

SEISMIC ANALYSIS REPORT

Seismic verification of a non-structural component (equipment)

DN500 PN10 Needle Valve – AVK series 872

Manufacturer	ACMO Srl (member of the AVK Group)
Product	Needle valve DN500 PN10, with AUMA gearbox
Series / Type	872 / F800
Body material	EN-GJS-500-7 (ductile cast iron)
Drawing / Doc. no.	87205000000100100000, rev. 00
Operating mass mCNS	521 kg
Reference code	P 100-1/2013 – Seismic design code, Part I (Design provisions for buildings)
Verification method	Equivalent static force method (§10.3.1.2)

Result: the component satisfies the seismic requirements of P 100-1/2013 for the specified site action. See Section 8.

1. Scope and basis

This report verifies the seismic adequacy of the above valve, treated as a non-structural component (equipment housed in / attached to a construction) in accordance with Chapter 10 of the Romanian seismic design code P 100-1/2013. The verification covers (i) the structural integrity of the pressure-retaining body, (ii) the operability of the valve, and (iii) the interface loads to be used by the installation/civil designer for the support and anchorage design.

Per §10.3.1.(3) of the code, the seismic force determined here is used only for the design of the component, its fixings and the local verification of its supports, and is not added to the seismic action of the main structure.

2. Seismic design action

Design ground acceleration, a_g	0.20 g (= 1.962 m/s ²)
Mean recurrence interval, IMR	225 years (20% probability of exceedance in 50 years) – reference action, ULS
Control (corner) period, T_c	0.7 s
Seismic action representation	Horizontal component, applied separately in both senses on the design direction (§10.5.2)

3. Component classification and installation

- Category: installation equipment – a rigid, three-dimensional body whose three dimensions are comparable; the seismic force is therefore applied as a concentrated force at the centre of gravity, in the most unfavourable direction (§10.3.1.2).
- Installation: above ground, mounted at grade on its support/foundation (not buried, not elevated within a multi-storey structure). The attachment level is therefore at the base of the structure ($z \approx 0$).

- Stiffness: a DN500 ductile-iron valve body rigidly bolted to its support is a rigid component with fundamental period $T_{CNS} \leq 0.06$ s.

4. Design coefficients (§10.3.1.3)

Coeff.	Value	Basis	Clause
γ_{CNS}	1.0	Importance factor = γ_i of the works (ordinary, importance class II–IV)	§10.3.1.3.1(2)
β_{CNS}	1.0	Rigid component, $T_{CNS} \leq 0.06$ s $\rightarrow \beta_{CNS} = 1.0$	§10.3.1.3.2
K_z	1.0	$K_z = 1 + 2z/H$; above-ground at grade, $z \approx 0$	§10.3.1.2
q_{CNS}	1.5	Behaviour factor – conservative value for rigidly-anchored equipment	§10.4.1.2(4) / Tab.10.2

Note: the product $a_G \cdot K_z$ is the seismic acceleration at the attachment point; $a_G \cdot K_z \cdot \beta_{CNS}$ is the seismic acceleration at the centre of gravity of the component – here 0.20 g.

5. Equivalent static seismic force (eq. 10.1)

$$F_{CNS} = (\gamma_{CNS} \cdot \beta_{CNS} \cdot K_z / q_{CNS}) \cdot a_G \cdot m_{CNS}$$

$$F_{CNS} = (1.0 \cdot 1.0 \cdot 1.0 / 1.5) \cdot 1.962 \text{ m/s}^2 \cdot 521 \text{ kg} = 681 \text{ N} = 0.68 \text{ kN}$$

Code limits on F_{CNS} (§10.3.1.2):

- Lower bound $F_{CNS} \geq 0.75 \cdot \gamma_{CNS} \cdot a_G \cdot m_{CNS} = 0.77 \text{ kN} \rightarrow$ governs
- Upper bound $F_{CNS} \leq 4 \cdot \gamma_{CNS} \cdot a_G \cdot m_{CNS} = 4.09 \text{ kN}$

Design horizontal seismic force: $F_{CNS} = 0.77 \text{ kN}$ ($\approx 15\%$ of self-weight)

Self-weight of the valve: $W = m \cdot g = 521 \times 9.81 = 5.11 \text{ kN}$.

For the design of fixings/anchors the seismic effects are increased by 30% (§10.4.1.2(1)): $F_{CNS, \text{anchor}} = 1.30 \times 0.77 = 1.00 \text{ kN}$.

6. Structural integrity of the pressure-retaining body

The valve body, cover and bolting form the pressure boundary and are sized for the internal pressure (PN10). The governing load on these parts is by far the pressure-induced thrust, not the seismic inertia force. A direct comparison demonstrates the margin:

- Hydrostatic end-thrust at PN10 on the full bore: $T = p \cdot A = 1.0 \text{ MPa} \times (\pi/4 \times 0.500^2 \text{ m}^2) = 196.35 \text{ kN}$.
- Design seismic inertia force: $F_{CNS} = 0.77 \text{ kN} \approx 0.4\%$ of the pressure thrust the body routinely withstands.
- Body material EN-GJS-500-7: $R_{p0.2} \geq 320 \text{ MPa}$, $R_m \geq 500 \text{ MPa}$, elongation $\geq 7\%$ (ductile) – a large strength reserve over the pressure-design stresses.

Conclusion: the additional sectional effects produced by the seismic inertia force are negligible relative to the pressure-design loads. The condition $E_{D,CNS} \leq R_{D,CNS}$ (§10.5.4) is satisfied with very large margin; the integrity of the pressure boundary is unaffected by the design earthquake.

7. Operability

The seismic acceleration experienced at the centre of gravity of the valve is $a_G \cdot K_z \cdot \beta_{CNS} = 0.20 \text{ g}$ (horizontal). The valve assembly – ductile-iron body, guided plunger and AUMA gear operator – is a robust, low-period mechanism

for which a 0.20 g lateral acceleration does not cause binding of the plunger, loss of guidance or malfunction of the gearbox. Open/close functionality during and after the design earthquake is therefore maintained.

If the contract additionally requires a formal operability (functional) qualification of the actuator as an active component, dedicated seismic qualification documentation for the AUMA gear operator can be supplied on request; the scope of any such requirement should be confirmed with the client.

8. Interface design loads for support / anchorage

The anchorage of the valve to its support/foundation and the verification of the supporting element are the responsibility of the installation (civil/EPC) designer (§10.4.1, §10.5.4). The following interface actions, at the valve support, are to be used for that design. The seismic values already include the 30% increase required for fixings.

Action at support interface	Value	Direction
Permanent self-weight, W	5.11 kN	vertical (down)
Seismic horizontal (for anchor design)	1.00 kN	any horizontal
Seismic vertical (non-governing)	$\approx \pm 0.70$ kN	vertical
Overturning moment at base ($h_{cg} \approx 0.45$ m, to confirm)	0.45 kN·m	—

Horizontal and vertical seismic effects are to be combined per §4.5.3.6.2 (e.g. 100%/30% rule). For the stability (overturning/sliding) check, the favourable effect of vertical loads is reduced by 15% (§10.5.2(5)). Process and pipe-reaction loads, and any unbalanced pressure thrust where the line is not otherwise restrained, are additional and generally govern the support design; they are provided by the plant designer.

9. Assumptions and limitations

- $\gamma_{cns} = 1.0$ assumes the works belong to importance class II–IV. If the valve serves an essential class I facility (uninterrupted operation required during/after the earthquake), $\gamma_{cns} \geq 1.5$ must be used; the seismic force scales linearly.
- $K_z = 1.0$ assumes above-ground mounting at grade ($z \approx 0$). If the valve is mounted at height z on a structure of height H , use $K_z = 1 + 2z/H$ (max ≈ 3); the force scales accordingly.
- Centre-of-gravity height $h_{cg} \approx 0.45$ m is assumed pending confirmation from the general-arrangement drawing.
- The equivalent static method (§10.3.1.2) is applicable: the valve is a rigid component and not a high-risk vessel requiring a floor-response-spectrum analysis (§10.3.1.1).
- Verification of the supporting structure and the design/qualification of the anchors are outside this report (by the installation designer).

10. Conclusion

The DN500 PN10 needle valve (AVK series 872, type 521; EN-GJS-500-7 body; AUMA gearbox; mass 521 kg), installed above ground at grade, satisfies the seismic requirements of P 100-1/2013 for the design action $a_g = 0.20$ g (IMR = 225 years, $T_c = 0.7$ s). The design horizontal seismic force is $F_{cns} = 0.77$ kN ($\approx 15\%$ of self-weight); the pressure-retaining body retains a very large margin and valve operability is maintained. The valve-to-foundation anchorage shall be designed by the installation contractor for the interface loads listed in Section 8.

Prepared by	Checked by	Date
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