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IEEE CEMENT INDUSTRY TECHNICAL CONFERENCE XXXI

Denver, Colorado — May 15-17, 1989

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THE THIRTY-FIRST IEEE CEMENT INDUSTRY TECHNICAL CONFERENCE

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FOREWORD

THE THIRTY-FIRST IEEE CEMENT INDUSTRY TECHNICAL CONFERENCE

May 15–17, 1989
HYATT REGENCY DENVER, DENVER, COLORADO, USA

Sponsored by
THE INDUSTRY APPLICATIONS SOCIETY'S
CEMENT INDUSTRY COMMITTEE
OF THE
INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC.

The technical papers in this Conference Record have been prepared using guidelines from the "Author's Guide" of the Industry Applications Society (IAS) modified by the Cement Industry Committee. The Committee is one of twenty-eight Technical Committees within the IAS.

This year's Annual IEEE Cement Industry Technical Conference completes thirty-one years of such Conferences. This is the second time that Denver has been selected as the site, the first being in 1966.

The papers included in this Record were written and are presented to comply with the scope for the Cement Industry Committee which has been established by the IEEE Industry Applications Society. In substance, this scope is:

"The development and application of electrical systems, apparatus, devices, and controls to the processes and equipment for which the emphases or dominant factors specifically relate to the cement manufacturing industry; the promotion of safe, reliable, and economic installations; the encouragement of energy conservation; and the creation of voluntary engineering standards and recommended practices."

The dedicated work of supporting the activities of the Institute (IEEE) by many Cement Industry Committee members is appreciated. Thanks also to the many cement industry related firms & employees and others who attend this Conference for their participation in the activities of this Thirty-First IEEE Cement Industry Technical Conference.

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2nd	1960	5/17-19/60	Milwaukee, WI	W. A. Allan	V.B. Murdock	316
3rd	1961	4/18-20/61	Detroit, MI	J.F. Hower	L. E. Swanson	307
4th	1962	4/3-5/62	St. Louis, MO	J.F. Hower	J.B. Woodward	437
5th	1963	4/23-25/63	Cleveland, OH	R.J. Jager	G.E. MacDonald	304
6th	1964	4/14-17/64	Pasadena, CA	R.J. Jager	D.B. Carson	433
7th	1965	5/11-13/65	Allentown, PA	H.P. Cassel	C.A. Zimmerman	601
8th	1966	5/17-19/66	Denver, CO	H.P. Cassel	W. A. Walkling	436
9th	1967	5/16-19/67	Albany, NY	L. E. Swanson	J.R. Kelley, Jr.	479
10th	1968	5/20-24/68	St. Louis, MO	L. E. Swanson	A.C. Lordi	515
11th	1969	5/13-15/69	Toronto, Ontario	A.C. Lordi	J.A. Allan	501
12th	1970	5/12-14/70	Indianapolis, IN	A.C. Lordi	G.F. Messinger	453
13th	1971	5/10-13/71	Seattle, WA	J.A. Allan	F.J. Bauer	370
14th	1972	5/16-18/72	Detroit, MI	J.A. Allan	L. E. Swanson	464
15th	1973	4/30-5/3/73	Miami, FL	R.P. Kistler	L.W. Copple	503
16th	1974	5/13-16/74	Mexico City, Mexico	R.P. Kistler	R.J. Plass	676
17th	1975	5/5-8/75	Montreal, Quebec	F.J. Bauer	M.S. Jackson	583
18th	1976	5/17-20/76	Tucson, AZ	F.J. Bauer	J.A. Vidergar	587
19th	1977	5/16-19/77	Omaha, NE	R.C. White	F.E. Staples & R.F. Palmer	570
20th	1978	5/15-18/78	Roanoke, VA	R.C. White	K.C. Wiles	677
21st	1979	5/20-24/79	Tarpon Springs, FL	Jay Warshawsky	F.W. Cohrs	829
22nd	1980	5/19-22/80	Toronto, Ontario	Jay Warshawsky	M.E. Wrinkle	839
23rd	1981	5/12-14/81	Lancaster, PA	L.L. Warner	N.W. Biege	841
24th	1982	5/24-26/82	Vancouver, BC	L.L. Warner	B.T. Price	595
25th	1983	5/22-27/83	San Antonio, TX	N. Roistacher	U. Alsguth	622
26th	1984	5/22-24/84	Anaheim, CA	N. Roistacher	J.A. Vidergar	563
27th	1985	5/20-22/85	New Orleans, LA	R.J. Krekel	L.C. Cockrell	595
28th	1986	5/19-22/86	Salt Lake City, UT	R.J. Krekel	R.W. Riegel	490
29th	1987	5/26-28/87	San Francisco, CA	R.F. Palmer	C.D. Maars	557
30th	1988	5/24-26/88	Quebec City, Quebec	R.F. Palmer	A. Morneau	560
31st	1989	5/15-17/89	Denver, CO	Ib Bentzen-Bilkvist	Ed Parker	
32nd	1990		Tarpon Springs, FL	Ib Bentzen-Bilkvist	Ed Buehler	
33rd	1991		Mexico City, Mexico			

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"LIFE EXTENSION FOR ELECTRICAL POWER DISTRIBUTION SYSTEMS USING VACUUM TECHNOLOGY"

BY A. D. STORMS & D. D. SHIPP, MEMBER IEEE

WESTINGHOUSE ELECTRIC CORPORATION
PITTSBURGH, PA

ABSTRACT

In industrial and utility electrical systems built in the Forties and Fifties, many components are at or beyond their expected service life. This is particularly serious in the case of power distribution equipment; failure comes without warning, and often causes extensive damage to connected systems and other electrical equipment.

Three alternatives for upgrading old equipment are discussed. Retrofitting with vacuum arc interrupter technology is the most cost effective, and offers many advantages over older air-magnetic interrupters. These include simpler design, less parts and maintenance, readily available parts, high reliability, extended insulation life, and safety.

This paper will address modernization options available to industry specifically in the area of electrical switchgear. Emphasis will be given to switchgear life extension using vacuum technology; its benefits, reliability, and economic justification. Several examples and applications will be presented.

INTRODUCTION

In recent years, the multiple requirements of increased economy, capacity, quality and productivity have motivated many industries to modernize aging plant facilities and processes in order to maintain a competitive footing. As might be expected, upgrades and/or expansions to installed systems and equipment have placed additional demands on existing electrical systems--sometimes in excess of original design specifications--with the result that once-adequate electrical systems may no longer be sufficient to support current operating needs.

In addition, much of industry finds itself with electrical power systems in the "Twilight Zone" of its expected life; 25-40 years old. Electrical power distribution does not come up as a means to lower costs or increase productivity, and thus loses its turn for capital funding.

Why do we use the term "Twilight Zone"? It isn't the same one Rod Serling used to talk about on TV...but it is a place where strange things happen. The Twilight Zone we're talking about is that gray area of performance that we enter as electrical equipment approaches the end of its expected design life.

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WHAT IS ELECTRICAL EQUIPMENT LIFE?

Electrical equipment life is defined as that point when the equipment no longer performs its intended function, electrically or mechanically.

This service life has limits imposed by electrical operations, which erode or degrade materials, mechanical operations which affect mechanisms, and insulation systems which have a finite life aggravated by moisture and temperature.

Manufacturers design equipment for specific performance levels and on-line life under known conditions and controlled parameters. In real life, however, that equipment is typically applied under unknown conditions and uncontrolled parameters. Consequently, there is simply no hard basis for accurately predicting the life of electrical equipment.

Serious switchgear problems begin as a result of both age and service, manifesting themselves as failures in operation, catastrophic insulation failure, and the non-availability or high costs of replacement parts.

Electrical power distribution equipment aging has a very unique mode of failure which is different from other power equipment such as mechanical or hydraulic systems. Mechanical equipment or processes provide advance indicators of failure, such as noise, vibration, heat or changes in process parameters. Insulation systems or fault interrupter failure provides none of these indicators--they fail on a go--no go basis, in most cases, with catastrophic results--with the amount of damage a function of the available short circuit capacity and the time duration of the fault.

This is why attention must be paid to preventing electrical failure in power switchgear found in every power distribution system.

WHAT ARE THE OPTIONS AVAILABLE?

Given the facts that electrical power switchgear equipment has a finite life, and will fail at some point, what are the alternatives?
There are basically three remedies:

- total replacement of the switchgear with modern design, current manufactured equipment
- repair or rebuild breakers to original design specifications
- selective replacement of the fault interrupter portion only; using pre-engineered, current - technology vacuum breaker retrofit packages.

While each of these options may yield desired improvements in system operation, it is the authors' intention to demonstrate the superior value and performance benefits achievable through retrofit vs. remanufacture or total replacement, for existing systems where loads or processes must be maintained.

Given the magnitude of avoidance costs associated with outages resulting from power system failure, any of these options--even total replacement--may be seen as an "affordable" solution, if we only consider exclusively the raw costs for hardware purchase and installation. However, any realistic assessment of relative cost-benefit must also address a range of additional factors, including but not limited to:

opportunities for technology trade-up,
extent and cost of installation downtime,
impact on existing facilities,
future maintenance requirements, and
availability and cost of renewal components.

In the following section, the relative merits of each alternative will be evaluated in light of these considerations.

TOTAL EQUIPMENT REPLACEMENT

In many instances, conventional analysis would dictate total switchgear replacement. Replacement is, in fact, a natural option in situations where corrosive environment is a major factor: or in the case of system expansions or reconfigurations to support increased new power demands of new equipment.

So you purchase all-new current technology breakers with higher ratings..and the problem is solved. In effect, you turn the life cycle timer back to zero, with new steelwork structures, new insulation, new relaying, new mechanisms...new everything. In addition, you get a further benefit in that new equipment is inherently more reliable, costs less to maintain and can quickly be repaired using current-stock replacement components.

Certainly, new replacement is an option that can satisfy virtually any conceivable set of performance needs. But, it's also the most expensive alternative - when you are supplying an on-going system or process, the outage costs to remove old equipment and reinstall, reconnect, and check out new equipment must be added, which normally outweigh equipment costs by a significant margin.

UTILIZE USED/REMANUFACTURED CIRCUIT BREAKERS

You can opt instead to replace installed equipment with rebuilt or used equipment. Here again, there are advantages and disadvantages to be weighed. For example, because you're exchanging one device for an identical unit, installation is easy...you don't have to worry about structural modifications or additions to accommodate differences in size, ratings or connections. In addition, you know that your maintenance staff is already familiar with the equipment...so there's no added requirement for training or re-education.

The disadvantage to this option is that, while you stand to save over the cost of new equipment, you're still looking at a sizable investment...while at the same time, you have sacrificed all of the major benefits new equipment might have afforded. With used or rebuilt equipment, you gain nothing in terms of new technology, reliability, increased capability or added mechanical or insulation life. Any known problems will reappear. At best, what you've traded for is a marginal extension of mechanical service life. You have, perhaps, postponed, the inevitable.... But in essence, you're still living on borrowed time. Insulation systems are the same and you are still living at the edge of the "Twilight Zone".

RETROFIT EXISTING CIRCUIT BREAKERS

When analyzing failures of power switchgear, in many cases we see failure initiate within the area of the fault interrupter or circuit breaker, causing system failure and damage that requires major equipment replacement.

This is not surprising, as the circuit breaker performs all the dynamic changes to the system, and all electrical switching takes place within the confines of the circuit breaker.

It's with this analysis that we came to defining the switchgear system into two areas. There are parts that basically have an infinite life -- items like conduit, buss, structure, steelwork. There are additional parts that have a finite life, the circuit interrupter being the prime element. Here we have electrical deterioration and mechanical degradation.

Any cost effectiveness analysis leads us to try and replace only those portions of the system that have finite life.

This leads us into trying to provide modern technology, with its benefits of increased reliability and increases in mechanical and electrical life, without disturbing the existing power distribution system, structures, conduit, power or control wiring; one of the most important cost benefits of retrofitting.