged.
Export: JSON, DXF, glTF (.glb)	Network and geometry for other software.
Export: CSV	Tables of airways and results.
Export: Screenshot PNG	The current 3D view.

5.3 Autosave, backups and recovery

- Every change is autosaved on the computer.
- A backup copy is kept at most every three minutes; the last five are listed in File, Backups. Very large projects (over about 1.5 MB of network data) are not backed up this way and should be saved to file.
- After an unexpected exit, ASM Lab offers to recover the autosave. File, Recover Autosave does the same at any time.
- If one part of the window fails, only that part shows an error card with Retry, Save a copy and Reload; the project is autosaved at once.

6 Solver

6.1 Method

ASM Lab solves the network as a whole with a nodal Newton method: the unknowns are node pressures, and each Newton step is solved with a preconditioned conjugate-gradient method. A line search with a sufficient-decrease test keeps the iteration stable on symmetric and near-zero-flow networks. The network is not simplified into series and parallel equivalents, so fixed flows on fans and regulators are always respected.

6.2 Airway law

$$R = k \cdot L \cdot P / A^3 \qquad \textit{(Atkinson resistance at reference density)}$$

$$\Delta p = R \cdot Q \cdot |Q| \qquad \textit{(pressure drop along an airway)}$$

When no resistance override is given, the resistance used is scaled from the reference density of 1.2 kg/m³ to the density of the air in the airway:

$$R_{op} = R_{std} \cdot \rho / 1.2$$

6.3 Density and natural ventilation

$$\rho = P / (R_{air} \cdot T) \qquad \textit{(dry ideal gas, T in kelvin)}$$

Node density follows from pressure and temperature; airway density is the average of its two nodes unless stated. Along each airway the balance includes the elevation change, which produces natural ventilation pressure where air columns of different density meet:

$$R \cdot Q \cdot |Q| - p_{fan} + \rho \cdot g \cdot (z_{to} - z_{from}) = p_{from} - p_{to}$$

At every free node, mass is conserved: the sum of ρ·Q over the connected airways is zero.

6.4 Fans and regulators

- Fan curves may come from the fan library, a quadratic, a field test or blade geometry; fan laws adjust for speed and density.
- Fans in series and in parallel are handled directly in the network; stall is detected and reported.
- A regulator holds its airway at a set flow (or set pressure drop); the rest of the network adjusts.

6.5 Convergence

- The solve converges when the largest mass imbalance at any node is below one millionth of the largest airway mass flow (a relative test).
- The solver stops after at most 2 000 iterations if it has not converged, and says so in the solver log.
- Solver diagnostics (Simulate) show how the residual fell during the last solve.

6.6 Thermal mode

With Solve mode set to aerodynamics and thermal, a thermal pass follows the airflow solution. Autocompression and heat exchange are applied in this pass only; the aerodynamic solution itself uses the density model above.

6.7 Network check

Simulate, Check reports problems in the network before solving, such as airways that do not connect to the rest.

7 Verification

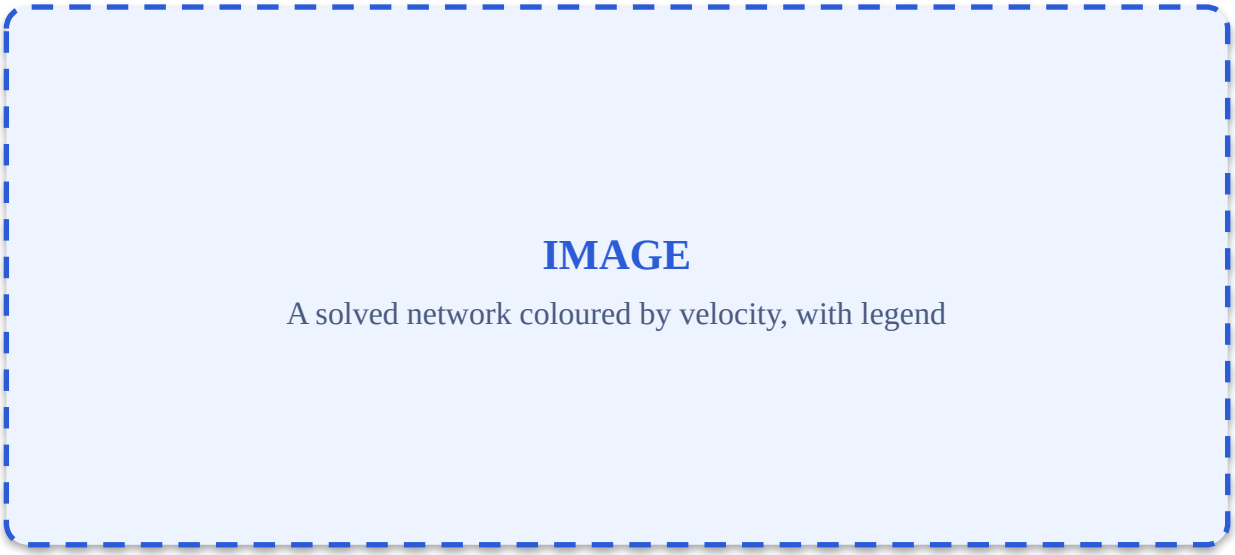
Ten check cases ship with ASM Lab (Mine, Load sample, and ASM-Lab-Samples.zip). Each has a closed-form answer. Results from the current solver:

Case	Expected	ASM Lab	Difference
01 Single airway	279.508 m³/s	279.570 m³/s	+0.02 %
02 Parallel airways	559.017 m³/s	559.140 m³/s	+0.02 %
03 Series airways	197.642 m³/s	197.630 m³/s	−0.01 %
04 Resistance override	44.721 m³/s	44.720 m³/s	0.00 %
05 Fan curve	53.452 m³/s	53.450 m³/s	0.00 %
06 Fans in series	66.667 m³/s	66.660 m³/s	−0.01 %
07 Fans in parallel	60.302 m³/s	60.300 m³/s	0.00 %
08 Regulator	35.000 m³/s	35.000 m³/s	0.00 %
09 Natural ventilation	Flow down S1, up S2	As expected	–
10 Symmetric ladder	Converges, no sign flips	7 iterations	–

Note
Cases 01 and 02 differ by 0.02 % because ASM Lab scales resistance to the actual air density, while the hand calculation uses the reference density. This is the intended behaviour.

8 Results and reporting

Feature	Description
Colour by	Flow, mass flow, velocity, pressure drop, resistance, density, dry-bulb and wet-bulb temperature, elevation or airway kind, with a min/max legend.
Inspect	Results and properties of the selected airway, node, fan or regulator.
Flow arrows and animation	Fixed arrows show direction; the animation moves markers with the air, at a speed ratio from ×0.05 to ×4.
Fan curves	Operating point of each fan on its curve; the fan library.
Report	Summary of the solved network, for printing or sharing.
Block models	Colour by any field with numeric ranges; hide ranges; opacity.



9 Keyboard shortcuts

Key	Command
Ctrl+N / Ctrl+O	New / Open
Ctrl+S / Ctrl+Shift+S	Save / Save As
Ctrl+Z / Ctrl+Shift+Z	Undo / Redo
A	Draw tunnel
J	Connect the last two nodes
Shift+D	Duplicate (with spacing and count)
Del	Delete
Alt+A	Select none
G / R	Move / rotate gizmo
Arrow keys, Page Up/Down	Nudge the selection
F5	Solve
F1	Tutorials
7 / 1 / 3 / 0	Top / front / right / iso view
5	Perspective or orthographic
.	Frame all
M / I	Measure distance / inquire elevation
Esc, right-click	Finish or cancel drawing

10 Troubleshooting

Problem	What to do
Windows warns about an unknown publisher	Choose More info, Run anyway. The warning goes once the application is code-signed.
No update prompt	Only the installed version updates; the portable file does not. Updates need an internet connection at start-up.
The solve does not converge	Run Simulate, Check. Look for disconnected parts, airways with zero size, or fans pushing against each other. Solver diagnostics shows how the solve progressed.
A DXF opens as a solid	Choose Treat as tunnels in the prompt or in Inspect to turn its lines into a network.
A .dmx file will not open	Convert it to legacy .dm with Datamine tools.
The 3D view is blank or shows a graphics error	Update the graphics driver; WebGL 2 is required.
Work was lost	File, Backups lists the last five versions; File, Recover Autosave restores the latest.
Something else is wrong	Use Report bug, or Report this crash on an error card.

11 Privacy and bug reports

ASM Lab works offline and does not collect usage data. Only two things use the internet: the update check, and bug reports that the user chooses to send.

A bug report contains	It does not contain
The text the user typed, and the severity	The user's name or email
ASM Lab version, desktop or web, operating system family	Computer name, screen, language or browser details
Error messages recorded in that session (shown, and editable, before sending)	Project name, files or geometry
Optional: project size (counts) and a picture of the 3D view	

Reports are private to the ASM Lab team. The public bug board shows only totals and the bugs the team chooses to publish. Reports made offline are kept and sent when the computer is next online.

Appendix A Glossary

Term	Meaning
Airway	Any path for air: drive, crosscut, raise or shaft.
Atkinson friction factor k	Describes the roughness of an airway; with its size and length it gives resistance.
Collection	A group of airways and nodes, usually one level or area.
Natural ventilation pressure	Pressure from differences in air density between connected air columns.
Node	A junction or end point of airways.
Regulator	A device that restricts an airway to control its flow.
Residual	The remaining mass imbalance during the solve; it falls towards zero as the solve converges.