SCHULZ ELECTRIC
POWER SYSTEMS BY TIMKEN

Charles 'Bill' Eldredge
QA Manager

T 203.859.7413
F 203.562.1082
C 203.619.3216
eldredge@schulzelectric.com

June 13, 2018
Docket No. 99901269

U.S. Nuclear Regulatory Commission
ATTENTION: Document Control Desk
Washington, DC 20555-0001

Subject: Response to Notice of Nonconformance No. 99901269/2018-201-01

Reference: NRC Inspection Report No. 99901269/2018-201

Enclosed is Schulz Electric's response to NCR Report Number 99901269/2018-201 and Notice of Nonconformance Number 99901269/2018-201-01.

The enclosure to this letter addresses the reason for the noncompliance, corrective steps that have been taken and the results achieved and corrective steps that will be taken to avoid future non-compliances. Schulz Electric has also provided a discussion on Compensating Factors that are relevant to the noncompliance.

Please contact me if you have any questions or require any additional information.

Respectfully,

CC:
Terry W. Jackson
Chief, Quality Assurance Vendor Inspection Branch-1
Division of Construction Inspection and Operational Programs
Office of New Reactors

Enclosure:
Schulz Electric response to Notice of Nonconformance 99901269/2018-201-01

IE09
NRO

Timken Motor and Crane Services, LLC
dba Schulz Electric
30 Gando Drive
New Haven, CT 06513 USA

Schulz Electric Response to NRC Notice of Nonconformance 99901269/2018-201-01
Docket Number: 99901296
Inspection Report Number 99901269/2018-201

Noncompliance Statement

Criterion III of Appendix B to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Design Control," states in part that, "Measures shall also be established for the selection and review for suitability of application of materials, parts, equipment, and processes that are essential to the safety-related functions for the structures, systems and components."

Criterion VII, "Control of Purchased Material, Equipment, and Services," of Appendix B to 10 CFR Part 50, states, in part, that "Measures shall be established to assure that purchased material, equipment, and services, whether purchased directly or through contractors and subcontractors, conform to the procurement documents. These measures shall include provisions, as appropriate, for source evaluation and selection, objective evidence of quality furnished by the contractor or subcontractor, inspection at the contractor or subcontractor source, and examination of products upon delivery."

SEC Technical Evaluation #725 "Three Phase Fractional and Integral HP Squirrel-Cage Induction Motors NEMA Frame Size 680 or IEC Frame Size 400 and Smaller Continuous and Intermittent Duties," identifies the motor shaft material as a critical characteristic that must be verified when the end use of the motor will be in a seismic environment, harsh environment, side-loaded application, or the shaft has a specific material requirement.

Contrary to the above, as of April 13, 2018, SEC failed to ensure the suitability of certain parts used in the manufacture of safety-related motors. Specifically, SEC failed to establish and implement an acceptable method to verify by direct inspection, commercial-grade survey, source surveillance, or other acceptable methods, the material composition of shafts used in AC motors provided by a commercial supplier.

1. Reason for the Nonconformance

Schulz Electric, based on a long history of sampling shaft material from various motor OEMs (> 15 years) for the purpose of dedicating standard commercial grade, NEMA frame "off the shelf" motors for safety related use with no discrepancies identified, made the decision to reduce the number of shafts sampled to only being required when the motor is being custom manufactured or if some other requirement (specialty application, unusual service conditions that would adversely impact the shaft, etc.) dictated that the shaft material verification was warranted[1]. Schulz Electric, however, failed to properly provide objective evidence to support this decision, did not revise the Technical Evaluation appropriately, and did not implement controls that would dictate when shaft sampling is required.

2. Corrective Steps Taken

Schulz Electric generated Corrective/Preventive Action Request (CPAR) 18-08 to determine the root cause and determine the necessary corrective action(s). The corrective action was determined and Schulz Electric wrote a Position Paper that captured and objectively evaluated the historical data, evaluated the risk associated with the projects for which the material was

[1] For further information supporting this determination, please see Section 5, Compensating Factors.

Timken Motor and Crane Services, LLC
dba Schulz Group
30 Gando Drive
New Haven, CT 06513 USA

not directly verified and made recommendations concerning programmatic changes that should be made. Training on the approved Position Paper was held with the Engineering and Quality Assurance departments to ensure all personnel were aware of both the issue and the changes to be implemented.

At the time of the Nuclear Regulatory Commission (NRC) inspection, a spreadsheet was developed and discussed with the inspectors identifying the number of NEMA motors dedicated for safety related use and the shaft material verification method used for each. Following the NRC inspection, this spreadsheet containing the motors identified was used to review the potential extent of condition and subsequently perform an evaluation to determine whether the nonconformance was reportable under 10 CFR 21. The nonconformance was determined to be neither a deviation, nor a failure to comply, associated with a basic component based on the Compensating Factors discussed in Section 5 below.

3. Corrective Steps to Prevent Future Noncompliance

Further noncompliance will be avoided through leaving the critical characteristic of determining shaft material in the Technical Evaluation (TE) and subsequently re-establishing that requirement that Schulz Electric will verify motor shaft material (e.g. perform material analysis, certification from approved sub-tier suppliers, etc.) of all motor shafts for motors that will be dedicated for safety related use and include the resulting objective evidence in the motor's dedication package.

4. Date of Full Compliance

Since the closure of CPAR 18-08 on April 23, 2018, Schulz Electric has performed 100% material analysis on shafts for all motors to be dedicated for safety related use (currently 5 motors) with no unsatisfactory results. As such, Schulz Electric is in full compliance with Criterion III and VII Appendix B to Title 10 of the Code of Federal Regulations (10 CFR) Part 50 and Schulz Electric TE 725.

5. Compensating Factors

A. Seismic

For those motors in an end use application where seismic qualification was required, Schulz Electric offers the following:

Schulz Electric has performed extensive research into the capability of motors to withstand a seismic event. This research includes shake table testing, literature/document research and numerous motor qualifications by static analyses.

Generally, motors are considered to be inherently rugged in consideration of the overall postulated seismic forces motors may be subject to in commercial nuclear power plant applications. The commercial nuclear power industry has acknowledged and embraced this philosophy. EPRI NP-4917, 1988 "Commercial Grade Motors in Safety Related applications", Page 6-4 states the following, "During steady state operation and start/stop cycles motor components experience large and varying forces. Motor designs must address these forces which result from thermal stresses, centrifugal forces on the rotation shaft assembly, starting and running torques and the resultant reaction forces. In order to withstand these forces and maintain proper shaft alignment and rotor-to-stator clearances, motors are designed to be structurally rigid.

Motors generally do not have natural frequencies below 33 Hertz and therefore, do not tend to amplify the seismic inputs that may occur. It is generally accepted that virtually all motors have the inherent capability to function during and following seismic events, (i.e. nominal design for operation gives motors inherent ruggedness under earthquake loading). Earthquake experience has verified this ruggedness to certain 'bounding spectra' levels." EPRI NP-4917, "Page 6-5 further states, "Use of the SQUG experience data to demonstrate seismic capability may significantly simplify the seismic evaluation scope for operating plants. The acceptable use of the operating experience data will likely limit the evaluation to mounting anchorage design and reverification that the database adequately bounds the particular safety related application."

EPRI NP-5223-SL, Rev. 1, 1991, "Generic Seismic Ruggedness of Power Plant Equipment", Page D-21, Section 1.0, states the following, "Due to the normal operating vibration inherent in rotating machinery, a motor has sufficiently rugged construction which should preclude any concerns about the ability of a motor to operate under/after a seismic event, given that anchorage adequacy is validated. During start/stop cycles, motor components experience large and varying forces. Most motor manufacturers maintain that winding starting forces are in excess of seismic force levels. In order to withstand these forces and maintain proper shaft alignment and rotor-to-stator clearances, motors are designed to be structurally rigid. Motors generally do not have natural frequencies less than 33 Hz and are usually qualified for seismic loads by static analyses."

IEEE 334-1994, Section 6.4, "Qualification in Mild Environments", states the following, "Inherent in a motor's design are features accounting for induced electrical magnetic stress, starting torque stress, and load variation stress. These features result in motors that, when properly applied and installed, are inherently rugged to seismic events. A motor's internal forces during normal operation are much greater than the seismic forces. Thus, each time a motor is started and loaded; it experiences internal forces much greater than those experienced during a seismic event."

Additionally, Schulz Electric performed seismic shake table testing during the qualification effort of Schulz Electric's EQ motor insulation system (Schulz Electric Project N4446). This also verified that motors tend to be seismically rugged as no anomalies or failures were observed. It should be noted that the motors were started, stopped, and ran steady state during seismic testing. As a result, motors are considered seismically rugged.

Based upon the above, when procuring motors from reputable NEMA motor manufacturers, a strong argument can be made that material analysis of the shaft need not be performed in order to have reasonable assurance that the motor meets specified requirements, will perform its safety function during a seismic event and are suitable for the end use application.

B. Functional/Performance Testing as Part of Dedication

Schulz Electric's basis for dedicating a commercial grade NEMA frame motor for safety related, mild environment use within the envelope of Schulz Electric's program is to

dedicate the motor as a complete component and not necessarily dedicate the individual materials, parts or subcomponents of the motor.

For the purposes of this discussion the following Failure Modes and Effects Analysis, only as it pertains to the shaft, is performed to further identify whether or not shaft material analysis must be independently verified exclusive of the requirements identified in Schulz Electric TE 725.

Failure Mode

1) The shaft extension could be dimensionally incorrect

2) The shaft could deform or shear due to application of torque beyond the stress capability of the material

3) The shaft could be exposed to a corrosive environment and degrade Failure Effects

Failure Effect

Any of the above failure modes could result in the motors inability to transmit torque to the driven load, thereby preventing the motor from performing its safety function; therefore the shaft, as an individual component, must be considered safety related and critical characteristics associated with credible failure modes must be considered. The critical characteristics identified by TE 725 for the shaft, exclusive of verification of shaft material, as they pertain to the motor shaft are as follows:

Component	NEMA Lettering	IEC Lettering	Description
Shaft	S	F	Width of the Key Seat
	U	D	Diameter of the Shaft Extension
	R	G	Bottom of the key seat (or flat) to the bottom of the shaft
	V (where criteria exists)	(there is no "V" dimension equivalent on IEC machines)	Length of the shaft available for coupling, pinion, or pulley hub (on a straight shaft extension this is a minimum value

In addition to dimensional inspections, full load testing is performed on each motor to ensure the motor meets NEMA performance requirements for:

- Full-Load Torque – The full-load torque of the motor is the torque necessary to produce its rated horsepower at full-load speed.
- Locked-Rotor Torque (static torque) – The locked-rotor torque of a motor is the minimum torque which it will develop at rest for all angular positions of the rotor, with rated voltage applied at rated frequency. The locked-rotor torque requirements depend on motor size, design and speed but range from 70% to 275% of the full-load torque.

- Pull-up Torque – The pull-up torque of a motor is the minimum torque developed by the motor during the period of acceleration from rest to the speed at which breakdown torque occurs. The pull-up torque requirements depend on motor size, design and speed but range from 65% to 190% of the full-load torque.
- Breakdown Torque – The breakdown torque of a motor is the maximum torque which the motor will develop with rated voltage applied at rated frequency, without an abrupt drop in speed. The breakdown torque requirements depend on motor size, design and speed but range from 175% to 300% of the full-load torque.

There are many additional performance characteristics measured during the performance testing while dedicating a motor in accordance with TE 725, but the torque measurements above are those that can be directly associated not only with the motor's ability to generate the required torque, but also with the shaft's ability to transfer that torque to the load without damage.

The following should also be noted:

- The shaft extension diameter, which is also the smallest diameter of the shaft upon which torque is applied, is specified by NEMA MG-1 and is measured/verified by Schulz via actual full load test
- The full load torque produced by the motor is specified by NEMA MG-1 and is measured/verified by Schulz via actual full load test

When the additional tests and inspections specified by TE 725 are performed with satisfactory results, there is reasonable assurance that the motor being dedicated meets specified requirements and is suitable for the end use application without the specific and direct verification of shaft material by materials analysis.

C. Conclusion

Schulz Electric recognizes that the stated nonconformance is accurate in that Schulz Electric TE 725 did require verification of motor shaft material and Schulz Electric was not in compliance with that requirement for some NEMA frame motors dedicated for safety related use. However, it is Schulz Electric's opinion that the motor shaft material was indirectly verified to be suitable for end use application based upon other compensating factors as discussed above.