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April 7, 1983

Commander, Atlantic Division
Naval Facilities Engineering Command
Building N-26, Naval Station
Norfolk, Virginia 23511

Attention: M. L. Bryant, P. E.
Code 09A21B3:MLB

Subject: Electrical Distribution Study for
Service to Courthouse Bay and Rifle Ranges
Marine Corps Base, Camp Lejeun, N. C.
AE Contract No. N62470-81-C-3892
Change Order P00002A

Dear Mr. Bryant:

Enclosed for your use are four copies of the Report on the subject Study. By copy of this letter we are transmitting two copies of the Report to the Public Works Department at Camp Lejeune and one copy to Mr. Herman Ireland at the Base Maintenance Department at Camp Lejeune.

Please contact me if you have any questions regarding this Report.

Yours very truly,

OLSEN ASSOCIATES, INC.

Dale N. Lee

Dale N. Lee, P. E.
DNL:mj
encl.
cc: Mr. Vann Marshburn
Mr. Herman Ireland

MARINE CORPS BASE, CAMP LEJEUNE, N. C.
AMPHIBIOUS VEHICLE MAINTENANCE SHOP

PROJECT: N62470-81-C-3892
CHANGE ORDER: P00002 a.
ELECTRICAL DISTRIBUTION STUDY FOR SERVICE TO COURTHOUSE BAY AND RIFLE RANGES

Pursuant to the subject change order the site was visited and the 12.47 KV circuit from the main substation to the Rifle Ranges was surveyed. During the survey the wire sizes and spacing were noted and the sizes and locations of transformers were recorded. Also the locations of circuit breakers, fuses, sectionalizing switches, voltage regulators, and capacitors were noted.

The results of this survey are indicated on the accompanying drawing with certain scattered connected loads lumped at the load centers as indicated by ℄ 1, ℄ 2, and ℄ 3.

FEEDER LOAD

The total connected transformer KVA load is approximately 11,840 KVA. However, according to spot load checks reported to us by the Camp Maintenance Electrical Supervisor, the highest load he has ever observed on this Feeder is 110 amperes or 2400 KVA. Assuming that the peak load might be 50% higher than his maximum observed load; this would be 3600 KVA or 30% of the connected transformer KVA capacity. The anticipated additional transformer for the Amphibious Vehicle Maintenance Building is sized at 500 KVA which when added to the 3600 KVA demand will produce a demand of 4100 KVA or less for a peak load of 190 amps or 33% of the connected transformer KVA.

CIRCUIT CAPACITY

The wire size on the Rifle Range Feeder is 1/0 cu. which has a current rating of approximately 310 amperes. The line voltage regulators, RR-1 and RR-2 are 750 KVA, ± 10%, step voltage regulators rated at 328 amperes at 10% raise or lower with increasing current ratings for lower percentages of boost or buck.

The observed positions of the regulators at the time of our survey were as follows:

	Regulator	KVA	Position Pointer	% Raise	% Lower
	RR-1	750	3 L		1.875
	RR-2	750	2 R	1.25	
*	RR-3	2-60	15 L, 16 L		9.375/10
**	RR-4	500	13 L		8.125

* RR-3 consists of 2 single phase regulators.

** RR-4 operating mechanism out of order. This was observed by the Camp Maintenance Supervisor who made note of it as a maintenance item.

VOLTAGE REGULATION

The calculated voltage drops from the substation to the indicated points on the line based on 33% of the connected KVA loads at 85% P.F. for a total load of 4100 KVA or 190 amps are as follows:

From	To	% Voltage Drop
Substation	℄ 1	1.5
"	℄ 2	3.0
"	℄ 3	4.4
"	RR-1	5.4
"	Engrs. stockade	7.3
"	RR-2	7.9
"	Triangle Outpost Tap	8.6
"	Onslow Beach Sub.	8.9
"	Camp Site 2 Tap	9.6
"	Courthouse Bay Tap	15.2
"	Rifle Range	17.6

The contributions of the regulators toward minimizing the voltage drops were ignored in the above calculations, however, it is obvious that the existing facilities are adequate to handle the existing loads and the presently proposed load additions without producing low voltage at any point on the system -- provided that the voltage regulators are properly set and maintained in good operating condition.

FAULT CURRENTS

The available short circuit KVA and currents for 3 phase and phase to ground faults at the 12.5 KV bus of the Carolina Power and Light Company substation

at Camp Lejeune were obtained from the Power Company. Three phase and phase to ground faults were calculated for various locations on the Rifle Range 12.47 KV Feeder, and the results are shown on the Load, Voltage, and Fault Coordination Study drawing.

The relay types, taps and time settings and C.T. ratios were noted for the O.C.B.'s at the substation and at points on the line and the coordination of the settings was checked. We agree that most of the present relay settings are correct and the coordination between the settings of the relays at the sub-station and those at Lyman Road, Onslow Beach Sub., Courthouse Bay, and Rifle Range is good. However, the instantaneous ground relay at the main substation might trip on ground faults near O.C.B. No. 44. Suggest increasing the instantaneous ground relay setting at the main substation to 25 amps for a 3000 amp. ground fault. Also the instantaneous phase relays at the Courthouse Bay O.C.B. (#43) should be set at 10 amps to trip on 600 amps phase to phase faults. The present setting of 2400 amps fault current is too high.

CAPACITORS

Three phase non-switched capacitor banks are located at the Onslow Beach substation and on the Courthouse Bay tap line. Each of the capacitors is a G.E., Dielektrol, 3 phase, 60 HZ, 300 KVAR, 95 KV. BIL, Unit, Cat. No. 59L631KC, rated 12470/7200 volts. The bank of capacitors on the tap line to Courthouse Bay contains five capacitors for a total of 1500 KVAR.

The capacitors at the Onslow Beach Sub. consists of two units for a total rating of 600 KVAR. However, these units are on the 2400 volt side of the substation, therefore, the effective capacity is only $600 \div \frac{(12470)^2}{(2400)^2}$ on 22.2 KVAR.

They should be relocated to the 12470 volt side of the Onslow Beach substation.

LIGHTNING ARRESTERS

In recent years the Camp Maintenance Department has added lightning arresters and driven ground rods at approximately every mile along the Rifle Range Feeder, and the maintenance supervisor indicated that the line performance had improved noticeably.

RECLOSERS

It is suggested that consideration be given to the installation of reclosers on the Triangle Outpost tap line and on the Rifle Range line beyond the Courthouse Bay tap. These would eliminate most of the service trips to replace fuses on

the tap line to the Triangle Outpost and would prevent outages on the line between O.C.B. #44 to Courthouse Bay due to faults on the line between Courthouse and the Rifle Range O.C.B. # 40.

CONCLUSIONS

The results of this Study lead us to the conclusions as follows:

1. The Rifle Range Feeder has adequate capacity to serve the existing loads plus the contemplated additional loads which have been revealed to us, namely, approximately 500 KVA in the Amphibious Vehicle Base area.

2. The voltage regulators are adequate to provide good regulation on the line, however, Regulator RR-2 would be better located in the main line in the vicinity of Camp Site No. 2 tap line. Also the operating mechanism to Regulator RR-4 should be fixed, and the voltage levels and line drop compensators in all regulators should be rechecked and adjusted for most desirable results.

3. The capacitors (2-300 KVAR Units) at the Onslow Beach Substation should be relocated from the 2400 volt side to the 12,470 volt side of the substation.

4. Power Factor: Based on the peak load estimate of 4100 KVA at 85% P.F. this results in 3485 KW and 2160 KVAR lagging load, however, the capacitors at Courthouse Bay reduce the lagging KVA to 660 KVAR and raises the power factor to 98% during peak load. If the capacitors at the Onslow Beach Substation are relocated to the 12,470 volt side of the substation, it will raise the power factor to 100%.

5. Future Considerations: As indicated in the early part of this report, at peak load the Demand Factor is only about 33% of the total connected KVA of transformer capacity. If conditions should change so as to increase the demand as much as 50% above the existing peak load, further measures should be undertaken to improve the voltage regulation and reduce line losses. At present the line losses amount to approximately 9.8% at peak load on the Rifle Range Feeder.

6. When such load increases are contemplated, it would be our recommendation that a delta-wye step-up transformer be provided at the main substation on the Rifle Range Feeder and that that Feeder neutral conductor be extended from Lyman Road to the end of the line and all taps with driven ground rods at every other pole (about 14 per mile) so as to ground the neutral effectively. The existing transformers

would be reconnected line to neutral instead of line to line. This arrangement of course would change the line to line voltage to 21,600 volts and line to neutral volts to 12,470 volts. This also will necessitate replacing all of the regulators and circuit breakers on the line and the step-down tranformers in the Onslow Beach Substation. The line losses would be reduced to one third of the present line losses, and the voltage regulation would be reduced 73%.

At a load factor of 50% and a peak load of 3500 Kw. with line losses of 9.8% the annual cost of line losses at $0.05 per KWH amounts to $75,000.00. By converting to 21.6 KV operation the savings in line losses amount to approximately $50,000.00 per year.

The assistance rendered by the Electrical Engineer section of the Public Works Department and by the Camp Maintenance office at Camp Lejeune is greatly appreciated.

Report prepared by:

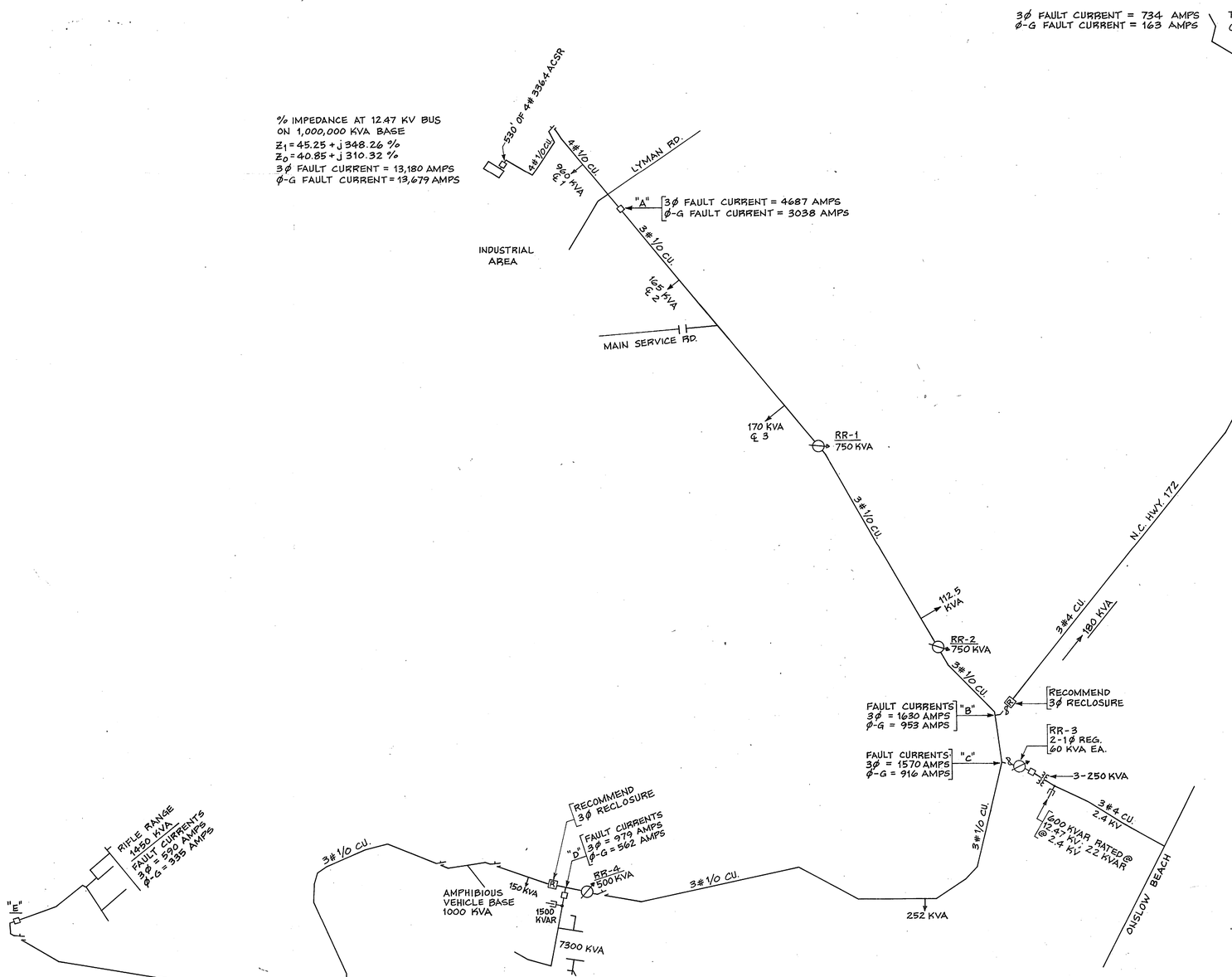
OLSEN ASSOCIATES, INCORPORATED

Kenneth T. Knight, P. E.

SEAL

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVED

% IMPEDANCE AT 12.47 KV BUS
ON 1,000,000 KVA BASE
$Z_1 = 45.25 + j\,348.26$ %
$Z_0 = 40.85 + j\,310.32$ %
3Ø FAULT CURRENT = 13,180 AMPS
Ø-G FAULT CURRENT = 13,679 AMPS



SYMBOLS

- STEP VOLTAGE REGULATOR ± 10%
- OIL CIRCUIT BREAKER
- FUSED DISCONNECT
- 3 POLE GANG SWITCH
- [R] OIL OR VACUUM RECLOSURE - PROPOSED
- TRANSFORMERS

#	DATE

T-2

K.T. Knight 4-1-83

NORTH CAROLINA REGISTERED SEAL 1330 ENGINEER KENNETH T. KNIGHT

ES-1

OLSEN ASSOCIATES
RALEIGH, N. CAROLINA
ENGINEERS & ARCHITECTS

DEPARTMENT OF THE NAVY NAVAL FACILITIES ENGINEERING COMMAND
ATLANTIC DIVISION
NAVAL STATION NORFOLK, VIRGINIA

DES KTK | DR JDC | CHK KTK
PROJ MGR DNL CH ENGR
SUBMITTED BY DATE
FIRM MEMBER PRINCIPAL
EFD RVD
MD DIR
APPROVED DATE
ACTIVITY – SATISFACTORY TO
APPROVED DATE
FOR EFD FOR COMMANDER NAVFAC

MARINE CORPS BASE, CAMP LEJEUNE, N.C.
AMPHIBIOUS VEHICLE MAINTENANCE SHOP

LOAD, VOLTAGE & FAULT COORDINATION STUDY – RIFLE RANGE 12.47 KV FEEDER

SIZE | CODE IDENT NO. | NAVFAC DRAWING NO.
CONSTR. CONTR. NO. N62470-81-C-3892
SCALE 1"=2500' | SPEC. | SHEET OF
EFD DWG NO