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SUBJECT: Forwards util 790731 response to NRC 790712 request re undervoltage protection.Requests info be withheld (ref 10CFR2.790).

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August 3, 1979

Director of Nuclear Reactor Regulation
Attention: Mr. Dennis L. Ziemann, Cheif
Operating Reactors Branch No. 2
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Undervoltage Protection
RG&E Ginna Nuclear Power Plant
Docket 50-244

Dear Mr. Ziemann:

As Counsel for Rochester Gas & Electric Corporation we enclose the following letter (including 3 copies for your convience) in response to your letter of July 12, 1979 concerning Undervoltage Protection at the RG&E Ginna Nuclear Power Plant. It is accompanied by Figure 1, "A Single Line Diagram Train A for Existing Undervoltage System," and Enclosure A, "The Ongoing Evaluation of Safety System Integrity," which the licensee has requested be treated as proprietary and be withheld from public disclosure in accordance with the applicable rules and regulations of the Commission. The request is submitted by affivadit of Mr. L. D. White, Jr., Vice President, Electric and System Production, Rochester Gas and Electric Corporation.

This material is proprietary as it contains trade secrets and commerical information held in confidence by its owner, Rochester Gas and Electric Corporation, is information

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Therefore, pursuant to 10 C.F.R. Section 2.790 of the Commissions Rules of Practice and Part 9.5 of the Commissions Regulations, we request that the enclosed Figure 1 and Enclosure A be withheld from public disclosure.

Very truly yours,

Robert S. Faron

LeBOEUF, LAMB, LEIBY & MacRae
Attorneys for Rochester Gas
and Electric Corporation

Enclosures

RG&E

ROCHESTER GAS AND ELECTRIC CORPORATION • 89 EAST AVENUE, ROCHESTER, N.Y. 14649

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July 31, 1979

Director of Nuclear Reactor Regulation
Attention: Mr. Dennis L. Ziemann, Chief
Operating Reactors Branch No. 2
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Undervoltage Protection
R.E. Ginna Nuclear Power Plant
Docket No. 50-244

Dear Mr. Ziemann:

In response to your letter of July 12, 1979, the following letter is submitted.

Question 1. Provide the voltage setpoint trip and time delay and the tolerance on the 4160 volt side for the second level voltage protection monitors in the Technical Specification.

Response: As shown on the enclosed single line for train A (from our submittal of May 1, 1978), the undervoltage load shedding and sequencing system is entirely at the 480V level. Since there are no 4160V safety related loads, there are no undervoltage protection monitors for the load shedding and sequencing system at that level.

Question 2. State the operating modes, total number of channels, and number of channels to trip on the under-voltage degradation protection system. Refer to Table 3.3-3, NRC letter, "Safety Evaluation and Statement of Staff Positions Relative to the Emergency Power Systems For Operating Reactors," June 2, 1977. Describe the coincident logic used.

Response: The operating modes, total number of channels, and number of channels to trip are described in our Application for Amendment to Operating License is enclosed with this response. The coincident logic used in this design is described in our submittal to you, dated July 24, 1979, under the subject "Amendments to Prior Design Modifications on Undervoltage Protection Systems."

Question 3. State the channel check frequency. Describe more fully the bases for performing the channel functional tests monthly. Give the operating modes in which surveillance is required.

Response: The subject undervoltage monitoring system does not supply inputs to either the Reactor Protection System, or the Safeguards Actuation System and therefore is subject to checks associated with those systems. Our enclosed Application for Amendment to Operating License as well as our submission to you dated December 22, 1977, describes the simulation of loss of voltage and degraded voltage to be performed during refueling shutdowns. The system reliability of the proposed design has been analyzed and the sensitivity to variation in component reliability is considered. This analysis (Enclosure A of this attachment) assumes an approximate one year interval between functional tests.

Question 4. Describe the extent to which the design of the voltage monitors of the second-level protection meet IEEE Std. 279-1971.

Response: The applicability of IEEE Std. 279-1971 to this system is discussed in Section 6.6 of our submission to you dated July 21, 1977, under the subject "Design Analysis for the Addition of a Second Level of Undervoltage Protection."

Pursuant to Section 2.790 of the Commission's Rules of Practice and Part 9.5 of the Commission's Regulations, we request that the enclosed Figure 1 and Enclosure A be withheld from public disclosure.

Very truly yours,

L. D. White, Jr.

L. D. White, Jr.

Subscribed and sworn to before me on this 31st day of July 1979.

Rose Marie Perrone

ROSE MARIE PERRONE
NOTARY PUBLIC, State of N. Y., Monroe County
My Commission Expires March 30, 1980

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

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DATE: 8-10-79

NOTE TO NRC AND/OR LOCAL PUBLIC DOCUMENT ROOMS

The following item submitted with letter dated 8-3-79 from LeBoeuf, Lamb, Leiby + MacRae is being withheld from public disclosure in accordance with Section 2.790.

PROPRIETARY INFORMATION

Fig. 1 + Encl. A dealing with Safety System Integrity

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Distribution Service's Branch

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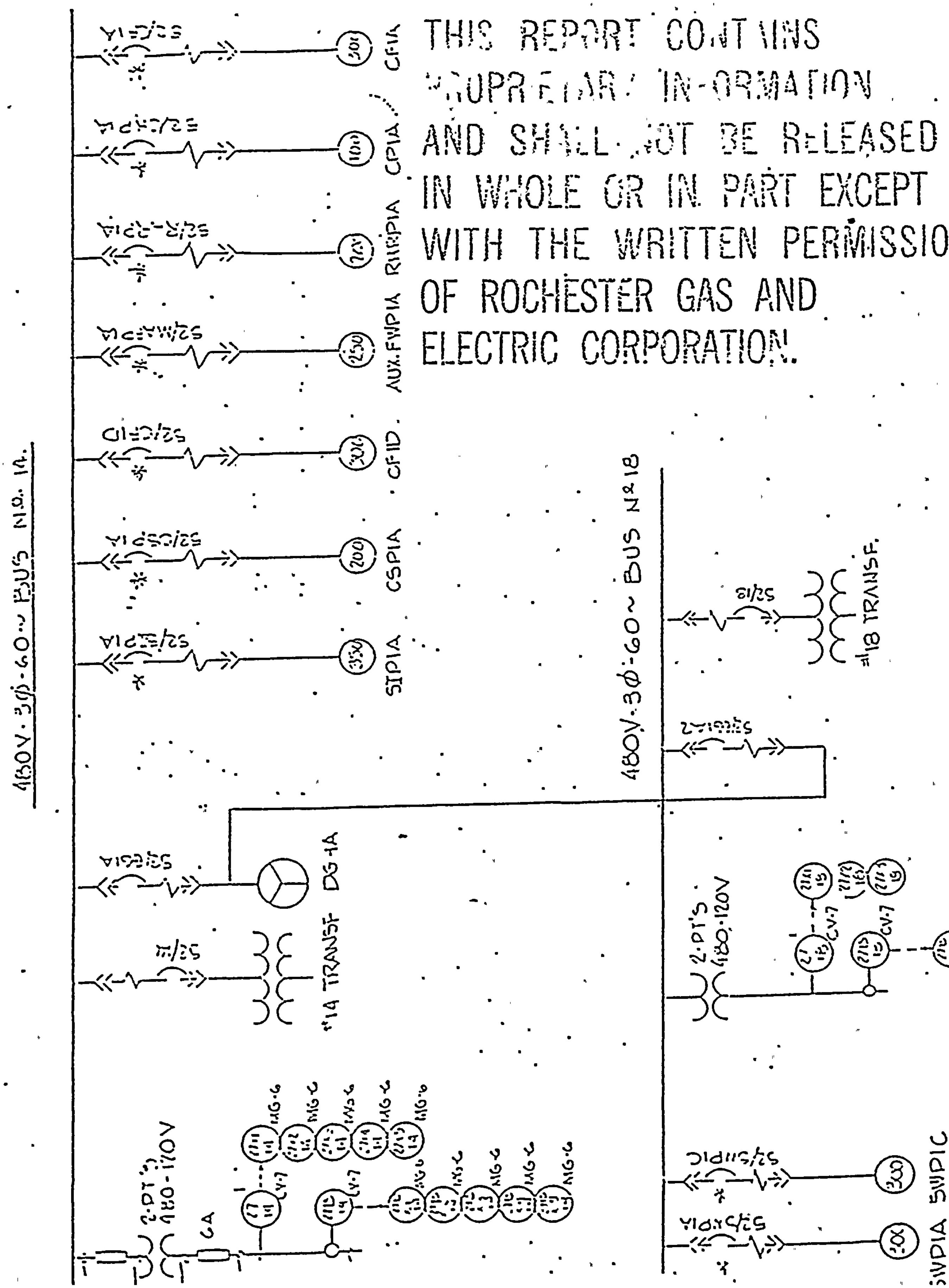

FIG. 1 SINGLE LINE DIAGRAM TRAIN A EXISTING UNDERVOLTAGE SYSTEM

ENCLOSURE A

Ongoing Evaluation of Safety System Integrity

I Introduction

It is the purpose of this analysis to provide a methodology for ongoing review and assessment of Safety System integrity. This methodology is based on detailed review of the system design coupled with the results of plant specific and industry operating experience and test results as they become available during the operating life of the plant. The most suitable figure of merit for this type of analysis is the system availability, as defined in IEEE Std. 352-1975. Availability, unlike reliability, is time invariant and allows for failure and subsequent repair of individual components.

As will be shown for the Load Shedding and Sequencing System below, it is imperative to establish not only a "best estimate" of availability from the most current data, but to also determine the "sensitivity" of this figure of merit to the uncertainties in the input data. Since there is almost no available information or published estimates of uncertainty in industry data, such estimates must be based on engineering judgement and the experience of operating, maintenance, and test personnel.

II Quantitative Methods

Quantitative methods for estimating individual component availability are in conformance with section 5.1.2 of IEEE Std 352-1975 for failures which can only be detected during periodic testing. Component failures which are self annuciating are considered using best estimates of failure rate and associated "down time".

The system availability is considered to be the product of all component availabilities.

$$A_s = \prod_{j=1}^{n} A_j$$

– For the existing system.

This approach accounts for all single failures and any combination of failures that may occur when the system is called upon to function.

III <u>System Description</u>

The Load Shedding and Sequencing System detects the loss of voltage on the Class 1E 480V buses, opens the feeder breakers to all safety related loads and blocks the Safety Injection starting sequence until bus voltage is restored. If a Safety Injection Signal is present, the system resets when voltage is restored by the diesel generators and the Engineered Safety Features are loaded on the bus in proper sequence by the Agastat time relay relays. It is important to note that the load shedding and sequencing relay logic is an integrated system of primary and auxiliary relays. This is a significant consideration when evaluating the degree to which the addition of coincident logic improves system availability. The requirement for coincident undervoltage logic, as stated by the NRC in their letter of June 3, 1977 applies only to the initiating, undervoltage relays. The

NRC Staff has never provided a quantitive basis for this requirement. Since the only system failures which are mitigated by this modification are those due to the failure of fuses, potential transformers, or undervoltage relays, it is of very limited value in increasing system availability. It is shown however, that the system availability is highly sensitive to the uncertainty in auxiliary relay failure rates. Because of this sensitivity, it is recommended that the design modification of this system, proposed by the RG&E Electrical Engineering Group in August 1978, and reviewed and approved by the NRC Staff, be installed during the 1980 refueling shutdown.

IV Active and Passive Components

The passive elements in this system are fuses, potential transformers, cable terminations, and enclosures. Normally such components are highly reliable and contribute negligibly to the system failure rate. However, fuses are often pulled during test and maintenance activities. This can result in abnormal wear and tear on fuse clips, and possible errors when the fuses are replaced. Thus a large uncertainty should be attached to fuse reliability data.

The active components in the system are electromechanical relays. There are induction disk type, U.V. relays (CV7), auxiliary relays (MG-6 and BFD), and Agastat time delay relays. In addition, SG type relays are used to monitor DC control voltage. The switchgear that is controlled by this system is not within the scope of this evaluation. Active components are inherently subject to a greater diversity of failure modes than passive ones and thus greater uncertainty in failure rate data.

V Detectable and Undetectable Failures

Failure of potential transformers or A.C. fuses is self-annunciating in the existing system, since they activate the undervoltage relays. The D.C. fuses are monitored and alarmed. Thus there are no undetectable failure modes for the passive components. However following any such failure there will be a period, conservatively estimated at one day, for repair and replacement.

Failure of relays during the periodic test interval must be considered undetectable (although some failures might be self annunciating) and are treated in accordance with IEEE 352-1975, Section 5.1.2.

VI Component Availability

1. Available Industry Data

Failure rate data used in this analysis are taken from IEEE Std 500-1977, IEEE Nuclear Reliability Manual. The span of failure rates considered here is from the "recommend" to the "maximum" value. Availabilities calculated from the "maximum" failure rates are referred to as "worst case" values. The uncertainty in the availability is considered to be conservatively enveloped in the span between "recommended" and "worst case" values. Ginna operating experience may provide a sufficient basis for a less conservative estimate

of uncertainty. In all cases the consistency of the industry data with Ginna operating experience is considered.

2. Potential Transformers

All failures are assumed self annunciating and the mean time to repair is estimated to be one day.

IEEE Std 500-1978	0.5360 failures/10^6 hr	Recomended
	8.0 failures/10^6 hr	Maximum

A_{PT1} (Recommended Availability) $= 1 - \frac{0.536 \times 24}{10^6} = 0.99999$

A_{PT2} (Worst Case Availability) $= 1 - \frac{8.0 \times 24}{10^6} = 0.99981$

These results appear to be conservative when Ginna experience is considered. The current "best estimate" for Ginna is approximately 0.0108 failures/10^6 hrs.

3. Fuses

0.03 failures/10^6 hr	Recommended
0.3 failures/10^6 hr	Worst Case

$A_{F1} = 1 - \frac{.03 \times 24 \text{ hr}}{10^6 \text{ hr.}} = 0.99999$ Recomended

$A_{F2} = 1 - \frac{.3 \times 24}{10^6} = 0.99999$ Worst Case

These results appear to be conservative when Ginna experience is considered. The current best estimate for Ginna is:

$$0.0060 \text{ failures}/10^6 \text{ hr.}$$

4. <u>Relays</u> 0.102 failures/10^6 hrs. (Recommended)
   12.04 failures/10^6 hrs. (Maximum)

availability based on <u>one year</u> periodic test interval

$$U = 1/2 \times 0.102 \times \frac{365 \times 24}{10^6} = 4.4671 \times 10^{-4}$$

$$A_{R1} = 0.99955 \text{ Rec.}$$

$$U = 12.04 \times \frac{365 \times 24}{10^6} = 5.2735 \times 10^{-2}$$

$$A_{R2} = 0.94726 \text{ Worst Case}$$

There has been one operational auxiliary relay failure during ten years of testing at Ginna. Assuming this relay was inoperative for one half the test interval (6 mo.), this yields an availability,

$$A_{R3} = \frac{40 \times 10 - 0.5}{40 \times 10} = 1 - \frac{0.5}{400} = 0.99875$$

This result falls between the recommended and "worst case" availabilities calculated using IEEE-Std 500 values. This gives some confidence in the conservatism of the industry data. However, there have been several relay malfunctions which, although not resulting in operational failures have indicated the potential for such failures. It is therefore prudent to consider the "worst case" availability as the lower limit on the uncertainty of the data.

VII System Analyses

The availability of each train of the existing system depends on the availability of all components in the train. There are differences in consequences of failure by the various components. For example some auxiliary relay failures will result in the lock out of particular pumps, others result in lock out of all pumps fed off a particular bus. Conservatively however any loss of function is considered to be a system failure.

The arrangement of the existing system is shown in Figure 1. The availability of this system is given by

A_S (Existing System Availability) = $A^{p}_{PT} \ A^{q}_{F} \ A^{r}_{R}$

where p = (# of potential transformers) = 2

q = (# of fuses) = 5

r = (# of relays) = 30

The availabilities of cables, terminations, and enclosures is considered to be unity.

$$A_{S1} \text{ (Recommended Value)} = (.99999)^2 \times (.99999)^5 \times (.99955)^{30}$$

$$= .99998 \times .99995 \times .98659 = 0.98652$$

$$A_{S2} \text{ (Worst Case)} = (.99981)^2 \times (.99999)^5 \times (.94726)^{30}$$

$$= (.99962) \times (.99995) \times (.19682) = 0.19674$$

$$A_{S3} \text{ (Ginna experience)} = .99998 \times .99995 \times .96317 = 0.96310$$

The system availability experience at Ginna is well above the worst case value. However the availability is extremely sensitive to any uncertainty in individual relay failure rate.

This is of particular concern as the components become older. Any significant increase in relay failure rate due to aging effects could result in high system unavailability.

It should be noted that the NRC Staff requirement for coincident undervoltage logic would only mitigate failures due to the CV 7 U.V. relays, not failures in the auxiliary relays. This comment applies also to the scheme proposed by Dasgupta and Murphy.

2. The Proposed System

The general arrangement of the proposed system is shown in Figure 2. This system will function if one of each pair of corresponding relays operates. The general relation for the availability of two components in an "OR" configuration is,

$$A_s = A_1 + A_2 - A_1 A_2.$$

Since all relays are assigned the same availability in this analysis, this expression may be simplified as shown,

$$A_s = A (2 - A)$$

It is necessary for ten relay pairs (loss of voltage and second level) to function in this manner, in each of four arrangements. The four arrangements represent the primary and backup protection on each of two buses. The system availability for this scheme is given by,

$$A_{rs} = A_1^{40} = A^{40} (2-A)^{40}$$

The effect of fuse and PT availability is negligible. There are however ten Agastat and BFD relays, which remain unmodified in the proposed design, all of which must function. Accounting for these, the final system availability is given by,

$$A_{rs} = A^{50} (2-A)^{40}$$

Recommended Value	A = .99955	A_{rs} = 0.99550
Worst Case Value	A = .94726	A_{rs} = 0.52036
Ginna Experience	A = .99875	A_{rs} = 0.98751

A comparison of the existing and proposed designs is shown below.

	Existing Design	Proposed Design
Recommended Value	0.98652	0.99550
Worst Case	0.19674	0.52036
Ginna Experience	0.96310	0.98751

VIII Conclusion

It is concluded that the availability of the proposed design offers a distinctly higher tolerance to uncertainty in relay failure rate. The tolerance of higher failure rates will become more significant as these components age. It is recommended that the design be modified as proposed.

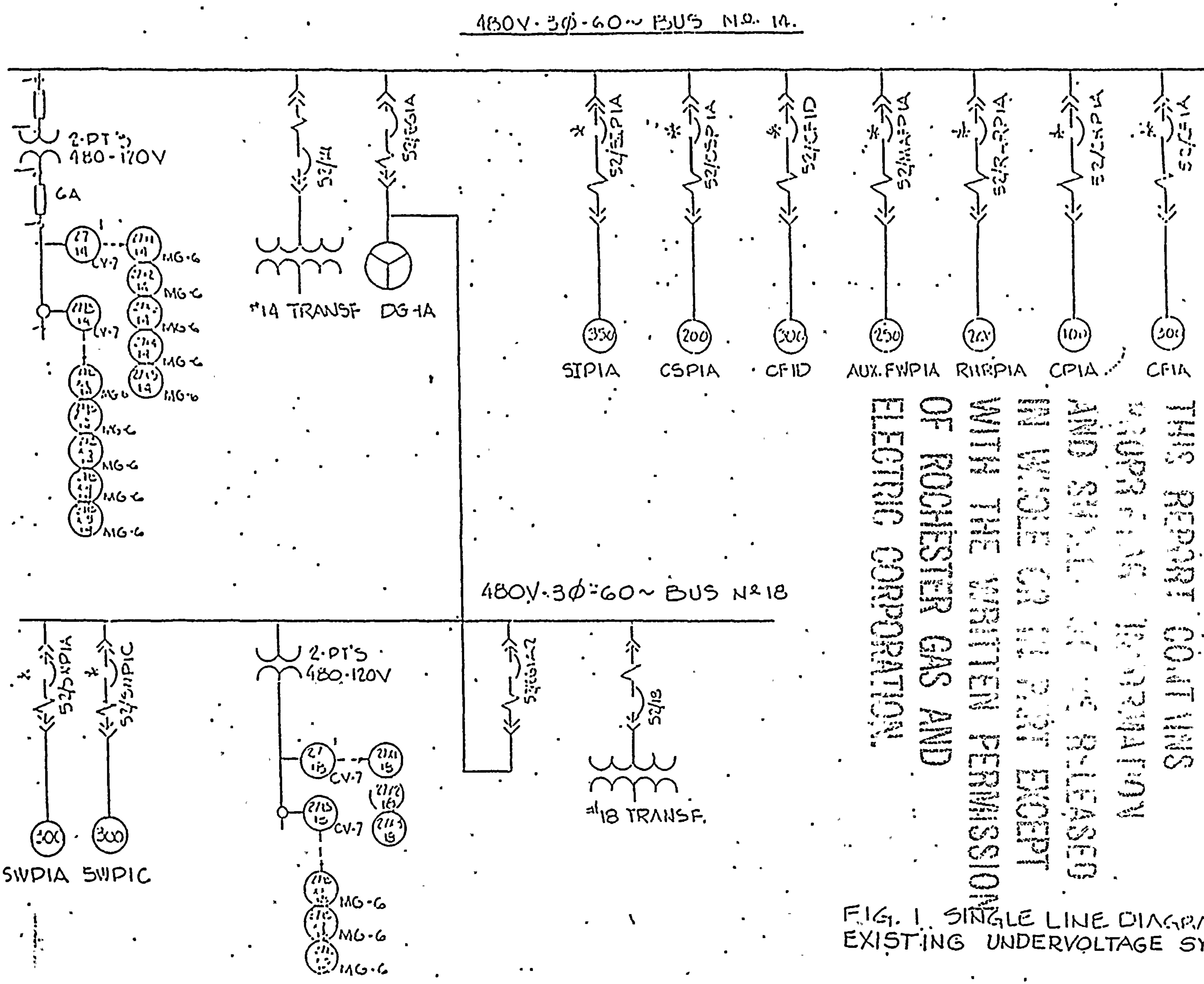

FIG. 1. SINGLE LINE DIAGRAM TRAIN A
EXISTING UNDERVOLTAGE SYSTEM

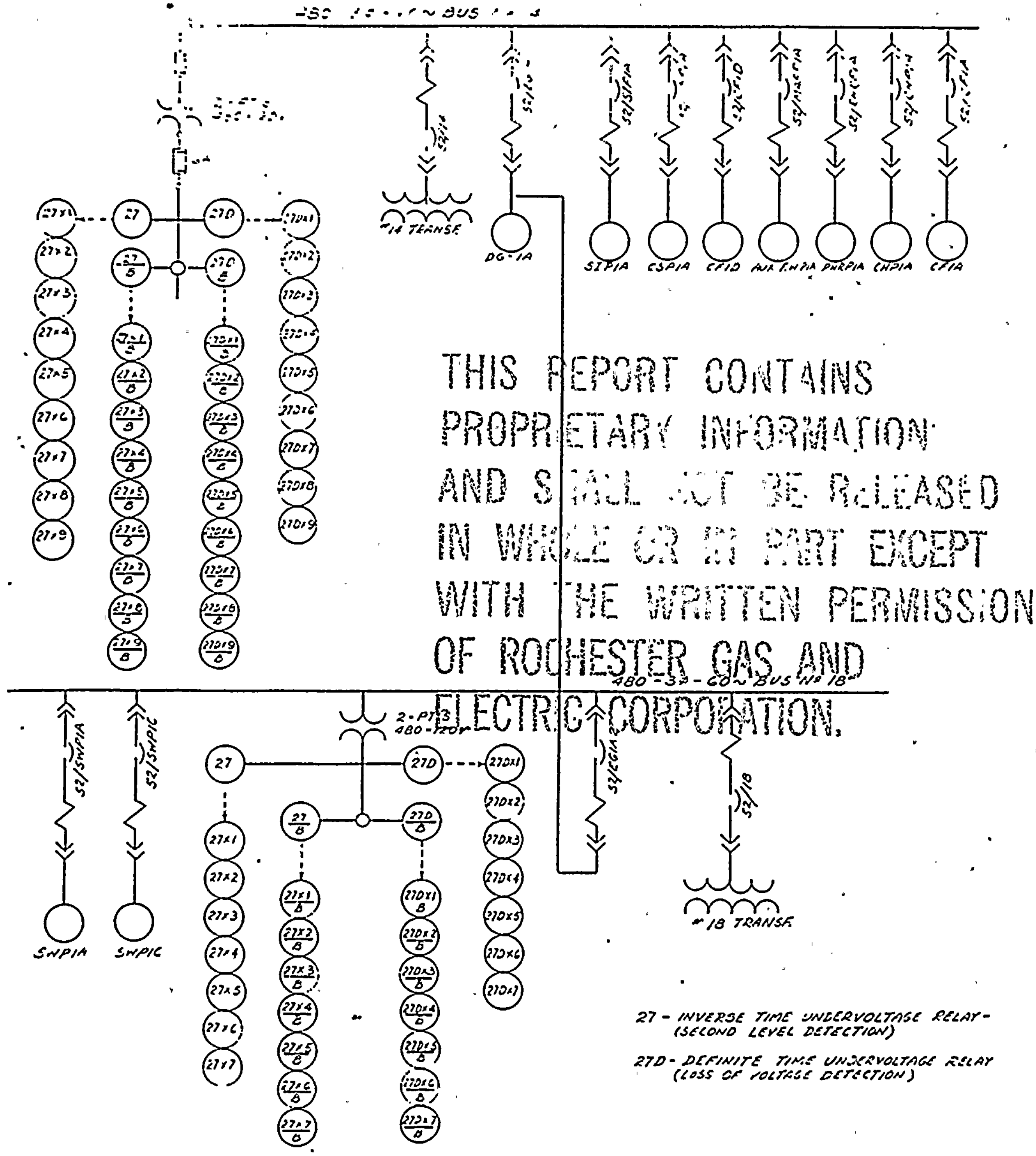

FIG. 1 SINGLE LINE DIAGRAM EWR-1444
PROPOSED UNDERVOLTAGE SYSTEM

JOB NO	
DRAWING NO	
REV	
SCALE	
ORIGINAL	
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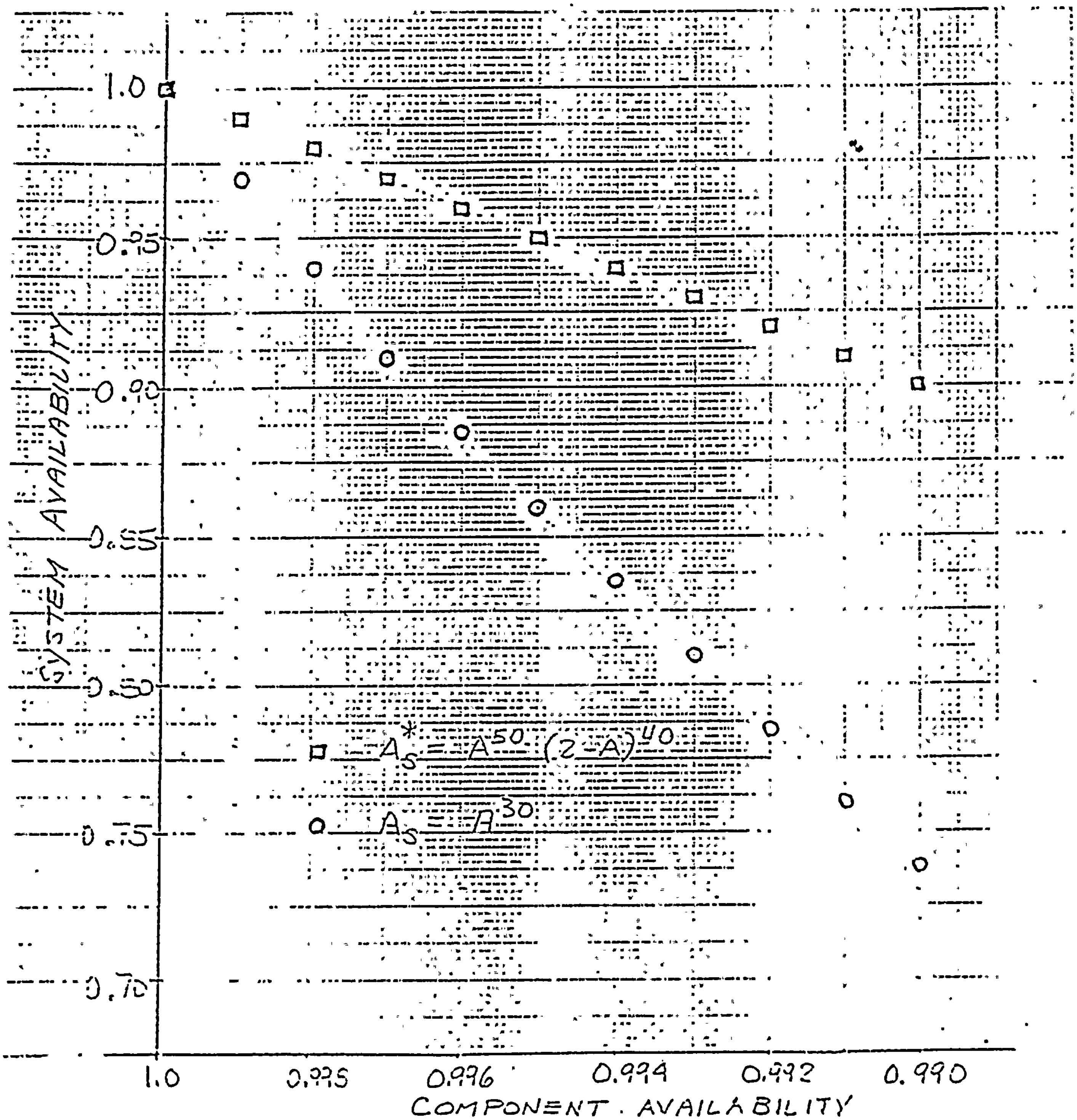

SYSTEM AVAILABILITY
1.0
0.95
0.90
0.85
0.80
0.75
0.70
$A_S^* = A^{50} (2-A)^{40}$
$A_S = A^{30}$
1.0
0.998
0.996
0.994
0.992
0.990
COMPONENT AVAILABILITY