SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For Cable Separation Associated with Diesel Generator VAR Transducers		Calc. No. 19BD-2	
	Safety-Related	Non-Safety-Related	Rev. 0	Date 4-20-82
			Page 1	of 1

Client ILLINOIS POWER COMPANY		Prepared by J.W. Buchanan EPED	Date 4-20-82
Project CLINTON UNIT 1		Reviewed by [illegible] EPED	Date [illegible]
Proj. No. 4536-00	Equip. No. VARIOUS	Approved by Mark F. [illegible] EPED	Date 5-19-8[illegible]

FOR REFERENCE ONLY

DETAILED REVIEW METHOD USED.

FILE NO. 19BD
RESPONSIBLE DIV - EPED

PURPOSE: The purpose of this calculation is to determine whether or not VAR transducers and their output resistors are adequate to serve as isolation devices.

UNCONTROLLED COPY

DRAWING REFERENCES:

Number	Revision	VAR transducer
E02-1AP12 sheet 019	F (2-17-82)	1JY-DG804
E02-1AP12 sheet 020	F (2-17-82)	1JY-DG810

The reference drawings show the two transducers and their output voltage developing resistors. To qualify as an isolation device, these transmitters must prevent open circuits, short circuits, and "strange" voltages on the non-safety-related (output) side from causing any effect on the safety-related (input) side.

See attached telecon memo Ed Horn/J.S. Paniaguas March 18, 1982 concerning open and short circuits on the output side. They will have no effect on the input

Form GO 3.08.1 Rev. 2

SARGENT & LUNDY ENGINEERS CHICAGO

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side. Also see the attached descriptive catalog excerpt describing the amplifiers. Specifically, note the description under "Operation." The signal from the pulse generators passes through an amplifier to convert it to a "load-independent" (constant-current) output. Therefore there is no effect on the input from open or short circuits on the output. Also note "Amplifier Protective Circuit" and surge withstand capability.

The wiring of the output circuits runs from 1H13-P861 to 1H13-P877-14B and 1C91-P614 and also from 1H13-P851 to 1H13-P877-15B and 1C91-P614. All this wiring is run in PGCC floor sections. All such wiring is 600 Volt insulated or above. The highest voltage levels present are 125 VDC and 120 VAC. The PGCC floor sections are also monitored for fires and have fire suppression gas systems. Therefore there will be no high voltages imposed on the output circuits of the transmitters which could even attempt to get through the transmitters and cause unfavorable

Form GQ 3.08.1 Rev. 2

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effects in the safety-related input circuits.

If the transmitters are considered isolation devices, then the wiring on the output side must be run as non-safety related or analyzed to determine whether or not this wiring would present a hazard to contiguous safety-related wiring. As stated above the wiring runs in PGCC floor sections and cabinets, is 600 Volt insulated and runs with 125VDC or 120VAC maximum voltages. Therefore it will transmit no hazards from non-safety-related circuits to contiguous safety-related circuits. Any hazards which may originate in the transmitter itself or upstream of it would be considered a single randomly occurring failure, and this is allowed under the rules for application of the single failure criterion.

Form GQ 3.08.1 Rev 2

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Relaxation of the minimum separation distance requirement stated in the FSAR is justified because the Fire Suppression System prevents propagation of a fire in a non-safety-related area to either or both Safety-Related circuits.

The relaxation is also justified because a fault in one safety-related Division cannot cross over to the other safety-related Division via the non-safety-related wiring due to the insulation levels being far above the levels present or possible on the wiring.

Form GO 3 08 1 Rev 2

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Conclusion:

Therefore the two VAR transmitters, 1JY-DG804 and 1JY-DG810 may be considered the required isolation devices. Analog signal optical isolators 1UØ-AP619B and 1UØ-AP620C may be disconnected and bypassed. The wiring from the transmitter to the voltage developing resistor and from the resistor to the cabinet terminals may be considered non-safety-related, but it may be permitted to run with safety-related wiring in the cabinets.

The optical isolators may be abandoned in place or completely disconnected, removed, and stored for spares.

SARGENT & LUNDY

MEMORANDUM OF
TELEPHONE CONVERSATION

Date: March 18, 1982

Time: A.M.

Person Called: Ed Horn (Name) of Westinghouse (Company)

Person Calling: J. S. Paniaguas (Name) of Sargent & Lundy (Company)

Project: Clinton Project No. 4536-00

Subject Discussed: Westinghouse V-4 Transducers

Summary of Discussion, Decisions and Commitments:

Ed advised that if output side of V-4 transducers are open or short-circuited, there will be no effect on primary.

Action;

cc: J. M. Buckman - 24

J. S. Paniaguas
Signature

File: 19BD

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Westinghouse Catalog Section 43-871

Descriptive Bulletin for V-4 Watt and VAR Transducers

Application
Type V-4 watt and var transducers convert current and voltage input signals from a power system into dc output signals proportional to the true power or the reactive power on that system. Output polarity changes with direction of power flow. The outputs can be utilized by computers, control and data systems or by analog or digital instruments.

The watt transducers are identified as type VP4-846 and the var transducers as type VV4-846.

Operation
These transducers employ the time-division multiplication principle. The measuring circuitry generates a train of pulses whose height is proportional to current and whose length is proportional to voltage. The area of each pulse is proportional to the power flowing within the duration of each pulse. There are many pulses per cycle. Integrating these pulses, therefore, yields a rate of flow of power. The circuitry presents this in the form of a proportional dc signal.

The signal is passed through an amplifier to convert it to a load-independent (constant-current) output.

Var transducers are similar to the watt transducers except that the potentials are shifted 90° by means of an internal R-C network.

Features
Westinghouse is a major supplier of the apparatus and the systems which control electrical power systems. They are, consequently, especially knowledgeable of the actual needs in the accessories for such systems.

Time-Division Multiplier
This circuitry employs complementary MOS digital integrated circuits for superior accuracy, linearity and stability.

Printed Circuit Construction
All components are mounted on printed circuit boards of a glass-epoxy. This material possesses great strength; it does not support fungus growth; it has a high resistance to damage due to a re-soldering of parts during repair or modification under field conditions. All circuit boards are accessible for repair. This is especially important in the case of the power supply and amplifier board which is exposed to externally-caused damage from accidental misconnection to sources beyond the level of the inherent protective circuitry.

Plug-in Integrated Circuits
All amplifiers and multipliers are IC's for consistency in performance with plug-in mounting for convenience in servicing.

Convertible Power Supply
Jumpers are supplied on the terminal block of each transducer to connect the power supply source to the measured potential transformer circuit. With jumpers removed the transducer may be operated from a separate control power source. Thus, only one style transducer need be used to serve both functional requirements.

Amplifier Protective Circuit
The output amplifier is protected from damage due to inadvertently applied voltages or induced surges on the output leads. The amplifier can withstand the application across its terminals of a surge equivalent to the SWC test, and the short-time (approximately 5 minutes) application of 120 volts ac in the event of miswiring.

Radio-Frequency By-Pass
Each transducer contains by-pass circuitry to give the device a relatively high immunity to radio frequency interference (RFI).

Modular Design
The case represents the best possible compromise between the requirements of the various mounting methods normally used.

a) Unistrut® channel.
b) Standard relay rack panels.
c) Standard rack unit mounting strip.
d) Pre-drilled channel.
e) Pre-drilled panel.

The basic module is 1½ inches wide and uses 5¼ inch vertical distance between mounting holes as suggested by an IEEE proposed standard. Watt and Var transducers are made in modules (3 inches) with the same 5¼ inch mounting dimension. The horizontal holes are arranged so that any array of transducers can be mounted side-by-side with pre-drilled mounting holes on 1½ inch centers. If rack unit mounting strip is used there will be a ¼ or ½ inch space between units. A 19 inch rack will mount a full set of watt, var, voltage and current transducers for a three-phase line (see Page 1). There is no interaction between transducers regardless of mounting space.

® Trade Mark – UNISTRUT CORP

Terminal Blocks
Molded terminal blocks with #8-32 screws to accept wire sizes up to #12 in lugs to ⅜ width.

Temperature Stability
Low temperature coefficient resistors and zener diodes are used to obtain a low temperature influence without resorting to the resistor-thermistor compensation schemes which were needed on the Hall generator transducers. Good temperature performance is designed in, and not compensated in.

Adjustments
Models are available with both a ±10% and a 0 – 110% output adjustment capability. Because of the grade of amplifier used it has not been necessary to limit the adjustment range in order to maintain a reasonable accuracy at the low end. The calibration control is a 20-turn potentiometer accessible from the top of the case. Any element trimming and phase shifting adjustments are accessible from the outside of the case. These are bench type adjustments. These trimmers are accessible from the top in watt transducers and the bottom in var transducers. Inasmuch as the multiplier circuit has a relatively high output, no zero adjustment is ever necessary. This is in contrast to the Hall type which does require a zero adjuster because the low output of the Hall circuitry necessitates a high-gain amplifier.

Surge Withstand Capability (SWC)
Experience in the application of solid-state devices to power system control circuits has shown the need for integral surge protection circuitry. The major concern has been in the protection of solid-state protective relays from damage or malfunction under transient surge conditions. Relay engineer's have adopted SWC specification in IEEE Standard 472-1974 (ANSI C37.90a, 1974).

In designing the V-4 transducers Westinghouse was able to draw upon the knowledge of its static relay design and application engineers. In so doing it became apparent that the relay SWC specification was not completely adequate as a standard for transducers. Relays terminate in a switching circuit while transducers terminate in a precision amplifier of much lower capacity. Relays cannot tolerate a transient which would cause a false trip while a transducer output may be momentarily affected so long as the unit is not damaged.

The IEEE standard defines the test wave and locates the test points on a relay. Westinghouse has adopted the same test wave but has defined the application points in terms of a transducer, making certain that all critical areas are tested and that the tests, as performed, are valid.

The Surge Withstand Test which all Westinghouse V-4, 60 Hz transducers will meet is:

1. SWC Test Wave: An open circuit oscillatory wave, 1.0 to 1.5 MHz, 2.5 to 3.0 KV crest value of the first half cycle peak decaying to 50% of the initial crest value in 6.0 microseconds or longer. Surge generator terminal