AD FALCON API Manual

Discharges — User Manual

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Contents

1 Discharges — User Manual

The **Discharges** section defines volumetric flow (flux) boundary conditions for water (`Qw`) or air (`Qa`).

- In **2D** (plane strain / axisymmetric): discharge is applied on **element edges** using `Edgenodes`.
- In **3D**: discharge is applied on **element faces** using `Facenodes` (currently supported for **6-node quadratic triangular faces**).

1.1 Syntax

1.1.1 Section header

FALCON treats section names as case-insensitive and whitespace-insensitive, so these headers are equivalent:

```
% DischargeBoundary
% Discharge Boundary
% DischargeBoundaries
% DischargeBoundaryConditions
```

1.1.2 Section placement

Start with one of the accepted headers (recommended):

```
% DischargeBoundary
```

End with:

```
%%%
```

The section continues until a line `%%%` or the next line starting with `%` (the next section header) is encountered.

1.2 Input Format

1.2.1 Multiple discharge definitions

- Define multiple discharges by listing multiple discharge blocks inside the same discharge section.
- Each discharge block starts with `@Qw:` or `@Qa:` and consists of three lines (`@Q*`, `Values`, `LoadType`) plus an optional fourth `TabularData` line (only when `LoadType Tabular` is used).

Each discharge definition spans three or four consecutive lines (a fourth line is present only for Tabular loads):

1. **Marker line**
   `plaintext @Qw: ElemId <ElementID> Edgenodes <Node1> <Node2> ... <NodeN> (2D) @Qw: ElemId <ElementID> Facenodes <Node1> <Node2> ... <NodeN> (3D)` or `plaintext @Qa: ElemId <ElementID> Edgenodes <Node1> <Node2> ... <NodeN> (2D) @Qa: ElemId <ElementID> Facenodes <Node1> <Node2> ... <NodeN> (3D)`
   - `@Qw:` indicates water discharge (case-insensitive; recommended style: `@Qw:`).
   - `@Qa:` indicates air discharge (case-insensitive; recommended style: `@Qa:`).
   - `ElemId <ElementID>`: ID of the element to which the discharge applies.
   - The labels `ElemId`, `Edgenodes`, and `Facenodes` are case-insensitive.
   - `Edgenodes` (2D): list of node IDs on that element's edge. **2 or 3 nodes** are supported (linear/quadratic edges).
   - `Facenodes` (3D): list of node IDs on that element's face. Currently **6 nodes** are required (quadratic triangular face).
   - Ranges like `10-20` are accepted on the marker line.
2. **Values line** `plaintext Values <D1> <D2> ... <DN>`
   - One discharge magnitude per listed boundary node (edge node in 2D, face node in 3D).
   - Positive for injection; negative for extraction.
   - The `Values` label is case-insensitive, and `Values:` is also accepted.
3. **LoadType line**
   `plaintext LoadType <Type> [<Params>] Step <StepID>`
   - Defines time variation and the step at which discharge applies.
   - `<Type>` can be:
     - `Immediate` — applied instantly at `StepID` and then held constant over that step.
     - `Ramp` — linear increase from zero to full value over the duration of the step.
     - `Sinusoidal` — requires `Frequency <value>` and optional `PhaseLag <degrees>`.
     - `DampedSinusoidal` — requires `Frequency <value>`; accepts `DampingFactor <value>` (defaults to 0) and `PhaseLag <degrees>` (defaults to 0).
     - `Tabular` — time history specified via a `TabularData` line (see below).

- `Step <StepID>` indicates the simulation step when this discharge is activated.

4. **TabularData line (only for `LoadType Tabular`)** `text TabularData t1 v1; t2 v2; t3 v3`
   - `t_i` = time coordinates (in the same units as step time).
   - `v_i` = scalar load factor multiplying the nodal `Values` at time `t_i`.
   - Values between listed times are obtained by linear interpolation.
   - Time/magnitude pairs may be separated by whitespace and/or `;` (commas are not treated as separators).

The available load types and their time evolution are the same as for stress boundaries (see loadtypes.md), but here they scale **fluxes** rather than surface tractions.

1.3 Time Evolution and Propagation

- The discharge load law is evaluated on the **same global analysis time axis** as other load types: if a discharge uses `Ramp`, `Sinusoidal`, or `DampedSinusoidal`, that law is applied continuously in time.
- The `Step <StepID>` on the `LoadType` line selects the first simulation step on which the discharge is active.
- There is **no explicit `Propagate` keyword** in the `% DischargeBoundary` section. Instead, each discharge behaves as if:

```
Propagate: Yes
```

  from its start step through the last simulation step.
- For **Tabular** discharges, the `TabularData` table defines a time history $F(t)$ that multiplies the nodal `Values`. The table is interpreted over the full simulation time; there is no option to truncate it with a `FinalStep` propagation limit.

1.4 Physical Meaning and Formulation

- The `Values` on a discharge boundary represent a **Darcy flux** $\overline{\mathbf{w}}^{\beta} \cdot \mathbf{n}^{*}$ prescribed on the boundary of the domain, where:
  - $\beta = w$ for `@Qw:` (water) and $\beta = g$ for `@Qa:` (air),
  - $\mathbf{n}^{*}$ is the outward unit normal on the boundary,
  - dimensions are volume per unit area per unit time.

- In the finite-element formulation this boundary term appears as a **Neumann (flux) condition** in the phase mass-balance equation, consistent with the generalized Darcy law given in:
  - Coupled theory (saturated) — water flux on Γ_{q_w},
  - Fully coupled theory (unsaturated) — water/air flux on Γ_{q_β}.
- **Sign convention in FALCON input (per solver implementation):** a positive `Values` entry corresponds to flux **into** the domain/soil (opposite the outward normal), and a negative `Values` entry corresponds to flux **out of** the domain/soil (along the outward normal).

1.5 Validation & Errors

For a complete list of validation checks and error messages related to `% Discharge Boundary`, see the % Discharge Boundary section of the error dictionary.

1.6 Examples

1.6.1 Water Discharge, Ramp at Step 2

```
% DischargeBoundary
@Qw: ElemId 12 Edgenodes 101 102 103
Values  0.1 0.1 0.1
LoadType Ramp Step 2
%%%
```

1.6.2 Air Discharge, Sinusoidal at Step 5

```
% DischargeBoundary
@Qa: ElemId 8 Edgenodes 201 202
Values  0.05 0.05
LoadType Sinusoidal Frequency 1.0 PhaseLag 45 Step 5
%%%
```

1.6.3 Water Discharge with Tabular Time History

```
% DischargeBoundary
@Qw: ElemId 20 Edgenodes 301 302 303
Values  0.2 0.2 0.2
LoadType Tabular Step 1
TabularData 0 0.0;  1.0 0.5;  2.0 1.0;
%%%
```

This example prescribes the same nodal flux pattern on all steps starting from Step 1, but the overall magnitude follows the tabular factor: zero at time 0, half of the specified `Values` at time 1.0, and the full `Values` by time 2.0, with linear interpolation in between.

1.6.4 3D Water Discharge on a Face (Facenodes)

```
% DischargeBoundary
@Qw: ElemId 42 Facenodes 1001 1002 1003 1101 1102 1103
Values  0.02 0.02 0.02 0.02 0.02 0.02
LoadType Ramp Step 3
%%%
```
