Rapid Pressure Rise Relays

Concept, Construction, Application & Testing

Rapid Pressure Rise Relays

Agenda

- Introduction
- Operation
- Applications
- Possible Reasons for Misoperations
- Testing
- Conclusion
- Questions

Rapid Pressure Rise Relays

Introduction

- Internal arcing in an oil-filled power transformer can instantly become a catastrophic failure
- It can damage or destroy other equipment
- Present extreme hazards to workers and the environment

Rapid Pressure Rise Relays

- The Rapid Pressure Rise Relay (RPRR) utilize sudden changes in internal transformer pressure to sense internal faults
- Then with its control circuit de-energize the transformer and/or provide an alarm
- High level internal faults are detected sooner by other electrical relays
- RPRR can sense low level internal faults that are often not able to be identified by conventional protection schemes

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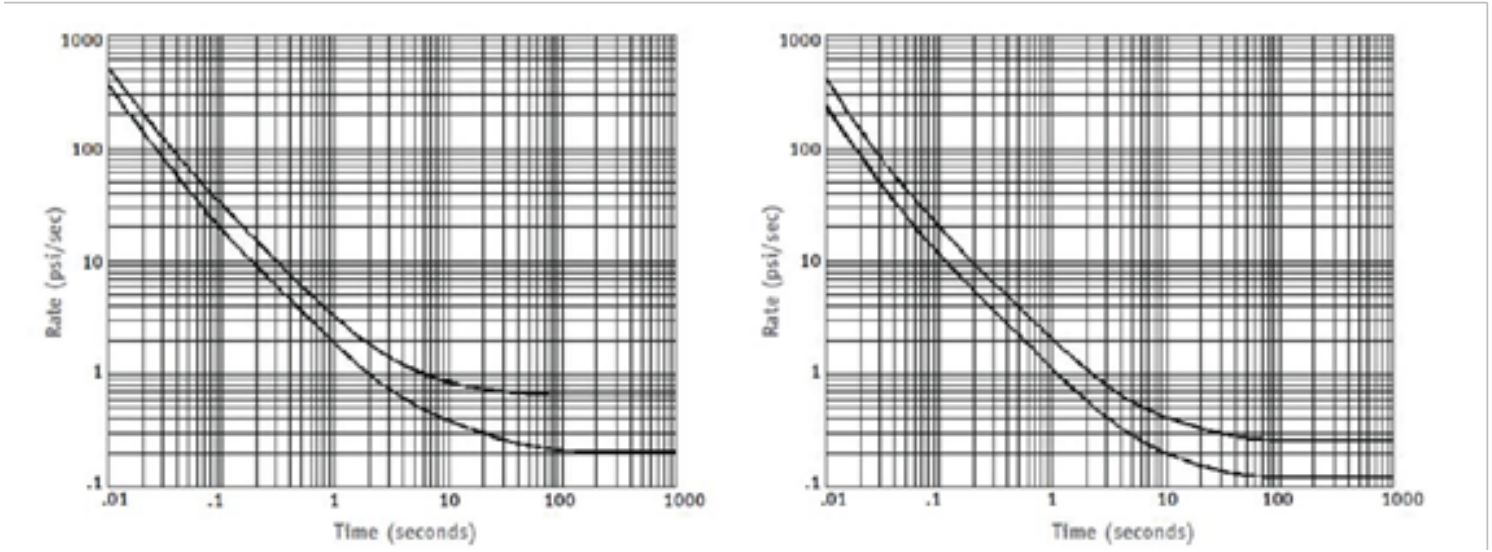
- RPRR are designed to not operate for steady state or non-fault changes in:
  - Temperature
  - Vibration
  - Mechanical shock
  - Pump surges
- But to operate quickly and with an inverse time characteristic, for changes in these parameters due to internal faults

Rapid Pressure Rise Relays



Under Oil

In Gas

RPRR Response Curves

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- RPRR are sometimes prone to operation due to external faults and other non-fault events
- Makes their application a tradeoff between dependability for internal transformer faults and security against other events

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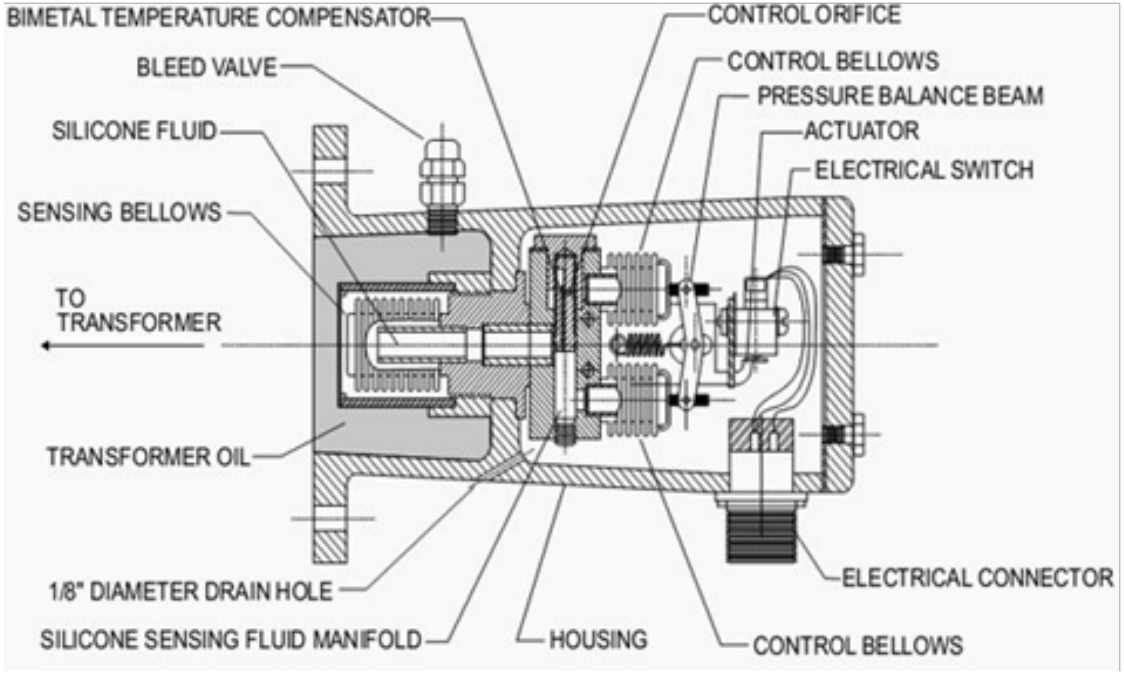
- Operation



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Rapid Pressure Rise Relays

- Microprocessor based relay available since 1990s
- Monitors separately for rapid pressure rise, slow (static) pressure rise, provides a built-in seal-in relay, and an analog current loop to provide SCADA or remote pressure sensing
- It may be used for either “in gas” or “under oil” applications by settings adjustments
- It has adjustable sensitivity and are commonly applied at nuclear/generation facility transformers where safety and sensitivity to trip XFMR are greater issues

Rapid Pressure Rise Relays

- Available with one or three pressure sensors
- Adjustable fast and slow pressure rise set points
- Momentary or seal-in actuation of control and alarm signals

- Individual set points to provide alarms prior to trip signals should a pressure event occur
- Feature 2 of 3 logic to trigger a trip signal

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Rapid Pressure Rise Relay Applications

- Detect faults not normally seen by current based relays
- Applicable to any size and type of liquid filled transformer
- Use often based on the transformer size, location within the power system, cost, and past operating experience
- Decision to trip and/or alarm has been an ongoing concern since the early development of this type of relay.

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The Faults that are low in current magnitude that may not be detected by conventional current based relays and other unusual events include:

- Turn to turn
- High resistance joints
- High eddy current between laminations
- High impedance faults
- Hot spots on the core due to a short circuit of the lamination insulation
- Core bolt insulation failure
- Faulty joints
- Loss of oil due to leakage

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- RPRR could also aid in the protection of grounding transformers and transformers with complicated circuits like phase shifting and phase regulating
- RPRR is insensitive to the exact location of the winding fault
- RPRR may also be used in the tap changer mechanism compartment
- Faults listed above may result in current magnitudes that are well below the sensitivity of the overcurrent or differential relay
- These conditions will eventually evolve into a more significant fault, but perhaps at the expense of considerable damage.
- The ability to detect the condition sooner and to initiate tripping could prevent extensive transformer damage.

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The decision to use a Rapid Pressure Rise Relay may be based on the following factors:

- Cost
- Transformer MVA size
- Location within the power system
- Past operating experience
- Type of RPRR and whether to trip or alarm.

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Possible Reasons for Rapid Pressure Rise Relay Misoperations

1. Inappropriate mounting
   - The relay mounting must be rigid
   - If mounted on an isolation valve, care to minimize the moment arm
   - Relays mounted in the horizontal position must be installed with the electrical connector pointed straight down
   - Relays must have installed the vent with proper orientation to assure weathertightness

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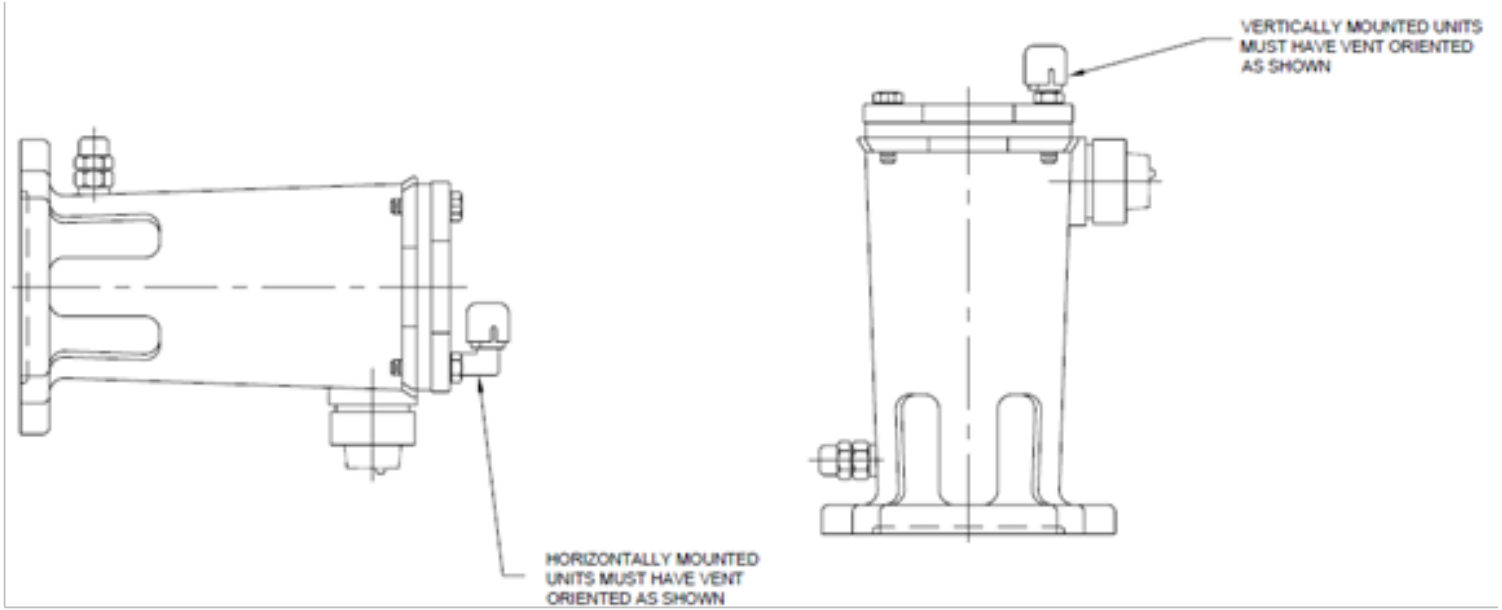
- Electrical Connector & Vent Proper Orientation



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2. Inappropriate circuit design increases the likelihood of a false operation due to electrical transients

3. Vibration due to seismic areas and some industrial applications

4. Shock waves in the transformer oil during cooling pump starts and stops

5. Shock waves in the transformer oil due to winding movement during a through fault

6. Surges in pressure during maintenance operations may be enough to operate the relay

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Rapid Pressure Rise Relay Testing

- An appropriate RPRR test program should be used to ensure RPRR works correctly
- Tests can be performed using a simple pressure (GO - NO GO) test within specific pressure ranges
- Performed at installation and at least during the transformer's normal maintenance cycle (every 3 to 5 years).

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- Pressure tester kit available from the RPRR manufacturer
- Test can be performed while the RPRR is installed
- Approximate measure of calibration

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The test procedure includes the following steps:

1. Remove the RPRR from the control circuit by removing the cable.
2. Connect an ohm meter across the relay contacts.
3. Pump up the pressure to the upper end of the range and hold constant for 30 seconds.
4. Quickly release the pressure. The relay should operate (GO test).
5. Pump the pressure to just below the lower end of the operate range and hold constant for 30 seconds.
6. Quickly release the pressure. The relay should not operate (NO GO test).

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The test procedure steps 3 – 6 may be repeated

- To gain confidence in the consistency of the relay operation
- Identify the specific GO - NO GO pressure

If the RPRR does not test within the manufacturer's specifications the RPRR must be either re-calibrated or replaced.

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There is also another pressure tester device available from the RPRR manufacturer

- Duplicates the production line testing
- Allows to perform the same calibration as the factory test

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Conclusions

- RPRR have proven to be a relatively dependable relay for rapid detection of low level internal faults
- However, their nature is such that they are sometimes prone to operation due to external faults and other non-fault events
- Most users use Rapid Pressure Rise Relays to trip for some purpose, and over half also use them to alarm
- Newer relays and designs have reduced misoperations and may warrant reconsideration for those utilities that changed their designs to alarm only or removed the trip.

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