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PN-004-021

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CHAPARE REGIONAL
DEVELOPMENT PROJECT

Contract 511-067-C-00-6104

CHAPARE PROJECT
FINAL REPORT
TECHNICAL SPECIALIST, JAMES VAN COEVERING

The following activities were carried out by the indicated Technical Specialist during the period from April 26 to June 8, 1986. The assistance of personnel from the Empresa Nacional De Electricidad (ENDE) and of the Secretariat for Development of the Bolivian Tropics (SDTB) is gratefully acknowledged.

DESIGN

1) REVIEW OF PREVIOUSLY COMPLETED WORK

The Design Report (Appendix A), details the results of a review of work completed by ENDE. The principle recommendations are:

A) Power Requirement Study

The market study prepared by ENDE projects significant growth in consumption of electricity for industrial purposes. A field trip through the project area does not indicate much likelihood for such an expansion. It is recommended that energy sales projections be based on an essentially residential system with a load factor of 25% to 30%, in place of the 50% projected by the ENDE market study. The peak kilowatt demand projection made in the market study is appropriate, however. This means that principle design decisions, such as the use of 34.5kV as a primary voltage, are appropriate.

B) Conductor Selection

A change in the size of the conductor selected for the secondary (low voltage) system was recommended and has been accepted by ENDE. Substitution of duplex number 2 AWG in place of the number 4 AWG originally recommended by ENDE will give better voltage regulation and will help protect the transformer against burn outs due to high resistance secondary faults.

C) Transformers

Completely Self Protected (CSP) distribution transformers are appropriate for this project. It is recommended that they be procured with a modified time current characteristic for the low voltage breaker.

D) Poles

It is recommended that eleven meter class six poles be used as the base pole for the distribution lines rather than the ten meter class six recommended by ENDE. Ruling span remains at 160 meters and average span at 150 meters. This change in pole size will provide increased clearance to ground over that originally planned.

2. DESIGN REVIEW OF 50 KILOMETER SUBTRANSMISSION LINE

Appendix B.

3. FEASIBILITY OF THE CHIMORE SUBSTATION

Appendix C.

4. FIELD REVIEW OF LINE STAKING

Appendix D.

5. ADDITIONAL ACTIVITIES

Appendix E.

6. CONTRACTS

A) Materials

Technical specifications for materials and equipment, previously prepared by ENDE, were reviewed. No significant alterations were found necessary. Attached are copies of the following documents prepared under the supervision of the Specialist.

a.1) Technical Specifications for Poles

Appendix F.

a.2) Contract Form for Supply of Materials and Equipment

Appendix G.

B) Construction

The contract form and technical specifications for project construction were prepared by the Specialist and are attached as Appendix H.

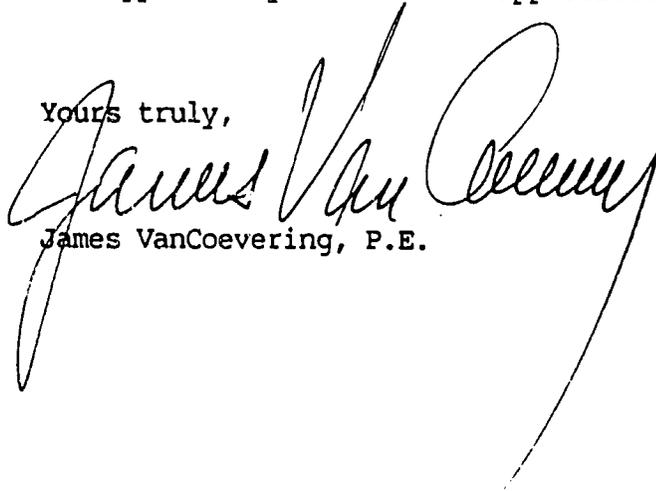
I would like to take this opportunity to express my appreciation to Federico Lucero, Manager of Distribution and to Carlos Ulloa of his staff, who invested many personal hours in this project. I would like to thank the support staff

at ENDE whose efforts were essential to the timely completion of the terms of the contract.

I would like also to especially thank Conrado Camacho and Rafael Vera of SDTB, who placed all of their facilities at my disposal. Particularly appreciated is the unconditional use of their word processor. This gesture often required them to delay their own projects, but without such cooperation, it would have been impossible to complete the documents in this report.

The opportunity to serve is appreciated.

Yours truly,

A large, stylized handwritten signature in black ink, appearing to read "James VanCoeving". The signature is written over the typed name and extends significantly to the right and downwards.

James VanCoeving, P.E.

APPENDIX A

REVIEW OF DESIGN CHAPARE RURAL ELECTRIFICATION PROJECT

I. THE PROJECT

1) Objective

The objective of this report is to document the review of the project description titled Rural Electrification Project: Chapare, prepared by ENDE in February of 1985. This report will follow the format of the original.

2) Description of the Project

The general description of the project has been altered slightly due to recent field work done by personnel from ELFEC. The current description is as follows:

- 49.1 kilometers of subtransmission line from San Jose to Villa-Tunari. (May be replaced by Chimore Substation).
- 91 kilometers of three phase primary line at 34.5/19.9kv.
- 17 kilometers of single phase primary line at 19.9kv.
- 34 kilometers of secondary underbuild at 380/220 volts three phase and 220 volts single phase.
- 22 kilometers of secondary line on its own poles at 380/220 volts three phase and 220 volts single phase.
- 2,875 KVA of single phase transformers.
- 2,000 service drops and meters.

- 550 street lighting installations.
- 6 installations of sectionalizing and protection equipment.

3) Source of Power

The original plan for power supply to the project called for the construction of 9 kilometers of 115kV line (part of the Central East Interconnection) from Santa Isabel to San Jose; construction of a substation at San Jose with a 115/34.5kV transformer and the construction of 49 kilometers of 34.5kV subtransmission line from San Jose to Villa-Tunari. This plan is currently being reviewed. ENDE is considering the construction of a substation which taps the Central East Interconnection at Chimore with a 220/34.5kV transformer. This would replace the San Jose Villa-Tunari subtransmission line and the tap substation at San Jose. Should this modification be approved, the only change in the other details of the project would be the addition of 8 kilometers of single phase distribution line from Villa-Tunari to Padresama.

4) Market Analysis

It was not possible to verify in detail the census of potential consumers, but the following observations were made during field trips to the project area:

4a) Residential Class

There is considerable residential construction activity going on in the project area, especially around Sinjota and Chimore as

well as around Samusabet and Eterazama. In addition to construction activity, many of the more primitive residences are being replaced with more permanent construction. It is very probable that the census undertaken by ELFEC could be conservative in its count of potential residential users due to this rapid growth.

4b) Commercial/Institutional Class

This class consists principally of hotels and institutions such as schools, neither of which are demonstrating the growth indicated by the residential class. Many of the hotels, which are principally located around Villa-Tunari, have been closed due to the reduction in tourism in recent years. This loss is balanced somewhat by the increase in the number of small commercial locations, such as stores, in the areas where population growth is substantial.

4c) Industrial Class

This class is composed principally of small industries linked to agricultural activity, such as rice mills and saw mills. As a class it has practically disappeared due to the redirection of financial resources to the coca/cocaine industry in recent years. Those installations which remain are very primitive, operate sporadically and do not represent an electrical demand of any importance.

In the future this class could become important given the potential for growth in the area. With the construction of roads which will tend to reduce transportation costs and the development of an agricultural industry not based on illicit drug traffic, it is possible that there could be a substantial growth in processing plants for various products, as well as in irrigation installations.

4d) Energy Usage

As indicated above, the estimate of number of residential users is probably conservative. The estimate of monthly energy consumption per residential user is reasonable. The combination of these two factors will yield an underestimation of the residential load. It is difficult to provide figures, but from experience on other projects of a similar nature it is possible that residential load could be underestimated by from 50% to 100%.

On the other hand the projection of industrial use is optimistic, especially for the first years, by nearly 90%. The projections of industrial use contained in the ENDE document could be realized if the development of alternatives to the cultivation of coca is successful.

The projection for the commercial/institutional class is reasonable for future years, but probably optimistic by about

30% for the early years of the project. The projection for energy usage due to street lighting is underestimated by about 20%, due to the change in the projected number of lighting installations.

With these observations it is possible to prepare a revised load forecast for the project. Due to the reduced importance of industrial loads, it is estimated that the principal use of energy for all classes will be for lighting, comfort and food preservation. This will result in a system with peak load occurring during the early hours of the night, from 7:00 PM to 10:00 PM. Annual load factor will be around 25%. The results of this analysis are summarized in the following table.

It is apparent that, in spite of the reduction in total kilowatt hour sales, peak demands are not notably different from those contained in the ENDE report. This is due to the difference between a system based on industrial load, with a high load factor, and one based on domestic consumption with its resulting low load factor. The previous projection had been based on a load factor of approximately 50%, far too high for this system.

Consumer Class	Load Forecast		
	Year 1	Year 2	Year 5
Residential:			
Customers	2905	3290	5656
Kwh/month	49	52	62
Mwh/year	1708	2053	4208
Industrial:			
Customers	45	48	60
Kwh/month	1000	1000	1000
Mwh/year	540	576	720
Commercial:			
Customers	170	181	319
Kwh/month	212	212	212
Mwh/year	432	460	812
Street Lighting			
Units	500	500	600
Kw/month	41	41	41
Mwh/year	246	246	295
Total Sales-Mwh/year	2926	3335	6035
Losses (9%)	263	300	543
Total Purchases Mwh/year	3189	3635	6578
Peak Demand	1456 Kw	1660 Kw	3000 Kw
Load Factor	25%	25%	25%

5) Construction Cost Estimates

The construction cost estimates presented in the ENDE report were based on U.S. market prices from 1984. There has not been a significant increase in cost during the recent years. On the contrary, in some categories there have been price reductions. For this reason, the cost estimates previously prepared are considered appropriate.

ELECTRICAL AND MECHANICAL DESIGN

II.

1) Standards

System designs prepared by ENDE in 1984 were based on REA design standards publications dating from the 1970's. These have since been replaced by new editions with significant changes. It is recommended that ENDE obtain up-to-date design standards publications for its future projects.

2) Electrical Design

2a) Selection of Primary Conductors

An economic analysis of conductors was prepared to verify the sizes selected by ENDE.

The largest conductor that can be used without need for heavy construction framing is 1/0 AWG ACSR. Breaking load for this conductor is 4,280 lbs., and structure type VCl is limited to conductors with breaking strengths of less than 4,500 lbs. In addition the maximum span limited by structure strength for the 11 meter class 6 base pole is 180 meters for 1/0 conductor. This is an optimum result for a 160 meter ruling span and larger conductors would require class 5 poles or shorter ruling spans, both of which have substantial economic disadvantages. It is therefore, established that 1/0 conductor is the largest which will be analyzed. In the same fashion it can be determined

that, for mechanical reasons, the smallest practical conductor for this project would be N^o6 AWG ACSR.

The conductor analysis was prepared utilizing the following assumptions:

Conductor Cost: \$2.40 US/KG

Loss Cost:

Demand Losses: \$1,500 US/KW

Energy Losses: \$10.00 US/MWH

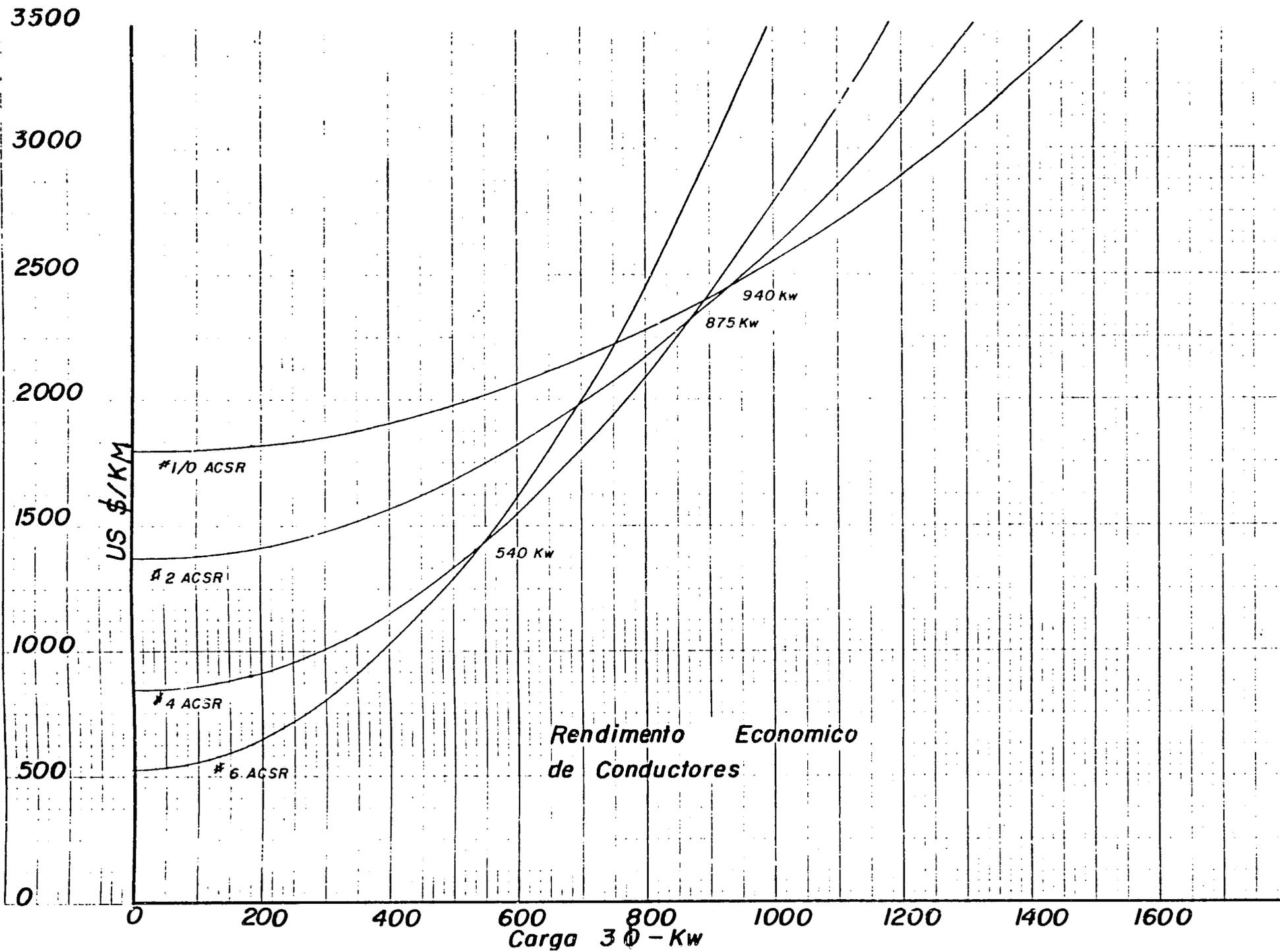
Load Factor: 30%

Present Worth Factor: 6.7 (this is applied only to the annual cost of energy)

The results are presented in the attached graph. It is apparent that N^o 6 ACSR conductor has an economic limit of approximately 540KW. Given the potential for load growth in the area, use of this conductor is not recommended.

N^o 2 AWG conductor has a very small range of economic preference, that is from 875 to 940 kW. Its use is not recommended.

The conductors which have the largest range of economic preference are N^o 4 AWG ACSR and N^o 1/0 ACSR. This analysis



mg

confirms the selection of these conductors for use in primary lines.

2b) Insulators

The insulators selected by ENDE for use in 34.5/19.9kV lines are of the pin type ANSI class 56-3 for tangent structures, and strings of three ANSI 52-3 suspension insulators for deadends. Spool insulators ANSI 53-2 are specified for the neutral. The selection of these insulators is appropriate for the altitude and the voltage level. It should be noted that ANSI 56-3 insulators require a longer pin shank to provide necessary clearance from the lower insulator skirt to the crossarm, and also have a greater skirt diameter than the ANSI 56-2 insulators used by ENDE for their 24.9/14.4kV system. This means that it will not be possible to interchange insulator pins between systems of the two voltages, even though both insulators have the same pin thread diameter. It will be necessary to take special care in the design of double insulator structures for light and medium angles to avoid interferences between the skirts of these larger diameter insulators.

2c) Voltage Levels

The nominal voltages selected for secondary service are those which are standard in Bolivia, that is 380/220 volt three phase and 220 volt single phase.

Voltage regulation limits selected are reasonable for a system in the final phases of its development. It should be expected that voltage drops during the initial phase would be lower due to the lighter loads.

2d) Voltage Drop Calculations

Studies of voltage drop were prepared both for the system fed from San Jose as well as the alternate system utilizing a substation in Chimore. As indicated in the attached report, (Appendix C) both alternatives have sufficient capacity for phase I of the project, although the use of the Chimore station feed gives important advantages for future expansion.

2e) Secondary System

The use of duplex, triplex and quadraplex conductors for secondary systems is common all over the world and is quite justified here. The use of insulated conductors such as duplex, triplex and quadraplex will give better reliability of service, since contact with trees or houses will not necessarily cause an outage. This is appropriate for a project area consisting of tropical rain forest with a number of developing communities.

Unfortunately, the conductor size originally chosen for the secondary system is too small to give adequate service. Voltage drop calculations for distributed load indicate that a total load of only 5 KVA is enough to produce 5% voltage drop at the end of a

secondary sector of 350 meters. Since it is common to feed two or three sectors from the same transformer, this would imply that the maximum permissible transformer size would be 10 to 15 KVA. This is too small to provide for any future growth.

The majority of complaints for bad service are due to poor voltage regulation, and undersized secondary conductors are the principle cause. The use of N^o 4 AWG conductor for this application will provide very poor regulation, especially for motor loads such as refrigerators, fans, etc., which have significant starting currents.

A simple voltage drop study indicates that N^o 2 duplex could serve a maximum load of 8.3 KVA per sector and 1/0 a maximum load of 13.2 KVA, for a given 5% maximum voltage drop. The additional costs for 45 kilometers of N^o 2 duplex or N^o 1/0 duplex are \$14,000 U.S. and \$40,000 U.S., respectively (assuming the cost of duplex to be \$3.50 per kilogram). The greater weight of N^o 1/0 duplex (almost 2.5 times as heavy as N^o 4) will give construction difficulties, which would cause additional increases in cost. N^o 2 AWG duplex weighs only 50% more than N^o 4 and should not give problems in installation.

It is recommended that N^o 2 AWG duplex and quadruplex be considered minimum sizes for the secondary system since this

will permit the development of a more acceptable service. The length of secondary sectors should be limited to 350 meters maximum.

It is recommended that the duplex and quadruplex conductors be ordered with high density polyethylene insulation instead of low density polyethylene. High density polyethylene has greater mechanical strength than low density, which will give better immunity to short circuits caused by scrapes against buildings or trees.

Recent communications from ENDE indicate that these recommendations are being implemented.

2f) Service Drops

The use of N₈ 8 AWG duplex for service drops is acceptable, given that the typical customer in the project area will have a usage of less than 50 kilowatt hours per month. High density polyethylene insulation is recommended for service drop conductors for the same reasons as indicated above for secondary circuits.

It should be noted that a change in the method of construction of the service drop is recommended. In previous projects the service drop duplex is connected to a concentric service conductor without the use of a weatherhead or drip loop. This has resulted in a high incidence of short circuits at the junction. It is recommended that this practice be modified to include a weatherhead in the form of an inverted U-bend in the

service mast and the use of a generous drip loop in the service conductor itself.

2g) Distribution Transformers

Due to the cost of the auxiliary equipment and its weight, especially at 34.5kV, it is recommended that distribution transformers be of the completely self-protected (CSP) type instead of the older conventional type.

ELFEC, the distribution company responsible for operation and maintenance of the project, has advised of problems with premature failure of CSP transformers. Normally a prematurely failed transformer is found to have failed due to over-temperature (burn out). This condition is normally caused by overload, but in many of the cases investigated, the served load has been within the capacity of the transformer.

A study of short circuit currents was made and appears to indicate another problem. Distribution transformers generally have an impedance of approximately 2%. This impedance in conjunction with the impedance of the system is sufficiently low to deliver a short circuit current of approximately 40 times nominal current for a short circuit at the low voltage bushings. This is sufficient to trip the thermal breaker on the low voltage side of a CSP transformer. Fault current diminishes rapidly with distance from the transformer. For example, fault

current at the end of a 350 meter secondary circuit consisting of N₂⁰ 4 duplex is approximately 220 amperes, regardless of the capacity of the transformer. This is only 3 times nominal current for a transformer of 15 KVA. This level of current is not sufficient to trip the low voltage breaker, but it is sufficient to burn out the transformer after a prolonged time. The use of N₂⁰ 2 AWG duplex for secondary runs increases the available fault current to 320 amperes, or 4 times nominal current. Although this is a marginal level, it should trip the breaker.

It is apparent that undersized secondary conductors can introduce problems with premature failure of transformers, as well as producing poor voltage regulation. As well as using larger secondary conductors, it is recommended that CSP transformers be ordered with a modified curve for the low voltage circuit breaker as indicated in the short circuit study attached as Appendix E.

3) Mechanical Design

3a) General Conditions

The light loading district of the NESC is appropriate for use in the Chapare region. NESC Grade C construction is also appropriate. REA Bulletin 160-2 should be used for mechanical design of distribution lines. The editions of Bulletin 160-2

and the NESC in ENDE office are outdated. New editions were obtained and used for the re-design documented here.

The line-to-ground clearance to be used in spotting should be that indicated for "areas subject to cultivation". The clearance for lands "along rural roads" should not be used. This last clearance designation was developed for situations wherein the limits of the road right of way are marked with a continuous fence, and by this manner the general purpose use of the right-of-way is not permitted. This situation does not exist in the Chapare where there are no right-of-way fences and areas close to the road are as susceptible to development as any other.

3b) Mechanical Calculations for Conductors

Sag and tension calculations for conductors have been prepared utilizing out of date information which did not take into account long term creep of a conductor. This fact caused an error of approximately 50 centimeters in the ruling span sag calculation. A majority of the project has been staked utilizing the erroneous calculation, with a ruling span of 160 meters, a ground clearance of 6 meters and a base pole of 10 meters in length. In order to re-utilize the existing staking, new staking tables were prepared taking into account conductor creep, with a ruling span of 160 meters, ground clearance of 6.5 meters and an 11 meter base pole. This has yielded the

necessary result, that is a project which fulfills the chosen criteria while it preserves the majority of the previously prepared staking.

3c) Mechanical Calculation of Structures

As indicated above, it is recommended that the base pole be changed from 10 meters to 11 meters. This does not imply significant limitations on the structures since the horizontal span limit for 11 meters class 6 poles is 170 meters for 1/0 ACSR conductor. This is the same as the horizontal span limit for the previously used 10 meter class 6 pole.

The change from N₄⁰ duplex to N₂⁰ duplex should also not have an important effect, since the horizontal span limit for an 8 1/2 meter class 7 pole is in excess of 200 meters with N₂⁰ duplex.

3d) Guys and Anchors

The use of galvanized 5/16" EHS strand is adequate for guys on this project.

It is recommended that anchors of the expansion type not be used for this project due to probable soil conditions in the Chapare. The traditional treated log anchors, construction type F2-1, are recommended as these provide greater soil contact area and reducing soil pressures. Soils in the Chapare are principally

poorly consolidated alluvial sediments subject to saturation during the wet season. This combination is perhaps the poorest possible from the standpoint of anchoring efficiency, and calls for a large area anchor.

4) System Protection

The location and specification of protective devices recommended for the project is included in Appendix E.

DESIGN SUMMARY

SAN JOSE VILLA TUNARI SUBTRANSMISSION LINE

GENERAL INFORMATION

The San Jose Villa Tunari subtransmission line will be the power source for the Chapare Rural Electrification Project. From the step down substation at San Jose, the line crosses the steep inclines of the Cordillera Del Tunari towards the village of Villa Tunari where the Rural Electrification Project begins. The voltage of the subtransmission line will be 34.5/19.9kV, and its length approximately 50 kilometers. The route of the line generally follows the route of the Cochabamba-Chapare Highway.

DESIGN CRITERIA

- A. The line will be designed for NESC light-loading conditions, that is for a wind-loading of nine pounds per square foot ($44\text{KG}/\text{M}^2$) without ice at a temperature of 32°F (0°C).

- B. The design conditions used will be those specified in Bulletins 62-1 and 160-2 of the Rural Electrification Administration (REA) and the National Electrical Safety Code (NESC) of the United States. The line will be designed to NESC Grade B construction. Ground clearances will be according to the NESC for the terrain classification, "other areas accessible to vehicles", except when it can be established without doubt that an area is accessible only to pedestrians.

CONDUCTOR SELECTION

Voltage drop calculations indicate that the smallest conductor that can provide satisfactory service (for fifth year load) is 4/0ACSR. Increases in conductor size do not improve voltage drop until impractical conductor sizes are reached. This is due to the increasing importance of the reactive portion of the impedance as the resistive portion is reduced.

An economic conductor analysis was prepared utilizing the following assumptions:

Load: 3200 KVA

Loss Costs:

Demand \$ 1500 U.S. /Kw

Energy \$ 10 U.S. /Mwh

Cost of Conductor: \$2.40/Kg

Loss Load Factor: 30%

Present Worth Factor: 6.7

(energy cost only)

Results are:

<u>Conductor</u>	<u>Losses in 50Km</u>	<u>Cost of Conductor</u>	<u>Cost of Losses</u>	<u>Total Cost</u>
2/0	189 Kw	\$ 94,636	\$ 316,780	\$ 411,416
4/0	119 Kw	\$ 144,562	\$ 199,453	\$ 344,015
266.8 MCM	95 Kw	\$ 181,500	\$ 159,227	\$ 340,727
397.5 MCM	63 Kw	\$ 270,468	\$ 105,592	\$ 376,060

The difference in total cost between 4/0 and 266.8 MCM is less than 1.5% and the two conductors can therefore be considered equivalent in longterm cost. The difference in initial cost between the two conductors is almost \$40,000, or 25% in favor of 4/0. It is therefore recommended that the San Jose Villa

Tunari line be constructed of 4/0 ACSR. As this line will feed directly (no intervening transformer) into a distribution system, it is recommended that a neutral conductor of 1/0 ACSR be included and run continuously with the phase conductors.

DESCRIPTION OF THE AREA

The San Jose Substation is located near the Rio San Jacinto on the eastern slopes of the Cordillera Del Tunari. The climate is categorized as sub-tropical. Annual precipitation levels vary from 2,000 millimeters at San Jose to 4,000 millimeters at Villa Tunari. Temperatures vary from 10°C to 30°C. Terrain is extremely broken, with variations in elevation of hundreds of meters in a 500 meter span. Soil is unstable due to the extremely high rainfall, and landslides, mudslides and other earth movements are common.

SAG AND TENSION CALCULATIONS

Conductors have the following characteristics:

	Phase	Neutral
Size	4/0 AWG	1/0 AWG
Stranding	6/1	6/1
Type	ACSR	ACSR
Code Word	Penguin	Raven
Diameter	14.31 mm	10.11 mm
Unit Weight	433.4 Kg/Km	216.2 Kg/Km
Breaking Strength	3795 KG	1932 Kg
*Resultant Loaded	.8389 Kg/m	.5691 Kg/m

*Includes K=.0745 Kg/m

Limiting conditions are:

Maximum loaded tension 50% RBS
Maximum unloaded tensions
 Initial conditions at 0°C 33%
 Final conditions at 0°C 25%

Sags and tensions are calculated utilizing stress strain curves developed by the Aluminum Association of the United States and take into account the effects of creep after ten years at 15°C. Ruling span was selected after a review of the profile and the calculation of span limits of structures, taking into account the difficulty of obtaining poles longer than 15 meters.

Sag and Tension Calculations

Conductor: 4/0 ACSR - 5/1 - "Penguin"

Ruling Span: 300m

Temp. °C	Loading	Initial		Final	
		Tension Kg	Sag m.	Tension Kg	Sag m
0	0	1128	4.26	(947)	5.16
0	LLD	1542	6.18	1445	6.54
20°	0	952	5.13	811	6.08
50°	0	806	6.09	687	7.08

Conductor: 1/0 ACSR-6/1 "Raven"

Ruling Span: 300m.

Temp.	Loading	Initial		Final	
		Tension	Sag	Tension	Sag
°C		Kg	m	Kg	m
0°	0	561	4.35	473	5.16
0°	LLD	893	7.14	876	7.29
20°	0	475	5.13	405	(6.08)
50°	0	400	6.08	343	7.08

The controlling sag for the 1/0 conductor has been taken to be equal to the sag at 20°C of the 4/0 conductor. In this fashion, appropriate spacing will be maintained between the phases and the neutral conductor.

Due to the low electrical load in relation to the thermal capacity of the line, the maximum working temperature has been assumed to be 50°C. Line capacity is limited by voltage drop conditions to such a degree that it is unlikely that the conductor temperature will exceed significantly the ambient temperature.

CLEARANCES AND SPACINGS

A. Conductor to Ground Clearance

Table II-4 of REA Bulletin 160-2 was utilized to determine line to ground clearances. The basic clearance for the San Jose via Tunari line will be 6.7 meters for phase conductors and 5.5 meters for neutral conductors, both measurements determined from the 50°C hot curve of the conductor.

B. Phase Spacing

The equation governing phase to phase spacing from the NESC is:

$$D = 7.38 (H - 0.0076(kV))^2$$

Where:

D = final unloaded sag 20°C

H = phase to phase spacing in meters

kV = 34.5

This equation is applied only to distribution lines (voltages less than 50kV) and should therefore be considered as a minimum. Another equation used for transmission lines is, for the light load district:

$$D = 2.48 (H - .0076(kV))^2$$

This equation can be extremely conservative, especially for areas that are not susceptible to galloping oscillations as is the region under consideration. For the purposes of this line, which is neither distribution nor transmission, the following equation will be used. This utilizes the equation of the NESC modified by the factor of experience included in REA Bulletin 62-1, that is F=1.15.

$$D = 5.58(H - .0076(kV))^2$$

This gives the following limiting spans:

For structure type TH1D-470 meters

For structure type TH1E-614 meters

C. Spacing Between Phase Conductors and Neutral

Due to the differences in size and sag between phase and neutral conductors, Rule 235G of the NESC applies. In its appropriate part it requires a vertical spacing at the support of 1.02 meters between the neutral and the phase position. This requirement is fulfilled in all of the proposed structures.

INSULATION

The typical insulator for 34.5kV lines is the pin insulator ANSI Class 56-3 whose characteristics appear below:

Flashover Voltage

60 Hz Dry.....	125kV
60 Hz Wet.....	80kV
Positive Impulse.....	200kV
Negative Impulse.....	265kV

Critical Distances

Leakage Distance.....	53 cm
Dry Arcing Distance.....	24 cm

The influence of altitude serves to reduce these values according to the factor derived from the equation:

$$F = .0345B$$

Where: B = atmospheric pressure in inches of mercury

The altitude at San Jose is approxiamtely 2,000 meters and at Villa Tunari approximately 300 meters. Due to the de-rating factor, the actual insulation level varies from 81% of nominal at San Jose to 100% at Villa Tunari. Given the recommendation of REA to maintain an insulation level of 90% of nominal, and of the tropical conditions of the area it is recommended that insulators of ANSI Class 56-4 be used for this line. Characteristics of this insulator are as follows:



ANSI 56-4 Insulator

<u>Flashover Level</u>	<u>At Sea Level</u>	<u>At 2000 Meters</u>	<u>% Compared to ANSI 56-3</u>
60 Hz Dry	140 KV	113 KV	90%
60 Hz Wet	95 KV	77 KV	96%
Positive Impulse	225 KV	182 KV	91%
Negative Impulse	310 KV	251 KV	95%

The neutral insulator will be the normal ANSI Class 53-2. Deadend strings will be composed of three units of ANSI 52-3 suspension insulators.

MAXIMUM LEVEL GROUND SPANS

The maximum level ground span is calculated for a given structure from the following equation:

$$H = S \sqrt{\frac{hc - 6.7}{D}}$$

Where:

S = Ruling span

hc = Height of conductor at the support

D = Ruling span sag at 50°C final unloaded

For poles of various lengths in TH1D and TH1E structures

<u>Pole</u>	<u>Maximum Level Ground Span</u>
11 m	188 m
12 m	218 m
13.5 m	250 m
14 m	260 m
15 m	280 m

31

SPANS LIMITED BY STRUCTURE STRENGTH

A. Vertical Span

The crossarm used for TH1D and TH1E structures has section demensions of 12cm by 15cm.

The limiting vertical span is calculated according to the equation:

$$V = \frac{M - 4AL}{4WL}$$

Where:

M = Resistive moment of the crossarm

$$= \frac{b(d^3 - a^3)f}{600d}$$

b = 12 cm

d = 15 cm

a = 2 cm (diameter of bolt hole)

f = 550 KG/cm² - fiber strength

A = Weight of insulator and hardware

= 16 Kg

W = Unit weight of conductor

= .433 Kg/m

L = Moment arm of crossarm
= 95 cm for TH1D
= 120 cm for TH1E

Limiting vertical spans are:

TH1D - 1464 m

TH1E - 1151 m

B. Horizontal Spans

The insulator-pin assembly has lateral strength of 1363Kg (3,000 lbs.). The following equation, which includes a safety factor of 2 applies.

$$H = \frac{1363 - 4T \sin(\emptyset/2)}{88D}$$

Where:

D = Diameter of conductor = .01431 m

T = Loaded tension

= 1542 Kg.

\emptyset = Horizontal line angle, degrees

H = Maximum horizontal span

The following table is prepared:

<u>Angle</u>	<u>Limit Span</u>	<u>Two Insulators</u>
	One Insulator	
0°	1082 m.	2165 m
10°	655 m.	1738 m.
20°	232 m.	1314 m.
30°	-	897 m.
35°	-	692 m.

Structures with one insulator per phase should be used for angles from 0 to 10° and structures with two insulators per phase should be used for angles from 10° to 35°. For line angles greater than 35°, deadend structures should be utilized.

The equation for maximum horizontal span for structures without X bracing is:

$$H = \frac{M - 4(44) (h)^2 (2d-a)}{6}$$
$$2PL$$

Where:

M = Resistive moment of pole - *Kg m*

h = Height of the crossarm, m.

d = Diameter of the pole top, m.

a = Diameter of pole at groundline, m.

P = Unit load of conductors, Kg/m

L = Effective moment arm, m.

$$P = 44 (3D_1 + D_2)$$

D₁ = Diameter of phase conductor, m.

D₂ = Diameter of neutral conductor, m.

$$L = \frac{44(3D_1 h + D_2(h - 1.0))}{P}$$

35

$$M = \frac{f \pi d_A^3}{3\lambda}$$

d_A = diameter of pole at groundline - m

f = fiber strength of wood (550 Kg/cm² for pine or
800 Kg/cm² for eucaliptus)

The question of what poles will be used on the project, and therefore what span limits will apply is complex. ANSI standards for pole dimensions and fiber stress apply only to the pole types commonly used in the USA, mainly pine and fir. Eucaliptus, frequently used for distribution poles in Bolivia, is not covered at all. Other national standards which do cover Eucaliptus are not compatible with ANSI. Thus, for purposes of illustration, the following calculations will be based on ANSI standards for Class 4 Southern Pine poles. The calculations should be redone if it is decided to use Eucaliptus poles.

Pole dimensions for Class 4 Southern Pine Poles are:

	11 m.	12 m.	13 m.	15 m.
Diameter-poletop	1.9cm.	16.9cm.	16.9cm.	16.9cm.
Diameter at 1.8m				
from Butt	25.8cm.	26.9cm.	28.3cm.	29.6cm.
Groundline location	1.8m.	1.85m.	1.95m.	2.1m.
Groundline diameter	25.8cm.	26.9cm.	28.1cm.	29.3cm.

Fiber strength is assumed similar to that of pine, that is 550 Kg/cm². Eucaliptus fiber strength is 800Kg/cm², but pole dimensions are usually reduced to compensate. Thus limits should be similar.

Limit spans are:

Pole	11m.	12m.	13,5m.	15m.
Span .	183m.	183m.	183m.	183m.

These spans are not adequate for the project.

The addition of X-bracing will increase horizontal span limits. The equations governing the application of X-bracing are detailed as follows:

The equations for determining spans for different types of wood H-frame structures are given on Pages XIII-22 to XIII-25. All units should be consistent. The following abbreviations apply:

- F = wind pressure on a cylindrical surface, Pa (psf).
- F_s = presumptive skin friction value, Pa (psf).
- HS = horizontal span, m (ft.).
- M_a = moment capacity of crossarm.
- M_N = moment capacity at the indicated location, N-m (ft-lb.), includes moment reduction due to bolt hole, i.e., $M_N = M_{cap} - M_{bh}$.
- OCF = overload capacity factor.
- R_N = reaction at the indicated location, N (lbs.).
- V_N = induced axial force at the indicated location, N (lbs.).
- W_c = weight of conductors (plus ice, if any), N (lbs.).
- W_g = weight of OHGW (plus ice, if any), N (lbs.).
- W_p = weight of pole, N (lbs.).
- W_t = total weight equal to weight of conductors (plus ice, if any) - W_c, plus weight of insulators - W_i.
- VS = vertical span, m (ft.).
- d_t = diameter of pole at top, m (ft.).
- d_{bt} = diameter of pole at butt, m (ft.).
- d_{avg} = average diameter of pole between groundline and butt, m (ft.).
- d_n = diameter at location "n", m (ft.).
- f_s = calculated skin friction value, Pa (psf).
- h_n = length as indicated, m (ft.).
- P_t = total horizontal force per unit length due to wind on the conductors and overhead ground wire, N/m (lbs/ft.).
- s = distance as shown, m (ft.).
- U = dummy variable.
- V = dummy variable.
- w_c = weight per unit length of the conductors (plus ice, if any), N/m (lbs/ft.).
- w_g = weight per unit length of overhead ground wire (plus ice, if any), N/m (lbs/ft.).

D_e = embedment depth



OCF 4 in width
2 in depth

imposed

STRUCTURE 2
(Figure XIII-18)

$$HS_B = \left[M_B - \frac{(OCF)(F)(y_1)^2(2d_t + d_b)}{6} \right] / (OCF)(p_g)(y_1) \quad \text{Eq. XIII-14a}$$

$$HS_E = \left[M_E - \frac{(OCF)(F)(y)^2(2d_t + d_e)}{6} \right] / \frac{(OCF)(p_t)(y_o)}{2} \quad \text{Eq. XIII-14b}$$

$$HS_D = \left[M_D - \frac{(OCF)(F)(h-x_o)(x_1)(d_t + d_c)}{2} \right] / \frac{(OCF)(p_t)(x_1)}{2} \quad \text{Eq. XIII-14c}$$

$$HS_A = \left[M_A - \frac{(OCF)(F)(h-x_o)(x_o)(d_t + d_c)}{2} \right] / \frac{(OCF)(p_t)(x_o)}{2} \quad \text{Eq. XIII-14d}$$

For crossbrace:

$$HS_X = \left[125,800(b) - 2(OCF)(F)(h-x_o)^2(2d_t + d_c)/6 \right] / (OCF)(p_t)(h_2) \quad \text{(Metric) Eq. XIII-14e}$$

$$HS_X = \left[28,300(b) - 2(OCF)(F)(h-x_o)^2(2d_t + d_c)/6 \right] / (OCF)(p_t)(h_2) \quad \text{(English) Eq. XIII-14f}$$

For uplift:

$$HS(p_t)(h_2) - VS(w_g)(b) - 1.5VS(w_c)(b) = W_1(b) + W_p(b) + X - Y \quad \text{Eq. XIII-14g}$$

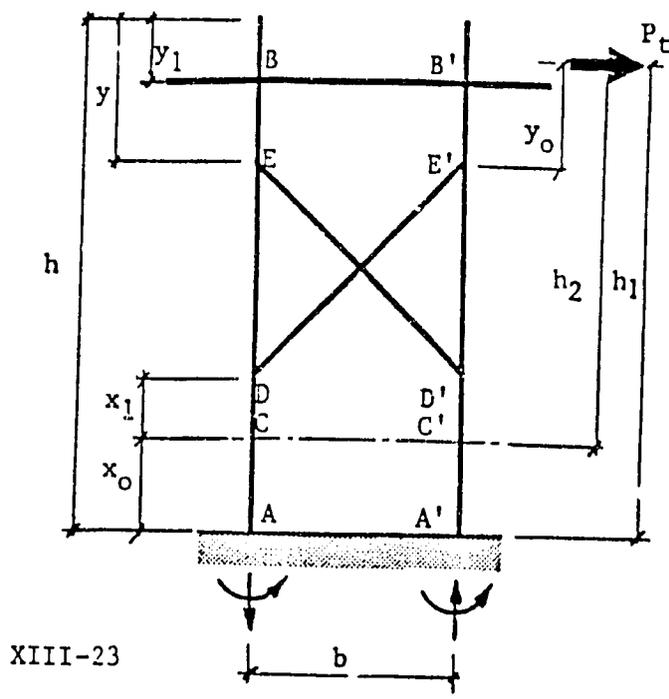
For bearing:

$$HS(p_t)(h_2) + VS(w_g)(b) + 1.5VS(w_c)(b) = W_2(b) - W_p(b) + X - Y \quad \text{Eq. XIII-14h}$$

where:

- $W_1 = F_s(D)(d_{avg})\pi/OCF$
- $W_2 = (\pi d_{bt}^2/4)(Q_u)/OCF$
- $X = (F)(h-x_o)(d_t + d_c)(x_o)$
- $Y = 2(F)(h)^2(2d_t + d_a)/6$

FIGURE XIII-18



XIII-23

The compression limit of the X-bracing is given by:

$$P_{cr} = \frac{\pi^2 EI}{l^2}$$

Where:

E = Modulus of Elasticity

I = Minimum moment of inertia of the section

$$= \frac{bd^3}{12} = 2160 \text{ cm}^4$$

l = Free length

= 370 cm. for TH1D

= 470 cm. for TH1E

b = 15 cm

d = 12 cm

$P_{cr} = 19,777 \text{ Kg}$ for TH1D

$P_{cr} = 12,256 \text{ Kg}$ for TH1E

The table of values is:

Structure - TH1D

Class 4 poles

Poletop diameter: 16,9 cm.

$$Y = 2,0 \text{ m.}$$

$$P_t = 2,3338 \text{ Kg/m.}$$

Pole	Burial Depth	$d_A - \text{CM}$	$d_e - \text{CM}$	$d_d - \text{CM}$	$d_c - \text{CM}$	$Y_0 - \text{M}$	$X_0 - \text{M}$	$X_1 - \text{M}$
11m.	1.8m.	25.82	18.82	21.9	24.09	1.56	2.22m.	1.78m.
12m.	1.85m.	26.88	18.82	21.9	24.11	1.56	2.82	2.13m.
13.5m.	1.95m.	28.12	18.82	21.9	24.55	1.56	3.68	2.67m.
15m.	2.1m.	29.31	18.82	21.9	24.9	1.56	4.58	3.12m.

Structure - TH1E

Class 4 poles

Poletop diameter: 16.9 cm.

$$Y = 2.0 \text{ m.}$$

$$P_t = 2.3338 \text{ Kg/m.}$$

Pole	Burial Depth	$d_A - \text{CM}$	$d_E - \text{CM}$	$d_D - \text{CM}$	$d_c - \text{CM}$	$Y_0 - \text{M}$	$X_0 - \text{M}$	$X_1 - \text{M}$
11m	1.8m.	25.82	18.82	22.7	24.12	1.56	1.74m.	1.46m.
12m.	1.85	26.88	18.82	22.7	24.6	1.56	2.3m.	1.85m.
13,5m.	1.95m.	28.12	18.82	22.7	25.04	1.56	3.16m.	2.39m.
15m.	2.1 m.	29.31	18.82	22.7	25.41	1.56	4.04m.	2.86m.

41

Limiting spans for X-braced structures with Class 4 poles are:

TH1E Structure

Span limited by bending strength at point:

Pole	A	D	E	X-brace
11 m.	1087	869	<u>486</u>	840
12 m.	915	670	<u>486</u>	789
13.5m.	747	500	<u>486</u>	727
15 m.	650	<u>403</u>	486	679

TH1D Structure

Span Limited by bending strength at point:

Pole	A	D	E	X
11m.	843m.	632	<u>483 m.</u>	1177
12m.	740m.	514	<u>486 m.</u>	1112
13,5 m.	638m.	<u>394</u>	486 m.	1022
15m.	570m.	<u>324</u>	486 m.	957

C. Base Pole Selection

The selection of a base pole is a complex process involving consideration of the limit values calculated previously, as well as the availability and relative cost of poles of various lengths. The nature of the terrain to be crossed is an important factor also. Experience has indicated some approximate ratios to aid in this process.

In terrain as rough as that crossed by this line, ruling span can be substantially longer than maximum level ground span for the base structure. A suggested value for ruling span is 120% of level ground span. By the same token, the structure limit for the base structure should be 30% to 50% greater than ruling span. It is also necessary for the vertical span limit to be twice the horizontal span limit. The phase to phase clearance limit should not be less than 150% of the ruling span. Observance of these ratios will result in maximum useage of the base structure, which minimizes special structure designs.

The THID 11 or 12 meter poles have structural strength well in excess of their ruling span capability or phase to phase clearance limits. This implies that they do not use the material efficiently, resulting in higher costs. The THID with 15 meter poles, on the other hand cannot achieve its ruling span capability due to limited structural strength. This structure would require sideguys on a significant number of structures, again resulting in high cost. The THID with 13.5 meter poles is nearly optimum based on these criteria and would be a good choice as base structure.

THID Structure

Ø-Ø Clearance Limit - 470 meters

Pin limit, 0° Line Angle - 1082 meters

Vertical Span Limit - 1464 meters (1)

Pole	Level	(2)	(3)	Ratio <u>(1)</u>	Ratio <u>(3)</u>
	Ground Span	Allowable	Structure	(3)	(2)
	Meters	Ruling Span	Limit Meters		
		Meters			
11/4	188	225	483	3.0	2.15
12/4	218	262	486	3.0	1.86
13.5/4	250	300	394	3.7	1.3
15/4	280	336	324	4.5	.96

THIE Structure

Ø-Ø Clearance Limit - 614 meters

Pin limit 0° Line Angle - 1082 meters

Vertical Span Limit - 1151 (1)

Pole	Level	(2)	(3)	Ratio <u>(1)</u>	Ratio <u>(3)</u>
	Ground Span	Allowable	Structure	(3)	(2)
	Meters	Ruling Span	Limit Meters		
		Meters			
11/4	188	225	486	2.37	2.16
12/4	218	262	486	2.37	1.86
13.5/4	250	300	486	2.37	1.62
15/4	280	336	403	2.86	1.20

44

D. Span Limits for Deadend Structures

The forces applied to the deadend structures are a combination of horizontal loads (due to tension of conductor and wind loading) and vertical loads (due to weight span of conductors or uplift). Transverse loads due to wind are absorbed in the same fashion as for tangent structures, that is in the X-bracing or side guying. The tension and weight loads are absorbed by the crossarms. The equation for the combined loads is:

$$f = K_1 \left(\frac{TL}{S_1} \right) + K_2 \left(\frac{V WcL}{S_2} \right)$$

Where:

T = Loaded conductor tension

L = Moment arm

S_1 = Section modulus of both crossarms about the vertical axis

K_1 = Longitudinal overload factor

= 2.0

K_2 = Vertical overload factor

= 4.0

V = Weight span

Wc = Unit weight of conductor

S_2 = Section modulus of both crossarms about the horizontal axis

f = Fiber strength

= 550 Kg/cm² or 800 Kg/cm² for eucaliptus

For the crossarm at a deadend:

T = 1542 Kg

L = 90 cm.

$$S_1 = 2 \left(\frac{(d-a)(b)^2}{6} \right)$$

Where:

d = 15 cm.

a = 2 cm. (bolt hole diameter)

b = 12 cm.

$S_1 = 624 \text{ cm}^3$

Wc = .433 Kg/m.

$$S_2 = 2 \left(\frac{b(d^3 - a^3)}{6d} \right)$$
$$= 898 \text{ cm}^3$$

Solving:

$$V = 605 \text{ m.}$$

Clearly, this limit applies only to the single-deadend condition, that is when the structure terminates the line. For double deadend structures, each adjacent span should be analyzed separately. Since the deadend structures have no X-bracing, horizontal span limits are controlled by guying design.

GUYED STRUCTURE DESIGN

Guys are applied at line angles, deadends and long spans (sideguys).

In all cases, the governing equation is:

$$G \cos \phi = 4(a + b) + 2c$$

Where:

a = Transverse wind load on all conductors

b = Transverse wind load on pole

c = Effective component of line tension

G = Guy tension

ϕ = Depression angle from horizontal to guy

A. Sideguys

Sideguys are used to increase horizontal span limit. Guys will be 1 strand of 5/16" EHS, breaking strength 5,090 Kg. Anchors will be log deadmen with nominal pullout resistance of 7,270 Kg.

For 13.5m poles

$$a = 2,3338 \text{ (H)}$$

$$b = \frac{(2d_t + d_a) 44 (10.15)^2}{3X}$$

$$c = 0 \text{ (Angle } 0^\circ)$$

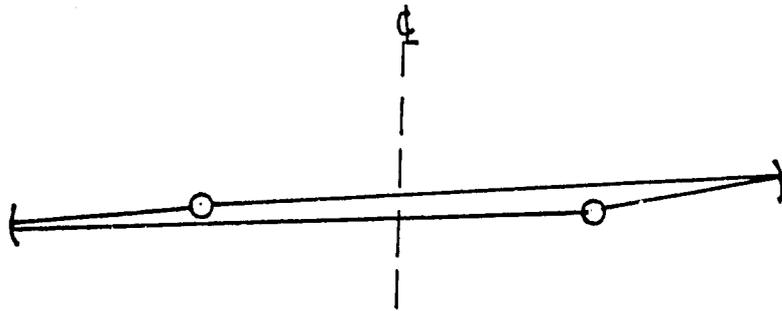
$$\varnothing = 45^\circ \text{ (Assumed)}$$

$$G = 7,270 \text{ Kg (Anchor limit)}$$

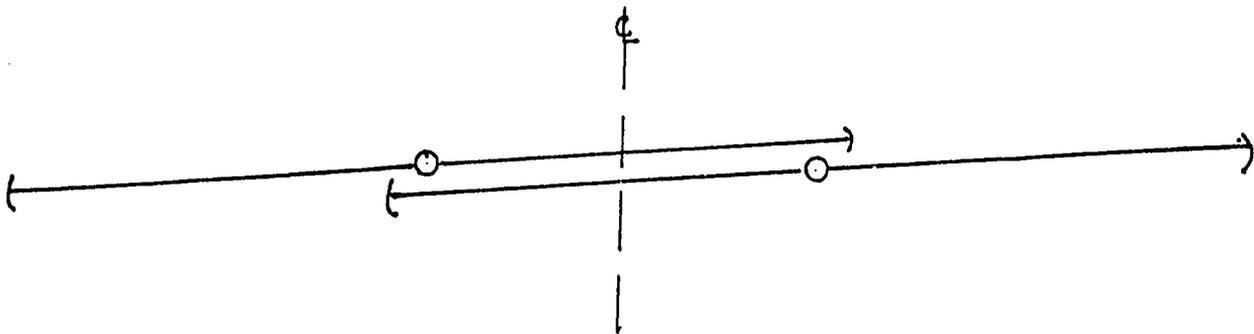
X = Height of guy on pole

H = 509 m. = Horizontal span limited by sideguys

Guying guide:



For longer spans, anchors may be separated



$$G = 10,180 \text{ Kg}$$

$$H = 729 \text{ m.}$$

B. Guyed Angles

For a 10° Line Angle

$$c = 6 T_1 \sin (\phi/2) + 2 T_2 \sin (\phi/2)$$

$$T_1 = 1542 \text{ Kg (Phase conductors)}$$

$$T_2 = 893 \text{ Kg (Neutral)}$$

$$\phi = 10^\circ$$

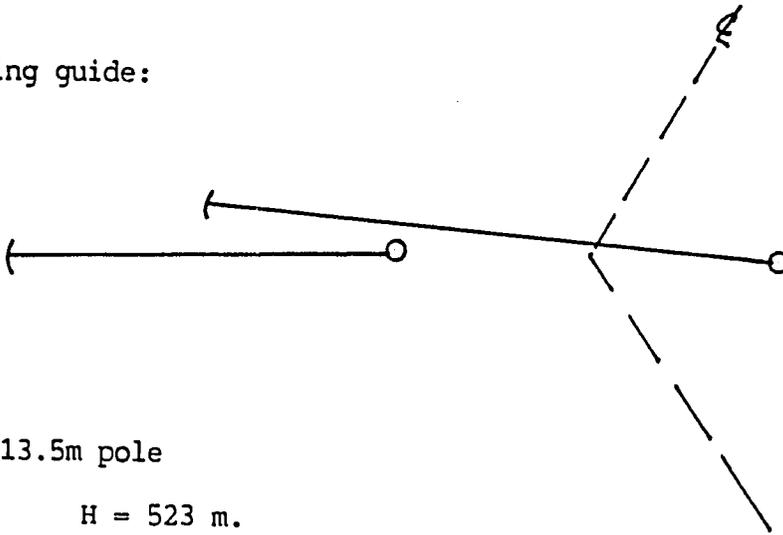
b = See previous section

$$a = 2,3338 \text{ H}$$

$$\phi = 45^\circ - \text{assumed}$$

$$G = 10180 \text{ Kg}$$

Guying guide:

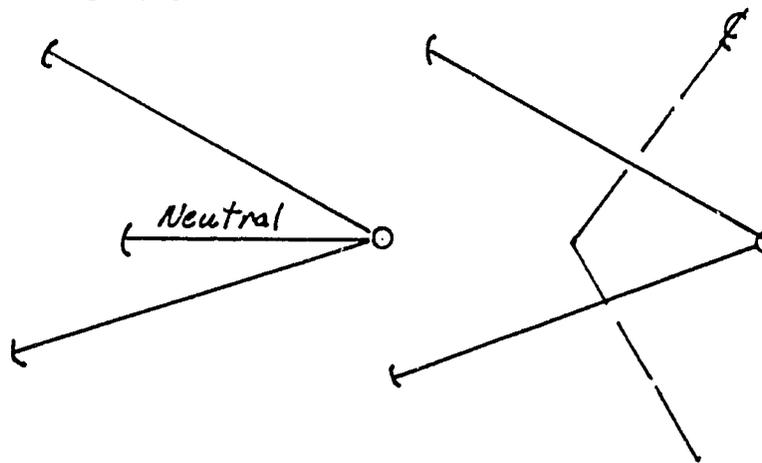


For 13.5m pole

$$H = 523 \text{ m.}$$

For a 20° Line Angle

Guying guide:



$$H = 1090 \text{ m.}$$

For a 30° line angle

$$H = 884 \text{ m.}$$

For a 40° line angle (neutral guy added)

$$H = 1016 \text{ m.}$$

For a 60° line angle

$$H = 629 \text{ m.}$$

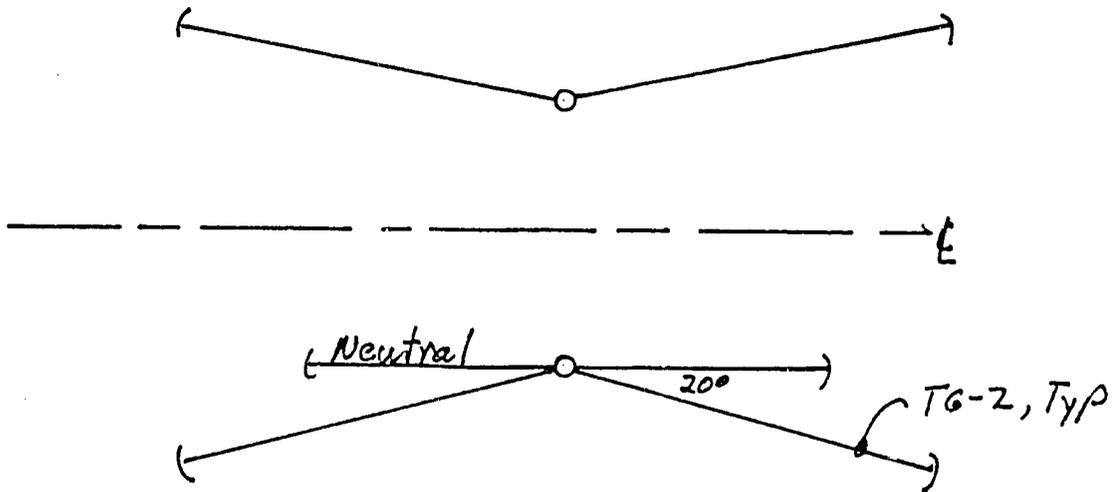
For a 60° line angle and TG-2 guys (two strands of 5/16" EHS in each guy) on phase and neutral:

$$G = 29,080 \text{ Kg (limited by anchors)}$$

$$H = 1445 \text{ m.}$$

C. Head and back guys

Guying Guide



All wires intact (transverse loadings)

$$G = 14,540 \text{ (limited by anchor)}$$

$$\varnothing = 45^\circ$$

$$c = 0 \text{ (No line angle)}$$

$$b = 97 \text{ Kg (13,5 m pole)}$$

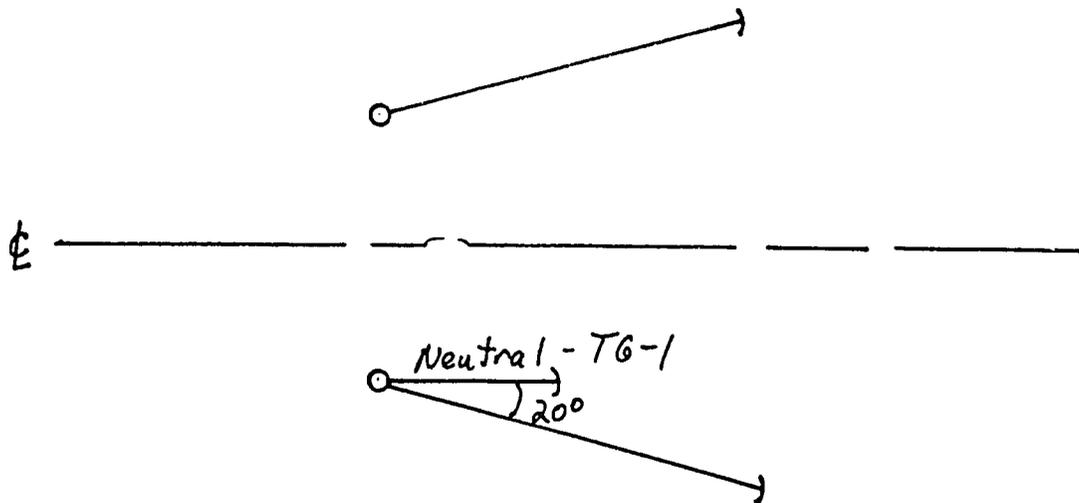
$$a = 2,3338 \text{ H}$$

$$G \cos \varnothing \sin 20^\circ = 4 (a + b)$$

$$H = 335 \text{ m.}$$

This means that sideguys will be required for spans above 335 m.

For single deadend conditions:



$$a = 3 (1542)$$

$$= 4626 \text{ Kg}$$

$$(G \cos \phi) \cos 20^\circ = 2a$$

$$G = 13,926 < 14,540 \text{ Kg.}$$

This guide is adequate for deadending.

It is necessary to examine the stability of poles in guyed structures, since they act as slender columns. The equation is:

$$P_{cr} = \frac{2\pi^2 EI}{l^2}$$

This is the equation for fixed/pinned end conditions.

The elements are:

E = Modulus of elasticity

$$= 127,000 \text{ Kg/cm}^2 \text{ (for pine)}$$

I = Moment at inertia at one-third of free length

l = Free length that is the length from guy attachment to ground line

For 15 m poles without neutral

$$l = 12.4 \text{ m.}$$

$$I = \frac{d^4}{64} = 9437 \text{ cm}^4$$

$$P_{cr} = 15,386 \text{ Kg.}$$

For 15 m poles with neutral

$$l = 11,5 \text{ m.}$$

$$I = 11,250 \text{ cm}^4$$

$$P_{cr} = 21,324 \text{ Kg.}$$

Vertical loads are applied by the guys. The same overload factors as for guy strength will be used. This should ensure that the pole will not fail before the guys.

Vertical load may be calculated as follows:

$$F = (G) \sin \theta + 2V(3/2 W_c + W_n) + W_s$$

Where:

G = Sum of maximum guy tensions applied to pole

V = Weight span

W_c = Unit weight of conductor

W_n = Unit weight of neutral (only applied to one pole)

W_s = Structure weight excluding poles

$$= 3(16) + 100 \text{ (estimated)}$$

$$= 148 \text{ Kg.}$$

For a structure with a 60° line angle, 1000 m vertical span, 15 m poles, and TG-2 guys (this is an extreme condition).

Pole without neutral

$$G = 14,540 \text{ Kg.}$$

$$F = 11.728 \text{ Kg.} < 15,386 \text{ Kg.}$$

Pole with neutral

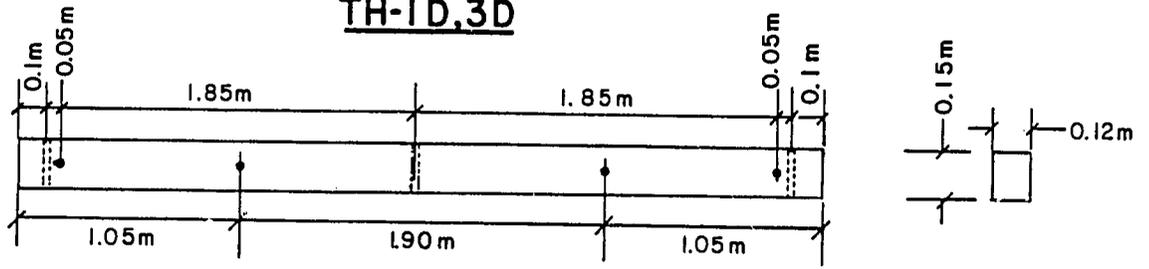
$$G = 19,630$$

$$F = 15,759 \text{ Kg.} < 21,324 \text{ Kg.}$$

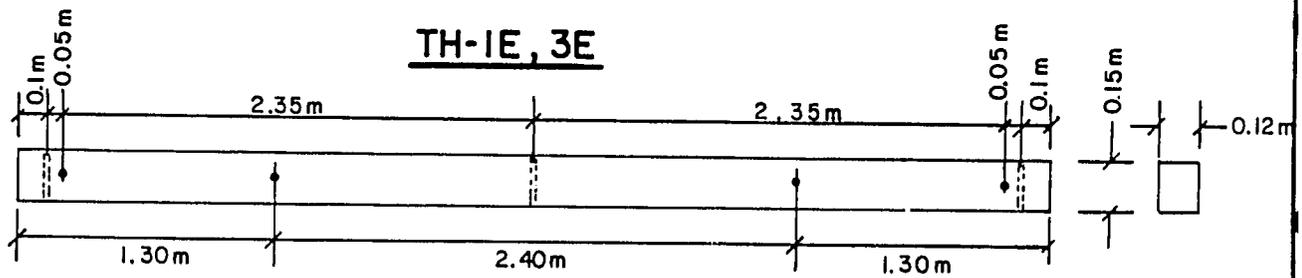
The structures are stable.

This may be repeated for single deadend structures and it will be found that the structure is also stable for those conditions.

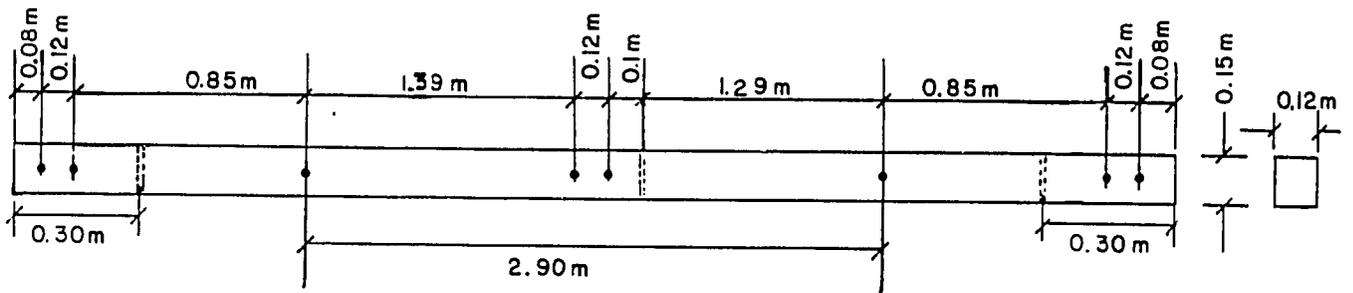
TH-1D,3D



TH-1E,3E



TH-2E



NOTE: ALL HOLES 13/16"

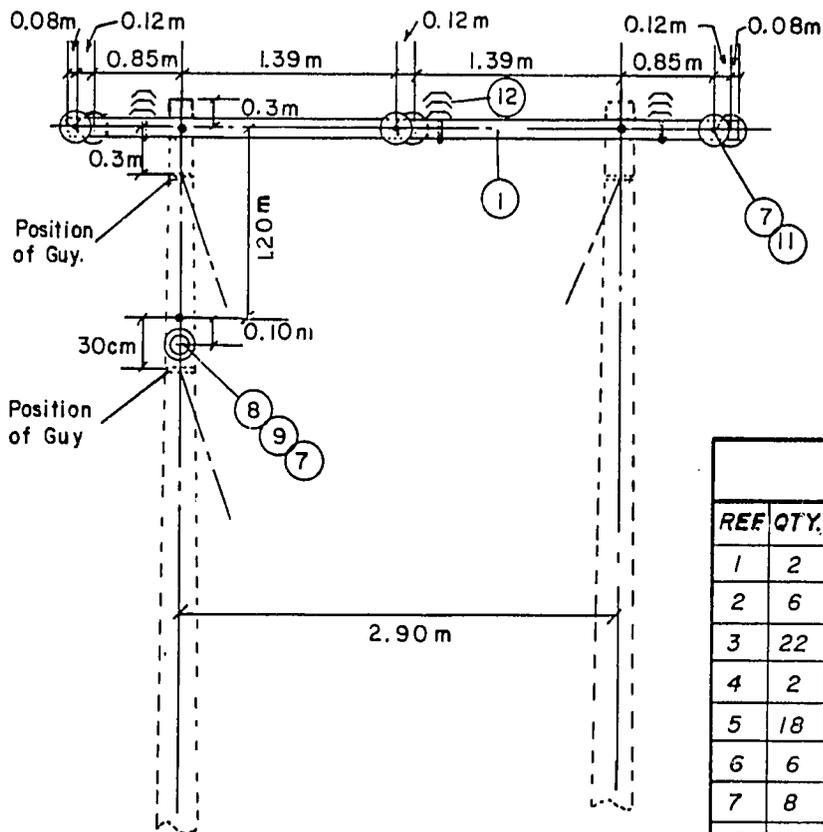
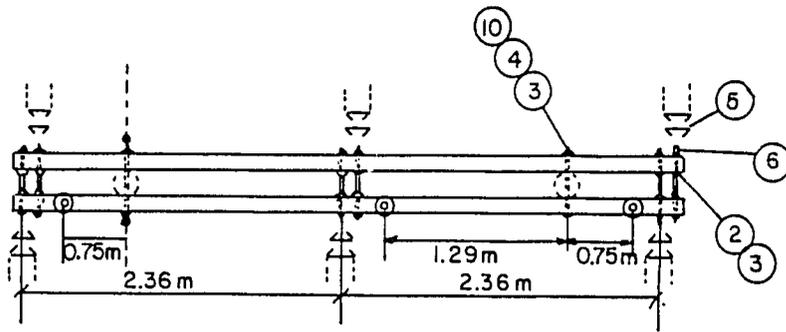
ENDE

**TRANSMISSION CROSSARM
DRILLING GUIDE**

DESIGNED: J.V.C.

No Scale

5-86



LIST OF MATERIAL

REF	QTY.	DESCRIPTION
1	2	Crossarm 12cm X 15cm X 5m
2	6	3/4" X Required Length D.A. Eye Bolt
3	22	2" X 2" X 1/4" Sq. Washer , 13/16 hole
4	2	3/4" X Required Length D.A. Bolt
5	18	5- 3/4" X 10" 20,000 lb. ANSI 52-3
6	6	Clevis - Ball 20,000lb.
7	8	Conductor D/E Preformed
8	2	3/4" X Required Length Thimble Eye Bolt
9	2	4" X 4" X 1/4" Sq. Curved Washer
10	27	Locknuts For 3/4" Bolt
11	6	Thimble For Conductor D/E
12	3	ANSI 56-4 Insulator and Pin

ENDE

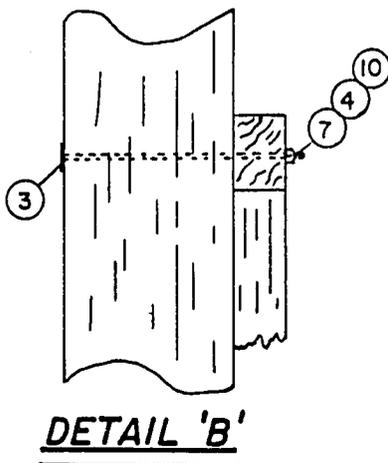
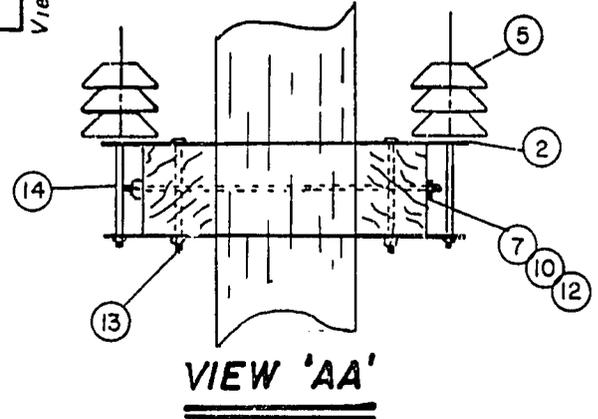
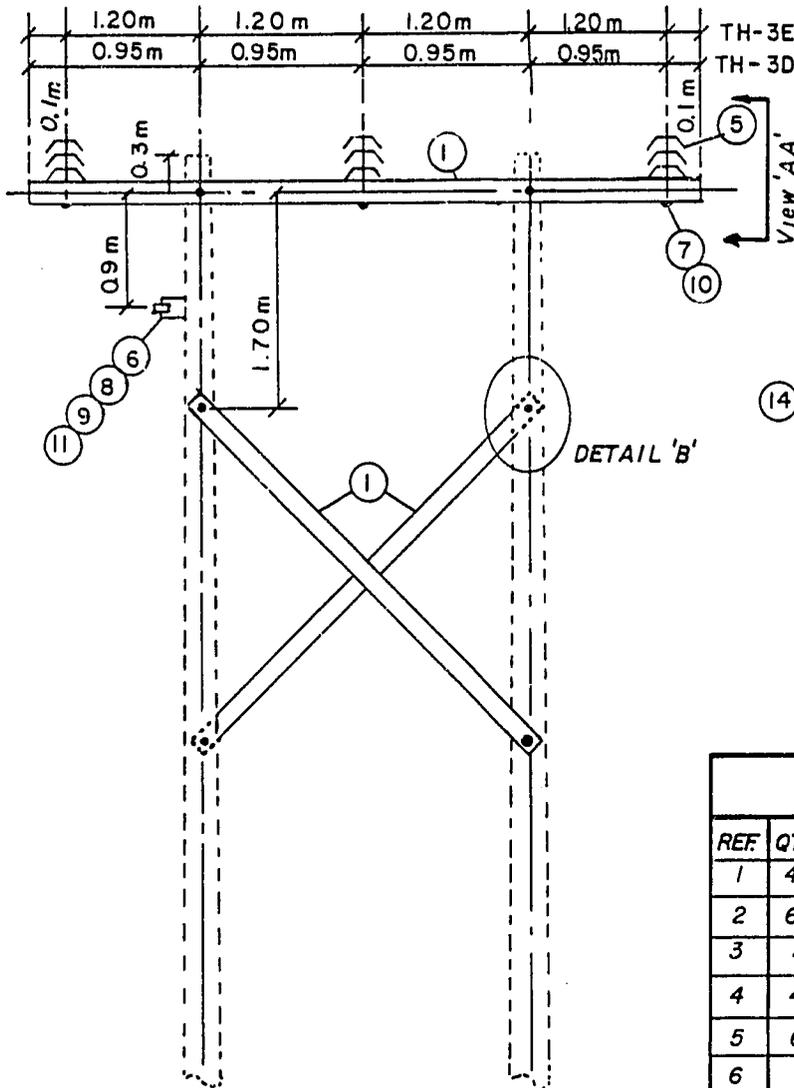
TRANSMISSION STRUCTURE

TH-2E Double Deadend

DESIGNED: JVC.

No Scale

5-86



LIST OF MATERIAL

REF.	QTY.	DESCRIPTION
1	4	Crossarm 12cm X 15cm X 4m TH-3D (Only)
2	6	Double Arming Plate 3" X 3/8" X 24" Galv. Steel
3	4	4" X 4" X 1/4" Sq. Curved Washer 13/16" hole
4	4	3/4" X Required Length Machine Bolt
5	6	ANSI 56-4 Insulator and Pin
6	1	Spool Insulator ANSI 53-2 and Bracket
7	8	2" X 2" X 1/4" Sq. Washer 13/16" hole
8	1	5/8" X Required Length Machine Bolt
9	1	2" X 2" X 3/16" Sq. Curved Washer 11/16" hole
10	14	Locknuts for 3/4" Bolt
11	1	Locknuts for 5/8" Bolt
12	2	3/4" X Required Length D.A. Bolt
13	6	3/4" X 8" Machine Bolt
14	6	6" Pipe Spacer
1	4	Crossarm 12cm X 15cm X 5m TH-3E (Only)

E N D E

TRANSMISSION STRUCTURE

TH-3D — Line Angle 10°-35°
 TH-3E — Line Angle 10°-35°

DESIGNED: J.V.C.

No Scale

5-86

FEASIBILITY STUDY

CHIMORE SUBSTATION

I. GENERAL

In 1981 feasibility studies were prepared covering various power supply alternatives for the Chapare Region which consists of the area around a line drawn from the village of Villa Tunari through Chimore to Puerto Villarroel. This report established the feasibility of power supply by means of a tap substation of the 220kV Central East Interconnection line. The Interconnection was to be in service in 1984. Due to financing problems, the Central East Interconnection was delayed for an undetermined period and it was necessary to study power supply alternatives for the Chapare Project. As a result of these investigations, the construction of a 9 kilometer 115kV line from the hydroelectric plant at Santa Isabel to the site of the future San Jose substation was proposed. This line will become part of the Central East Interconnection when that project is constructed. At the San Jose substation it was planned to install a 115/34.5kV transformer which would then feed approximately 40 kilometers of 34.5kV subtransmission line, terminating in the community of Padresama. In Padresama the subtransmission would be converted to distribution lines for delivery of energy to users through secondary voltage distribution systems in the population centers. The terrain along the proposed route of the San Jose Padresama line is extremely broken and practically unpopulated. It is not

anticipated that there would be any significant number of customers in this area.

Financing has recently been found for the Central East Interconnection project and it appears that this project will be constructed in the near future. This has reopened the possibility of utilizing a 220/34.5kV tap to serve the Chapare Rural Electrification Project, eliminating the San Jose Padresama subtransmission line.

II. POWER SUPPLY ALTERNATIVES

For the purposes of this report, two power supply alternatives are studied as follows:

A. Alternate I

A 115/34.5kV substation is constructed in San Jose feeding 40 kilometers of 34.5kV subtransmission line from San Jose to Padresama. This is the currently proposed alternative.

B. Alternate II

A 220/34.5kV tap substation is established in Chimore. Since Chimore is included in the first phase of the Chapare electrification project, no additional distribution line construction will be necessary.

Both alternatives include, with the same scope, the Chapare Rural Electrification Project, first phase.

III. SYSTEM CAPACITY

A. Voltage Drop

Voltage drop studies prepared for both alternatives, utilizing the procedure of REA Bulletin 45-1, give the following results:

Alternate I

In the fifth year of phase one (total load 2,700KW), voltage drops will be on the order of 7.7% at the primary voltage level. The voltage drop from San Jose to Padresama is 5.8%, almost 75% of the total voltage drop. This implies that the execution of the second phase (extension of line to Puerto Villarroel) will only be feasible utilizing multiple banks of voltage regulators. It also implies that a significant investment in additional subtransmission lines will be inevitable as load increases.

Alternate II

In the fifth year of the first phase, voltage drops will be less than 5% in the extreme points of the high voltage system. Due to the location of Chimore Substation at the east end of the phase one project, execution of the second phase will not result in any increases in voltage drop. That is, voltage drops will be on the order of 5% at both ends of the system. This implies that it should

Alternativa F

U. S. DEPARTMENT OF AGRICULTURE
RURAL ELECTRIFICATION ADMINISTRATION

VOLTAGE DROP SHEET

SYSTEM DESIGNATION
CHAPARR
SYSTEM ENGINEER
J. VAN CONVERTING

SUBSTATION
SAN JOSE
CIRCUITS

SYSTEM DESIGN
DATE
15/05/86

SECTION		LOAD										LINE					VOLTAGE DROP			
SOURCE END	LOAD END	CONSUMERS					CONCENTRATED			TOTAL kW	POWER FACTOR	CONDUCTOR SIZE ALUMINUM	φ	kV	VOLTAGE DROP FACTOR	LENGTH OF SECTION IN km	kW-km	VOLTAGE DROP		
		WITHIN THIS SECTION	BEYOND THIS SECTION	EQUIV. THIS SECTION	kWh PER MONTH	PEAK kW	WITHIN THIS SECTION	BEYOND THIS SECTION	EQUIV. THIS SECTION									THIS SECTION	TOTAL	AT POINT
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
10	11	-	507	507	62	117	-	-	-	117	.85	# 4	3	19.9	.139	11	1287	.1780	7.0	11
7	10	332	579	745	62	169	-	45	45	214	.85	# 4	3	19.9	.139	12.4	2654	.369	6.9	10
8	9	72	72	102	62	29	-	-	-	29	.95	4	1	19.9	.508	4.5	130.5	.0662	7.26	9
7	8	108	240	294	62	71	27	187	201	272	.85	# 4	3	19.9	.139	18.5	5032	.6991	7.2	8
1	7	-	1331	1331	62	300	-	390	390	690	.85	1/0	3	19.9	.067	6.5	4485	.300	6.5	7
5	6	-	107	107	62	29	-	92	92	121	.85	# 4	3	19.9	.139	5.2	629	.087	7.7	6
2	5	276	407	545	62	125	157	456	535	660	.85	1/0	3	19.9	.067	23.2	15.378	1.03	7.5	5
3	4	-	38	38	62	11	-	-	-	11	.85	4	1	19.9	.508	5	55	.028	6.66	4
2	3	-	168	168	62	42	-	37	37	79	.85	4	3	19.9	.139	1.3	102.7	.014	6.6	3
1	2	24	851	863	62	196	393	650	947	1043	.85	1/0	3	19.9	.067	6	2258	.419	6.6	2
0	1	-	2206	2206	62	496	-	1457	1457	1953	.85	1/0	3	19.9	.067	3.0	5859	.392	6.2	1
0/1	0	-	2576	2576	62	580	-	2140	2140	2720	.85	4/0	3	19.9	.04267	50	136.000	0	5.8	0

Alternativa II

U. S. DEPARTMENT OF AGRICULTURE
RURAL ELECTRIFICATION ADMINISTRATION

VOLTAGE DROP SHEET

SYSTEM DESIGNATION

CHADANI
SYSTEM ENGINEER

T. VAN COVERTING

SUBSTATION

CHIHORI
CIRCUITS

SYSTEM DESIGN

DATE

15/05/96

SECTION		LOAD										LINE					VOLTAGE DROP			
SOURCE END	LOAD END	CONSUMERS					CONCENTRATED					CONDUCTOR SIZE ALUMINUM	φ	KV	VOLTAGE DROP FACTOR	LENGTH OF SECTION IN km	LW-km	VOLTAGE DROP		
		WITHIN THIS SECTION	BEYOND THIS SECTION	EQUIV. THIS SECTION	kWh PER MONTH	PEAK kW	WITHIN THIS SECTION	BEYOND THIS SECTION	EQUIV. THIS SECTION	TOTAL kW	POWER FACTOR							THIS SECTION	TOTAL	AT POINT
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	0	-	370	370	62	88	-	683	683	771	.85	1/0	3	19.9	.067	3.0	2049	.137	4.39	1
3	9	72	72	103	62	29	-	-	-	29	.85	#4	1	19.9	.508	4.5	130.5	.0663	5.3	2
7	8	100	240	294	62	71	27	187	201	272	.85	#4	3	19.9	.139	12.5	5032	.629	5.26	5
10	11	-	507	507	62	117	-	-	-	117	.85	#4	3	19.9	.139	11	1287	.1789	5.1	11
7	10	332	579	745	62	169	0	45	45	214	.85	#4	3	19.9	.139	12.4	2654	.369	4.93	16
1	7	-	1331	1331	62	300	-	390	390	690	.85	#1/0	3	19.9	.067	6.5	4485	.300	4.56	7
2	1	24	1701	1713	62	391	393	1097	1294	1685	.85	#1/0	3	19.9	.067	6.0	10110	.677	4.26	1
3	4	-	38	38	62	11	-	-	-	11	.85	#4	1	19.9	.508	5	55	.028	3.63	4
2	3	-	168	168	62	42	-	37	37	79	.85	#4	3	19.9	.139	1.3	102.7	.014	3.59	3
5	2	276	1893	2031	62	464	157	527	1605	2069	.85	1/0	3	19.9	.067	23.3	12207	3.22	3.59	2
S/O	5	-	2576	2576	62	588	-	2140	2140	2729	.85	1/0	3	19.9	.067	2	5456	.365	3.65	5

63

be possible to construct the third phase of rural electrification without additional subtransmission lines.

Alternate II, therefore, offers important benefits when considering voltage regulation in the near term and the minimization of future investments in the long term.

B. Short Circuit Currents

Even though it is true that voltage drop problems can be partially solved with regulator banks or installation of shunt capacitors, a true limit to service extension is defined by the limit on the reach of protective devices. These limits are controlled by the availability of short circuit current. The table below indicates the levels of short circuit current available at various locations. The short circuit currents indicated are for minimum power supply conditions but do not include arc resistance.

	ALT I			ALT II		
	30	0-0	10	30/	0-0	10
San Jose 34.5kV	527	453	632	-	-	-
Villa Tunari	342	298	299	376	323	329
Chimore	257	222	204	520	447	556
*Puerto Villarroel	184	158	137	309	266	253
**Puerto Ramos	142	122	103	208	178	157
*Second Phase						
**Third Phase						

The preceding table indicates that levels of available fault current for Alternative II are almost 50% higher than those for Alternate I. This indicates that Alternate II will have a delivery capacity much greater than that of Alternate I. It would be necessary to conduct a coordination study to determine the exact difference, but it should be more than double. This is due to the use of two circuits at 34.5kV in Alternate II (one towards Villa Tunari, and another towards Puerto Villarroel) while Alternate I is limited to a single circuit from San Jose.

IV. OPERATION AND MAINTENANCE CONSIDERATIONS

A. Alternate I

An integral part of Alternate I is the 40 kilometer line from San Jose to Padresama, which crosses heavily forested mountains, roughly following the route of the Central East Interconnection. The 220kV line of the Central East Interconnection has made use of very long spans (in some cases in excess of 1,000 meters) and tall towers to hop from ridge top to ridge top. It will not be possible to duplicate this method with the subtransmission line which will be constructed on distribution class wooden poles in order to reduce its cost. This implies a much greater number of structures for the subtransmission line than for the Central East Interconnection which will complicate all the traditional problems related to line access. It also exposes the subtransmission line in much more considerable fashion to the problem of earth slides in this geologically unstable area. The towers of the Central East Interconnection are in general

located on the crest of the ridges in specially selected sites. The staking engineers for the subtransmission line will not have this luxury and a relatively high incidence of outages due to earth movements is inevitable.

The problems presented by the terrain can be resolved but will certainly cause increased cost and possible problems with the planning of the construction.

Maintenance of the line which is charged to the distribution company ELFEC, will be extremely difficult. According to conversations with ELFEC personnel, this company depends on the residents of the area for right of way clearing. Such practice will be very difficult to maintain in this area since there are no inhabitants.

B. Alternate II

No problems with the construction of this alternate are anticipated. The substation can be located in an accessible area of relatively flat land without any problem. Maintenance of the substation could present some problem due to its location in a site remote from the remainder of ENDE's system, but the level of additional effort will be minimal compared with the requirement for maintenance of the San Jose Padresama line of Alternate I. Since the substation will not be attended, there exists the possibility of long outages until appropriate personnel can arrive but the incidence of this kind of fault should be minimal.

V. PROBLEMS RELATED TO THE OPERATION OF THE CENTRAL EAST INTERCONNECTION

Given the importance of the Central East Interconnection, it is necessary to insure that problems originating in the rural electrification system would have minimal effect on the Interconnection.

Alternate I

The power supply substation for Alternate I is located in San Jose, the 220/115kV tie substation for the Interconnection. The 115/34.5kV transformer will have its own protective scheme and fault interrupter. In this fashion its influence on normal operation of the Interconnection would be minimized. During periods of breaker maintenance or for breaker failure the Interconnection could be interrupted. Failure of the carrier relaying system could also interrupt the Interconnection. Particularly, a failure of the blocking terminal would permit the Santa Isabel breaker to open for faults in the 115/34.5kV substation. With a normal level of maintenance on this system, faults of this type should be few.

Alternate II

This alternative, included as it is within the zone of protection of the carrier relaying system of the Interconnection could at first glance cause problems. The impedance of the tap transformer (approximately 180% on a 100 MVA base) is so large in comparison with the line impedance (29%) that there should be no interference.

Another area of interest is the single pole reclosing system which will be applied for the first time in Bolivia on the Interconnection. This

system is based on the interruption of only the faulted phase (for line to ground faults) and has as its object maintaining synchronism between the central and east systems until the faulted phase can be reclosed. Its satisfactory operation demands special measures to cancel out the coupling between phases and thus permit the voltage on the tripped phase to decrease sufficiently to extinguish the arc. If a Delta Y transformer were used on the tap, it would tend to sustain the voltage on the faulted phase in such fashion that the single pole tripping scheme would not work. A star-star transformer without Delta tertiary would eliminate this problem and would maintain the independence of phases necessary for satisfactory operation of the single pole tripping system. It would also be possible, as a backup measure, to install a transfer trip terminal on the tap station such that the transformer interrupter would be opened for any fault on the 220kV line.

One consideration to keep in mind when specifying a star star transformer for the tap is the possibility of third harmonic voltages formed due to nonlinear exciting currents. In this case the zero sequence impedances of the Interconnection are so low due to the presence of the two auto-transformers at the terminals that all of the third harmonics generated by the tap transformer will flow as current in the 220kV line. The level of these currents should not be greater than 200 miliamps, a minimal level which should not cause any interference. The star star transformer connection would also eliminate any possible problems with ferroresonance during single pole trip operation.

The level of overvoltages generated by switching of the Interconnection is of interest for design of the tap transformer. According to a transient network analysis study prepared by Gilbert Commonwealth in 1980, overvoltages during energization of the line would not exceed 1.14p.u. on a continuous basis or 2.05pu on a momentary basis. The switching surge overvoltage of 2.05p.u. is well within the acceptable range for 220kV transformers, but the continuous level of 1.14p.u. exceeds levels permitted by standards. The recommended solution would be to specify a transformer with additional insulation such that it could withstand this level of overvoltage continuously. This would increase the tap transformer cost by approximately 5%.

If the recommended actions are taken, the Chimore substation will not have any more affect on the operation of the Central East Interconnection than the San Jose Substation. There is always the possibility that a fault in a lightning arrester or a failed breaker could cause an Interconnection outage, but this possibility is the same for the San Jose Substation as it is for the Chimore Substation.

VI. ECONOMIC ANALYSIS

In order for an economic analysis to be valid, the alternatives being examined must be equivalent in useful life as well as in fulfillment of the performance criteria. As was established previously, Alternate II is superior to Alternate I in delivery capacity and voltage drop considerations and also offers important benefits for maintenance and construction. It is apparent that Alternate II also offers the

possibility of extending service to a greater area of the Chapare without additional investments in subtransmission systems.

These advantages are difficult to quantify, especially those farthest in the future. For that reason, only initial costs are compared in the following table. Details of cost estimates are contained in the Appendix.

Cost of Alternatives

Alternate I - \$1,532,000

Alternate II - \$1,065,000

This clearly indicates the economic advantage of Alternate II. The difference in initial cost is on the order of \$500,000, corresponding to a savings of almost 30%.

RECOMMENDATIONS

It is recommended that Alternate II, the construction of a 220/34.5kV substation in Chimore be selected as the power source for the Chapare Rural Electrification Project for the following reasons:

- 1) The cost of this alternate is 30% less (or almost \$500,000) than the initial cost of Alternate I.

- 2) Alternate II provides the opportunity of avoiding significant difficulties in construction and maintenance of subtransmission lines in the difficult mountainous regions around San Jose. This factor will produce a lower operation and maintenance cost and better reliability of rural service.
- 3) Alternate II offers the opportunity to delay significant investment in subtransmission lines by allowing construction of all three phases of the Chapare Rural Electrification Project without construction of system of any voltage greater than 34.5kV.

The possibilities of interference with the operation of the Central East Interconnection have been examined with the following conclusions:

- 1) Even though it is possible that interruptions of the Interconnection may occur for faults in the 220/34.5kV tap substation, that risk is no greater than that posed by the 115/34.5kV substation in San Jose (Alternate I).
- 2) It is possible to eliminate the interference with the single pole reclosing system through the use of a tap transformer with a star star connection. This transformer should be specified with an overvoltage capability of 1.15p.u. due to the sustained high voltage conditions occurring during energization of the 220kV line.

It may be concluded that the presence of the Chimore Substation does not constitute an unresolvable interference with the operation of the Central East Interconnection. This study confirms the results of studies prepared in 1981, which determine the feasibility of the construction of a 220/34.5kV substation as a power source for Chapare Rural Electrification System.

APPENDIX

Cost Estimates

Alternate I

San Jose Sub

Estimate prepared 11/84 For AID

Materials	306,500
Construction	190,000
Engineering, Admin. and Other	<u>106,500</u>
Total Cost \$US	603,000

San Jose Padresama 34.5kV Line

Poles	79,000
Structures	107,000
Guys	46,000
Conductor	251,000
Various	<u>3,000</u>
Total Materials	486,000

Construction	254,000
Engineering Administration	104,000
Contingencies	<u>85,000</u>
Subtotal	443,000
Total Cost-Line	928,000
Total Cost-Project	1,532,000

ALTERNATE II

Chimore Substation

Materials

220kV Side

Switching	75,000
Transformer (5/6.25 MVA)	345,000
Other	5,000

34.5kV Side

Switching	16,000
OCR	36,000
Metering equipment	12,000

General

Steel	70,000
Protective Equipment	100,000
Other	<u>10,000</u>

Total Material 669,000

Construction 210,000

Engineering, Administration, Other 186,000

Total Chimore

Substation 1,065,000

FIELD TRIP REPORT
CHAPARE RURAL ELECTRIFICATION PROJECT

On April 24 and 25, 1986 the following individuals were involved in a field trip to the area of the Chapare Rural Electrification Project:

Mr. Fernando Reinaga-ENDE
Mr. Louis Heredia-ELFEC
Mr. J. VanCoevering

The following observations were made:

SAN JOSE SUBSTATION

Vegetation, which had previously been cleared off the site of the San Jose Substation, had regrown to the point that it was not possible to precisely relocate the site, but a review of the area on foot indicates that there should be adequate space for the substation, but that considerable earthwork will be required since the site is located on the bluffs overlooking the river. There was no indication of geologic instability at the substation site, but the access road could well be subject to mudslides. Due to the difficulties inherent in the area it is probably not possible to find a better location.

SAN JOSE-CAMPOVIA LINE

In this area the sub-transmission line is expected to follow the route of the Central East interconnection. The first problem to be encountered lies between towers #2 and 3 on the interconnection and is a 928 meter span across the San Jacinto River. It will be completely impossible to follow the route of the interconnection in this area due to the span lengths (maximum spans for wood structures are normally between 400 and 600 meters). The site chosen for tower #3 is on the crest of a rocky ridge and probably would not be large enough for an additional structure. Preliminary investigations towards locating a better route were not very successful.

This area demonstrates all the disadvantages of both mountain and jungle construction at the same time. The terrain is extremely broken, but without the security of the solid rock that one normally finds in mountain areas. There is luxuriant vegetation which blocks the view and water saturated soil typical of tropical jungles. The resulting terrain is very unstable with many indications of earthslides, especially near the highway. The highway has been cleared and many of the cut banks are steep enough to erode. This makes the highway cut a center of earth movements. For this reason it would be advisable to site the line at some distance from the highway. In this the designers of the Central East interconnection apparently concur because, although the line generally follows the route of the highway, it is rarely closer than one-half kilometer.

From tower #3 to tower #24 along the edge of the Espiritu Santo River, it should be possible to follow the route of the Central East interconnection. This is an area crossed by deep ravines. The interconnection utilizes spans of 550 to 650 meters and towers up to 40 meters in height to cross this area. The exception is an 834 meter span between towers #16 and #17 across a tributary of the Espiritu Santo River. The minimum span of the crossing would be on the order of 700 meters which would require a route change or special structures

for the sub-transmission line. Between towers #24 and #26 the interconnection crosses the Espiritu Santo River twice. It would be advisable to locate a new route for the sub-transmission line in this area.

From tower #27 to tower #42 it should be possible to follow the Central East interconnection across this area of steep rock faces (nearly 10 meters of altitude difference in 30 horizontal meters).

From tower #42 to #43 the interconnection uses a span of 690 meters to cross the Espiritu Santo River. This cannot be duplicated by the sub-transmission line, although the route looks feasible. It should be possible to separate the route of the sub-transmission line from that of the interconnection at tower #43 and follow the highway through several population centers in the area, such as the Campovia Community.

CAMPOVIA-CRISTAL MAYU-PADRESAMA

From tower #47 to tower #66 it should be possible to rejoin the route of the Central East interconnection although it may also be possible to follow the highway and provide service to the communities of Mendoza and Cristal Mayu.

From tower #66 it will be necessary to leave the highway to follow the interconnection. Spans from tower's #76 to #78 include two crossings of the Espiritu Santo River of 726 meters and 633 meters with an elevation difference of almost 100 meters. It will be necessary to utilize special structures here since no other route appears feasible.

From tower #78 to #82 it should be possible to follow the highway. The span from #82 to #83 is 794 meters, with an elevation difference of 120 meters. It appears to be possible to utilize a route which follows the highway through this area, but this would have to be verified with detailed field investigations. If this is not possible, special structures will be required.

The broken ground continues to tower #87 with a span of 631 meters. Special structures will be required in this area.

PADRE SAMA-VILLA TUNARI-CHIMORE

The route of the sub-transmission line in this area can follow the highway with few exceptions. The principal exceptions are river crossings, of which there are at least six, some with spans longer than 200 meters. In this area the banks of the rivers are not very high and there is considerable evidence of considerable water flow. For this reason it is recommended that each crossing be specially designed and have considerable clearance margin.

If it is necessary due to the lack of sufficiently tall wood poles, concrete poles should be considered. Other alternatives include the use of alumaweld conductor (AWACS) or other high-strength ACSR conductors.

The Cochabamba Puerta Via Royal oil pipeline follows this route also. This pipeline is built with black iron pipe three inches in diameter laid on concrete supports above ground surface with underground sections only at highway crossings. The covering on those portions of the pipe which are buried consists of a single layer of PVC tape which will provide minimum protection

against corrosion. It would be advisable to avoid long stretches in which the electric lines run parallel to this oil pipeline. Earth return currents can cause corrosion in underground metal pipes that are not well protected as is this.

LOW VOLTAGE SYSTEM

The staking for the low voltage systems in the population centers was examined where it could be relocated. Most of the stakes previously set had been destroyed and it will be necessary to restake the entire project. The following observations were made:

- 1) In cases where the village has customers along both sides of the highway it would be recommended to utilize lines and poles along both sides and not attempt to cross the highway with service drops. At first glance this would seem to be an additional cost, but in this area the highway is generally elevated above the surrounding terrain and it would be necessary to use a booster pole for the service drop. This will result in a veritable forest of booster poles, one in each service drop, creating a tremendous maintenance problem. A line of poles along each side of the highway with a single highway crossing at the transformer would be much better.
- 2) The staking of the low voltage system has been undertaken in accordance with the law regarding construction along highways. This law specified minimum setbacks from the center of the highway to the fronts of the buildings. This is all very well but in the majority of the villages, the inhabitants have not built their houses with this law in mind. This results in some cases in the electric lines running very close to the fronts of the houses. This is dangerous and will give considerable opportunity for power theft. It is recommended that a practical view be maintained during staking operations and that the low voltage poles be located well away from the fronts of the houses even though this may not comply with the highway laws.

SUMMARY OF RECOMMENDATIONS

The field trip through the San Jose-Padre Soma area indicated the difficulties that construction of a sub-transmission line will bring. Even though it is true that the construction of such a line is possible, roughly following the route of the Central East interconnection, it would be advisable to consider the possibility of establishing a tap on the 220kV line approximately at Chimore. This should provide the opportunity to increase the area served substantially. It will also avoid many of the problems with maintenance that can be expected with a sub-transmission line crossing such an unstable area.

Recommendations for other observations made on the trip are contained within the report.

The assistance of Mr. Reinaga and Mr. Heredia is greatly appreciated. Their knowledge of the project area is considerable and their judgement weighed heavily in the preparation of the recommendations found in this report.

OBJECTIVE

The objective of this report is to propose a coordinated protection system for the Chapare Rural Electrification Project which will fulfill the following requirements:

- 1) The protected equipment should clear a fault before the protecting equipment interrupts the circuit.
- 2) Outages due to permanent faults should be restricted as much as possible and not allowed to affect other unfaulted circuits.
- 3) Transformer protection should clear overloads as well as faults.

METHODOLOGY

Using a system circuit diagram (Appendix I) a fault study was prepared following the procedures outlined in REA Bulletin 61-2 and utilizing data provided by the Distribution System Protection Manual, published by McGraw-Edison. Once the maximum and minimum fault current levels were established equipment was selected and trip levels were coordinated utilizing information from the following manufacturers:

- 1) McGraw-Edison for reclosers.
- 2) S & C curves "T" standard for fuses.

In spite of the use of the foregoing manufacturers data other types of equipment can certainly be utilized due to the standardization between various manufacturers. In the case of fuses curves other than the T curve should be not utilized. In any case coordination of the system should be verified once it is known which equipment will be purchased.

FAULT STUDY

Fault current was calculated for the following conditions:

- 1) Maximum fault current for a 3-phase fault with minimum source impedance.
- 2) Phase-to-phase fault current calculated for the highest anticipated source impedance condition.
- 3) Phase-to-ground fault current for minimum source impedance conditions and including an arc resistance of 40 ohms.

Impedance of lines and transformers are assumed to be as follows, expressed in per unit on a 100 MVA base:

220/34.5kV 5MVA transformer $Z_1 = Z_0 = 1.8$ P.U.

For 34.5kV distribution line:

1/0 ACSR conductor.

$$Z_1 = .0584 + J.067 \text{ P.U./KM.}$$

$$Z_0 = .0791 + J.1198 \text{ P.U./KM.}$$

#4 ACSR conductor.

$$Z_1 = .1341 + J.0368 \text{ P.U./KM.}$$

$$Z_0 = .1423 + J.1199 \text{ P.U./KM.}$$

The results of the fault current analysis are presented in Appendix II.

SECTIONALIZING STUDY

Equipment Location

The circuit locations for the sectionalizing equipment were selected to minimize the effect of branch circuit faults on the main circuit, that is, the line between Chimore and Villa Tunari, and also to permit extensions of the system without major changes. The following locations were selected:

1) Chimore Substation.

The initial capacity of this substation will be 5/6.25 MVA and a recloser with a 100 amp trip coil would be necessary.

2) Nueva Canaan Tap.

This tap is 6 kilometers long, but due to its short distance from the substation, it will be protected with fuses.

3) Dorado Tap.

This tap will be protected with fuses.

4) Tap to San Francisco and Samusabet.

These taps share the first six miles of their route, that is, as far as Chipiriri. Between the two of them they combine more than 50 kilometers of exposed length. The second phase of the Chapare project calls for their extension and for this reason it would be recommended to protect them with reclosers at Chipiriri. Two 50 amp three phase reclosers are shown.

5) Chimore Padresama line

The reach of the substation recloser at Chimore is limited and it is anticipated that a 50 amp 3-phase unit will be required at point 3 (See appendix I) on the Villa Tunari side of the Chipiriri Tap.

6) Paracti Tap.

This 6 kilometer tap will be protected with fuses.

Equipment Coordination

Appendices III, IV, and V show coordination curves for the various pieces of equipment.

Appendix II demonstrates the coordination between the 100 and 50 amp reclosers. According to the recommendations of McGraw-Edison, curve separations of less than 2 cycles (.04 seconds) do not provide positive coordination while curve separations greater than 12 cycles will insure coordination. This implies that there is no coordination between the high speed curves (A curve) of the two reclosers, but that there will be coordination between the slow curves. This means that the substation recloser at Chimore may operate on the high speed curve for faults beyond point 3, but that it will not lock out. The 50 amp reclosers at point 3 and Chipiri will clear permanent faults on the slow curves.

A ground fault trip accessory is recommended for the recloser at the Chimore substation in order to extend its range of sensitivity to more securely cover the six kilometer line from point 3 to Chipiri.

Appendix IV shows the coordination between the Chimore substation recloser and the tap fuses. It is apparent that there is no coordination for faults greater than 900 amps. This implies that when the transformer capacity of the Chimore substation is increased, the fuse/recloser coordination should be reexamined. It will probably be necessary to increase fuse size to 40 T.

Appendix V gives the coordination between the 50 amp reclosers and the tap fuses.

Appendix IV lists the recommended equipment.

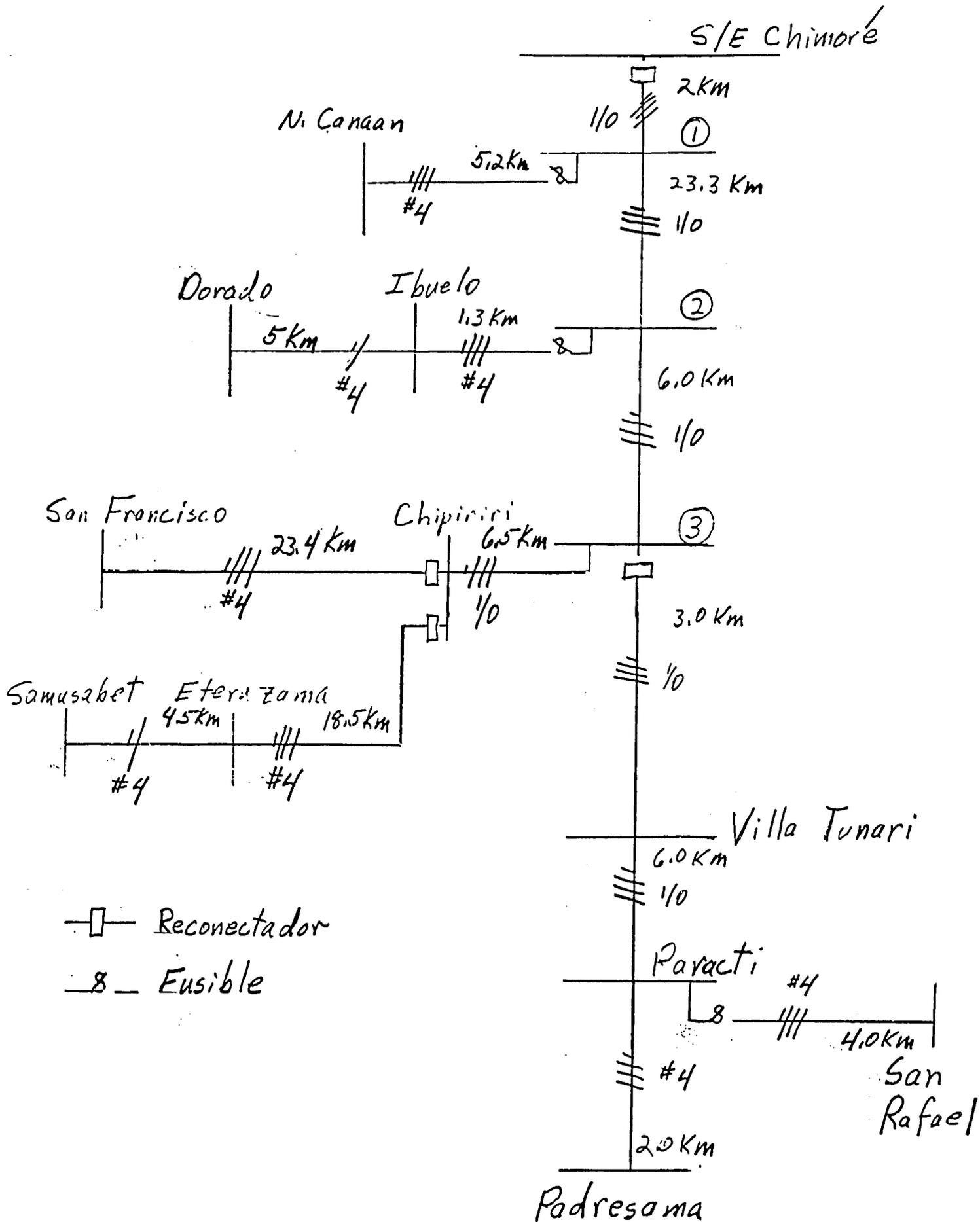
TRANSFORMER PROTECTION

The transformers to be installed on the project will be type CSP for single phase installations and of the conventional type for 3 phase banks. Protection of single phase transformers on 34.5kV systems is difficult due to the unavailability of sufficiently low current fuses. Maximum load current for a 10 KVA transformer on the high voltage side is only 1/2 ampere. The smallest fuse available is the Type 1H 1 ampere fuse. It is apparent that some additional protection is required.

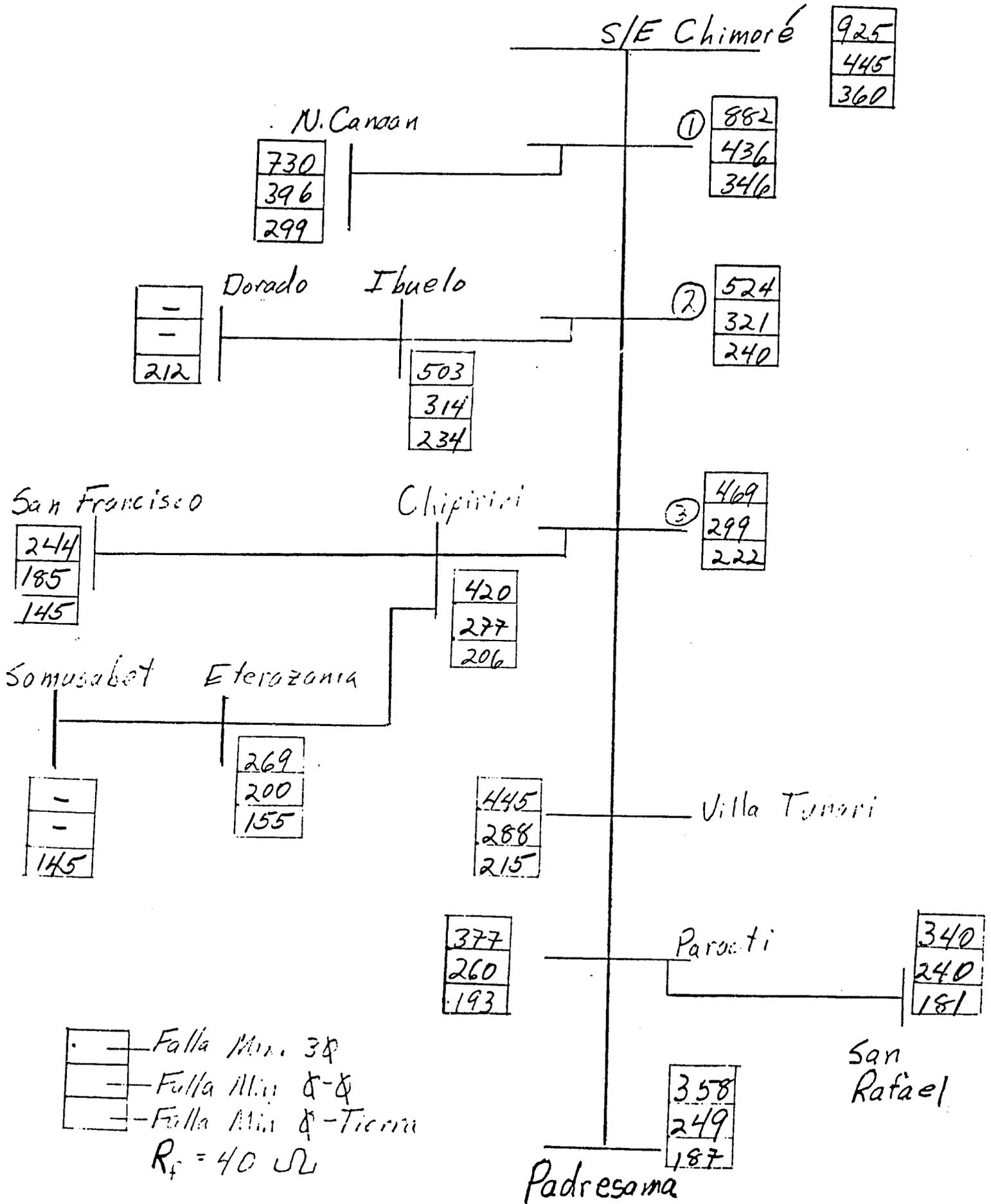
The CSP transformer is provided with a circuit breaker on the low voltage side, but this is set to operate on a curve which closely follows the short circuit current damage curve of the transformer and does not provide any significant protection against overloads. It is recommended that transformers for this project be obtained with low voltage circuit breakers operating on the curve outlined in Appendix 7.

Conventional transformers should have fuses according to the attached table and the 3 phase bank should be provided with a circuit breaker on the low voltage side as indicated.

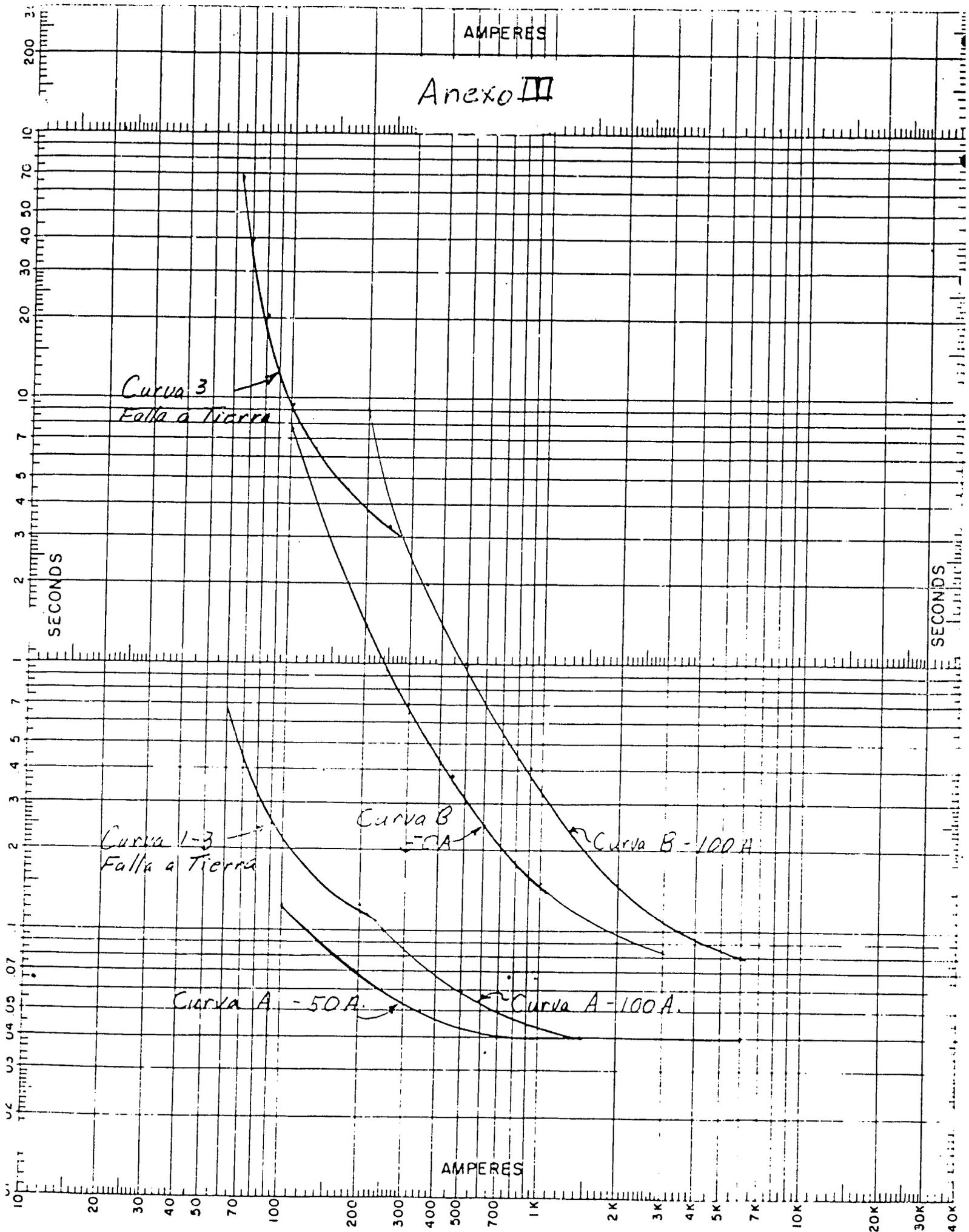
Anexo I



Anexo II

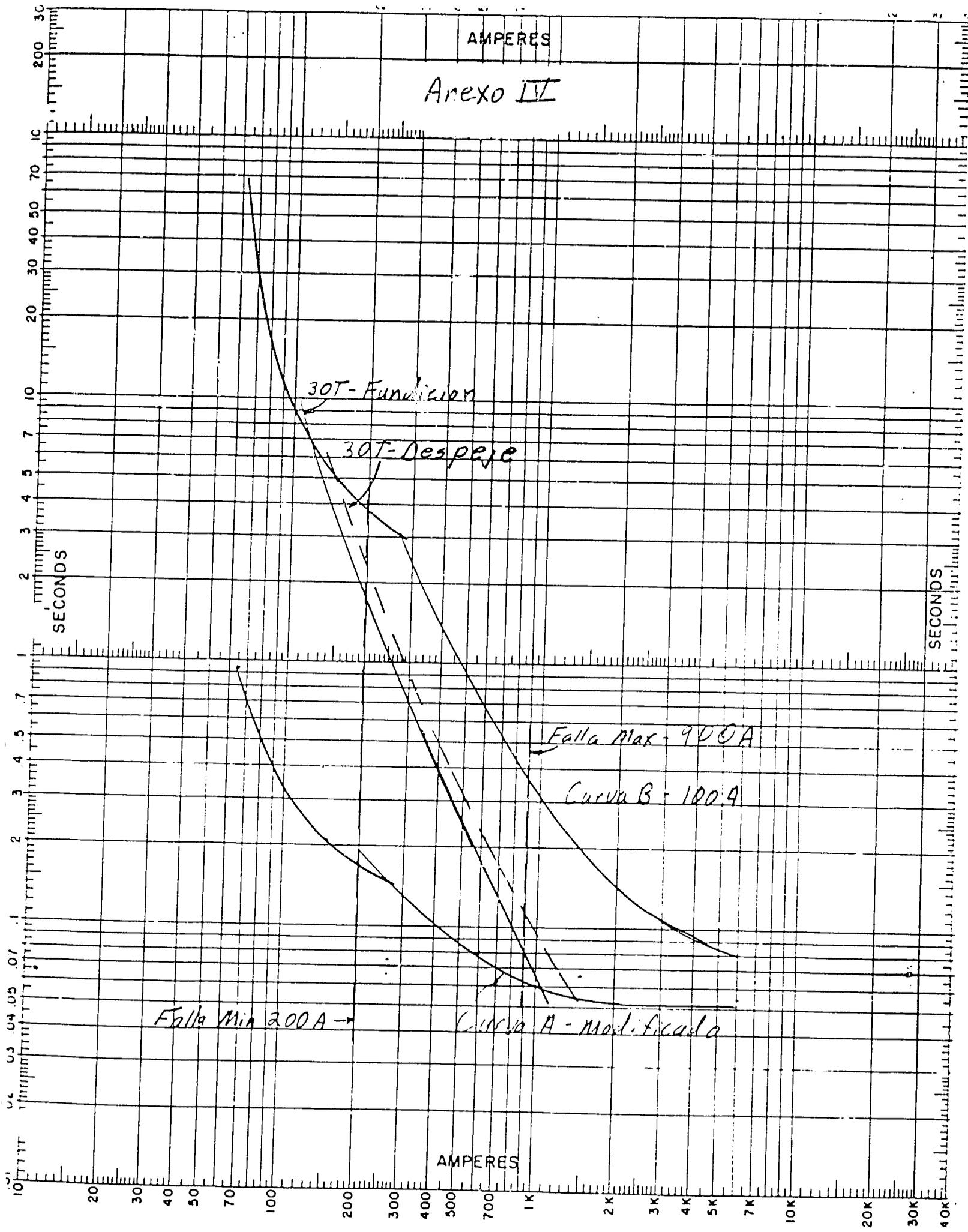


Anexo III



Anexo IV

AMPERES

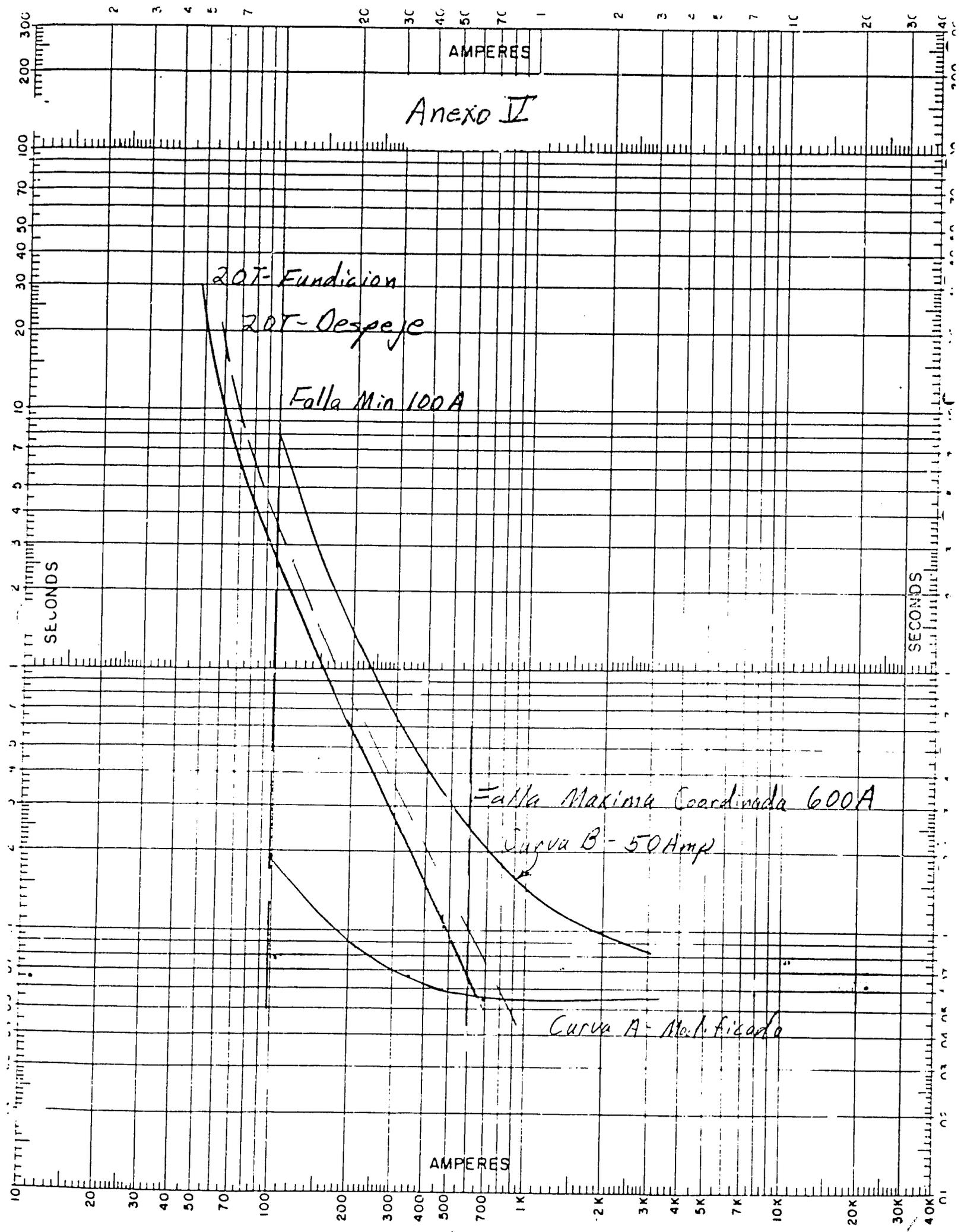


AMPERES

SECONDS

SECONDS

Anexo II



APPENDIX VI

Location	Equipment Type	Current Rating	Phase Trip Current	Phase Curves Hi-speed Delayed	Ground Trip Current	Ground Trip Hi-speed	Curves Delayed
Chimore	Recloser	100 A	200 A	2-A 2-B	63.5 A	2-1-3	2-3
1	Fuse	30 T					
2	Fuse	30 T					
3 (Facing Villa Tunari)	Recloser	50 A	100 A	2-A 2-B			
Chipiriri (Facing San Francisco)	Recloser	50 A	100 A	2-A 2-B			
Chipiriri (Facing Sanusabet)	Recloser	50 A	100 A	2-A 2-B			
Puracti (Facing San Rafael)	Fuse	20 T					

26

APPENDIX VII

Modified trip curve for L.V. circuit breakers.

<u>Trip Time</u>	<u>Trip Current</u>
10 min.	125%
1 min.	200%
10 secs	400%
1 sec	1000%

Nominal rating for low voltage circuit breakers
for CSP transformers.

<u>Transformer Size</u>	<u>Nominal Rating</u>
10 KVA .	50Amp.
15 KVA	75Amp.
25 KVA	125Amp.
37.5 KVA	175Amp.

TRANSFORMER FUSES

Bank Size	Transformer Size	H. V. Fuse	L. V. Breaker
30	10	1 H	50Amp.
45	15	1 H	75Amp.
75	25	2 H	125Amp.
112.5	37.5	2 H	175Amp.

98

Division II-Technical Specifications
PART 1 - WOOD POLES

1. GENERAL

- A. This specification covers the manufacture and supply of pressure treated pine and eucalyptus wood poles for use in electric distribution lines.
- B. Poles will be used under the following climatic conditions

Average Annual Ambient Temperature	25°C.
Average Annual Rainfall	4000 mm
Estimated equilibrium moisture content	40%

Conditions favor attack by deteriorating organisms.

- C. Proposals for the supply of wood poles of species other than those specified herein will also be considered, provided that they be equivalent in function and capabilities to those specified

For such cases the Bidder shall include in his proposal data related to technical specifications, treatment, mechanical capacities, useful service life, and other relevant information.

2 MATERIAL

- A. Poles shall be of the following species:
 - 1. A species of the genus Pinus.
 - 2. One of the following species of the genus Eucalyptus:

Division II-Technical Specifications
PART 1 - WOOD POLES

1.1. GENERAL

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For such cases the Bidder shall include in his proposal data related to technical specifications, treatment, mechanical capacities, useful service life, and other relevant information.

1.2 MATERIAL

A. Poles shall be of the following species:

1. A species of the genus Pinus.
2. One of the following species of the genus Eucalyptus:
 - (a) Globulus
 - (b) Alba
 - (c) Rostrata
 - (d) Saligna
 - (e) Teraticornis
 - (f) Liminalis

B. Notwithstanding the foregoing, poles supplied by a single manufacturer shall be of the same species and treatment type.

C. Poles offered of the indicated species or other treatable species shall be of a species routinely used as pressure treated poles for either electric distribution or telephone service by public service utilities in the country of their manufacture.

D. Poles of durable species intended to be used untreated may be

Division II-Technical Specifications
PART 1 - WOOD POLES

considered. Such offerings shall be of species routinely used as poles by electric or telephone public service utilities under tropical conditions in the country of their manufacture. Poles of such species shall not be subject to the provisions of this specification except clauses 1.5. B, C, and D; 1.6.; 1.7. A, B, E, and F; 1.8.; and 1.11.

- E. Each manufacturer desiring to offer poles shall present evidence of having supplied poles of the offered species and treatment type for a period of not less than five years prior to this offering.

1.3 CODES AND STANDARDS

- A. The following specifications and standards (latest revisions) shall govern the supply of pine poles:
- Specification DT-5C of the Rural Electrification Administration (REA) of the U.S. "Specification for wood poles, stubs and anchor logs and preservative treatment of these materials".
 - REA STD DT-19 "Quality control and Inspections of Timber Products".
 - Standard P5 for Chromated Copper Arsenate (CCA) Salts, of the American Wood Preservers Association (AWPA).
 - AWPA Standards C1 and C4.
 - AWPA Standards M1 and M2.
- B. The supply of Eucaliptus poles shall be governed for purposes of treatment and inspection only, by the following specifications, except as stated herein:
- REA STD DT-19, latest revision
 - REA specification DT-5C
 - AWPA Standards C1, C4, P1, P9 and P5.

- C. Where there is conflict between this specification and any of the above referenced specifications, this specification shall govern.

In case of conflict between any two of the above referenced specifications, that specification establishing more stringent requirements shall govern.

1.4 DEFINITIONS

- A. The following definitions shall apply to the terms used in this specification:

Air Seasoning. Drying by the use of air where the air temperature is not more than 60 C either in the open or under cover.

Boulton Drying. Drying by heating in nonaqueous solution under vacuum.

Division II-Technical Specifications
PART 1 - WOOD POLES

Check. The lengthwise separation of the wood that usually extends across the rings of annual growth and commonly results from stresses set up in wood during seasoning.

Compression Wood. Abnormal wood formed on the lower side of branches and inclined trunks of softwood trees. Compression wood is identified by its relatively wide annual rings, usually eccentric, relatively large amount of summerwood, sometimes more than 50 percent of the width of the annual rings in which it occurs, and its lack of demarcation between springwood and summerwood in the same annual rings. Compression wood, compared with normal wood, shrinks excessively lengthwise.

Cross Break. A separation of the wood cells across the grain. Such breaks may be due to internal strains resulting from unequal longitudinal shrinkage or to external forces.

Dead Streak. An area, devoid of bark, resulting from progressive destruction of the growth cells of wood and bark at the edges of the streak. On a pole, a dead streak is characterized by a discolored weathered appearance and by lack of evidence of overgrowth along the edges of the deadened surface.

Decay. The decomposition of wood substance by fungi.

Decay, Advanced (or typical). The older stage of decay in which the destruction is readily recognized because the wood has become punky, soft and spongy, stringy, ring-shaked, pitted, crumbly or, in poles not stored or rafted in water, is in a soggy condition. Decided discoloration or bleaching of the rotted wood is often apparent.

Decay, Incipient. The early stage of decay that has not proceeded far enough to soften or otherwise perceptibly impair the hardness of the wood. It is usually accompanied by a slight discoloration or bleaching of the wood.

Decayed Knot. A knot containing decay. Two types of decayed knot are recognized.

Type I .- Knots containing soft or loose fibers (decay) which may extend the full length of the knot into the pole and which are associated with heart rot.

Type II .- Knots containing soft or loose fibers (decay) which are not associated with heart rot.

Face of pole. The concave side of greatest curvature in poles with sweep in one plane and one direction, or the side of greatest curvature between groundline and top in poles having reverse or double sweep.

Groundline Section. That portion of a pole between 1 foot (30 cm)

Division II-Technical Specifications
PART 1 - WOOD POLES

above and 2 feet (60 cm) below the groundline, as defined in the pole dimension tables.

Hollow Heart. A void in the heartwood caused by decay or insect attack.

Hollow Pith Center. A small hole at the pith center of the trunk or of a knot caused by disintegration of the pith (small soft core occurring in the structural center of a tree or branch).

Insect Damage. Damage resulting from the boring into the pole by insects or insect larvae. Scoring or channeling of the pole surface is not classed as insect damage.

Kerfing. A process whereby a slot or kerf is cut into the pole over a portion of its length to discourage the subsequent development of checks.

Kiln Drying. Drying by the use of heated air at temperatures 60 C or above in batch or progressive type kilns.

Knot Diameter. Diameter of a knot on the surface of the pole measured in a direction at right angles to the lengthwise axis of the pole. The sapwood as well as the heartwood portion of a knot shall be included in the measurement.

NOTE: For a description of means for defining the limits of knots, see American National Standard Definitions of Terms Relating to Timber, 04.5-1958 (ASTM D9-30 (1958)).

Red Heart. A condition caused by a fungus, *Fomes pini*, that occurs in the living tree. It is characterized in the early stages of infection by a reddish or brownish color in the heartwood. This is known as "firm red heart." Later the wood of the living tree disintegrates (decays) in small, usually distinct, areas that develop into whitelined pockets.

Sap Stain. A discoloration of the sapwood, caused by the action of certain molds and fungi, that is not accompanied by softening or other disintegration of the wood.

Scar (cat face). A depression in the surface of the pole resulting from a wound, where healing has not re-established the normal cross section of the pole.

Shake. A separation along the grain, the greater part of which occurs between the rings of annual growth.

Short Crook. A localized deviation from straightness which, within any section 5 feet or less in length, is more than 1/2 the mean diameter of the crooked section. (See Fig. 1, Diagram 3.)

Division II-Technical Specifications
PART 1 - WOOD POLES

Spiral-Grained (twist-grained) wood. Wood in which the fibers take a spiral course about the trunk of a tree instead of a vertical course. The spiral may extend in a right-handed or left-handed direction around the tree trunk. Spiral grain is a form of cross grain.

Split. A lengthwise separation of the wood due to the tearing apart of the wood cells.

Steam Conditioning. Subjecting poles in a closed vessel to steam prior to treatment.

Sweep. Deviation of a pole from straightness. (See Fig. 1, Diagrams 1 and 2.)

1.5 MATERIAL REQUIREMENTS

- A. Rate of Growth: The average rate of growth of pine poles measured on the butt in the outer 5 cm of poles having a circumference of 95 cm or less at 1.8 m. from the butt, and in the outer 8 cm of poles having a circumference of more than 95cm. at 1.8 m from the butt, shall be not less than 6 rings per 2.5 cm. Exception: Poles with 4 and 5 rings per 2.5 cm are acceptable if 50% or more summerwood is present.

Eucalyptus poles shall have an average growth rate, as measured above of not less than 2 rings in 2.5 cm. without exception.

As an alternative, the ring count and summerwood measurements mentioned above may be made on an increment core taken at 1.8 m. from the butt directly above the place where the average rate of growth is indicated on the butt surface.

B. Prohibited Defects:

1. Cross breaks (cracks)
2. Decay, except as permitted under "firm red heart", "defective butts," and "decayed knots"
3. Dead streaks.
4. Holes, open or plugged, except holes for test purposes, which shall be plugged
5. Hollow butts or tops, except as permitted under hollow pith centers and defective butts.
6. Marine borer damage
7. Nails, spikes, and other metal not specifically authorized by the purchaser
8. Hollow heart
9. Shakes (in Eucalyptus only)

C. Permitted Defects:

Division II-Technical Specifications
PART 1 - WOOD POLES

1. Firm Red Heart: Firm red heart not accompanied by softening or other disintegration (decay) of the wood is permitted.
2. Hollow Pith Centers: Hollow pith centers in the tops or butts and in knots are permitted in poles that are to be given full-length treatment.
3. Scars: Turpentine acid face scars are permitted anywhere on the pole surface.

D. Limited Defects:

1. Bark Inclusions: Depressions containing bark inclusions shall be not more than 2 inches in depth, measured from the surface of the pole.
2. Compression Wood: The outer 1 inch of all poles shall be free from compression wood visible on either end.
3. Defective Butts: Hollowing in the butt caused by "splinter pulling" in felling the tree is permitted, provided that the area of such a hollow is less than 10% of the butt area.
4. Insect Damage: Insect damage, consisting of holes 1/16 inch or less in diameter, or surface scoring or channeling is permitted. All other forms of insect damage are prohibited.
5. Knot: The diameter of any single knot and the sum of knot diameters in any 30 cm. section shall not exceed the limits of the following Table (Table 1).
Type II "decayed knots" are permitted.

Division II-Technical Specifications
PART 1 - WOOD POLES

TABLE 1
LIMITS OF KNOT SIZES
PINE POLES

Poles up to 14.0 m length
Classes 4 to 10

Maximum sizes permitted

	Diameter of any single knot		Sum of diameters of all knots greater than 0.5 inch (1 cm) in any 1-foot section	
	(cm)	(inch)	(cm)	(inch)
Lower half of length	5	2	20	8
Upper half of length	10	4	20	8

EUCALIPTUS POLES

	Diameter of any single knot (cm)	Sum of diameters of all knots greater than 1.5 cm. in any 30 cm. section
Between groundline and 10 cm. above same.	Not permitted.	Not permitted
Outside the above defined section	5.0	15.0

6. Scars: A scar is the result of injury to the living tree and which has begun to heal. This provision does not refer to damage done to the tree (pole) after it has been cut. No pole shall have a scar or turpentine cat face (southern pine) located within 2 feet (60 cm) of the groundline. Turpentine scars need

1/6

Division II-Technical Specifications
PART 1 - WOOD POLES

be trimmed only to the extent necessary for examination for evidence of fungus infection and insect damage. Other sound scars are permitted elsewhere on the pole surface, provided they are smoothly trimmed and do not interfere with the cutting of any grain and provided that:

- a) The circumference at any point on trimmed surfaces located between the butt and two feet (60 cm) below the groundline is not less than the minimum circumference specified at six feet (1.80 m) from the butt for the class and length of the pole; and
 - b) The depth of the trimmed scar is not more than 1/5 the pole diameter at the location of the scar.
7. Shakes: (Pine poles only) Shakes in the butt surface which are not closer than 2 inches (5 cm) to the side surface of the pole are permitted, provided they do not extend to the groundline. Shakes or a combination of connected shakes which are closer than 2 inches (5 cm) to the side surface of the pole are permitted, provided they do not extend farther than 2 feet (60 cm) from the butt surface and do not have an opening wider than 1/8 inch (3 mm). Shakes in the top surface are permitted in poles that are to be given full-length preservative treatment, provided that the diameter of the shake is not greater than 1/2 the diameter of the top of the pole. Shakes are not permitted in Eucalyptus poles.
8. Shape: Poles shall be free from short crooks. A pole may have sweep subject to the following limitations:
- (a) Where sweep is in one plane and one direction only, for poles 15.0 m (50 feet) and shorter of all species a straight line joining the surface of the pole at the groundline and the edge of the pole at the top, in 90% or more of an inspection lot, shall not be distant from the surface of the pole at any point by more than 1 inch for each 10 feet (0.8 cm for each meter) of length between these points. In the remainder of the inspection lot (10%), the poles may have a deviation of 1 inch for each 6 feet (1.4 cm for each meter) of length when measured as above.
 - (b) Where sweep is in two planes (double sweep) or in two directions in one plane (reverse sweep), a straight line connecting the midpoint at the groundline with the midpoint at the top shall not at any intermediate point pass through the surface of the pole. (See Fig. 1, Diagram 2.)
9. Spiral Grain: Spiral grain (twist grain) is permitted as a maximum of one complete twist in any 4 m. of length in Eucalyptus poles, and in pine poles as follows.

Division II-Technical Specifications
PART 1 - WOOD POLES

<u>Length of Pole (m)</u>	<u>Maximum Twist of Grain Permitted</u>
9.0 & shorter	1 complete twist in any 3.0 m
10.0-13.5 inclusive	1 complete twist in any 5.0 m

10. Splits and Checks:

- (a) In the Top: A split or a combination of two single checks (each check terminating at the pith center and separated by not less than 1/6 of the circumference) having one or both portions located in a vertical plane within 30 degrees of the top bolt hole shall not extend downward along the pole more than 30 cm. No single check or split shall pass through both bolt holes at the top of the pole.
- (b) In the Butt: A split or a combination of two single checks, as defined above, shall not extend upward along the pole more than 75 cm.

1.6 DIMENSIONS

- A. Length: Poles less than 15.0 m in length shall be not more than 5.0 cm shorter or 15 cm longer than nominal length. Length shall be measured between the extreme ends of the pole.
- B. Circumference: The minimum circumferences at 1.80 m from the butt for each strength class shall be determined from the tests required in section 1.11. Poles subsequently produced under this specification shall be classed according to their circumference as measured 1.8 m. from the butt. Circumference of the top of the pole shall in no case be less than 60% of the circumference at 1.8 m. from the butt.
- C. Shrinkage: A tolerance of not more than two percent, in circumference, is allowed for shrinkage after treatment. Poles to which this provision applies shall not be more than five percent of any lot.

1.7 MANUFACTURING REQUIREMENTS

- A. Bark Removal: Outer bark shall be completely removed from all poles. On all poles, no patch of inner bark more than 2.5 cm wide shall be left on the pole surface between the butt and 60 cm below the groundline. On poles that are to be given full-length treatment, no patch of inner bark larger than 2.5 cm wide and 15 cm long shall be left on

Division II-Technical Specifications
PART 1 - WOOD POLES

the pole surface between the top and 60 cm below the groundline.

- B. Sawing: All poles shall be neatly sawed at the top and at the butt along a plane which shall not be out of square with the axis of the pole by more than 20% of the diameter of the sawed surface. Beveling at the edge of the sawed butt surface not more than 1/12 the butt diameter in width, or an equivalent area unsymmetrically located, is permitted.
- C. Trimming: Completely overgrown knots, rising more than 1 inch above the pole surface, branch stubs, and partially overgrown knots shall be trimmed close. Completely overgrown knots less than 1 inch high need not be trimmed. Trimming may be done by shaving machine or by hand.
- D. Shaving: If shaving is used, the depth of cut shall not be more than necessary to remove inner bark and to trim smoothly and closely all branch stubs and overgrown knots. There shall be no abrupt change in the contour of the pole surface between the groundline and the aboveground sections. The lower 60 cm of poles may be trimmed to remove wood fibers causing butt flare, provided sufficient sapwood remains to obtain the minimum penetration requirement.
- E. Marking and Code Letters: The following information shall be burn-branded legibly and permanently on the face. Items (4) and (5) shall also be noted on the butt of each pole on a metal tag affixed thereto.
- (1) The supplier's code or trademark
 - (2) The month and the year of treatment
 - (3) Code letters denoting the pole species, preservative and retention used.
 - (4) The true circumference-class numeral and numerals showing the length of the pole.
 - (5) An "R" shall be added to the brand on retreated poles.

The code letters, not less than 5/8-inch high if burn-branded, and not less than 1/8-inch high if on a metal tag, designating the pole species, preservative and retention used, shall be as accorded by the Purchaser and the supplier.

The bottom of the brand or mark shall be placed squarely on the face of the pole and at 3.0 m +/- 5 cm from the butt of poles 15.0 m or less in length or as otherwise specified in the purchase order.

- F. Framing: All poles and anchor logs shall be bored, gained and cut to length prior to final treatment, but subsequent to seasoning and in accordance with the attached drawings or with any drawing which accompanies an order to contract. Anchor logs shall be bored as required by the order for them. When gains are required on one side only, they shall be cut on the face of the pole. Gains shall be perpendicular to the bolt hole and the gained surfaces shall be in

Division II-Technical Specifications
PART 1 - WOOD POLES

approximately parallel planes.

- G. Kerfing: Poles of all species shall be kerfed longitudinally for a distance of 60 cm. above and below the ground line prior to treatment but subsequent to seasoning. Width of the kerf shall be no more than 6 mm. The Kerf shall extend from the surface of the pole to the pith center except at the ends (to allow for withdrawal of the saw).
- H. Sapwood: In Eucalyptus poles, sapwood depth shall not be less than 2.0 cm. at any section of the manufactured pole.

1.8 STORAGE AND HANDLING

- A. Storage: When it is necessary to hold poles in storage, they shall be stacked on treated or other nondecaying skids of such dimensions, and so arranged, as to support the poles without producing noticeable distortion of any of them. The height of the stacks shall be limited to avoid damage to poles on the bottom layers. Poles shall be piled and supported in such a manner that all poles are at least one foot above the general ground level and any vegetation growing thereon. No decayed or decaying wood shall be permitted to remain underneath stored poles.
- B. Handling: Poles shall not be dragged along the ground. Cant hooks, pole tongs, or other pointed tools shall not be applied to the groundline section of any pole.
- C. Damage: Poles are not acceptable if they contain indentations, attributed to loading or handling slings that are one-quarter inch (0.6 cm) or more deep over 20 percent or more of the pole circumference, or more than 1/2" (1.2 cm) deep at any point. Other indentations or abrasions, i.e., forklift damage, chain saw damage, etc., shall not be more than 1/10 the pole diameter at the point of damage up to a maximum of 1" (2.5 cm). If the damage occurs in an oversized section, the excess of wood shall be taken into consideration in evaluating the effects of the damage. Minimum circumference for a given class will be required within 2' (60 cm) of the classing point if mechanical damage occurs.

1.9 PRESERVATIVES

Preservatives shall be selected from one of the following:

- A. Cresosote: Cresosote shall be a distillate derived from tar produced by the high temperature carbonization of bituminous coal and conform to all requirements of AWWA Standard P1 when analyzed in accordance with the methods in AWWA Standard A1, Sections 2, 3, 4, either 5 or 9, and 6.

Division II-Technical Specifications
PART 1 - WOOD POLES

- B. Pentachlorophenol: Pentachlorophenol shall contain not less than 95 percent chlorinated phenols and conform to AWPA Standard P8 when analyzed in accordance with A5, Sections 1, 2, 3 and 4. The hydrocarbon solvents for introducing the preservative into the wood shall meet the requirements of AWPA Standard P9 Heavy Oil (Type A) determined in accordance with referenced ASTM standards for physical properties.
- C. Water-Borne Preservatives: Chromated copper arsenates (CCA) shall meet the requirements of either type B or type C of the formulations given in AWPA Standard P5-83. Tests to establish conformity shall be made in accordance with AWPA Standard A2, Sections 2, 5 and 6, or AWPA Standard A10-82. CCA treatments shall be of the oxide formulation. Salt formulations are not permitted. Determinations of the required pH of treating solutions of the water-borne preservatives shown in AWPA Standard P5, Section 8 should be determined in accordance with AWPA Standard A2, Section 9.

1.10 PRESERVATIVE TREATMENT

A. Conditioning Prior to Treatment:

1. All Eucalyptus species and those pine species for which air-seasoning is required (see REA spec DT-5C Group A, Table 1, Appendix A) shall have been dried by natural air circulation or by kiln drying (at a temperature not to exceed 105°C. for a period not to exceed 6 hours). They shall be checked to the heartwood. The moisture content shall not exceed 25 percent by use of resistance type meter at a depth of 1-1/2" (38 mm) or at the sapwood heartwood line, whichever is less.
2. Poles for which full air-seasoning is not required may be partially conditioned by natural air-seasoning or by approved forced-air circulation or by kiln drying at a temperature not to exceed 105°C. and further conditioned by the steam-vacuum process (Group C, Table 1, Appendix A of REA spec DT-5C) within the following limits:

Division II-Technical Specifications
PART 1 - WOOD POLES

a) Steam-Vacuum Process:

Steam-(limits)	Temperature deg. C. -----	Max. hours <u>Total Time</u>
Southern Pine	118 max.	(1) 17 (2) - 20

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- (1) Pole classes nominally less than 37.5 inches circumference at six feet from butt.
 (2) Pole classes nominally 37.5 inches or larger at six feet from butt.

3. Boulton Drying is not permitted.

4. All poles shall be conditioned prior to or during treatment in such way that the pith center of the pole be heated for at least two hours at a temperature of 65 degrees C.

B. Treatment (Pressure Process):

	<u>Maximum Limits</u>		
	Preservative Temperature Deg. C (Creo. & Penta)	Impregnation Pressure (Psi)	2 (Kg/cm)
Eucalyptus-all species	99	150	10.50
Jack & Red Pine	99	150	10.50
Lodgepole Pine	99	150	10.50
Southern Pine	99	200	14.00
Ponderosa (Western) Pine	99	200	14.00
All Species CCA	49	Same as above	

All poles treated with water borne salts shall be by full cell process described in AWPA Standards C1 and C4 except as modified by the provisions of ANSI O5.1.

C. Results of Treatment:

1. Penetration and retention of preservative shall be tested on borings taken at any point on the periphery approximately: One foot (30 cm) above or below the brand on all species of poles.
2. Retention of preservative shall be not less than specified in Table 2 below as determined by:
 - a. Toluene extraction for creosote.

Division II-Technical Specifications
PART 1 - WOOD POLES

- b. Lime fusion test or copper pyridine test for pentachlorophenol when the preservative is a penta-petroleum solution.
- c. Copper pyridine test for pentachlorophenol when poles treated with penta-petroleum solution are known to have been stored or rafted in sea water, and for all species native to the Pacific Coast region.
- d. Tests in accordance with the recognized standard methods for chromium, copper, and arsenic ions listed in AWWA Standards A2, A10, A11 and A7. The components of the preservatives shall be calculated as As_2O_5 , CuO and CrO_3 . Analysis by AWWA Standard A9-70 are satisfactory only for plant control. Retention of individual components shall not be less than the following values (AWPA-P5):

	Kg/m ³	Kg/m ³
	<u>Type_B</u>	<u>Type_C</u>
- Copper, as CuO	2.13	1.90
- Chromium, as CrO ₃	3.83	5.15
- Arsenic, as As ₂ O ₅	4.90	3.70

TABLE 2

MINIMUM RETENTION OF PRESERVATIVES

Creosote		C C A		Pentachlorophenol		<u>Test Zone (*)</u> distance from surface	
(pcf)	(kg/m ³)	(pcf)	(kg/m ³)	(pcf)	(kg/m ³)	(in)	(cm)
12	192.5	.75	12	.6	9.6	0.5 to 2.0	1.3 to 5.1
						Or limit line between sapwood and heartwood.	

(*) The distances given here are applicable to species other than those listed in the REA Specification DT-5C. The test zone for U.S. species shall be as given in table 10, REA Specification DT-5C.

3. Penetration sampling of poles shall be as follows:

- (1) Bore 20 percent of poles or 20 poles, whichever is greater; accept if 100 percent conform, otherwise bore all poles.

Division II-Technical Specifications
PART 1 - WOOD POLES

- (2) Retreat the charge if more than 15 percent of the borings are found to be nonconforming.
 - (3) Retreat all nonconforming poles if 15 percent or less fail the requirements.
4. The depth of penetration shall be measured along a boring from the outer end toward the inner end for a distance throughout which there is continuous preservative penetration as indicated by evidence of preservative in each annual ring included.
 5. The minimum depth of preservative penetration shall be 3.5" (8.9 cm) or 100% of the sapwood.
- D. Retreatment: Poles may be retreated once. CCA treated poles shall be dried sufficiently to accept the treatment
1. Creosote and Pentachlorophenol-Petroleum - Limits of steam for initial treatment and retreatment shall not exceed those found in paragraph 1.10.A.2.
Retreatment of Reserve Treated Stock poles shall be by submersion in hot preservative (creosote or pentachlorophenol-petroleum solution) for not less than 10 minutes under 25 pounds pressure, or not less than 30 minutes at atmospheric pressure.
- Retreated poles shall conform fully to all the requirements of this specification.
Retreated poles shall have a letter "R" placed in the butt and on the brand to indicate that the pole or poles have been retreated.

1.11 MECHANICAL REQUIREMENTS

- A. Circumference classification of poles as specified in Paragraph 1.6.B. shall be established subject to the actual load bearing capacity as demonstrated below.
- B. For all purposes of classification, the minimum breaking load applied transversely at 60 cm. from the top and with the indicated groundline distances from the bottom shall be as shown in table 3.

Division II-Technical Specifications
PART 1 - WOOD POLES

TABLE 3
MECHANICAL STRENGTH

Pole Length (m)	Groundline (m)	Minimum Top displa- cement at Failure-cm.	Class			
			4	5	6	7
8.50	1.60	95	----	----	----	540
10.00	1.75	100	1080	855	675	----
11.00	1.80	120	1080	855	675	----
12.00	1.85	140	1080	855	675	----
13.50	1.95	180	1080	855	675	----

C. The relationship between breaking strength and circumference at 1.8 m. from the butt shall be established for each class of poles offered under this specification by one of the following methods:

1. By reference to previously performed full-length tests on a statistically significant number of poles in the indicated strength classes. Such tests, if performed by the manufacturer, shall be certified by a competent independent authority such as a National Forestry Agency, University Forestry Department or an approved timber inspection agency.
2. By tests witnessed by the Purchaser for the purpose of certifying compliance under this specification. Such tests shall be performed to the breaking point on at least five treated poles in each class offered.

Minimum circumferences shall be determined by calculations utilizing the actual dimensions and modulus of rupture of the specimens.

3. By reference to such other data as the Purchaser may deem acceptable.

Division II-Technical Specifications
PART 1 - WOOD POLES

- D. Flexibility of poles offered under this specification shall be established by the manufacturer from test data or by other means. The minimum displacement of the top of the pole when tested in accordance with 1.11 B shall not be less than the values indicated in Table 3.

1.12. INSPECTION AND ACCEPTANCE

- A. Inspection of poles shall be made in accordance with REA STD DT-19, "Quality Control and Inspection of Timber Products".
- B. A lot is defined as the total set of poles of the same type, class and length, presented for inspection at one given time.
- C. If the classing procedure of 1.11 C, paragraphs 1. or 3. is used, a sample of 0.1% (one tenth of one percent), or a minimum of one piece, of each lot shall be subject to a flexural strength test. This test shall be conducted up to the breaking point of the specimen.
- D. In the event of failure of the test piece, at less than 90% of rated load or displacement, five more poles of that lot shall be tested to failure. Failure of more than one of these at less than 90% of rated load, or displacement shall be considered grounds for rejection of the entire lot.
- E. Acceptance shall conform to the procedure in REA STD DT-19, and the Inspector and Manufacturer shall undersign the corresponding certificates.

Division I - Invitation for Bids
PART 1 - NOTICE AND INSTRUCTION TO BIDDERS

1.1 GENERAL

- A. Sealed proposals for the furnishing and delivery of line hardware and equipment for a Rural Electrification Project, to be financed pursuant to a Loan Agreement between the Government of The Republic of Bolivia and the Agency for International Development (AID) will be received by the Empresa Nacional de Electricidad, S.A. (ENDE) hereinafter called the Purchaser at the offices of ENDE, calle Colombia 0-655, Cochabamba, Bolivia, by Twelve hundred hours (12:00) on.....1986. The Proposals will be opened and read publicly in the offices of the Empresa Nacional de Electricidad, S.A. at fifteen hundred hours (15:00) on the same day. Any proposal received subsequent to the time specified will be returned promptly to the Bidder unopened. All bids and bid guarantees shall remain valid for a period of not less than one hundred and Twenty (120) days. The Purchaser reserves the right to reject any and all proposals.

1.2. DESCRIPTION OF PROJECT

- A. The Rural Electrification Project in the area of El Chapare, provinces Carrasco and Chapare of the Department of Cochabamba, Republic of Bolivia will consist of the following:
- One 220 kV-34.5 kV step-down substation
 - **108.0** Km. primary distribution lines in 34.5/19.9 kV and 19.9 kV
 - 56.3 km secondary distribution lines in 380/220 V and 220 V
 - 2875 kVA distribution Transformers
 - 2300 service drops
 - Sectionalizing and protection installations

1.3. BIDS OF MANUFACTURERS AND SUPPLIERS

- A. Manufacturers of the materials included in this Invitation for Bids may bid directly in their name, if qualified to submit a proposal under the terms and conditions herein.
- B. Suppliers and manufacturer's representatives or agents may also submit proposals if qualified under the terms and conditions herein. Such proposals, however, must be accompanied by a certified letter (s) from manufacturer(s), or other evidence satisfactory to the Purchaser, that the Bidder is

Division I - Invitation for Bids.
PART 1 - NOTICE AND INSTRUCTION TO BIDDERS

authorized to bind the manufacturer to furnish and deliver the materials for which a bid is submitted and that all materials and equipment so supplied will be warranted by the manufacturer as required herein.

1.4 OBTAINING BID DOCUMENTS

- A. Complete sets of Bidding Documents, including proposal forms, specifications and contract documents may be obtained from The Empresa Nacional de Electricidad, S.A., P.O. Box 565, Cochabamba, Bolivia, Telex 6251 BV, for the price ofUS\$.

1.5 SOURCE AND ORIGIN

- A. The Agency for International Development (AID) has granted a Loan (AID Loan Number 511-T-067) to the Government of the Republic of Bolivia to assist in financing the Rural Electrification Project in El Chapare. In accordance with the conditions of the AID Loan Agreement, all materials and related services comprising this public bid will have their source and origin in the United States of America and "selected free world countries" as designated by AID Geographical Code 941, including the Republic of Bolivia (See Exhibit H).
- B. With respect to distribution materials and equipment the origin thereof is the country in which such material was mined, grown, or produced through manufacturing, processing, or assembly; the source thereof is the country or territory from which such commodity is shipped to the borrower country, except that when equipment or materials are shipped to the borrower country from a free port or bonded warehouse in the form in which received therein, source means the country or territory from which equipment or material was shipped to such free port or bonded warehouse, except that if the equipment or material is located in the borrower country at the time of its purchase for the project, source means the borrower country. A produced commodity shall be deemed of borrower-country origin if as a result of such manufacturing, processing, or assembly in the borrower country, a commercially recognized new commodity results that is substantially different in basic characteristics or in purpose or utility from any of its imported components. Items of equipment or materials which are normally imported for sale to meet a general demand in the borrower country for the item shall be deemed of borrower country origin,

Division I - Invitation for Bids.
PART 1 - NOTICE AND INSTRUCTION TO BIDDERS

provided:

1. They have been imported from the United States or other 941 Code countries for commercial resale and in the case of equipment, machinery and vehicles, their resale value does not exceed \$us. 2,000 per item, provided that the latter value restriction may be waived by AID on a case by case basis when it is satisfied that the equipment, machinery, or vehicles involved have not simply been trans-shipped through the United States but are actually of United States origin. No total value limitation is placed on the purchase of materials, supplies, and tools imported from the United States or other 941 Code countries and available for off-the-shelf procurement in the borrower country except the aggregate amount of local currency financed by AID for the project as a whole.
 2. That if they have been imported from AID Geographic Code 935 (See Exhibit "G") source outside the United States, the total invoice value of any single transaction does not exceed the local currency equivalent of \$us. 500 and the total purchase value of all such transactions does not exceed \$us. 50,000 in local currency equivalent or five percent (5%) of the total AID loan, whichever is less.
- C. No produced commodity whether of United States or borrower country source and origin shall be eligible for AID financing if such commodity contains any component from a Communist Block country (i.e., a country not specified in AID Geographic Code 935).
- D. No produced commodity shall be eligible for AID financing:
1. If such commodity contains any component or components which were imported into the producing country; and
 2. Such components were acquired by the producer in the form in which they were imported; and
 3. The total cost of such components (delivered at the point of production) amounts to more than fifty percent (50%) of the lowest price (excluding the cost of ocean transportation and marine insurance) at which the supplier makes the

Division I - Invitation for Bids.
PART 1 - NOTICE AND INSTRUCTION TO BIDDERS

commodity available for export sale, whether or not financed by AID. Components from the other eligible source countries and from Bolivia may be used without limitation in applying this percentage rule.

- E. No produced commodity shall be eligible for AID financing if such commodity has been transported to the borrower country:
 - 1. By transportation medium owned, operated, or under the control of any Communist Block country (i. e., a country not specified in AID Geographic Code 935).
 - 2. On a vessel which AID, by written notice to ENDE, has designated as ineligible.
 - 3. Under any ocean or air charter which has not received prior approval by AID.
- F. In the case of insurance, source and origin means the country in which such insurance is placed. Insurance shall be deemed to be placed in a given country only if payment of the insurance premium is made to an insurance company office located in such country and the insurance policy is issued by an office in such country.
- G. In the case of delivery services, source and origin means the country in which such services are rendered. With respect to ocean or air freight, it means the flag of the carrier vessel or air craft.
- H. In the case of incidental services, source and origin means the source of equipment to which such services relate.
- I. Certification of Source and Origin shall be included with each invoice in the form attached hereto (See Exhibit A.).

1.6. SHIPPING

- A. AID Loan funds may be used to pay freight and insurance costs only if:
 - 1. Goods financed under this loan are transported by flag carriers of countries included in AID Geographic Code 941, and Bolivia, and
 - 2. The insurance is placed in Bolivia or a country included in AID Geographic Code 941.

Division I - Invitation for Bids.
PART 1 - NOTICE AND INSTRUCTION TO BIDDERS

- B. AID regulations, as stated in the Loan Agreement, are as follows:
1. Goods procured from a Code 941 country, and financed under the Loan, may be transported to Bolivia on flag carriers of any country included in Code 935 of the AID Geographic Book as in effect at the time of shipment.
 2. Unless AID shall determine that privately-owned United States flag commercial vessels are not available at fair and reasonable rates for such vessels;
 - a. At least fifty percent (50%) of the gross tonnage of Code 941 goods financed under the Loan and transported on ocean vessels from United States ports (computed separately for dry bulk carriers, dry cargo liners and tankers) shall be transported on privately-owned United States-flag commercial vessels' and at least fifty percent (50%) of the gross freight revenue generated by ocean shipments of Code 941 goods financed under the Loan and transported on dry cargo liners from United States ports shall be paid to or for the benefit of privately-owned United States-flag commercial vessels; and
 - b. At least fifty percent (50%) of the gross tonnage of all Code 941 goods financed under the Loan and transported on ocean vessels from non-United States port (computed separately for dry bulk carriers, dry cargo liners and tankers) shall be transported on privately-owned United States-flag commercial vessels; and at least fifty percent (50%) of the gross freight revenue generated by ocean shipments of Code 941 goods financed under the Loan and transported on dry cargo liners from non-United States Ports shall be paid to or for the benefit of privately-owned United States-flag commercial vessels. No such goods may be transported on any ocean vessel or aircraft (i) which AID, in a notice to the borrower, has designated as ineligible to carry AID financed goods or (ii) which has been chartered for the carriage of AID financed goods unless such charter has been approved

Division I - Invitation for Bids.
PART 1 - NOTICE AND INSTRUCTION TO BIDDERS

by AID.

3. Marine insurance on Code 941 goods may be financed under the Loan with disbursements made pursuant to Section 7.01 of the Loan Agreement, provided (i) such insurance is placed at the lowest available competitive rate in Bolivia or in a country included in Code 941 of the A.I.D. Geographic Code Book as in effect at the time of placement, and (ii) claims thereunder are payable in freely convertible currency. If in connection with the placement of marine insurance on shipments financed under United States legislation authorizing assistance to other nations, Bolivia, by statute, decree, rule or regulation, favors any marine insurance company of any country over any marine insurance company authorized to do business in any state of the United States of America, Code 941 goods financed under the Loans shall, during the continuance of such discrimination, be insured against marine risk in the United States of America with a company or companies authorized to do marine insurance business in any state of the United States of America.
 4. The borrower shall insure, or cause to be insured, all goods from Code 941 countries financed under the Loan against risks incident to their transit to the point of their use in the Project. Such insurance shall be issued upon terms and conditions consistent with sound commercial practices, shall insure the full value of the goods, and shall be payable in any freely convertible currency. Any indemnification received by the borrower under such insurance shall be used to replace or repair any material damage or any loss of the goods insured or shall be used to reimburse the borrower for the replacement or repair of such goods, or shall be used for repayment of this Loan. Any such replacements shall have their source and origin in countries included in Code 941 of the AID Geographic Code Book as in effect at the time orders are placed or contracts are entered into for such replacements, and shall be otherwise subject to the provisions of this Agreement.
- C. Suppliers will make every effort to ship goods on U.S. flag carriers, and if such carriers are not available, on flag carriers of countries included in AID

Division I - Invitation for Bids.
PART 1 - NOTICE AND INSTRUCTION TO BIDDERS

Geographic Code 941. Although permitted, flag carriers of countries included in AID Geographic Code 935 should be used only when those from 941 countries are not available. The supplier must obtain permission from ENDE when he plans to use means of ocean transportation other than U.S. flag carriers.

1.7. SUBMISSION OF PROPOSALS

- A. The Bidder's proposal shall be submitted in a sealed envelope, marked "A", which shall contain two inner sealed envelopes marked "B" and "C" respectively, and which shall be also clearly marked as follows:

Proposal for Distribution Hardware and Equipment
Chapare Rural Electrification Project
Envelope "A"

- B. One of the two inner sealed envelopes shall be marked as follows:

Envelope "B": Documents

This envelope shall contain the following:

- a). Statement of Qualifications as per Clause 1.14, Part 1, Division I
- b). Bolivian firms presenting proposals of their own, or acting as representatives of foreign firms shall present:
 - Documents certifying the legal existence of the firm.
 - Certificate of compliance with taxes and Tributes (Solvencia Tributaria).
 - Certificate of Fiscal Solvency extended by the Contraloria General de la Republica.
 - Certificate of inscription in the Direccion de Comercio, Ministerio de Industria y Comercio.
 - Certificate of inscription in the Camara de Industrias or Camara de Comercio.
- c) A foreign firm shall present documentation relative to its constitution, duly legalized in its country of origin.

Division I - Invitation for Bids.
PART 1 - NOTICE AND INSTRUCTION TO BIDDERS

- d) Other formalities as required by these Bidding Documents.
- C. The second sealed inner envelope shall be marked:
Envelope "C": Proposal, and shall contain the following:
- a) The Bidder's Check List (Part 2, Division I)
 - b) The Bidder's Proposal, in original and three (3) copies on the forms supplied herewith, with attachments as required.
 - c) The Proposal Prices, in original and three (3) copies, as explained in Clause 1.8, Part 1, Division I of these documents.
 - d) The Bid Bond (clause 1.9, Part 1, Division I).
 - e) The Delivery Schedule on the forms supplied herein.
 - f) According to the requirements of the Bolivian Law, stipulated in the "Decree No. 10120" dated February 2nd, 1972, all Bidders shall include with their proposal: (i) one sheet of Sealed Paper of current nominal value for each sheet of the submitted Proposal Forms, and (ii) Legal Stamps, for a nominal value of one per ten thousand (1/10,000) of the total amount of the Proposal.
- Instead of Sealed Paper and Legal Stamps, the Bidder who cannot obtain these may comply with the requirements of this Clause by issuing a check for an amount equivalent to nominal value of said Sealed Paper and Legal Stamps. For purpose of converting \$b. (Bolivian Pesos) to \$us. (U.S. Dollars), the exchange rate to be used shall be the official rate standing at the date of submission of proposal.
- This check shall be issued in U.S. Dollars to the name of Empresa Nacional de Electricidad, S.A. The above mentioned sum will not be refunded to the Bidders.
- E. If the Bidder is a partnership, the proposal must be signed in the partnership name by a

Division I - Invitation for Bids
PART 1 - NOTICE AND INSTRUCTION TO BIDDERS

partner. If the Bidder is a corporation, the proposal must be signed in the corporate name by a duly authorized officer and the corporate seal affixed and attested by the secretary of the corporation.

- F. Proposals shall be in the English or English/Spanish languages.
- G. All the proposal form pages shall be signed. The signature or signatures at the end of the proposal form shall be duly attested by an authorized Notary Public from Bolivia or authorized Notary Public in the country of origin and certified by the relevant Bolivian Consulate.

1.8. UNIT PRICE PROPOSAL

A. Bidders shall quote their prices including insurance and applicable freight on the Material Schedule Sheets included herewith. The following prices shall be written in U.S. Dollars :

- a) Unit Prices F.O.B. Port of Embarcation. (Firm basis).
- b) Total Prices C.I.F. Port of Entry. (Santos, Brazil, Buenos Aires, Argentina; Matarani, Perú; Antofagasta, Chile are recommended as ports of entry for U.S.A. Bidders) (Estimated basis).
- c) Total Prices C.I.F. Point of Destination which will be indicated in the relevant Delivery Schedule. (Estimated basis).
- d) Ocean and land freight shall be based upon current rates. These prices will be adjusted upward or downward to the rates in effect on the date of shipment or on the date indicated in the relevant delivery schedules, whichever is the earlier date, for (b) and (c) above. Any insurance or freight charges in a quotation considered unreasonable by ENDE or AID will be grounds for rejection of bids. The basic price for study, evaluation, and adjustment will be (b) above. In the event of variation between unit price and extended price, the unit price shall govern.

B. Proposals may be submitted for one or more of the

Division I - Invitation for Bids.
PART 1 - NOTICE AND INSTRUCTION TO BIDDERS

Material Schedules, but each individual Schedule for which a proposal is submitted must be bid in its entirety. Bids of partial Schedules will not be accepted.

1.9. CURRENCY

- A. Price quotations shall be expressed in U.S. Dollars.
- B. Payments for all materials and services under the present Invitation for Bids shall be made in U.S. Dollars.

1.10. BID BONDS

- A. Each proposal must be accompanied by a bid bond valid for not less than one hundred and twenty (120) days from the date of the opening of the bids, in the form attached hereto, with sureties issued by a Bank acceptable to the Purchaser, or a cashier's check in United States Dollars, issued by any reputable banking institution, payable to the order of the Purchaser, in an amount at least equal to ten (10) percent of the maximum bid price. A Letter of Credit in equal amount and time period, approved by the Purchaser may be furnished in lieu of the Bid Bond.

Each Bidder agrees that said proposal shall be firm and binding upon each such Bidder until a proposal is accepted and a satisfactory performance bond is furnished by the successful Bidder, or for a period not to exceed one hundred twenty (120) days from the date set for the opening of the proposals, whichever is the lesser period.

- B. The Bid Bond will be returned to all Bidders except the three (3) lowest responsive Bidders within thirty (30) calendar days from the bid opening date.
- C. Within five (5) calendar days after the Purchaser and the successful Bidder have signed the Contract, the Bid Bond will be returned to the remaining (2) two Bidders. The Bid Bond of the successful Bidder will be returned by the Purchaser when the Contract is signed and the Performance Bond has been received and accepted by the Purchaser.

1.11. PERFORMANCE BONDS

- A. The successful Bidder shall be required to execute three (3) additional copies of his proposal and to furnish a Performance Bond in triplicate in the form

Division I - Invitation for Bids.
PART 1 - NOTICE AND INSTRUCTION TO BIDDERS

attached hereto with sureties acceptable to the Purchaser in a penal sum not less than thirty (30) percent of the contract price within 30 days after written notice of the acceptance of the proposal. Performance Bonds shall extend for a period not less than one year from the date of completion of the delivery of the materials to the point designated in the Delivery Schedule. A bank guarantee or Letter of Credit in equal amount and period from any banking institution approved by the Purchaser may be furnished in lieu of the Performance Bond.

1.12. REFUSAL TO EXECUTE CONTRACT

- A. Should the successful Bidder fail or refuse to execute such copies of the proposal or to furnish a Performance Bond within thirty (30) days after written notice of the acceptance of the proposal by the Purchaser, the Bidder will be considered to have abandoned the proposal. In that event, the Purchaser shall be entitled to enforce the Bid Bond in accordance with the terms or to retain the proceeds of a certified check, and the Purchaser may in good faith contract with another Bidder for the supply of the materials, refunding the excess, if any, in which the Bid Bond or cashier's check exceeds the difference between the amount of the contract and the amount of the abandoned proposal.

1.13. ELIGIBLE BIDDERS

- A. No firm included on the list of suspended, debarred or ineligible Bidders maintained by AID will be eligible to bid individually or in a Joint Venture, or be financed by AID as a sub-contractor or otherwise. No United States firm, nor any other firm which is more than fifty (50%) percent beneficially owned by a United States firm, shall be eligible for AID financing if the firm is not in compliance with its equal opportunity obligations under Executive Order 11246, as amended, and regulations and orders issued thereunder.

1.14. QUALIFICATIONS OF BIDDERS

- A. All Bidders shall furnish with their bids a Statement of Qualifications on the form attached as Exhibit E stating dollar volumes which the Bidder has produced and/or sold in the past four years of the types of materials in each of the Material Schedules for which a proposal is submitted.

Division I - Invitation for Bids.
PART 1 - NOTICE AND INSTRUCTION TO BIDDERS

- B. The statement shall include a list of major contracts and sales with names and complete addresses of individuals knowledgeable of the Bidder's qualifications for the production and/or delivery of the materials specified.
- C. The Purchaser reserves the right to reject the bid of any Bidder if in his judgement the qualification information is incomplete, or information submitted or obtained from references indicates that the Bidder is not fully qualified to supply the materials according to specifications within the delivery period stated in the Delivery Schedule.

1.15. DELIVERY SCHEDULE

- A. Maximum delivery periods shall be those specified in the Delivery Schedule, for delivery C.I.F. port of entry. Bidders shall estimate delivery periods to the point of destination.

1.16. BASIS FOR CONTRACT AWARD

- A. Contract awards shall be made for each individual Material Schedule to the lowest cost qualified responsive Bidder whose proposal accepts all of the terms and conditions of the Contract Documents described in Clause 3.2 of the Bidder's Proposal.
- B. A responsive bid is one which accepts all of the terms and conditions of the Contract Documents without material modification. A material modification is one which affects in any way the price, quantity, quality, scope, delivery date, or completion date of equipment or materials or other services to be supplied or performed; or which limits in any way any responsibilities, duties, or liabilities of the Bidder or any rights of the Purchaser or of AID, as any of the foregoing have been specified or defined in the Invitation for Bids, and may be cause for rejection of the Proposal. The Purchaser may waive any minor informality in a bid which does not constitute a material modification. The Purchaser also reserves the right to reject any and all bids.
- C. No Bidder shall have the right after the bid closing time to change a bid which is unresponsive in order to make it responsive or otherwise make any changes in the bid.

Division I - Invitation for Bids
PART 1 - NOTICE AND INSTRUCTION TO BIDDERS

- D. To be considered for award a bid must be responsive to the Invitation for Bids and be considered by ENDE and AID to meet the test of price, quality, delivery and completion date of project. The award shall be made to that qualified Bidder whose bid, responsive to the Invitation for Bids, is both reasonable and lowest in price (U.S. dollars) after adjustment by arithmetical computation to account for any factor other than price required or permitted by the Invitation for Bids to be considered in the evaluation of bids.

1.17. ADDENDA, TELEGRAPHIC BIDS

- A. Bidder may request, in writing, not less than twenty (20) days before the date of the bid opening, from the Purchaser any interpretation or correction of any ambiguity, inconsistency, or error in the bidding documents. Such interpretations or corrections will be issued in writing, by means of a letter which will be sent by mail to each person recorded as having received the required sets of bidding documents.
- B. Any addenda, amendment or revision to this Notice and Instruction to Bidders shall be sent by certified airmail to all prospective Bidders of record not less than fifteen (15) days prior to the time and date set for the opening of bids. Such addenda, amendment or revision must be considered in the bid and shall be properly signed and returned with the proposal.
- C. Telegraphic bids will not be considered, regardless of when received. Modifications of completed bids made by telegram or cable and received prior to the time of the opening of bids will be evaluated only in the form received by the Purchaser, regardless of transmittal errors.
- D. Any modification of the Bidding Documents, prior to bid opening, will be issued by addendum, telex, cable or letter, and approved by AID; copy of same will be delivered to each Bidder. The Bidder shall confirm in writing his receipt of each addendum.

1.18. LATE BIDS

- A. Bidders shall assume all responsibility for the delivery of proposal or modifications thereof to the office of ENDE, prior to the date and time set for the opening of proposals. A late bid will not be considered even though it became late because of factors beyond the Bidder's control, such as delays

Division I - Invitation for Bids.
PART 1 - NOTICE AND INSTRUCTION TO BIDDERS

in mail handling, telegraphic transmission or customs clearance. A late bid will be considered only when such bid is received at the place designated prior to award and when the sole cause for its becoming late is due to mishandling on the part of ENDE, its employees, or agents.

1.19. EXPORT LICENSES AND TAXES

- A. The cost of Consular Invoices or any export licenses or taxes imposed by the source country or transportation taxes of any kind shall be obtained and paid for by the Bidder.

1.20. IMPORT DUTIES AND TAXES

- A. All materials delivered to the points of destination specified in the Delivery Schedule shall be exempt from all import duties and taxes.
- B. The Purchaser shall provide the Bidder with the necessary documentation to make effective such exemptions.

1.21. CONTRACT IS ENTIRE AGREEMENT

- A. The contract to be effected upon acceptance of the Proposal shall be deemed to include the entire agreement between the parties thereto, and the Bidder shall not claim any modification thereof resulting from any representation or promise made at any time by an agent, officer or employee of the Purchaser, or any other person.

1.22. LEGALIZATION OF CONTRACT

- A. The costs of legalization of the Contract shall be borne in equal amounts by the Purchaser and the Bidder, except when the Purchaser is exempt of such payments, in which case the Bidder shall pay his corresponding part of the costs.

Division I - Invitation for Bids .
PART 1 - NOTICE AND INSTRUCTION TO BIDDERS

1.23. WITHDRAWAL OF BIDS

- A. Bids may be withdrawn by written request to ENDE any time prior to the date of opening of bids.

1.24. TIME AND SCHEDULES

- A. All references to times and periods in these Documents are understood to be in calendar days, unless otherwise specifically stated.

EMPRESA NACIONAL DE ELECTRICIDAD S.A.

Ing. Claude Bessé Arze
Gerente General

Division I - Invitation for Bids .
PART 2 - BIDDER'S CHECK LIST

Documents that form part of the Bidder's Proposal

The Bidder must fill in, in ink:

I _____ certify that
the following documents form part of this Proposal
Number _____, dated _____

2.1. Bidding Documents: Division I, Part 1 through
7, and Division II, Parts 1 through.

2.2. Addenda Nos. _____

2.3. Bidder's Statement of Qualification as Exhibit
No. _____

2.4. Bid Bond for an amount of \$us _____
issued by _____

2.5. Shipping time estimate (See Division I, Part 7,
Delivery Schedule) as exhibit No. _____

2.6. Authorization of the _____
_____ as Exhibit No. _____
_____ (See Division I, Part 1 Notice
and Instruction to Bidders).

2.7. Certificate that the materials offered will be
manufactured and supplied in strict accordance
with the conditions prescribed by AID, duly
issued by _____, and duly attested
by _____, as Exhibit No. _____.

Division I - Invitation for Bids
PART 2 - BIDDER'S CHECK LIST

2.8. Affidavits that the Bidder and/or the manufacturer of the materials or equipment are not included on the list of suspended, debarred or ineligible Bidders maintained by the United States General Service Administration, United States Comptroller General, or the Department of Labor or maintained by AID, issued by:

and such affidavits shall be duly attested by a Notary Public and included by the Bidder with his proposal as Exhibit No. _____.

2.9. Affidavits that the equipment quoted has been thoroughly proven in commercial operation, issued by: _____

and such affidavits shall be duly attested by a Notary Public and be included by the Bidder with his proposal as Exhibits No. _____

2.10. Descriptive Technical Information as detailed: _____

as Exhibits Nos. _____

2.11. Others _____

as Exhibits Nos. _____

Bidder's Signature

Title

Secretary

Date _____

Mailing Address _____

Division I - Invitation for Bids
PART 3 - BIDDER'S PROPOSAL

3.1. OFFER TO FURNISH

A. The undersigned (hereinafter called the Bidder) hereby proposes to furnish and deliver distribution hardware and equipment for the rural electrification project in El Chapare, executed by the Empresa Nacional de Electricidad, S.A. (hereinafter called the Purchaser, ENDE) in strict accordance with the terms and conditions of the Proposal, Material Schedules, Delivery Schedule, and Technical Specifications attached hereto and made a part thereof, for the prices hereinafter stated.

3.2. DESCRIPTION OF CONTRACT

A. The following parts shall constitute the Contract, all of which are included in meaning of term "Contract Documents" as used herein.:

1. Notice and Instructions to Bidders.
2. Bidders Check List.
3. Bidders Proposal.
4. Acceptance.
5. Proposal Summary .
6. Material Schedules.
7. Bid Bond.
8. Performance Bond.
9. Delivery Schedule.
10. Technical Specifications.
11. Numbered Addenda issued to foregoing.

3.3. FAMILIARITY WITH CONDITIONS

A. The Bidder certifies that he has carefully examined the Contract Documents as described in "Description of Contract" herein, and that he is aware of the location of the point of destination of the distribution

Division I - Invitation for Bids
PART 3 - BIDDER'S PROPOSAL

hardware and equipment, the transportation facilities available, and any other factors which would affect price and delivery of such materials and equipment.

The Bidder therefore gives up any claim he may have based on lack of knowledge or information, or deficiencies or misinterpretation of such information, including the present Contract Conditions and Technical Specifications.

3.4. BID WITHOUT COLLUSION

- A. The Bidder warrants that his proposal is made in good faith and without collusion or connection with any other person or persons.

3.5. FINANCIAL RESOURCES

- A. The Bidder warrants that he possesses adequate financial resources and agrees that in the event this proposal is accepted he will furnish a Performance Bond properly executed by a bank or surety company acceptable to the Purchaser in a penal sum not less than thirty percent (30 %) of the Contract Price.

3.6. PROPOSAL ON UNIT BASIS

- A. The Bidder understands and agrees that the various items on which bids are made in this proposal are on a unit basis.

Division I - Invitation for Bids
PART 3 - BIDDER'S PROPOSAL

3.7. TIME OF DELIVERY

- A. The Bidder agrees to complete delivery within the period specified in the Delivery Schedule. Delivery period shall begin on the date of issuance of the Letter of Commitment and shall be completed upon delivery to port of entry as shown by the corresponding Customs Documentation.

3.8. WARRANTY

- A. Bidder warrants that all distribution hardware, materials and equipment to be furnished under this proposal shall be free of defects in workmanship and materials and shall be of the kind and quality specified herein. If, within one year from date of delivery to the point of destination specified in the Delivery Schedule, the Purchaser discovers defects in workmanship and/or material and so notifies the Bidder promptly in writing, the Bidder shall remedy such defects or nonconformance to specifications at his expense by repair or replacement at the option of the Purchaser within sixty (60) days of such notification.
- B. In addition, successful Bidder shall furnish for the benefit of the Purchaser standard warranties and guarantees for all materials and equipment furnished under this contract.
- C. All manufacturer's warranties and guarantees on distribution materials and/or equipment shall be transferred and assigned to Purchaser.

3.9 TESTS AND INSPECTIONS

- A. Bidder shall furnish Purchaser a certificate in the form attached that all products have passed applicable standards association tests, standard factory inspection and tests, and/or specific tests as may be required by the Technical Specifications herein. Cost of these tests shall be for the account of the Bidder.
- B. Purchaser or his authorized representative, at his expense, shall have the right to inspect and test products during manufacture and prior to shipment. If requested by Purchaser, the Bidder shall advise Purchaser at least two weeks in advance of date or dates products will be ready for inspection and

Division I - Invitation for Bids
PART 3 - BIDDER'S PROPOSAL

testing.

- C. The Bidder shall provide the Purchaser, within reason, the instruments, materials, labor and facilities required for the assays and tests needed to verify the quality of the materials and/or equipment supplied.
- D. The Purchaser's representative(s) shall have free access at all times to the manufacturer's premises in order to inspect the materials and/or equipment supplied under this Contract. The Bidder shall facilitate all documents pertaining to the materials, work in progress and the execution of this Contract.
- E. Bidder shall promptly replace defective materials or items not conforming to specifications found by such inspection prior to shipment. However, no decision by the Purchaser or its authorized representative shall be deemed to relieve the Bidder of full and complete performance of its obligations to supply the materials and equipment in full conformity with the specifications.

3.10. FINAL INSPECTION AND ACCEPTANCE

- A. The Purchaser shall inspect all materials and equipment delivered to the point of destination specified in the Delivery Schedule within sixty (60) days of the date of such delivery. Materials and equipment conforming to specifications shall be accepted for final payment, provided all required certificates and documents have been delivered to Purchaser.
- B. Any inspection shall not relieve the Bidder from full responsibility for furnishing the materials and equipment conforming to the specifications herein, nor prejudice any claim, right or privilege which Purchaser may have under the warranty of the Bidder.

3.11. PATENTS

- A. The Bidder shall save harmless and indemnify the Purchaser from any and all claims, suits, and proceedings for the infringement of any patents covering any of the materials or equipment accepted in this Proposal, and delivered under this Contract.

Division I - Invitation for Bids
PART 3 - BIDDER'S PROPOSAL

3.12. CHANGES AND MODIFICATIONS

- A. It is mutually understood that prior to shipment, certain changes within the general scope of the work may require amendments in quantities, specifications, method of shipment or packing or delivery, and such changes will not impair the Contract. Therefore Purchaser may, at any time after acceptance of a proposal and prior to shipment by the Bidder from the factory, make changes in the Contract regarding Technical Specifications, method of shipment or packing or place of delivery. If any such changes causes an increase or decrease in the cost of the materials or equipment or time required for delivery, an equitable adjustment shall be made in the Contract price or delivery schedule, or both, and the Contract shall be modified in writing accordingly.
- B. Any claim by the Bidder for adjustment under this clause must be made in writing within thirty (30) days from the date of receipt by the Bidder of notification of change. Failure to agree to any adjustment shall be matter of dispute concerning a question of fact within the meaning of this clause as defined in Part 3, Section 3.25, "Disputes and Arbitrations".
- C. Where the cost of work made obsolete or in excess as a result of a change is included in the Bidder's claim for adjustment, the Purchaser may have the right to prescribe the manner of disposition of such work.
- D. Bidder agrees that the Purchaser shall have the right to increase the quantities of any item in the Material Schedules by not more than twenty-five (25%) percent or to decrease the quantities of any item in the Material Schedules by not more than ten (10%) percent of the quantity specified therein at the same unit price, provided that notification of the exercise of such option is made within ninety (90) days of acceptance of this proposal. The Bidder agrees to deliver any such additional orders within sixty (60) days after the completion date specified in the original Contract. Any decreased orders shall be delivered according to the schedule specified in the original Contract.
- E. No modification of the Contract to be effected upon acceptance of a Bidder's proposal may be made except in writing signed by the Bidder and the Purchaser. Any such modification shall require prior approval of

Division I - Invitation for Bids
PART 3 - BIDDER'S PROPOSAL

AID.

3.13. SHIPPING

- A. Maritime and/or land transportation shall be prepaid by the Bidder from the factory to the point of destination stipulated in Division I, PART 7, Delivery Schedule.
- B. For the convenience of the Purchaser, the total cost of international freight shall be separately itemized on all Commercial Invoices.

3.14. INSURANCE

- A. The Bidder shall provide, at his expense, insurance covering transportation of materials and equipment to be delivered under this proposal from warehouse of the Bidder to the site specified in Part 7, Division I, Delivery Schedule.
- B. Such insurance shall be upon terms and conditions consistent with sound commercial practice for one hundred ten (110%) percent of the full C.& F. value of the materials and equipment and for a period not less than ninety (90) days after arrival of the materials and equipment at the point of destination specified in the Delivery Schedules. The insurance may be issued by any company or companies authorized to do a marine insurance business in any state of the United States and/or any country designated by AID Geographic Code 941, including the Republic of Bolivia, and the proceeds shall be payable to the Purchaser in United States dollars.
- C. For the convenience of the Purchaser, the total cost of insurance from the port of exportation to the port of entry and to the point of destination specified in the Delivery Schedule shall be separately itemized on all Commercial Invoices.

3.15. METHOD OF PAYMENT

- A. All payments to the Bidder for distribution materials and equipment furnished under this proposal will be made under a Direct Letter of Commitment opened by AID in favor of the Bidder, in the amount for which the proposal is accepted, as follows:
 - a) Ninety percent (90%) of each invoice shall be paid upon delivery of materials and equipment to the

Division I - Invitation for Bids
PART 3 - BIDDER'S PROPOSAL

Port of Exportation as evidenced by the documents described in Clause 3.16 below.

- b) The remaining ten percent (10%) of each invoice shall be paid upon presentation of the corresponding Certificate of Acceptance issued by ENDE on the delivery of materials and equipment at the Final Delivery Point, except that such final payment shall not be retained for more than sixty (60) days following delivery, unless withheld due to fault of the Bidder as stated in Clause 3.18..

3.16. DOCUMENTS FOR PAYMENT

- A. For payment of 90% of each invoice the Bidder must submit to ENDE:
 - a) AID form FE-1034 in original and three (3) copies.
 - b) The Supplier's Commercial Invoice in original and three (3) copies.
 - c) The Bill of Lading, Consular Invoice, Insurance Certificate and the Freight Invoice.
 - d) Certificate of Source and Origin as required by AID.
 - e) Supplier's Certificate and AID Agreement form F-1450-4.
 - f) Certificate of inspection issued by the Purchaser or its authorized representative.
- B. For payment of the remaining 10% of each invoice the Bidder shall submit the Certificate of Acceptance issued by ENDE (Clause 3.15 above).

3.17. DESCRIPTION OF DOCUMENTS FOR PAYMENT

- A. Commercial (Supplier's) Invoice and AID Required Documents shall show, in addition to the date and invoice number, the contract number, item numbers and description of materials as listed in the Material Schedule, quantity of each shipped item, unit and total price of each item, total invoice price, and the total cost of insurance and total cost of freight included in the total invoice price.

Division I - Invitation for Bids
PART 3 - BIDDER'S PROPOSAL

The original of the Commercial (Supplier's) Invoice must be accompanied by the original of a Contractor's Certificate (AID Form F-1450-4). Each copy of the invoice must be accompanied by a copy of this certificate. Standard Form No. FE-1034, and other documents required by AID shall also be submitted. Specimens of the Contractor's Certificate (AID F-1450-4) and Standard Form FE-1034 are included in Division III.

- B. Bills of Lading shall show port of embarkation, name of vessel, if applicable, or date and information on carrier, date of loading and port of entry (destination), invoice and packing list number, and total amount of freight charge, clearly marked 'PREPAID'.
- C. Bidder's Certificate in the form attached hereto.
- D. Certificate of Source and Origin in the form attached hereto.
- E. Certificate of Insurance showing full coverage as specified in Clause 3.15, Insurance.
- F. Consular Invoice specifying distribution materials and equipment shipped and value as specified by total amount of Commercial (Supplier's) Invoice.
- G. Detailed Packing List shall include contract number, item number, package numbers and type of package, net and gross weight in kilograms of each package and total net and gross weight in kilograms of entire packing list.

3.18. PAYMENT DURING DEFAULT

- A. No payments shall be due while the Bidder is in default in respect to any of the provisions of this Contract.

3.19. RELEASE OF LIEN

- A. Upon the completion of final delivery of the distribution materials and equipment by the Bidder, the Bidder shall deliver to the Purchaser in duplicate releases of all lien and of rights to claim any lien, in the form attached hereto from all manufacturers, and a certificate to the effect that all materials and equipment delivered for the project have been paid for and that all releases have been

Division I - Invitation for Bids
PART 3 - BIDDER'S PROPOSAL

submitted to the Purchaser. The Purchaser shall have the right to delay final payment to the Bidder until these releases and certificates have been furnished to and approved by the Purchaser.

3.20. COMPLETION ON BIDDER'S DEFAULT

- A. If default shall be made by the Bidder in the performance of any of the terms of this Proposal, the Purchaser, without in any manner limiting its legal and equitable remedies in the circumstances, may serve upon the Bidder and the Surety or Sureties upon the Performance Bond or bonds a written notice requiring the Bidder to cause such default to be corrected forthwith. Unless within twenty (20) days after the service of such notice upon the Bidder such default shall be corrected or arrangements for the correction thereof satisfactory to the Purchaser shall be made by the Bidder or its Surety or Sureties, the Purchaser may prosecute the delivery to completion by Contract or otherwise for the account and at the expense of the Bidder, and the Bidder and its Surety or Sureties shall be liable to the Purchaser for any increase in cost or expense of the Contract price occasioned thereby. The Purchaser in such contingency may exercise any rights, claims or demands which the Bidder may have against third persons in connection with this Contract and for such purpose the Bidder does hereby assign, transfer and set over into the Purchaser all such rights, claims and demands.

3.21. LIQUIDATED DAMAGES

- A. If for any reason the Bidder is unable to make delivery C.I.F. destination as specified in the Delivery Schedule, the Bidder shall promptly notify the Purchaser of the reason for such delay and the date delivery will be made. If such delay is not excused by causes beyond the control of the Bidder as set forth in Clause 3.12 "Changes and Modification", or 3.23. "Force Majeure" herein, the Bidder shall pay the Purchaser as liquidated damages, and not as a penalty, the following amount: 1/2 0/000 (one half per thousand) of the total Contract price for each calendar day for which the Completion of Supply is delayed, up to a maximum of ten (10%) percent of the total Contract price of the delayed materials.
- B. Payment of such liquidated damages which become due to the Purchaser shall be deducted from the remaining payments due to the Bidder.

Division I - Invitation for Bids
PART 3 - BIDDER'S PROPOSAL

3.22 CUMULATIVE REMEDIES

- A. Every right or remedy herein conferred upon or reserved to the Purchaser shall be cumulative, shall be in addition to every right and remedy now or hereafter existing at law or in equity or by statute and the pursuit of any right or remedy shall not be construed as an election, provided, however, that the provision of "Liquidated Damages" herein shall be the exclusive measure of damages for failure by the Bidder to complete the delivery of the distribution materials and equipment within the time agreed upon herein.

3.23. FORCE MAJEURE

- A. Definition: Force Majeure shall mean unforeseeable causes beyond the control and without the fault or negligence of the Bidder, including but not restricted to acts of God or public enemy, fires, floods, epidemics, quarantine restrictions, strikes, freight embargoes, and unusually severe weather, or delays of subcontractors due to such causes.
- B. Notification of Force Majeure: When, in the opinion of the Bidder, force majeure has occurred, the Bidder shall notify the Purchaser not later than ten (10) days after such occurrence as to the date, nature, and possible extent of force majeure.
- C. Termination: If, in the opinion of the Purchaser, the cause of force majeure is sufficient to prevent delivery of the materials and equipment purchased within a reasonable period of time after the delivery specified in the Delivery Schedule, the Purchaser shall have the right to cancel all or any part of the Contract. In the event of such cancellation, the Bidder shall be entitled to payment for all materials and equipment delivered to the port of exportation at the prices set forth herein.

3.24. DISPUTES AND ARBITRATION

- A. Disputes: except as otherwise provided in this Contract, any disputes concerning a question of fact arising under this Contract which are not disposed of by agreement, shall be settled by arbitration.
- B. Arbitration Procedure: if any dispute or controversy arises between the Purchaser and the Contractor relative to or caused by this Contract, the matter shall be referred to and solved by an Arbitration

Division I - Invitation for Bids
PART 3 - BIDDER'S PROPOSAL

Panel. This Arbitration Panel shall consist of three (3) arbiters, one designated by each part within thirty (30) days following the date in which one part notifies the other in writing of its decision to submit the controversy to arbitration; the third member, acting as President of the Panel, shall be designated by the other two members of the Panel within fifteen (15) days following the nomination of the second arbiter. If any of the parts fails to designate its arbiter within thirty (30) days following the written notification of the other part's decision to submit the controversy to arbitration, or if both parts fail to designate the third member, this arbiter shall be nominated by the President of the Sociedad de Ingenieros de Bolivia. If this official declines to effect this nomination, or does not effect it within forty (40) days of receiving his designation, the arbiter shall be nominated by the President of the Consejo Nacional de Ingenieria of Bolivia. No person having personal interest in the controversy shall form part of this Arbitration Panel. The procedure of arbitration shall take place in Cochabamba, Bolivia, under the laws of Bolivia. The decisions of the Arbitration Panel shall be adopted by simple majority and not be subject to appeal, except as noted hereinbelow. The Panel may consult experts who shall advise but will not have the right to vote. A record of proceedings shall be kept and shall be signed by the members of the Panel after each meeting.

- C. Cost of Arbitration: The arbitrators are authorized to award to the party whose contention is sustained, such sums as they shall consider proper for the time, expense and trouble incidental to arbitration including their own expenses. Said sum to be paid by the other party.
- D. Award: the decision of the arbitrators and awards of arbitration shall be in writing, signed by the arbitrators, and delivered by registered mail or personally to the Bidder and the Purchaser who hereby agree to accept said award as binding. This "disputes" clause does not preclude consideration of law questions in connection with decisions provided for in the first paragraph; provided that nothing in this Contract shall be construed as making final the decision of any administrative official, representative, or board on a question of law.

3.25. RELATIONSHIP WITH AID

Division I - Invitation for Bids
PART 3 - BIDDER'S PROPOSAL

- A. This Contract is financed under United States Agency for International Development (AID) Loan No. 511-T-067.

3.26. LEGAL EFFECTS OF CERTAIN AID APPROVALS

- A. The parties hereto understand that AID has reserved certain approval rights including, but not limited to, the right to approve the terms of this Contract, the Bidder, and any or all plans, reports, specifications, subcontracts, bid documents, drawings or other documents related to this Contract and the project of which it is part. The parties hereto further understand and agree that AID, in reserving any or all of the foregoing approval rights, has acted solely as a lender to assure the proper use of United States Government funds, and that any decision by AID to exercise or refrain from exercising these approval rights shall be made as a lender in the course of financing this project and shall not be construed as making AID a party to the Contract. The parties hereto understand and agree that AID may from time to time exercise the foregoing approval rights, or discuss matters related to these rights and the project of which this Contract is part, with the parties jointly or separately, without thereby incurring any responsibility or liability to the parties jointly or to any of them.
- B. Any approval or failure to disapprove by AID of any plan, report, specification, contract, bid document, drawing or other documents shall not bar the Purchaser or AID from asserting any right, or relieve Bidder of any liability which Bidder might otherwise have to Purchaser or AID, because of such plan, specification, contract, bid document, drawing or other document, or any performance or failure of performance thereunder, or any AID contractor's or supplier's certificate.

3.27. CHANGES AND MODIFICATIONS

- A. Any changes and/or modifications in this proposal not approved by AID shall not be financed by AID.

3.28. ASSIGNMENTS AND SUBCONTRACTS

- A. Assignments: this Contract shall not be assigned by the Bidder in whole or in part without the prior approval in writing of the Purchaser and AID.
- B. Subcontracts: the Bidder shall not subcontract any part of the furnishing and delivery of materials and

Division I - Invitation for Bids
PART 3 - BIDDER'S PROPOSAL

equipment under this Contract without the consent of the Purchaser in writing and approval by AID. This requirement does not apply to purchase orders to manufacturers from Bidders.

3.29. COMMISSIONS AND KICKBACKS

- A. No amount representing a discount, credit, or similar allowance, nor any payment or benefit in the nature of a kickback shall be paid or made in connection with any transaction under this Contract.
- B. The Bidder shall be entitled to pay commissions to bona fide agents, provided such commissions do not exceed the lesser of (1) amounts customarily paid for such services in similar transactions, and (2) amounts customary to the trade.
- C. No person shall be deemed a bona fide agent of a Bidder if such person acting as a purchasing agent of the Purchaser hereunder is affiliated by ownership or management ties with the Bidder on a cost reimbursement basis.

3.30. BOOKS AND RECORDS

- A. The Bidder shall maintain adequate books and records showing and supporting transactions under or in connection with this Contract in accordance with generally accepted accounting principles. These books and records shall be made available for inspection and audit by AID or its authorized agents or representatives during the Contract term and for a period of five (5) years after final payments under the Contract.

3.31. DEFINITIONS

- A. The term "Proposal" shall mean the same as "Contract" under any proposal accepted by the Purchaser.
- B. The term "Purchaser" or "Owner" shall mean Empresa Nacional de Electricidad, S.A., or their duly authorized representatives.
- C. The term "Project" shall mean the Rural Electrification Project in El Chapare or portions thereof:
- D. The term "Bidder" as used herein refers to the party or parties furnishing the distribution line materials and equipment or services as specified.

Division I - Invitation for Bids
PART 3 - BIDDER'S PROPOSAL

- F. The term "Manufacturer" or "Supplier" as used herein refers to the party or parties manufacturing the materials and equipment as specified, complete or in part.
- G. The term "Completion of Delivery of Materials" shall mean full performance by the Bidder of the Bidder's obligations under the Bidder's Contract and all amendments and revisions thereof except the Bidder's obligations in respect to Release of Lien under Clause 3.19, "Release of Lien" thereof and other final documents.
- I. The term "AID" shall mean the USAID Mission to Bolivia, American Embassy, La Paz, Bolivia or the United States Agency for International Development central offices in Washington, D.C.
- J. The term "Contractor" shall mean the same as "Bidder" under these Contract Documents.

3.32. COMMUNICATIONS AND NOTICES

- A. All official notices, required or permissible hereunder shall be valid only in writing, and they may be delivered in person, by telegraph, by cable, or by registered mail. They shall be delivered to:

Purchaser:

Empresa Nacional de Electricidad, S.A.
Subgerencia de Distribución
Calle Colombia No. 656
P.O. Box 565
Cochabamba-Bolivia
Télex Address: 6251 ENDE BV

Bidder:

Cable address:

- B. In the event all or part of this Proposal is accepted, AID will open the Letter of Commitment

Division I - Invitation for Bids
PART 3 - BIDDER'S PROPOSAL

provided in Part 3, Clause 3.15, "Method of Payment,"
in favor of _____

3.33 TRANSPORTATION INFORMATION

- A. Information on land transportation between the ordinary Ports of Entry and Points of Destination in Bolivia is supplied in Exhibit "J".
- B. These data (to be used for estimating purposes) have been compiled from faithful private or official sources in effect in December, 1965 and are furnished to assist Bidder in preparing his proposal. ENDE assumes no responsibility for the accuracy of such information.

3.34. TIME LIMIT

- A. This Proposal is void unless it is accepted by the Purchaser within one hundred and twenty (120) days after the specified Bid Opening Date.

3.35. CONTRACT

- A. Upon acceptance of this Proposal, the Proposal shall become the Contract and the successful Bidder shall be the Contractor, and all references in the Proposal to the Bidder shall apply to the Contractor.
- B. Refer to Exhibit "I" for Form of Contract.

3.36. EXTENSION TO SUCCESSORS

- A. Each and all of the covenants and agreements contained in the Contract effected by the acceptance of this Proposal shall extend to and be binding upon the successors of the parties hereto.

Bidder

By:

Title

ATTEST;

138

Division I - Invitation for Bids
PART 3 - BIDDER'S PROPOSAL

Secretary

Mailing Address

Date of Proposal

DIVISION I INVITATION TO BID
PART I-NOTICE AND INSTRUCTIONS TO BIDDER

1.1 GENERAL

- A. Sealed proposals in the English language for the installation of material and construction of a Rural Electrification Project, to be financed pursuant to a Loan Agreement between the Government of The Republic of Bolivia and the Agency for International Development (AID) will be received by the Empresa Nacional de Electricidad, S.A. (ENDE; hereinafter called the Purchaser at the office of ENDE, CALLE Columbia 0-655, Cochabamba, Bolivia, by Twelve hundred hours (12:00) on _____ 198___. The proposals will be opened and read publicly in the offices of Empresa Nacional de Electricidad, S.A. at fifteen hundred hours (15:00) on the same day. Any proposal received subsequent to the time specified will be returned promptly to the Bidder unopened. All bids and bid guarantees shall remain valid for a period of not less than one hundred and twenty (120) days. The Purchaser reserves the right to reject any and all proposals.

1.2 DESCRIPTION OF PROJECT

- A. The Rural Electrification Project in the area of El Chapare of the Department of Cochabamba, Republic of Bolivia will consist of two sub-projects as follows:

Subproject A

44.3 Km of 3 phase primary distribution lines at 34.5/19.9kV

29.0 Km secondary distribution lines at 380/220V and 220V

1450 kVA distribution transformers

1200 service drops

4 sectionalizing and protection installations

280 street light installations

Subproject B

63.7 Km of primary distribution lines at 34.5/19.9kV and 19.9kV

27.3 Km secondary distribution line at 380/220V and 220V

1425 kVA distribution transformers

1100 service drops

2 sectionalizing and protection installations

270 street light installations

Work included in this invitation consists of the construction of distribution lines, secondary lines, the installation of distribution transformers and accessories, service drops, meters and street lighting fixtures; and the furnishing of all equipment required by the Purchaser for construction.

Proposals may be submitted for one or both of the subprojects, but each subproject for which a proposal is submitted shall be bid in its entirety. Partial bids will not be accepted. A subproject will be considered partially bid if the bid does not include complete Proposal Price Sheets for each and all Schedules.

1.3 OBTAINING BID DOCUMENTS

- A. Drawings, proposal forms, specifications and contract publications for both subprojects may be obtained from the Gerente General, Empresa Nacional de Electricidad, S.A., Casilla 565, Cochabamba, Bolivia, Telex 6251 BV.

DIVISION I INVITATION TO BID
PART I-NOTICE AND INSTRUCTIONS TO BIDDER

- B. The cost of publications are as follows and are not subject to refund:
1. One set of composite Contract Bidding Documents including proposal forms, specifications, and contract documents for both the subprojects is \$us. 50.00 .

1.4 PRE-BID CONFERENCE

- A. A pre-bid conference will be held in the offices of Empresa Nacional de Electricidad, S.A. (ENDE) at 0900 (zero nine hundred hours), thirty (30) days prior to the specified Bid Receipt Date for final clarification as to ambiguities or other difficulties in the bidding documents. If appropriate, addenda will be made part of the bid documents.

1.5 EXAMINATION OF BIDDING DOCUMENTS AND PROJECT SITE

- A. The Bidders shall make and shall be deemed to have made a careful examination of the Project site, drawings, specifications and the bid documents. The Bidder, when submitting his Proposal, guarantees that he has complied with all the above investigations, including those necessary in the field, that he is aware of the relative conditions he will encounter during the work's performance, of the responsibility, quality and quantity of same and of the necessary requirements for the Contract's proper execution. Submission of a Proposal for the Project, on the date indicated above, will be considered conclusive evidence that the Bidder has made such investigations and is acquainted with the conditions indicated.

1.6 SOURCE AND ORIGIN

- A. The Agency for International Development (AID) has granted a Loan (AID Loan Number 511-T-067) to the Government of the Republic of Bolivia to assist in financing the Rural Electrification Project in El Chapare. In accordance with the conditions of the AID LOAN Agreement, all materials and related services comprising this public bid will have their source and origin in the United States of America and "selected free world countries" as designated by AID Geographical Code 9-1, including the Republic of Bolivia (See Exhibit H).
- B. With respect to equipment the origin thereof is the country in which such equipment was mined, grown, or produced through manufacturing, processing, or assembly; the source thereof is the country or territory from which such commodity is shipped to the borrower country, except that when equipment or materials are shipped to the borrower country from a free port or bonded warehouse in the form in

142

DIVISION I INVITATION TO BID
PART I- NOTICE AND INSTRUCTIONS TO BIDDER

which received therein, source means the country or territory from which equipment or material was shipped to such free port or bonded warehouse, except that if the equipment or material is located in the borrower country at the time of its purchase for the project, source means the borrower country. A produced commodity shall be deemed of borrower-country origin if as a result of such manufacturing, processing, or assembly in borrower country, a commercially recognized new commodity results that is substantially different in basic characteristics or in purpose or utility from any of its imported components. Items of equipment or materials which are normally imported for sale to meet a general demand in the borrower country for the item shall be deemed of borrower country origin, provided:

1. They have been imported from the United States or other 941 Code countries for commercial resale and in the case of equipment, machinery and vehicles, their resale value does not exceed \$us.2,000 per item, provided that the latter value restriction may be waived by AID on a case by case basis when it is satisfied that the equipment, machinery, or vehicles involved have not simply been trans-shipped through the United States but are actually of United States origin. No total value limitation is placed on the purchase of materials, supplies, and tools imported from the United States or other 941 Code countries and available for off-the-shelf procurement in the borrower country except the aggregate amount of local currency financed by AID for the project as a whole.
 2. That if they have been imported from AID Geographic Code 935 (See Exhibit "G") source outside the United States, the total invoice value of any single transaction does not exceed the local currency equivalent of \$us. 500 and the total purchase value of all such transactions does not exceed \$us. 50,000 in local currency equivalent or five percent (5%) of the total AID loan, whichever is less.
- C. No produced commodity whether of United States or borrower country, source and origin shall be eligible for AID financing if such commodity contains any component from a Communist Block country (i.e., a country not specified in AID Geographic Code 935).
- D. No produced commodity shall be eligible for AID financing:
1. If such commodity contains any component or components which were imported into the producing country; and.
 2. Such components were acquired by the producer in the form in which they were imported; and.
 3. The total cost of such components (delivered at the point of production) amounts to more than fifty percent (50%) of the lowest price (excluding the cost of ocean transportation and marine insurance) at which the supplier makes the commodity available for export sale, whether or not financed by AID. Components from the

DIVISION I INVITATION TO BID
PART I-NOTICE AND INSTRUCTIONS TO BIDDER

other eligible source countries and from Bolivia may be used without limitation in applying this percentage rule.

- E. No produced commodity shall be eligible for AID financing if such commodity has been transported to the borrower country:
1. By transportation medium owned, operated, or under the control of any Communist Block country (i. e., a country not specified in AID Geographic Code 935).
 2. On a vessel which AID, by written notice to ENDE, has designated as ineligible.
 3. Under any ocean or air charter which has not received prior approval by AID.
- F. In the case of insurance, source and origin means the country in which such insurance is placed. Insurance shall be deemed to be placed in a given country only if payment of the insurance premium is made to an insurance company office located in such country and the insurance policy is issued by an office in such country.
- G. In the case of delivery services, source and origin means the country in which such services are rendered. With respect to ocean or air freight, it means the flag of the carrier vessel or aircraft.
- H. In the case of incidental services, source and origin means the source of equipment to which such services relate.
- I. Certification of Source and Origin shall be included with each invoice in the form attached hereto (See Exhibit A.).
- J. AID source and origin rules apply to procurement of equipment of the Contractor as follows:
1. To equipment to be incorporated in the Subprojects or otherwise transferred to the Purchaser including spare parts for the same, e.g., "included commodities" in the manner and to the extent as specified herein before under "Source and Origin."
 2. To equipment not to be incorporated in the Subprojects or otherwise transferred to the Purchaser, e.g., "Contractor owned commodities," in the manner and to the extent as specified below:
 - a. Equipment owned or leased by the Contractor prior to the opening of the bids for the Contract shall not be subject to AID source and origin requirements; however, in no event may any equipment be utilized in the Subprojects unless the source and origin thereof is a country or countries included in the AID Geographic Code 935 (i.e., is not of Communist Block source or origin).

DIVISION I INVITATION TO BID
PART I-NOTICE AND INSTRUCTIONS TO BIDDER

1.7 SHIPPING

- A. AID Loan funds may be used to pay freight and insurance costs only if:
1. Goods financed under this loan are transported by flag carriers of countries included in AID Geographic Code 941, and Bolivia, and
 2. The insurance is placed in Bolivia or a country included in AID Geographic Code 941.
- B. AID regulations, as stated in the Loan Agreement, are as follows:
1. Goods procured from a Code 941 country and financed under the Loan may be transported to Bolivia on flag carriers of any country included in Code 935 of the AID Geographic Book as in effect at the time of shipment.
 2. Unless AID shall determine that privately-owned United States flag commercial vessels are not available at fair and reasonable rates for such vessels;
 - a. At least fifty percent (50%) of the gross tonnage of Code 941 goods financed under the Loans and transported on ocean vessels from United States ports (computed separately for dry bulk carriers, dry cargo liners and tankers) shall be transported on privately-owned United States-flag commercial vessels and at least fifty percent (50%) of the gross freight revenue generated by ocean shipments of Code 941 goods financed under the Loan and transported on dry cargo liners from United States ports shall be paid to or for the benefit of privately-owned United States-flag commercial vessels; and
 - b. At least fifty percent (50%) of the gross tonnage of all Code 941 goods financed under the Loan and transported on ocean vessels from non-United States port (computed separately for dry bulk carriers, dry cargo liners and tankers) shall be transported on privately-owned United States-flag commercial vessels; and at least fifty percent (50%) of the gross freight revenue generated by ocean shipments of Code 941 goods financed under the Loan and transported on dry cargo liners from non-United States Ports shall be paid to or for the benefit of privately-owned United States-flag commercial vessels. No such goods may be transported on any ocean vessel or aircraft (i) which AID, in a notice to the borrower, has designated as ineligible to carry AID financed goods or (ii) which has been chartered for the carriage of AID financed goods unless such charter has been approved by AID.
 3. Marine insurance on Code 941 goods may be financed under the Loan with disbursements made pursuant to Section 7.01 of the Loan Agreement, provided (i) such insurance is placed at the lowest available competitive rate in Bolivia or in a country included in

115

DIVISION I INVITATION TO BID
PART I-NOTICE AND INSTRUCTIONS TO BIDDER

Code 941 of the A.I.D. Geographic Code Book as in effect at the time of placement, and (ii) claims thereunder are payable in freely convertible currency. If in connection with the placement of marine insurance on shipments financed under United States legislation authorizing assistance to other nations, Bolivia, by statute, decree, rule or regulation, favors any marine insurance company of any country over any marine insurance company authorized to do business in any state of the United States of America, Code 941 goods financed under the Loans shall, during the continuance of such discrimination, be insured against marine risk in the United States of America with a company or companies authorized to do marine insurance business in any state of the United States of America.

4. The borrower shall insure, or cause to be insured, all goods from Code 941 countries financed under the Loan against risks incident to their transit to the point of their use in the Project. Such insurance shall be issued upon terms and conditions consistent with sound commercial practices, shall insure the full value of the goods, and shall be payable in any freely convertible currency. Any indemnification received by the borrower under such insurance shall be used to replace or repair any material damage or any loss of the goods insured or shall be used to reimburse the borrower for the replacement or repair of such goods, or shall be used for repayment of this Loan. Any such replacements shall have their source and origin in countries included in Code 941 of the AID Geographic Code Book as in effect at the time orders are placed or contracts are entered into for such replacements, and shall be otherwise subject to the provisions of this Agreement.
- C. Suppliers will make every effort to ship goods on U.S. flag carriers, and if such carriers are not available, on flag carriers of countries included in AID Geographic Code 941. Although permitted, flag carriers of countries included in AID Geographic Code 935 should be used only when those from 941 countries are not available. The supplier must obtain permission from ENDE when he plans to use means of ocean transportation other than U.S. flag carriers.

1.8 SUBMISSION OF PROPOSALS

- A. Sixty (60) days prior to the date specified herein for opening of construction bids, each bidder shall submit qualification information. Such information shall be submitted in a sealed envelope marked:

Prequalification Information
Chapare Electrification Project

(Name of Bidder)

This envelope shall contain the following:

- a) Statement of Qualifications as per Exhibit D.

DIVISION I INVITATION TO BID
PART I-NOTICE AND INSTRUCTIONS TO BIDDER

- b) Bolivian firms presenting proposals of their own, or acting as representatives of foreign firms shall present:
- Documents certifying the legal existence of the firm.
 - Certificate of compliance with taxes and Tributes (Solvencia Tributaria).
 - Certificate of Fiscal Solvency extended by the Contraloria General de la Republica.
 - Certificate of inscription in the Direccion de Comercio, Ministerio de Industria y Comercio.
 - Certificate of inscription in the Camara de Industrias or Camara de Comercio.
- c) Foreign firms shall present documentation relative to its constitution, duly legalized in their country of origin.
- d) If applicable, a legally documented agreement of association or Letter of Intent between a foreign company and a Bolivian Company.
- e) Detailed resumes of the probable construction superintendent and any supervisory personnel expected to be on site.
- f) A preliminary construction schedule on the forms supplied herein.
- g) Other formalities as required by these Bidding Documents.
- B. Following analysis of the qualifications of the prospective Bidders an approved Bidders List will be prepared. Each prospective Bidder will be notified not less than forty five (45) days prior to the date specified herein for opening of construction bids. Such notification shall be by telex or cable. Bidders not selected may appeal the decision by presenting additional information. Such appeals will not after the date of bid opening. No Bidder whose qualifications have not been approved by the Purchaser prior to the bid opening date shall be eligible to present a bid.

In consideration of being permitted to submit his qualifications as a prospective Bidder for review, the relevant Bidder waives any claim against the Bid Committee, AID or ENDE that might arise with respect to their decisions as to a prospective Bidder's qualifications. It is understood that the decision of ENDE and AID, with respect to the qualifications of any prospective Bidder, is final. A prospective Bidder will not be considered qualified by ENDE and AID unless he possesses reputation, ability, experience, qualified personnel, availability of equipment, and net current assets or working capital sufficient in the judgment of ENDE and AID to render it probable that he can satisfactorily execute the Contract, should it be awarded to

14/1

DIVISION I INVITATION TO BID
PART I-NOTICE AND INSTRUCTIONS TO BIDDER

him, and meet his obligations therein incurred.

- C. The Bidder's construction proposal shall be submitted in a sealed envelope marked as follows:

Proposal for Construction
Chapare Project

(Name of Bidder)

Date and Time of Bid Opening

This envelope shall contain the following:

- a) The Bidder's Check List (Part. 2, Division I).
- b) The Bidder's Proposal, in original and three (3) copies on the forms supplied herewith, with attachments as required.
- c) The Proposal Prices, in original and three (3) copies, as explained in Clause 1.8, Part. 1, Division I of these documents.
- d) The Bid Bond (clause 1.11, Part. 1, Division I).

In preparing proposal, the following instructions are offered:

1. No alterations or erasures shall be permitted, unless made before submission of the proposal and initialed and dated.
2. The proposal shall be signed in ink by the Bidder or his authorized representative with his full name, title and business address typed or printed in the spaces provided.
3. All pages of Form of Proposal, Proposal Price Sheets, Annex A and Annex B shall be signed. The signature or signatures at the end of the proposal form shall be duly attested by an authorized Notary Public from Bolivia or authorized Notary Public in the country of origin and certified by the relevant Bolivian Consulate.
4. If the Bidder is a partnership, the proposal must be signed in the partnership name by a partner. If the Bidder is a corporation, the proposal must be signed in the corporate name by a duly authorized officer and the corporate seal affixed and attested by the secretary of the corporation.

D. Proposals shall be in the English language.

E. According to the requirements of the Bolivian Law, stipulated in the "Decree No. 10120" dated February 2nd, 1972, all Bidders shall include with their proposal: (i) one sheet of Sealed Paper of current nominal value for each sheet of the submitted Proposal Forms, and (ii) Legal Stamps, for a nominal value of one per ten thousand (1/10.000) of the

DIVISION I INVITATION TO BID
PART I-NOTICE AND INSTRUCTIONS TO BIDDER

total amount of the Proposal.

Instead of Sealed Paper and Legal Stamps, the Bidder who cannot obtain these may comply with the requirements of this Clause by issuing a check for an amount equivalent to nominal value of said Sealed Paper and Legal Stamps. For purpose of converting #b. (Bolivian Pesos) to \$us. (U.S. Dollars), the exchange rate to be used shall be the official rate standing at the date of submission of proposal.

This check shall be issued in U.S. Dollars to the name of Empresa Nacional de Electricidad, S.A. The above mentioned sum will not be reimbursed to the Bidders.

1.9 UNIT FIXED PRICE PROPOSAL

- A. The Bidder understands and agrees that the various items on which bids are made in this proposal are on a unit fixed price basis unless escalation is otherwise provided for in this Invitation.
- B. The unit fixed prices of the Proposal Price Sheets shall include any direct and complementary charges and any other expenses which have not been separated and especially provided for with another price. It is understood that the Contract's unit fixed prices will likewise include the Contractor's general expenses for which payment has not been separated and especially determined with another price. It is understood that the Contract's unit fixed prices will comprise the Contractor's general expenses which have been predetermined with a special price in the Proposal Price Sheets as well as the ones not predetermined including Contractor's utilities.
- C. With inclusion and without limitation, the principal items for which compensation is included in the Contractor's prices are:
 1. Furnishing of all necessary equipment and material not furnished by the Purchaser.
 2. Transportation of all equipment and materials to and on the site.
 3. Installation, maintenance and operation of all necessary installations of the Contractor at the project site.
 4. Furnishing of all common and specialized labor.
 5. Depreciation of all machinery, setting up installations, construction instruments and all other Contract construction.
 6. Accessory construction depending on the site's physical conditions.
 7. General organization and construction superintendency.
 8. Personnel administration.

DIVISION I INVITATION TO BID
PART I-NOTICE AND INSTRUCTIONS TO BIDDER

9. Adequate measures for accident prevention.
 10. Insurance required by this Contract and cost of all guarantee bonds.
 11. Insurance costs to cover risks such as fires, earthquakes, floods, lightning, or any fortuitous case that could harm the project as well as the machinery and the Contractor's appliances during construction as indicated in the General Conditions.
 12. Expenses for preliminary construction, provisional housing, feeding and medical assistance to the personnel, provisional ways at the site and maintenance costs of any equipment, materials or places to be used during the works.
 13. General expenses related to the contractor's main office organization.
 14. Study of all detailed drawings and relevant calculations as specified in the bidding documents.
- D. The unit fixed prices for labor, equipment and transportation and materials and the extended price for labor, equipment and transportation and materials will be separated by the Bidder to conform with the format of the Proposal Price Sheets in this Contract. All prices will be expressed in \$U.S. (U.S. Dollars).

Payment for materials, equipment and transportation and labor procured in Bolivia will be made in Bolivian Pesos in an amount equivalent to the unit price in dollars at the official exchange rate in-force at the time of payment. Payment for required equipment and transportation as well as superintendency and specialized type labor procured from outside Bolivia will be made in U.S. Dollars.

The acceptance of personnel or superintendency and specialized type labor procured from outside Bolivia as proposed by the Bidder will be subject to the approval by the Purchaser and will generally be restricted to the following classifications:

Superintendents

Engineers

Foremen

Equipment Operators (Limited to minimum)

Monthly Fees in \$us. (U.S. Dollars) for this proposed superintendency and specialized type staff will be presented as an Annex A to the Bidder's proposal. These fees shall be inclusive and provide for the Bidder's superintendency and specialized staff salaries, overseas differential, social and other benefits, overhead and administrative

DIVISION I INVITATION TO BID
PART I-NOTICE AND INSTRUCTIONS TO BIDDER

costs and profit and similar expenses. The fees lists will be applicable only for the time staff is actually assigned to the project in their respective categories. If additional staff is required due to an accelerated construction program or for other reasons, the listed fees will be used as a basis for negotiation for assigning additional staff.

This Annex A of superintendency and specialized type staff fees shall be related with the unit fixed prices proposed by the Bidder in his Proposal Price Sheets and permit the Purchaser to make a relevant price correlation and comparison.

Equipment for hole digging, pole erection, conductor stringing, etc., and transportation required for construction as proposed by the Bidder and which will be procured in Bolivia or from outside Bolivia will be subject to the Purchaser's approval.

Relevant monthly fees in \$B. (Bolivian Peso) for equipment and transportation if procured in Bolivia or in \$us. (U.S. Dollars) if procured from outside Bolivia will be presented in an Annex B to the Bidder's proposal. These fees shall be inclusive and provide for depreciation, maintenance, fuel, operators' associated costs, overhead and administrative costs and profit, and similar expenses. The fees listed will be applicable only for the time equipment or transportation are actually utilized on the Subprojects in their respective categories. If additional equipment or transportation are required due to an accelerated program or for other reasons, the listed fees will be used as a basis of negotiation for additional equipment and/or transportation.

This Annex B of equipment or transportation shall be related with the unit fixed prices proposed by the Bidder in his Proposal Price Sheets and permit the Purchaser to make a relevant price correlation and comparison.

- E. In the event of variation between unit price and extended price, the unit price shall govern.

1.10 WITHDRAWAL OF BIDS

- A. Bids may be withdrawn by written request delivered to the Purchaser prior to the Bid Opening Date. After this date, the Bidder will not be permitted to withdraw his bid unless the Purchaser does not accept it within one hundred twenty (120) calendar days from the Bid Opening Date.

1.11 BID BONDS

- A. Each proposal must be accompanied by a bid bond valid for not less than one hundred twenty (120) days from the date of the opening of bids in the form attached hereto, with sureties issued by surety companies or banks and acceptable to the Purchaser, or a cashier's

DIVISION I INVITATION TO BID
PART I-NOTICE AND INSTRUCTIONS TO BIDDER

check, in United States dollars, issued by any reputable banking institution payable to the order of the Purchaser, in an amount at least equal to ten (10) percent of the maximum bid price. A letter of Credit in equal amount and time period, approved by the Purchaser may be furnished in lieu of the bid bond. Each Bidder agrees that said proposal shall be firm and binding upon each such Bidder until a proposal is accepted and a satisfactory performance bond is furnished by the successful Bidder, or for a period not to exceed one hundred twenty (120) days from the date set for the opening of the proposals, whichever is the lesser period.

- B. The bid bond will be returned to all Bidders within sixty (60) calendar days of the Bid Opening Date, except those the three (3) lowest responsive Bidders.
- C. Within five (5) calendar days after the Purchaser and the successful Bidder have signed the Contract, the bid bond will be returned to the remaining Bidders. The bid bond of the successful Bidder will be returned by the Purchaser when the Contract is signed and the performance bond and payment bond have been received and accepted by the Purchaser.

1.12 PERFORMANCE AND PAYMENT BONDS

- A. The successful Bidder on each Subproject shall be required to execute 6 additional copies of this proposal and to furnish a performance bond and a payment bond in sextuplicate in the form attached hereto with sureties acceptable to the Purchaser in a penal sum for each bond not less than thirty percent (30%) of the contract price within 30 days after written notice of the acceptance of the proposal. Performance and payments bonds shall extend until the construction termination date. These bonds or guarantees are to be issued by surety companies or banks acceptable to the Purchaser.

1.13 REFUSAL TO EXECUTE COPIES

- A. Should the successful Bidder fail or refuse to execute such copies of the proposal or to furnish a performance or payment bond within thirty (30) days after written notice of the acceptance of the proposal by the Purchaser, the Bidder will be considered to have abandoned the proposal. In that event, the Purchaser shall be entitled to enforce the bid bond in accordance with the terms or to retain the proceeds of a certified check, and the Purchaser may in good faith contract with another Bidder for the construction of the project, refunding the excess, if any, in which the bid bond or Cashier's check exceeds the difference between the amount of the contract and the amount of the abandoned proposal.

1.14 ASSOCIATION WITH BOLIVIAN COMPANY

DIVISION I INVITATION TO BID
PART I-NOTICE AND INSTRUCTIONS TO BIDDER

- A. Foreign companies must be associated with a Bolivian company having a minimum of ten percent (10%) of the total Contract value. A legally documented agreement of association between the successful Bidder and the Bolivian firm must be submitted and approved by the Purchaser not later than thirty (30) days after award of Contract.

1.15 ELIGIBLE BIDDERS

- A. No firm included on the list of suspended, debarred or ineligible Bidders maintained by AID will be eligible to bid individually or in a Joint Venture, or be financed by AID as a sub-contractor or otherwise. No United States firms, nor any other firms which is more than fifty (50%) percent beneficially owned by a United States firm, shall be eligible for AID financing if the firm is not in compliance with its equal opportunity obligations under Executive Order 11246, as amended, and regulations and orders issued thereunder.

1.16 BASIS FOR CONTRACT AWARD

- A. The Contract will be awarded by the Purchaser with the approval of AID. The Contract will be awarded within one hundred and twenty (120) calendar days from the Bid Opening Date by written notification to the Bidder whose proposal is considered by the Purchaser as the most advantageous and beneficial to its interests.
- B. To be considered for award, a bid must be responsive to the invitation and be considered by AID and the Purchaser to meet the test of price, quality, delivery and completion date of project. The award shall be made to that qualified Bidder whose bid, responsive to the invitation, is both reasonable and lowest in price after adjustment by arithmetical computation to account for any factor other than price required or permitted by the invitation to be considered in the evaluation of bids.
- C. A responsive bid is one which accepts all of the terms and conditions of the IFB without material modification. A material modification is one which affects in any way the price, quantity, quality, or delivery or installation date of equipment or materials; or, the price, quality scope, or completion date of construction or other services to be supplied or performed; or, which limits in any way any responsibilities, duties, or liabilities of the Bidder or any rights of the Purchaser or of AID, as any of the foregoing have been specified or defined in the invitation. The Purchaser may waive any minor informality in a bid which does not constitute a material modification.
- D. The Purchaser reserves the right to accept or reject any or all the proposals if necessary or simply convenient to its interests. The following factors considered separately or jointly, may be cause for rejection of a proposal:

DIVISION I INVITATION TO BID
PART I-NOTICE AND INSTRUCTIONS TO BIDDER

1. Completion time longer than 180 calendar days for any subproject.
 2. Claims or arbitrations pending with the Purchaser.
- E. No Bidder shall have the right after the bid closing time to change a bid which is unresponsive in order to make it responsive or otherwise make any changes in the bid.

1.17 ADDENDA, TELEGRAPHIC BIDS

- A. Any modification of the bidding documents, prior to Bid receipt date, will be issued by addendum and approved by the Purchaser, and AID; copy of same will be delivered to each Bidder. The Bidder shall confirm in writing his receipt of each addenda by Telex, cable or registered air mail letter.
- B. Bidders may request, in writing, not less than thirty (30) days before the date of the bid opening from the Purchaser's Engineer any interpretation or correction of any ambiguity, inconsistency, or error in the bidding documents. Such interpretations or corrections will be issued in writing, by means of a letter which will be sent by registered mail to each Bidder recorded as having received the required sets of bidding documents.
- C. Any addenda, amendment or revision to this Notice and Instructions to Bidders shall be sent by certified air mail to all prospective Bidders of record not less than twenty (20) days prior to the time and date set for the opening of bids. Such addenda, amendment or revision must be considered in the bid and shall be properly signed and returned with the proposal.
- D. Telegraphic bids will not be considered, regardless of when received. Modification of completed bids made by telegram or cable and received prior to the time of the opening of bids will be evaluated only in the form received by the Purchaser, regardless of transmittal errors.

1.18 LATE BIDS

- A. Bidders shall assume all responsibility for the delivery of proposals or modifications thereof to the office of the Purchaser prior to the date and time set for the opening of proposals. A late bid will not be considered even though it became late because of factors beyond the bidder's control, such as delays in mail handling, telegraphic transmission or customs clearance. A late bid will be considered only when such bid is received at the place designated prior to award and when the sole cause for it becoming late is due to mishandling on the part of ENDE, its employees, or agents.

1.19 EXPORT LICENSES AND TAXES

64

DIVISION I INVITATION TO BID
PART I-NOTICE AND INSTRUCTIONS TO BIDDER

- A. The cost of Consular Invoices or any export licenses or taxes imposed by the source country or transportation taxes of any kind shall be obtained and paid for by the Contractor.

1.20 IMPORT DUTIES AND TAXES

- A. All materials specified to be furnished and delivered by the Contractor for the purposes of this Contract shall be exempt from all import duties and taxes. Any such costs billed to the Contractor shall be paid for or otherwise liquidated by the Purchaser.

1.21 CONSTRUCTION TIME LIMIT

- A. Contractor shall prosecute dilligently and complete construction of a Subproject in accordance with plans and specifications within 180 calendar days following the commencement date of that Subproject.

1.22 COMMISSIONS, KICKBACKS

- A. No amount representing a discount, credit or similar allowance nor any payment or benefit in the nature of a kickback shall be paid or made in connection with any transaction under this Contract.
- B. The Contractor shall be entitled to pay commissions to bona fide agents, provided such commissions do not exceed the lesser of:
1. Amounts customarily paid for such services in similar transactions.
 2. Amounts customary to the trade.
- C. No person shall be deemed a bona fide agent of a Contractor if such person acting as a purchasing agent of the Purchaser hereunder is affiliated by ownership or management ties with the Contractor on a cost or reimbursement basis.

1.23 COMMUNICATIONS AND NOTICES

- A. All official notices, required or permissible hereunder shall be valid only in writing, and they may be delivered in person, by telegraph, by cable or by registered mail.

They shall be delivered:

To the Purchaser: Attention Gerente General
Empresa Nacional de Electricidad, S.A.
Casilla No. 565
Cochabamba, Bolivia

135

DIVISION I INVITATION TO BID
PART I-NOTICE AND INSTRUCTIONS TO BIDDER

Telex : 6251BV
Cable address : ENELECTRIC, Cochabamba, Bolivia
To the Bidder : _____

(official address)
Cable address : _____

1.24 ADDITIONAL INFORMATION REQUIRED

- A. During the period between the bid opening and Contract award, the Purchaser reserves the right to request that Bidders provide subsequent information and clarification.

1.25 PURCHASER FURNISHED MATERIAL

- A. All materials as specified in Division I, Part 2, to be installed in the construction of the Project will be furnished by the Purchaser. Such materials will be furnished by the Purchaser with access to the inventory by the Contractor at the storage sites located in Cochabamba.
- B. After receipt of Purchaser's furnished materials, the Contractor will be responsible for the proper handling, security, warehousing and relevant control of records and accounting of Purchaser's furnished materials. This includes coordinating material flow requirements of the project with the Purchaser to ensure the proper execution of the work.

1.26 WORK ON ENERGIZED LINES

- A. All construction work, including attachments to existing poles and line changes, shall be done with the lines de-energized.

1.27 PAYMENT CONDITIONS

- A. Funds will be primarily from AID Loan 511-T-067 and local contribution. Payment by the Purchaser to the Contractor for all type labor, equipment and transportation and material procured in Bolivia will be made in Bolivian Pesos. Payment by the Purchaser to the Contractor for superintendent and specialized type labor and equipment and transportation procured outside of Bolivia will be made in U.S.

136

Dollars.

1.28 PURCHASER'S GUARANTEE

- A. The Purchaser will furnish all materials for the construction of the Project as specified in the List of Materials. Such materials will be available at the Purchaser's warehouse or other locations as specified by the Purchaser in the pre-bid conference.
- B. Line extensions not called for in these documents may be ordered by the Purchaser in writing, for each individual case or in a general grouping.
- C. Purchaser certifies that all easements and right-of-way have been obtained from the owners of the properties through which the project is to be constructed.
- D. All surveying and preliminary staking of the lines have been completed. Final staking will be completed by the Purchaser in advance of the construction forces.
- E. Prompt payment for the construction of the Project will be made by the Purchaser.
- F. If the Purchaser shall fail to comply with any of the undertakings contained in the foregoing representations or if any of such representations shall be incorrect, the Contractor shall be entitled to an extension of time of completion for a period equal to the delay, if any, caused by failure of the Purchaser to comply with such undertakings or by any such incorrect representation, provided the Contractor shall have promptly notified the Purchaser in writing of its desire to extend the time of completion in accordance with the foregoing, and provided further that such extension, if any, of the time of completion, shall be the sole remedy of the Contractor for the Purchaser's failure to comply with any of the foregoing representations.

1.29 BID WITHOUT COLLUSION

- A. The Contractor warrants that his proposal is made in good faith and without collusion or connection with any other person or persons.

1.30 CONTRACT IS ENTIRE AGREEMENT

- A. The Contract to be effected upon acceptance of the Proposal shall be deemed to include the entire agreement between the parties thereto, and the Contractor shall not claim any modification thereof resulting from any representation or promise made at any time by an agent, office or employee of the Purchaser or any other person.

DIVISION I INVITATION TO BID
PART I-NOTICE AND INSTRUCTIONS TO BIDDER

June 1, 1986

Empresa Nacional de Electricidad, S. A.

Ing. Claude Gesse
Gerente General

158

DIVISION I INVITATION FOR BIDS
PART 6 FORM OF CONTRACT

ARTICLE I GENERAL

6.1 OFFER TO CONSTRUCT

- A. The undersigned (hereinafter called the Bidder) hereby proposes to construct distribution facilities for the rural electrification project en el Chapare, executed by the Empresa Nacional de Electricidad, S.A. in accordance with the terms and conditions of the Proposal, the Plans and Specifications and Construction Drawings and Technical Specifications attached hereto and made a part hereof for the prices hereinafter stated.

6.2 DESCRIPTION OF CONTRACT

- A. The following parts shall constitute the Contract, all of which are included in meaning of term "Contract Documents" as used herein:

Division I

1. Notice and Instructions to Bidders.
2. Owner Furnished Materials.
3. Bidders Check List.
4. Bidders Proposal.
5. Numbered Addenda issued to the invitation.
6. Form of Contract.
7. Bid bond and Performance Bond.

Division II

1. Special Specifications.

Division III

1. Technical Specifications.

Division IV

1. Contract Drawings.
2. Exhibits.

6.3 FAMILIARITY WITH CONDITIONS

- A. The Bidder certifies that he has carefully examined the Contract

74
D.

DIVISION I INVITATION FOR BIDS
PART 6 FORM OF CONTRACT

Documents as described in "Description of Contract", herein, and that he is aware of the location of the points of destination the transportation facilities available, and any other factors which would effect price and construction schedules. Bidder further warrants that he has made a careful examination of the locality of the project and is familiar with all conditions, including, but not limited to availability of labor, soil conditions, availability of housing, or any other factor which could effect the cost or construction schedule.

The Bidder therefore gives up any claim he may have based on lack of knowledge or information or deficiencies or misinterpretation of such information, including the present Contract Documents.

6.4 BID WITHOUT COLLUSION

- A. The Bidder warrants that his proposal is made in good faith and without collusion or connection with any other person or persons.

6.5 FINANCIAL RESOURCES

- A. The Bidder warrants that he possesses adequate financial resources and agrees that in the event this proposal is accepted he will furnish a Performance Bond properly executed by a bank or surety company acceptable to the Purchaser in a penal sum not less than twenty five (25%) percent of the Contract price.

6.6 DEFINITIONS

- A. The following descriptions and expressions used in the Contract Documents shall have the meaning hereunder indicated:
1. "Contractor" shall mean the natural or juridical person to whom the Contract has been awarded by the Purchaser and who is, therefore, subject to the terms of the Contract Documents.
 2. "Contract Documents" consist of the items listed in 6.2A above.
 3. "Purchaser" or "Owner" or ENDE shall mean the Empresa Nacional de Electricidad, S.A., Cochabamba, Bolivia, South America.
 4. "AID" shall mean the Agency for International Development.
 5. "At the site," "at the place," "on the project," "required," "prescribed," "specified," "approximate" and other similar expressions shall mean:
 - a. The location where the project construction of this Contract is to be completed.

163

DIVISION I INVITATION FOR BIDS
PART 6 FORM OF CONTRACT

- b. That they must be interpreted as if such terms were followed by the expression "by the Contract Documents and/or the Purchaser".
6. "Engineer" shall mean the technical representative of the Purchaser, who is entrusted with the general supervision and direction of the work.
 7. "Local currency" shall mean Bolivia's own currency: the Peso.
 8. "Drawings" shall mean those plans, maps, and drawings which are included in the Contract Documents in accordance with what is established by the Contract Documents, or which will be provided by the Purchaser and/or the Engineer, or which will be submitted by the Contractor and approved by the Purchaser and/or the Engineer.
 9. "Total prices" shall mean the prices established by the Contract as total payment for the work performed without depending on measured units.
 10. "Unit fixed prices" shall mean the prices established by the Contract as payment for each measured unit of the work performed or material furnished.
 11. "Subcontractor" is any natural or juridical person who supplies work under the supervision of the Contractor and is responsible only to the Contractor for the correct performance of the work.
 12. "Time," "term," "calendar days," or simply "days" shall mean the number of calendar days, including holidays, designated in these documents and indicating the time available for the completion of the work contemplated in this Contract.
 13. "Foreign currency" shall mean the United States Dollar (\$).
 14. "Project or work" shall mean all the services to be supplied by the Contractor in agreement with the Contract Documents.

6.7 OWNER-FURNISHED MATERIALS

The Bidder understands and agrees that, if this Proposal is accepted, the Owner will furnish to the Bidder the material set forth in the attached "List of Purchaser's Materials" and the Bidder will give a receipt therefor in writing to the Purchaser. The materials referred to are on hand at, or will be delivered to, the locations specified in the Lists and the Bidder will use such materials in constructing the Project.

DIVISION I INVITATION FOR BIDS
PART 6 FORM OF CONTRACT

Materials, if any, not required for the Project, which have been furnished to the Bidder by the Owner shall be returned to the Owner by the Bidder upon completion of construction of the Project. The value of all materials not installed in the Project nor returned to the Owner shall be deducted from the final payment to the Bidder.

The Owner shall not be obligated to furnish materials in excess of the quantities, size, kind and type set forth in the attached Lists. If the Owner furnishes, and the Bidder accepts, materials in excess thereof, the values of such excess materials shall be their actual cost as stated by the Owner.

6.8 PURCHASE OF MATERIALS NOT FURNISHED BY OWNER

The Bidder will purchase all materials and equipment (other than owner-furnished materials) outright and not subject to any conditional sales agreements, bailment, lease or other agreement reserving unto the seller any rights, title or interest therein. All such materials and equipment shall become the property of the Owner when erected in place.

6.9 PROPOSAL ON UNIT BASIS

The Bidder understands and agrees that the various Construction Units on which bids are made are defined by symbols and descriptions in this Proposal, that all said bids are on a unit basis, and that the Owner may specify any number or combination of construction Units that the Owner may deem necessary for the construction of the Project. Separate Construction Units are designated for each different arrangement which may be used in the construction of the Project. This Proposal is based on a consideration of each unit in place and includes only the materials listed on the corresponding Construction Drawings or description of units where no drawing exists.

6.10 TAXES

The unit prices for Construction Units in this Proposal include provisions for the payment of all monies which will be payable by the Bidder or the Owner in connection with the construction of the Project on account of taxes imposed by any taxing authority upon the provision of services, materials or labor in connection with the Project.

DIVISION I INVITATION FOR BIDS
PART 6 FORM OF CONTRACT

The Bidder agrees to pay all such taxes, except taxes upon the sale, purchase or use of owner-furnished materials. The Bidder will furnish to the appropriate taxing authorities all required information and reports pertaining to the Project, except as to the owner-furnished materials.

The Contractor shall be obligated to pay all the Social Services charges that are in force or will be in effect in Bolivia during the Project. These charges shall be included in the Contract unit and total prices. It will be the Contractor's obligation to know and observe the applicable Bolivian labor laws.

Imported equipment used on the Project shall be exempt from consular and custom duties as established by Bolivian laws. The Contractor's equipment for rendering service during construction will be admitted duty-free under bond approved by the Purchaser. If the Contractor should sell any of this equipment in Bolivia during or after the job is completed, this equipment will then be subject to import duties.

The Contractor will be required to obtain all licenses and pay all fees (other than import duties) in connection with the export and import of his equipment. The Purchaser does not assume any responsibility due to delays caused by measures or governmental procedures in the prosecution or transaction of these licenses.

All charges relating to the bid bond, performance bond, and payment bond shall be paid by the Contractor and included in the Contract's unit and total prices.

6.12 CHANGES IN QUANTITIES

The Bidder understands and agrees that the quantities called for in this Proposal are approximate, and that the total number of units upon which payment shall be made shall be as set forth in the inventory. If the Owner changes the quantity of the total number of Assembly Units in any Section of any SubProject Assembly Units specified in this Proposal by more than plus or minus 15%, and the cost to the Bidder is increased thereby to an extent which would not be adequately compensated by application of the unit prices in this Proposal to the revised quantity of such unit or units, such change, to the extent of the quantities of such units in excess of such 15%, shall be regarded as a change in the construction within the meaning of 6.13d of this proposal.

6.13 TIME AND MANNER OF CONSTRUCTION

- A. The Bidder agrees to commence construction of the Project on a date (hereinafter called the "Commencement Date") which shall be determined

by the Owner after notice in writing of approval of the Contract by the Owner and AID and notice in writing from the Bidder that the Bidder has sufficient personnel and equipment on site to warrant commencement and continuation of construction, but in no event will the Commencement Date be later than 60 calendar days after date of approval of the Contract by the Owner and AID. The Bidder further agrees to prosecute diligently and to complete construction of each Subproject in strict accordance with the Plans, Specifications and Construction Drawings within 180 calendar days (excluding Sundays) after Commencement Date: Provided, however, that the Bidder will not be required to dig holes, set poles or install anchors nor to perform any construction on such days when in the judgment of the Owner rain, or wind, or the results of rain or wind, make it impracticable to perform any operation of construction and to the extent of the time lost due to the conditions described herein and approved in writing by the Owner, the time of completion set out above will be extended if the Bidder makes a written request therefor to the Owner as provided in 6.13B.

- B. The time for Completion of Construction shall be extended for the period of any reasonable delay which is due exclusively to causes beyond the control and without the fault of the Bidder, including Acts of God, fires, floods, inability to obtain materials and acts or omissions of the Owner with respect to matters for which the Owner is solely responsible: Provided, however, that no such extension of time for completion shall be granted the Bidder unless within ten (10) days after the happening of any event relied upon by the Bidder for such an extension of time the Bidder shall have made a request therefor in writing to the Owner, and provided further that no delay in such time of completion or in the progress of the work which results from any of the above causes except acts or omissions of the Owner, shall result in any liability on the part of the Owner.
- C. The sequence of construction shall be as set forth below, the numbers or names being the designations of extensions or areas (hereinafter called the Subprojects) corresponding to the numbers or names shown on the maps attached hereto.
- If both Subprojects are awarded to the same Bidder, Subproject A shall be started first. Subproject B shall commence no later than 30 days after Subproject A. Subproject A shall be constructed from Villa Tunari to Chimore. Subproject B shall be constructed from the Chipiriri tap towards the north.
- D. The Owner, with the approval of AID, may from time to time during the construction of the Project make such changes in, additions to or subtractions from the Plans, Specifications, Construction Drawings, List of Materials and sequence of construction provided for in the previous paragraph which are part of the Contractor's Proposal as conditions may warrant: Provided, however, that if any change in the construction to be done shall require an extension of time, a reasonable extension will be granted if the Bidder shall make a written request therefor to the Owner within ten (10) days after any

DIVISION I INVITATION FOR BIDS
PART 6 FORM OF CONTRACT

Project. The Owner and AID shall have the right to inspect all payrolls, invoices of materials, and other data and records of the Bidder and of any subcontractor, relevant to the construction of the Project. The Bidder shall provide all reasonable facilities necessary for such inspection and tests and shall maintain an office at the site of the Project, with telephone service where obtainable and at least one office employee to whom directions and instructions of the Owner may be delivered. Delivery of such directions or instructions in writing to the employee of the Bidder at such office shall constitute delivery to the Bidder. The Bidder shall have an authorized agent accompany the Owner when final inspection is made and, if requested by the Owner, when any other inspection is made.

- D. In the event that the Owner, or AID shall determine that the construction contains or may contain numerous defects, it shall be the duty of the Bidder and the Bidder's surety or sureties to have an inspection made by an engineer approved by the Owner and AID for the purpose of determining the exact nature, extent and location of such defects.
- E. The Owner may instruct that the Bidder suspend the work wholly or in part for such period or periods as the Owner may deem necessary due to unsuitable weather or such other conditions as are considered unfavorable for the satisfactory prosecution of the work or because of the failure of the Bidder to comply with any of the provisions of the Contract: Provided, however, that the Bidder shall not suspend work pursuant to this provision without written authority from the Owner so to do. The time of completion hereinabove set forth shall be increased by the number of days of any such suspension, except when such suspension is due to the failure of the Bidder to comply with any of the provision of this Contract. In the event that work is suspended by the Bidder with the consent of the Owner, the Bidder before resuming work shall give the Owner at least twenty-four (24) hours notice thereof in writing.

6.19 DEFECTIVE MATERIALS AND WORKMANSHIP

- A. The acceptance of any materials, equipment (except owner furnished materials) or any workmanship by the Owner or the Engineer shall not preclude the subsequent rejection thereof if such materials, equipment, or workmanship shall be found to be defective after delivery or installation, and any such materials, equipment or workmanship found defective before final acceptance of the construction shall be replaced or remedied, as the case may be, by and at the expense of the Bidder. Any such condemned material or equipment shall be immediately removed from the site of the Project by the Bidder at the Bidder's expense. The Bidder shall not be entitled to any payment hereunder so long as any defective materials, equipment or workmanship in respect to the Project, of which the Bidder shall have had notice, shall not have been replaced or remedied, as the case may be.

DIVISION I INVITATION FOR BIDS
PART 6 FORM OF CONTRACT

changed. Such compensation shall be in lieu of any other payment for the installation and removal of the original unit. (If a new or replacing unit is installed, payment for such new or replacing unit shall be made as shown in the final inventory.)

No payment shall be made to the Bidder for materials or labor involved in correcting errors or omission on the part of the Bidder which result in construction not in accordance with the Plans and Specifications.

6.17 CONSTRUCTION NOT IN PROPOSAL

The Bidder also agrees that when it is necessary to construct units not shown in the Proposal it will construct such units for a price arrived as follows.

- A. The cost of labor shall be the reasonable cost thereof, but in no event shall it exceed an amount determined by calculating the ratio of the total labor costs to the total material costs (including Owner Furnished Materials) in the section of the Proposal involved, and multiplying the total cost of materials (including Owner Furnished Materials) for the unit in question by this ratio.

6.18 SUPERVISION AND INSPECTION

- A. The Bidder shall cause the construction work on the Project to receive constant supervision by a competent superintendent (hereinafter called the "Superintendent") who shall be present at all times during working hours where construction is being carried on. The Bidder shall also employ, in connection with the construction of the Project, capable, experienced and reliable foremen and such skilled workmen as may be required for the various classes of work to be performed. Directions and instructions given to the Superintendent shall be binding upon the Bidder.
- B. The Owner reserves the right to require the removal from the Project of any employee of the Bidder if in the judgment of the Owner such removal shall be necessary in order to protect the interest of the Owner. The Owner or the Supervisor, if any, shall have the right to require the Bidder to increase the number of its employees and to increase or change the amount or kind of tools and equipment if at any time the progress of the work shall be unsatisfactory to the Owner or Supervisor; but the failure of the Owner or Supervisor to give any such directions shall not relieve the Bidder of its obligations to complete the work within the time and in the manner specified in this Proposal.
- C. The manner of construction of the Project, and all materials and equipment used therein, shall be subject to the inspection, tests and approval of the Owner and AID, and the Bidder shall furnish all information required by the Owner or by concerning the nature or source of any materials incorporated or to be incorporated in the

DIVISION I INVITATION FOR BIDS
PART 6 FORM OF CONTRACT

such change is made. And provided further, that if the cost to the Bidder of construction of the Project shall be materially increased by any such change or addition, the Owner shall pay the Bidder for the reasonable cost thereof in accordance with a Construction Contract Amendment signed by the Owner and the Bidder and approved by AID, but no claim for additional compensation for any such change or addition will be considered unless the Bidder shall have made a written request therefor to the Owner prior to the commencement of work in connection with such change or addition.

- E. The Bidder will not perform any work hereunder on Sundays unless there is urgent need for such Sunday work and the Owner consents thereto in writing. The time for completion specified in 6.13A shall not be affected in any way by inclusion of this subsection nor by the Owner's consent or lack of consent to Sunday work hereunder.

6.14 ENVIRONMENTAL PROTECTION

The Bidder shall perform work in such a manner as to maximize preservation of beauty, conservation of natural resources and minimize marring and scarring of the landscape and silting of streams. The Bidder shall not deposit trash in streams or waterways, and shall not deposit herbicides or other chemicals or their containers in or near streams, waterways or pastures. The Bidder shall follow, under the general direction of the Owner, the criteria relating to environmental protection as specified herein by the Owner.

6.15 THE BIDDER

Agrees that in the event this Proposal is accepted it will make available for use in connection with the proposed construction all necessary tools and equipment and qualified superintendents and foremen.

6.16 CHANGES IN CONSTRUCTION

The Bidder agrees to make such changes in construction previously installed in the Project by the Bidder as required by the Owner for prices arrived at as follows:

- A. For substations and other units where only a portion of the complete unit is affected by the change, the compensation for such change shall be as agreed upon in writing by the Bidder and the Owner and approved by AID prior to the commencement of work in connection with such change.
- B. For all other units, the compensation for such change shall be the reasonable cost thereof as agreed upon in writing by the Bidder and the Owner prior to the commencement of work in connection with such change, but in no event shall it exceed two (2) times the labor price quoted in the Proposal for the installation of the unit to be

DIVISION I INVITATION FOR BIDS
PART 3 FORM OF CONTRACT

- B. Notwithstanding any certificate which may have been given by the Owner or the Engineer, if any materials, equipment (except owner-furnished materials) or any workmanship which does not comply with the requirements of this Contract shall be discovered within one (1) year after Completion of Construction of the Project, the Bidder shall replace such defective materials or equipment or remedy any such defective workmanship within thirty (30) days after notice in writing of the existence thereof shall have been given by the Owner. If the Bidder shall be called upon to replace any defective materials or equipment or to remedy defective workmanship as herein provided, the Owner, if so requested by the Bidder shall deenergize that section of the Project involved in such work. In the event of failure by the Bidder so to do, the Owner may replace such defective materials or equipment or remedy such defective workmanship, as the case may be, and in such event the Bidder shall pay to the Owner the cost and expense thereof.

6.20 PAYMENTS TO BIDDER

- A. The Owner shall make partial payment to the Bidder for construction accomplished during the preceding calendar month on the basis of completed Assembly Units furnished and certified to by the Bidder, recommended by the Engineer and approved by the Owner solely for the purposes of payment: Provided, however, that such approval shall not be deemed approval of the workmanship or materials. Only ninety percent (90%) of each such estimate approved during the construction of the Project shall be paid by the Owner to the Bidder prior to Completion of the Project: Upon completion by the Bidder of the construction of the Project, the Engineer will prepare a Final Inventory of the Project showing the total number and character of Assembly Units and, after checking such Inventory with the Bidder, will certify it to the Owner, together with a certificate of the total cost of the construction performed. Upon the approval of such certificates by the Owner and AID, the Owner shall make payment to the Bidder of all amounts to which the Bidder shall be entitled thereunder which shall not have been paid: Provided, however, that such final payment shall be made not later than one hundred fifty (150) days after the date of Completion of Construction of the Project, as specified in the Certificate of Completion, unless withheld because of the fault of the Bidder.
- B. The Bidder shall be paid on the basis of the number of Construction Units actually installed at the direction of the Owner shown by the inventory based on the staking sheets or structure lists; Provided, however, that the total cost shall not exceed the maximum Contract price for the construction of the Project as set forth in the Acceptance, unless such excess shall have been approved in writing by AID.
- C. Imported equipment used on the Project shall be exempt from consular and custom duties as established by Bolivian laws. The Contractor's equipment for rendering service during construction will be admitted

1163

DIVISION I INVITATION FOR BIDS
PART 3 FORM OF CONTRACT

- duty-free under bond approved by the Purchaser. If the Contractor should sell any of this equipment in Bolivia during or after the job is completed, this equipment will then be subject to import duties.
- D. The Contractor will be required to obtain all licences and pay all fees (other than import duties) in connection with the export and import of his equipment. The Purchaser does not assume any responsibility due to delays caused by measures or governmental procedures in the prosecution or transaction of these licenses.
- E. All charges relating to the bid bond, performance bond, and payment bond shall be paid by the Contractor and included in the Contract's unit and total prices.

6.21 PAYMENT METHODS

- A. The method of payments employed on this Project for U. S. Dollar payment is the Letter of Commitment Procedure.
- B. All payments to the Bidder for authorized U. S. Dollar payment under this proposal shall be made under a confirmed and irrevocable Letter of Credit opened by ENDE under the governing AID Letter of Commitment in favor of the Bidder, in the amount for which the proposal is accepted.
- C. The peso payment will be made directly by the Owner to the Contractor within fifteen (15) days after the presentation of the appropriate invoice.

6.22 PAYMENT RULES

- A. Notice to proceed:
1. The Contractor shall commence work upon receipt from the Owner of a notice to proceed.
 2. AID will not finance costs incurred by the Owner prior to the date AID has approved for incurring cost.

6.23 DOCUMENTS

- A. Any claims by the Contractor for payment or reimbursement for goods and services must be supported by the documents specified in this section and/or such other documents as may be specified in the Loan Agreement, Letter of Implementation, or other related documents. (All documents should indicate the AID number of the Loan 511-T-067 under which payment is sought). Further, each document should be completed, executed, and submitted in the number of copies as specified in the instructions thereon or in the Letter of Implementation.

DIVISION I INVITATION FOR BIDS
PART 6 FORM OF CONTRACT

- B. The supporting documents must be submitted individually to cover services of United States or other eligible country source and origin. Contractor must submit separate invoices for the dollar and the peso payments.
- C. The documents, and certification thereon or as submitted therewith, may not include less information or less authentication than outlined in Paragraph d. through except as modified pursuant to Paragraph a. Each document shall be the original carbon, or photocopy.
- D. The Voucher SF 1034 is to be submitted in an original and three copies, normally prepared by the U. S. banking institution under direct financing.
- E. For progress or final payments, the Contractor shall submit one copy of the invoice describing the services performed, and identifying the covering Contract and the section or paragraph which provides for such payment and the total quantity and unit price of the units contracted and approved for payment by the Engineer as of the date of the invoice. Each invoice shall have attached or endorsed thereon the following certification :

The undersigned certifies that the costs reimbursable to the Contractor and the amount payable to the Contractor in accordance with the terms of the Contract, up to date of this certificate, are not less than the total payment received or claimed by the Contractor under the Contract (including the payment claimed under this invoice), and that the Contractor has fully complied with the terms and conditions of the Contract, including the plans and specifications.

- F. Contractor's certificate and agreement:
1. The Contractor's Certificate and Agreement with the Agency for International Development and the Related Contractor's Invoice and Contract Abstract for AID Form 1440-3 shall be executed by and shall bind the person organization on whose behalf it is executed.

6.24 LATE PAYMENT

Interest at the rate of seven percent (7%) per annum shall be paid by the Owner to the Bidder on all unpaid balances due on monthly estimates, commencing thirty (30) days after the receipt by the Owner of a properly documented invoice provided the delay in payment beyond the due date is not caused by any condition within the control of the Bidder.

Interest at the rate of seven percent (7%) per annum shall be paid by the Owner to the Bidder on the final payment for the Project any completed Section thereof, commencing fifteen (15) days after the due date. The due date for purposes of such final payment shall be the date of approval by the AID of all of the documents requiring such approval, as a condition

precedent to the making of final payment, or one hundred fifty (150) days after the date of Completion of Construction of the Project, as specified in the Certificate of Completion, whichever date is earlier.

No payment shall be due while the Bidder is in default in respect of any the provisions of this Contract and the Owner may withhold from the Bidder the amount of any claim by a third party against either the Bidder or the Owner based upon an alleged failure of the Bidder to perform the work hereunder in accordance with the provisions of this Contract.

6.25 RELEASE OF LIENS AND CERTIFICATE OF CONTRACTOR

(See sample Form 224, Waiver and Release of Lien and sample Form 231, Certificate of Contractor.) Upon the completion by the Bidder of the construction of the Project but prior to final payment to the Bidder, the Bidder shall deliver to the Owner, in duplicate, releases of all liens and of rights to claim any lien, in the form attached hereto from all manufacturers, materialmen, and subcontractors furnishing services or materials for the Project and a certificate in the form attached hereto to the effect that all labor used on or for the Project has been paid and that all such releases have been submitted to the Owner; and the Owner shall deliver to AID for AID approval one of the duplicates of each such release and certificate.

6.26 PAYMENTS TO MATERIALMEN AND SUBCONTRACTORS

The Bidder shall pay each materialman, and each subcontractor, if any, within five (5) days after receipt of any payment from the Owner, the amount thereof allowed the Bidder for and on account of materials furnished or construction performed by each materialman or each subcontractor.

6.27 PERFORMANCE BOND

- A. The Bidder at the time the contract is executed will furnish a guaranty document granted by a bank acceptable to the Owner that would guarantee the fulfilment of the covenants of this Contract by the Bidder during the original period of the Contract and any extensions that may be granted by the Purchaser and covenants, conditions and agreements of any and all duly authorized modifications of the Contract. The sum of this bond is to be equal to twenty five (25%) percent of the Contract's total price. The bond shall bear the same effective date as the date of signature of the Contract.
- B. At the date of the final acceptance of the Project work original performance bond in the amount of twenty five (25%) percent will be returned by the Purchaser to the Contractor. The Contractor, at the time the performance bond is returned, will furnish a guaranty document granted by a bank acceptable to the Purchaser that would guarantee that the Contractor perform and fulfill all the

17

DIVISION I INVITATION FOR BIDS
PART 6 FORM OF CONTRACT

undertakings, covenants, terms, conditions and agreements of the Contract Documents. This guaranty is to equal ten percent (10%) of the Contract's total value and shall remain in full effect for twelve (12) months from the acceptance date. The Contractor shall bear the costs of the performance bond and guaranty bond which shall be included in the Contract's unit or total prices.

6.28 PAYMENT BOND

- A. The Contractor, at the time Contract is signed, will furnish a guaranty document granted by a bank acceptable to the Purchaser that would guarantee that the Contractor shall promptly make payments to all persons supplying labor and material in the prosecution of the work in the Contract Documents, and any duly authorized modifications of the Contract that may hereafter be made. The sum of this bond is equal to twenty five (25%) percent of the Contract's total price. The bond shall bear the same effective date as the date of signature of the Contract.
- B. Within thirty (30) days after the date of acceptance this payment bond will be returned to the Contractor provided he has complied with the provisions of Section 6.25.

6.29 ARBITRATION

- A. Any claim or controversy that arises between the parties for the application or interpretation of the Contract Documents, in all and each one of its parts, will be submitted for resolution to arbitration constituted in the following way: each party will nominate an arbitrator and the two so nominated will nominate a third arbitrator within the five calendar days from their nomination. If the first two arbitrators do not reach an agreement to nominate the third party within the period of time stipulated above, the President of the Consejo Nacional de Ingenieria will nominate him.
- B. The arbitrators nominated by the parties shall render their judgment within fifteen (15) calendar days after having received the matter for solution. If the two arbitrators cannot reach an agreement, the third party nominated shall solve the disagreement within ten (10) days after having received the matter of disagreement.
- C. The parties mutually agree that the decision of the arbitration must be definitive and obligatory. All arbitration proceedings shall conform in all respects with any legal disposition or dispositions which are in effect currently in Bolivia. The arbitration tribunal will reside in Cochabamba. It is understood that while the controversy exists, the construction shall continue in its normal course and any payment due by the Purchaser to the Contractor shall not be retained unless they are the subject of the matter in dispute.

DIVISION I INVITATION FOR BIDS
PART 6 FORM OF CONTRACT6.30 PURCHASER'S RIGHT TO TERMINATE THE CONTRACT

- A. The Purchaser, for his convenience or based upon reasons that exist to justify such action, may without prejudice to any other right or remedy and after giving the Contractor twenty (20) days written notice, terminate the employment of the Contractor and take possession of the site and of all materials, plants, equipment and appliances thereon and finish the work by whatever method he may deem expedient. Sufficient causes for termination exists:
1. If the Contractor should be adjudged bankrupt or if he should make a general assignment for the benefit of his creditors.
 2. If the Contractor should persistently or repeatedly refuse or fail, except in cases for which extension of time is provided, to provide enough skilled workmen or proper materials.
 3. If the Contractor should fail to make prompt payment to subcontractors or for material or labor.
 4. If the Contractor should persistently disregard laws, ordinances, or the directions of the Engineer or Owner.
 5. If the Contractor should otherwise be guilty of a substantial violation of any provision of this Contract.
- B. In any of the above cases, the Purchaser reserves the right to terminate the work enforcing the performance bond and payment bond. The Purchaser shall complete the work in a way the Purchaser considers convenient. No payment will be received by the Contractor from that moment or until the work is finished. In the last case, if the unpaid balance as specified and calculated in accordance with the provisions of this Contract shall exceed the expense of finishing the work, including compensation for additional managerial and administrative services, such excess shall be paid to the Contractor. If such expense shall exceed the unpaid balance, the Contractor shall pay the difference to the Purchaser.
- C. In case of termination for convenience, the Contractor will be compensated for reasonable expenses incurred in good faith for performance of the Contract, but not for unearned profit.

6.31 CONTRACTOR'S RIGHT TO STOP OR TERMINATE CONTRACT

- A. The Contractor is entitled, upon sixty (60) days written notice to the Purchaser, to stop work or terminate this Contract and recover from the Purchaser payment for all work executed and any loss sustained upon any plant or materials and reasonable profit and damages under any of the following conditions:
1. Persistent failure of the Purchaser to make payments according to

DIVISION I INVITATION FOR BIDS
PART 6 FORM OF CONTRACT

the provisions of this Contract or the stipulations agreed upon.

- 2. Refusal of the Purchaser to submit to, and abide by, arbitration or court judgement, as the case may be.

6.32 SUCCESSORS AND DESIGNATIONS

- A. The Purchaser and the Contractor, or their successors, executors administrators and designees, bind themselves and each one in favor of the other party to the fulfillment of this Contract.

6.33 GOVERNING LAW

- A. The validity and interpretation of this Contract will be governed by the laws of Bolivia.

6.34 PROTECTION TO PERSONS AND PROPERTY

The Bidder shall at all times take all reasonable precautions for the safety of employees on the work and of the public, and shall comply with all applicable provisions of National, and Local safety laws and building and construction codes, as well as the safety rules and regulations of the Owner. All machinery and equipment and other physical hazards shall be guarded in accordance with the "Manual of Accident Prevention in Construction" of the Associated General Contractors of America unless such instructions are incompatible with Bolivian National or local laws or regulations.

The following provisions shall not limit the generality of the above requirements:

- A. The Bidder shall at no time and under no circumstances cause or permit any employee of the Bidder to perform any work upon energized lines, or upon poles carrying energized lines.
- B. The Bidder shall so conduct the construction of the Project as to cause the least possible obstruction of public highways.
- C. The Bidder shall provide and maintain all such guard lights and other protection for the public as may be required by applicable statutes, ordinances and regulations or by local conditions.
- D. The Bidder shall do all things necessary or expedient to properly protect any and all parallel, converging and intersecting lines, joint line poles, pipelines, highways and any all property of others from damage, and in the event that any such parallel, converging and intersecting lines, joint line poles, pipelines, highways or other property are damaged in the course of the construction of the Project the Bidder shall at its own expense restore any or all of such damaged property immediately to as good a state as before such damage

DIVISION I INVITATION FOR BIDS
PART 6 FORM OF CONTRACT

occurred.

- E. Where the right-of-way of the Project traverses cultivated lands, the Bidder shall limit the movement of its crews and equipment so as to cause as little damage as possible to crops, orchards or property and shall endeavor to avoid marring the lands. All fences which are necessarily opened or moved during the construction of the Project shall be replaced in as good condition as they were found and precautions shall be taken to prevent the escape of livestock. The Bidder shall not be responsible for loss of or damage to crops, orchards or property (other than livestock) on the right-of-way necessarily incident to the construction of the Project and not caused by negligence or inefficient operation of the Bidder. The Bidder shall be responsible for all other loss of or damage to crops, orchards, or property, whether on or off the right-of-way, and for all loss of or damage to livestock caused by the construction of the Project. The right-of-way for purposes of this said section shall consist of an area extending 3 meters on each side of the center line of the poles along the route of the Project lines, plus such area reasonably required by the Bidder for access to the route of the Project lines from Public roads to carry on construction activities.
- F. The Project, from the commencement of work to completion, or to such earlier date or dates when the Owner may take possession and control in whole or in part as hereinafter provided shall be under the charge and control of the Bidder and during such period of control by the Bidder all risks in connection with the construction of the Project and the materials to be used therein shall be borne by the Bidder. The Bidder shall make good and fully repair all injuries and damages to the Project or any portion thereof under the control of the Bidder by reason of any Act of God or other casualty or cause whether or not the same shall have occurred by reason of the Bidder's negligence. The Bidder shall hold the Owner harmless from any and all claims for injuries to persons or for damage to property happening by reason of any negligence on the part of the Bidder or any of the Bidder's agents or employees during the control by the Bidder of the Project or any part thereof.
- G. Any and all excess earth, rock, debris, underbrush and other useless material shall be removed by the Bidder from the site of the Project as rapidly as practicable as the work progresses.
- H. Upon violation by the Bidder of any of the provisions of this Section, after written notice of such violation given to the Bidder by the Owner, the Bidder shall immediately correct such violation. Upon failure of the Bidder so to do the Owner may correct such violation at the Bidder's expense: Provided, however, that the Owner may, if it deems it necessary or advisable, correct such violation at the Bidder's expense without such prior notice to the Bidder.
- I. The Bidder shall submit to the Owner monthly reports in duplicate of all accidents, giving such data as may be prescribed by the Owner.

118

DIVISION I INVITATION FOR BIDS
PART 6 FORM OF CONTRACT

- J. The Bidder shall not proceed with the cutting of trees or clearing of right-of-way without written notification from the Owner that proper authorization has been received from the owner of the property, and the Bidder shall promptly notify the Owner whenever any landowner objects to the trimming or felling of any trees or the performance of any other work on its land in connection with the Project and shall obtain the consent in writing of the Owner before proceeding in any such case.

6.35 INSURANCE

The Bidder shall take out and maintain throughout the construction period insurance in the following minimum requirements:

- A. Workmen's compensation insurance covering all employees in statutory limits who perform any of the obligations assumed by the Bidder under the Contract.
- B. Public liability and property damage liability insurance covering all operations under the Contract: limits for bodily injury or death not less than \$100,000 for one person and \$300,000 for each accident; for property damage, not less than \$25,000 for each accident and \$50,000 aggregate for accidents during the policy period.
- C. Automobile liability insurance on all self-propelled vehicles used in connection with the Contract, whether owned, non-owned, or hired; public liability limits of not less than \$100,000 for one person and \$300,000 for each accident; property damage limit of \$10,000 for each accident.
- D. The Owner shall have the right at any time to require public liability insurance and property damage liability insurance greater than those required in subsections B and C of this Section. In any such event, the additional premium or premiums payable solely as the result of such additional insurance shall be added to the Contract price.

Upon request by the Owner or AID, the Bidder shall furnish a certificate evidencing compliance with the foregoing requirements.

6.36 DELIVERY OF POSSESSION AND CONTROL TO OWNER

- A. Upon written request of the Owner the Bidder shall deliver to the Owner full possession and control of any portion of the Project provided the Bidder shall have been paid at least ninety percent (90%) of the cost of construction of such portion. Upon such delivery of the possession and control of any portion of the Project to the Owner, the risk and obligations of the Bidder as set forth in 6.34 hereof with respect to such portion of the Project so delivered to the Owner shall be terminated: Provided, however, that nothing herein contained shall relieve the Bidder of any liability with respect to defective materials and workmanship as contained in 6.19 hereof.

DIVISION I INVITATION FOR BIDS
PART 6 FORM OF CONTRACT

6.37 ENERGIZING THE PROJECT

- A. Prior to Completion of the Project the Owner, upon written notice to the Bidder, may test the construction thereof by temporarily energizing any portion or portions thereof. During the period of such test the portion or portions of the Project so energized shall be considered as within the possession and control of the Owner and governed by the provisions of 6.36. Upon written notice to the Bidder by the Owner of the completion of such test and upon deenergizing the lines involved therein said portion or portions of the Project shall be considered as returned to the possession and control of the Bidder unless the Owner shall elect to continue possession and control in the manner provided in 6.36.
- B. The Owner shall have the right to energize permanently any portions of the Project delivered to its possession and control pursuant to the provisions of 6.36 of this Article.

6.38 ASSIGNMENT OF GUARANTEES

All guarantees of materials and workmanship running in favor of the Bidder shall be transferred and assigned to the Owner prior to the time the Bidder receives final payment.

6.39 COMPLETION ON BIDDER'S DEFAULT

If default shall be made by the Bidder or by any subcontractor in the performance of any of the terms of this Proposal, the Owner, without in any manner limiting its legal and equitable remedies in the circumstances, may serve upon the Bidder and the Surety or Sureties upon the Contractor's Bond or Bonds a written notice requiring the Bidder to cause such default to be corrected forthwith. Unless within twenty (20) days after the service of such notice upon the Bidder such default shall be corrected or arrangements for the correction thereof satisfactory to both the Owner and AID shall be made by the Bidder or its Surety or Sureties, the Owner may take over the construction of the Project and prosecute the same to completion by Contract or otherwise for the account and at the expense of the Bidder, and the Bidder and its Surety or Sureties shall be liable to the Owner for any cost or expense in excess of the Contract price occasioned thereby. In such event the Owner may take possession of and utilize, in completing the construction of the Project, any materials, tools, supplies, equipment, appliances, and plant belonging to the Bidder or any of its subcontractors, which may be situated at the site of the Project. The Owner in such contingency may exercise any rights, claims or demands which the Bidder may have against third persons in connection with this Contract and for such purpose the Bidder does hereby assign, transfer and set over unto the Owner all such rights claims and demands.

177

DIVISION I INVITATION FOR BIDS
PART 6 FORM OF CONTRACT

6.40 LIQUIDATED DAMAGES

The time of the Completion of Construction of the Project is of the essence of the Contract. Should the Bidder neglect, refuse or fail to complete the construction within the time herein agreed upon, after giving effect to extensions of time, if any, herein provided, then, in that event and in view of the difficulty of estimating with exactness damages caused by such delay, the Owner shall have the right to deduct from and retain out of such moneys which may be then due, or which may become due and payable to the Bidder the sum of Six hundred dollars (\$ 600) per day for each and every day that such construction is delayed in its completion beyond the specified time, as liquidated damages and not as a penalty; if the amount due and to become due from the Owner to the Bidder is insufficient to pay in full any such liquidated damages, the Bidder shall pay to the Owner the amount necessary to effect such payment in full; Provided, however, that the Owner shall promptly notify the Bidder in writing of the manner in which their amount retained, deducted or claimed as liquidated damages was computed.

6.41 CUMULATIVE REMEDIES

Every right or remedy herein conferred upon or reserved to the Owner or AID shall be cumulative, shall be in addition to every right and remedy now or hereafter existing at law or in equity or by statute and the pursuit of any right or remedy shall not be construed as an election: Provided, however, that the provisions of 6.40 of this Part shall be the exclusive measure of damages for failure by the Bidder to complete the construction of the Project within the time herein agreed upon.

6.42 FRANCHISES AND RIGHTS-OF-WAY

The Bidder shall be under no obligation to obtain or assist in obtaining: Any franchises, authorizations, permits or approvals required to be obtained by the Owner from National, Municipal or other authorities; any rights-of-way over private lands; or any agreements between the Owner and third parties with respect to the joint use of poles, crossings, or other matter incident to the construction and operation of the Project.

6.43 NONASSIGNMENT OF CONTRACT

The Bidder shall perform directly and without subcontracting not less than twenty-five percent (25%) of the construction of the Project, to be calculated on the basis of the total Contract price. The Bidder shall not assign the Contract effected by an acceptance of this Proposal or any interest in any funds that may be due or become due hereunder or enter into any contract with any person, firm or corporation for the performance of the Bidder's obligations hereunder or any part thereof, without the approval in writing of the Owner and AID and of the surety or sureties on any bond furnished by the Bidder for the faithful performance of the Bidder's obligations hereunder. If the Bidder, with the consent of the

DIVISION I INVITATION FOR BIDS
PART 6 FORM OF CONTRACT

Owner, AID and any surety or sureties on the Contractor's Bond or Bonds, shall enter into a subcontract with any subcontractor for the performance of any part of this Contract, the Bidder shall be as fully responsible to the Owner and the Government for the acts and omissions of such subcontractor and of persons employed by such subcontractor as the Bidder would be for its own acts and omissions and those of persons directly employed by it.

6.44 LEGAL EFFECT OF CERTAIN AID APPROVALS AND DECISIONS

- A. The parties hereto understand that AID has reserved certain approval rights including, but not limited to, the right to approve the terms of this Contract, the Contractor, and any or all plans, reports, specifications, subcontracts, bid documents, drawings, or other documents related to this Contract and the Project of which it is part. The parties hereto further understand and agree that AID, in reserving any or all of the foregoing approval rights, has acted solely as a lender to assure the proper use of United States Government funds and that any decision by AID to exercise or refrain from exercising these approval rights shall be made as a lender in the course of financing this Project and shall not be construed as making AID a party to the Contract. The parties hereto understand and agree that AID may, from time to time, exercise the foregoing approval rights or discuss matters related to these rights and the Project of which this Contract is part with the parties jointly or separately without thereby incurring any responsibility or liability to the parties jointly or to any of them.
- B. Any approval, or failure to disapprove, by AID of any plan, report, specification, contract, bid document, drawing, or other documents shall not prevent the borrower or AID from asserting any right, or relieve the Contractor of any liability which Contractor might otherwise have to the Purchaser or AID, because of such plan, specification, contract, bid document, drawing, or other document, or any performance or failure of performance thereunder, or under any AID contractor's supplier's certificate.

In witness whereof, the parties hereto have executed this Contract in eight (8) identical copies as of the _____ day of _____, 19__ in the city of Cochabamba, Bolivia.

BY THE EMPRESA NACIONAL DE ELECTRICIDAD, S.A.

Title

DIVISION II CONDITIONS OF THE CONTRACT
PART I - SPECIAL SPECIFICATIONS

INDEX

- 2.1 Construction Plant and Camp
- 2.2 Occupation of Sites
- 2.3 Leaving Construction Plant and Camp
- 2.4 Warehouse and Purchaser-Furnished Materials
- 2.5 Hoisting of Material and Equipment
- 2.6 Transportation of Materials and Equipment
- 2.7 Loading, Transportation, and Unloading of Material and Equipment
- 2.8 Return of Packing
- 2.9 Replacement of Damaged Material and Equipment
- 2.10 Labor, Salaries, and Social Security
- 2.11 Relations with Other Contractors
- 2.12 Electricity and Water Requirements
- 2.13 Project Signs
- 2.14 Facilities for the Purchaser and the Owner at the Construction Site
- 2.15 Reports
- 2.16 Data to Accompany Bids
- 2.17 Intent of Specifications
- 2.18 Interpretation of Specifications
- 2.19 Form of Specifications
- 2.20 Interference with Other Work
- 2.21 Coordination of Construction
- 2.22 Local Conditions
- 2.23 Construction Inspectors
- 2.24 Sanitary Facilities
- 2.25 Construction Services
- 2.26 Contractor's Office

DIVISION II CONDITIONS OF THE CONTRACT
PART I - SPECIAL SPECIFICATIONS

2.1 CONSTRUCTION PLANT AND CAMP

- A. The sites and facilities established by the Contractor for the construction of each Subproject shall be maintained according to the criteria furnished by the Owner in the pre bid conference and subject to his approval. The provisional buildings constructed to serve as office, warehouse, workshops, housing facilities for employees, etc., shall be subject to acceptance of and approval by the Owner.

2.2 OCCUPATION OF SITES

- A. The Contractor shall furnish the sites and facilities required by the construction needs at his own expense unless otherwise indicated.

2.3 LEAVING CONSTRUCTION PLANT AND CAMP

- A. Upon completion of each Subproject, the Contractor's construction plant and camp, together with any and all debris, useless material, etc., shall be removed by the Contractor and the sites and fences shall be restored to a condition as good as originally encountered.

2.4 WAREHOUSE AND PURCHASER-FURNISHED MATERIALS

- A. Warehouse and/or storage facilities acquired, including sites and rentals as required by the construction program, shall be subject to the approval of the Owner and relevant expenses shall be the responsibility of the Contractor.

2.5 HOISTING OF MATERIAL AND EQUIPMENT

- A. The Contractor shall take special care when handling and hoisting the material and equipment during construction and shall respect the relevant recommendations specified by the manufacturer. The Contractor shall understand that any and all damage caused to materials and equipment by improper handling will be at his expense.

2.6 TRANSPORTATION OF MATERIALS AND EQUIPMENT

- A. The Contractor shall utilize vehicles in accordance with the needs of and properly fitted for the transportation of materials and equipment in hauling and transporting all materials and equipment within the Project area. In hauling and transporting all materials and equipment, the Contractor shall ensure that bulky items do not excessively project beyond the overall contour of vehicles. Clearly

181

DIVISION II CONDITIONS OF THE CONTRACT
PART I - SPECIAL SPECIFICATIONS

visible signs shall be used to indicate that a load may be projecting. All permits, licenses permissions or other approvals required for transportation of materials and equipment shall be obtained by and at the cost of the Contractor.

2.7 LOADING, TRANSPORTATION, AND UNLOADING OF MATERIAL AND EQUIPMENT

- A. The Contractor shall exercise due care and vigilance when loading, transporting, and unloading materials and equipment. The Contractor shall furnish the necessary means to ensure that the proper and safe loading, transportation, and unloading of materials and equipment is realized.

2.8 RETURN OF PACKING

- A. The Contractor shall return to the Purchaser, if requested, all packing material in which the construction materials have been delivered. The Contractor shall avoid damaging packing material.

2.9 REPLACEMENT OF DAMAGED MATERIAL AND EQUIPMENT

- A. Any and all materials and equipment that become damaged due to lack of proper handling, storage, or care during installation by the Contractor shall be replaced by the Contractor at his own expense. The substituted material shall be similar or equal to the original and subject to the approval of the Owner.

2.10 LABOR, SALARIES, AND SOCIAL SECURITY

- A. The Contractor shall employ such capable, experienced, reliable, and skilled personnel as are required so that the work progresses correctly and as scheduled. Wages, salaries, and payment of the Contractor's personnel shall conform with Bolivian law and local regulations.

2.11 RELATIONS WITH OTHER CONTRACTORS

- A. If the Contractor experiences delay or difficulties during the development of work which is directly or indirectly caused by other contractors, he shall inform the Owner so that the Owner may initiate the necessary corrective action.

2.12 ELECTRICITY AND WATER REQUIREMENTS

- A. These shall be provided by the contractor at his expense.

DIVISION II CONDITIONS OF THE CONTRACT
PART I - SPECIAL SPECIFICATIONS

2.13 PROJECT SIGNS

- A. Project signs clearly identifying the name of the project, the Owner, the Contractor and USAID shall be located at all warehouse, staging, office, or other semipermanent area. Such signs shall be at least 3 feet by 4 feet and shall be professionally prepared so as to present a workmanlike appearance. Cost shall be borne by Contractor.

2.14 FACILITIES FOR THE PURCHASER AT THE CONSTRUCTION SITE

- A. The Contractor shall provide work space in his office facility for the use of Owner's on-site Construction Inspectors.
- B. In the event that Contractor utilizes radio communication equipment in the control of his crews, Contractor shall provide one radio transceiver of the appropriate Contractor's frequency for the use of Owner's Construction Inspector and shall install such radio (and maintain it in working order) in the Inspector's work vehicle.

2.15 REPORTS

- A. In the pre bid conference, the number, type, and frequency of reports to be submitted by the Contractor to the Purchaser will be specified. The relevant forms in the English language will be provided to the Contractor by the Purchaser.
- B. If additional copies of these forms or other forms are required by the Contractor, these will be prepared at his expense in accordance with the instructions of the Owner.

2.16 DATA TO ACCOMPANY BIDS

- A. Submit the following with each copy of bid:
1. Information called for in Contract Documents.
 2. List of makes, types, and sizes of proposed equipment.

2.17 INTENT OF SPECIFICATIONS

- A. To set forth requirements of performance, type of equipment desired, and standards of materials and construction.

2.18 INTERPRETATION OF SPECIFICATIONS

- A. Report any error or ambiguities in specifications to Owner as soon as detected. Owner will answer questions regarding and interpret intended meaning of specifications; his interpretation shall be

DIVISION II CONDITIONS OF THE CONTRACT
PART I - SPECIAL SPECIFICATIONS

accepted as final.

2.19 FORM OF SPECIFICATIONS

- A. Abbreviated, outline type.

2.20 INTERFERENCE WITH OTHER WORK

- A. Purchaser reserves the right to let other contracts in connection with this work. Contractor shall afford other contractors reasonable opportunity for the delivery and storage of their materials and the execution of their work and shall properly connect and coordinate his work with theirs.
- B. If any of Contractor's work depends, for proper execution or results, upon the work of any other contractor, Contractor shall inspect and promptly report to Owner any defects in such other work that render it unsuitable for such proper execution and results. His failure so to inspect and report shall constitute an acceptance of the other contractor's work as fit and proper for the reception of his work.
- C. When two or more contracts are being executed at one time in such manner that work on one contract may interfere with that on another, Owner shall decide which contractor shall cease work and which shall continue, or whether the work on both contracts shall progress at the same time and in what manner. When the territory of one contract is the necessary or convenient means of access for the transportation or movement of men, materials, or appliances for the execution of another contract, such privilege may be granted by Owner to the contractor so desiring to the extent, in the amount, in the manner and at the time necessary.

2.21 COORDINATION OF CONSTRUCTION

- A. Coordinate work with Owner to assure orderly and expeditious progress of work.
- B. Select order of work and establish schedule of working hours for construction, subject to approval of Owner.
- C. Maintain existing transmission lines and substation buses in substantially continuous operation during construction.
- D. Perform work hazardous to operation of existing transmission lines or which will require interruption of service at time specifically approved by Owner.
- E. Make any temporary connections necessary for maintaining service during course of work and continued operation of existing transmission lines.

184

DIVISION II CONDITIONS OF THE CONTRACT
PART I - SPECIAL SPECIFICATIONS

1. Make temporary connections in a workmanlike manner; avoid hazards to personnel or service.
 2. Remove temporary connections after permanent connections are made.
- F. Schedule construction to minimize interruptions to utility service or use of street barricades and detours.

2.22 LOCAL CONDITIONS

- A. Bidders are expected to examine the sites, interpret or disregard soil boring logs as they see fit, and arrive at own conclusions regarding character and locations of materials to be encountered.
- B. Bidders may make soil borings and investigations if they so desire.

2.23 CONSTRUCTION INSPECTORS

- A. Owner shall provide qualified Construction Inspectors to act as Owner on site representative.
- B. The duties of the Construction Inspector consist only in determination that the results of the Contractor's work are in compliance with the Specifications and shall not extend to direct supervision of Contractor's personnel or operations.
- C. Presence of Inspectors will in no way relieve Contractor of any responsibility assumed under this Contract.

2.24 SANITARY FACILITIES

- A. Sanitary facilities shall be provided by Contractor for use of his personnel for the duration of the Project and upon completion of the work shall be removed from the site.

2.25 CONSTRUCTION SERVICES

- A. Contractor shall provide water, electricity, compressed air, and other services he may require as needed.

2.26 CONTRACTOR'S OFFICE

- A. Contractor shall provide, maintain, and heat an office for his use at project site, equipped with telephone if available.

103

DIVISION III - TECHNICAL SPECIFICATIONS
PART 1 - ELECTRIC LINE CONSTRUCTION

INDEX

- 1.1 Reference
- 1.2 General
- 1.3 Poles
- 1.4 Pole Top Assemblies
- 1.5 Conductors
- 1.6 Anchors and Guys
- 1.7 Grounds
- 1.8 Insulators
- 1.9 Equipment

186

DIVISION III - TECHNICAL SPECIFICATIONS
PART 1 - ELECTRIC LINE CONSTRUCTION

1.1 REFERENCE

- A. Requirements of Division I and II of this contract apply to all work under this part.

1.2 GENERAL

- A. All Construction work shall be done in a thorough and workmanlike manner in accordance with the Plans, Specifications and Contract Drawings.
- B. The requirements of the latest edition of the U.S. National Electric Safety Code have been followed in the design of the 19.9/34.5 kv distribution facilities and shall also be followed by the Contractor.

1.3 POLES

- A. Poles shall be distributed such that large, choice, close grained, straight poles shall be used for transformer, deadend, angle and corner poles.
- B. Poles shall be transported and handled by means which will not mar, gouge, or otherwise damage them. Dragging of poles is not permitted. Use of pole tongs, or cant hooks is not permitted. Poles shall not be dropped off transports, used as skids or chocks, or otherwise abused. Poles shall be transported on suitable trailers using wood blocking to prevent metal-to-pole contact and shall be firmly secured. Length of trailer and method of loading shall be such that unsupported pole overhang is no more than 30% of the length of any pole.

Poles which suffer handling damage attributable to Contractor shall be replaced at Contractor's expense.

Poles are not to be cut for any reason whatever.

- C. If poles are to be stored prior to distribution, they shall be stored in an area cleared of vegetation down to sterile soil. Poles shall be stored on treated wood skids such that the poles are at least 30 cm off the ground. Skids shall be of such size and number that poles are supported every 4 meters.
- D. When poles are transported to their final locations, they shall not be allowed to lay on the ground for more than one week prior to erection.
- E. Pole holes shall be at least six inches but not more than 12 inches greater in diameter than the pole. Pole hole depths shall be as follows:

..Page8

Pole	Depth
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157

DIVISION III - TECHNICAL SPECIFICATIONS
PART 1 - ELECTRIC LINE CONSTRUCTION

8.5 m	1.60 m
10.0 m	1.75 m
11.0 m	1.80 m
12.0 m	1.85 m
13.5 m	1.95 m

Holes shall not be dug overdepth. Holes no more than 5 cm overdeep may be backfilled to the specified depth with earth tamped by pneumatic tampers to a density equivalent to native soil.

- F. Pole holes shall be excavated "on point" such that the resulting line of poles is straight, as designed.
- G. Poles shall not be set in holes without first removing any accumulated water. Pole holes shall be backfilled with dry earth without organic matter, thoroughly tamped using pneumatic tampers in the ratio of two men tamping to one shoveling. In the event that the earth excavated from the hole is unsuitable, either due to excess water or the presence of organic matter, Contractor shall import suitable backfill. For the case of wet holes, suitable backfill shall consist of river-run gravel, sorted to remove rocks too large to fall to the bottom of the hole. Such backfill shall be tamped as indicated above.
- H. Tangent Poles shall be set plumb aligned so that sweep is longitudinal (along the line). Angle and corner poles shall be raked against the strain at least 1 cm for each 3 m of pole length but not more than 10 cm total.

1.4 POLE TOP ASSEMBLIES

- A. Pole top assemblies shall be assembled as shown on the drawings, with no substitutions or deletions unless authorized by the Owner in writing.
- B. Crossarms shall be mounted and braced square to the pole axis.
- C. Field drilled holes and field cut gains shall be treated with approved CCA solution. Unused holes shall be plugged with treated dowels.
- D. Washers shall be provided between the head or nut of all bolts and any mating wood part. Thimble eye and single arming eye bolts will be installed without washers under the eye. Such bolts will be drawn up until the eye is seated firmly into the wood. Locknuts will be installed behind all nuts. Locknuts shall be of type MF and shall be used only once (i.e. locknuts removed from disassembled parts shall not be reused).
- E. Hardware shall be handled and installed with care to avoid damaging the galvanizing. Hardware nuts shall be installed with the beveled side down (facing the washer) and the flat end up to allow the MF

DIVISION III - TECHNICAL SPECIFICATIONS
PART 1 - ELECTRIC LINE CONSTRUCTION

locknut to seat properly. Hardware will be tightened using proper wrenches. Channel-locks and similar plier type wrenches are not permitted on the job. Hardware found to be installed with such tools will be replaced at the contractors expense.

- F. Poles shall be framed so that alternate crossarms face in opposite directions. On crossings or long spans poles shall be set such that both crossarms face away from the crossing or the long span.
- G. Bolt lengths shall be selected such that bolts protrude a minimum of 1 cm but not more than 5 cm past the hardware. No bolts shall be cut-off.
- H. Special care shall be taken not to damage the lead threads of the insulator pins.
- I. Hardware damaged during handling or installation shall be replaced at Contractors expense.

1.5 CONDUCTORS

- A. Conductors shall be loaded and transported in such fashion as to avoid damage to either the conductor or the reel. Reels shall be lifted using an axle and sling with a spreader bar. Under no circumstances shall reels be lifted using slings or chains around the conductor or slings placed through the arbor hole. Fork lift trucks may be used to move reels only by lifting the edges of the reel, not with the forks bearing on the conductor. Conductor reels shall be stored and transported on edge, not flat. Reels shall not be dropped off transports or otherwise abused.
- B. Conductors may be strung by any method which will not kink, mar, twist, abraid, gouge or otherwise damage them. Conductors shall not be trampled, run over, or dragged over rocks, fences, buildings or other protrusions. Road crossings shall be achieved by constructing guard structures on either side of the road to support the conductor until tensioned, not by laying conductor in the road and allowing traffic to run over it. Pole top assemblies shall be provided with suitable free-running dollies or pulleys allowing the conductor to run without binding.
- C. Conductor shall be sagged in accordance with the sagging charts supplied by the Owner. Temperature of the air shall be checked by a conductor thermometer made by extracting the core from a suitably sized conductor and inserting an etched glass or dial type thermometer. This assembly shall be allowed to hang in the sun for one half hour prior to beginning sagging operations. Sags shall be checked in at least one span per kilometer or portion thereof. Sags may be checked using either the return wave method or the target method. Sag tolerance shall be + 10 cm, - 0 cm. Observed sags and actual temperature, as well as location of check spans shall be recorded on the wire forman's report forms supplied by the Owner.

107

DIVISION III - TECHNICAL SPECIFICATIONS
PART 1 - ELECTRIC LINE CONSTRUCTION

- D. Following sagging, conductor shall be allowed to hang in the dollies for not less than two hours prior to clipping in. Total time that conductor shall be allowed to hang in the air, from stringing through being tied to the insulators shall not exceed 72 hours.
- E. Conductor shall be spliced using preformed splices, installed according to manufacturers recommendations. There shall be no splices in crossings. Splices shall be no closer than 3 meters from a structure. Splices shall not be reused if for some reason they have been removed.
- F. Conductor shall be deadended using preformed deadends and thimbles installed according to the manufacturers recommendations. Deadends shall not be reused if for some reason they have been removed.
- G. In the event of damage to the conductor, preformed armor rod repair units (line- splices) may be used to repair damage if:
 - 1) The steel core is intact.
 - 2) No more than two of the aluminum strands are broken .
 - 3) Broken aluminum strands can be formed to lay smoothly into the conductor without cutting. Such repairs will not be allowed within 3 meters of a structure or in highway crossing spans. Cost of such repair will be for Contractor account.

1.6 ANCHORS AND GUYS

- A. Anchors shall be installed such that the anchor rod is in line with the strain.
- B. Anchors will be staked at the location where the rod is to protrude from the ground. Contractor shall be responsible for determining appropriate anchor log location.
- C. Anchor rods shall protrude at least 5 cm but not more than 20 cm from the ground.
- D. Rock anchors shall be installed in solid rock only, utilizing non-shrink machinery bedding grout to set the rod. Use of portland cement is not permitted. After anchor has set for seven days, Contractor shall conduct a tensile test of the anchor to its rated working load, held for three minutes. In case of failure, Contractor shall replace anchor at his expense.
- E. Guys shall be installed so that multiple guys are balanced and structure is straight and plumb.

1.7 GROUNDS

(10)

DIVISION III - TECHNICAL SPECIFICATIONS
PART 1 - ELECTRIC LINE CONSTRUCTION

- A. Pole grounds shall be installed as shown on the drawings where indicated on staking sheets.
- B. Ground rods shall not be cut off.

1.8 INSULATORS

- A. Insulators shall be installed clean. Insulators may be cleaned with rags and clean water only. Insulators shall be cleaned subsequent to pole setting if they have become dirty during the setting process.
- B. Insulators shall be undamaged at time of line acceptance. Chips, missing skirts, bent metal parts, etc are grounds for rejection.
- C. Suspension insulators shall be loaded in tension only, that is, strings of suspension insulators shall not be lifted only from one end.
- D. Conductors shall be tied in the top groove on tangent structures and on the side away from the strain on angles.

1.9 EQUIPMENT

- A. Transformers and reclosers shall be installed in accordance with the drawings and manufacturers recommendations.
- B. There shall be two separate ground connections to the tanks of each transformer.
- C. Jumpers shall be routed so as to maintain a minimum clearance of 1 meter between phases and 70 cm from phase to ground.
- D. Equipment shall be handled and transported so as to protect insulators and attached equipment such as surge arresters. Handling damage shall be repaired at Contractor cost. Transformers and reclosers shall be lifted with nylon slings attached to the lifting eyes only. Under no circumstances will bushings or attached equipment be used as handles, nor shall equipment be skidded or rolled.