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Calibration regulation for SF_6 gas density relay

六氟化硫气体密度继电器校验规程

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Calibration regulation for SF6 gas density relay

1 Scope

This Standard specifies the general technical requirements, metrological property requirements, calibration items and calibration methods of the spring tube type SF_6 gas density relays (hereinafter referred to as “density relays”).

This Standard is applicable to the on-site calibration and laboratory calibration of the spring tube type SF_6 gas density relays newly produced, in use and after repair. Other types of SF_6 gas density relays can be calibrated by reference to this Standard.

2 Normative references

The following documents are essential to the application of this Standard. For dated references, only the editions with the dates indicated are applicable to this Standard. For undated references, only the latest editions (including all the amendments) are applicable to this Standard.

GB/T 2423.10 *Environmental testing for electric and electronic products - Part 2: Test methods - Test Fc: Vibration (sinusoidal) (GB/T 2423.10-2008, IEC 60068-2-6: 1995, IDT)*

GB/T 11287 *Electrical relays - Part 21: Vibration, shock, bump and seismic tests on measuring relays and protection equipment - Section one: Vibration tests (sinusoidal) (GB/T 11287-2000, IEC 255-21-1:1988, IDT)*

GB/T 22065-2008 *Pressure type SF_6 gas density monitor*

DL/T 393 *Regulations of condition-based maintenance & test for electric equipment*

3 Terms and definitions

The terms and definitions defined in DL/T 393-2010 and the following ones are applicable to this Standard.

3.1 Rating pressure

It refers to the pressure of filling the equipment air chamber with the required SF_6 gas under standard atmospheric conditions, before the equipment is put into operation or during air injection.

3.2 Alarm pressure

It refers to the pressure of giving alarm signals, when the SF_6 gas pressure in the equipment air chamber drops to a certain set value.

3.3 Lock pressure

It refers to the pressure of giving lock signals, when the SF_6 gas pressure in the equipment air chamber drops to a certain set value.

3.4 Overpressure alarm pressure

It refers to the pressure of giving overpressure alarm signals, when the SF_6 gas pressure in the equipment air chamber rises to a certain set value exceeding the rating pressure.

3.5 Absolute pressure type density relay

It refers to the gas density relay indicated with absolute pressure and using absolute vacuum as reference pressure.

3.6 Relative pressure type density relay

It refers to the gas density relay indicated with relative pressure and using environmental atmospheric pressure as reference pressure.

3.7 Relatively mixed pressure type density relay

It refers to the gas density relay indicated with relative pressure and using standard atmospheric pressure as reference pressure.

3.8 Absolutely mixed pressure type density relay

It refers to the gas density relay indicated with absolute pressure and using environmental atmospheric pressure as reference pressure.

3.9 Condition-based maintenance

It refers to a kind of maintenance strategy used for arranging the maintenance reasonably, based on the equipment status and taking the security, reliability, environment, cost and other factors into overall consideration.

[Definition 3.1.1 in DL/T 393-2010]

4.2.1 As for the density relay equipped with a stop pin, whose scale starts from a certain positive pressure value, when the ambient temperature is 20°C and the atmospheric pressure is standard atmospheric pressure, the pointer shall rest against the limit nail under non-pressure working condition, before the pressure-rise calibration and after the pressure-drop calibration. For the specific relationships among reference zero, temperature and atmospheric pressure, REFER to the instruction manual of this density relay.

4.2.2 As for the density relay whose scale starts from the minimum pressure value, the pointer zero error under non-pressure working condition, before the pressure-rise calibration and after the pressure-drop calibration, shall comply with the following requirements:

a) For the absolute pressure type density relays, when the ambient temperature is 20°C, the pointers shall point at local atmospheric pressure value. When the ambient temperature is higher than 20°C, the pointers shall point at the pressure which is lower than local atmospheric pressure. When the ambient temperature is lower than 20°C, the pointers shall point at the pressure which is higher than local atmospheric pressure. For the specific relationships among reference zero, temperature and atmospheric pressure, REFER to the instruction manual of the density relays.

b) For the relative pressure type density relays, when the ambient temperature is 20°C, the pointers shall point within the width range of the zero index line. The width of the zero index line shall not exceed twice the absolute value of the maximum allowable basic error. When the ambient temperature is higher than 20°C, the pointers shall point at the position below the zero. When the ambient temperature is lower than 20°C, the pointers shall point at the position above the zero. For the specific relationship between reference zero and temperature, REFER to the instruction manual of the density relays.

c) For the relatively mixed pressure type density relays, when the ambient temperature is 20°C, the pointers shall point at the difference of local environmental atmospheric pressure minus standard atmospheric pressure. When the ambient temperature is higher than 20°C, the pointers shall point at the position below this difference. When the ambient temperature is lower than 20°C, the pointers shall point at the position above this difference. For the specific relationship between reference zero and temperature, REFER to the instruction manual of the density relays.

d) For the absolutely mixed pressure type density relays, when the ambient temperature is 20°C, the pointers shall point within the width range of the 0.1MPa index line. The width of the index line shall not exceed twice the absolute value of the maximum allowable basic error. When the ambient temperature is higher than 20°C, the pointers shall point at the position below

Under rating pressure, the hysteresis error shall not be greater than the permissible error specified in Section 5.1.

5.4 Tapping displacement

TAP the case so that the pointer can swing freely. The variation of the pointer's indicating value shall not be greater than 1/2 of the absolute value of the permissible error specified in Section 5.1.

5.5 Pointer deflection stability

Within the range of measurement, the pointer deflection shall be stable and without obvious jitter and jam faults, except when the pressure-rise pointers pass near the low-pressure lock contacts and low-pressure alarm contacts.

5.6 Switching value error

On the set point of the same signal contact, the difference between the actual pressure values during the signal connection and disconnection or switching of the density relay shall not exceed 3% of the range.

6 Calibration conditions

6.1 Environmental conditions

6.1.1 The ambient temperatures shall refer to the temperatures required by the standards and density relays for normal operations. The standards and density relays shall be protected from direct sunlight, and shall not be affected by stronger heat sources. In addition, the ambient temperatures shall be steady. The periods with larger temperature fluctuations shall be avoided during on-site calibration.

6.1.2 Relative ambient humidity: no greater than 85%.

6.1.3 Ambient pressure: atmospheric pressure.

6.1.4 Before calibration, the density relays shall operate or stand for at least 3h in the calibration environment.

6.2 Standard

6.2.1 The absolute value of the standard's permissible error shall not be greater than 1/4 of the absolute value of the permissible error of the density relay to be inspected.

6.2.2 The available standards include:

calibration. PAY attention to the connection mode between density relay and equipment body, so as to prevent gas leakage.

6.3.2 During the on-site calibration of the density relays, it is allowed to lead the contact signal lines from wherever it is easy to connect lines in principle. For instance, directly REMOVE the original output lines for each group of signal contacts from the density relays, and LEAD the signal lines for calibration; or CONNECT lines on the terminal blocks of the wiring cabinets. In the latter case, the lines connected in the control systems have to be disconnected from the terminal blocks, so as not to affect the calibration by preventing the secondary circuits and the sampling signal lines from constituting loops.

6.3.3 During the zero and metrological property calibrations, the density relays shall maintain upright or normal operating condition.

6.3.4 As for the density relays using the environmental atmospheric pressure as reference pressure, it is necessary to confirm that the screws on the top have been loosened according to the requirements given in the instruction manual before calibration, so as to keep the air pressure balance inside and outside the case.

6.3.5 In order to accurately measure the temperatures of the density relays, the temperature probes of the thermometers or calibrators shall be close to the density relays as far as possible. Furthermore, KEEP the temperature balance along with the density relays. The specific temperature equilibrium time shall be suitable to local conditions. In principle, the temperatures shall be thoroughly balanced. Generally speaking, the temperature equilibrium time shall not be less than 0.5h. The specific time is related to the temperature differences between standards and density relays and the structures of the density relays.

6.4 Working media for calibration

6.4.1 REMOVE the density relays to be inspected from the SF_6 equipment for calibration, until they break away from the bodies. It is allowed to use clean and dry air or clean, non-toxic and harmless gases with stable chemical properties, such as nitrogen, SF_6 gas, etc.

6.4.2 When calibrating the density relays without breaking away from the SF_6 equipment, the SF_6 gas with a purity of not less than 99.9% shall apply.

7 Calibration method

For the test process for the density relay calibration, SEE Annex A.

7.1 Appearance

USE visual observation method for appearance calibration, which shall comply with the requirements of Section 4.1.

7.2 Zero

USE visual observation method for zero calibration, which shall comply with the requirements of Section 4.2.

7.3 Calibration of the indicating value error, hysteresis error and tapping displacement

7.3.1 ESTIMATE the indicating values of the density relays according to 1/5 of the division value.

7.3.2 The indicating value calibration of the density relays shall only be conducted to the rating pressure points. During calibration, the pressure shall be increased gradually and steadily. When the indicating value comes up to the upper limit, CUT off the pressure source. WITHSTAND the pressure for 3min. The pressure shall be steadily decreased for calibration. As for the rating pressure points, NOTE down the indicating values p_{u1} and p_{u2} before and after tapping the case during the pressure-rise calibration of the density relay, the indicating values p_{d1} and p_{d2} before and after tapping the case during the pressure-drop calibration, and the indicating value p_s of the standard.

7.3.3 As for the calibration points, the differences $\triangle p$ BETWEEN the indicating values before and after tapping the case during the pressure-rise and pressure-drop calibrations and the indicating value of the standard shall comply with the requirements of Section 5.2. The indicating value error of the density relay $\triangle p$ refers to the maximum of the absolute values of $\triangle p_{u1}$, $\triangle p_{u2}$, $\triangle p_{d1}$ and $\triangle p_{d2}$. For the calculation of $\triangle p_{u1}$, $\triangle p_{u2}$, $\triangle p_{d1}$ and $\triangle p_{d2}$, SEE Equations (3) to (6).

$$\Delta p_{u1} = p_{u1} - p_s \quad (3)$$

$$\Delta p_{u2} = p_{u2} - p_s \quad (4)$$

$$\Delta p_{d1} = p_{d1} - p_s \quad (5)$$

$$\Delta p_{d2} = p_{d2} - p_s \quad (6)$$

7.3.4 As for the calibration points, the difference $\triangle r$ between the indicating values after tapping the case during the pressure-rise and pressure-drop calibrations shall comply with the requirements of Section 5.3. For the $\triangle r$ calculation, SEE Equation (7).

$$\Delta r = |p_{d2} - p_{u2}| \quad (7)$$

When the output contacts of the density relay are connected, USE a digital multimeter to measure the DC resistance value between both ends of each group of output contacts. The results shall comply with the requirements of Section 4.5.

7.8 Sealing property test

CONDUCT the sealing property test according to the test method specified in Section 6.15 of GB/T 22065-2008. The results shall meet the requirements of Section 4.3.

7.9 Vibration resistance test

CONDUCT the vibration resistance test according to the requirements of Section 4.6 and the test method specified in GB/T 2423.10. After the test, MAKE calibration according to Sections 7.2 to 7.4. The results shall conform to the provisions of Section 4.2 and Chapter 5.

7.10 Impact resistance test

CONDUCT the impact test with a pulse duration of 7ms and a total of 30 pulses according to the impact levels specified in Section 4.7. After the test, MAKE calibration according to Sections 7.2 to 7.4. The results shall conform to the provisions of Section 4.2 and Chapter 5.

7.11 Temperature compensation test

USE constant high and low temperature test chambers or standards at special temperatures on site for calibration, by reference to the requirements of Sections 7.3 and 7.4. The results shall conform to the provisions of Section 4.8.

8 Calibration standard, cycle and items

8.1 Calibration cycle

8.1.1 The density relays newly produced and attached with exit-factory inspection certificate as well as in normal use are able to be calibrated according to the routine test items. Before use, the density relays after repair shall be calibrated according to the diagnostic test items. As for the density relays found to have abnormities or suspected to have faults in use but passing the routine test, CONDUCT the diagnostic test, so as to determine whether the density relays are available.

8.1.2 The density relays in use shall be calibrated according to the reference cycle specified in DL/T 393.

Annex B

(Normative)

Pressure conversion method

B.1 During calibration, READ the SF_6 gas pressure value at 20°C from the standard, or CONVERT into the pressure at 20°C according to the SF_6 status equation or status parameter curve.

B.2 According to the types of the density relays to be calibrated (absolute pressure type, relative pressure type, relatively mixed pressure type and absolutely mixed pressure type density relays) and the types of the pressure standards for measurement (absolute pressure type and relative pressure type), CONVERT the indicating value of the standard into the numerical value adopting the same reference pressure as the density relay to be inspected, so as to make comparison with the nominal value of the density relay.

B.3 In principle, the conversion procedures are as follows: indicating value of the standard → absolute pressure value → absolute pressure value at 20°C → numerical value adopting the same reference pressure as the density relay to be inspected. For the specific conversion method, SEE Table B.1. COMPARE the numerical value converted according to Table B.1 with the indicating value of the density relay and the contact setting value.

Table B.1 Pressure Conversion Method

Pressure standard / Density relay	Absolute pressure type	Relative pressure type
Absolute pressure type	CONVERT the indicating value of the standard into the numerical value at 20°C.	The indicating value of the standard adds the environmental atmospheric pressure, and then converts into the numerical value at 20°C.
Relative pressure type	The numerical value at 20°C converted from the indicating value of the standard minus the environmental atmospheric pressure.	The indicating value of the standard adds the environmental atmospheric pressure, converts into the numerical value at 20°C, and then minuses the environmental atmospheric pressure.
Relatively mixed pressure type	The numerical value at 20°C converted from the indicating value	The indicating value of the standard adds the environmental atmospheric pressure, converts into