Joslyn Clark

Joslyn Clark Controls, Inc.

Simple, Safe, Retrofit Programs to Significantly Extend Life of Existing Circuit Breakers

Introduction

This discussion describes in detail retrofitting medium voltage circuit breakers to medium voltage fused vacuum starters/ controllers. This can equally apply to 480/600 volt switchboards.

Vacuum switching of electric power is well proven in both switchgear and motor control applications.

Vacuum switching technology is today readily available in vacuum circuit breakers and vacuum contactors covering all applications in low voltage and medium voltages.

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In addition the modular design of Joslyn Clark's contactors allows for multiple and paralleling high current applications to be successfully applied.

The advantages of using vacuum contactors/starters can be reviewed as follows:

- Long Electrical Life
- Long Mechanical Life
- Compact Size
- Maintenance Free
- Self Adjusting
- Impervious to Harsh Atmospheres
- Arc Containment

To carry forward the advantages of vacuum technology the starter/ controller package should also reflect the advantages of the vacuum contactor as a component, i.e. maintenance free, compact, etc.

Joslyn Clark designs reflect these features in particular our medium voltage starter designs also incorporate additional safety features such as:

- Starter Segregation by Grounded Metal
- Fault Make Load Break "Disconnect" Switches
- Automatic Load Side Grounding when Disconnecting
- Fixed Style Designs with Bolted Electrical Connections
- "K.I.S.S." Keet it Simple & Safe – Principles

In years past many medium voltage systems were designed with circuit breakers being specified with breakers being considered superior by consultant engineers over fused contactors (air break contactors in those days).

Today fuse technology has advanced significantly with the availability of self-protecting, current limiting fuses. The fuses can be provided with blown indicators, which when coordinated into a three phase trip bar design will protect instantaneously against single phasing, in the event of a blown fuse, a long time concern of the consultant engineer.

Thus with a fused vacuum contactor, short circuit coordination is achieved in excess of 400 MVA levels at 5.0KV current limit, I t, and mechanical stress allowed on an electrical system when compared to the I t let through of circuit breakers.

In addition, circuit breakers have always had a downside when compared to fused contactor type starters namely:

- High Cost
- Low Mechanical Life (10,000)
- High Maintenance
- Expensive Parts

Fuse technology has advanced significantly with the availability of self-protecting, current limiting fuses.

When applied to intermittent duty, such as feeder circuits, circuit breakers are quite suitable, but if applied to motor switching or more frequent switching duty, users usually experience the downside problems of circuit breakers.

Switching a circuit breaker three times a day will mechanically exhaust the life of the breaker within nine years, not long for capital equipment and during these nine years users have to spend a lot of downtime dollars on parts and labor to maintain these devices.

A quick fix often recommended is to retrofit the existing air circuit breaker to a vacuum circuit breaker "***this is not the correct solution***." The V.C.B. will still only provide to 10,000 mechanical life operations by "ANSI" standards. Another nine years and such a retrofit are very expensive.

The logical solution is to replace the circuit breakers, which have high maintenance cost, with fused vacuum contactors. It should be remembered that it is only the switching device or its associated closing/tripping mechanism which is likely to be causing trouble in

the circuit breaker mechanism. The remainder of the switchgear unit is in general quite serviceable and does not need replacing.

The Fused Vacuum Contactor

Existing problems can be overcome simply by taking the operational load (the mode of switching operations away from the circuit breaker) and transferring this duty to a fused vacuum contactor, while retaining the existing circuit breaker to provide short circuit protection to the line side of the current limiting fuses. Correct coordination between the circuit breaker, fuses and contactor, will insure that the appropriate device operates at its correct current level.

There are many thousands of circuit breakers currently in service on motor starting duty. The range of Joslyn Clark vacuum contactors can be applied on all these circuit breakers

Vacuum contactors can be arranged for electrically held AC or DC control voltages or for mechanically latched contactors with appropriate AC or DC trip coils. We would recommend electrically held control circuits be used wherever possible.

Modification Advantages

There are many thousands of circuit breakers currently in service on motor starting duty. The range of Joslyn Clark vacuum contactors can be applied on all these circuit breakers in the appropriate current and voltage range. The advantages of such a modification are numerous.

1. The original problem of exhausted mechanical life of the original equipment and any difficulties in obtaining replacement parts are eliminated.
2. When the modification is complete, there are added bonuses that in both the new, and the existing installations, are virtually maintenance free. This eliminates routine plant shutdowns an important factor to consider in a continuous process plant.
3. The existing switch room requires no additional construction work apart from the installation of the additional fused vacuum contactor unit, which can be installed in the switch room or any convenient place, between the existing circuit breaker and motor.
4. In the majority of switchboard installations, motor starting circuits are interspersed with transformer feeder or capacitor bank circuits. The latter usually have more restricted operational duty leaving plenty of mechanical life in the units controlling the circuits. The motor circuits in the switchboard can be easily

modified, if necessary one at a time, without effecting the adjacent circuits at all.

5. The existing switchboard requires little modification except for minor work to the circuit breaker. Reconnecting the control circuit wiring which would be the close and trip circuits, wired from the circuit breaker into the contactor, other trip circuits such as ground fault protection overload tripping are likewise wired into the contactor trip circuits. Circuit breaker modifications can be carried out individually, thus allowing continuous process plans to remain operational.
6. Current limiting fuses are provided with striker pins and a three phase trip bar with an electrical contact wired into the contactor trip circuit. This arrangement provides protection against single phasing in the event of a single fuse blowing in one phase.
7. Various indicators can be installed in the new panel providing visual indication to the status of the contactor and the status of various tripping functions. Controls can be installed in the new panel although in general control switches are already in the existing circuit breaker panel, control of the motor can be maintained for the existing installation, in common with other feeder circuits such as transformer feeders or capacitor feeders which would probably not require modification.

Grounding and Safety Procedures

The fused vacuum contactor cabinet should be provided with a key or lock system that prevents operator access until the existing circuit breaker is isolated. This key or lock system forms part of the grounding and safety scheme that should be in existence. It is important that grounding and operational procedures on the modified circuit breakers remain as near as possible on existing procedures.

For example, transformer feeders or capacitor bank feeders will generally not be modified, and it is therefore desirable for site personnel to have continuity in grounding and operational procedures, where transformer feeder, capacitor bank feeder circuits are on the same switchboard as the modified motor switching circuits.

Consideration must be given to the requirements for grounding circuits down. Bear in mind that two additional devices would now have been connected between the circuit breaker and the motor.

It is worth considering the addition of controls to signal the condition of the fused vacuum contactor back to the circuit breaker panel, especially if the fused vacuum contactor unit cannot be seen from the circuit breaker.

Installation

Figures 1 and 2 illustrate a typical installation and single line diagram. Installation would involve:

1. Mounting the fused vacuum contactor unit.
2. Connecting the new unit in series between the existing circuit breaker and motor as detailed in figure 2.
3. Location of the new unit should be selected to avoid possibly any new lengths of motor cable being used.
4. The wiring of the control circuits to provide all start-stop and tripping functions being rewired from the existing breaker into the contactor strip circuit.
5. Addition of the key or lock systems be added to be sure that grounding and operational procedures are followed as per site requirements.

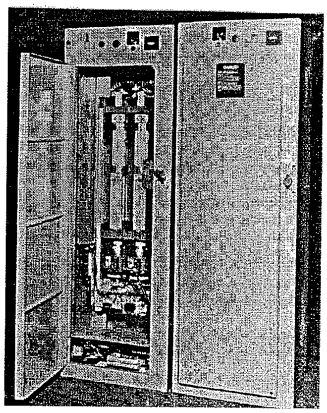
Conclusions

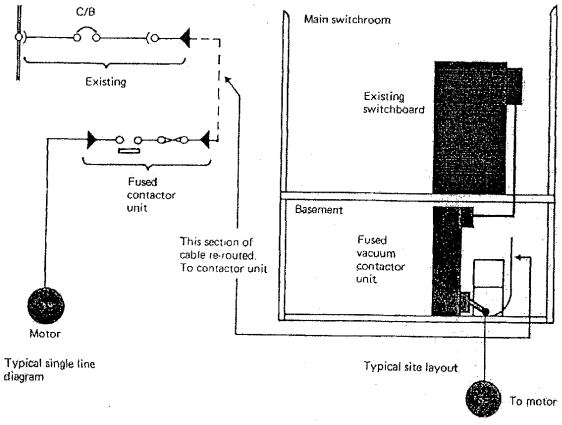
With the modifications complete, the user can look forward to the following advantages:

1. An increased life of the circuit breaker by as much as 50 years.
2. With the existing circuit breaker operating as a backup isolator to the contactor, and having an on load operation say once every 12 months, routine shutdowns for circuit breaker servicing are eliminated.
3. Maintenance should be carried out on the vacuum contactor, which is a simple overtravel check that is required only once every 500,000 operations. On a switching duty of 20 operations per day, a check would be required every 68 years, hence our claim that the installation is virtually maintenance free.
4. With the Joslyn Clark vacuum contactor now switching the motor, the lower chopping current levels, as opposed to those associated with circuit breakers, must minimize the risk of motor winding failure. An important consideration since the motor impulse level will be decreasing with age.
5. The user, originally faced with the cost of complete switchboard replacement together with the extra construction and cabling

cost, could now complete this modification including cabling and site modification work, for a cost often less than 50% of the cost of replacement circuit breaker.

Figures





John Lett became involved with vacuum power switching in the early 1960s, soon after completing his engineering studies at Aston University in his native UK. Working on Low and Medium Voltage Contactor and Motor Control Center designs, Lett's work in Engineering, Sales and Product Management developed competitive vacuum designs and expanded their acceptance in European markets. In 1978, he moved to the United States to continue this work in North America, where at the time few manufacturers of vacuum power products existed.

Vacuum designs are extensively used today, and at medium voltage almost exclusively used in power switching for motors, transformers and capacitors.

Lett retired from JCC/Danaher in 2009, but still works as a consultant for the company. He considers the next step for vacuum products to be utilized in the 10-15 Kv ranges as new motor designs are developed.