POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

PLANNING AND DESIGN OF EHV TRANSMISSION AND CONTROL SYSTEMS

APA-83-R-025

HARZA-EBASCO

JOINT VENTURE

Volume I PART 1 of 2

PROPOSAL

December 13,1982

HARZA-EBASCO
JOINT VENTURE
Transmission and Control Systems
APA-83-R-025
SUMMARY OF MAN-HOURS BY TASK

	Description of Task	MAN HOURS	MAN HOUR Costs, $
E1	Route Selection and Station Siting		
E1.1	Review corridor selection and prior studies	1243	53,012
E1.2	Selection of ROW and station siting study	4423	173,806
E1.3	Public Participation Meeting Supports	2908	113,778
E1.4	Land Acquisition Support	1694	74,681
Subtotal E1.1-E1.4			415,277
E2	Technical Design		
E2T1	Review of Prior Studies	2970	128,499
E2T2	Transmission Line Structure	3329	144,812
E2T3	Conductor and Accessories	513	20,969
E2T4	Shield Wire and Guy Wire	405	16,502
E2T5	Insulators and Hardware	825	32,883
E2T6	Anchors and Guy Fittings	670	28,302
E2T7	Construction - Watana Gold Creek	4808	184,143
E2T8	Construction - Healy-Willow	5434	204,510
E2T9	Construction - Ester Sub - Healy	6326	237,933
E2T10	Construction - Willow - University	5076	194,113
E2T11	Submarine 345 kV Cables	3344	146,437
Subtotal E2T1-E211			1,339,103
E2S1	Switching Arrangement Study	522	21,971
E2S2	SF_6 Versus Open Air Study	0	0
E2S3	Insulation Coordination Study	442	20,816
E2S4	Line Protection Study	582	24,885
E2S5	Controls and Annuciation Study	552	23,743
E2S6	Communication System	6880	322,904
E2S7	Autotransformers and Surge Arrestors	1791	76,566
E2S8	Shunt Reactors	804	34,543
E2S9	Static Var Systems	1555	64,095
E2S10	Power Circuit Breakers	1474	60,119
E2S11	Disconnecting Switches	1201	47,714
E2S12	Coupling Capacitor Voltage Devices	656	25,371
E2S13	Substation Structures, Buses and Insulators	1121	39,211
E2S14	Control Switchboards	4373	181,843
E2S15	Station Service Equipment	1313	51,762
E2S16	Knik Arm Substation Construction	8400	311,289
E2S17	Willow Substation Construction	8190	305,534
E2S18	Gold Creek Substation Construction	7360	274,890
E2S19	University Substation Construction	10725	408,318
E2620	Ester Substation Construction	10280	392,490
Subtotal E2S1-E2S20			2,688,064

HARZA-EBASCO
JOINT VENTURE
Transmission and Control Systems
APA-83-R-025
SUMMARY OF MAN-HOURS BY TASK (cont.)

	Description of Task	MAN HOURS	MAN HOUR Costs, $
E.3	Collateral Support		
E3.1	Archeological Survey	0	0
E3.2	Visual Simulation	0	0
E3.3	Line Route Survey	2627	107,539
E3.4	Soil Test	522	24,590
E3.5	RIV & TIV Preconstruction Measures	360	15,599
E3.6	Field Assistance and After Award Services	6900	421,743
Subtotal E3.1-E3.6			569,471
E4	Design Management and Scheduling		
E4.1	Project Management	12000	1,379,988
E4.2	Project Scheduling and Support Services	16020	628,220
Subtotal E4.1-E4.2			2,008,208
	TOTAL	150,618	7,020,123

DLG
RSL

ALASKA POWER AUTHORITY

334 WEST 5th AVENUE - ANCHORAGE, ALASKA 99501

Phone: (907) 277-7641
(907) 276-0001

January 14, 1983

Mr. Donald Sandiforth
Harza-Ebasco
400-112th Ave. N.E.
Bellevue, Washington 98004

Dear Mr. Sandiforth:

I am pleased to advise you that you are on the short list for our Request for Proposal APA-83-R-025, Planning and Design of EHV Transmission and Control Systems. We expect to determine the preferred contractor at our next Board of Director's meeting, presently planned for very early in February.

We will be anxious to start work on a portion of the line routing and station siting task only, as soon as possible after that selection. Accordingly, I would appreciate it if you could formally respond to the following points.

a. Will you enter into an interim contract for initial services, pending negotiation of the primary contract?

b. A condition of any such interim contract is that it would be separate and distinct from the primary contract, and would not establish or represent any precedents for the primary contract. Is this acceptable to you?

c. The interim contract would be composed of three parts: an Appendix A, Standard Agreement Form; an Appendix B, Scope of Services; and an Appendix C, Commercial Terms. Specimens of Appendices A and C were provided with the RFP, and the current version is attached to this letter. Are you agreeable to using the attached Appendices A and C for the interim contract without change or exception thereto?

d. Will you be prepared to initiate discussions on an Appendix B for the interim contract within twenty-four hours after selection? Will you commit to an agreement on an Appendix B for the interim contract within five working days subsequent to selection? This Appendix B will be based on your proposal, but will have to be tailored to address the corridor selection subtask only, and will have to clearly reflect work tasks to be performed, their schedule, their budget, individuals who will perform the work, and deliverables (including the schedule for those deliverables).

e. What would be your most expedited mobilization and work start schedule subsequent to signing a contract? What would be your preferred equivalent schedule?

I would appreciate a response to these inquires by January 21, 1983.

Sincerely,

David D. Wozniak
Deputy Project Manager, Design

DDW/jk

SUSITNA HYDROELECTRIC PROJECT

PLANNING AND DESIGN
OF
EHV TRANSMISSION AND CONTROL SYSTEMS

HARZA-EBASCO

JOINT VENTURE

DECEMBER 13, 1982

VOLUME I

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TRANSMITTAL LETTER

HARZA-EBASCO

HARZA-EBASCO

December 13, 1982

Mr. David D. Wozniak
Susitna Hydroelectric Project
Deputy Project Manager, Design
Alaska Power Authority
334 West Fifth Avenue, Second Floor
Anchorage, Alaska 99501

Subject: RFP APA-83-R-025
SUSITNA HYDROELECTRIC PROJECT
PLANNING AND DESIGN OF EHV TRANSMISSION
AND CONTROL SYSTEMS

Gentlemen:

Harza-Ebasco is pleased to have the opportunity to submit this Proposal for the Susitna Transmission Line Project. The Proposal, which is attached, is to remain in effect in its entirety (work scope and cost) for a period of 180 days following due date of December 13, 1982.

Harza and Ebasco are both authorized to practice professional engineering in Alaska in compliance with AS 08.48.281 and other applicable statutes. Harza holds Corporate License No. C-0251, and Ebasco holds Corporate License No. C-0278. The Harza Business License is No. 008004; SIC Code 8910, and the Ebasco Business License is No. 067100; SIC Code 7392.

The organizational unit submitting this Proposal is identified as follows:

Harza-Ebasco, A Joint Venture
400 - 112th Avenue, NE
Bellevue, Washington 98004
(206-451-4500)

Harza-Ebasco acknowledges receipt of the following two amendments to the Proposal in accordance with your instructions:

Amendment Number	Date
1	November 22, 1982
2	November 23, 1982

We would like you to direct Alaska Power Authority inquiries during the evaluation of the Proposal to:

Donald Sandiforth
Harza-Ebasco
400 - 112th Avenue, NE
Bellevue, Washington 98004
(206-451-4500)

Mr. Sandiforth will be in a position to respond to inquiries and route them to the proper individuals with the Joint Venture.

The proposed contract with Appendices A and C is, in general, acceptable. We assume that minor points, as discussed and agreed upon in the Joint Venture Contract with Alaska Power Authority on the Susitna Project, will also apply to the contract for the EHV Transmission and Control Systems. Pricing is based on the same structure and rates as were used in the proposal for Susitna Hydroelectric Project.

It is our pleasure to have the opportunity to provide this Proposal document to the Alaska Power Authority since it integrates with the work we are doing for you on the Hydroelectric Project. We would be pleased to respond to questions as they arise.

Very truly yours,

HARZA/EBASCO, A JOINT VENTURE

Dwight L. Glasscock

Arthur W. Lotz

DLG:AWL:dk

CORPORATE COMMITMENT

HARZA-EBASCO

December 9, 1982

Alaska Power Authority
334 West Fifth Avenue
Anchorage, Alaska 99501

Subject: CORPORATE COMMITMENT STATEMENT

Reference: Susitna Hydroelectric Project Planning and Design of EHV Transmission and Control Systems

Gentlemen:

The Harza-Ebasco Susitna Joint Venture is proposing to provide engineering and environmental serivces to the Alaska Power Authority for the Susitna EHV Transmission and Control Systems Project. As Chief Executive Officers of our respective firms, it is our mutual objective to reaffirm our corporate commitment to supporting the Susitna Joint Venture and meeting the goals and objectives of the Susitna Project.

Since the Power Authority selected Harza-Ebasco as the Susitna Design Engineer, the Joint Venture has become fully operational and the mobilization of our key project staff is essentially complete. We believe the Harza-Ebasco Susitna Joint Venture provides the ideal framework to execute the Transmission System design.

To successfully carry out the Transmission System design within the Harza-Ebasco Susitna Joint Venture, we have committed to staffing the Joint Venture with additional experienced individuals dedicated to meeting the objectives of the Transmission System Project. To lead the Transmission System Project Team, we have committed the services of William J. Rom, a Vice President of Ebasco. We believe Bill's background in electrical engineering and transmission system design, combined with his executive-level managerial talents, makes him an excellent candidate for this key position.

The Power Authority has indicated that it has confidence in the ability of the Harza-Ebasco Susitna Joint Venture. We are aware of the responsibility that has been placed on our respective companies and pledge our full support to the Joint Venture and the Susitna Transmission System and Hydroelectric Projects.

Sincerely

Richard D. Harza
President
HARZA ENGINEERING COMPANY

Sincerely

William Wallace, III
Chairman of the Board and CEO
EBASCO SERVICES INCORPORATED

400 112th Avenue, NE Bellevue, Washington 98004 206 451-4500

JOINT VENTURE AGREEMENT

EXECUTIVE SUMMARY

1 Project One

D.2 Project Two

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HARZA-EBASCO

JOINT VENTURE AGREEMENT

between

HARZA ENGINEERING COMPANY

and

EBASCO SERVICES INCORPORATED

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THIS JOINT VENTURE AGREEMENT ("Agreement") is made as of the 6th day of August, 1982, between Harza Engineering Company, a Delaware corporation having its principal place of business at 150 South Wacker Drive, Chicago, Illinois 60606 ("Harza"), and Ebasco Services Incorporated, a New York corporation having its principal place of business at Two World Trade Center, New York, New York 10048 ("Ebasco"), collectively referred to herein as the "Joint Venturers."

WHEREAS the Joint Venturers are being considered for the performance of preliminary and final design and related services (the "Services") for the Susitna Hydroelectric Project (the "Project"), being undertaken by the Alaska Power Authority (the "Power Authority"), a public corporation of the State of Alaska in the Department of Commerce and Economic Development but with separate and independent legal existence.

WHEREAS the Joint Venturers desire to associate themselves with each other in a joint venture for the purposes of performing the Services as more fully described in the proposal to be prepared by the Joint Venturers for submittal to the Power Authority.

WHEREAS it is the intention of the parties to enter into a contract (the "Contract") with the Power Authority for the performance of the Services for the Project.

In order to set forth the respective rights, interests, duties and obligations to each other in connection with the Contract for Services, the parties agree as follows:

1. FORMATION. The parties hereby form a Joint Venture ("Joint Venture") for the sole purpose of negotiating, executing, carrying out and performing the Contract to be entered into with the Power Authority. Harza is designated as the sponsoring firm. This Joint Venture is limited to the Contract with the Power Authority. Otherwise, each of the Joint Venturers may carry on its separate business for its sole benefit.

2. RELATIONSHIP OF THE JOINT VENTURERS. Nothing contained in this Agreement shall be construed to create a partnership between the parties or give rise to any agency relationship except as specifically necessary and set forth in this Agreement for performance of the Contract. The Joint Venturers shall be joint venturers only with respect to performance of the Contract, and nothing contained in this Agreement shall render any Joint Venturer liable for any debts or obligations unrelated to the Joint Venture.

3. BEST EFFORTS. Each Joint Venturer shall use its best efforts to carry out the purposes of this Agreement, to cooperate with the other Joint Venturer fully, and to attend all meetings of the Management Committee to the end that the business affairs of the Joint Venture shall be conducted in an orderly and businesslike manner.

4. NAME. The name of the Joint Venture shall be "Harza/Ebasco, a Joint Venture," and the principal place of business of the Joint Venture shall be 400-112th Avenue NE, Bellevue, Washington 98004.

5. CONTRACT PERFORMANCE

5.1 The Contract shall be carried out and be performed by the Joint Venture under the direction of the Management Committee as described in Section 6 (Management Committee). Harza and Ebasco agree that Harza will be responsible for and benefit from approximately sixty-five percent (65%) and that Ebasco will be responsible for and benefit from approximately thirty-five percent (35%) of the obligation to perform the Services pursuant to the Contract, the percentages to be calculated in accordance with Subsection 5.4. The Joint Venturers shall cooperate with each other to the end that the Services will be performed in an efficient and cost-effective manner. The Services of each Joint Venturer shall be undertaken in the spirit of technical cooperation, with each Joint Venturer making the contribution which is most appropriate to its corporate experience, capabilities and personnel, consistent with the overall objective of providing Services of maximum quality.

5.2 Each Joint Venturer shall make available to the Joint Venture for the performance of Services for the Project such of its technical and administrative personnel, facilities and equipment as are, in the judgment of the Management Committee, necessary and appropriate for the orderly and efficient execution of the Project and as are acceptable to the Project Manager.

5.3 The Joint Venturers will reevaluate the allocation of responsibility and of performance in the furnishing of the Services hereunder if (a) such reallocation is necessary for efficient and effective performance of the Services, (b) major changes occur in the scope of work under the Contract, or (c) additional phases or portions are added to the Project. In any of such events, the participation of the Joint Venturers shall be determined on the basis of the Joint Venturer best suited to provide the services required. Any reallocation herein shall be made in increments of not less than five percent (5%).

5.4 At the conclusion of the Services, each Joint Venturer's actual participation in the Joint Venture shall be finally determined on the basis of the proportion that each Joint Venturer's billings for costs of Services actually provided (which shall be defined as salaries, fringes and overhead costs, but excluding all other costs) bears to the total cost of Services billed by both Joint Venturers to the Joint Venture.

6. MANAGEMENT COMMITTEE

6.1 The management of the business and affairs of the Joint Venture shall be vested in a Management Committee which will be composed of two (2) principal representatives, each having one vote. Each Joint Venturer shall designate one (1) principal representative and one (1) alternate

representative on the Management Committee. The alternate representative shall serve on the Management Committee in the event his respective principal representative is absent, incapacitated, or otherwise unable to serve. The principal and alternate representatives appointed by each Joint Venturer shall be officers or senior employees of his respective Joint Venturer. The Harza principal representative shall be the Chairman of the Management Committee, and in his absence he shall designate one of the other representatives as acting Chairman. Until written notice of any change is given as hereinafter provided, the representatives are as follows:

Harza:	Dwight L. Glasscock	Principal
	Earl J. Beck	Alternate
Ebasco:	Carl F. Whitehead	Principal
	Arthur W. Lotz	Alternate

6.2 Each alternate representative on the Management Committee shall be notified in advance of, and may be present at, all meetings of the Management Committee but shall have the right to vote at such meetings only when the alternate is serving in place of a principal representative and such principal representative is absent. Any decision, approval, consent or other action on behalf of any Joint Venturer shall be equally binding on such Joint Venturer, whether made, given or taken by a principal representative or by an alternate representative.

6.3 Either Joint Venturer may change its principal or alternate representatives on the Management Committee at any time by giving written notice to that effect to the other Joint Venturer.

6.4 Regular meetings of the Management Committee will be held no less frequently than quarterly. In addition, either principal representative or the alternate representative acting in his place or the Project Manager may call a special meeting of the Management Committee at any time by giving written or telephonic notice at least five (5) days prior to the meeting. Notice of all meetings shall be given to the principal and alternate representatives and to the Project Manager. Unless the Management Committee shall otherwise agree with respect to a particular meeting, regular quarterly meetings shall be held on an alternating basis at the Joint Venture offices in Anchorage and Bellevue. The first meeting shall be held in the Anchorage office.

6.5 A meeting may be conducted by telephone without prior notice, in an emergency or at any time convenient to the representatives on the Management Committee and the Project Manager.

6.6 All action taken at any meeting shall be recorded in the minutes of the Management Committee, which shall be maintained by the Chairman of the Management Committee. In addition, the Management Committee may act without a meeting provided that such action is set forth in a written consent signed by the Management Committee representatives, which document shall be maintained with the minutes. The Chairman of the Management Committee will provide copies of all minutes and consents to the principal and alternate representatives and the Project Manager.

6.7 The Project Manager shall be entitled to be present in person or by conference telephone at all meetings of the Management Committee.

6.8 For any meeting of the Management Committee, a quorum shall be comprised of both principal representatives, or in the absence of either or both principal representatives, their respective alternate representative(s). No decision, determination, approval, consent or other action by the Management Committee shall be valid or binding on the Joint Venturers unless adopted and approved by both principal representatives or their respective alternate representative(s); provided, however, that in the event of a tie vote of the Management Committee, the matter at issue shall be referred to the Chief Executive Officers of the Joint Venturers for resolution. If the Chief Executive Officers cannot resolve the matter, it shall be resubmitted to the Management Committee for reconsideration, at which time the Project Manager shall be entitled to have one vote, and a majority vote shall decide the matter.

7. MANAGEMENT COMMITTEE AUTHORITY

7.1 The Management Committee shall have full authority in any matter in connection with or relating to the Contract and the Joint Venture, including without limitation the following:

(a) To negotiate the Contract.

(b) To call for capital contributions.

(c) To negotiate, prosecute and settle any claim or lawsuit by the Joint Venture against a third party arising out of performance of this Agreement or the Contract.

(d) To withdraw and disburse funds from the Joint Venture.

(e) To adopt procedures to execute and terminate subcontracts, purchase orders and directives with respect to the Contract, or any change order to a subcontract or purchase order.

(f) To assign key personnel.

(g) To provide for handling and controlling the funds of the Joint Venture.

7.2 The Management Committee may establish rules and regulations for the conduct of its proceedings and for the administration of the affairs of the Joint Venture, which shall be consistent with the terms and provisions of this Agreement.

8. KEY PROJECT PERSONNEL

8.1 Each Joint Venturer shall make available to the Joint Venture key Project personnel for the performance of the Services for the Project as indicated in the Project Organization Chart made a part of the Proposal. Neither Joint Venturer shall withdraw key personnel from the Services in progress without reasonable prior notice of such withdrawal to the Project Manager and to the other Joint Venturer. Each Joint Venturer will exercise its best efforts to replace personnel so withdrawn with personnel having experience and qualifications commensurate with the assignment.

8.2 Project Manager. The Joint Venturers agree that R. S. LaRusso shall be the Project Manager. The Project Manager shall have general charge of the Joint Venture's performance of the Services under the Contract, in accordance with project management procedures established by the Management Committee as being best suited to the performance of the Services for the Project. The Project Manager shall be responsible to the Management Committee for the Joint Venture's performance of the Services for the Project. The Project Manager shall be the representative of the Joint Venture, and the Joint Venturers shall share responsibility to third parties (including, but not limited to the Power Authority) for the Project Manager's acts in proportion to each Joint Venturer's respective final participation in the Joint Venture as determined in accordance with Subsection 5.4. The Project Manager's responsibility and authority shall include but not be limited to the following:

(a) To oversee, coordinate and direct the efforts of all personnel assigned by the Joint Venture for the performance of Services for the Project, whether on the premises of the Joint Venture, on the premises of either Joint Venturer, at the Project site or elsewhere;

(b) To represent the Joint Venture in its relationship with the Power Authority and to execute any and all other contracts and other agreements on behalf of the Joint Venture as and to the extent specifically directed and authorized by the Management Committee;

(c) (i) To monitor the overall effort of the Joint Venture on the Project in relation to the Contract, the Project Schedule and the Project budget as established from time to time, and
(ii) to ensure that all charges made to the Project have been authorized for a specific task within a previously agreed budget;

(d) To evaluate the activities of personnel assigned to the Project, to identify potential problems and their causes and, subject to the general direction and control of the Management Committee, to initiate appropriate remedial measures as and to the extent necessary;

(e) To ensure that changes and additional Services beyond the scope of the Contract are estimated in advance of performance and that the Power Authority and the Management Committee are made aware of, and approve, the number of man-hours to be consumed and the effect thereof on the original man-hour estimate, budget, Project Schedule and Project cost;

(f) To prepare and submit to the Management Committee for approval, appropriate written procedures for performing all engineering, design, procurement and related technical portions of the Services; and

(g) To report directly to the Management Committee regarding all aspects of the Project.

8.3 Engineering Operations Manager. The Joint Venturers agree that A. Zagars will be the Engineering Operations Manager. During performance of engineering, design and procurement services and thereafter as determined by the Management Committee, the Engineering Operations Manager shall direct the engineering and design aspects of the Project and the Services and will supervise the resolution of major engineering and design alternatives and conflicts in the technical effort of the Joint Venture. He will report to the Project Manager.

8.4 Regulatory and Environmental Programs Manager. The Joint Venturers agree that G. Lawley will be the Regulatory and Environmental Programs Manager. He will be responsible for the technical management and overall direction of the environmental programs. He will report to the Project Manager.

8.5 Project Control Operations Manager. The Joint Venturers agree that M. Soniker will be the Project Control Operations Manager. He will be responsible for Project cost and schedule control, contract administration, Project accounting, estimating and administration of the Anchorage office. He will report to the Project Manager.

8.6 Principal Design Office Manager. The Joint Venturers agree that D. Ruotolo will be the Principal Design Office Manager. He will be responsible for all Project engineering and design activities in the Bellevue office. He will report to the Engineering Operations Manager.

8.7 Transition Program Staff. The Joint Venturers agree that J. Ehasz, S. O. Simmons and R. L. Meagher will be assigned as Transition Program Staff Members. They will be available to the Project Manager to assist in the orderly start of the Project for a period of time deemed appropriate by the Project Manager.

8.8 The employees assigned by the Joint Venturers to the performance of Services to be provided by the Joint Venture shall be and remain the employees of each Joint Venturer. Except as otherwise provided in this Agreement, each Joint Venturer will pay all costs and expenses incident to the performance of its own personnel, including, without limitation, direct salaries, overtime pay, if any, fringe benefits, other employee contributions, payments and applicable overhead expenses. Any assignment of personnel to the Project by the Joint Venturers shall be done subject to and in accordance with the applicable terms of the Contract.

9. BASIS OF COMPENSATION AND PAYMENT BY THE POWER AUTHORITY

9.1 The Joint Venturers have set forth in this Section 9 their anticipated basis of compensation and payment to them by the Power Authority for the Services; however, the final effective basis of compensation and payment by the Power Authority to the Joint Venture for the Services shall be as set forth in the Contract. Upon execution of the Contract and any amendments thereto by the Power Authority and the Joint Venture, the basis of payment by the Power Authority, as set forth in the Contract, shall be deemed to be incorporated by reference into this Agreement.

9.2 The Joint Venturers shall invoice to the Joint Venture, and the Joint Venture shall consolidate, all Project charges, accounting records and reports. The Joint Venture shall thereafter invoice the Power Authority for payment and reimbursement in accordance with the terms of the Contract.

9.3 The Joint Venturers shall establish a budget for the Project, which shall be revised periodically to take into account any change in the scope of the Services. Any such change shall be subject to approval in advance by the Project Manager before it is reflected in a revision of the Project budget. Each Joint Venturer shall so regulate its performance as to limit its charges in both man-hours and dollars to the amount established in the Project budget then in effect.

9.4 Subject to the provisions of the Contract as finally negotiated and executed by the Joint Venture and the Power Authority, the Joint Venturers anticipate that each of the Joint Venturers shall bill the Joint Venture for its salary, fringes, overhead and direct (out-of-pocket) costs on a monthly basis. The multipliers used for fringes and overhead will be either (a) provisional based on the most recent audit and forecast, subject to annual adjustment in accordance with approved audits, or (b) stipulated for the duration of the Contract, such stipulated rates to be established in conjunction with the negotiation of the Contract. The Joint Venture shall combine the actual salaries so billed, include the appropriate composite multiplier for fringes and overheads, add the direct costs and a fee portion and prepare and submit an invoice to the Power Authority for payment on a monthly basis.

9.5 Within fifteen (15) days following receipt by the Joint Venture of a payment from the Power Authority during the performance of Services under the Contract, the Joint Venture shall distribute to each Joint Venturer the amount of such payment to which such Joint Venturer shall be entitled as reimbursement for its allowable costs. The fee portions shall be retained by the Joint Venture if necessary to cover working capital requirements and shall otherwise be distributed to the Joint Venturers as the Management Committee may in its discretion direct from time to time, which distributions shall be made to each of the Joint Venturers on a provisional basis in the same proportion as its then current respective participation in the Joint Venture, subject to adjustment to reflect each Joint Venturer's respective final participation as determined in accordance with Subsection 5.4.

10. FUNDS OF THE JOINT VENTURE

10.1 The Management Committee shall establish one or more bank accounts in the name of the Joint Venture in such bank or banks as the Management Committee shall deem appropriate. All capital, including capital contributions, of the Joint Venture and all funds received by the Joint Venture from any source (including, but not limited to, payments from the Power Authority) shall be deposited in such bank account or accounts, and such accounts shall be subject to the control of the Management Committee. All invoices received by the Joint Venture and approved for payment by the Management Committee, or by such person or persons as the Management Committee may authorize to act on their behalf in that regard, shall be paid by checks drawn on said bank account or accounts and signed by persons so authorized by the Management Committee. The Management Committee may require the bonding of any person or persons authorized to draw upon the funds of the Joint Venture.

10.2 The Management Committee may cause funds of the Joint Venture to be invested at interest on a short-term basis, in US Government securities, bank certificates of deposit or savings accounts.

10.3 Not later than thirty (30) days after issuance of the Power Authority's notice of intent to negotiate a Contract with the Joint Venture, Harza shall make a capital contribution of Sixty-Five Thousand Dollars ($65,000.00) to the Joint Venture, and Ebasco shall make a capital contribution of Thirty-Five Thousand Dollars ($35,000.00) to the Joint Venture. The Management Committee may direct each Joint Venturer to make further capital contributions in proportion to its respective participation in the Joint Venture, if deemed by the Management Committee to be in the best interests of the Joint Venture. The Joint Venturers' capital contributions shall be used to pay in part the expenses of the Joint Venture, as authorized by the Management Committee. The Management Committee may direct the return of the unexpended portions of the Joint Venturers' capital contributions, in whole or in part, at such times and under such circumstances as the Management Committee may determine to be appropriate.

10.4 Each of the Joint Venturers will be responsible for and pay all of its own costs, expenses, and other fees incurred prior to formation of the Joint Venture and signing of the Contract with the Power Authority.

11. BOOKS OF ACCOUNT AND RELATED MATTERS

11.1 Separate books of account for the performance of the Contract and all matters pertaining thereto and for the Joint Venture shall be maintained under the supervision of the Management Committee on behalf of the Joint Venturers in accordance with detailed accounting procedures approved by the Management Committee. The Project Manager shall be responsible for maintaining such books of account until such time, if any, as the Management Committee shall appoint a financial manager to perform this function. The prescribed methods of accounting in all matters relating to the affairs of the Joint Venture and the performance of the Contract shall be those known as generally accepted accounting principles applicable under the circumstances and applied on a consistent basis. All books, records, vouchers, contracts, inventory, supplies, equipment, property and other data of the Joint Venture shall be available for examination and audit by each Joint Venturer at all reasonable times at the principal office of the Joint Venture. In addition, if required by the Management Committee, certified audits shall be prepared by Arthur Andersen & Co. or such other accountants as may be designated by the Management Committee, covering the period through December 31 of each year. The audits will be distributed to the Joint Venturers within sixty (60) days after December 31. A final certified audit shall be prepared and distributed to each of the Joint Venturers at the completion of the Contract, if requested by either Joint Venturer.

11.2 Harza and Ebasco shall be responsible for maintaining, at their cost, respectively, their respective books of account pertinent to their respective operations in connection with the Project. Such books of account relating to salary, the number of hours individuals performed services, and out-of-pocket expenses which are reimbursable by the Power Authority or the Joint Venture shall be subject to audit at any time by the Joint Venture or either Joint Venturer.

11.3 All financial, technical and other records of the Joint Venture shall be kept and preserved for no less than three (3) years subsequent to the completion of the Services to be rendered under the Contract, at such place or places as the Management Committee may from time to time designate.

11.4 Provisions for insurance shall be agreed upon as required to conform with the terms and conditions of the Contract.

12. EXPENSES OF THE JOINT VENTURE; REMAINING PROFITS

12.1 Except as otherwise provided in Subsections 9.5 and 10.3 of this Agreement, the capital contributions of the Joint Venturers and the fee portions of payments made by the Power Authority shall be retained by the Joint Venture and may be used to pay any expenses incurred by the Joint Venture as authorized by the Management Committee, which are not recoverable from the Power Authority as an allowable cost.

12.2 Fixed asset items purchased jointly will be disposed of on completion of the Project and the values obtained shared in proportions equivalent to those used for allocating the costing of such assets.

12.3 In proportion to each Joint Venturer's respective final participation in the Joint Venture as determined in accordance with Subsection 5.4, the Joint Venturers shall share all costs incurred by the Joint Venture for any agreed expenses which are not reimbursable by the Power Authority, if any.

12.4 The Management Committee shall review the allocation of unreimbursed Joint Venture expenses, if any, from time to time to ensure its continuing equitability. The actual method of payment and reimbursement for Joint Venture expenses shall be reviewed from time to time by the accountants of each Joint Venturer and, if necessary, changed after approval by the Management Committee.

12.5 As soon as reasonably practicable after the completion of the performance of the Services under the Contract, the portions of the fee, which have theretofore been retained by the Joint Venture, shall be used to pay all outstanding obligations and other indebtedness of the Joint Venture; and sufficient reserves, as determined by the Management Committee, shall be established for known or reasonably anticipated contingencies not theretofore discharged. Thereafter, any funds remaining in the bank account or accounts of the Joint Venture, or which shall be received by or for the account of the Joint Venture or which shall become available in any manner for distribution, shall be distributed to the Joint Venturers in proportion to their respective final participation in the Joint Venture as determined in accordance with Subsection 5.4. When funds set aside as reserves are no longer required for such purpose, then such funds shall be similarly distributed.

13. PLACE OF PERFORMANCE OF SERVICES

13.1 It is the intention of the Joint Venturers that the Services will be managed and directed from the Project office located in Anchorage, Alaska and that the principal design office be located in Bellevue, Washington.

13.2 Where Services are performed at a Joint Venturer's established office:

(a) Harza shall reimburse Ebasco for all actual costs incurred by Ebasco as a result of the presence of Harza personnel in Ebasco's offices, to the extent that such costs are not directly reimbursed by the Power Authority. Likewise, Ebasco shall reimburse Harza for all actual costs incurred by Harza as a result of the presence of Ebasco personnel in Harza's offices to the extent that such costs are not directly reimbursed by the Power Authority. Such costs will be recorded, allocated and documented in accordance with generally accepted accounting principles. Examples of such costs are:

(i) Rent of office space, including appropriate allowances for maintenance, alterations, repairs, leasehold improvements and common space.

(ii) Furniture.

(iii) Office Supplies.

(iv) Non-Project specific charges such as:

Nonreimbursable telephone charges.

Nonreimbursable photocopying and printing.

Nonreimbursable computer charges.

Nonreimbursable word processing.

Nonreimbursable postage.

(b) The initial determination of the above cost allocations shall be made and documented in accordance with the respective Joint Venturer's judgment as to purpose and benefit of the expenditures.

14. LIMITATION OF LIABILITY

14.1 In no event shall either Joint Venturer be liable to the other Joint Venturer or the Joint Venture for the acts or omissions of any officer, employee or agent of either Joint Venturer, nor shall any duly authorized principal or alternative representative on the Management Committee be liable to either Joint Venturer or the Joint Venture, except for direct (but not consequential) damages resulting from actual fraudulent or dishonest conduct.

14.2 If any third party (including but not limited to the Power Authority) should assert any claim or commence any legal action against one or both of the Joint Venturers or against the Joint Venture in connecton with any matter arising under the Contract or associated with the Project, then Harza and Ebasco shall share all costs thereof, including, but not limited to, all damages, judgments, fees and expenses, in proportion to their respective final participation in the Joint Venture as determined in accordance with Subsection 5.4.

14.3 In the event that performance or reperformance of any of the Services by the Joint Venture or by either Harza or Ebasco is authorized by the Management Committee because such Services were not performed in accordance with customarily accepted good engineering and technical practices and procedures and such performance or reperformance is not reimbursed by the Power Authority, the costs of such performance or reperformance shall be borne entirely by the Joint Venturer which failed to perform in accordance with such standards. Where such individual Joint Venturer liability is not evident from work package allocations, the costs shall be shared by Harza and Ebasco in the same proportions as set forth in the preceding Subsection. Prior to the start of any such reperformance, the Management Committee shall determine the scope, costs and responsibility of such reperformance.

15. SUBCONTRACTING AND ASSIGNMENT

15.1 The Joint Venturers contemplate that, unless otherwise determined by the Management Committee, all subcontracts and other agreements with respect to the Services to be performed under the Contract shall be executed in the name of the Joint Venture.

15.2 Neither this Agreement nor any interest or obligation of either Joint Venturer herein, including any interest in funds belonging to or which may accrue to the Joint Venture, or any interest in any bank account of the Joint Venture, or in any property of any kind employed or used in connection with the Contract, may be assigned, pledged, transferred, subcontracted or hypothecated by either Joint Venturer without the prior written consent of the other Joint Venturer, which consent shall not be unreasonably withheld.

16. INSOLVENCY

16.1 The filing of a voluntary petition of bankruptcy, adjudication as bankrupt or insolvent, appointment of a receiver for all or substantially all of the assets, assignment for benefit of creditors, any other proceeding for relief under the bankruptcy laws of the United States, or failure to discharge any judgment against a Joint Venturer or levy or seizure of the property of a Joint Venturer within ten (10) days, shall be a default by the party committing such act. Upon such default, the interest of the defaulting party ("Defaulting Party") in this Joint Venture shall terminate and be limited to the rights under this Joint Venture specifically set forth herein. However, the business of this Joint Venture shall continue to be conducted under the same name by the remaining Joint Venturer and such Joint Venturer shall carry on and perform the remainder of the Services to be completed on the Contract. Neither the Trustee, Receiver, nor Custodian of the Defaulting Party, nor such Defaulting Party itself, shall have any interest in any profits resulting from the completion of the Services on the Contract, after the date of default. The Joint Venture and the remaining Joint Venturer shall have title to and the right to possession of all the remaining assets of the Joint Venture.

16.2 Notwithstanding the provisions of Subsection 16.1, the Defaulting Party shall remain liable for its share of any losses sustained by the Joint Venture with respect to the performance of the Contract as a whole (as determined pursuant to the terms and conditions of this Agreement). However, the Defaulting Party shall be entitled to receive that proportion of the profits of the Joint Venture, if any, to which it would otherwise be entitled as the monetary value of the Services completed at the time of the happening of any of the events described in this Section bears to the monetary value of all Services to be performed under the Contract. Such share of the profits shall be determined by the Management Committee without the participation of the principal or alternate representative of the Defaulting Party. The payment of any such share of the profits to the Defaulting Party shall be paid at the times and in the manner provided in this Agreement. If such

insolvency, bankruptcy or other proceedings of the type described in this Section should cause damage or additional costs to the remaining Joint Venturer, then such damages or additional costs shall be charged against the interest of the Defaulting Party and against any amounts to which the Defaulting Party would otherwise be entitled pursuant to the terms and provisions of this Agreement.

17. NOTICES

Any notice which is required or permitted to be given under any provision of this Agreement, except notices of special meetings of the Management Committee as provided in Section 6 (Management Committee), shall be given in writing and shall be delivered either in person or by registered or certified mail, by telegram or cable, and shall be deemed effective if and when received by the party to be notified at such party's address as set forth below. Either Joint Venturer may, by written notice to the other Joint Venturer as provided in this Section, change its address for receiving such notices.

(a) Harza Engineering Company
150 South Wacker Drive
Chicago, Illinois 60606
Attention: Dwight L. Glasscock,
Vice President

(b) Ebasco Services Incorporated
Two World Trade Center
New York, New York 10048
Attention: Carl F. Whitehead,
Senior Vice President

18. TERM OF THE JOINT VENTURE; SUBSEQUENT PHASES

18.1 This Agreement, and the Joint Venture hereby created, shall remain in effect only for such period of time as necessary to carry out the Services to be performed for the Project, to receive full and final payment of all amounts owed to the Joint Venture, to make appropriate provision for all actual and contingent liabilities of the Joint Venture and otherwise to carry out the terms and provisions of this Agreement; provided, however, that if the Power Authority should either (a) terminate the Contract, (b) abandon the Project, (c) in the judgment of the Management Committee, unduly delay the Project, or (d) proceed with the Project in a manner not involving both of the Joint Venturers, then, in any of such events, this Agreement and the Joint Venture hereby created shall continue in effect only for such period of time as may be necessary for the Joint Venture to receive full and final payment of all amounts owed to the Joint Venture, to make appropriate provision for all actual and contingent liabilities of the Joint Venture and otherwise to carry out the terms and provisions of this Agreement.

18.2 Each Joint Venturer hereby covenants and agrees with the other Joint Venturer that it will pursue a contract for Services for any additional phases or portions of the Project only as a participant in this Joint Venture, unless the Power Authority requests otherwise.

19. ARBITRATION

19.1 In the event that a dispute arises between the Joint Venturers which is not resolved by the Management Committee, then, at the request of either Joint Venturer, such dispute shall be submitted to arbitration before a panel of three (3) arbitrators acceptable to both Joint Venturers, in accordance with the then existing Rules of the American Arbitration Association as in effect at the time of such arbitration. In the event that the Joint Venturers cannot agree as to such arbitrators, they, or so many as cannot be agreed to, shall be finally chosen in accordance with such Rules. The place of such arbitration shall be Chicago, Illinois. The Joint Venturers agree that the decision and award of the arbitration shall be final and binding upon them, may be entered as a judgment in any court of competent jurisdiction and shall not be subject to appeal. Notwithstanding such Rules to the contrary: (a) either party to the arbitration may avail itself of discovery procedures, including depositions, interrogatories, requests for production and inspection of documents and reports as provided for in the Federal Rules of Civil Procedure; and (b) the arbitrators shall be required to issue written findings, conclusions and award.

19.2 In the event of any arbitration between the parties arising under this Agreement, the prevailing party shall be entitled to its costs, expenses, and reasonable attorneys' fees. The determination of which party is the "prevailing party" shall be made by the arbitrators.

20. GOVERNING LAW

This Agreement shall be governed by and shall be construed and interpreted in accordance with the laws of the State of Illinois.

21. LIMITATION ON THE RIGHTS OF OTHERS

Nothing in this Agreement, whether express or implied, shall be construed to give any person other than the Joint Venturers any legal or equitable right, remedy or claim under or in respect of this Agreement. As used in this Section, the term "person" includes the Power Authority.

22. EMPLOYMENT OF JOINT VENTURER'S PERSONNEL

During the term of this Agreement and for a period of six (6) months thereafter, each Joint Venturer shall refrain from employing or offering employment to any present or former personnel of the other Joint Venturer associated with the Project unless (a) the other Joint Venturer shall have first given its written consent to such employment or offer of employment, or (b) six (6) months shall have elapsed since the person in question was last employed by the other Joint Venturer.

23. MISCELLANEOUS

23.1 No Waiver. Neither the failure of either party to exercise any power given to such party under this Agreement or to insist upon strict compliance by the other party with such party's obligations under this Agreement, nor any custom or practice of the parties at variance with the terms hereof, shall constitute a waiver of either party's right to demand exact, full and complete compliance by the other party with the terms and provisions of this Agreement.

23.2 Entire Agreement. This Agreement contains and constitutes the entire agreement of Harza and Ebasco with respect to the performance of preliminary and final design of technical Project facilities and associated Project features.

23.3 Severability of Invalid Provision. If any provision of this Agreement shall for any reason be held to be invalid, illegal or unenforceable in any respect under the laws of the State of Illinois, any such invalidity, illegality, or unenforceability shall not affect any other provision of this Agreement, and this Agreement shall be construed as if such invalid, illegal, or unenforceable provision had never been incorporated herein and the rights of the parties hereto shall be construed and enforced accordingly.

23.4 Successors. Neither the interest of a Joint Venturer in the Joint Venture or its right to share in the profits, nor any right of a Joint Venturer hereunder, may be assigned or transferred to any third party nor may any security interest therein be created, without the prior written consent of the other Joint Venturer. No assignment, with or without such consents, nor any assumption of obligations hereunder by a third party shall relieve any Joint Venturer of its obligations hereunder unless such Joint Venturer is expressly so relieved in writing by the other Joint Venturer.

23.5 Amendments. This Agreement shall not be changed, amended, modified, or waived otherwise than by a written instrument signed by duly authorized officers of Harza and Ebasco.

23.6 Counterparts. This Agreement may be executed in multiple counterparts, each of which shall be deemed to be an original and all of which, together, shall constitute one and the same instrument.

IN WITNESS WHEREOF, Harza and Ebasco have caused this Agreement to be executed by their duly authorized officers as of the day and year first above written.

Harza Engineering Company

Attest: Sean Hastings
Sean Hastings
Secretary

By: Richard D. Harza
Richard D. Harza
President

Date: August 12, 1982

Ebasco Services Incorporated

Attest: Herbert M Blum
Herbert M. Blum
Assistant Secretary

By: Roger J. Sherman
Roger J. Sherman
Chairman of the Board

Date: August 11, 1982

AMENDMENT NO. 1

to the

JOINT VENTURE AGREEMENT

between

HARZA ENGINEERING COMPANY

and

EBASCO SERVICES INCORPORATED

THIS AMENDMENT NO. 1 to the Joint Venture Agreement dated as of August 6, 1982 between Harza Engineering Company and Ebasco Services Incorporated is made as of the 22nd day of November, 1982.

The parties agree as follows:

1. FORMATION. Add the following paragraph at the end of Section 1:

> Pursuant to Subsection 18.2 of this Agreement, the parties agree to include within the scope of this Agreement the negotiation, execution, carrying out and performance of the planning and design services for the EHV Transmission and Control Systems for the Susitna Hydroelectric Project. If performance of the aforesaid services is awarded to the Joint Venture, the parties contemplate that the said services will be added to the scope of the Contract for preliminary and final design and related services.

2. NAME. Revise Section 4 to read as follows:

> 4. NAME. The name of the Joint Venture shall be "Harza-Ebasco Susitna Joint Venture", and the principal place of business of the Joint Venture shall be 400-112th Avenue NE, Bellevue, Washington 98004.

3. Except as specifically provided in this Amendment No. 1, all terms and conditions of the Joint Venture Agreement shall continue in full force and effect.

IN WITNESS WHEREOF, Harza and Ebasco have caused this Amendment No. 1 to be executed by their duly authorized officers as of the day and year first above written.

Harza Engineering Company

Attest: _____
Sean Hastings
Secretary

By: _____
Richard D. Harza
President

Date: November 22, 1982

Ebasco Services Incorporated

Attest: _____
Herbert M. Blum
Assistant Secretary

By: _____
Arthur W. Lotz
Senior Vice President

Date: 11/24/82

EXECUTIVE SUMMARY

SCOPE OF WORK

With the planned construction of the Susitna Hydroelectric Project, additional transmission line facilities are required to connect the output to the primary load centers of Anchorage and Fairbanks, Alaska. The Watana phase of the project is scheduled to produce power in 1993, and presently there are no electrical transmission facilities between the load centers and the Watana hydro station. A 345 kV transmission line called the "Intertie" is scheduled to be completed between Willow and Healy in late 1984. This line, currently under design, will be initially energized at 138 kV. The Susitna transmission project scope will reinforce the existing intertie and provide extensions at both extremities, and also a connection to the Watana station. When the Watana station and expanded sections of the transmission line are constructed, the complete intertie will then be energized at 345 kV.

The intertie will use guyed-hinged tubular steel X towers. It is the intention that the components of the expanded transmission system should substantially reflect the initial intertie design. However, some re-evaluation may be necessary to suit site conditions and, in particular, tower selection must be re-evaluated for the urban sections of Fairbanks and Anchorage.

The intertie route was influenced by extensive input resulting from public hearings, and similar public hearings are expected for the balance of the transmission system.

Details of project requirements will be developed from work previously performed by Gilbert-Commonwealth Associates, Inc. and Acres American, Inc. Based on this information, the Joint Venture projects that the scope of the project will be as shown on Figures 1 and 2, and the proposal is formulated on this basis.

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The Susitna Transmission Line and substations will form an extremely important link in the supply of reliable power and energy for the State of Alaska. Vital project design issues that must be effectively dealt with will include the following:

- Licensing and permitting are complex, and the entire project development process will be undertaken in an environment of intense public scrutiny.

- The transmission line must be constructed under subarctic climatic conditions in locations with limited access.

- Special factors including seismicity of the region, the existence of permafrost zones and unique environmental conditions must be considered in the design.

- Because the entire output from the Susitna Hydroelectric Project will be transmitted over these lines to Fairbanks and Anchorage, reliability is of the utmost importance.

- Substation computer control must be coordinated with the Susitna computer control systems.

Selection of Harza-Ebasco Joint Venture

We believe the Harza-Ebasco Joint Venture is best qualified to provide the required engineering services for the following reasons.

Combined Organization. The Joint Venture proposal is based on the concept that the project organization for the Transmission and Control Systems project can be combined with the organization for the Susitna Hydroelectric project. It is felt that there are tangible and other advantages to the Power Authority if the two organizations are combined.

Discussion of the advantages for the combined organization are given throughout this proposal. In summary the advantages are:

- o Coordination of licensing and land use activities.
- o Shared use of personnel to achieve improved level of effort.
- o Shared use of professional and field subcontractors.
- o Reduced costs due to incremental effects.
- o Overall coordination of design and construction scheduling.
- o Common office location facilitates ease of communication on technical matters.
- o Utilize system studies data base and work carried out under main hydroelectric project.

Design Competence The respective staffs of the Joint Venture have successfully completed the engineering and design of numerous transmission line and substation projects throughout the world. These projects include the Hayden-Blue River 345 kV Transmission Line in Colorado, the Terror Lake Hydroelectric Transmission Line in Alaska and the Water and Power Development Authority 500 kV Transmission System in Pakistan.

Licensing Support The Joint Venture brings to the project extensive experience in the licensing of both transmission lines and hydroelectric projects, including specific experience with the FERC licensing process on many projects. Licensing support for the transmission line will be conducted within the overall FERC license coordination framework established by the Joint Venture for the Susitna Hydroelectric Project, allowing for efficiencies in communications and responses to FERC and agency requests.

Personnel Commitments The Joint Venture has committed senior level management and technical personnel to the project team to effectively manage, license and design the Susitna Transmission Line and associated substations.

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Cost/Schedule Control The Joint Venture brings to the Susitna Transmission Line Project the Ebasco Project Information and Control System (EPICS) which is a proven system for defining monetary status and reporting project cost and schedule performance on large multi-billion dollar projects. This is the same system which the Joint Venture will use on the Susitna Hydroelectric Project.

Office Locations The Joint Venture is committed to the assignment of a dedicated transmission system Project Manager who will work along with the Susitna Hydroelectric Project Management Team in Anchorage. This will permit close control over Alaskan activities and provide day to day communication with the Power Authority.

Detailed design will be performed in the Joint Venture office in Bellevue, Washington. This will permit a close working relationship with the Susitna Hydroelectric Project team, allowing a smooth exchange of design information while taking advantage of the support staff and organization already established to provide services for the hydroelectric project. Technical input to the routing studies and public participation program from Jones and Jones staff members will originate in the firm's Seattle office, providing for close and effective coordination with the Bellevue support office. The Bellevue location is ideally suited to supporting the Anchorage operations because the travel to and communication with Anchorage is rapid, convenient and cost-effective.

Sensitivity to Alaska Issues The Joint Venture firms recognize the importance of a balanced public participation program to the route selection task. Both firms have gained experience from ten different assignments in Alaska during the last three years which have contributed substantially to our understanding of local, technical, socio-economic and environmental issues. Jones and Jones has also been involved with recent major projects in Alaska, and has demonstrated capabilities and familiarity with sensitive public issues related to transmission lines. Based on this collective familiarity, we have proposed a program to ensure that the public input receives due weighting where appropriate in the corridor selection and identification of the actual right-of-way and centerline.

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Schedule The Joint Venture has included a design schedule that supports the initial environmental public participation, licensing and permitting process and also the final energization date as stated in the RFP. To provide a cost-effective design process, the major design effort will be scheduled to minimize engineering, manufacturing and construction costs.

The Joint Venture believes that it would be in the Power Authority's interest to construct the Watana to Gold Creek section early to provide construction power, as considerable savings could be made. Our preliminary analysis shown in Section E4.2 indicates annual savings of between 15 and 21 million dollars over a 6 year period between 1987 and the start up of Watana in 1992.

The proposed schedule, therefore, includes provision for the energizing of the Watana-Gold Creek section at 138 kV as a source of construction power in 1987, which coincides with the major tunneling work.

An alternative schedule is also provided. This schedule shows the construction of the lines and substations to be staggered in time, and to achieve an inservice date of 1991 for Unit 1 at Watana. The alternative schedule has three advantages; they are:

- Levels out the demand for construction labor, and favors Alaska residents.
- Allows Power Authority flexibility in bidding for major material and equipment to take advantage of market conditions.
- Avoids discontinuity in engineering effort from design to bidding and evaluation period.

It is expected that the design and construction schedule would be adjusted at an early stage during discussion with the Power Authority.

Management and Organization

The Joint Venture can provide the needed personnel, organization framework and control systems to ensure on-schedule and within budget design of the Susitna Transmission Line Project. Our plan for accomplishing this is summarized below.

Management Team To ensure effective management and timely completion of the design, the Joint Venture will staff management positions with individuals whose proven records of accomplishment in similar assignments have led to high levels of responsibility within the parent companies. The transmission line design project will be provided with its own dedicated Project Manager based in Anchorage and, at the same time, be integrated into the overall management of the Susitna Hydroelectric Project. The manager of the transmission system project will be W.J. Rom - Vice President of Ebasco.

Mr. Rom will be responsible for managing the transmission line project and will report directly to the Susitna Hydroelectric Project manager, Dr. R.S. LaRusso - Vice President, Harza.

A brief resume of Mr. Rom's experience is given below.

Mr. W. J. Rom is an electrical engineer, and a Vice President of Ebasco Services. He has over 30 years experience on transmission lines, substations and related electric utility power facilities projects. He is a registered engineer in 25 states. He is a senior member of the Power Engineering Society of the Institute of Electrical and Electronics Engineers, and serves on the Power Generation Committee.

Our organization for the project includes a Project Engineer located at the Bellevue office. He would coordinate day-to-day engineering design activities and be in daily contact with the Project Manager. As necessary, he would be in Anchorage on short-term to fill in for the Project Manager. We are proposing Mr. D. Sandiforth for the position of Project Engineer.

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Mr. Sandiforth has 32 years of experience on electric utility and related power projects, and has been with Ebasco services for 15 years. He is presently manager of electrical engineering at the Ebasco Services office in Bellevue, Washington. His strong background and experience with all aspects of substation design make him particularly well suited for this assignment. He is a registered engineer in 7 states and has an application pending for registration in Alaska.

The proposed organization is designed to provide an efficient design operation while maximizing the services and skills available on the Susitna Hydroelectric Project without detracting from that project's efforts.

A separate listing of proposed staff and backup staff for the key positions has also been included to demonstrate the depth of expertise available in the Joint Venture firms and also the dedication to providing the best personnel for each position.

Joint Venture Organization The Joint Venture is organized to provide efficient and effective services to the Power Authority in accordance with the organization chart Figure A1-3. Key positions are structured to interface directly with the Power Authority to permit interchange of ideas and to involve the Power Authority directly in project formulation. The Susitna Hydroelectric Project management offices in Anchorage and Bellevue will be utilized. This will ensure the most cost-effective utilization of the facilities. Assigning the design office in Bellevue has the following advantages:

- Cost savings over an alternative plan of relocating all personnel to Anchorage.

- Better communication with the Power Authority than could be obtained if design work were performed further East, because the time difference between Chicago or New York and Anchorage would limit the effective hours of communication each day.

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o Reduction in travel time and cost, and communication expense.

The Bellevue office organization will be divided into teams covering transmission line, substation, environmental, geotechnical, surveying and cost control. Each will be provided with a team leader responsible for the day to day performance of work in his area on time and within budget.

The design teams will be supported by the home office resources of both firms. However, all key personnel involved with the project over the long term will be located in the Bellevue office. This deployment will facilitate the close involvement of the transmission line project personnel with the design personnel working on the Susitna Hydroelectric Project. It will also enable the Joint Venture to more efficiently use the special skills and outstanding cold region engineering experience available on the hydroelectric project team.

Geotechnical exploration, surveying, and Radio/TV interference measurements will be sub-contracted to Alaska-based personnel by use of an RFP procedure similar to that used by Power Authority.

Environmental and regulatory permitting and public participation programs will be operated from Anchorage during the active period to assist in the establishing of the final transmission line centerline.

General Operating Plan The operating plan and schedule developed by the Joint Venture recognizes the need for an early decision on the final right-of-way and centerline. The environmental and public participation personnel will commence work in early 1983 to assist the Power Authority in obtaining license approval for the project. During this period, the necessary level of engineering support will be provided by the lead engineers.

Environmental Compliance The Joint Venture has assigned an environmental team to provide the Power Authority with the necessary assistance to accomplish the process of resolution of issues related to acquisition of the necessary licenses and right-of-way. This environmental staff will include complete representation of the social, biological, and physical sciences, and will have additional resources available as necessary within the Bellevue and Anchorage offices of the Joint Venture. The environmental team assigned to the project has considerable experience with transmission lines in Alaska and the Pacific Northwest, as well as an extensive background in agency coordination, public involvement, and environmental analysis in general.

The Joint Venture recognizes that a significant interactive process of agency coordination, consultation and public participation will be necessary. The lead personnel will be located in Anchorage on a full-time basis, until all the transmission line requirements are approved by the Power Authority. Specific plans or guides for public participation and agency cooperation will be prepared in the initial phase of the project and monitored throughout. Licensing and permitting activities will be coordinated with similar activities for the Susitna Hydroelectric Project, and monitored through a master tracking system.

Engineering Work Plan Engineers of the Joint Venture staff have reviewed the project requirements and developed a detailed work plan. A description of each individual task is given in Section E-2 of the proposal.

The plan results in the production of five material specifications and five construction specifications for the transmission line, and ten material and five construction specifications for the substations.

Cost/Schedule Control The Joint Venture recognizes that control of cost and schedule is of special importance to the Power Authority, second only to the quality of project construction. To maintain the level of control necessary to ensure timely and cost-effective implementation of the Susitna Transmission Line Project design, we will implement a cost/schedule control system identical to that for the Susitna Hydroelectric Project.

The cost/schedule control program that will be used is the Ebasco Project Information and Control System (EPICS). Cost and schedule control will be under the direction of the same lead engineer assigned to the hydroelectric project, as the incremental increase in work is relatively small once the system is operational. This will not detract from the hydroelectric project effort and will provide the Power Authority project control managers with a single-source responsibility in the Bellevue office.

Concluding Statement The Harza-Ebasco Joint Venture has the capability and is fully equipped to undertake the design of the Susitna Transmission and Control System Project. We have a combined staff with extensive design experience in transmission lines, substations, communications, and submarine cables, and we have the required support services. We have the capability to perform the line routing and station siting, land use rights, system studies, design services, collateral support and construction support services required by the Power Authority.

We will make maximum use of all relevant earlier work and implement public participation programs to assist the Power Authority in obtaining rights-of-way and any other land needs which might exist for the lines and the substations.

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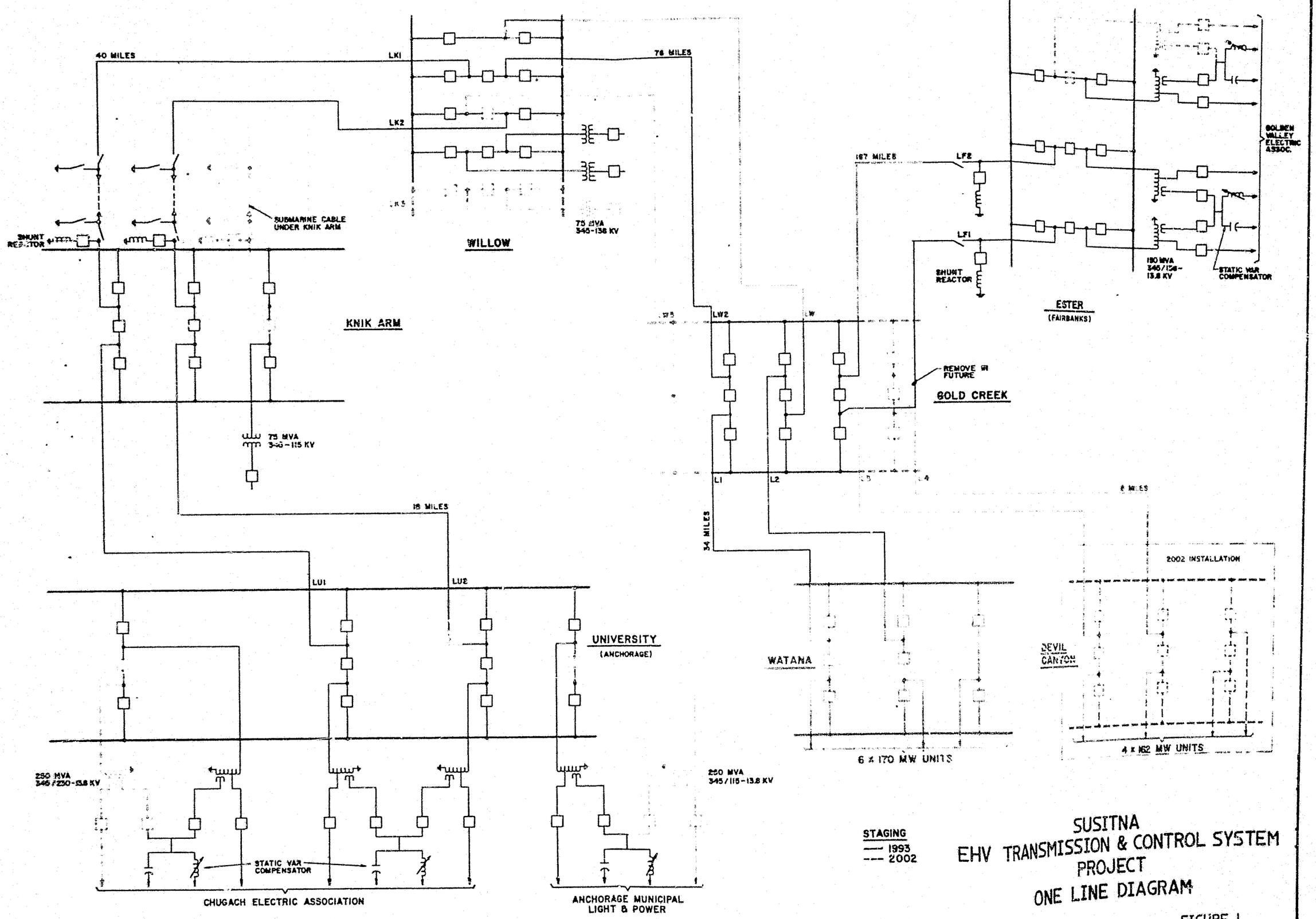
We will also make maximum use of the system studies prepared by Harza-Ebasco for the hydroelectric project and provide full design services for all the transmission and substation facilities, including the Knik Arm submarine crossing. The design will be completed in sufficient detail to permit the Power Authority to accomplish construction utilizing firm, fixed-price contracts with a minimal use of unit prices.

We will provide support to the Power Authority construction management contract, including vendor evaluation, review of the contractor's shop drawings, and final 'as built" drawings.

The Joint Venture approach to the project is designed to maximize communications with the Power Authority and the personnel on the hydroelectric project. As the design work would be done in the same location in Bellevue, the interface should prove extremely effective, permitting a smooth transfer of technical data and a sharing of personnel which will result in economies to the Power Authority.

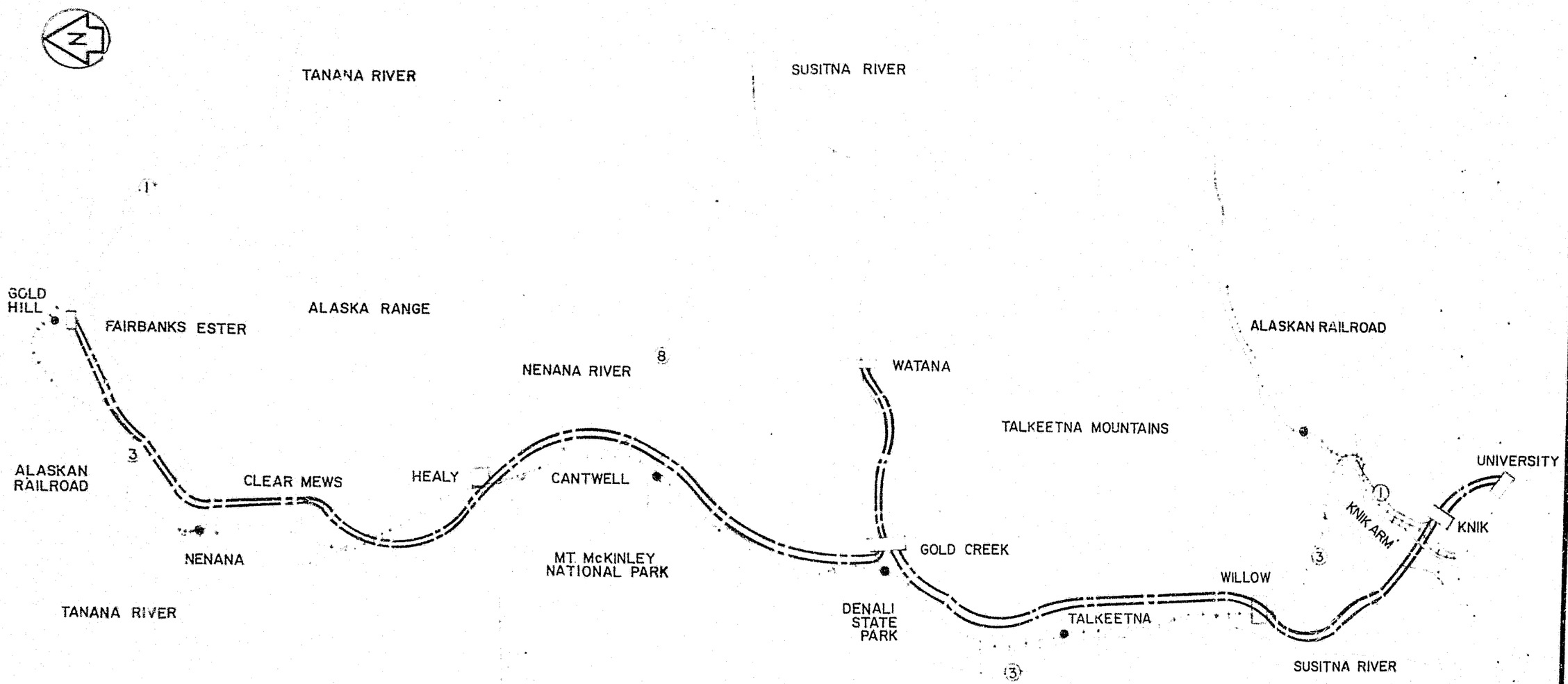
The Joint Venture, in conjunction with the Power Authority, will develop and help implement a program for operating and maintenance personnel, to provide them with "hands-on" knowledge of the particular sites, equipment, and operational features at the earliest possible date, consistent with construction progress and cost constraints.

We are confident that our approach to the project and the work planned and developed will lead the Susitna Transmission and Control System Project to successful completion.



SUSITNA
EHV TRANSMISSION & CONTROL SYSTEM PROJECT
ONE LINE DIAGRAM

FIGURE 1



SUSITNA
EHV TRANSMISSION & CONTROL SYSTEM
PROJECT
SITE MAP

FIGURE 2

A. ORGANIZATION

1.a Overall Corporate Organization

This proposal is being made by a joint venture consisting of the Harza Engineering Company and Ebasco Services.

Joint Venture - Parent Companies Figure A1-1 sheets 1 and 2 show the corporate organization of the Harza Engineering Company, while Figure A1-1 sheet 3 shows the corprate organization of Ebasco Services.

Joint Venture - Project Organization Figure A1-2 shows how the two parent companies form an interlocking joint venture that relates to the proposed project organization for the Transmission and Control Systems project. This figure also indicates that the Transmission and Control Systems project could be incorporated into the project organization of the joint venture's existing organization for the Susitna hydroelectric project.

1.b Project Organization

Figure A1-3 is the proposed project organization for the Transmission and Control Systems project. This organization shows how the project team of engineers and technical specialists will be organized to accomplish the goals of the Power Authority with regard to the implementation of plans to construct the 345 kV transmission lines and substations.

Figure A1-3 shows the names, positions and project titles of personnel proposed for assignment on this project. The proposed location of these personnel together with an indication of the percent of time to be devoted to the work, whether they are regular company employees or an outside hire, the name of their parent company, and the number of personnel estimated to be necessary are given on the list of project positions, Table A-1.

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The proposed organization will locate a project manager in Anchorage, and he will interface on day to day technical matters with the Power Authority representative for the Transmission and Control System Project. An engineering office will be established at Bellevue, Washington, and engineering work will be done there. The coordination of the engineering design work at the Bellevue office will be done by the Project Engineer.

Joint Venture - Project Organization Since this proposal is being submitted by the same joint venture that has been awarded the design contract for the Watana dam it is possible to offer a unique opportunity to the Power Authority. If the Transmission and Control System Project is awarded to this joint venture, it will be possible to integrate the project organization for the Transmission and Control System project into the organization for the Susitna Hydroelectric Project. Figure A1-4 shows the integrated organizations.

The chart of the combined organizations indicates how the Power Authority will have access to top level management. It also shows how the personnel assigned to the Transmission and Control System project will report to the top executive of the joint venture during the control period. This chart also shows how the work will be managed by the top executives of the firms comprising the joint venture. The joint venture proposal is based on the concept that the Transmission and Control System project can be integrated into the Susitna Hydroelectric project organization.

Integrating the two projects together will permit the hydroelectric project staff to assist in those areas where a combination of efforts will be beneficial and where level of effort for the transmission and substation design will be intermittent and cannot justify full-time persons.

The combined organization would allow for the coordination of the Public Participation and Licensing and Permitting work. Incorporating

these aspects of the Transmission and Control systems project into the existing infrastructure will avoid duplication of effort and minimize chances for conflicting efforts.

With the combined project it will be possible to closely coordinate the systems studies and the design of substations, communications, data acquisition and energy management systems. Within the substation design area it will be possible to assure standardized substation layout protection, communication, control and data logging designs.

Establishment of design principles, as well as detailed coordination and interface for these features of substation design will be achieved by the same team that will be responsible for the overall systems design in the principal contract. Again, this close coordination will permit better coordinated designs, with significant increases in efficiency and economy.

One set of Contract documents can be used for the procurement of major electrical equipment for the Watana switchyard and the transmission system substations. This will result in major equipment that will be of the same manufacture for the entire Susitna project, with attendant benefits in operation, maintenance, engineering and procurement costs.

ENGINEERING OPERATIONS

CHIEF ENGINEER
J. A. Veltrop

DEPUTY CHIEF ENGINEER
W. T. Bristow

SENIOR PROFESSIONAL STAFF
Chief Staff Engineer
A.E.Allen

Principal Civil Engineer	A. Zeevaert	Principal Mechanical Engineer	T.Zowski
Principal Civil Irrigation Engineer	M.A. Olson	Principal Planning Engineer	K.E. Sorenson
Principal Electrical Engineer	Y. Fukuda	Principal Power Development Engineer	A.E. Allen
Principal Geologist	E.E. Komie	Principal Geotechnical Engineer	J.A. Scoville
Principal Hydraulic Engineer	D.S. Louie		
Principal Hydrologist	B.H. Wang		

A. C. Hounsold
Assistant to the Chief Engineer

H. K. Pratt
Assistant to the Chief Engineer

E. T. Moore
Senior Hydroelectric Engineer

WATER AND ENERGY PLANNING AND DESIGN DEPARTMENT
H. H. Chen

Energy Resources Planning	V. Tammakivi
Water Resource Planning	M. P. Saunders
Hydroelectric Planning	L. D. Nichol
Hydraulic Analysis & Design	F. G. DeFazio
Small Hydro Design & Fish Facilities	K. R. Leonardson

LAND RESOURCES AND ENVIRONMENTAL SCIENCES DEPARTMENT
J.C. Jones

Environmental Sciences	J. T. Thrall
Hydrology	R. E. Aten
Land Reclamation & Irrigation	O. B. Palmer
Special Projects	J. T. Passage

GEOTECHNICAL DEPARTMENT
D. E. Kleiner

Geology	R. C. Acker
Soil Mechanics & Foundation I	R. G. Oechsel
Soil Mechanics & Foundation II	U.E. Kleiner (Acting Head)

HYDROELECTRIC DEPARTMENT - CIVIL
R. J. Banyai

Architecture	J. J. Schalk
Hydroelectric I	P. Naris
Hydroelectric II	R. D. Witte
Hydroelectric VI	R.E. Gewargis

HYDROELECTRIC PUMPED-STORAGE DEPARTMENT - CIVIL
M. Beuras

Hydroelectric III	V. J. Zipparro
Hydroelectric IV	B. A. McKiernan
Pumped-Storage	A. Duros
Wastewater Structures	E.E. Gruninger

STRUCTURAL DEPARTMENT
R. P. Wengler

Structural Analysis and Design	C.H. Yeh
Structural Design I	H. Sedath
Structural Design II	J. M. Hahn
Computer Services	K.J. Reca

ELECTRICAL DEPARTMENT I
J.T. Nikolas
Assistant Head J. C. Aberer

Hydro Generation & Substations I	J. C. Aberer
Industrial Projects	E. W. Nance
System Studies	P. J. Donalek
Transmission & Distribution	A.V. Sapelkin

ELECTRICAL DEPARTMENT II
L. Eilau

Computer Control & Communications	R.L. Kuntzendorf
Hydro Generation & Substations II	L. Eilau
Pumped Storage	H. M. Henjiksen

MECHANICAL DEPARTMENT
W. E. Lemm
Assistant Head G. H. Post

Gates, Cranes and Hoists	U. Vitols
General Mechanical I	R. S. Burkhart
General Mechanical II	C. Esser
Hydraulic Machinery	R. W. Fazalara
Thermal Systems	G. H. Post

ENVIRONMENTAL ENGINEERING DEPARTMENT
A. L. Lagvankar

Water and Waste Management	A. E. Molzann
Treatment Plants	T. W. Hurdle
Industrial Processes	K.V. Mayenkar

CONSTRUCTION MANAGEMENT DEPARTMENT
D J. Duck
Assistant Head R.D. Hilliard

Contracts and Construction Services	S.E.G.Hjertberg
Contract Documents and Procurement	A. L. Schlüter
Scheduling & Estimating	L.F. Levy
Field Contracts & Administration	D.J. Duck

FIGURE A1-1
SHEET 1

MANAGEMENT GROUP OPERATIONS

PROJECT MANAGEMENT AND BUSINESS DEVELOPMENT ACTIVITIES

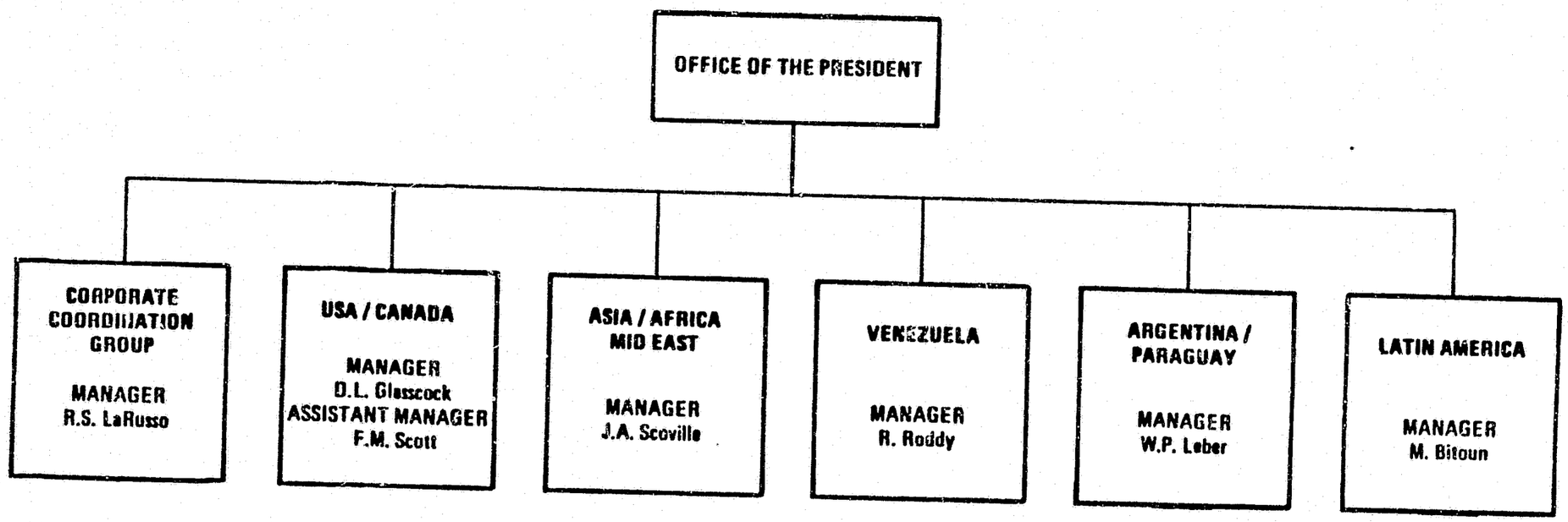
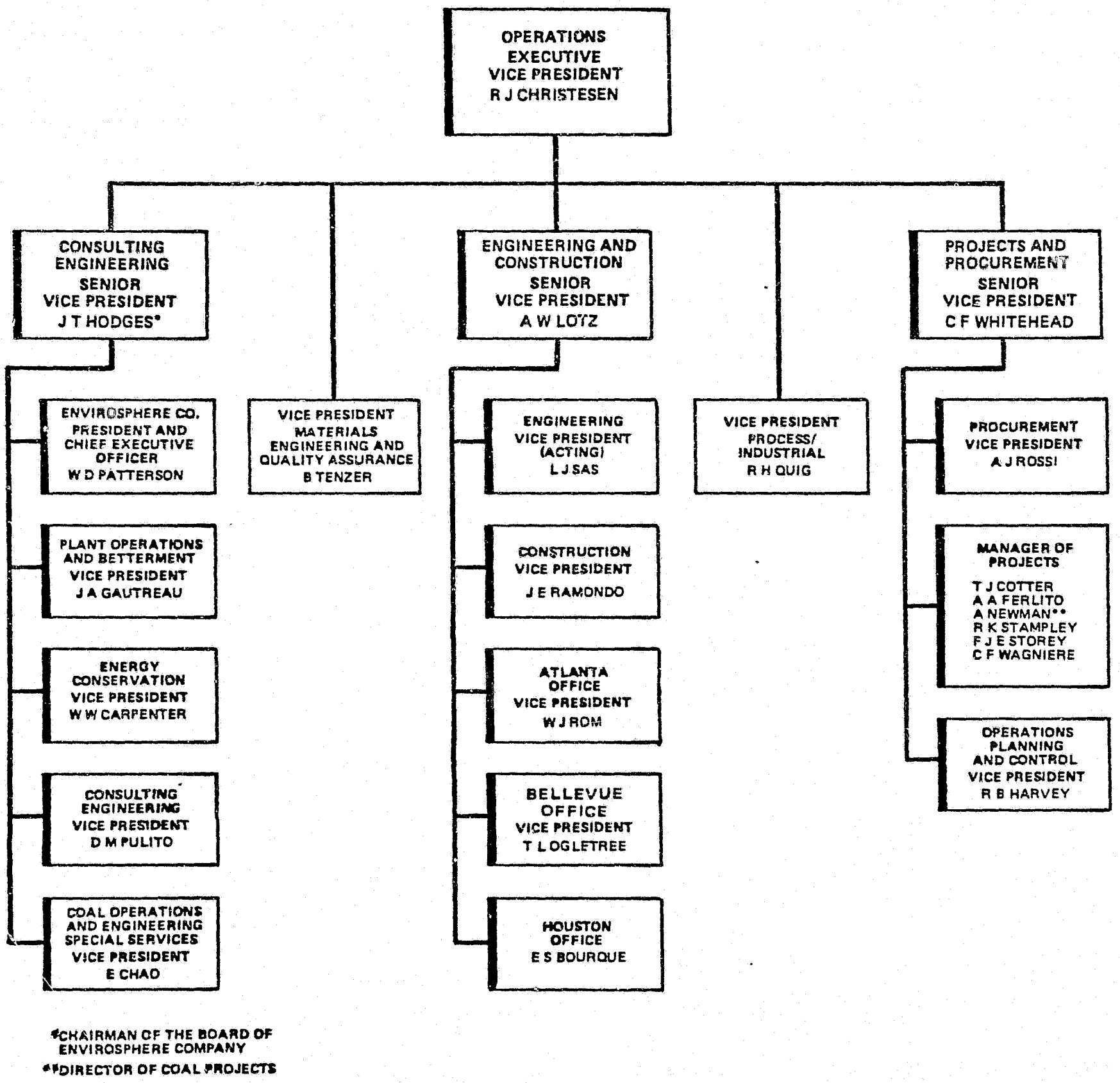


FIGURE A1-1
SHEET 2

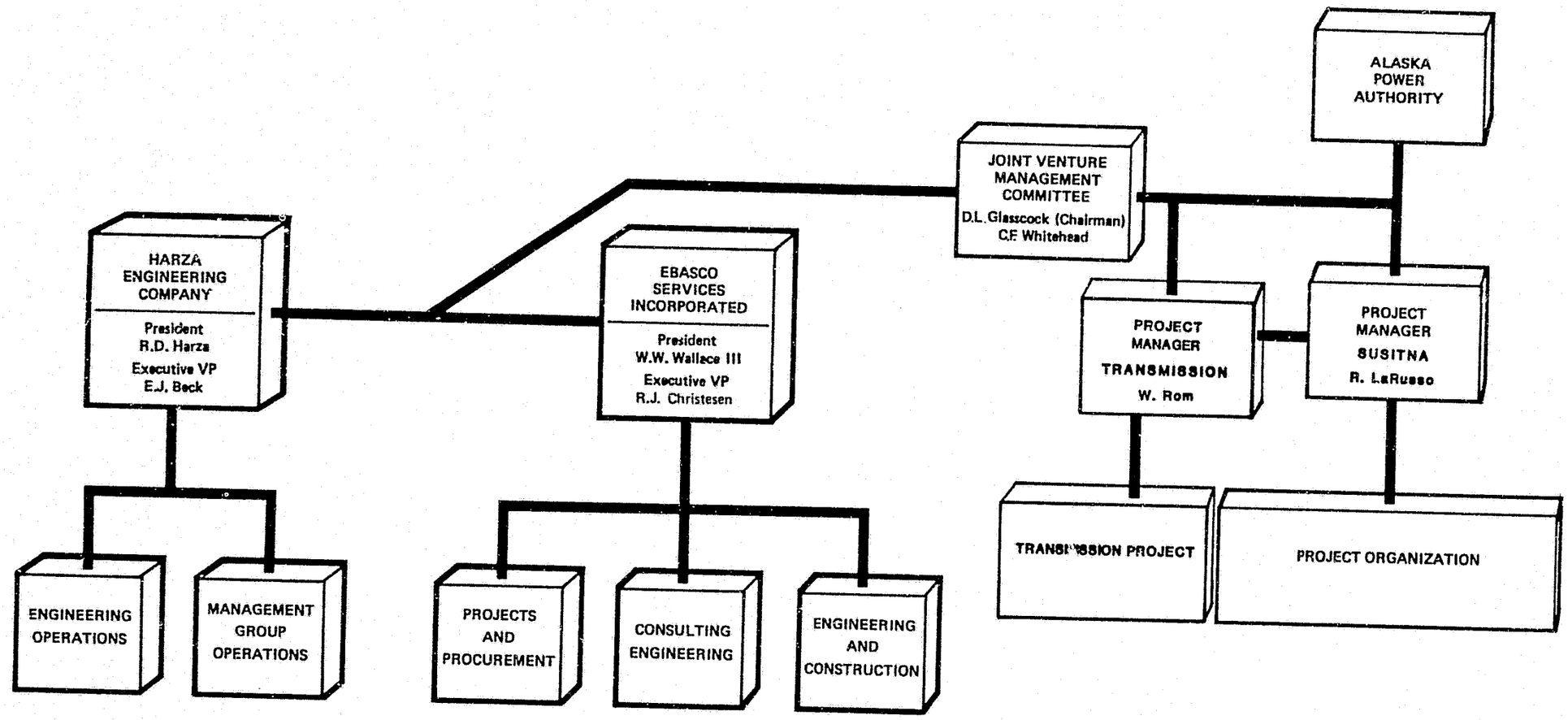
FIGURE A1-1
SHEET 3

Ebasco Services Incorporated
COMPANY ORGANIZATION - OPERATIONS



*CHAIRMAN OF THE BOARD OF ENVIROSPHERE COMPANY

**DIRECTOR OF COAL PROJECTS



SUSITNA HYDROELECTRIC PROJECT

CORPORATE ORGANIZATION

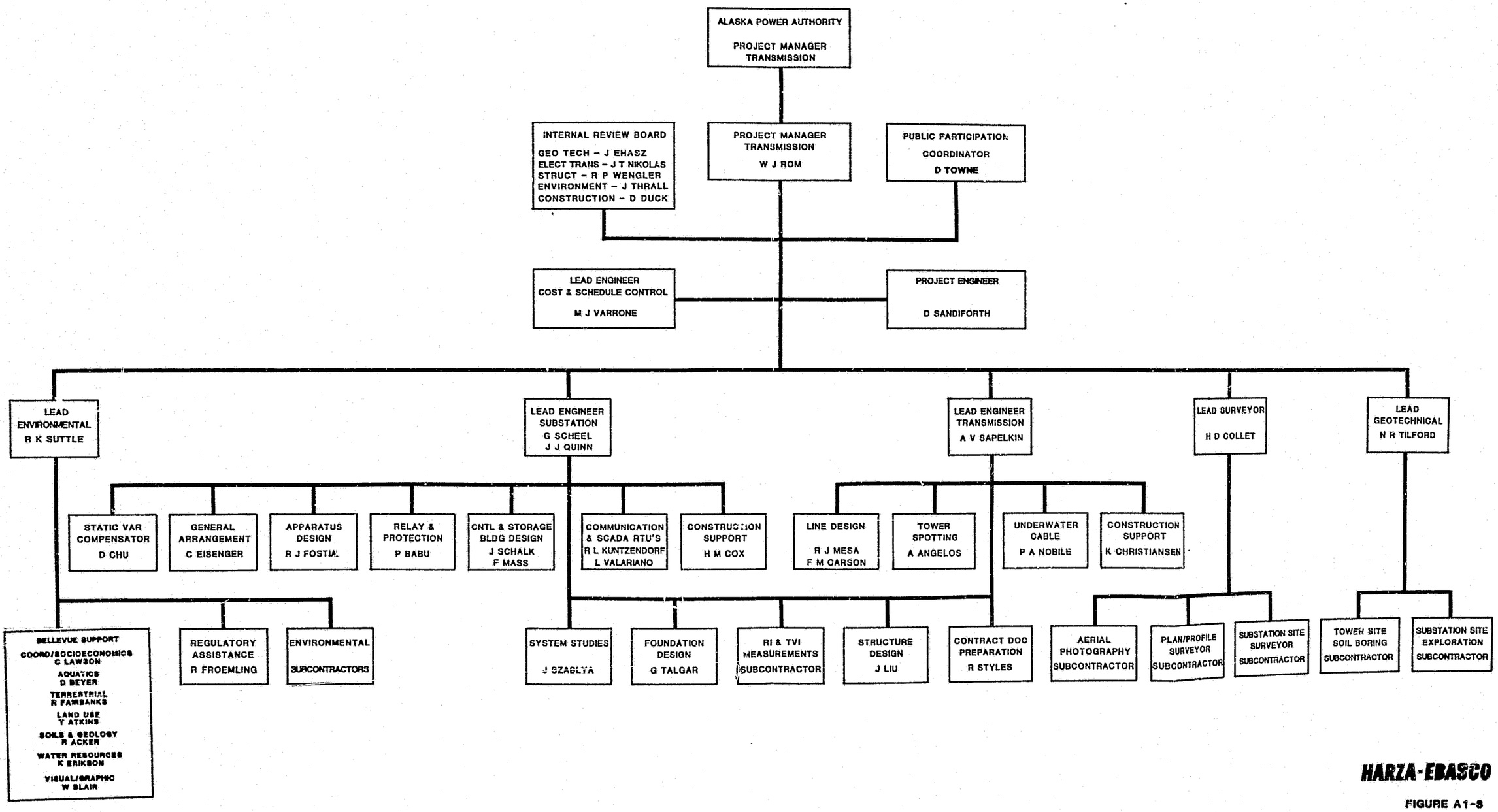
HARZA-EBASCO

FIGURE A1-2

SUSITNA

EHV TRANSMISSION & CONTROL SYSTEM
PROJECT

ORGANIZATION CHART



HARZA-EBASCO

FIGURE A1-3

HARZA/EBASCO JOINT VENTURE SUSITNA PROJECT TEAM
ORGANIZATION CHART

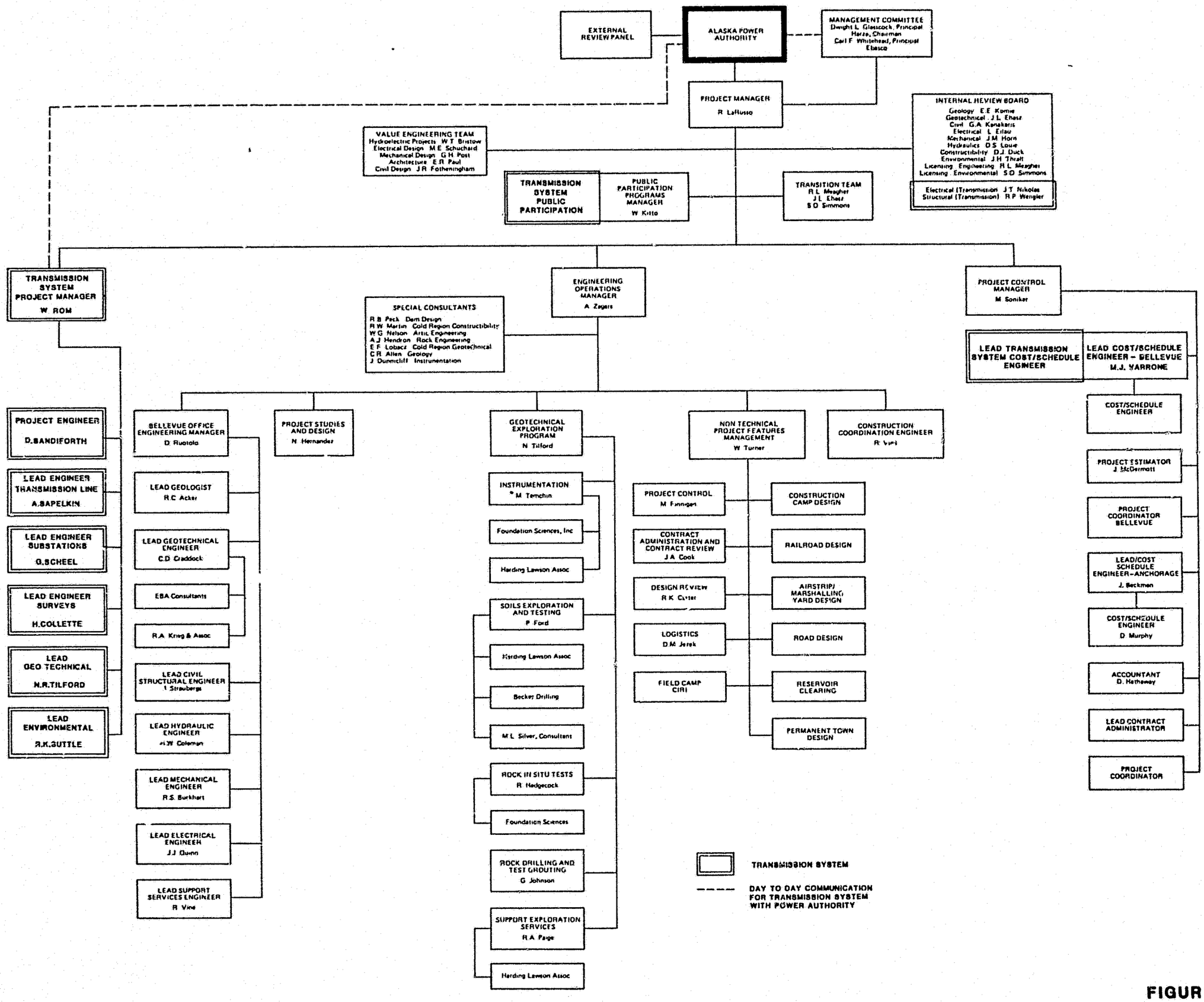


FIGURE A1-4

TABLE A-1
LIST OF PROJECT POSITIONS

FUNCTIONAL TITLE	PERSONNEL REQUIRED	PROPOSED INDIVIDUAL	PERCENTAGE OF TIME DEVOTED TO WORK	DURATION OF ASSIGNMENT	LOCATION	TYPE OF EMPLOYEE	PARENT COMPANY
Project Manager Transmission	1	W. J. Rom	100	1/83-12/89	Anchorage	Regular	Ebasco
Public Participation Coord.	1	D. Towne	25	1/83-1/85	Anchorage	Regular	Jones & Jones
Project Engineer	1	D. Sandiforth	75	1/83-12/89	Bellevue	Regular	Ebasco
Internal Review Board							
Geotechnical	1	J. Ehasz	5	1/83-12/89	New York	Regular	Ebasco
Electrical (Transmission)	1	J. T. Nikolas	5	1/83-12/89	Chicago	Regular	Harza
Structural (Transmission)	1	R. P. Wengler	5	1/83-12/89	Chicago	Regular	Harza
Environmental	1	J. Thrall	5	1/83-12/89	Chicago	Regular	Harza
Construction	1	D. Duck	5	1/83-12/89	Chicago	Regular	Harza
Lead Engineer Cost & Schedule Control	1	M. J. Varrone	20	1/83-1/85	Anchorage	Regular	Ebasco
Lead Environmental	1	R. K. Suttle	60	1/83-1/85	Anchorage	Regular	Harza
Regulatory Assistant	1	Fromeling	20	1/83-3/89	Anchorage	Regular	Ebasco/ FMAA
Socioeconomics	1	C. Lawson	20	1/83-1/84	Bellevue	Regular	Ebasco
Aquatic	1	D. Beyer	10	1/83-1/84	Bellevue	Regular	Ebasco
Terrestrial	1	R. Fairbanks	10	1/83-1/84	Bellevue	Regular	Ebasco
Land Use	1	T. Atkins	10	1/83-1/84	Bellevue	Regular	Jones & Jones
Soils/Geology	1	R. Acker	10	1/83-1/84	Bellevue	Regular	Harza
Water Resources	1	K. Erikson	10	1/83-1/84	Bellevue	Regular	Ebasco
Visual/Graphics	1	W. Blair	10	1/83-1/84	Bellevue	Regular	Jones & Jones
Lead Engineer Transmission	1	A. V. Sapelkin	100	1/83-3/89	Bellevue	Regular	Harza
Transmission Line Design	1	R. J. Mesa	100	9/87-9/88	Bellevue	Regular	Harza
Engineering 2151B	1	F. M. Carson	100	1/83-12/84	Bellevue	Regular	Ebasco

TABLE A-1
LIST OF PROJECT POSITIONS

FUNCTIONAL TITLE	PERSONNEL REQUIRED	PROPOSED INDIVIDUAL	PERCENTAGE OF TIME DEVOTED TO WORK	DURATION OF ASSIGNMENT	LOCATION	TYPE OF EMPLOYEE	PARENT COMPANY
Tower Spotting	1	A. Angelos	100	1/83-6/83 3/84-12/84 9/87-9/88	Bellevue	Regular	Harza
Undersea Cable Engineer	1	P. A. Nobile	50	6/83-9/83 9/87-6/88	New York	Regular	Ebasco
Construction Support Transmission	1	K. M. Christiansen	20	6/85-6/87 3/89-6/91	Bellevue	Regular	Ebasco
Lead Substation Engineer	1 1	G. Scheel J. J. Quinn	100 20	6/83-9/92 6/83-9/92	Bellevue Bellevue	Regular Regular	Harza Harza
Static Var Compensation	1	D. Chu	10	6/83-9/82	New York	Regular	Ebasco
General Arrangement Substations	1	C. J. Eisinger	50	1/87-9/92	Bellevue	Regular	Harza
Substation Apparatus Design	1	R. J. Fostiak	100	1/84-3/90	Bellevue	Regular	Harza
Relay and Control	1	P. Babu	80	6/88-9/92	Bellevue	Regular	Harza
Storage and Control	1	J. J. Schalk	40	6/85-12/90	Bellevue	Regular	Harza
Building Design		F. B. Mass	40	6/85-12/90	Bellevue	Regular	Harza
Communication and SCADA-Remote	1	R. L. Kuntzendorf	10	6/83-9/92	Chicago	Regular	Harza
Terminal Units	1	L. H. Valeriano	40	6/83-9/92	Bellevue	Regular	Harza
Construction Support Substation	1	H. M. Cox	20	6/87-12/91	Bellevue	Regular	Harza
System Studies Engineer	1	J. F. Szablya	20	6/83-3/84	Bellevue	Regular	Ebasco
Foundation Design Line and Substation	1	G. Talgar	100	1/83-12/83 6/84-12/84 1/88-9/88	Bellevue	Regular	Harza
Structural Design Line and Substations	1	J. J. N. Liu	100	3/83-12/83 6/84-12/84 1/88-9/88	Bellevue	Regular	Harza
Contract Document Preparation	1	R. B. Styles	20	9/84-3/85 3/88-3/89	Bellevue	Regular	Harza
Lead Surveyor	1	H. D. Collet	100	3/83-1/85 6/87-9/88	Anchorage	Regular	Harza
Lead Engineer Geotechnical	1	N. R. Tilford	15	1/83-1/85	Anchorage	Regular	Ebasco

ALTERNATIVE PERSONNEL

Position	Name	Parent Company
Project Manager	J. J. Keller	Harza
Lead Engineer Geotechnical	R. Wong	Harza
Lead Engineer - Transmission	J. O. C. Kansog	Ebasco
Structural Design Line and Substations	N. Mueller	Ebasco
Relay Engineer	N. Reese	Harza

A2. Position Description

The Joint Venture has developed position descriptions for key personnel on the organization chart Figure A1-3. Position descriptions have been organized as follows:

Project Management
Engineering Operations
Project Control
Environmental

Project Management

Transmission and Control Systems Project Manager (Anchorage) will be responsible for day to day liaison with the Power Authority Project Manager. He will be the formal link between the Power Authoirty on all technical elements of the project.

In accordance with the terms of the Joint Venture agreement, he will work with the Susitna hydroelectric Project Manager. In conjunction with the Susitna hydroelectric project manager, he will execute subcontracts in support of the Anchorage and Bellevue officers, and he will be responsible for final approval of personnel assignments. Development of employment conditions will be made by the Project Manager for the Transmission and Control Systems and the Hydroelectric projects together with the Management Committee for the joint venture.

He will oversee and hold the responsibility for final authorizations concerning operations of the Transmission and Control Systems Project team, and he will be directly responsible for formal issue of all project documents. Upon receipt of programs for investigations, studies and design efforts from the project engineer, the Transmission and Control Systems Project Manager will be responsible for final authorization and budget allocation.

The Transmission and Control Systems Project Manager will initiate, schedule and chair meetings between project staff and the Power Authority and the Internal Review Board. He will make presentations as necessary to the Power Authority's Board of directors and, when requested, to public information forums.

The Transmission and Control Systems Project Manager will report to the Hydroelectric Project Manager and the Joint Venture Management Committee concerning the status of the Project.

Public Participation Program Coordinator (Anchorage) The Public Participation Program Coordinator will be responsible for communicating information about the Project's engineering, environmental and cost elements to the Power Authority Public Participation Office. The Transmission Line Coordinator will be assigned to the Hydroelectric Program Manager's Staff and will be available at public meetings, meetings with Citizen Advisory committees and working groups to assist the Power Authority in the collection, preparation and distribution of information. He will report to the Transmission and Control Systems Project Manager and have direct access to the project engineer and lead engineers to provide convenient exchange of information between the Project Team and interested individuals and groups.

Engineering Operations

Project Engineer (Bellevue)

The Project Engineer will be the cross-discipline technical leader of the transmission and substation project team in Bellevue. He will be responsible for directing the overall engineering effort in Bellevue, and will coordinate all activities of the Lead Environmental, Transmission Line, Substation, Geotechnical and Cost Control Engineers. Furthermore, he will be directly responsible to the Transmission and Control Systems Project Manager for the formal issue of all project documents from the Bellevue office, and for the final authorization of budget allocations.

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The Project Engineer will report to the Transmission and Control Systems Project Manager in Anchorage. He will advise the Project Manager on all engineering matters, and will participate in all meetings with the Power Authority.

Lead Engineer-Substations (Bellevue) The Lead Engineer/Substations will be an electrical engineer responsible for the conceptual and detailed electrical design of each substation. His design responsibilities will include: selection of the switching arrangement, protective relaying, major substation electrical equipment, together with station service, grounding, control, lighting and miscellaneous systems. He will administer and supervise a staff of engineering specialists as shown on the organization chart, who will assist him in the areas of general arrangement, apparatus design, relay protection, communication and SCADA systems design, static var compensation design and in the design of substation yards, control buildings, and storage buildings.

In addition, a systems study engineer who will also perform the systems study work on the hydroelectric project will establish the criteria for an insulation coordination study and parameters to be followed in the substation electrical design.

The Lead Engineer/Substations will be responsible for formulating design criteria and issuing electrical design memoranda formalizing these criteria. He will also direct the preparation of the electrical technical specifications, contract/construction drawings and construction/installation quality control memoranda. He will coordinate the interfacing of his section's work with that of the communications, mechanical, architectural, civil, structural, and other disciplines work and with the internal review board. He will also coordinate his staff's work with design of the hydroelectric project. He will prepare technical analyses of electrical equipment bids and provide input to the electrical section of the construction bid documents for the substations.

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He will supervise the review of electrical manufacturer's submittals and in-plant acceptance inspections and tests and coordinate the review by other disciplines of all other shop drawings. He will assist the Power Authority and the construction manager's staff in field inspection and testing and project startup.

Operation and maintenance manuals will be prepared under his direction.

A total listing of substation tasks is given in E2S1 through E2S20.

Lead Engineer-Transmission (Bellevue) The Lead Engineer-Transmission will be responsible for design of all sections of the overhead transmission line and also the submarine cable crossing of the Knik Arm. He will be responsible for establishing the basic design criteria, establishing line clearances, conductor selection, insulator selection and tower location and design.

He will administer and supervise a staff who will provide specialized assistance as shown on the organization chart in the areas of line design, tower spotting, submarine cable design, foundation and structure design.

A systems study engineer who will also perform the same work on the hydroelectric project will provide input for the basic electrical design criteria.

In addition, a further subcontractor will be engaged to provide radio and TV interference measurements.

The lead transmission engineer will be responsible for preparing design memoranda formalizing the criteria. He will direct the preparation of the final design specifications, contract/construction drawings and construction/installation quality control memoranda. He will

coordinate the interfacing of his section's work with that of the other disciplines and the internal review board. He will also coordinate his work with the Joint Venture staff on the hydroelectric project. He will prepare technical analyses of equipment bids and provide input to the technical sections of construction bid documents.

He will supervise the review of manufacturer's submittals and in-plant acceptance inspections and tests. He will assist the Power Authority and the construction manager's staff in field inspection and testing at project startup.

A total list of transmission line tasks is given in EST1 through E2T11.

Lead Geotechnical Engineer (Bellevue) The Lead Geotechnical Engineer will be responsible for the review and evaluation of all geotechnical data resulting from the field exploration program subcontractors and will coordinate with the civil engineer in applying geotechnical parameters to the project design. He will carry out analyses and studies of soil mechanics and rock mechanics bearing on the design of the transmission tower and substation foundations. He will be responsible for the preparation of specifications and evaluations of bids for the tower site and substation soil boring subcontracts. After contract award he will be responsible for technical administration of the subcontractor.

Lead Surveyor (Anchorage) The Lead Surveyor will be responsible for all transmission line and substation site surveys. He will prepare technical specifications for the accuracy and control of field and aerial surveys, and will assist in the selection of subcontractors. Then he will review and evaluate all field data produced by the subcontractors for the transmission line centerline and substation sites. Also, he will oversee the aerial photography and the submarine crossing mapping.

The Lead Surveyor will supervise the reduction of the plan-profile data for input into the computer, and the preparation of topographical maps for the substation sites and the submarine cable crossing. Then he will prepare the property descriptions necessary for the Power Authority to acquire the right-of-way or substation sites and the permits across U.S. Government, State, or Native Lands.

After the tower spotting has been completed, he will supervise the location and referencing of the tower sites. In addition, he will establish the baselines and the grades for the substation sites. Then after contract award, he will coordinate all surveying matters with the Construction Manager.

Project Control

Lead Cost/Schedule Control Engineer (Bellevue) The Lead Cost/Schedule Control Engineer in Bellevue, who reports to the Hydroelectric Project Control Manager in Anchorage, is responsbile for the control of services costs, capital cost and schedules for the activities performed in the Bellevue office. Reporting to the lead Cost/Schedule Engineer are Estimators, Service Cost Engineers and additional Cost/Schedule Control Engineers who will develop and maintain cost and schedule baselines for the Project in order to perform these control functions.

Environmental

Lead Environmental (Anchorage) The Lead Environmental Scientist will be responsible for implementing the work plan outlined in Section E1, "Route Selection and Station Siting." He will be the Project Team's key individual in the execution of environmental and regulatory programs that are central to the issue of project licensing. He will be the principal point of contact with the Power Authority's and other agencies' environmental staff on technical issues, and will provide assistance as needed to the Public Participation Program, engineering studies and project control functions.

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He will supervise a team of specialists as shown on the organization chart to establish transmission line right-of-way and acquire the necessary land and permits for the transmission line and substations. He will be responsible for preparing periodic progress reports on the status of environmental program activities. He will also have overall responsibility for all technical environmental documents developed by the Joint Venture.

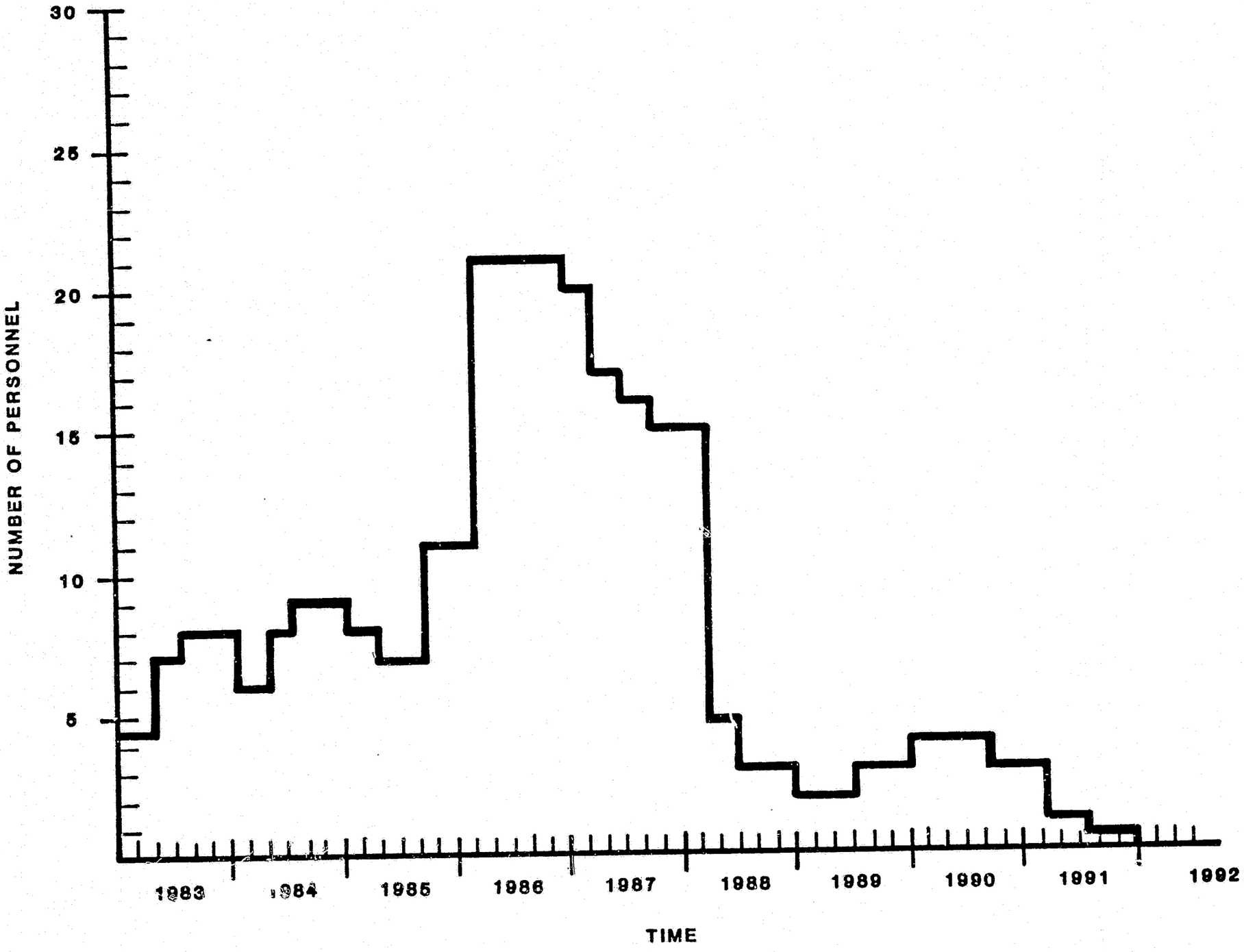
From an administrative standpoint, he will be part of the Hydroelectric Project, Regulatory Environmental and Regulatory Programs Manager's staff. He will be responsible for managing the costs and maintaining the schedule of the environmental program.

A.3.a SUMMARY OF NUMBER OF PERSONNEL BY LOCATION

Anchorage	7
Bellevue	26
Home Office	
Harza	5
Ebasco	3
TOTAL	41

A.3.b DATES OF ASSIGNMENT

Dates of assignment are shown on Table A-1.



HARZA-EBASCO

SUSITNA HYDROELECTRIC PROJECT

MAN LOADING PLAN

FIGURE A3-1

RESUME FOR ALASKA REPRESENTATIVE RESPONSIBLE FOR PROJECT

PROJECT MANAGER AND PUBLIC PARTICIPATION COORDINATOR

C EVALUATION CRITERIA

1 Project One

D.2 Project Two

D.3 Project Three

HARZA-EBASCO

HARZA-EBASCO

WILLIAM J. ROM

Job Title:	Project Manager
Work Location:	Bellevue
Education:	Bachelor of Electrical Engineering (Cum Laude), Polytechnic Institute of Brooklyn - 1954, Graduate Courses (Vector and Tensor Analysis), (functions of complex variable and applications), (Engineering Economics), Alexander Hamilton Institute, Modern Business, Westinghouse Cypak Engineering Design School
Special Qualifications:	Over thirty years engineering management and engineering experience including transmission lines, substations, hydroelectric and pumped storage projects. Major positions held - Vice President, Manager of Engineering and Projects, Corporate Chief Electrical Engineer and Project Manager.
Professional Registration:	Registered professional engineer in the states of New York, California, Arizona, Connecticut, Florida, Georgia, Iowa, Kansas, Louisiana, Maryland, Michigan, Minnesota, Montana, New Hampshire, North Carolina, Ohio, Oregon, Pennsylvania, Texas, Utah, Vermont, West Virginia, Washington, Wisconsin and Wyoming and the National Council of Engineering Examiners.
	Affiliations: Vice President - U.S. National Committee CIGRE; Institute of Electrical and Electronic Engineers, Senior Member and Member of Main Power Generation Committee; Association of Edison Illuminating Companies - Electric Apparatus Group; Member - American Society of Military Engineers.
Parent Company:	Ebasco Services Incorporated

Experience and Qualifications Relevant to the Susitna Project:

Ebasco Services Incorporated, 1950 to present.
Vice President (3 years) - Responsible for total performance of Ebasco's Atlanta Regional Office with a staff varying between 400 and 500. Reporting functions included Manager of Projects, Engineering, Computer Operations, Personnel and Finance.

Manager of Engineering and Projects (3 years) - Responsible for engineering management and project management. Reporting departments included Project Management, Project Engineering, Civil, Electrical, Instrumentation & Control, Mechanical Engineering, Purchasing, Operations Planning & Control, Estimating and Cost Engineering.

Corporate Chief Electrical Engineer (7 years); Assistant Chief Electrical Engineer (1 year) - Responsible for technical direction of a staff of approximately 250 supervising, principal, senior electrical engineers and designers in corporate headquarters and three branch offices engaged in transmission line, substation, hydroelectric, pumped storage as well as conventional steam electric plants.

Project Manager (5 years) - Transmission Line and Substation Projects. Five separate projects of single and double circuit transmission lines including engineering, design and inspection of construction.

Manager of Standards and Procedures (1 year) - Organized new department to develop technical and administrative procedures for the Company. Responsible for directing preparation and reviewing contents of engineering specifications and guides for all engineering disciplines in the Company.

Supervising Electrical Engineer (4 years) - Supervising Electrical Engineer responsible for directing staff of Electrical Engineers and Designers for all electrical facilities including 345kV switchyard.

Client References:

Cincinatti Gas & Electric Company
Robert P. Wiwi - Vice President, Elec. Operations
P. O. Box 960
Cincinatti, Ohio 45201
(513) 381-2000

Idaho Power Company
Larry G. Tepley - Vice President-Engineering
P. O. Box 70
Boise, Idaho 83721
(208) 383-2200

HARZA-EBASCO

DAVID L. TOWNE

Job Title: Public Participation Coordinator

Work Location: Anchorage

Education: Bachelor of Arts
1957, University of Washington

Special Qualifications: Expert witness testimony and general regulatory issues; knowledgable of land-use, zoning, condemnation and less than fee real estate acquisition and regulation; experienced in conducting public hearings, presentations and citizen involvement techniques; experienced in local, state and federal operational issues and policies.

Professional Associations: Certified Administrator -- Washington State Recreation & Park Association
American Planning Association
American Management Association
National Recreation & Park Association

Parent Company: Jones & Jones

Experience and Qualifications Relevant to the Susitna Project:

1977 to Present: Principal and Planner in the firm of Jones & Jones. Responsibilities included administering and conducting various planning and development projects for both public and private clients.

1969 to 1977. Assistant Superintendent and Superintendent of Seattle's Department of Parks & Recreation. Responsibiities included the planning, developent and administration of the park system under the direction of the Major as well as serving on the Planning Commission and Board of Public Works for the City.

- Columbia River Gorge Analysis, Washington. Managed a study of the Columbia River Gorge for the State of Washington involving the inventory and analysis of natural and political systems. This included extensive public involvement and coordination with over thirty agencies and organizations.

- Clark/Cowlitz (JOA) Hydroelectric Project, Washington. Coordinated the preparation of an Exhibit R for the Federal Energy Regulatory Commission relicensing application for the JOA. This effort involved recreation and visual planning as well as agency coordination.

- o Heyburn State Park Analysis, Idaho. Conducted a recreational and land management study of Heyburn State Park for the U.S. Department of Justice. The study and findings were used as a basis for expert witness testimony involving a question of reversionary rights.

- o St. Edwards Seminary Feasibility Study, Washington. Managed a detailed economic feasibility study of alternative re-use of this Washington State Park facility located in a politically sensitive urban area east of Seattle. This study included extensive public involvement and visual aids to inform the various interested agencies on cost benefit options.

- o Washington Park Management Plan, Oregon. Conducted a study of this main downtown 300 acre park relating to the development of management policies and general site plans. This project involved resolving conflicting interests between the neighborhood, major cultural institutions leasing property in the park, and the regional environmental community.

- o Klamath Basin Transmission, Oregon. Managed the landuse, recreational and visual studies for the controversial 500 kV transmission through the Klamath Basin for the Oregon Public Utility Commssion. The study involved extensive citizen and agency involvement in presenting and testing alternative routes.

- o Forward Thrust Program, Seattle, Washington. Responsible for the planning and implementation of an approximately 125 million dollar capital program for land acquisition and major development to park facilities. This program encompassed the purchase of over 2,000 acres of land, and construction of over 175 park facilities including major improvements such as the Waterfront, Aquarium, Zoo and Freeway Parks.

- o Board of Public Works, Seattle, Washington. Served as a member and chairman of the Board of Public Works who were the responsible entity for the bidding, award and construction of all City of Seattle public improvement contracts including those for the City Light and Water Utilities.

- o Seattle Urban Renewal Enterprise, Washington. Directed the staffing and programs for this independent organization whose purpose was to advise and assist in implementing the City of Seattle's industrial, residential and commercial redevelopment program.

Client References:

1. Columbia River Gorge
   Ms. Karen Rahm
   Director
   Planning and Community Affairs Agency
   9th and Columbia Building
   Olympia, WA 98504
   (206) 753-2200

2. JOA-Hydroelectric . oject
   Mr. Byron Haley
   Director
   Resource Development Associates
   P.O. Box 512
   Olympia, WA 98507
   (206) 786-1212

3. Heyburn State Park
   Mr. James Clear
   Attorney
   U.S. Department of Justice
   Room 1744
   Lands & Natural Resources Division
   Washington, D.C. 20530
   (202) 633-2847

4. St. Edwards
   Mr. Thomas France
   Director of Planning & Acquisition
   Washington State Parks Commission
   7150 Clearwater Lane
   Olympia, WA 98504
   (206) 753-2018

5. Washington Park
   Mr. John Sewell
   Chief Planner
   Portland Bureau of Parks
   409 S.W. 9th Avenue
   Portland, Oregon 97205
   (503) 248-4526

6. Klamath Basin
   Mr. Roy Hemingway
   Council Member
   Northwest Regional Power Planning Council
   155 Cottage Street N.E.
   Salem, Oregon 97310
   (503) 378-5487

7. City of Seattle
Mr. Joe Recchi
Superintendent
Seattle City Light
1015 3rd Avenue
Seattle, Washington 98104
(206) 625-3200

8. Alaska
Mr. Paul Diener
Director of Public Works
Municipality of Anchorage
Anchorage, Alaska 99502
(907) 263-8160

Mr. Robert Robertson
Director
Department of Cultural and Recreational Services
Municipality of Anchorage
Anchorage, Alaska 99502
(907) 264-4365

C EVALUATION CRITERIA
TECHNICAL COMPETENCE

D.1 Project One

D.2 Project Two

D.3 Project Three

RESUMES
HOME OFFICE
REPRESENTATIVE

HARZA-EBASCO

HARZA-EBASCO

DONALD SANDIFORTH

Job Title: Project Engineer

Work Location: Bellevue

Education: Bradford Technical College, England--Higher National Certificate of the Institution of Electrical Engineers (London)-1955.

Special Qualifications: Over thirty-two years of related engineering experience.

Currently Manager of Electrical Engineering in the Seattle regional office, responsible for the technical and administrative management of the Engineering and Design Departments.

Previously Assistant Chief Electrical Engineer in the corporate headquarters in New York.

Professional Registrations: Professional Engineer - New York, Louisiana, Washington, Florida, Texas, Oregon, Colorado and Alaska (pending).

Affiliations:

IEEE - Member
Power Engineering Society - Chairman Working Group NPS-2

Parent Company: Ebasco Services Incorporated

Experience and Qualifications Relevant to the Susitna Project:

Representative Experience:

Client	Project	Position
Washington Public Power Power Supply System	230kV and 500 kV Transmission Tie Lines for 2 1300 MW nuclear plants	Assistant Chief Supervisor
Carolina Power & Light Company	230kV and 500kV switch-yards for 4 900 MW nuclear power plants	Lead Supervisor

Client	Project	Position
Vermont Yankee Nuclear Power Corp.	115kV and 345kV switchyard for 537 MW nuclear power plant	Senior Engineer
Alaska Power Authority	138kV switchyard for Terror Lake Hydroelectric Plant	Lead Engineer

Employment History:

Ebasco Services Incorporated, Bellevue, WA; 1982-Present
- Chief Electrical Engineer

Ebasco Services Incorporated, New York, NY; 1967-1981
- Assistant Chief Electrical Engineer, 1979-1981
- Supervising Electrical Engineer, 1974-1979
- Principal Electrical Engineer, 1972-1974
- Senior Electrical Engineer, 1967-1972

English Electric Company Limited, Tonbridge, England; 1964-1967
- District Sales Engineer

English Electric Company Limited, Liverpool, England; 1961-1964
- Switchgear Contracts Engineer

Spooner Food Machinery Company, Ilkley, England; 1960-1961
- Senior Designer

English Electric Company Limited, Bradford, England; 1959-1960
- Designer

Royal Air Force--National Service; 1957-1959

English Electric Company Limited, Bradford, England; 1954-1957
- Junior Designer

English Electric Company Limited, Bradford, England; 1949-1954
- Student Apprenticeship

Client References:

Alaska Power Authority
J. Longacre
334 West Fifth Avenue
Anchorage, Alaska 99501
(907) 276-0001

DONALD SANDIFORTH
Project Engineer

Washington Public Power Supply System
K. Kirkevold
Satsop Power Plant
Elma, Washington 98541
(206) 482-4428

Carolina Power & Light Company
W. Moore or N. Stewart
Center Plaza Building
Fayetteville Street
Raleigh, North Carolina 27502
(919) 836-6111

Yankee Atomic Electric Company
G. Tsouderos - Engineering Office
1671 Worcester Road
Framingham, Massachusetts 01701
(617) 872-8100

C EVALUATION CRITERIA
TECHNICAL COMPETENCE

D.1 Project One

D.2 Project Two

D.3 Project Three

INTERNAL REVIEW BOARD

HARZA-EBASCO

JOSEPH L. EHASZ

Job Title:	Internal Review Board and Transition Team - Geotechnical and Civil
Work Location:	New York /Anchorage
Education:	B.S. Civil Engineering 1963, Rutgers University M.S. Foundation Engineering 1965, Rutgers University
Special Qualifications:	FERC Expert Witness Testimony on various hydroelectric license applications. Expert Witness and Testimony on various Nuclear Power Plant Applications and licenses before the USNRC and at ACRS hearings. Numerous publications on Civil and Geotechnical Engineering.
Professional Registrations:	Alaska, Arizona, California, Florida, Georgia, Louisana, Michigan, Minnesota, New Jersey, New York, North Carolina, Pennsylvania, Texas, Virginia, Washington and West Virginia.
Parent Company:	Ebasco Services Incorporated

Experience and Qualifications Relevant to the Susitna Project:

June 1980 to Present: Presently Chief Consulting Civil Engineer in the Corporate Offices of Ebasco in New York City. Mr. Ehasz is responsible for both the technical and administrative direction of approximately fifty experienced Professional Engineers and Registered Geologists. He is responsible to the Vice President for all feasibility and siting studies, advanced engineering and special problems associated with hydroelectric projects and civil features of all power projects.

In late 1980 Mr. Ehasz led a technical review effort of the Bath County PSP for Allegheny Power Corporation. This review was to assess the project design and construction, as well as a review of the cost to complete. During the past eighteen months, Mr. Ehasz has been responsible for technical input and review of various small hydroelectric studies and projects in Alaska. In

particular, the Grant Lake Feasibility & Licensing Project and the review of the technical requirements and construction of the Terror Lake Project.

May 1979 to June 1980: Chief Design Engineer in the Corporate Offices of Ebasco in New York. Mr. Ehasz was responsible for both the technical and administrative direction of approximately five hundred engineers and designers. He was responsible to the Vice President of Engineering for all civil engineering and design associated with hydroelectric, fossil and nuclear power projects.

May 1977 to May 1979: Assistant Chief Civil Engineer, responsible for all geotechnical engineering within Ebasco as well as civil engineering on hydroelectric projects. As head of the geotechnical engineering Mr. Ehasz was responsible for the evaluation of soils and geologic conditions on all power projects and established the final design parameters for various soils and rock foundations, rock tunnels and powerhouse construction.

June 1973 to May 1977: Supervising Civil Engineer, responsible for the supervision of fifteen to twenty soils engineers and lead civil engineers on various power projects. Mr. Ehasz personally was responsible for a unique foundation for a nuclear power plant in Louisiana. This plant is a 1100 MW nuclear power plant located about 20 miles upstream from New Orleans. He evaluated the foundation conditions and was responsible for the final foundation design concept, namely, a "floating foundation". This concept was necessary to minimize settlements and essentially involves balancing the total structure weight with the weight of the soil removed.

During this period Mr. Ehasz also directed the geotechnical investigations and supervised the civil design of the Davis Pumped Storage Project, a 1000 MW Project in West Virginia. He led an intensive rock mechanics program and evaluation to evaluate the potential for utilizing an underground powerhouse at the site. He also had given expert testimony in the FERC Licensing hearings for the Project.

June 1965 to June 1973: Civil Engineer responsible for various hydroelectric project features. Of particular mention with respect to large hydroelectric projects is the foundation related work on two large hydroelectric projects in Turkey. The first project was the Gokcekaya Hydroelectric Project which involved a 500 ft high thin arch dam and 360 MW powerhouse. The

stress conditions were analyzed and the stability analysis was performed which dictated the various fault excavation and treatment beneath the arch dam and thrust blocks. An instrumentation program to monitor the dam and foundation program to monitor the dam and foundation performance was also developed.

The other project was the Keban Dam and Hydroelectric Development in eastern Turkey. The Project involved a 680 ft high earth and rockfill dam, a 350 foot high concrete gravity dam at the intake area and a large spillway. The major problem at the Project was the Karstic limestone foundation. He evaluated the foundation conditions along and beneath the dam and cutoff. Mr. Ehasz performed various stability analyses for the rockfill dam as well as the large gravity dam and spillway. He designed the instrumentation system to monitor the performance of the rockfill dam and the seepage and groundwater conditions throughout the damsite area. During the five years of his association with these two Projects he made 18 trips to Turkey to establish the actual field conditions and adapt the design to the actual foundations. Mr. Ehasz worked with our Resident Engineers and Geologists on the site to complete the Project. Both Projects have been operating successfully since 1975.

During this period Mr. Ehasz also was the responsible geotechnical engineer on the construction of the Ludington Pumped Storage Project. He was instrumental during construction in solving difficult geotechnical construction problems and has led the efforts in monitoring the upper reservoir during first filling. The instrumentation of this Project is unique in that it is one of the few, if not the only, large reservoir where the actual seepage can be measured and related to the design conditions.

Client References:

Project Name: Bath County Project Review
Mr. Ralph Haffner
Director, Power Engineering
Allegheny Power System/Bulk Power Supply
800 Cabin Hill Drive
Greensburg, Pennsylvania 15601
412/838-6761

Mr. Richard Sequin
Plant Manager
Ludington Pumped Storage Plant
RR #1, South Lake Shore Drive
Ludington, Michigan 49431
616/845-6264

Keban & Gokcekaya Hydroelectric Projects
Mr. Refik Akarun
Devlet Su Isleri
Bakanlikar, Ankara, Turkey
Ankara - 90-41-18-1100

Davis Pumped Storage Project
Mr. Ralph Haffner
Director, Power Engineering
Allegheny Power System/Bulk Power Supply
800 Cabin Hill Drive
Greensburg, Pennsylvania 15601
412/838-6761

Waterford Nuclear Power Station
Mr. David Lester, Plant Superintendent
Louisiana Power & Light Company
P. O. Box "B"
Killona, Louisiana 70066
504/467-8211

HARZA-EBASCO

JAMES T. NIKOLAS

Job Title: Internal Review Board - Electrical (Transmission)

Location: Chicago

Education: Master of Science in Electrical Engineering
1958, Illinois Institute of Technology
Bachelor of Science in Electrical and
Mechanical Engineering
1953, Technical University of Athens,
"Ethnikon Metsovion Polytechnion," Greece

Professional Registration: Illinois, Indiana, Massachusetts, South Carolina, Washington and Greece

Parent Company: Harza Engineering Company

Experience and Qualifications Relevant to the Susitna Project:

July 1959 to Date. Harza Engineering Company. Vice President (1978) and Head of Electrical Department (1975). Twenty-five years of experience, primarily in the electrical design of power stations, including two steam and 16 hydroelectric power stations, high voltage substations, and transmission lines. As head of Electrical Department I, he is responsible for departmental administration and staffing, as well as for budgeting, scheduling, and electrical design for all projects assigned to the department. Mr. Nikolas has also served as project manager or assistant project manager for a number of power generation and substation projects.

- 15 High Voltage and Extra High Voltage Substation. Supervised establishment of design criteria, preparation of layouts, design memoranda, plans and specifications, construction drawings, and review of shop drawings for a number of substation project (1967 to present). Representative projects include:

  - 230 kV SF6 gas-insulated substation, Yacyreta Project, Argentina-Paraguay.
  - 230 kV SF6 gas-insulated switchyard, Hrauneyjafoss Project, Iceland.
  - Six 115 kV substations, CEL Third Power Project, El Salvador.
  - Four 400/230 kV substations, Karun EHV Transmission Project, Iran.
  - 400 kV switchyard, Karun River Hydroelectric Project, Iran.
  - 230 kV switchyard and receiving substation, Finchaa Project, Ethiopia.

- Project Manager for the 138/69 kV Duncan Substation Project, Jamaica. Director preparation of plans, specifications, and construction drawings; provided client liaison (1972-74).

- Lead Engineer for the 230 kV Mossyrock Open-Air Switchyard, WA. Developed design criteria, prepared design memoranda, plans and specifications (1964-70).

- Lead Engineer for the 138 kV Karadj Switchyard and Receiving Substation, Iran. Prepared plans, specifications and construction drawings (1959-60).

- Lead engineer for the 138 kV Angat Switchyard, Philippines (1961-64).

- 7 Transmission Line Projects
  Supervised the preparation of design memoranda and plans and specifications for several transmission projects (1967 to present). Representative projects include:
  - 530 kilometers of 500 kV transmission lines, Pakistan.
  - 900 kilometers of 400 kV transmission lines, Karun EHV Transmission Project, Iran.
  - 200 kilometers of 115 kV transmission lines, El Salvador.

- 16 Hydroelectric Generating Station Projects
  Supervised the preparation of electrical design criteria, plans and specifications for a number of hydroelectric generating stations (1967 to present). Representative projects include:
  - 3,000 MW Yacyreta Project, Argentina-Parguay
  - 1,000 MW Karun Project, Iran
  - 300 MW Uribante Project, Venezuela
  - 210 MW Hrauneyjafoss Project, Iceland
  - 180 MW San Lorenzo project, El Salvador
  - 135 MW Cerron Grande Project, El Salvador
  - 100 MW Finchaa project, Ethiopia
  - 80 MW Rio Lindo Project, Honduras
  - 6 MW La Yeguada project, Panama

- Lead electrical engineer responsible for development of design memoranda, preparation of plans and specifications, and review of shop drawings for major electrical equipment for various projects, including:
  - 300 MW Mossyrock Hydroelecric Project, WA (1964-70).
  - 212 MW Angat Hydroelectric Project, Philippines (1961-64).
  - 80 MW Karadj Hydroelectric Project, Iran (1959-60).

- Supervised preparation of designs, plans, and specifications for expansion of three hydroelectric stations (1970 to present):
  - Addition of two 200 MW units at the Boundary Project, WA
  - Addition of one 45 MW unit at the Mayfield Project, WA
  - Addition of two 20 MW units at the Rio Lindo Project, Honduras.

- Project manager for the field acceptance testing of the turbines, governors, and generators of the Malpaso Project, Mexico (1972). Prepared field testing and commissioning procedures, witnessed field tests on major electrical equipment, and director commissioning of the following hydroelectric stations:
  - 300 MW Mossyrock project, Wa (1969-70).
  - 80 MW Karadj Project, Iran (1959-60).

Client References:

1. Yacyreta Hydroelectric Project
   Entidad Binacional Yacyreta (EBY)
   Torre Madero, Pio 20
   Ave. Eduardo Madero 940
   Buenos Aires CP 1106, Argentina
   Ing. Rolando Herron
   Manager, Electrical and Mechanical Engineering
   Tel: 0-11-54-1-361-0038

2. San Lorenzo Project
   Comision Ejecutive Hidroelectrica Del Rio Lempa
   Apartado Postal No. 2669
   San Salvador, El Salvador, C.A.
   Ing. Francisco Granadino
   Executive Director
   Tel: 1-503-223454

3. Hayden-Blue River 345 kV Line
   Tri-State G & T Assoc., Incl.
   12076 Grant Street
   Denver, Colorado 80233
   Adrian Rojas
   Tel: 800-525-0454

HARZA-EBASCO

ROMAN P. WENGLER

Job Title: Internal Review Board - Structural (Transmission)

Location: Chicago

Education:
Master of Science in Civil Engineering, 1954, University of Minnesota
Bachelor of Science in Civil Engineering, 1952, University of Minnesota
Bachelor of Business Administration, 1952, University of Minnesota

Professional Registration:
Professional Engineer - Alaska, California, Colorado, Florida, Illinois
Structural Engineer - Illinois

Parent Company: Harza Engineering Company

Experience and Qualifications Relevant to the Susitna Project:

1954 to Date: Harza Engineering Company. Vice President (1978) and Head, Structural Department (1976).

- Responsible for supervision of three Sections assigned to the Structural Department. These Sections design and prepare drawings for a wide variety of structures including dams, powerhouses, bridges, transmission towers, substations and penstocks.

- Assistant Project Director and Project Manager for the Foothills Project in Colorado. Responsibilities included supervision of the design and preparation of construction drawings for the 300 foot high Strontia Springs Thin Arch Dam.

- Project assignments have progressed from trial load analysis of the 250-ft. Mayfield Arch Dam in Washington through analysis and design of the 178-meter Karadj Arch Dam, Iran; 606-ft. Mossyrock Arch Dam, Washington; and supervision of the design of the 200-meter Reza Shah Kabir Arch Dam, Iran.

- Responsible for overall work on special studies and computer programs utiizing the finite element method for dynamic earthquake analysis and elasto-plastic stress analysis.

- Member of Consulting Board for Farraday Dam, Oregon.

Client References:

1. Starontia Springs Dam
   Mr. Jack Parsons
   Denver Water Department
   1600 West 12th Avenue
   Denver, Colorado 80254
   (303) 623-2500

2. Mossyrock
   Mr. Lynn Larse
   City of Tacoma
   Department of Public Utilities
   P.O. Box 11007
   Tacoma, Washington 98411
   (206) 383-2471

HARZA-EBASCO

JAMES H. THRALL

Job Title:	Internal Review Board - Environmental
Work Location:	Chicago
Education:	Doctor of Philosophy in Biological Sciences, 1972, Illinois State University Master of Science in Biological Sciences, 1967, St. Mary's College Bachelor of Science in Biology, 1964, St. Mary's College
Special Qualifications:	FERC License Applications final technical review
Professional Registration:	Not applicable
Parent Company:	Harza Engineering Company

Experience and Qualifications Relevant to the Susitna Project: 1974 to Date: Senior Aquatic Ecologist and Head, Environmental Sciences Section. Duties are personnel management, new business development, and budget management and final technical review of all environmental assignments carried out by the Company. Responsible for or participated in environmental assessment and impact studies for nine domestic and six foreign hydropower development projects.

- FERC License Studies for the Stony Creek Pennsylvania Pumped Storage Project; evaluated the impacts of reservoir development on trout populations.

- Lead Environmental Scientist, Summersville, West Virginia. Hydropower Development Study COE. Responsible for impact assessment of reservoir water quality and fisheries; downstream flow rates and water temperature effects on fish eries and impacts on white water boating on the lower Gauley River, (a premier white water river). Prepared the Draft Environmental Impact Statement for the Project.

- Lead Scientist, Boundary Dam Hydropower Modification Study (Seattle City Light, Pend Orielle River, Washington). Prepared the FERC Exhibit E. Assisted the client at agency and public meetings to explain project's environmental and socioeconomic impacts.

C EVALUATION CRITERIA
TECHNICAL COMPETENCE
Project One
D.2 Project Two
D.3 Project Three

JAMES H. THRALL

Job Title:	Internal Review Board - Environmental
Work Location:	Chicago
Education:	Doctor of Philosophy in Biological Sciences, 1972, Illinois State University Master of Science in Biological Sciences, 1967, St. Mary's College Bachelor of Science in Biology, 1964, St. Mary's College
Special Qualifications:	FERC License Applications final technical review
Professional Registration:	Not applicable
Parent Company:	Harza Engineering Company

Experience and Qualifications Relevant to the Susitna Project: 1974 to Date: Senior Aquatic Ecologist and Head, Environmental Sciences Section. Duties are personnel management, new business development, and budget management and final technical review of all environmental assignments carried out by the Company. Responsible for or participated in environmental assessment and impact studies for nine domestic and six foreign hydropower development projects.

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- Lead Scientist, Boundary Dam Hydropower Modification Study (Seattle City Light, Pend Orielle River, Washington). Prepared the FERC Exhibit E. Assisted the client at agency and public meetings to explain project's environmental and socioeconomic impacts.

- Managed and provided final technical review for FERC License projects such as Kootenai Falls (Montana), Raystown (Pennsylvania), and Black Bear Lake (Alaska). Responsible for management of the St. Joseph's River Project (Michigan, Indiana), Bethel (Alaska) Energy Development Study and Strontia Springs (Colorado) Hydropower Project.

- Carried out fisheries and aquatic impact assessment studies including experimental fishing and water quality analysis programs for the Sogomoso Project (Colombia), Uribante-Caparo Project (Venezuela), Lower Caroni Project (Venezuela), San Lorenzo Project (El Salvador), Yacyreta and Corpus projects (Argentina and Paraguay).

- Participated in design of fish passage facilities and laboratory facilities to be included in both the Yacyreta and Corpus projects.

- Lead Environmental Scientist for the South Park, Colorado Reservoir Project (Colorado). Directed water quality, fisheries, benthos and in-stream flow studies on Tarryall Creek, site of a proposed 60,000 acre foot storage reservoir to supply the City of Thornton's future water needs. Assisted client at agency and public meetings.

- Supervised preparation of on environmental report for the Bureau of Reclamation on the riverine ecosystems affected by the Garrison Diversion Unit Irrigation Project, North Dakota. Studies focused on impacts of diversion water on terrestrial and aquatic biota, and environmental quality of the receiving streams.

- Supervised the preparation of an environmental assessment report for the 80,000-acre Lake Andes-Wagner Irrigation Development, South Dakota. Evaluated project impacts on terrestrial, aquatic and recreation resources and made recommendations for mitigating.

- Project Manager for the preparation of a technical review of the U.S. Fish and Wildlife Service's impact and mitigation studies for the Garrison Diversion Project. Review comprised assessment of the project's impacts on wetlands, waterfowl and native and introduced fish species.

- Project Manager for the preparation of a technical review of the International Joint Commission's report on the Garrison Diversion Unit. Supervised the technical review report for the Garrison Conservancy District and presented testimony at public hearings held by the International Joint Commission in North Dakota.

- Helped prepare a special report for the Ohio-Kentucky-Indina Regional Planning Commission (Section 208 of the Federal Water Pollution Control Act) on the areawide wastewater management planning and aquatic resources.

1972 to 1974: Fisheries Biologist, Peace Corps, Smithsonian Institute Environmental Program. Worked with the "Instituto de Desarrollo de los Recursos Naturales Renovables" (Colombia), to develop a fish culture program. Engaged in studies of a fresh-water fish, the Sabaleta/(Brycon henni), doing research on its life history and basic ecology. Made limnological studies of El Penal reservoir and on the Porce River, Colombia. Advisor to the staff of INDERENA (a Colombian conservation agency) in the planning of fish culture stations and future fisheries research projects.

1964 to 1966: Assistant Professor and Lecturer, Institute of Medical Technology in Minneapolis, Minnesota.

Client References:

Project Name: Boundary Hydroelectric Project
Seattle Department of Lighting
1015 Third Avenue
Seattle, WA 98104
Mr. Dean Sunquist
(206) 625-3056

Project Name: Garrison Diversion Project
Mr. H. M. Engelhorn
Garrison Congervancy District
P. O. Box 140
Carrington, North Dakota 58421
(701) 652-3194

Project Name: South Park Reservoir Project

Mr. W. F. Ketellapper
Manager of Planning and Research
City of Thornton
Thornton, Colorado 80229
(303) 289-5801

HARZA-EBASCO

DONALD J. DUCK

Job Title:	Internal Review Board - Construction
Work Location:	Chicago
Education:	Bachelor of Science in Civil Engineering 1959, Rose Hulman Instit. of Technology
Special Qualification	Responsible for constructability review - Guri, Uribante, Bath County and TARP.
Professional Registration:	Wisconsin
Parent Company:	Harza Engineering Company

Experience and Qualifications Relevant to the Susitna Project:

1980 to Date: Vice President and Head, Construction Management Department. Responsible for field construction engineering activities. Supervises Resident Engineers assigned to projects in the construction phase. Ultimate responsibility for quality control, quality assurance, cost and schedule monitoring, quantity computation, progress payment and reporting, design change implementation and contract change negotiations. Technically and administratively responsible for central office scheduling, estimating, constructability review of designs, the review and issuance of contract documents, procurement services, contract administration and claims evaluation, and for maintaining a central staff of construction technical specialists. Present major projects in the construction phase include: Guri, Venezuela; Uribante Doradas, Venezuela; Foothills, Denver; Bath County, Virginia; Summer Falls, Washington; San Lorenzo, El Salvador; El Nispero, Honduras; Tunnel and Reservoir Plan, Chicago.

1972 to 1980: Deputy Assistant Commissioner - Engineering and Research. U. S. Bureau of Reclamation.

Shared responsibility for coordinating and directing the design and construction activities for the $600 million per year USBR water resources program. Program included up to ten dams in the construction phase as well as canals, tunnels, pipelines, powerplants, pumping plants, and power transmission facilities.

- Responsible for resolving major construction problems and negotiating major contract disputes.

- Contracting Officer for 125 construction contracts and 62 major equipment supply contracts, totaling $906 million; led team in continuing effort to improve constructability of designs.

- Led and coordinated activities related to the re-evaluation of the seismicity of the Auburn damsite following the Oroville, California earthquake in 1975. Work included contracting for engineering services. Provided briefings for subcommittees of Congress. Participated in selection of structure type for the Auburn damsite following the re-evaluation of seismicity of the area.

- Other major projects with significant involvement include: Crystal Dam, CO; Nambe Falls Dam, NM; Current Creek Dam, UT; Mountain Park Dam, OK; Palmetto Bend Dam, TX; Choke Canyon Dam, TX; Tyzak Dam, UT; Sugarpine Dam, CA; Tiber Dam, MT; Buckskin Mountain Tunnel, AZ; Pacheo Tunnel, CA; Vat and Stillwater Tunnels, UT; Bacon Tunnel, WA.

1967 to 1972: Chief, Field Engineering Division, Grand Coulee Third Powerplant, Grand Coulee, WA. USBB. Responsible for all field construction activities; directed the engineering, inspection, and field control of the contractors' operations including construction safety. Project included modification and relocation of major electrical facilities, one of the most comprehensive controlled-blasting programs associated with a hydro project, tunnel excavation in existing concrete dam by both blasting and non-blasting methods, construction of cellular cofferdams, large concrete gravity dam, and powerplant (3900 MW in six units).

1963 to 1967: Chief, Civil Engineering Division, Yellowtail Dam, Fort Smith, MT., USBR. Responsible for the engineering and inspection of the civil activities of the contractors' operations including safety. Project included diversion tunnel; inclined spillway tunnel; large concrete arch dam; powerplant and four turbine-generating units; and composite embankment and concrete afterbay dam.

1959 to 1963: Supervisory Construction Engineer, Flaming Gorge Dam, Dutch John, UT. USBR responsible for supervising inspection of contractors operations including safety on an assigned shift. Project included a diversion tunnel; inclined spillway

tunnel; large concrete arch dam; and powerplant housing three turbine generating units.

1951 to 1954: Chief of Surveys, Air Installations. USBR. USAF Elmendorf AFB, Alaska. Field surveys for design and construction of both new and rehabilitation roads, railroads, airfields, water, sewer, utilities, and remote radar installations.

Technical Papers:

"Tunnel Excavation-Grand Coulee Third Powerplant," Rapid Excav. and Tunnel. Conf., 1972.

"Safety Requirements Point Way to Versatile Nonelectric Rock Blasting Methods Used at Grand Coulee's Third Powerplant," Reclamation Safety News, 2nd Qtr, 1971.

"Blasting-Mass Concrete Removal-Third Powerplant Forebay," Construction Report, Grand Coulee Third Powerplant.

"Construction of Grand Coulee Third Powerplant," Journal of the Construction Division, ASCE 1975.

"Reclamation and Western Development," Symposium on Inland Waterways for Navigation, Flood Control and Water Diversions, 3rd Ann. Symp. Waterways, Harbors and Coastal Eng. Div. ASCE, Aug. 10-12, 1976.

"Better Contracting for Underground Construction". Participated on Subcommittee No. 4 - Contracting Practices, National Academy of Sciences, U. S. Committee on Tunneling Technology.

Client References:

Project Name: TARP
The Metropolitan Sanitary
District of Chicago
100 E. Erie Street
Chicago, Illinois 60611
Jospeh H. Irons
Ronald A. Newbauer

Frank E. Dalton
(312) 751-5600

Project Name: Bath County Pumped Storage Project
Virginia Electric and Power Company
Powerstation Engineering and Construction
P.O. Box 564
Richmond, Virginia 23204
Mr. J. M. Hagood, Jr.
(804) 771-6103

Project Name: CVG - Electrificacion Del Caroni, C.A.
Direccion Obras de Guri
Apartado No. 62413
Caracas, Venezuela
Dr. Luis Del Rio
Tel 011-582-921155

C EVALUATION CRITERIA
TECHNICAL COMPETENCE

D.1 Project One

D.2 Project Two

D.3 Project Three

PROJECT CONTROL

HARZA-EBASCO

HARZA-EBASCO

MICHAEL J. VARRONE

Job Title:	Lead Engineer - Cost Control
Work Location:	Bellevue
Education:	Adephi University - MBA City College of New York - BE (Civil)
Special Qualifications:	Over 12 years related experience
Professional Registration:	Professional Engineer - New York

Affiliations:

ASCE - Associate Member

Experience and Qualifications Relevant to the Susitna Project:

Registered Professional Engineer with over 12 years experience in civil engineering and cost and schedule control for major hydroelectric and steam electric generating stations. Present responsibilities include engineering and construction planning, scheduling, budgeting, monitoring, analyzing and reporting cost and schedule status both in the home office and at the construction site.

- Previous responsibilities included developing conceptual structural design criteria, reviewing design drawings, coordinating fabrication, erection and construction schedules, preparing and administering structural contracts, obtaining permits, performing shop and field inspections and resolving contract disputes.

Representative Experience:

Ohio Power Company
Racine Hydroelectric Project

Houston Lighting & Power Company
Limestone Steam Electric Station

Washington Public Power Supply System
WNP-3 Nuclear Project

Florida Power & Light Company
St. Lucie Nuclear Project Unit 2

Employment History:

Ebasco Services Incorporated (1980-Present)
Cost/Schedule Control Engineer

American Electric Power Service Corporation
(1974-1980)
Engineer

Consolodated Edison Company of New York
(1970-1974)
Associate Engineer
Assistant Engineer

C EVALUATION CRITERIA
TECHNICAL COMPETENCE

1 Project One

D.2 Project Two

D.3 Project Three

ENVIRONMENTAL AND REGULATORY PROGRAMS

HARZA-EBASCO

HARZA-EBASCO

RICK K. SUTTLE

Job Title: Lead Environmental Scientist

Work Location: Anchorage

Education: Master of Landscape Architecture
1978, University of Michigan
Bachelor of Science in Natural Resources
1975, University of Michigan

Parent Company: Harza Engineering Company

Experience and Qualifications Relevant to the Susitna Project:

May 1978 to Present: Landscape Architect, Land Resources and Environmental Sciences Department. Responsibilities include recreation planning and design, environmental planning and impact analysis, facility siting studies, visual impact assessment, and mine reclamation.

- Black Bear Lake Hydroelectric Project, Alaska. Conducted a visual impact assessment study and developed a recreation plan for Exhibits V and R of the Black Bear Lake FERC License Application. Also conducted a transmission corridor alternative evaluation study as part of Exhibit W. Developed mitigation measures for identified adverse impacts and land management measures for transmission line routing and construction.

- 12th Street Hydroelectric Project, Virginia. Provided an evaluation of the impacts on existing recreation resources and potential for additional recreation associated with the restoration of an existing small hydroelectric site in Richmond, Virginia.

- Summersville Modification Study, West Virginia. Identified and evaluated recreation and aesthetic resources associated with feasibility of adding hydroelectric power to an existing flood control and recreation reservoir. Study included an on-site survey of whitewater boaters to aid in evaluating the potential impacts that alternative flow release patterns might have on whitewater boating. Evaluated potential effects on downstream fishing and developed a conceptual recreation plan. Also probed the effects different reservoir levels would have on reservoir-based recreation activities and resources. Aesthetic study included the evaluation of a river stretch recommended for inclusion into the National Wild and Scenic River System.

- Raystown Hydroelectric Project, Pennsylvania. Developed a recreation plan and cost estimate for Exhibit E of the FERC License Application. Devised mitigation measures to reduce project impacts on existing resources.

- Boundary Dam Hydroelectric Project Expansion, Washington. Developed reports on land use, recreation and aesthetic resources for Exhibit E of the FERC License Application. Studies included descriptions of existing recreational opportunities and use, land use and visual resources, development of a recreation plan, assessment of net effects on visual and recreation resources, and development of land management and resources protection measures.

- Bath County Pumped Storage Project, Virginia. Developed a recreation master plan for the borrow area. Report included an area design concept, area master plan, design details and estimated development costs. Additional studies involved evaluations of recreation demand, need and national trends and their effect on projected recreation use and development of proposed recreation facilities. Additional studies also involved coordination with FERC itself.

- Kootenai River Hydroelectric Project, Montana. Developed a recreation plan and conducted a visual impact assessment study using the U.S. Forest Service's computerized VIEWIT program for Exhibits R and V of a FERC license application. Developed mitigation measures for identified adverse impacts which included shoreline modification and development of flow distribution structures. Also prepared expert witness testimony on recreation and visual resources in support of the client's application for license.

- St. Joseph River Hydroelectric Project, Indiana & Michigan. Performed the analysis of benefits and adverse impacts of hydroelectric development along the St. Joseph River, upon recreation, scenic and historic resources. Studied potential impacts of construction and operation alternatives associated with developing additional generating capacity at five low-head hydroelectric dams for a report to the U.S. Department of Energy. Recommended mitigating measures for identified adverse impacts.

Client References:

Bath County

Mr. Jim Hagood, Jr.
Director of Hydroelectric Engineering
Virginia Electric and Power Company
P. O. Box 564
Richmond, Virginia 23204
804/771-6103

Black Bear Lake	Mr. Brent Petrie, Project Manager Alaska Power Authority 334 West Fifth Avenue Anchorage, Alaska 99501 907/276-0001
Kootenai	Mr. William T. Nordeen, General Manager Northern Lights, Inc. Sandpoint, Idaho 83864 208/263-2163
Raystown	Mr. Robert C. Richert Water Resources Manager GPU Service Corporation P. O. Box 1018 Reading, Pennsylvania 19603 215/921-6545
Summersville	Mr. Gerry Baumgardner U.S. Army Corps of Engineers, Huntington District Huntington, West Virginia 304/529-5639
St. Joseph River	Mr. William Stelle Chief Civil Engineer American Electric Power Service Corporation 2 Broadway New York, New York 10004 212/440-9000
Boundary Dam	Mr. G. Wayne Bishop Director of Civil Engineering City of Seattle - City Light Dept. 1015 Third Avenue Seattle, Washington 98104 206/625-3000

HARZA-EBASCO

RICHARD H. FROEMLING

Job Title:	Permits Coordinator
Work Location:	Anchorage
Education:	Valparaiso University, B.S.-Business Administration Selected Courses in Government Contracts
Special Qualifications:	Involvement on several Alaska Projects; permits, coordination and administration, lands research/acquisition, contracts administration.
Professional Registration:	None
Parent Company:	Frank Moolin & Associates, Inc.

Experience and Qualifications relevant to the Susitna Project:

September, 1980 to Present: As Manager of Land Use Planning for Frank Moolin & Associates in Anchorage, Mr. Froemling serves as a control point in the area of lands authorization and planning for all FMAA project management and engineering contracts. Provides a separate marketable service for lands research, negotiations and other consultative work in the area of land use planning.

- Researched land status for the City of Barrow and surrounding federal and native lands for the North Slope Borough's Barrow Utility System. Planned and managed programs of contacting local native residents for acquisition of appropriate property rights. Conducted negotiations involving numerous lands issues with the Navy, the regional corporation, village corporation, related state and federal agencies and the City of Barrow.

- Was involved in lands status and permit coordination for the Valdez Container Terminal Project. Permit modifications due to design modifications were drafted and forwarded to appropriate agencies.

- Previous to his current position, Mr. Froemling served as Administrative Assistant to the Vice President of Engineering. He was responsible for the formalization of the design and administrative procedures in FMAA's engineering department.

- Mr. Froemling's initial position at FMAA was as Supervisor of Contracts Permits and Permissions. He prepared and administered contractual documents relating to all business endeavors, including those relating to proposals, contracts and subcontracts. He directly coordinated with governmental permitting agencies such as the U.S. Army Corps of Engineers, Bureau of Indian Affairs, Department of the Navy, Department of Natural Resources, Department of Environmental Conservation and Division of Occupational Safety and Health.

  He also created engineering services documents for the Barrow Utilities System project and was involved in contract administration for the Valdez Container Terminal project.

Employment History:

November 1976 to June 1980: Brokers Title Company, Anchorage, Vice President of Title Operations. He directed operations of the title company.

June 1970 to October 1976: Northwest Airlines, Senior Sales Representative.

Client References:

Project Name: Barrow Utilities System Project
Irving Igtanloc, Director of Public Works
North Slope Borough
Barrow, Alaska
(907) 852-2611

HARZA-EBASCO

CHRIS E. LAWSON

Job Title:	Socioeconomics Coordinator
Work Location:	Bellevue
Education:	Western Illinois University, B.S. Geography, 1976 University of Washington, M.A. Geography, 1979
Special Qualifications:	Oregon Energy Facility Siting Council Expert Witness Testimony - 1982
Professional Registration:	None
Parent Company:	Ebasco Services Incorporated

Experience and Qualifications Relevant to the Susitna Project

November 1979 to Present: Presently Senior Associate Resource Planner in the Bellevue, Washington office of Envirosphere Company, a division of Ebasco Services Incorporated. Mr. Lawson has been responsible for performing economic, social, land use, and recreation studies for various environmental projects conducted by Envirosphere.

- Has worked on several water resources projects, including the preparation of the FERC license application Exhibit E for two Puget Sound Power and Light Company hydroelectric projects in Washington. For the Nooksack Falls Project, Mr. Lawson prepared the socioeconomic report and portions of the recreation report, and assisted on the land use and aesthetics reports. Responsibilities for the Sandy Creek Project Exhibit E involved review of the four social science reports. Mr. Lawson also developed the socioeconomic and land use studies for the environmental impact statement on the Ak Chin Water Supply Project in Arizona, undertaken for the U.S. Bureau of Indian Affairs.

- Extensive experience with environmental studies of transmission lines. Mr. Lawson performed several land use and socioeconomic tasks in the preparation of the environmental impact statement for a proposed Pacific Power and Light Company 500 kV transmission line from Eugene to Medford,

Oregon. The EIS was prepared in a third-party role for the U.S. Bureau of Land Management, with the Bonneville Power Administration and Oregon Department of Energy also involved as cooperating parties. Specific project responsibilities included participation in routing studies, technical investigations of agricultural, forestry, floodplain and socioeconomic (including human health) impacts, preparation of EIS sections for these elements, and expert witness testimony before the state siting council. Mr. Lawson also conducted socioeconomic studies and assisted on the forestry and agriculture studies for an EIS on a proposed Bonneville Power Administration 230 kV power line in the Flathead Valley area of Montana, and had a major role in a study of non-transmission line alternatives to this project.

- Assigned primary responsibility for several major components of a socioeconomic study performed for a client seeking to relocate a large work force in Montana (client confidential). The project required Envirosphere to recommend a course of action on the basis of analyses of baseline economic, social, demographic, political, public service and related conditions; the potential socioeconomic impacts resulting from relocating several hundred workers, and hiring more in the local community; and location-sensitive business cost factors.

- Much of Mr. Lawson's experience has concerned public land management and planning efforts. He was responsible for the economic, demographic and forest use components of socioeconomic overviews of the Mt. Baker-Snoqualmie and Colville National Forests in Washington, prepared for the U.S. Forest Service. Similar project work involved participation on a socioeconomic overview of the Wenatchee National Forest in Washington, baseline socioeconomic characterization for a Bureau of Indian Affairs forest management plan for the Hoopa Indian Reservation in northern California, and studies of the economic effects of proposed timber management changes for Bureau of Land Management lands in western Oregon.

August 1979 to November 1979: Mr. Lawson served in the research division of the Washington Department of Commerce and Economic Development, performing a variety of research and public contact tasks. He assisted the division's economists in revision of the Washington Projection and Simulation Model, including research on major construction projects in the state and future trends in

the agriculture and forest products sectors. Mr. Lawson also prepared briefing papers on socioeconomic conditions of various areas of the state for the governor and department officials, and responded to agency, business and citizen requests for economic information on Washington State.

June 1978 to September 1978: Mr. Lawson was an administrative intern with the research division of the Washington Department of Commerce and Economic Department. His major responsibility was to prepare a review of local economic development plans and economic assessments for regional subdivisions of the state.

September 1976 to August 1977: Mr. Lawson served as a planner on the staff of the Western Illinois Regional Council. This experience involved providing technical assistance to local governments; developing grant applications; preparing regional land use, housing and manpower reports; conducting a water rate study for a municipal system; and performing A-95 reviews.

Client References:

Project Name: Nooksack Falls Project, Sandy Creek Project
Terry Oxley
Puget Sound Power and Light Company
10608 N.E. Fourth Street
Bellevue, Washington 98004
(206) 454-6363

Project Name: Ak Chin Water Supply Project
James R. Crowther
U.S. Bureau of Indian Affairs
3030 North Central Avenue
Phoenix, Arizona 85012
(602) 241-2275

Project Name: Eugene-Medford 500 kV Transmission Line
Ron Smith
U.S. Bureau of Land Management
P.O. Box 2965
Portland, Oregon 97208
(503) 231-6951

Project Name: Flathead Valley Reinforcement Project
Judy Woodward
Bonneville Power Administration
825 N.E. Multnomah Street

Socioeconomics Coordinator

Portland, Oregon 97208
(503) 230-4997

Project Name: Mt. Baker-Snoqualmie, Colville, Wenatchee National Forest
Forest Socioeconomic Overviews
Arnold Holden
U.S. Forest Service, Region 6
319 S.W. Pine Street
Portland, Oregon 97201
(503) 221-2877

Project Name: BLM Timber Management Study
Robert Vincent (representing the Association of Oregon and California Counties)
176 Evergreen Road
Philomath, Oregon 97370
(503) 929-5635

DONALD L. BEYER

Job Title: Aquatics Scientist

Work Location: Bellevue

Education:
Ph.D., University of Washington, 1977, Fisheries Science
M.S., University of Washington, 1973, Fisheries Science
B.S., Oregon State University, 1970, Fisheries Science

Professional Affiliations:
American Institute of Fishery Research Biologists
American Fisheries Society
Pacific Fisheries Biologists
American Association of the Advancement of Science
American Water Resources Association

Special Qualifications: Over twelve years experience including: transmission line siting; design and coordination of aquatic monitoring programs and studies; stream ecology and aquatic habitat assessment; aquatic toxicology; hydroelectric and thermal generating plant licensing and environmental impact statements and assessments.

Parent Company: Ebasco Services Incorporated

Experience and Qualifications Relevant to the Susitna Project

Senior Aquatic Ecologist, Bellevue Office of Envirosphere Company, a division of Ebasco Services Incorporated. (Since 1978).

Responsibilities have encompassed the design, coordination and involvement in numerous environmental programs and licensing efforts including: environmental impact statements for transmission line routing; license applications for small hydro facilities in the Pacific Northwest and Alaska; National Pollutant Discharge Elimination System permits and railroad corridor siting; and impact analysis of energy-related projects on ecosystems. Recent efforts have included studies on water quality problems in Grays Harbor, Washington; impacts of siltation on the aquatic resources of specific streams in Grays Harbor County; log storage effects on the Columbia River; impact prediction for cooling water withdrawal from the Chehalis River; and presentation of testimony to the Washington State Energy Facility Site Evaluation Council in defense of the Washington Public Power Supply System's fisheries monitoring program in relation to NPDES modifications. Also, Dr. Beyer has completed the field techniques,

computer techniques, and negotiation courses involving the U.S. Fish and Wildlife Service Instream Flow Incremental Methodology. He has applied this methodology (IFG) to several streams in the Pacific Northwest to assess instream flow requirements.

Employment History:

University of Washington
Fisheries Research Institute
Fisheries Biologist (1 year)

Responsibilities included design and coordination of activities on three studies: (1) environmental impact of drilling fluid discharges from an offshore drilling operation; (2) effects of simulated cooling tower blowdown on salmonids; (3) effects of a polyelectrolyte (used to remove suspended sediments from water) on salmonids; and (4) effects of copper, zinc, and other cooling system corrosion products on salmonids. The drilling fluids study was conducted on a drilling rig in lower Cook Inlet, Alaska; the other studies were conducted at the Fisheries Research Institute, University of Washington.

Research Assistant (3 years)

Responsibilities included planning and conducting experiments with a hyperbaric chamber and associated electronic gas concentration monitors, including analysis and presentation of data. Additional studies included bioassays of smelter wastes, surveys of marine organisms at a slag fill site, investigation of algicide-related fish kills, and resumption of feeding by steelhead (Salmo gairdneri) following spawning.

Research Assistant (3 years)

Responsibilities included planning and coordinating a study on the effects of salmon cannery waste on water quality and intertidal organisms in relation to canneries at Petersburg, Alaska; bioassays (with salmonids) of salmon cannery waste; and analysis and presentation of data.

Environmental Impact Statements and Licensing Efforts

- Eugene-Medford Transmission Line Environmental Impact Statement, U.S. Department of Interior, Bureau of Land Management
- Flathead Valley Transmission Line Environmental Impact Statement, Bonneville Power Administration

- Navajo Railroad Environmental Impact Statement, Con Paso Coal Company.
- Washington Public Power Supply System National Pollutant Discharge Elimination System Permit Submittal and Hearings.
- Nooksack Falls Hydroelectric Project License Application to the Federal Energy Regulatory Commission, Puget Sound Power and Light Company.
- Sandy Creek Hydroelectric Project License Application to the Federal Energy Regulatory Commission, Puget Sound Power and Light Company.
- Grant Lake Hydroelectric Project License Application to the Federal Energy Regulatory Commission, Alaska Power Authority.
- White Salmon River Hydroelectric Project Fish and Wildlife Study Plan submitted to the Federal Energy Regulatory Commission, Klickitat County Public Utility District.

2277B

HARZA-EBASCO

RONALD L. FAIRBANKS

Job Title: Terrestrial Biologist

Work Location: Bellevue

Education:
M.S., University of Washington, 1979, Wildlife Ecology and Biostatistics
B.S., University of Washington, 1972, Wildlife Sciences

Professional Affiliations:
Northwest Scientific Association
Pacific Northwest Bird and Mammal Society
The Wildlife Society
Xi Sigma Pi National Forestry Honor Society
Certified Wildlife Biologist, the Wildlife Society
Certified SCUBA Diver, Professional Association of Diving Instructors

Special Qualifications: Nine years experience in the design, coordination, and conduct of comprehensive environmental monitoring programs, ecological research, and ecological inventories, including Environmental Impact Statements for EHV transmission line projects.

Parent Company: Ebasco Services Incorporated

Experience and Qualifications Relevant to the Susitna Project:

Principal Wildlife Biolgist/Environmental Program Manager, Bellevue Office of Envirosphere Company, a division of Ebasco Services Incorporated (since 1976).

Responsibilities are distributed over a variety of projects that include supervising:

- Vegetation and wildlife field studies and the preparation of those respective sections of Exhibit E of the FERC license application for the Grant Lake Hydroelectric Project, Alaska, for the Alaska Power Authority.
- All biological studies and the preparation of the biological sections of a Study Documentation Report, including a Wetlands Assessment, and Environmental Impact Statement for a 230 kV transmission line project in northwestern Montana for Bonneville Power Administration.

- All biological studies and the preparation of the biological sections of a Technical Investigations Report and Environmental Impact Statement for a 500 kV transmission line project in southwestern Oregon for the Bureau of Land Management. This was a third party EIS sponsored by Pacific Power and Light Company.

- Preparation of terrestrial ecology impact assessments for a wide variety of electrical power generation alternatives throughout the Railbelt region of Alaska for Battelle.

And program managing:

- Of an extensive environmental monitoring program associated with Washington Public Power Supply Nuclear Projects 3 and 5 in southwestern Washington for 2 years. Program involved field and laboratory studies of water quality, aquatic ecology, terrestrial ecology, and air quality and required a full-time staff of approximately five scientists and technicians.

- For an evaluation of the effects on wildlife of wilderness versus multiple-use management of a forested watershed in western Oregon, for review of wildlife-forestry conflicts associated with a Bureau of Land Management Plan in southwestern Oregon, and for the preparation of an annotated bibliography on Roosevelt Elk.

Also participated and reviewed studies concerning the utilization of shrub-dominated habitats by wildlife in a proposed strip mine expansion area in southeastern Montana.

Performed assessments of the impacts on vegetation and wildlife of a wide variety of electrical power generation alternatives in southcentral Alaska.

Field Supervisor (2 years)

Responsible for supervision and implementation of ecological field studies in connection with the Washington Public Power Supply System Nuclear Projects 3 and 5 in southwestern Washington. These studies included extensive ecological sampling of aquatic and terrestrial ecosystems, water quality monitoring, toxicity experimentation, as well as special field studies such as ultrasonic tracking of salmonids. Responsible for review of baseline wildlife studies conducted for the B.C. Hydro and Power Authority Environmental Report concerning a proposed coal-fired power plant near Hat Creek, British Columbia.

Employment History:

Rocky Mountain Arsenal, Department of Army
Ecosystems Analysis Division
Biostatistician (1 year)

Responsible for: design and implementation of an ecological sampling program to determine population sizes, habitat preferences and reproductive success of terrestrial and aquatic vertebrates and some invertebrates, and the distribution of vegetation on Rocky Mountain Arsenal; design of the sampling program for pesticides, heavy metals and other contaminants in soil and plant and animal tissue. Wildlife species emphasized in these studies included mule deer, small mammals, hawks and owls, waterfowl, and songbirds.

John Graham and Company
Environmental Studies Group
Terrestrial Ecologist (1 year)

Responsibilities included studies for a variety of environmental impact assessments and natural resource inventories. Major projects included: environmental impact assessments for proposed developments in Washington State; operation and maintenance of Fern Ridge Reservoir, a Corps of Engineers project in western Oregon; and natural resource inventories for the Chena River Lakes and John Day Lock and Dam Master Plans, both Corps of Engineers projects on the Chena and Tanana Rivers (Alaska) and the Columbia River (Washington and Oregon), respectively.

As an independent contractor, analyzed six years of data and prepared a report presenting a review of procedures from a deer population monitoring program for the Washington Department of Game; conducted an ecological survey of a western Washington site and prepared a report describing ecological conditions and ecological impacts of proposed development for the Quadrant Corporation, A Weyerhaeuser Company.

University of Washington
Center for Quantitative Science in Fisheries, Forestry and Wildlife
Teaching Assistant (1 year)

Responsibilities included teaching and lecturing for undergraduate biostatistics courses.

University of Washington
College of Forest Resources, Wildlife Science Department
Research Assistant (1 year)

Evaluated deer and elk census methods in western Washington, participated in a radio-tracking study of elk movements, developed an index of deer abundance based on road-kills and took part in a variety of other wildlife field studies. These projects included the biotic survey of Ross Lake, I.B.P. study of the Cedar River watershed, and various projects with the Washington Department of Game.

2277B

HARZA-EBASCO

J. THOMAS ATKINS

Job Title: Land Use Specialist

Work Location: Seattle

Education: Master of Landscape Architecture
1972, University of Pennsylvania
Bachelor of Landscape Architecture
1968, Louisiana State University

Special Qualifications: Land use impact assessment, preparation of impact statements, zoning and land ownership studies, visual resource management, expert testimony. Former resident of Alaska.

Professional Registration: Landscape Architect -- Washington, 1982
Pennsylvania, 1974

Parent Company: Jones & Jones

Experience and Qualifications Relevant to the Susitna project:

November 1979 to Present: Became principal, Jones & Jones, Seattle, in 1982. Responsibilities include development and management of land use/environmental studies, visual impact management programs and impact statements of utility pipelines, transmission lines and water quality planning studies. Also responsible for the preparation of prefiled and expert testimony. In addition, responsible for several land use and recreation development projects.

January 1977 to October 1979: Senior Landscape Architect and Environmental Planner, Wallace McHarg Roberts and Rodd, Philadelphia. Responsbilities included development and management of large scale land use plans, impact statements, zoning studies, recreation plans and environmental park plans.

January 1976 to January 1977: Director of Planning, R & M Consultants, Inc., Anchorage, Alaska. Responsbilities included management of the Planning Department, development and project management of energy conservation studies, and land use plans, recreation feasibilities studies, and the development of land use planning guidelines for a series of land parcels to be selected by a Native Alaskan Group.

January 1975 to January 1976: Visual Resource Management Program Consultant - Trans Alaskan Pipeline System, The Collins, DuTot Partnership, Anchorage, Alaska. Project Manager for firm's involvement in the visual impact assessment and amelioration recommendations related to the TAPS project.

June 1968 to January 1975: Partner, The Collins DuTot Partnerships. Became Partner in 1973. Responsibilities included project management and development for a range of large scale environmental planning and land use studies. In addition, responsible for several project scale land use and recreation plans.

- Northwest Alaska Gas Pipeline. Project manager and field coordinator for the development of the Visual Resource Management Program Phases 1 and 2. Phase 1 involved a field survey of the visual resources along the 750 mile corridor from Prudhoe Bay to the Canadian border. Phase 2 involved the field assessment and design recommendations of material and disposal sites along the corridor.

- Trans Alaska Pipeline System. Project Manager for the firm's invovlement in the Visual Impact Engineering Program for Alyeska. The program involved the visual impact assessment and restoration recommendations for a series of sites along the corridor from Dietrich Camp to Valdez.

- MANDAN Transmission Project, South Dakota and Nebraska. Project manager of the recreation and visual resource assessment of a 500 kV transmission line. Development of a recreation assessment, viewshed mapping and photosimulations assisted in the development of prefiled testimony, rebuttal testimony and cross examination questions.

- Vegetation Management Program EIS. Principal-in-charge of land-use, recreation and visual resource elements for a Generic EIS for Transmission Facilities within the BPA System, as subconsultant to Jones and Stokes.

- Flathead Transmission Reinforcement Project, Montana. Project manager of the land-use, recreation, and visual resource portions of a 230 kV transmission line project EIS, as subconsultant to Envirosphere.

- Colville 208 Water Quality Plan, Washington. Principal-in-charge of land use, future plans and sensitive environments portion of the 208 Water Quality Plan which included the formulation of Best Management Practices for the Colvile Confederated Tribes Reservation, as a subconsultant to J.M. Montgomery Engineers, Inc.

- Lake Washington/Green River Basins Wastewater Management Study, Washington. Project manager for the land use, land ownership, zoning and baseline environmental conditions elements of the Renton 201 Plan. The work was performed as a joint venture with Brown and Caldwell.

Client References:

1. Alaska Gas Pipeline
   Mr. Robert Sibley
   Fluor Northwest Inc.
   c/o Fluor Engineers & Constructors, Inc.
   3333 Michelson Drive
   Irvine, California 92730
   (714) 966-3469

2. Trans Alaska Pipeine System
   Mr. James W. Rooney
   Partner
   R & M Consultants, Inc.
   19700 Fairchild
   Suite 180
   Irvine, California 92715
   (714) 833-0843

3. MANDAN
   Mr. William A. Merrill
   Division Manager
   Transmission and Distribution Projects
   1414 15th Street
   Columbus, Nebraska 68601
   (402) 563-5200

4. Vegetation Management
   Mr. Michael Berg
   Project Manager
   Bonneville Power Administration
   1002 N.E. holladay
   Portland, Oregon 97232
   (503) 230-3071

5. Flathead
   Ms. Judy Woodward
   Project Manager
   Bonneville Power Administration
   P.O. Box 3621
   Portland, Oregon 97209
   (503) 230-4997

6. Colville 208
   Mr. Rick Richens
   Project Manager
   J. M. Montgomery Engineers
   1201 Vista Avenue
   Boise, Idaho 83705
   (208) 345-5865

7. Lake Washington
Mr. John Lesniak
Supervisor
Facilities Planning Division
821 2nd Avenue
Seattle, Washington 98104
(206) 447-5881

2264B

HARZA-EBASCO

RICHARD C. ACKER

Job Title:	Geologist/Soils
Location:	Bellevue
Education:	Master of Science in Geology, 1950, Brown University Bachelor of Arts in Geology, 1947, Williams College
Special Qualifications:	Geologist assigned to Bellevue Office for Susitna Project. Corps of Engineers special studies of foundations in permafrost.
Professional Registration:	Registered Professional Geologist - California Registered Engineering Geologist - California

Parent Company: Harza Engineering Company

Experience and Qualifications Relevant to the Susitna Project:

November 1973 to Date: Head, Geology Section, Geotechnical Department. Directs geologic investigations which comprise core borings; in-hole permeability testing; down-hole geophysical surveys; surface geophysical surveys; exploratory adits; insitu tests in adits, chambers, and boreholes; hydrogeologic exploration; and seismic test evaluation for many of the Company's major projects.

- Rockfill Dams. Patia site 405, Colombia; feasibility investigations for 840 ft. high rockfill dam. Nader Shah Dam, Iran; feasibility and design investigations, for 480 ft. high rockfill dam and preparation of contract documents. Sogamoso Project, Colombia; feasibility investigations for 945 ft. high rockfill dam. Maqarin Project, Jordan; feasibility and design investigations for 495 ft. high rockfill dam and preparation of contract documents. La Honda Dam, Venezuela; feasibility and design investigations for 390 ft. high rockfill dam and preparation of contract documents. Project under construction.

- Arch Dams. Reza Shah Kabir Arch Dam, Iran; feasibility and design investigations for 600 ft. high dam, preparation of

HARZA-EBASCO

RICHARD C. ACKER

Job Title:	Geologist/Soils
Location:	Bellevue
Education:	Master of Science in Geology, 1950, Brown University Bachelor of Arts in Geology, 1947, Williams College
Special Qualifications:	Geologist assigned to Bellevue Office for Susitna Project. Corps of Engineers special studies of foundations in permafrost.
Professional Registration:	Registered Professional Geologist - California Registered Engineering Geologist - California
Parent Company:	Harza Engineering Company

Experience and Qualifications Relevant to the Susitna Project:

November 1973 to Date: Head, Geology Section, Geotechnical Department. Directs geologic investigations which comprise core borings; in-hole permeability testing; down-hole geophysical surveys; surface geophysical surveys; exploratory adits; insitu tests in adits, chambers, and boreholes; hydrogeologic exploration; and seismic test evaluation for many of the Company's major projects.

- Rockfill Dams. Patia site 405, Colombia; feasibility investigations for 840 ft. high rockfill dam. Nader Shah Dam, Iran; feasibility and design investigations, for 480 ft. high rockfill dam and preparation of contract documents. Sogamoso Project, Colombia; feasibility investigations for 945 ft. high rockfill dam. Maqarin Project, Jordan; feasibility and design investigations for 495 ft. high rockfill dam and preparation of contract documents. La Honda Dam, Venezuela; feasibility and design investigations for 390 ft. high rockfill dam and preparation of contract documents. Project under construction.

- Arch Dams. Reza Shah Kabir Arch Dam, Iran; feasibility and design investigations for 600 ft. high dam, preparation of

contract documents and construction surveillance. Project operating. Strontia Springs Arch Dam, Colorado; feasibility and design investigations for 300 ft. high dam, preparation of contract documents and surveillance during construction. Project complete October, 1982. Southpark Reservoir Project, Colorado; prefeasibility and feasibility investigations for 270 ft. high arch dam.

o Underground Projects. TARP Project, Chicago; feasibility investigations for 120 mile long tunnel and reservoir complex. Geologic monitoring during construction nearly completed of initial 21.5 mile mainstream segment. Includes tunnels 20 to 35 ft. in diameter and underground pumping chambers 63 ft. wide, 213 ft. long and 105 ft. high. Blue Mountain Water Supply Project, Jamaica; prefeasibility investigations for 29 mile long tunnel and reservoir complex. Feasibility investigations for initial 10 mile tunnel reach. Mt. Hope Project, New Jersey; geologic studies for planning development of an underground hydro or compressed air energy storage facility utilizing existing deep mine openings. Northwestern Illinois Project; prefeasibility investigations including three deep core borings (to 5500 ft.) and extensive borehole in-situ tests for potential 2000 MW - 3000 MW underground hydro development.

June 1967 to November 1973: Head, Geology Department, Geotechnical Division.

Major projects completed by the department included Reza Shah Kabir Dam, Iran (feasibility and design investigation and studies of 650-foot high arch dam); St. Lawrence Basin Appraisal Studies (18 damsites); Rio Grande River Basin, Bolivia (damsite appraisal studies); Blue Mountains Water Supply Project, Jamaica (appraisal and feasibility studies for diversion dams and 29 mile tunnel complex); Chicago North Side Rock Tunnel (feasibility investigations 120 mile rock tunnel complex); Patia River Basin, Colombia (appraisal of 28 damsites, prefeasibility investigation of five damsites, and feasibility study of 850-foot high rockfill dam); Nader Shah Dam, Iran (design investigations for 480-foot high rockfill dam); Gavin Fly Ash Dam and Reservoir (site selection and design studies); and Foothills Project, Site No. 3, Colorado (feasibility studies of 265-foot high arch dam).

August 1966 to June 1967: Geologist, Indus Basin Division. Responsibilities included review of geologic investigations and reports, design drawings and specifications for West Pakistan

water development projects; report writing; and technical assistance to Pakistan field staff.

February 1962 to August 1966: Principal Geologist and Chief, Geology and Materials Branch, Harza Engineering Company International, Lahore, Pakistan. Projects included Karachi Irrigation Project, Hub Dam (Earth); Khanpur Irrigation Project, Khanpur Dam (Earth); Gomal Irrigation and Hydro Project, Khajure Kach Dam (Gravity); Kachhi Plains (Sibi-Jhatpat) Projects; Kabul-Swat-Chitral Basin Reconnaissance Report; Tarbela Dam Project (Rockfill); Central Aggregate Contract, IBP Geological Investigation (mapping and report of Bulland Hill Quarry); Chasma Barrage Project; and Mangla Dam Project (Earth).

November 1956 to February 1962: District Geologist and Assistant to Chief. U.S. Corps of Engineers, New York, New York, Paving, Foundations and Materials Branch. Responsibilities included all geologic work relative to siting, foundation and materials investigations, design, construction and maintenance of structures, paving and water supply for nine military airfields and a widespread radar/communications network. Preparation and review of geologic reports, foundation designs and contract documents. Special studies of foundations in permafrost. Surveillance of foundation work, aggregate and quarry control during construction. Projects included DEW line, Southeast Extension; DEW line, Eastward Extension; NIKE sites,

Thule, Greenland; Ballistic Missile Early Warning Site (BMEWS), Thule; Ballistic Missile Early Warning Site (BMEWS), Alaska.
November 1950 to November 1956: District Geologist, U. S. Corps of Engineers, Baltimore, Maryland.
September 1947 to February 1950: Graduate Teaching Assistant. Brown University, Providence, Rhode Island.
June to September 1948: Geological Assistant to Mine Superintendent, R. T. Vanderbilt, Inc., Ralmat, New York.
August 1945 to November 1946: Geologist, U.S. Corps of Engineers, Ft. Belvoir, Virginia.

Technical Papers: "Rock Mechanics Studies for Mossyrock Arch Dam," with D. E. Kleiner, ASCE, Power Journal, January 1971.

"Foundation and Abutment Treatment for High Rockfill Dams," with Jack C. Jones, ASCE Journal Soil Mechanics and Foundations Division, October 1972.

"Geohydrologic Monitoring, Karun River Dam, Iran," with J. A. Scoville and M. Saines, Proceedings of the Tenth International Conference on Soil Mechanics and Foundation Engineering.

Client References:

Project Name: TARP
The Metropolitan Sanitary
District of Chicago
100 E. Erie Street
Chicago, Illinois 60611
Joseph H. Irons
Ronald A. Neubauer
Frank E. Dalton
(312) 751-5600

Project Name: Strontia Springs Arch Dam
Mr. Jack Parsons
Denver Water Department
1600 West 12th Avenue
Denver, Colorado 80254
(303) 623-2500

HARZA-EBASCO

KAROL A. ERICKSON

Job Title: Water Resources Specialist

Work Location: Bellevue, Washington

Education: University of Washington, MSE
Civil Engineering, Water Resources Divsion: 1982
University of Minnesota BS
Geology: 1978

Special Qualifications: Four year experience in hydrology, reservoir management, and water resources engineering

Professional Registration: EIT, Washington State

Parent Company: Ebasco Services Incorporated

Experience and Qualifications Relevant to the Susitna Project:

January 1982 to Present: Ms. Erickson recently completed water resource evaluations for two transmission line studies, the Flathead Valley Reinforcemnt Project (for Bonneville Power Administration) and the Eugene-Medford 500 kV transmission line (for the Bureau of Land Management). Analytical models were used to predict post-project sediment yield associated with transmission line construction.

Ms. Erickson is responsible for hydrologic and water resource investigations associated with energy, water supply, and industrial facility development. Recent projects have included a detailed evaluation of water resource impacts, including hydrology, water quality and water use, associated with a hydropower facility on the Kenai Peninsula in Alaska. Responsibilities included field reconnaissance and data collection, interpretation and analysis of water quality and hydrology data, and management of subconsultants in the area of water quality data collection.

Previous projects included a detailed hydrologic impact evaluation of five surface and subsurface coal mines in eastern Oklahoma. Mining permit applications were reviewed in terms of changes in the drainage patterns, adequacy of drainage berms, channels and sedimentation ponds, and changes in discharge water quality.

Ms. Erickson has served as lead Water Resource Engineer in charge of water quality monitoring and analysis for a salt water marina located in Birch Bay, Washington. Responsibilities included water quality data collection and analysis. Ms. Erickson also served as Assistant Project Manager for preparation of the Exhibit E of a license application for a hydropower plant in western Washington. Ms. Erickson was responsible for supervising the preparation of hydrology, water quality, and water use sections.

1979 to 1981: University of Washington, Civil Engineering Department
Research Engineer

Ms. Erickson developed a computerized reservoir simulation model for the Cedar/Tolt Water Supply System, including a predictive model of reservoir inflow for a range of forecast periods and probability levels, for the Seattle, Washington Water Department. As part of model development, extensive analyses of water demands and water use patterns were performed. Model input preparation included detailed precipitation and temperature compilations, adjusted for elevation and location.

Other studies included streamflow forecasting and flood hazard analyses using a computerized rainfall/runoff model.

1978 to 1979: Minnesota State Planning Agency Planner

Ms. Erickson prepared computer-generated development suitability maps depicting soil characteristics, land use, and water features, including wetlands and drainage patterns. She also assisted in a detailed groundwater-lake interaction study, including well water-level monitoring, in cooperation with the U.S. Geological Survey.

Minnesota Health Department Chemists Aid

Projects included an aquifer water quality study consisting of well and stream sampling and laboratory analysis for nutrient concentrations.

Publications and Presentations

Erickson, K., R. Palmer, and D. Lettenmaier. 1982. An Interactive Simulation Model for the Cedar/Tolt Water Supply System. Harris Hydraulics Report No. 73, University of Washington, College of Engineering, Seattle.

Erickson, K. 1980. Assessment of Runoff Response Changes in the Upper Cowlitz River Basin Related to Mt. St. Helens Ash Deposition. Presentation to the American Geophysical Union, San Francisco.

Lettenmaier, D., K. Erickson, and D. Parkinson. 1980. Evaluation of Snowmelt Forecasting Methods. Harris Hydraulics Report No. 68, University of Washington, Collge of Engineerng, Seattle.

Client References:

Project Name: Eugene-Medford 500 kV Transmission Line
Roland Smith
Bureau of Land Management
825 NE Multnomah
P. O. Box 2965
Portland, Oregon 97208
(503) 231-6950

Project Name: Flathead Valley Reinforcement Project
Judy Woodward
Bonneville Power Administration
825 NE Multnomah
Lloyd Tower, 18th floor
Portland, OR 97232
(503) 230-5756

Project Name: Grant Lake Hydroelectric Project
Eric Marchegiani
Alaska Power Authority
334 West Fifth Avenue
Anchorage, Alaska 99501
(907) 276-0001

Project Name: Sandy Creek Hydroelectric Project
Larry Tornberg
Puget Sound Power and Light Company
Puget Power Building
Bellevue, Washington 98009
(206) 454-6363

Project Name: Birch Bay Village Marine Monitoring Project
Frank Bradley
8201 Cowichan Road
Blaine, Washington 98230
(206) 332-6386

HARZA-EBASCO

WILLIAM G. E. BLAIR

Job Title: Visual/Graphics Consultant

Work Location: Seattle

Education: Master of Landscape Architecture
1974, Harvard University
Bachelor of Architecture, cum laude
1968, University of Washington

Special Qualifications: Visual impact assessment, preparation of photo-simulations, public response testing, expert testimony in contested proceedings

Professional Registration: Architect -- Massachusetts, 1974;
Washington (reciprocity pending)

Parent Company: Jones & Jones

Experience and Qualifications Relevant to the Susitna project:

January 1979 to Present: Principal, Jones & Jones. Responsibilities include development and management of environmental studies of hydroelectric projects, transmission lines, highways, and port facilities. Also responsible for preparation and presentation of expert testimony in permit, license, and court hearings for these facilities.

May 1978 to January 1979 and July 1974 to April 1977: Regional Planner and Architect, Jones & Jones. Responsibilities included performance and project management of siting and environmental studies for energy and transportation facilities. Also responsible for development and instruction of national training courses on visual resource management.

April 1977 to May 1978: Regional Planner, Kramer, Chin & Mayo, Inc. Responsiblities included preparation of comprehensive land-use plan and comprehensive parks and recreation plan for Kodiak Borough, Alaska.

- Susitna Hydroelectric Project, Alaska. Project manager and principal author of inventory and evaluation of the environmental, aesthetic, and recreation resources of the Upper Susitna River. Assessed the effects of feasibility-level, four-dam project on these resources, including dams located at the Devil Canyon, Watana, Vee, and Denali sites.

- Bradley Lake Hydroelectric Project, Alaska. Project manager and principal author of environmental assessment of feasibility-level design for diversion structures, dam, powerhouse, and 230kV transmission corridor from Homer to Anchorage.

- Libby Integration Transmission, Idaho and Montana. Developed generalized procedure for measuring the visual impact of high-voltage transmission facilities for corridor-level studies in the Pacific Northwest. Conducted public response studies to test visual compatibility of transmission structures and ROW with characteristic landscape types and differential sensitivity of viewer groups. Applied procedure to routing studies for 230 kV transmission for additional generation at Libby Dam.

- Klamath Basin Transmission, Oregon. Conducted land-use, recreation, and visual studies for controversial 500 kV transmission through urban, suburban, and rural areas in Klamath Basin. Identified alternative routes and assessed environmental effects. Presented expert testimony (the line has been constructed on one of the routes identified).

- Northwest Alaska Gas Pipeline. Principal-in-charge of development of Visual Resource Management program, as subconsultant to Fluor. Participated in field survey of visual resources along corridor from Fairbanks to the Canadian border. Participated in development of reclamation plans for individual impact sites.

- MANDAN Transmission Project, South Dakota ad Nebraska. Principal-in-charge of assessment of impacts of 500 kV transmission on recreation and visual resources in Gavins Point Dam area (Missouri National Recreation River). Developed photo-simulations and presented expert testimony in hotly contested South Dakota permit proceedings.

- Flathead Transmission Reinforcement, Montana. Principal-in-charge of land-use, recreation, and visual resource portions of EIS on 230 kV transmission project, as subconsultant to Envirosphere.

- Eugene-Medford Transmission, Oregon. Principal-in-charge of land-use, recreation, and visual resource portions of third-party EIS on 500 KV transmission project, as subconsultant to Envirosphere. Participated in definition of route alternatives in urban areas. Presented expert testimony in state siting hearings.

- Substation Visual Simulation Techniques. Developed, wrote, and illustrated a handbook on alternative techniques for simulating the visual appearance of 115 kV, 230 kV and 500 kV substations in the Pacific Northwest. Report stresses "how-to" aspects, including time and cost information.

Client References:

1. Susitna/Bradley Lake
   Mr. William Gabriel
   Division of Resources
   Alaska State Office, Bureau of Land Management
   (formerly Chief of Environmental Section, Alaska Division, Corps of Engineers)
   (907) 271-5069

2. Libby Dam
   Mr. Timothy J. Murray
   Environmental Specialist
   Bonneville Power Administration
   P. O. Box 3621
   Portland, Oregon 97208
   (503) 230-461

3. Klamath Basin
   Mr. Robert Johnson
   Assistant Counsel
   Northwest Natural Gas Company
   Oregon Department of Justice
   200 S.W. Market Street, Suite 1900
   Portland, Oregon 97209
   (503) 226-4211

4. Northwest Alaska Pipeline
   Mr. Robert Sibley
   Fluor Northwest Inc.
   c/o Fluor Engineers & Constructors, Inc.
   3333 Michelson Drive
   Irvine, California 92730
   (714) 966-3469

5. MANDAN
   Mr. William A. Merrill
   Division Manager
   Transmission and Distribution Projects
   Nebraska Public Power
   1414 15th Street
   Columbua, Nebraska 68601
   (402) 563-5200

6. Flathead
Ms. Judy Woodward
Project Manager
Bonneville Power Administration
P.O. Box 3621
Portland, Oregon 97209
(503) 230-4997

7. Eugene/Medford
Mr. Ron Smith
Chief
Environmental Coordination
Bureau of Land Management
P. O. Box 2965
Portland, Oregon 97208
(503) 231-6950

8. Substation Visuals
Mr. Ken Barnhart
Project Manager
Bonneville Power Administration
P.O. Box 3621
Portland, Oregon 97208
(503) 230-4329

G EVALUATION CRITERIA
TECHNICAL COMPETENCE

D.1 Project One

D.2 Project Two

D.3 Project Three

TRANSMISSION LINE

HARZA-EBASCO

HARZA-EBASCO

ALEXANDER V. SAPELKIN

Job Title: Lead Transmission Engineer

Location: Bellevue

Education: Master of Science in Electrical Engineering
1947, Harbin Polytechnic Institute, China

Professional Registration: California

Parent Company: Harza Engineering Company

Experience and Qualifications Relevant to the Susitna Project:

February 1971 to October 1973 and September 1976 to date: Harza Engineering Company.

- Senior Transmission Line Engineer, Company, 1980 to date. Project Engineer, responsible for Hayden-Blue River 345 kV design of transmission facilities.

- Resident Project Engineer for 500 kV Faisalabad-Multan Guddu Transmission Project, Pakistan. Responsible for planning, design procurement and construction of a 530 km 500 kV line. Planned the Indus River crossing with 12 km of flooded area. Designed one 220 kV switching station in Multan planned to be a 500 kV substation for future. (1976-1980).

- Staff Engineer, Tehran, Iran. Established basic criteria, line routes, preparation of necessary drawings and contract documents, and bid evaluation for 800 km of Karun System 400 kV transmission lines. Responsible for overall design of the transmission lines, advising and training of local staff, and establishing computer tower spotting programs in Tehran. Also studied the effect of meteorological and pollution conditions on design and operation of transmission lines. (1971-1973).

October 1973 to September 1976. International Engineering Company, San Francisco, California. Project Engineer for the preparation of line designs, specifications, material tests and construction surveillance for the ± 500 kV D.C. Inga-Shuba Transmission Line in Zaire. The line is 1700 km in length with transmission capacity of 1100 MW. Also Principal Engineer for the Black Mesa and Lake Powell 50 kV Electrified Railroad for Catenary and support structures design.

June 1965 to February 1971. Bechtel Corporation, San Francisco, California. Senior Transmission and Distribution Line Engineer. Various Transmission Line projects domestic and overseas. Assigned to the Power Division Chief Electrical Engineer's staff to provide consulting, planning and design standards and studies for transmission and distribution lines and substations.

December 1957 to May 1965. SADE S.A., Hedrager-Bosworth, and Themag Engineering Companies, Sao Paulo, Brazil. Senior Transmission Engineer. Responsible for design and planning of power lines, specification preparation, inspection of fabrication of materials and construction surveillance.

1947 to 1957. Design offices of Ministry of Light and Forest Industries, Peking, China. Design of industrial electrical installations, substations and distribution lines. Construction Supervision.

Client References:

1. Hayden-Blue River 345 kV
   Transmission line
   Tri-State Generation and Transmission
   Association, Inc.
   12076 Grant Street
   Denver, Colorado 80233
   (303) 452-6111
   B. Brickhouse - Project Manager
   A. Rojas - Civil/Structural Design Section Manager

2. Gatti-Multan-Guddu 500 kW
   Transmission line
   Water and Power Development Authority
   WAPDA House, Lahore, Pakistan
   Chief Engineer 500 kV
   Malik Ashraf
   Telex No. 44869 WAPDA PK

3. Inga-Shaba ± 500 kV DC Transmission Line, Zaire
   International Engineering Company
   San Francisco, California
   B. Causing - Vice President
   (415) 442-7300

HARZA-EBASCO

ROLAND J. MESA

Job Title: Transmission Line Design, Engineering

Location: Bellevue

Education: Master of Science in Electrical Engineering
1953, Havana University, Havana, Cuba
Bachelor of Science
1948, Instituto Santiago,
Santiago de Cuba, Cuba

Special Qualification: Surveying and Land Assessment
1948, Instituto Santiago,
Santiago de Cuba, Cuba.

Professional Registration: Cuba, Illinois, Pennsylvania, Colorado

Parent Company: Harza Engineering Company

Experience and Qualifications Relevant to the Susitna Project:

June 1973 to Date: Harza Engineering Company.

- Senior Transmission and Distribution Engineer. Responsible for design, engineering, economic evaluation of alternatives, construction surveillance and consulting on national and international power transmission projects. Projects include:
  - 220 kV, 400 kV and 765 kV lines for the Guri Project, Venezuela.
  - 83 km of 69 to 115 kV conversion, and several 115 kV lines for Comision Ejecutiva Hidroelectrica del Rio Lempa, El Salvador.
  - 500 km of 400 kV lines at the Reza Shah Kabir Project
  - 300 miles of 500 kV line for Water and Power Development Authority, Pakistan
- Project Engineer for a Rural Electrification Project which included 180 km of 138 kV lines, three high-voltage substations and electrification of 120 towns.
- Consulting, design, construction surveillance, engineering studies and engineering on international distribution systems including the North Sumatra Long Range Planning Study for two provinces in Indonesia and the Rural electrification of the Aguan Valley in Honduras which includes 102 towns.

1964 to 1973. Sargent and Lundy Engineers, Chicago, Illinois.

- Project Engineer: Responsible for complete design of HV and EHV transmission lines, including; route selection, wood H-frame and single pole structural design, computer application for line design. Application of steel tower, steel pole and laminated wood structures.

- Design Engineer: Design of transmission and industrial substations, including; line relays, switchyards, control and instrumentation, specifications, material selection and economic evaluations.

- Electrical Analyst Engineer: Relays and breakers, selection and coordination for generating station units and substations: switchgear selection, voltage drops, short circit calculation.

1961 to 1964. United Engineers and Constructores, Inc., Philadelphia, Pennsylvania. Senior Designer of steam generating units. Responsibilities included checked and correlated physical and schematic diagrams, including; control panels, switchgear data processing equipment. Development of basic schematic diagrams and of single line diagrams.

1956 to 1961. Compania Cubana de Electricidad, Havana, Cuba.

- Engineering Department: Design of all phases of rural and urban Transmission and Distribution lines. Tower spotting, selection of voltages, conductors, different types of structure, and hardware. Complete structure design for wood H-frame and single pole. Planning for electrical power distribution systems, including; voltage drops and loss calculations, use of capacitors and regulators, coordination programs. Studies and forecast of load growth. Economic studies and evaluation of different plans for improvement of distribution systems. Estimating and preparing budgets. Design of distribution substations.

- Electrical Department, Division Engineer: Operation, maintenance, and improvement of transmission and distribution systems. Responsible for job coordination of maintenance personnel. Dealing with labor union in problems related to workers. Supervision of transmission line construction. Construction supervision of 110/33 kV substations.

- Right of Way: Head of the Right of Way and Surveying Department.

1950 to 1956. Alvira Engineering Company, Consulting and Constructors Engineers, Havana, Cuba. Design, construction, and surveying of rural and urban transmission and distribution lines.

Client References:

1. Basin Electric Power Cooperative
   In-Place Cast Study 115 and 230 kV Transmission
   Mr. George Paraskeva
   Chief Engineer
   1717 East Interstate Avenue
   Bismarck, North Dakota 58501
   ( )

2. 115 kV Transmission Line
   Eng. Francisco E. Granadino
   Executive Director
   9a. Calle Ponista No. 950
   Entre 15 ay 17a
   Avenida Norte
   San Salvador, El Salvador, C.A.
   (503) 22-0855

HARZA-EBASCO

F. MIKE CARSON

Job Title:	Line Design Engineering
Work Location:	Bellevue
Education:	BSEE, 1967 - Oregon State University, 1962-1967 IEEE, Power Circuit Breaker School, 1979 IEEE, Relay Protection School, 1980 BASIC Computer Programming-Treaty Oaks, 1981 Arctic Region Engineering-University of Alaska - 1982
Special Qualifications:	Over twelve years experience in the design of transmissior and distribution systems.
Professional Registration:	Prof. Engineer-Oregon, 1974 (No. 8,130) California, 1980 (No. 10,500) Washington, 1981 (No. 19,753) Alaska (pending) REA Work Order Certification (Pending)
Parent Company:	Ebasco Services Incorporated

Experience and Qualifications Relevant to the Susitna Project:

Registered Electrical Engineer with over twelve years experience in the design of transmission and distribution systems for Rural Electrification Administration Cooperatives and Public Utility Districts. Performed the following engineering services for these clients:

- System Planning. Prepared long-range plans which include system load forecasts, voltage drop studies, annual cost comparisons of construction alternatives, and loss evaluation. Furthermore, prepared bi-annual construction work plans with a system analysis to justify the needed construction projects.

- Transmission System Design. Designed overhead 69kV and 115kV transmission lines. Responsible for the basic design data which include conductor size, sag and tension, mechanical strength of structures, and clearances. Also, selected route, type of structure, structure location and prepared plans and specifications for bid.

- Distribution System Design. Designed overhead and underground 24.9/14.4kV and 12.5/7.2kV distribution lines and substations

Responsible for route selection, pole location, type of structure, conductor selection, and plans and specifica tions. Furthermore, supervised the preparation of general arrangement and steel detail drawings for rural substations and provided material specifications for the transformers, reclosers, etc.

- System Protection. Designed and coordinated relay and fuse protection for transmission and distribution systems. Responsible for specifications for overcurrent, distance and differential relay systems. Also, prepared material specifications for power circuit breakers and oil circuit reclosers.

Representative Experience:

Client	Project	Position
Midstate Electric Cooperative, Inc.	Transmission and Distribution Protection Studies	Lead
Northern Wasco Public Utility District	Phasing Study	Lead
Northern Wasco Public Utility District	7th Street 7.2/12.5kV Feeder	Lead
Shasta Dam Area Public Utility District	System Protection Study	Lead
Surprise Valley Electrification Corporation	Brockman 69kV Substation	Lead
Surprise Valley Electrification Corporation	Construction Work Plan	Lead
Surprise Valley Electrification Corporation	Lookout-Bieber 69kV Line	Lead
Surprise Valley Electrification Corporation	Canyon Creek 69kV Line	Lead
Surprise Valley Electrification Corporation	Summer Lake 14.4/24.9kV Rebuild	Lead

Client	Project	Position
Surprise Valley Electrification Corporation	System Protection Study	Lead
Wasco Electric Cooperative, Inc.	Pine Grove 69kV Line	Lead
Wasco Electric Cooperative, Inc.	Construction Work Plans	Lead
West Oregon Electric Cooperative, Inc.	Construction Work Plans	Lead
West Oregon Electric Cooperative, Inc.	Clatskanie Mist 115kV Line	Lead
Western Oregon Electric Cooperative, Inc.	Necanicum Junction 115kV Substation	Lead
West Oregon Electric Cooperative, Inc.	System Protection Study	Lead
West Oregon Electric Cooperative	Haskins Creek 12.5 URD Cable	Lead
Bonneville Power Administration	Davis Creek (AHE) 115kV Tap	Lead
General Electric Cooperative, Inc.	Knott Pit 69kV Line	Lead
Midstate Electric Cooperative, Inc.	Construction Work Plans	Lead
Midstate Electric Cooperative, Inc.	Long-Range Plan	Lead

Employment History:

Ebasco Services Incorporated, Seattle, Washington; 1982-Present;

- Senior Electrical Engineer

Robert Welty Engineers, The Dalles, Oregon

- 1977-1982; Senior Engineer
- 1974-1977; Engineer
- 1971-1973; Field Engineer

References:

Larry Marsh
Bonneville Power Administration
P. O. Box 3621
Portland, Oregon 97208
503/230-5238

Robert Welty
Robert Welty Engineers
P. O. Box 501
The Dalles, Oregon 97058
503/296-6109

HARZA-EBASCO

ANDY ANGELOS

Job Title: Transmission Line Tower Spotting

Location: Bellevue

Education: Bachelor of Science in Electrical Engineering, 1974, Illinois Institute of Technology

Professional Registration: Illinois

Parent Company: Harza Engineering Company

Experience and Qualifications Relevant to the Susitna Project:

June 1977 to Date. Harza Engineering Company. Senior Trasmission and Distribution Engineer. Responsible for the design and engineering of transmission and distribution line projects up to 765 kV; conductor and transmission distribution economic studies, induction effects near HW and EHV lines and substations, insulation coordination, structure conceptual designs, structure loadings coordination. Responsible for coordinating all the technical engineering tasks required by the project at different stages; determine requirements for material specifications, analyzing supplier's proposals, making award recommendations.

Experience highlights are as follows:

- Prepared feasibility study for transmission/distribution for the Bethel Area Power Plan, Alaska.
- Electrical insulation coordination and lightning protection study for the Hayden-Blue River 345 kV line for the Tri-State Generation and Transmission Association, Colorado.
- Project Engineer for the 275 mile Antelope Valley 500 kV project for Basin Electric Power Cooperative, North and South Dakota.
- Lead Engineer for installed cost analysis study of various structure design concepts for 230 and 115 kV level prepared for Basis Electric Power Cooperative.
- Insulation coordination and induction effects under ten 765 kV circuits for the Guri Hydroelectric Project in Venezuela.
- Lead Engineer for the 132 kV transmission line and 4 kV distribution for the Maqarin Hydroelectric Project in Jordan.
- Lead Engineer for 33 kV line and 4 kV distribution for the King Talal Hydroelectric Project in Jordan.

o Prepared feasibility study, voltage and conductor selection for the Tempagapura Hydroelectric Project, Indonesia.

December 1968 to May 1977. Sargent and Lundy Engineers, Chicago, Illinois. Electrical Engineer and System Analyst. Responsible for the development and implementation of computer work associated with transmission systems. Developed a number of sophisticated computer programs implemented in the design and engineering of HV and EHV lines.

Client References:

Mr. George Fagart
Supervisor Transmission Line Engineering
Allegheny Power Service Corporation
Telephone (412) 837-3000

Mr. Nevins Wilburn
Chief, Transmission Design & Construction Division
Antelope Valley 345 and 500 kV Transmission Basin
Electic Power Cooperative
Telephone (701) 223-0441

Ms. Adrian Rojas
Civil Section Manager & Project Engineer
Hayden-Blue River 345 kV Transmission
Tri-State Generation & Transmission Association, Inc.
Telephone (303) 452-6111

HARZA-EBASCO

P. A. NOBILE

Job Title:	Undersea Cable Engineer
Work Location:	New York
Education:	Newark College of Engineering - BSEE - 1970
Professional Registrations:	Professional Engineer - New York
	Affiliations:
	Member-Institute of Electrical & Electronic Engineers Member-Insulated Conductors Committee
Special Qualifications:	Over twelve years related experience.
Parent Company:	Ebasco Services Incorporated

Experience and Qualifications Relevant to the Susitna Project:

Registered Professional Engineer with over twelve years experience in underground/underwater cable systems, generation planning, engineering economic studies and system reliability analyses. Performs feasibility and design studies and provides engineering expertise for high voltage AC (345kV) and DC (± 400kV) underground/underwater installation including exceptionally long underwater cable crossings.

- Prepares system designs, cable specifications and evaluates bid for underground/underwater transmission cables, as well as trouble-shoots cable problems in the field. Reviews all Ebasco cable specifications and engineering guides, and provides guidance to other Ebasco engineers on cable problems.

- System reliability studies were performed for overhead and underground/underwater transmission systems, diesel generators used as the emergency power supply to power plants. Also performed studies to determine the availability of the offsite power supply for power plants.

- In the area of generation planning and engineering economic studies, responsibilities include developing generation expansion plans, determining optimum unit sizes and performing economic evalutions for utility and industrial clients. Also advises other Ebasco personnel and clients regarding procedures for performing engineering economic studies.

Representative Experience:

Project Name:	Alaska Power Authority Feasibility and Economic Study of a 40 mile Submarine Cable Crossing in Alaska, interconnecting Bradley Lake Generating Station with Kodiak Island.
Project Name:	The Charter Company Feasibility of 64 Mile, 800 MW DC Submarine Cable System.
Project Name:	Sea Train Company Feasibility of 12 Mile, 800 MW DC Submarine Cable System
Project Name:	General Public Utilities Audit of Studies done on Feasibility of Submarine Cables Across Lake Erie.
Project Name:	Kansas Power & Light Company Inspect and Upgrade 13kV Underground Distribution System.
Project Name:	Consolidated Edison Company Engineering, Design and Installation of a 138kV Direct Buried Cable Installation in Staten Island including a River Crossing of Fresh Kills Creek.
Project Name:	Bonneville Power Administration Determine Outage Rates for Overhead Transmission Lines.
Project Name:	General Public Utilities Availability Analysis of Onsite and Offsite Power to Oyster Creek Power Plant.
Project Name:	Public Service of New Mexico 20 Year Generation Expansion Plan
Employment History:	Ebasco Services Incorporated, New York, NY; 1974-Present • Associate Consulting Engineer, 1982-Present • Principal Engineer, 1980-1982 • Senior Engineer, 1977-1980 • Engineer, 1974-1977

Consolidated Edison Company, New York, NY;
1970-1974

- Associate Engineer, 1971-1974
- Assistant Engineer, 1970-1971

Client
References:

GPU Service Corporation
P. O. Box 1018
Reading, Pennsylvania 19603
R. W. Werts-Assistant Vice President,
System and Operations
(215) 371-5355

Charter Oil Company
21 West Church Street
Jacksonville, Florida 32231
S. W. Bishop-Project Manager
(904) 358-4180

HARZA-EBASCO

KENNETH M. CHRISTIANSEN

Job Title: Construction Support Transmission

Work Location: Bellevue

Education: Civil Engineering - University of Minnesota
- San Jose State College

Foundations and Structures - University of Minnesota

Special Qualifications: Over twenty-five years in the construction industry with progressively increasing responsibilities in supervision and direction of large projects with emphasis on HV and EHV transmission lines and substations.

Professional Registration: None

Parent Company: Ebasco Services Incorporated

Experience and Qualifications Relevant to the Susitna Project:

Extensive experience in overhead, underground and submarine EHV systems including feasibility studies, routing, soils test, surveying (including photogrammetry), design, preparing bid documents, installation of all types of foundations, erection of all types of steel towers and poles, stringing and saging conductors, testing and energizing. Also a specialist in surveying and trouble shooting existing electrical distribution systems.

Employment History:

Project Superintendent

- Prepared proposal for construction management services of 345kV transmission lines in excess of 100 million dollars.
- Member of estimating team bidding on hard money construction contracts in isolated locations of Alaska for U.S. Army Corps of Engineers.

Electrical Superintendent

- Supervised the construction and installation of electrical works of a cogeneration plant. This included the modification of five existing substations and a complete new distribution system.

Electrical Transmission and Distribution Specialist

- Converted overhead lines to underground cable.
- Design and construction of new underground transmission system for Riyadh Electric Company, Riyadh, Saudi Arabia.

Conductor Stringing Specialist, Contract Manager

- Supervised stringing and sagging of the Gilboa-Ledds 765kV transmission line for the Power Authority of the State of New York.

Project Director

- Supervised the final routing, design, preparation of bid documents and the construction management of the 230kV transmission line system which included three major substations linking La Fortuna Power Plant to Panama City for the Republic of Panama.
- Utilized photogrammetric engineering for the development of plan and profile drawings and transmission line route selection.

Construction Manager

- Directed the development of contract documents of all high voltage transmission lines for Vermont Electric Power Company from February 1969 to May 1973. This included overhead, underground and submarine installation from project conception through construction management, testing and final acceptance.

Project Engineer

- Supervised conductor stringing for 450 miles of 500kV transmission line associated with the Peace River 2400 MW hydroelectric power project for the British Columbia Hydro and Power Authority.

Construction Supervisor

- Directed all phases of construction on 500kV transmission lines throughout the South for Gulf States Utilities.
- Developed a construction program (because of swamps and a high water table) to install high voltage transmission lines completely from foundations to conductors utilizing barge mounted equipment.

Superintendent

- Supervised survey crews and installation of tower foundations for EHV, 230kV and 345kV transmission lines, substations and generating plants throughout the west.

C EVALUATION CRITERIA
TECHNICAL COMPETENCE

1 Project One

D.2 Project Two

D.3 Project Three

SUBSTATIONS &
COMMUNICATIONS

HARZA-EBASCO

HARZA-EBASCO

GUENTHER SCHEEL

Job Title:	Substation Engineer
Location:	Bellevue
Education:	Bachelor of Science in Electrical Engineering, 1950, Polytechnicum Giessen, Germany
Special Qualification:	Senior Engineer - Hrauneyfoss (Iceland)
Professional Registration:	Wisconsin
Parent Company:	Harza Engineering Company

Experience and Qualifications Relevant to the Susitna Project:

July 1969 to Date: Harza Engineering Company. Senior Electrical Engineer. Duties and responsibilities include supervision, coordination and review of electrical design, including preparation of contract documents, engineer's estimates, evaluation of bid proposals, construction drawings, witnessing factory tests of electrical equipment, and assistance to field during construction stage. Worked on the following projects:

- Hrauneyjafoss Project, Iceland. Three-unit, 244.5 MVA powerhouse and 220 kV SF-6 gas insulated substation.
- El Nispero Project, Honduras, C.A. One-Unit 23 MW powerhouse and 34.5/69 kV switchyard.
- Yacyreta-Apipe Project, Argentina, S.A. Twenty units, 3,450 MVA powerhouse and 220 kV SF-6 gas insulated substation.
- Karun River Project, Iran. Four units, 1,000 MVA powerhouse, dam and 400 kV switchyard. Karun EHV Transmission System, Iran. Four 400 kV substations. Gotvand Irrigation Project, Iran.
- Finchaa Project, Ethiopia. Three units, 105 MVA powerhouse and 230 kV switchyard.
- Rio Lindo Project, Honduras, C.A. Two units, 42 MVA powerhouse and 138 kV switchyards. La Puerta Substation, Honduras, C.A. Expansion of 138 kV switchyard incuding modification of control switchboard (field assignment).

November 1962 to July 1969. Erik Floor and Associates, Chicago, Illinois. Electrical Design Engineer. In charge of all electrical design and drafting of the following hydroelectric generating stations:

- Miller Ferry Project, Alabama. Three units, 79 MVA powerhouse and 115 kV switchyard.

- Sarijar Project, Turkey. Expansion of existing powerhouse and switchyard to accommodate two additional generating units of 44.5 MVA each.

- West Point Project, Georgia. Three units, 110.5 MVA powerhouse and 115 kV switchyard.

November 1959 to Ocrober 1962. A. J. Boynton & Company, Chicago, Illinois. Electrical Design Engineer. Work consisted of preparing cost estimates, calculations, equipment selection and requisitioning, physical layouts, wiring diagrams and modernization of existig steel plant (field assignment).

January 1957 to October 1959. Laramore, Douglas and Popham, Chicago, Illinois. Electrical Engineer. Work included electrical engineering design work of steamelectric generating stations and switchyards.

October 1950 to December 1956. Siemens & Schuckert, Germany. Electrical Field Engineer. Supervised field erection and testing of switchgear and transformers, industrial control, and machine tool control for industrial customers of apparatus division.

Client References:

1. Hranneyjafoss Substation and Powerhouse
   Mr. Gudmundur Helgason
   Deputy Head of Operation
   Landsvirkjun, The National Power Co.
   Haaleitvsbrant, 68
   108 Reykjavik, Iceland
   Telephone: 86400
   Telex: 2054 LANDSVIS

2. Yacyreta-Apipe Powerhouse and Substation
   Entedad Binacional
   Engineer Rolando S. Herron
   Torre Mederos Piso 20
   Avenedo Eduardo Maderos 940
   Buenous Aries, Argentina CP 1106
   Telex: 122659 AREBY

HARZA-EBASCO

JOHN J. QUINN

Job Title: Lead Substation Engineer

Location: Bellevue

Education: Bachelor of Science in Electrical Engineering, 1968, Illinois Institute of Technology
Bachelor of Arts in Math-Physics, 1960, St. Joseph's College, Rensselaer, Indiana

Professional Registration: Illinois

Parent Company: Harza Engineering Company

Experience and Qualifications Relevant to the Susitna Project:

January 1968 to Date: Harza Engineering Company, Chicago, Illinois.

- Boundary Project - Underground powerhouse located in the State of Washington. Lead Electrical Engineer. Preparation of equipment design memos, procurement specifications for two 210 MVA, 128.6 rpm generators and bid analysis; initiated design of controls, protective relaying and instrumentation; and initiated preparation of construction drawings.

- Yacyreta project - twenty 172 MVA Unit powerhouse, 220 kV SF_6 switchyard and nagivation locks located in Argentina. Electrical Lead Engineer responsible for project coordination; preparation of design studies, electrical equipment technical specifications and review of design; feasibilty study of 220 kV transmission line utilizing oil-filled cable and SF^6 bus.

- San Lorenzo generating station with two 87 MVA units and 115 kV switchyard in El Salvador. Lead Electrical Engineer in preparation of generator procurement specifications, design criteria and electrical construction drawings, and review of manufacturer's drawings.

- 138 kV Transmission Line system relay study. Project Engineer on the relay coordination study for the complete transmission system in Honduras.

- Mayfield Powerhouse Expansion, Tacoma, Washington, U.S.A. Senior Design Engineer responsible for preparation of powerhouse and substation electrical equipment specifications and designs for the addition of a 45 MVA generator.

- Rio Lindo Project, Honduras, C.A. Senior Design Engineer for expansion of the present Rio Lindo powerhouse and switchyard to accommodate two additional generating units of 21 VA each. Supervision, coordination and review of all electrical design facets, including preparation of contract documents, engineer's estimates, evaluation of bid proposals, construction drawings, review of equipment manufacturers' drawings and assistance to field during construction stage.

- Karun EHV Transmission System, Tehran, Iran. Design Engineer. Preparation of preliminary and review of final substation control design; review manufacturer's design of 230 kV and 400 kV power circuit breakers and current transformers, 15 kV metalclad switchgear, 230 and 400 kV coupling capacitor potential devices and lightning arresters, 230 and 400 kV disconnecting switches, control switchboards; and preparation of electrical equipment and cost estimates for four 230/400 kV substations.
- Sucre Power Plant, Sucre, Boivia. Design Engineer. Start-up and inspection of three unit, 10 MVA, 10 kV diesel-generator powerhouse and switchyard.

- Cornell Hydroelectric Plant, Wisconsin, U.S.A. Design Engineer. Responsibilities included preparation of specifications, design of controls and protective relaying for automatic operation of a four unit hydroelectric powerhouse.

- Medan Electric Power System, Sumatra, Indonesia. Design Engineer. Responsibilities included preparation of specifications, design, estimates, equipment selection for a 30 MVA, six unit diesel powerplant and 20 kV switchyard.

- South Carolina Public Service Authority, Santee Cooper Hydroelecric Plant, U.S.A. Design Engineer. Responsible for preparation of design and specifications for the generating stations and 115 kV switchyard including supervisory control.

- Central Nebraska Public Power District Hydroelectric Plants and Irrigation System, U.S.A. Preparation of specifications for the supervisory control equipment to control three unattended hydro plants and thirteen irrigation structures from the central office.

June 1960 to January 1968. Rauland Corporation, Chicago, Illinois. Electrical Engineer. Design Engineering, procurement, installation, testing, and operation of electrical facilities for a three plant 25,000 kVA industrial system in Chicago.

Client References:

1. Boundary Hydroelectric Project
   City of Seattle
   City Light Department
   1015 Third Avenue
   Seattle, Washington 98104
   Mr. Dean Sunquist
   (206) 625-3056

2. Mayfield Powerhouse Expansion
   City of Tacoma
   Department of Public Utilities
   P.O. Box 11007
   Tacoma, Washington 98411
   Mr. Art Herstrom
   (206) 383-2471

3. Rio Lindo Project
   Empresa Nacional de Engergia Electrica
   Apartado No. 99
   Tegucigalpa, Honduras, C.A.
   Mr. Marco Mass
   (504) 22-4373

DONALD CHU

Job Title: Static VAR Compensation Engineer

Work Location: Bellevue

Education:
Cornell University - MEE - 1976
Cornell University - BS - 1975
ASEA High Voltage Direct Current Course-1979
General Electric Company Protective Relay Course - 1981

Special Qualifications: Presented technical papers on:

"Application of Static VAR Compensation for Steady State and Dynamic Voltage Control", written in collaboration with J. J. Keane, O. Veraas, M. Rahman and R. Gutman; International Symposium on Controlled Reactive Compensation, Montreal, Canada, September 1979.

"Required Transmission for a Nuclear Energy Center in Mid-Atlantic Area Council System", written in collaboration with S. Linke; Brookhaven National Laboratory Publication, February, 1980.

Professional Registration:
Professional Engineer - New York
Member - IEEE

Parent Company: Ebasco Services Incorporated

Experience and Qualifications Relevant to the Susitna Project:

Professional Engineer with over four years experience in electrical design and engineering of transmission and distribution systems. Responsibilities include revising existing and writing new engineering guides and equipment specifications for generating stations.

- Previous responsibilities included developing electrical design criteria, preparation of equipment specifications, purchase requisitions and engineering support for field forces. Additional responsibilities included the preparation of electrical specifications and bid evaluations for high voltage switching devices, shunt capacitor banks and transformer auxiliary coolers.

- Project Engineer responsible for the development, design, engineering and construction support for a Static VAR

Compensation System project. Responsibilities included the preparation of electrical equipment specifications, technical and economic cost analysis of bid evaluations, review of all manufacturer and design drawings and preparation of construction schedule.

Employment History:

Ebasco Services Incorporated, New York, NY; 1980-Present

- Senior Engineer, 1982
- Engineer, 1980

American Electric Power Service Corporation, New York, NY; 1976-1980

- Engineer, 1980
- Associate Engineer, 1977-1980
- Assistant Engineer, 1976-1977

HARZA-EBASCO

CLARENCE J. EISINGER

Job Title: General Arrangement, Substations

Location: Bellevue

Education: Wright Junior College 1950-51
U.S. Army Southeastern Signal College 1952

Special Qualification: IEEE Member Grade Power Engineering Society
Consulting Electrical Engineers - Member

Parent Company: Harza Engineering Company

Experience and Qualifications Relevant to the Susitna Project:

November 1958 to Date: Harza Engineering Company. Section Head, Electrical Branch. Responsibilities include coordination and supervising the preparation of design, contract and construction drawings and supervision of outdoor switchyard and substation projects (both high-voltage and extra high-voltage systems).

- Supervised construction drawings, preliminary designs, and layouts for Powerhouse No. 2 of the Guri Project, Venezuela. Supervised design of all conduit and cable routing and cable tray installation for the Guri powerhouse, dam and spillway. Designed Guri 230 kV and 400 kV switchyards, and Santa Teresa and El Tigre 400 kV substations. Assisted in the preparation of the general contract specifications and major electrical equipment procurement contract documents for the new powerhouse. Design and supervised preparation of contract and contruction drawings and design of procurement contract documents. Design and coordinated 765 kV switchyard and transmission line for the project. Reviewed manufacturer's drawings of equipment to be furnished for the project.

- Prepared designs and supervised drafting relating to the Duncan Substation in Jamaica and the Hrauneyjafoss Substation, Iceland.

- Supervised the preparation of drawings and assisted in the prepartion of contract documents on the U.S. Army Corps of Engineers project, Lock and Dam No. 26, Alton, Illinois.

- Performed design and drafting of conduit and grounding arrangement drawings for the Wanapum and Hartwell projects, Washington, (U.S. Army Corps of Engineers). Also performed design and drafting of conduit and grounding arrangement drawings for steam power generator plants.

August 1951 to September 1955. Delta Star Electric Division of H. K. Porter Company, Chicago, Illinois. Designing and detailing of all switchyard and substation projects; coordination of fabrication of equipment and steel structures between the assembly plants and the engineering offices.

Client References:

Guri Powerhouse and Switchyard
Dr. Efrain Carerra
Vice President-Manager
EDELCA
Caracus, Venezuela
Telephone: 582-91-0579

Guri Powerhouse and Switchyard
Eng. Hector Beltran
Superintendent Electro-Mechanical Department
EDELCA
Caracus, Venezuela
Telephone: 482-91-0579

HARZA-EBASCO

ROSTYSLAW JOHN FOSTIAK

Job Title: Substation Apparatus Design

Work Location: Bellevue

Education: Bachelor of Science in Electrical Engineering, 1972, University of Illinois, Urbana

Professional Registration: Illinois

Parent Company: Harza Engineering Company

Experience and Qualifications Relevant to the Susitna Project:

September 1972 to Date: Harza Engineering Company

- Bath County 2,100 MW Pumped-Storage Plant and 500 kV Switchyard, Virginia. Supervised the preparation of conceptual designs, design memoranda, computations, specifications and the review of manufacturer's drawings. Designs for the 500 kV switchyard included evaluation of air and SF6 gas-insulated arrangements in terms of cost, reliability, and insulation levels of associated equipment.

- Yacyreta-Apipe 4,050 MW Hydroelectric Plant, Argentina. Design of Powerhouse and switchyard electrical equipment arrangements. Design computations and analyses of insulation coordination for overhead, transmission lines and open-air and SF_6 gas insulated substation arrangements at 220 and 500 kV.

- Guri 10,000 MW Hydroelectric Plant, Venezuela. Review of manufacturer's drawings, cost estimates, and feasibility studies for proposed powerhouse and switchyard expansion. Switchyard studies included layouts and design computations for 400 kV and 765 kV open-air and SF6 gas-insulated arrangements. Studies for the 765 kV air-insulated arrangement included analyses of the electrostatic effects in the vicinity of EHV lines.

- Field assignment at Reza Shah Kabit 1,000 MW Hydroelectric Plant and 400 kV switchyard, Iran. As the Assistant to the Electrical/Mechanical Resident Engineer, duties included field inspections of the contractors' work as to quality, workmanship, and conformity to the contract documents in such areas as conduit and tray systems, grounding and lighting systems, wiring, control systems, piping, and pipe pressure testing. Work also included in-field design of wiring drawings and the inception of a training program for the Client's personnel.

- Cerron Grande 150 MW hydroelectric Plant, El Salvador. Studies for powerhouse and switchyard equipment arrangements, layouts and quantity estimates.

Client References

1. Mr. W.L. Thompson
   VEPCO
   Virginia Electric and Power Co.
   Power Station Engineering & Constructio
   P.O. Box 564
   Richmond, VA 23204
   (804) 771-6308

2. Mr. Chuck Johnson
   VEPCO
   Virginia Electric and Power Co.
   Mountain Grove, Star Route
   Warm Springs, VA 24484
   (703) 279-3200

HARZA-EBASCO

PREM P. C. BABU

Job Title: Relay and Control Engineer

Location: Bellevue

Education: Bachelor of Technology in Electrical Engineering, 1966, Indian Institute of Technology, Madras, India

Professional Registration: England, United Kindgom

Parent Company: Harza Engineering Company

Experience and Qualifications Relevant to the Susitna Project:

October 1977 to Date: Harza Engineering Company. Relay application specialist. Responsibilities include preparation of electrical feasibility cost estimates for hydro plant and substations.

- Lead Electrical Engineer on Mayfield Project, Washington, for 45 MVA hydro generator addition and 230 kV switchyard modification to existing ring bus. Responsibilities include electrical design and project related activities;

- Study of technical aspects of substation uprating, 220 kV to 500 kV in Pakistan; Review of electrical drawings for 220 kV substation in Multan, Pakistan and for a 2-86 MW unit powerhouse and a 110 kV substation in El Salvador.

July 1970 to September 1977. A Reyrolle & Co., Hebburn, United Kingdom. Relay Application Engineer in Technical Department. Responsibilities included interpretation of customers inquiries and specifications to give recommendations of type of protective scheme and relate the protection performance to the requirements of generation, transmission, and distribution plant and equipment in the power system involved. Developed protection schemes, supervised laboratory tests, and prepared test and application reports. Transmission line protection schemes designed included those for the following voltages: 500 kV Ontario Hydro, Canada; 400 kV CEGB, United Kingdom, New Zealand Electrical Board, New Zealand, various Australian electricity boards.
April 1967 to May 1970. Post Graduate training at Reyrolle Burn, Ltd., Hawrah, India. During last year officiated as Assistant Engineer in the Technical Department.

Client Reference:

Mr. A. C. Herstrom
Chief Planning Engineer
City of Tacoma
Department of Public Utilities
P. O. Box 11007
Tacoma, Washington 98411

HARZA-EBASCO

JAMES JOHN SCHALK

Job Title: Storage and Control Building Design

Location: Bellevue

Education: Bachelor of Science in Architecture
1952, University of Illinois

Professional Registration: Architect - Illinois

Parent Company: Harza Engineering Company

Experience and Qualifications Relevant to the Susitna Project:

October 1956 to Date: Harza Engineering Company. Associate (1977) and Head, Architectural Section (1969). Responsible for the design and review of all architectural features of Harza's projects. Typical of his more than 40 projects are:

- Hartwell powerhouse, Georgia, Wanapum powerhouse, Washington, and Seneca powerhouse, Pennsylvania; Guri Hydroelectric Project, Venezuela; Cerron Granda Hydroelectric Project, El Salvador; and Karadj and Karun River Hydroelecric Projects in Iran.

- Powerhouses, operators village, and maintenance center for the Rio Lindo and Canaveral Hydroelectric Projects, Honduras, including design of all housing, recreational, street and sanitary layouts.

- Burfell powerhouse, Iceland, with cast-in-place sculptured relief in exterior wall depicting Icelandic history.

- Cowlitz Salmon Hatchery, Washington; planned entire complex, including residences and maintenance buildings. This installation is currently the largest salmon hatchery in the U.S.A.

- Idealized layout of site development potentials for recreational, residential, agricultural, and industrial use in the area surrounding a thermal power plant cooling ponds, Kincaid Reservoir, Illinois. The area, in excess of 4,000 acres, includes three marines, tent and trailer camping areas, shower shelter buildings, public beaches, lode and administrative building, private housing, golf course and motel area.

Client References:

1. Chicago Metropolitan San. Dist.
   Deep Tunnel Project
   101 E. Ontario Street
   Chicago, IL 60611
   Mr. D. J. Bielenberg, Chief Environmental Planner
   (312) 751-5807

2. Corps of Engineers
   Lock & Dam #1 Project
   St. Paul District
   1210 U.S. Post Office & Custom House
   St. Paul, Minn. 55101
   Mr. B. Tamte
   (612) 725-7526

3. Bath County Project
   VEPCO
   Box 564
   Richmond, Virginia 23204
   Mr. H. Engleman Jr.
   (803) 771-6121

HARZA-EBASCO

FRED B. MASS

Job Title: Storage and Control Building Design

Location: Bellevue

Education: Bachelor of Science in Mechanical Engineering, 1971, University of Illinois

Professional Registration: Professional Engineer - Illinois

Parent Company: Harza Engineering Company

Experience and Qualifications Relevant to the Susitna Project:

1971 to Date: Harza Engineering Company. Senior Mechanical Engineer.

- Lead Mechanical Engineer for Metropolitan Waste Control Commission, St. Paul, Minnesota Maintenance and Dispatch Building. Duties included preparing design specifications and contract drawings. Building features office areas, computer center, locker/shower area, machine shop, vehicle maintenance center and vehicle storage areas. Building mechanical systems include HVAC, fire protection, fuel storage, and solar water heating.

- Lead Mechanical Engineer for Foothills Water Works outlet, consisting of 8 free-discharge valves, diameters ranging from 8-inch to 48-inch, including associated cone type guard valves, designed for irrigation releases ranging from 10 cfs to 4000 cfs under 150 feet of head. Duties included initial design and layout work for the project, with continued engineering service during the construction phase including review of manufactured equipment, and witnessing shop testing. Additionally, for similar applications, responsibilities included establishing design criteria for the selection, sizing and general layouts for studies of free-discharge valves for diversion tunnels and outlet works.

- For the Chicago Tunnel and Reservoir Plan (TARP) Project, responsibilities included evaluation of design parameters for selection and sizing of pumps and valves, including preparation of contract documents.

- Prepared technical analysis of bid proposals covering Francis turbines and governors for the 144-MW Hrauneyjafoss Hydroelectric Project.

- Established design criteria and investigated various pump schemes involving pump selection and piping alignments for the Jordan Water Carrier Project, including comparative cost analysis.

- Selection, sizing, equipment layout and preparation of design for pumping stations. (Projects include: Gotvan, Zanya del Tigre, Fairview, Burlington, and Black River Upper Morass Expansion.)

Client References:

1. Rehab Interstate Highway Pump Station
   Illinois Department of Transportation
   9300 St. Clair Avenue
   Fairview Heights, Illinois 62208
   (618) 397-9530

   Mr. Barry Roberts - Construction Manager
   Mic Rolando - Resident Engineer
   Rodger Watson - Project Manager

2. Strontia Springs Dam
   Board of Water Commission
   1600 West 12th Avenue
   Denver, Colorado 80254
   (303) 623-2500

   Mr. Jack Parsons

HARZA-EBASCO

RAYMOND L. KUNTZENDORF

Job Title:	Communications and SCADA - remote terminal units
Location:	Chicago
Education:	Master of Science in Power Systems 1959, Illinois Institute of Technology Bachelor of Science in Electrical Engineering, 1958, University of Notre Dame
Special Qualifications:	Extensive experience in communications and supervisory control systems
Professional Registration:	Illinois
Parent Company:	Harza Engineering Company

Experience and Qualifications Relevant to the Susitna Project: 1975 to Date: Harza Engineering Company, Chicago, Illinois. Head Computer Control and Communications Section. Responsible for design guides, standards, project design memoranda and specifications related to microwave, power line carrier, radio and telephone voice and data communications; supervisory control including computer applications related to energy management centers, generating stations and individual unit control, high-voltage substation control, and industrial project control.

June 1973 to May 1975: Regional Manager, LFE Corporation, Boston, Massachusetts. Responsible for the sale, installation and acceptance of computer based supervisory control systems. Developed design criteria for plant computer multiplex and variable energy charge based on system demand.

February 1970 to June 1973: General Manager, KAY Sales, Inc., Chicago, Illinois. Prepared system estimates, reports and specifications for communication and control subsystems involving microwave, radio, power line carrier and transfer trip. Developed design criteria for utility radio controlled switching, automatic subscriber monitoring, IMTS base station monitoring, computer control of microwave alarm and computer telemetering data handling.

April 1966 to February 1970: Division Manager, Analog Digital System, Inc., Chicago, Illinois. Specified design criteria for all products. Duties included marketing and development of substation integrated circuit remote data loggers, and sequential event recorders. Designed numerous special purpose computer system interfaces for the scientific community.

September 1963 to April 1966: General Manager, Lundell Controls, Inc., Chicago, Illinois. Supervised the design and manufacture of power plant annunciators, sequential event recorders and temperature scanners. Instrumental in developing prewired terminal cabinets for bench board annunciators and systems. Project Manager for the development of first application of digital logic to supervisory control.

June 1959 to September 1963: Project Engineer, Commonwealth Edison Company, Chicago, Illinois. Assignments in system planning and station electrical engineering. Developed design guides, specified equipment and designed numerous substations. Specified and installed first all digital supervisory control equipment.

Publications:

"Computer Control Design Highlights of a Modern Hydroelectric Power Plant," presented at the IEEE Power Engineering Society winter meeting, New York, Paper A78-103-4, January 1978.

"Current Asymmetry in Resistance-Reactance Circuits," Power Apparatus and Systems, paper 60-825, December 1960.

Client References:

1. Bath County Pumped Storage
VEPCO
Mr. Larry Kidd
Computer Control Group
P.O. Box 564
Richmond, Virginia, 23204
(804) 771-6319

2. Demand Metering System
Richard R. Rurjich
Executive Vice President
Sayland Power Cooperative Inc.
675 West Imboden Drive
P.O. Box A1606
Decatur, Illinois 62525

3. Jack Watson
Communications Engineer
The Illinois State Toll Highway Authority
East-West Tollway
Oak Brook, Illinois 60521
(312) 654-2200

HARZA-EBASCO

LAURO H. VALERIANO

Job Title: Communications and SCADA - remote terminal units

Location: Bellevue

Education: Bachelor of Science in Electrical Engineering
1965, FEATI University, Manila, Philippines

Parent Company: Harza Engineering Company

Experience and Qualifications Relevant to the Susitna Project:

October 1981 to Date: Harza Engineering Company

Communications Engineer. Responsible for studies, engineering design, preparation of design memoranda and writing specifications for commuication and control systems. He is also responsible for reviewing and coordinating manufacurer's drawings and inspection of equipment.

- Field Communications Engineer for the El Nispero Hydroelectric Project, Honduras. Supervises ENEE personnel in commissioning communication, telemetry and control system (1981 to present).

June 1971 to October 1981. RFL Industries, Boonton, New Jersey. Communication System Engineer, Carrier Communication Systems. Responsibilities included voice and data communication system design and integration, system commissioning, factory acceptance testing and proposal writing.

- Project engineer responsible for design, system integration and scheduling for expansion of telecommunication system for the Jamaica public Service Company (1980-81).

- Powerline carrier system expansion for the New Zealand Electricity Department. System engineer responsible for design, system integration, client liaison, factory acceptance testing and preparation of operating manual (1981).

- System engineer on telecommunication/SCADA system for the Corporacion del Cobre, Chile. Responsibilities included voice and data cmmunication system design and integration, factory acceptance testing and preparation of operating manuals (1980).

- System engineer on powerline carrier system expansion for State Electricity Commission of Victoria (SECV), Australia. Duties included voice and data communication system design and integration factory acceptance testing and preparation of operating manuals (1977).

- Project engineer on telecommunication system for Southern Peru Copper Corporation, Peru. Duties included voice and data communication system design and integration, system commissioning, factory acceptance testing and preparation of operating manuals (1976).

June 1965 to March 1971: Manila Electric Company/GPU, Manila, Philippines. Commuication/Control Engineer. Responsibilities included design, operation and maintenance of utility's communication and SCADA system and supervised communication/control section personnel.

Client References:

1. Tennessee Valley Authority
   Chattanooga, Tennessee
   Lawrence Brayant
   (615) 755-2272
   (615) 755-3551

2. Montana Power Company
   40 East Broadway
   Butte, Montana
   Charles Beardslee
   (406) 723-5421

3. Tucson Electric Power Company
   Tucson, Arizona
   Jim Maneval
   (602) 622-6661

4. Empressa Nacional de Energia Electricidad (ENEE)
   Tegucigalpa, Honduras, C.A.
   Mario Villalta
   Project Manager, El Nispero Project

HARZA-EBASCO

HAROLD M. COX

Job Title: Construction Support for Substations

Location: Bellevue

Education: Attended University of Denver, Colorado

Professional Registration: Electrical Contractors License - Colorado
Master Electricians License - Colorado
Wisconsin P.E. - Pending

Parent Company: Harza Engineering Company

Experience and Qualifications Relevant to the Susitna Project:

November 1973 to Date: Harza Engineeering Company. Senior Construction Engineer, Transmission and Distribution Section. Responsibilities include line layouts, locating transformers, calculating loads, and making up material quantities. Advises and assists clients on oversees construction work in progress. Prepares and conducts necessary training programs and field reports for various projects. Reviews and approves drawings. Also inspection of materials and equipment being furnished in several USAID and World Bank Projects in Egypt and Central America. Included field trips to assist clients in routing lines and locating substations.

- Construction Superintendent for 530 km of 500 kV transmission line and a 220 kV substation and control house in Pakistan. Responsible for overall management of the project, including supervision of the expatriate and local engineers and inspectors, conducted training classes for Pakistan engineers, maintained records and as-built drawings, and assisted in preparing World Bank Reports, operation and maintenance manual and completion report. (1978-1981).

- Responsible for preliminary layout of distribution lines, transformers and substations for World Bank and USAID projects in Central America, U.S.A. and Egypt. Made quantity takeoffs for materials, and schedules ordering and delivery. Assisted in developing list of equipment and vehicles for the Egypt project. Organized and conducted training programs, and oversaw construction work in progress for several U.S. and overseas clients. (1976-1978).

- Project Engineer for 800 km of 400-kV single circuit transmission lines, Iran. Responsible for supervision of all local and expatriate field forces, and inspection and documentation of all phases of construction performed by the installation contractors. Also prepared project reports and submitted them to

the Client for Ministry of Energy, Government of Iran. Trained Client's personnel in construction of electrical facilities. (1973-1976).

August 1972 to November 1973. Neill Price International, Tehran, Iran. Electrical Superintendent for six pumping stations on 730 km of 30 inch crude oil pipeline, and construction of 38 miles of 11 kV 3 phase lines and underground cable with transformer banks.

July 1969 to August 1972: Bechtel Corporation, Gaithersburg, Maryland. Electrical Superintendent. Duties included supervision of the installation of two 500-kV and one 230-kV switchyards.

January 1967 to July 1969: A.S. Shulman Electric Company, Los Angeles, California. Electrical Superintendent in charge of construction of a Hydroelectric Power Plant and Dam. Direct supervision for the installation of 500-kV switchyard.

January 1955 to January 1967: Arch Dam Electric Co., Denver, Colorado. (Partnership-50% owner) Electrical Construction and Engineering Company. Supervision of construction of over 850 miles of REA and distribution lines in Colorado, Wyoming, and Nebraska.

Responsible for stringing of 80 miles of 345-kV, line erection of towers and stringing 240 miles of 230-kV steel tower line and construction of 230-kV substations for the U.S. Bureau of Reclamation.

Construction of 115-KV substations for Denver Water Board and the City of Fleming, Colorado. Constructed approximately 250 miles of 138-kV H-Frame line for the U.S. Bureau of Reclamation.

For 10 years, did operation and maintenance work for the Denver Water Board's distribution lines and substations.

Experienced in using helicopters for moving equipment and setting towers in inaccessible areas.

1952 to 1955: Worked for the U.S. Bureau of Reclamation as Electrician and Working Foreman, 115-kV Substation construction.

Client Reference:

Middle East Oil Pipe Line
Mr. Larry K. Bump
Chairman and President
Williams International Group Inc.
Tulsa, Oklahoma
(918) 496-7000

2264B

the Client for Ministry of Energy, Government of Iran. Trained Client's personnel in construction of electrical facilities. (1973-1976).

August 1972 to November 1973. Neill Price International, Tehran, Iran. Electrical Superintendent for six pumping stations on 730 km of 30 inch crude oil pipeline, and construction of 38 miles of 11 kV 3 phase lines and underground cable with transformer banks.

July 1969 to August 1972: Bechtel Corporation, Gaithersburg, Maryland. Electrical Superintendent. Duties included supervision of the installation of two 500-kV and one 230-kV switchyards.

January 1967 to July 1969: A.S. Shulman Electric Company, Los Angeles, California. Electrical Superintendent in charge of construction of a Hydroelectric Power Plant and Dam. Direct supervision for the installation of 500-kV switchyard.

January 1955 to January 1967: Arch Dam Electric Co., Denver, Colorado. (Partnership-50% owner) Electrical Construction and Engineering Company. Supervision of construction of over 850 miles of REA and distribution lines in Colorado, Wyoming, and Nebraska.

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1952 to 1955: Worked for the U.S. Bureau of Reclamation as Electrician and Working Foreman, 115-kV Substation construction.

Client
Reference:

Middle East Oil Pipe Line
Mr. Larry K. Bump
Chairman and President
Williams International Group Inc.
Tulsa, Oklahoma
(918) 496-7000

2264B

C EVALUATION CRITERIA
TECHNICAL COMPETENCE
Project One
D.2 Project Two
D.3 Project Three

Wasatch Electric
David Lyons - President
Salt Lake City, Utah
(801) 487-4511

USBR
Barney Bellport - Chief Engineer
Golden, Colorado

USBR
Jim Oldsen - Manager T & D
Loveland, Colorado
(303) 667-4410

HARZA-EBASCO

JOHN F. SZABLYA

Job Title:	Power Systems Engineer
Work Location:	Bellevue
Education:	Technical University of Budapest, Diploma (equivalent to M.S.), Mechanical Engineering, Electrical Option: 1947, Technical University of Budapest, Ph.D. Economics: 1948
Special Qualifications:	State Regulatory Commission Expert Witness Testimony - 1976 and 1981.
Professional Registration:	State of Washington-Province of British Columbia Great Britain
Parent Company:	Ebasco Services, Incorporated

Experience and Qualifications Relevant to the Susitna Project:

November 1981 to Present: Presently Electrical Consulting Engineer at the Bellevue, Washington office of Ebasco Services Incorporated. Dr. Szablya has overall resonsibility for consulting services offered in the areas of electric energy generation, transmission, distribution, control, management and industrial applications. Feasibility and design studies are made also under the direct supervision of Dr. Szablya.

- Overall responsibility as lead engineer for the design of the Kake-Petersbury Intertie in Alaska. The line will cross some environmentally sensitive areas, therefore will require careful technical design. Detailed evaluations were necessary to the economic feasibility and environmental compatibility of the intertie.

- Lead engineer for the Tyee Lake System Studies, an independent study within the framework of the Kake-Petersburg Intertie contract. Detailed studies were made on the Tyee Lake-Wrangell-Petersbury line under construction to assure that the line, which has four undersea cable crossing sec-

tions, will perform satisfactorily under all anticipated operational conditions.

- Participated in the Flathead Valley Alternate Transmission Study which investigated several alternatives, including non-electric-transmission versions. Project responsibilities involved the assessing of the loading and overloading capability of the entire area transmission system and to help establish load/generation schedule alternatives.

September 1963 to November 1981: Dr. Szablya authored a report, as an independent consultant, for the Trinidad and Tobago Electricity Commission. The report gave concrete recommendations regarding the development plans of the system which is planned to have a capacity close to 1,500 MW in the near future to serve the 1.3 million people of the two islands. The analysis addressed itself to the spectacular load growth (over 10% per annum), the effects of population drifts and heavy industrial developments which take place.

- Did studies in conjunction with the licensing process of the Colstrip 2 generation unit, in Colstrip, Montana. The studies involved assessment of different transmission line routings between Colstrip, Montana and Spokane, Washington, consideration of alternate sites for the power plant and comparing the costs and feasibilities of high voltage transmission and shipping the coal between the two places mentioned above. Dr. Szablya's report was submitted to the Montana PUC and he testified as an expert witness before the Commission.

- Made a detailed study of the performance and operation of the Malin Substation of the 500 kV Pacific Northwest Intertie on the Orgeon-California border, following an accident that seriously damaged the 300 MVA transformer, phase shifter and other equipment. The study involved not only the substation itself, but some 500 circuit miles of transmission lines and their protection and communication system. The anaysis came up with definite conclusions regarding the orgins of the problems involved.

- Project Manager for the testing and evaluation of the two 26,000 MVA, 230 kV circuit breakers tested on the 230 kV Pacific Northwest system. As a result, the manufacturer could, and did, increase the ratings of its circuit breakers. The testing affected EHV lines owned by several area

utilities and required extensive advanced coordination for each of the test series lasing for several days.

Client References:

Project Name: Kake-Petersburg Interties
Tyee Lake System Studies
Miles C. Yerkes
Remy Williams
Alaska Power Authority
334 West Fifth Avenue
Anchorage, Alaska 99501
(907) 276-0001

Project Name: System Reliability and Development
Grounding & Lighting & Surge Protection Design
Leo Martin
Trinidad & Tabago Electricity Commission
63 Frederick Street
Port of Spain - Trinidad W.I.
(809) 62-32684

Project Name: Flathead Valley Alternate Transission Study
Judy Woodward
Bonneville Power Administration
825 N.E. Mulnomah, Lloyd Tower, 18th Fl.
Portland, Oregon 97232
(503) 230-5756

Project Name: Colstrip 2, License Application
Donald Olson
Washington Water Power Company
P.O. Box 3727
Sponkane, Washington 99220
(509) 489-0500

Project Name: Pacific Northwest-Southwest Intertie Malin Substation
Henry K. Elliot
Engineering Department- Travelers
1 Tower Square
Hartford, Connecticut 06115
(203) 277-3283

HARZA-EBASCO

G. M. TALGER

Job Title: Foundation Design, Transmission Lines and Substations

Location: Bellevue

Education: B.S. in Civil Engineering, Robert College, 1962-1966, Istanbul, Turkey
M.S. in Civil Engineering (Major, Structures and Foundations)
Worcester Polytechnic Institute, 1967-1968, Worcester, Massachusetts

Professional Registration: Illinois

Parent Company: Harza Engineering Company

Experience and Qualifications Relevant to the Susitna Project:

December 1977 to Date. Harza Engineering Company.

Senior Transmission Engineer. Planning and design of EHV transmission lines.

- Tranmsission and Lead Structural Engineer for Tri-State's 345 kV Hayden-Blue River transmission line. Analysis of climatological data, development of line design criteria, establishing loadings, evaluation and design of all structure and foundation types, line cost estimates, preparation of technical specifications and the comprehensive design manual for the project.

- Resident Transmission Engineer, assigned to the 500 kV Lyallpur-Multan Guddu project, Pakistan, 1977 to 1981. Planning, design, and construction supervision for a 330 mile single circuit 500 kV line, including installation of 4 ft. and 5 ft. diameter cast-in-place piles for reinforced concrete river crossing foundations. Design of foundation types on the transmission line. Review of steel transmission tower and 220 kV switchyard structure designs and manufacturer's drawings. Preparation of plans, designs and specifications for use in project tender documents, tender documents, tender evaluations, construction contract surveillance, administration and inspection. Inspection of construction materials.

July 1969 to December 1977. Sargent & Lundy, Chicago, Illinois.
Trasmission and Substation Structural Engineer. Responsible for the design and engineering of transmission lines and substations up to 500 kV. Responsibilities included studies for design and loading conditions, writing specifications, analyzing suppliers; proposals and making recommendations. Designed caissons, grillages, spread footings and piles for tower foundations. Formulated design criteria and calculated design loads for all kinds of transmission towers.

Client References:

1. Adrian Rojas
   Project Eng. & Civ. Eng. Sect. Man.)
   Tri-State Generation and Transmission Association, Inc.
   12076 Grant Street
   P.O. Box 33695
   Denver, Colorado 80233
   (303) 452-6111

2. Don O. Johnson
   Elect. Engineer
   Illinois Power Company
   500 South 27th Street
   Decatur, IL 62525
   (217) 424-6765

3. Dale Wallskog
   Transmission Engineer
   Northern Illinois Public Service Company (NIPSCO)
   5265 Homan
   Hammond, Ind. 46325
   (219) 853-5564

HARZA-EBASCO

JAMES JIA-NAN LIU

Job Title: Structural Design - Transmission Line and Substations

Location: Bellevue

Education: Master of Science in Civil Engineering, 1960, University of Tennessee
Bachelor of Science in Civil Engineering, 1954, Taipei Institute of Technology, Formosa

Professional Registration: Professional Engineer - Illinois
Structural Engineer - Illinois

Parent Company: Harza Engineering Company

Experience and Qualifications Relevant to the Susitna Project:

January 1961 to date: Harza Engineering Company, Lead Structural Engineer, Structural Analysis and Design Section. Responsible for supervision, design, analysis, and review of advance hydrostructures including arch and gravity dams, penstocks, intakes, power tunnels, transmission tower, switchyards and substations.

- Lead Engineer for 345 kV transmission line towers for Hayden-Blue River Project, Colorado. Supervised design, analysis, and preparation of contract drawings.

- Lead Engineer for Antelope Valley Project and Missouri Basin Power Project, North and South Dakota. Supervised review and analysis of 500 kV, 345 kV and 235 kV transmission line towers and foundations.

- Responsibilities including supervision, preparation of design, drawings and technical specifications for 765 kV double circuit transmission towers and microwave antenna towers and their foundations for Guri Project, Venezuela; and design and preparation of construction drawings for 230 kV trasmission line towers, aluminum substation structures and foundations for Mayfield 4th Unit, Washington.

- Responsibilities including review and analysis of 500 kV transmission towers for WAPDA project, Pakistan; supervision of design and preparation of drawings for 115 kV transmission towers for CEL project, El Salvador; review and analyses of Karun 400 kV tranmission towers, and Reza Shah Kabir Switchyard structures, Iran; Cerron Grande 115 kV transmission tower; and design and preparation of drawings for substation foundations for CEL system expansion project and Cerron Grande project, El Salvador; 400 kV transmission towers for Guri project, Venezuela; reanalysis of Columbia-Wyocena 345 kV line steel poles for failure investigation, Wisconsin.

- Responsibilities including design and review of steel penstocks, welding procedures for Guri Project, Reza Shah Kabit Project, Uribante-Dorados Project, Venezuela, and Ullum Project, Argentina; and design of steel liners for Chicago Deep Tunnel Project.

- Responsibilities including supervision of stability analyses for Guri gravity dam monoliths, and steel penstocks and intake strucures, Venezuela; design and preparation of drawings for arch dam, spillway and intake structures for Foothills project, Colorado and for Reza Shah Kabit project, Iran.

- Responsibilities including analysis of arch stresses by using the trial-load methods for Foothills arch dam, Reza Shah Kabir arch dam, Mossyrock arch dam, Santeetlah arch dam and Calderwood arch dam. Responsible for reanalyses of existing dams, such as Cheesman gravity dam, Big Dalon dam, Santeetlah arch dam, Calderwood arch dam, High Rock gravity dam, Narrows gravity dam and Yardkin Falls gravity dam for dam safety investigation.

- Other responsibilities included the design of switchyard pull-off structures and post-tension concrete stoplogs for Robert S. Kerr project, Oklahoma; design and stability analyses of thrust blocks and gallery opening on the Mossyrock arch dam; review of structural design for tunnel linings and tunnel gate shafts by using finite element method for Tarbela dam project; design of concrete steel liner conduit for Burfell project; and design of suspension bridge for fish migrant flume of Mayfield project.

September 1954 to January 1959: Water Resources Planning Commission, Formosa, China. Civil Engineer. Responsibilities included primary planning of the main irrigation canal and laterals, primary designing of the syphon of Ta-Chia Chi-Cross-river; and primary designing of the flumes, culverts, chutes, tunnels and other irrigation systems structures for the Ta-Chia Chi Valley project.

Client References:

1. Mayfield Unit #4 and Switchyard
City of Tacoma
Department of Public Utilities
3628 South 35th Street
Tacoma, Washington 98411
Attention: Mr. A.C. Herstrom
(206) 383-2471

2. Antelope Valley 345 and 500 kV Transmission
Mr. Jim Miller
Basin Electric Power Cooperative
1717 East Interstate Avenue
Bismark, North Dakota 58501
(701) 223-0441

C EVALUATION CRITERIA
TECHNICAL COMPETENCE
D.1 Project One
D.2 Project Two
D.3 Project Three

HARZA-EBASCO

ROBERT B. STYLES

Job Title: Contract Document Preparation

Work Location: Bellevue

Education: Bachelor of Science in Mathematics 1965,
Illinois Institute of Technology

Parent Company: Harza Engineering Company

Experience and Qualifications Relevant to the Susitna Project:

March 1960 to April 1970 and December 1974 to Date: Harza Engineering Company, Chicago, Illinois. Assistant Head, Contract Documents and Technical procurement Section. Responsible for the preparation and issuing of contract documents for construction and equipment supply. Work involves the writing of contractual provisions and review and editing of technical specifications written by Harza design specialists. Mr. Styles is also responsible for overseeing the production, printing, and issuance to bidders of the contract documents and for translation to other languages when necessary.

- Preparation of construction and material supply contract documents for transmission and distribution line projects in the U.S., Egypt, and Latin America (1965-82).

- Responsible for preparation of four construction contracts and eight equipment contracts in Buenos Aires, Argentina for the Corpus Hydroelectric Project. Documents were prepared in both Spanish and English (1982).

- Responsible for preparation of all contract documents for the Guri Project Powerhouse No. 2, Venezuela; Urbante-Doradas Project, Venezuela, and Yacyreta Project, Argentina-Paraguay in English and Spanish. Other recent projects included the Magarin Dam and powerhouse, Jordan; Mayfield powerhouse expansion, Washington; Ullum powerhouse addition, Argentina; and the Hadley Falls powerhouse expansion, Massachusetts (1974-81).

- Lead specifications engineer for several hydroelectric projects, including Guri Project, Stage 1, Venezuela; Karun Project, Iran; Mossyrock, Wanapum, and Priest Rapids Projects, WA: Seneca Pumped-Storage Project, PA; Gualijoyo Project, El Salvador; and Canaveral and Rio Lindo Projects, Honduras (1963-70).

April 1970 to December 1974. Head of Contract Department, Cook County (IL) Department of Purchases. Was responsible for all contracts for construction, supplies, and services encompassing an annual volume of approximately $20 million. Work included preparation of contract documents; receiving and evaluating bids; recommendation of award of contract; preparation and processing of contracts, bonds, and change orders; amd review and approval of payment certificates.

October 1965 to April 1970: Harza Engineering Company, Chicago, Illinois. Assistant Head. Specification Department. Responsible for writing contractual provisions for contract documents and review and coordination of technical specifications; overseeing the final typing, proofreading, printing, binding, and issuing to bidders of contract documents; preparing lists of bidders for various construction and equipment contract; writing advertisements for bids for publication in newspapers and engineering magazines.

March 1960 to October 1965: Harza Engineering Company, Chicago, Illinois. Clerk-Proofreader. Specifications Department. Duties included preparing copies of contract documents for review of engineering staff and clients; proofreading contract documents after final typing, keeping bidders up-to-date; keeping files of specification material; writing routine letters for transmitting contract documents to clients and bidders.

C EVALUATION CRITERIA
TECHNICAL COMPETENCE

1 Project One

D.2 Project Two

D.3 Project Three

SURVEYING

HARZA-EBASCO

HARZA-EBASCO

HERMAN D. COLLET

Job Title:	Lead Surveyor
Location:	Anchorage
Education:	Bachelor of Science, Electrical Engineering, 1953, University of Florida, Associate of Arts, University of Florida
Special Qualification:	Past President, Daytona Beach Chapter, Florida Engineering Society; Chairman, Electrical Engineering Committee (1 year)
Professional Registration:	Professional Engineer - Florida and Georgia Land Surveyor - Florida
Parent Company:	Harza Engineering Company

Experience and Qualifications Relevant to the Susitna Project:

October 1968 to January 1978 and May 1980 to Date: Harza Engineering Company.

- Supervising Distribution Engineer for U.S.A.I.D. Project, Cairo, Egypt, May 1980 to Date. Rehabilitation and expansion of the Electrical Distribution Systems for Cairo, Alexandria, Shibin El-Kom and Beni Suef. Responsibilities included advice and assistance to the Egyptian Electricity Authority in the preparation of construction standards, procedures, design and installation schedules, and coordination of training for the installation of 66 kV, 11 kV and 380/230 V distribution equipment.

- Supervising Distribution Engineer, Cairo, Egypt, 1977 to 1978. Advised and assisted the Egyptian Rural Electrification Authority in the selection and organization of 66 kV transmission and distribution lines for 13 Rural Zones of the Authority.

- Resident Manager, Thailand, 1976 to 1977. Responsible for project management logistics and project feasibility study, Thailand Accelerated Rural Electrification. Superivisor of four-man team providing advisory services to the Office of Rural Electrification on construction practices,, management and coordination of the construction of electrical distribution lines and substations.

- Supervising Distribution Engineer, Electric Utility Management Project, Iran, 1968 to 1976. Responsible for the development of methods, techniques and procedures for development and

engineering management of six regional electric utility companies in Iran. Responsible for the three-stage development plan for the electric utility system of the City of Tabriz.

C. T. Main, Boston, Massachusetts, 1979-1980. Senior Engineer. Engineered and prepared cost estimates for 380 kV overhead transmission lines and underground high pressure pipe cable in Kuwait. Prepared designs, cost estimates and specifications for turn-key engineering, materials, supply and erection of substations and distribution facilities for elctrification of 3 provinces in southwest Saudi Arabia.

1964 to 1968. Self-employed, Florida. Engaged with twelve employees in private consulting engineering work relating to electric projects.

1953 to 1964. Florida Power and Light Company, Florida. Engineer. Responsibilities for both overhead and underground systems including underground engineering, substation design, voltage regulation and system overcurrent protection and coordination.

Client References:

1. Property Survey
   Bruce H. Davis
   3155 East Central Avenue
   Crescent City, Florida 32012
   (904) 698-1747

2. Property Survey
   C. Joe Asbury
   Realtor
   234 North Summit Street
   Crescent City, Florida 32012
   (904) 698-2641
   (904) 698-2776

3. Transmission Line and Substation Site Surveys
   Florida Power & Light
   P. O. Box 151
   Daytona Beach, Florida 32015
   Mr. W. D. Eirzin, Manager Land & ROW Dept.
   (904) 257-7182

C EVALUATION CRITERIA
TECHNICAL COMPETENCE

1 Project One

D.2 Project Two

D.3 Project Three

GEOTECHNICAL

HARZA-EBASCO

HARZA-EBASCO

NORMAN R. TILFORD

Job Title:	Lead Geotechnical
Work Location:	Anchorage
Education:	Arizona State University M.S. - Geology: 1966 Arizona State University B.S. - Geology: 1958
Special Qualifications:	Mr. Tilford has work on significant projects as an employee of Harza in the 1960's and Ebasco in the 1970's. This background will be a special asset to the Harza-Ebasco geotechnical team since he is familiar with the policies, procedures and senior staff of both organizations. Mr. Tilford holds joint appointments as Chief Geologist of Ebasco Services and Associate Professor of Engineering Geology in the graduate faculty of Texas A & M University. He has twenty-two years experience in civil engineering projects, geological studies, and research for hydroelectric, irrigation and nuclear projects including expert testimony before judicial and regulatory bodies.
Professional Registration:	Registered Professional Geologist in the States of Arizona (by examination), Georgia, Oregon and Delaware. Registered Engineering Geologist in the States of California, Idaho and Oregon.
Parent Company:	Ebasco Services, Incorporated

Experience and Qualifications Relevant to the Susitna Project:

1974 to Present: Consulting Geologist and Chief Geologist for Ebasco Services, Inc. In responsible charge of Earth Science aspects of Ebasco projects. On a part time basis, teaches aspects of level courses at Texas A & M University. Provides expert testimony before regulatory and judicial bodies as needed to support and defend the findings of corporate scientific investigations in the earth sciences. Reviewed foundation prepa-

ration and treatment for the 100' high rock fill dam at the Shearon Harris Nuclear Plant in 1980-81. Participated in review and licensing hearings for the Davis Pumped Storage Project in West Virginia.

1969 to 1974: Consulting geologist on dam inspection at the Peti Hydroelectric Project (Brazil) for Centrais Electricas Brasileiras, S.A. Resident Chief Foundation Engineer on Keban Hydroelectric Development (Turkey), Units 1-4, 620,000 kw, including 680 ft. high rockfill dam, twin 51 ft. diversion tunnels, 278 ft. high concrete gravity intake section, and 525,000 cfs concrete ogee and chute spillway and more than 15 km of hard rock tunnels and adits. Responsible for the undertaking of geotechnical studies for inspection of hydroelectric projects, as required by Federal Energy Regulatory Commission regulation, performed for Carolina Power and Light Company and geotechnical studies for Pacific Power and Light Company (Yale Pumped Storage) and Public Power Corporation, Athens, Greece (Kastraki Reservoir Study).

1966 to 1969: Philadelphia Port Corporation, Resident Engineer for planning and construction of a seven berth marginal marine terminal. Site selection studies encompassed environmental impact, foundation conditions and engineering economic considerations. The terminal consisted of a permanent steel sheet cellular bulkhead, dredged land filling, pile supported relieving platform and above grade elements including cranes, paving, rail facilities and transit sheds.

1965 to 1966: Arizona State University; holder of Inspiration Cooper Company Graduate Scholarship. Completed studies for MSc.

1960 to 1965: Harza Engineering Company. Participated in overseas projects in West Pakistan and Ethiopia as Engineering Geologist, Resident Engineer, and Contracts Engineer, involving ground water development, hydroelectric and irrigation planning and construction and construction materials processing. Projects included Magla Dam, Tarbela Dam Investigation, West Bank Indus Groundwater Project, Tanda Dam, Dhok Pathan Dam, Gomal River Scheme, Finchaa Hydroelectric Project and the Central Quarrying Contract for the Indus Basin Scheme. In the U.S., acted as Resident Representative for the excavation and grouting of the Markland Powerhouse Foundation.

1958 to 1960: U.S. Army Corps of Engineers, Los Angeles District; Engineering Geologist. Inspected foundation preparation and grouting treatment for Corps flood control projects and explored for missile sites.

Client References:

Project Name: Keban Dam, Turkey
Devlet Su Isleri
Mr. Refik Akarun
Head of Dam Division, DSI
Ankara, Turkey
Tel 90-41-181100

Project Name: Portland General Electric Company
Service Bldg. Bridge
121 SW Salmon Street
Portland, Oregon 92704
Mr. Raymond Halicki, Jr.
Generation and Facility Engineering
(503) 226-8060

Project Name: Shearon Harris Dams, North Carolina
Carolina Power & Light Co.
336 Fayetteville St.
P.O. Box 1551
Raleigh, North Carolina 27602
Mr. T. H. Wyllie, Manager Construction
(919) 836-6111

C EVALUATION CRITERIA
TECHNICAL COMPETENCE

1 Project One

D.2 Project Two

D.3 Project Three

RESUMES
ALTERNATES

HARZA-EBASCO

0 0 2 4 0

HARZA-EBASCO

JAMES JAY KELLER

Job Title: Project Manager

Location: Anchorage

Education: Bachelor of Science in General Engineering, 1953, University of Illinois

Professional Registration: Professional Engineer - Illinois, Michigan, New York and Colorado
Registered Land Surveyor - Illinois and Michigan

Parent Company: Harza Engineering Company

Experience and Qualifications Relevant to the Susitna Project:

January 1965 to September 1968 and May 1973 to date: Harza Engineering Company. Responsible for all phases of transmission and distribution engineering, review and overall supervision of T & D projects.

- Project Manager for Tri-State Generation and Transmission Association, Inc. Hayden-Blue River 345 kV Transmission Line in Northwestern Colorado. This line crosses Gore Pass at an elevation of approximately 10,500 feet and is 95 miles long.

- Antelope Valley - Broadland transmission line, North and South Dakota. 275 miles s/c 500 kV line for Basin Electric; 30 miles 345 kV d/c line and 350 miles of 345 kV s/c lines in U.S.A.

- Project Manager for 500 kV Upgrading Study for Water and Power Development Authority, Pakistan, to determine design parameters for 500 kV substations and compensation requirements.

- Project Manager for extension of 500 kV Transmission System, Gudu to Multan and Lyallpur, Pakistan. 330 miles of single circuit line passing through desert area and crossing of three major rivers, including one 220 kV substation. System studies, design, material procurement and construction management were included in this project.

- Project Manager for TAVANIR EHV Transmission System, Iran. Project includes 800 kilometers of single circuit 400 kV transmission line over half of which passes through elevated mountainous terrain at elevations up to 9,000 feet. Project also includes four 400/230 kV, 150 to 200 MVA substations in the severely contaminated desert areas, design and construction surveillance.

- Provided home office technical support to Distribution Rehabilitation projects in Thailand, Egypt, Pakistan and South America.

1953 to 1955, 1960 to 1962, 1968 to 1973. Commonwealth Associates, Inc., Jackson, Michigan.

- Substation Project Manager for special projects including 345 kV substation design review for Taiwan Power Company, establishing criteria for substation bus design, and preparing proposals for substation, transmission and distribution work. Also provided technical back-up to Rio de Janeiro Office of Inter-America Consultants, Inc.

- Resident Director of Technical Operations, Inter-America Consultants, Inc., Rio de Janeiro, Brazil (subsidiary of Commonwealth Associates). Responsible for engineering supervision and design of nearly 2,000 miles of 500, 345, and 230 kV transmission lines, two 345 kV, one 230 kV and three 500 kV substations.

- Project Manager of 500 and 230 kV substations, Gulf States Utilities (Texas), and worked on Delmarva Power and Light 500 kV/230 1300 MVA substation and preliminary studies for 345 kV switchyard at the Ohio Edison Bruce Mansfield Plant, Pennsylvania. Also participated in studies and preliminary design work on the economic and technical feasibility of 764 kV transmission systems.

1962 to 1965, Miner and Miner International, Lahore, West Pakistan. Electrical Engineer on design of 800 miles of 132 and 66 kV transmission line, and 500 miles of 11 kV distribution line.

- 1955 to 1960, George E. Snyder Associates, Jackson, Michigan. Structural Engineer and Head, Surveying Department. Responsibilities included design development and testing of aluminum alloy, modular distribution substation structures for 13 43.5 and 69 kV as well as small highway bridges, and all surveying operations of the firm.

Client References:

1. Clinton-Oreana 345 kV Line
   Mr. Dick Leeds
   Illinois Power Company
   500 S. 27th Street
   Decatur, Illinois 62525
   (217) 424-6723

2. Columbia-Wyocena 345 kV Line
   Clark Kimball
   Madison Gas and Electric
   100 North Fairchild Street
   Madison, Wisconsin 53701
   (608) 252-7288

3. Hartburg 500-230 kV Substation
   Mr. Lewis Gutherie
   Manager Engineering
   Gulf States Utilities Co.
   285 Liberty Street
   Beaumont, Texas 77701
   (713) 838-6631

4. Hayden-Blue River 345 kV Line
   Mr. Ben Brickhouse
   Tri-State G & T
   Thornton, Colorado 80241
   (303) 452-6111

HARZA-EBASCO

JURGEN O. C. KANSOG

Job Title: Lead Engineer Transmission

Work Location: Bellevue

Education:
Polytechnic Institute of Brooklyn, BSEE-1971
Polytechnic Institute of New York, MS - Engineering Management - 1977
Escola Tecnica Mackenzie, ET - 1959
Universidade de Sao Paulo - Department of Physics - 1960
General Electric - Seminar on Optimized Transmission Line Design - 1971
EEI Seminar on UHV Transmission - 1972
CPA Seminar on Transmission Line Route Selection - 1974
General Electric Power System Seminar - 1974

Ebasco Course on Boiling Water Reactors - 1976
Ebasco Course on Nuclear Power Plant Technology - 1978

Special Qualifications: Presented technical papers on:

"Sags and Tensions by Computer" October 1973 issue of Transmission and Distribution Magazine

"The Indian River Crossing: A combinations of Aesthetics and Engineering" presented to the EEI T & D Committee in January 1975

"The Laguna Verde 400kV/230 Hybrid Gas Insulated Substation (GIS)" IEEE Paper A80 095-0, February 1980.

"Selection, Design and Testing of the Hot Line Insulator Washing System of the Laguna Verde Nuclear Station's Switchyards", (coauthor) presented at the IEEE Mexicon-81.

Professional Registration: Professional Engineer - New York & New Jersey

Affiliations:

Senior Member - Institute of Electrical and Electronics Engineer (IEEE), IEEE Power Engineering Society; IEEE Industry Applications Society; Member of CIGRE

Parent Company: Ebasco Services Incorporated

Experience and Qualifications Relevant to the Susitna Project:

Registered Professional Engineer with over twenty-two years experience in construction and engineering, with major emphasis on electrical design engineering of electrical transmission line systems, substations and hydroelectric power plants. Project Manager for transmission line and substation projects. Responsible for directing a group of engineers and designers executing complete transmission line and substation projects. Also responsible for directing a group of lighting and communication engineering specialists. Was responsible for directing a group of engineers performing all electrical engineering on a pumped storage hydroelectric power plant. Was responsible for all generic aspects of power plant cable and conduit list preparation, development of standard engineering procedures, development of computer programs and conceptual and cost studies for electrical transmission and distribution research facilities. Was responsible for directing a group of engineers and designers performing all design engineering of AC/DC conversion equipment.

- Experience includes, four transmission line and substation projects, complete feasibility, cost and optimization studies, development of design criteria, detailed engineering, conductor, insulation, structure type selection, structure load calculations, equipment and material selection, preparation of specifications, bid evaluations, proposal preparations, transmission line route and substation site selections and field inspection. Construction experience includes inspection and supervision of transmission line and substation construction, topographic surveying, field design and modifications, training of field engineers and administrative tasks for contract administration.

- Also includes design engineering, testing and start-up of industrial AC/DC conversion equipment including rectifiers, transformers, saturable reactors, relaying and distribution substations.

Representative Experience:

Terror Lake Project, Alaska-138kV Transmission Line

Interconnection Project, Centromin-Electroperu (Peru) 220/138/50kV
Transmission Lines, WPPSS 500/230kV
Pumped Storage Hydroelectric Plant, Davis
Switchyards (SF6 Gas Insulated), CFE 400/230kv

Switchyard Study, Idaho 345kV
Transmission Line study and basic design, Jacksonville Electric Authority, 230kV
Large River Crossing and Basic Design, Jacksonville Electric Authority, 230kV
Large River Crossing, Carolina Power & Light Company, 230kV
Large River Crossings, Florida Power & Light Company, 230kV
Wood H Frame Transmission Line, Vermont, 138kV
Transmission Line Study, Florida Power & Light Company, 500kV
Transmission Research Facilities Study, EPRI
Several Transmission Line Projects, CCD, 345kV
Transmission Line, Chile, 69kV
Transmission Line, Millstone, 345kV
Transmission Lines, Ghana, 161kV
Substations, Ghana, 161kV
Various AC/DC conversion equipment, up to 10 kA
Transmission Line, Brazil, 400kV

Employment History:

Ebasco Services Incorporated, New York, New York; 1966-Present

- Supervising Engineer, 1976-Present
- Principal Engineer, 1972-1976
- Senior Engineer, 1969-1972
- Engineer, 1968-1969
- Assistant Engineer, 1966-1968

Kaiser Engineers and Constructors, Incorporated, Oakland, CA; 1963-1966

- Field Engineer (Construction Supervisor)

Prodelec S/A, Sao Paulo, Brazil; 1960-1962

- Engineer

Cia Auxiliar de Empresas Eletricas, Brazil; 1959-1960

- Field Engineer (Construction Supervisor)

Cia Cimento Vale do Paraiba S/A, Brazil; 1956

- General Maintenance and Transport Supervisor

Siderurgica Barra Mansa, S/A, Brazil; 1955-1956

- Assistant to Manager of Hot Rolling Mill

Cogeral S/A, Brazil; 1953-1955

- Assistant Chemist

Client References:

Cincinatti Gas and Electric Company
345kV Transmission Lines
R. Swanson or E. Kallendorf
139 East Fourth Street
P. O. Box 960, Cincinatti, Ohio 45201
(513) 381-2000

Jacksonville Electric Authority
230kV Transmission Lines Studies
G. Abdullah - Head Transmission & Substation Division
233 West Duval Street
P. O. Box 5315, Jacksonville, Florida 32201
(904) 633-4990

HARZA-EBASCO

NORBERT MUELLER

Job Title:	Structural Design-Transmission Line & Substations
Work Location:	Bellevue
Education:	University of Colorado City College of New York Wyle Lab. Seminar Wind Seminar & Structure Loading
Special Qualifications:	Over twenty-six years of related experience with emphasis on studies, estimates, preparation of specification, procurement of material, bid analysis evaluation and purchase recommendations. Associated with all transmission line and substation work done by Ebasco since 1956.
Professional Registration:	None
Parent Company:	Ebasco Services Incorporated

Experience and Qualifications Relevant to the Susitna Project:

Design and supervision of transmission line structures, substations and hydroelectric generating stations including transmission tower and foundation testing.

Representative Experience:

Client	Project/Transmission Line	Size kV	Responsibility
Centromin-Peru	S/C Yuncan Carhumayo	220	Lead Engineer
Centromin-Peru	S/C Yaupi-Yuncan	138	Lead Engineer
Centromin-Peru	S/C Mahr Tunnel-Oroya Peru	220	Lead Engineer
Washington Public Power Supply System	S/C WPPSS Nuclear Project Unit No. 3 & 5 S/C Tie Lines	500 & 230	Lead Engineer
Central Hudson Gas & Electric Corporation	D/C Roseton-Rock Tavern & New York	345	Lead Engineer
Central Hudson Gas & Electric Corporation	D/C Roston Line, New York	345	Lead Engineer

Client	Project/Transmission Line	Size kV	Responsibility
The Cincinnati Gas & Electric Co.	S/C J M Stuary-Pierce Line, Ohio	345	Lead Engineer
Central Electrica de Furnas, S A, Brazil	S/C Peixoto-Furnas-Belo Horizonte Line, Brazil	400	Sr. Designer
Carolina Power & Light Company	D/C Milboro-Roxboro Line, North Carolina	230	Sr. Designer
Carolina Power & Light Company	D/C Rockingham-Oakboro Line, North Carolina	230	Sr. Designer
Florida Power & Light Company	Lauderdale-Port Everglades Line, Florida	230	Sr. Designer
Arkansas Power & Light Company	Helena-Woodward Line, Arkansas	230	Sr. Designer
Lousiana Power & Light Company	D/C Mississippi River Crossing Vidalia, Mississippi	230	Job Engineer
Louisiana Power & Light Company	D/C Mississippi River Crossing Little Gypsy Plant, Louisiana	230	Job Engineer
Louisiana Power & Light Company	S/C Seven Intercoastal Water-way Crossing, New Orleans, Louisiana Area	230 230	Job Engineer
Montana-Dakota Utilities Company	S/C Missouri River Crossing Bismark, North Dakota	230	Job Engineer
Louisiana Power & Light Company	D/C Mississippi River Crossing No. 2, Taft, Louisiana	230	Job Engineer
Louisiana Power & Light Company New Orleans Public Service Inc.	D/C Mississippi River Crossing Ninemile, Louisiana	230	Job Engineer
Louisiana Power & Light Company	D/C Mississippi River Kaiser-Algiers, Louisiana	230	Lead Engineer

Client
References:

New York State Electric & Gas
Somerset Station
Mr. W. Teegarten - Project Manager
4500 Vestal Parkway East
Binghamton, New York 17902
(607) 729-2551

Louisiana Power & Light Company
Mr. M. Bauer - Transmission Division
142 Delavonde Street
New Orleans, Louisiana 70174
(504) 366-2345

HARZA-EBASCO

NORMAN D. REESE
Electrical Engineer

Job Title:	Relay Engineer
Location:	Bellevue
Education:	Bachelor of Science in Electrical Engineering 1961, Feen College (now Cleveland State University)
Professional Registration:	Professional Engineer - Michigan and Ohio License Journeyman Electrician General Commercial Radiotelephone Licenses Amateur Radio License
Parent Company:	Harza Engineering Company

Experience and Qualifications Relevant to the Susitna Project:

- Harza Engineering Company International, Lahore Pakistan. Substation Commissioning Engineer. Responsible for Contract Administration check-out and commissioning of 220 kV Multan Substation. Supervised installation of Merling Geran 220 kV Air Blast Circuit Breakers. Responsible for all metering control and protection equipment installation and check-out as well as teleprinter and power line carrier equipment of US and European manufactures.

- Currently consulting with various REA Coops in Southern Michigan and Instruction at Michigan State University in Electrical Technology involving instrumentation.

- Independent Consultant offering consulting services to various utility company clients in the following areas:

  - Power System Protection
  - R.I. and T.V.I. Field Strength Measurements
  - Power System Control Circuit Design
  - Industrial Expansion
  - Data Acquisition and Control
  - Instrumentation

November 1966 to April 1978. Commonwealth Associates, Inc., Jackson, Michigan. Principal Engineer responsible for utility and industrial power system substation protection application, settings and field calibration including protection system maintenance, substation control

circuit design application. Supervisory control and data acquisition system application for two years resided in Rio de Janeiro, Brazil as project engineer. Several other short-term assignments including Santa Catarina, Brazil, and Saudi Arabia.

November 1963 to November 1966. Gilmore Industries, Beechwood, Ohio. Test engineer designing and conducting post production testing procedures on tertiary standard automatic test system.

June 1961 to November 1963. Cleveland Electric Illuminating Company, Cleveland, Ohio. Assistant Engineer developing substation and power system control and relay equipment. Established maintenance procedures for power system protective equipment.

Client References:

1. Relay Protection Study
   Karold Dohl
   Iowa Public Service
   Souix City, Iowa
   (712) 277-7500

2. Control Circuit Design
   Richard Conarton
   President
   National Life Corporation
   Leslie, Michigan
   (517) 589-8231

HARZA-EBASCO

RODNEY M. WONG

Job Title: Lead Geotechnical Engineer

Location: Bellevue

Education: Master of Science in Civil Engineering
1962, University of Notre Dame
Bachelor of Science in Civil Engineering
1960, Hong Kong Baptist College

Professional Registration: Illinois

Parent Company: Harza Engineering Company

Experience and Qualifications Relevant to the Susitna Project:

January 1975 to Date. Harza Engineering Company. Senior Geotechnical Engineer. Responsibilities include special assignments to projects involving structural and geotechnical problems; feasibility studies; conceptual design and planning for proposed projects; structural design; preparation and review specifications for contract documents related to reservoirs, dams, spillway, powerhouse, dock facilities, and marine engineering, tunnel and recreational facilities; conducting subsurface exploration programs; and consulting and supervising construction activities.

- Project Geotechnical/Structural Engineer for the rehabilitation studies of all dams along the Croton Watershed system for the City of New York.
- Engaged in the stability study of existing lock structure and prepare final rehabilitation designs including cellular cofferdam, new monoliths of lock wall, intake and discharge manifolds, conduit steel liner, tendon anchor system and bracing system, and construction schedule for the lock and Dam No. 1 Rehabilitation Project, St. Paul, Minnesota, for the U.S. Army Corps of Engineer.
- Dam and Powerhouse inspection, geotechnical field investigations, and stability analysis of Petenwell, Castle Rock and Dubay Dams for the Wisconsin River Power Company.
- Design of fly ash storage facilities for Illinois Power Company; coal processing slurry disposal facility for Turrus Mine (Illinois); lime waste disposal facility for Dow Chemical Plant (Ludginton, Michigan); and tailings storage facility for the Chuquicamata Copper Mione (Chile).
- Design of barge unloading dock facilities for Dow Chemical Plant (Illinois); proposed dock facilities for Inland Steel Company (Indiana).

- Design of an underground reservoir and pumphouse for the Utility Department, Ann Arbor, Michigan.
- Design of a cofferdam and massive bracing system to maintain the stability of a high dam spillway for the Panama Canal Commission, Panama.
- Investigations of foundation structure failure and making necessary corrective measure designs.
- Numerous designs of shore erosion protection, foundation treatment and dewatering system for large construction project.

1973 to 1974. Wong Engineering Consultants, Inc., St. Croix, Virgin Islands. President and Chief Engineer. Highway bridges and pavement design for the St. Croix Cross Island Highway project, design of offshore loading platform for Hess Oil Refinery; St. Thomas Airport project for Virgin Islands Port Authority and the Virgin Islands College Expansion Project in Virgin Islands.

1968 to 1973. Soil Testing Services, Inc., Chicago, Illinois. Senior project Engineer, Project Engineer, and Resident Engineer.

May 1963 to May 1968. Division of Highways, State of Illinois. Responsibilit.'s included field inspection, testing and bridge designs.

Client References:

1. State of New York - Dams
   Mr. Edward Scheader, Deputy Chief Engineer (Design)
   Bureau of Water Supply
   1250 Broadway, 24th Floor
   New York, NY 1001
   (212) 966-7500

2. Lock and Dam No. 1
   Mr. G. John Plump
   Corps of Engineers
   1135 U.S. Post Ofice & Custom House
   St. Paul, MN 55101
   (612) 725-7506

3. Baldwin and Havina Projects
   Mr. H. B. PErkins
   Illinois Power Company
   500 South 27th Street
   Decatur, Illinois
   (217) 424-6975

4. Mr. Larry J. Koshire
Rochester Public Utilities
P.O. Box 6057
Rochester, MN 55901
(507) 285-8990

5. Mr. Richard T. Gallus/Mike J. Kmetz
Pennsylvania Electric Co.
1001 Broad Street
Johnstown, PA 15907
(804) 533-8111

C EVALUATION CRITERIA
TECHNICAL COMPETENCE

D.1 Project One

D.2 Project Two

D.3 Project Three

ALASKA
ENGINEERING
REGISTRATION

HARZA-EBASCO

TABLE B-4

ALASKA ENGINEERING REGISTRATION

Name	Project Position
J. L. Ehasz	Internal Review Board - Geotechnical
R. P. Wengler	Internal Review Board - Structural (Transmission)
N. R. Tilford	Lead Geotechnical
F. M. Carson	Transmission Line Design

Applications Pending Approval

D. Sandiforth	Project Engineer
J. Quinn	Substation

The Joint Venture has tentatively arranged for the University of Washington Cold Regions Engineering course to be given in the Joint Venture office to the technical staff of the Hydroelectric Project. This represents a four day course, with examination on the fifth day, given by staff members from the University of Alaska, the University of Washington and the State University of New York. The Joint Venture intends to assign Transmission and Substation System personnel to this training program as soon as is practicable after notice of the Power Authority's intent to negotiate a contract.

2150B

C EVALUATION CRITERIA
TECHNICAL COMPETENCE

Project One

D.2 Project Two

D.3 Project Three

C TECHNICAL COMPETENCE

Introduction

The Joint Venture has a combined experience record of more than 112 years in the engineering design and construction of high voltage and extra high voltage transmission systems.

Harza's permanent staff of transmission system specialists has provided system development services to investor-owned utilities, Foreign Governments, and public agencies throughout the world for over 35 years. The cumulative experience of this group covers the complete range of transmission system voltages from 34.5 to 765 kV and geographic conditions from desert areas and mountain ranges to cultivated farm lands and the sub-arctic. The scope of Harza transmission projects includes the design of short interconnections to the analysis and upgrading of entire national systems. The variety of disciplines represented in its staff make it possible for the company to provide all of the supplemental services required for the planning, design, and construction management of environmentally acceptable transmission facilities.

Since its founding in 1905, Ebasco has provided engineering and related services for utility, industrial and government clients in more than sixty nations. Many electric utilities and interconnected pooling systems throughout the world have selected Ebasco to plan, design and construct over 25,000 miles of high voltage and extra high voltage transmission lines as well as associated substation projects. Dependable electrical performance, structural integrity, "on-time" completion and low maintenance expenses have been fundamental requirements for each of these projects. Ebasco is able to achieve these objectives at minimum cost through an integrated approach to project execution that utilizes the coordinated efforts of system

planning engineers, electrical engineers and designers, structural specialists, soil engineers, metallurgists, environmental engineers, purchasing personnel, inspectors and expediters, estimators, computer programmers, construction managers and superintendents, field engineers and supervisors, and field accountants.

TECHNICAL COMPETENCE
O/H EHV Transmission Systems

HARZA-EBASCO

C.1 Overhead EHV Transmission Design

Harza Engineering Company competence in the design of overhead EHV transmission lines is based on many years of continuous experience. In Volume II of the proposal a list of transmission line projects from 1970 to 1980 is given for use by the Power Authority reviewers. A summary of recent Harza transmission line projects follows:

The Hayden-Blue River 345 kV transmission line is a project that is presently under design at Harza. Details of this project are given in Section D.1 of the proposal.

Clinton-Oreana 345 kV line structure analysis for the Illinois Power Company was carried out in 1981. Harza did not design this line, but Harza was requested to perform structural analysis after arms of the welded steel towers vibrated and failed during construction.

Columbia-Wyocena 345 kV line of Madison Gas and Electric, at Madison, Wisconsin. On this assignment Harza was requested to investigate failures of the welded steel poles, and to participate in considerable testing of steel by both cracked and uncracked Charpy impact testing during the investigation of brittle failure. Results of the Harza analysis were used by the client's attorneys to obtain a settlement from the pole designer-fabricator.

Other computer programs currently in use include sag template plot stringing, sag-tension data, economic structure application and plotting. Harza transmission personnel are experienced in both design and construction of EHV transmission lines in the U.S.A. and abroad. They frequently call on specialists from other areas of the company to supplement their technical competence when a specialized problem occurs.

Water & Power Development Authority 500 kV transmission line. Harza, in association with a local consulting firm, completed the design and construction management of 300 miles of 500 kV latticed steel tower line in Pakistan. This assignment began in 1976 and was completed in 1981. One special feature of this assignment was that a tower design by others was reviewed and it was found that by a complete redesign of the light suspension tower in the series of six or seven, considerable savings could be realized. Since much of this line was through desert with heavy contamination by sand and salt in relatively flat country, a very high percentage of the 1,400 towers in the line were suspension type. The alternate design proposed by Harza resulted in a savings to the client in material and labor costs of an amount somewhat greater than Harza's fee for the entire project.

Another special feature of this project was a river crossing of nearly nine miles. The Indus River meanders through a wide, flat plain of alluvial material washed out of the Himalayan Mountains. At the river crossing site, Harza hydrologists predicted a scour depth of sixty-five feet. The foundation design utilized four- and five-foot diameter bored cast-in-place reinforced concrete piling. A cluster of three piles connected by a heavy cap at each leg and four-foot by five-foot reinforced concrete grade beams connected the legs, for the final design of the highest towers. A photograph of this structure is included in Volume II.

Guri Powerhouse-Switchyard 765 kV Transmission Connections. Another unusual type of tower design was created as a result of the necessity to bring the 765kV circuits through a narrow downstream gorge from the new powerhouse on the Guri Hydroelectric Project. It was deemed more economical to use a separate 765kV circuit from each unit transformer at the powerhouse to the switchyard. Special double circuit flat configuration 765kV towers were designed for this application.

400 kV Transmission System - Iran. In Iran, Harza specifications for 400 kV single circuit latticed towers specified loading combinations including seismic forces. Avalanche splitters were installed in some locations of the Zagros Mountains where special tower application provided for towers to withstand without failure as much as 3" of radial ice on one span with the adjacent span bare. Cloud icing and rime ice conditions prevailed in some sections of these lines carrying 1000 MW of 50 Hertz power from a hydroelectric generating station also designed by Harza. These lines were built at elevations exceeding 3000 meters. An IEEE paper describing this project is included in Volume II.

Ebasco Services competence in the design of EHV transmission lines reflected in the total listing of projects given in Volume II. In addition it has the following recent experience:

Terror Lake-Kodiak 138 kV Transmission Line. The design of this 17 mile line has recently been completed, and Ebasco is now involved in the construction management. This line uses Corten steel poles that are set on concrete foundations. One special feature of this line is that it is designed for ice loading of 1 to 1-1/2 inch with an extreme wind loading of 36 pounds per square foot.

Centromin-Peru 138/220 kV Transmission Line. This 56 mile long line uses lattice type steel towers and a single 1113 kcmil ACSR Finch conductor. The single circuit line is designed to operate at elevations up to 14,000 feet, and interconnectstwo major electric power systems of Peru; Centromin and Electroperu.

500 kV Transmission Line tap for Washington Public Power Supply Nuclear Plant #3 at Satsop, Washington. This line uses steel pole H-frame type structrues and 2156 kcmil ACSR "Bluebird" conductor. When completed, the transmission circuit will connect the nuclear plant to the Bonneville Power Administration system.

In-house computer facilities and a complete library of technical programs to assist in the design of transmission line facilities are available from the Joint Venture. A list of available transmission line programs is shown in the following table.

TABLE C.1

JOINT VENTURE TRANSMISSION LINE PROGRAMS

- o Sags and Tensions Under Unequal Loading or Broken Cable Conditions
- o Sags and Tensions with Stress-Strain Curves for Level and Non-Level Spans
- o Transmission Tower Spotting (including computerized profile graphics)
- o Ruling Span Calculations
- o Sags and Tensions with Fixed Modulus of Elasticity
- o Structure Loads for Tangent, Angle, Dead-end and Take-off Towers
- o Catenary Plot Coordinates
- o Sags and Tensions including Effect of Insulator Strings, with Fixed Modulus of Elasticity
- o Stringing Data
- o Overhead Conductor Ampacities
- o Stringing and Clipping Off-Set Data
- o Backflashover Calculations
- o Shielding Angle Calculations
- o Ground Potential Rise Due to Zero Sequence Currents
- o Electrostatic Field Intensity Calculations
- o Conductor Gradient Calculations

Structural Programs

- o Pin-Jointed Stress Analysis
- o Rigid Frame Analysis
- o Pin-Jointed Truss Analysis

2261B

Foundation/Soils Programs

- Slip Slope Stability
- Wedge Slope Stability
- Footing Design
- Foundation on Piles
- Design of Caisson Foundations
- Design of Combined Footings
- Reinforced Concrete Column Design
- Reinforced Concrete Beam Design
- Dynamic Analysis of Structures
- Seismic Soil-Structure Interaction

Corrosion and Grounding Programs

- Soil Resistivity Analysis

TECHNICAL COMPETENCE
EHV Switchyards &
Substations

HARZA-EBASCO

C.2 EHV Transmission Switchyards and Stations

The Joint Venture has personnel qualified in all aspects of substation design. Design personnel have worked on a very large number of various types of substations and switchyards.

Personnel are thoroughly experienced in factory witness testing of transformers, circuit breakers and other substation apparatus.

Substation design personnel can provide comparison and reliability studies of physical layouts, switching schemes, and bus support systems. Specialists are also capable of providing control house layouts and styles, and are experienced in providing for future expansion of facilities. Architectural specialists contribute to the aesthetic as well as utilitarian aspects of the houses.

Instrumentation and control specialists are familiar with all types of control, metering and protection equipment. Telecommunication and computer control engineers have extensive experience in data-logging, event recorders and line fault indicators, and recorders. They are also experienced in design and installation of telephone, power line carrier, all forms of radio, and microwave communications equipment.

Substation structural personnel can provide designs suited to specific needs for support and pull-off structures, foundations for structures and equipment, cable trenches, yard work, grading and drainage. They have considerable experience with design of transformer oil retention vaults and facilities as well as fire protection systems. Mechanical design personnel have expertise in air conditioning of control houses, fire protection and remote sensing, and ventilation of battery rooms as well as design of compressed air systems for circuit breaker operation.

Joint Venture personnel also have extensive experience in the design of SF6 gas insulated substations. In the early sixties, Harza designed one of the first substations in the United States using 230 kV SF-6 breakers. Engineers at Harza continued to follow the development of the SF-6 gas insulated substations in Europe because of their compact features and obvious space advantage when used with underground power plants. General acceptance of this new kind of installation led to the design of a 500 kV SF-6 switchyard in the United States, a 230 kV switchyard in Argentina, a 230 kV substation in Iceland, and to the inclusion of SF-6 switchgear in planning for several projects in other countries.

Joint Venture personnel are capable of handling all aspects of substation contruction inspection, supervision and commissioning as well as providing support to the Owners construction manager as part of a construction support role. They are also qualified to provide assistance and inspection services during construction of control houses, installation of major equipment as well as check-out of control, supply and protection wiring.

Harza experience on EHV transmission switchyards and substations since 1946 is presented in a table in Volume II. Following are short descriptions of three major recent substation design projects.

Karun 400 kV Switchyard and 400/230 kV Receiving Substations - Iran

A 400 kV switchyard at the Karun generation station and four 400/230 kV receiving substations, one each at Arak, Ahwaz, Omideh, and Esfahan were commissioned in 1977. The overall scope of this project is analagous to that of the Susitna Project. Engineering services performed by Harza include the following:

1. Site selection and development.

2. Station design including electrical and all related features, such as civil, mechanical, architectural, etc. including provision for seismic loadings.

3. Preparation of contract documents for separate procurement of major electrical equipment as well as for construction. Included were specifications, drawings, assistance in tendering, cost estimates, and bid evaluation.

4. Preparation of construction drawings for switchyard and substations.

5. Services during construction consisted of review of manufacturer's shop drawings, field assistance and assistance in commissioning.

The Karun switchyard was designed for a full breaker-and-a-half switching arrangement for the 4 - 250 MVA generating units and 4 - transmission lines to the Arak, Ahwaz, Omideh, and Esfahan receiving substations. Two of the lines were equipped with three phase 400 kV shunt reactors located in the switchyard.

The substations were designed for an ultimate inverted breaker-and-a-half arrangement. The initial installation of each substation included 400 kV circuit breakers, 400/230 kV autotransformers and associated 230 kV breakers for connection to an existing 230 kV substation. Autotransformer tertiary windings were equipped with shunt reactors for overvoltage protection. In addition, 400 kV shunt reactors were furnished at two of the substations. Transmission line relaying utilized primary and secondary phase and ground distance relays with power line carrier channels.

SF6 Substation At Hrauneyjafoss Power Station, Iceland

Harza provided engineering services for the planning, and design of the 230 kV substation at the Hrauneyjafoss power plant.

Gas insulated switchgear (GIS) at 230 kV is installed in an indoor ring bus switching arrangement for the 3 generating units and 3 transmission lines. The GIS system was selected in place of the initially contemplated open air design in order to avoid flashovers and icing conditions currently being experienced in other open air installations in the country. Transmission line disconnecting switches within the substation are terminated in SF6-to-air bushings from which connections are made to the open-air arresters, wave traps, and potential devices of the transmission lines. Connections from the substation to the transformer's SF6 bushings are made with SF6 bus. This arrangement combines the reliability and space reduction associated with GIS switching equipment with the economics of open air transmission line terminal equipment.

500 kV SF6 Gas Insulated Switchyard, Virginia

A 500 kV switchyard, SF6 gas-insulated at Bath County pump storage plant is scheduled to be initially energized in 1984. Engineering services by Harza include:

Site selection, study to evalute SF6 insulated equipment located on powerhouse roof versus conventional switchyard located nearby, switchyard design, preparation of contract documents and preparation of construction drawings.

The switchyard is designed for a modified 4 breaker ring bus switching arrangement for 3 - 900 MVA step-up transformer banks and 2 transmission lines.

Ebasco has designed many high and extra high voltage substations that are associated with generating facilities. In addition, numerous other substation installations have been provided for transmission switching alone. Almost invariably, wiring diagrams, structural layouts and other proven designs are available from past projects which may correspond to the requirements of the assignment at hand. Review and modifications of these successful designs permit substantial reductions in design cost compared with developing an unproven design. Thus, Ebasco's qualified personnel extensive experience in substation design assures reliable performance, favorable cost and expeditious engineering. Some recent substation and switchyard design projects are:

1. Shearon Harris 500 kV and 230 kV, Air Insulated Substation with a capacity of 4000 MVA and a service date 1980 was engineered and designed for Carolina Power and Light.

2. Laguna Verde 400 kV and 230 kV, air and SF6 gas insulated substation with a capacity of 2100 MVA and a service date of 1979 was engineered, designed and construction managed for Comision Federal de Electricidad/Mexico.

3. La Oroga and Pachachaca 220 kV SF6 gas insulated and 50 kV air insulated Substations with a total capacity of 200 MVA and a service date of 1983 were engineered and designed for Centromin-Peru.

4. Bongi 230 kV, air insulated substation with a capacity of 240 MVA and a service date of 1978 was engineered and designed for Electrobras - Brazil.

5. Anhui 500/230 kV Substation with a capacity ov 1300 MVA in the Province of Anhui of The People's Republic of China (PRC). Ebasco completed conceptual engineering and design for this substation in Fegruary 1981. The Susbstation consists of 500 kv circuit breakers arranged in a breaker-and-a-half scheme, 230 kv circuit arranged in a ring bus scheme, switches and relaying and structural facilities.

6. Shandong 230 kV Substation with a capaciy of 1300 MVA in the Province of Shandong PRC. Ebasco completed conceptual engineering and design for this Substation in February 1984. The Substation consists of 230 kv circuit breakers arranged in a "breaker-and-a-half" scheme, switches, relaying and structural facilities.

D. EVALUATION CRITERIA
EXPERIENCE AND RECORD

1 Project One

D.2 Project Two

D.3 Project Three

TECHNICAL COMPETENCE
Power System Studies

HARZA-EBASCO

C.3. Reviewing and Interpreting Power System Studies

When transmission, substation and control system engineering design work is assigned at the design level, the engineer is often required to begin his work using available work done for the client by other engineers. Much of the experience of the Joint Venture includes assignments that require the use of power system studies by others.

For the 345 kV Hayden-Blue River Line, the client provided a transient network analyses study prepared by others. Harza reviewed this work and identified a specific additional case to be studied. The case was prepared by the engineer that did the original work.

For the Department of Natural Resources and Conservation, State of Montana, Harza reviewed power flow and transient stability evaluations. Based on the review, a report was prepared and expert witness testimony was given.

For the Water and Power Development Authority design of 330 miles of 500 kV line, Harza reviewed the feasibility and power system studies for line design and routes as prepared by the Canadian International Development Authority (CIDA). Based on this review, additional studies were carried out, design criteria were established, and the line design and construction was accomplished. The review included transient stability, short ciruit and load flow calculations. Most of these studies were done by computer, and the data base was given to Harza by the CIDA and converted to the Harza computer format.

The Nashville Electric Service has selected Harza to review a report for the five-year power system expansion plan. This assignment requires review of power system load flow, short circuit studies and associated plans for substation, transmission and distribution expansion. Load flows will be reviewed to determine line loadings, losses, transformer requirements and circuit breaker interrupting ratings.

For the Coal-by-Wire study report in the National Power Grid project, Harza reviewed related past power system reports on the subject. This included such reports as transmission study 190 for the Western states, as well as the annual reports from the nine reliability areas to the D.O.E. Federal Energy Regulatory Administration.

Ebasco has a Consulting Electrical Engineering Department which has a System Planning Group comprised of a team of engineers specialized in every aspect of system studies performance and analysis. This group has many years of experience both in transmission and generation planning as well as in computer simulation of problems. Such plans typically require the analysis of one or many interconnected utility systems.

Transient analysis and stability studies, load flow study, system short circuit study are frequently analyzed to obtain system parameters and characteristics such as overvlotages under abnormal system conditions, maximum and minimum operating voltages, available short circuit currents, system impedances, transient recovery voltages and normal and contingency power flows, which are used by Ebasco for the proper design of EHV transmission systems and for the correct selection and applicaiton of major substation equipment such as circuit breakers, transformers, reactors and capacitors.

Ebasco has recent experiences with three studies for the Power Authority:

Tyee Lake-Wrangell-Petersburg. Ebasco performed system studies of the transmission system. The line comprises 72 miles of overhead lines and four underwater crossings totaling nearly 13 miles, designed originally for 138 kV operation. Five alternatives were developed and a comparative analysis made of their features. Design analysis followed the final selection. The detailed design included the investigation of load flows including contingencies, voltage control, flicker, steady state limitations, system energization procedures, load acceptance, load rejection, short circuit studies and the review of the proposed protection scheme of the system. The proposed system is under implementation.

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The Kake-Petersburg Intertie is a proposed extension of the Tyee Lake-Petersburg transmission line. Ebasco investigated five alternatives, including a single phase ground return system. The selected alternative supplies the fishing village of Kake out of Petersburg through a 54 mile long 24.9 kV three phase transmission line. This line is designed using partly conventional three phase overhead lines, partly overhead aerial (Hendrix) cables with spacers and two underwater cable crossings totaling 1.6 miles. Because of the uniqueness of the line and the remoteness and smallness (1.6 MW by 2015) of the load, the system had to be carefully designed to meet all criteria.

The North Slope Gas Feasibility study requires the design of a transmission system from Prudhoe Bay to Fairbanks (450 miles) and on to Anchorage (330 miles). Out of the 700 and 1400 MW design loads only 20% is consumed in the Fairbanks area. Another scenario assumes generation at Fairbanks and a third one in Kenai. Several alternatives were investigated with 345, 525, 765 kVAC and HVDC systems considered. Because of the long distances involved (up to 780 miles), special attention was given to system studies, which resulted in a system in which even with the loss of one line (or one pole in case of HVDC) stable steady state operation can be maintained.

For Bonneville Power Administration Ebasco performed the Flathead Valley Reinforcement Study. This study investigated the loading capability of BPA's transmission system in western Montana. It included load flow studies to establish alternate methods by which BPA can supply reliable electric power to its customers in the near future. Among the customers was Anaconda's aluminum smelter at Columbia Falls. The system is hydro based.

TECHNICAL COMPETENCE
Critical System Reliability & Operating Design Criteria

D. EVALUATION CRITERIA
EXPERIENCE AND RECORD

1 Project One

D.2 Project Two

D.3 Project Three

HARZA-EBASCO

C.4. Developing Critical System Reliability and Operating Design Criteria

A major function in which the Joint Venture is experienced is the development of critical system reliability and operating design criteria for electric utility bulk power transmission projects.

This is developed through system studies utilizing Load Flow Analysis and System Stability Analysis Programs, and system operating criteria are developed based on reliability requirements and system emergency capacity.

For the Energy and Environmental System Division of Argonne National Laboratory in Illinois Harza carried out a study on the value of reliability. The general scope of this work was to provide consulting aid and information for the EES Division investigation of the value of electrical reliability (VOR). The information provided was directed toward the following three subjects.

- o A perspective in the reliability of the various sectors of the electrical supply system, and the interactions between the various sectors.

- o Discussion of the design options a utility has available to change the reliability of various parts of the transmission and distribution systems.

- o Information concerning outage rates and durations for various components of the electrical system.

On the Coal-by-Wire Study for the U.S. Department of Energy Harza's assignment included the planning of base load generation facilities and an associated 765 kV transmission network. To establish this, generation and transmisson system reliability and operating criteria were established.

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For the generating units the criteria included unit heat rates, outage and availability factors, load factors, as well as fixed and variable operating and maintenance costs. For the transmission network the planning criteria were established based on review of existing system performance requirements established for the nine electric reliability councils. These transmission related criteria included such factors as line loading limits, single and double contingency outage criteria, acceptable low voltage levels during normal and emergency conditions, stuck breaker contingency as well as line losses and reactive compensation requirements.

For Bonneville Power Ebasco analyzed transmission line outage data and developed mathematical models to estimate failure rates for the electric power system of BPA.

For Redstone Arsenal Ebasco performed an evaluation of alternate schemes for incorporating co-generation into the power system. This required an analysis of reliability of the 161 kV system.

For Alaska Power Authority Ebasco determined the DC system reliability for a system composed of 155 miles of overhead line and 45 miles of submarine cables. Several voltages ranging from ± 135 kv DC to 125 kv DC monopolar were considered. Failure rates were developed for the overhead line, cables and DC terminals and the forced outage time and cost of an outage were evaluated for each voltage level considered.

On the Venezuela National Power System Ebasco is planning an integrated power system to coordinate construction of facilities and operation of the national grid.

The work includes setting up reliability criteria for the integrated system and for individual load areas and testing alternative systems to assure that they meet the criteria.

Reliability considerations include outage rates of equipment, availability of water (for hydro generation), performance of the transmission system, and economic justification of the level of reliability used. Recognition is given to reliability aspects of load areas depending upon long distance transmission of hydro energy, rather than local generation, to conserve the nation's natural resources.

For the Charter Company Ebasco determined failure rates and overall system reliability for a ± 400 kv DC system comprised of 30 miles of overhead lines, 64 miles of underwater cables as well as the DC terminals. Mathematical models were developed to determine expected forced outage time and corresponding energy lost per year for the entire system.

For General Public Utilities Ebasco determined failure rates and overall system reliability for a 64 mile underwater crossing of Lake Erie. The system consisted of five, ± 300 kv DC cables and DC terminals. Failure rates were developed using Ebasco in-house data for the cables and terminals and the forced outage time was determined for the entire system.

TECHNICAL COMPETENCE
EHV Protective Relay
Systems & Related
Settings

HARZA-EBASCO

C.5. EHV Protective Relay Systems and Derivation of Related System Settings

The Joint Venture has many years of experience in planning, design, implementaton and commissioning of protection systems for high voltage switchyards and substations. The Joint Venture is staffed to provide complete engineering services for the protective relaying, control and commissioning aspects of transmission lines and EHV equipment such as power transformers, reactors and related substation equipment.

Some of the major substations Harza has designed and brief descriptions of the protection schemes furnished are summarized below:

Water and Power Development Authority Relay systems were specified for breaker-and-a-half, 3-bay, "Multan" substation. The transmission system was designed for a voltage rating of 500-kV and initial operation of 220-kV. The relaying scheme was designed to require minimum modifications during the future upgrading of the transmission system for operation at 500-kV. The substation was commissioned in 1979-1980.

Harza involvement included system studies, design and specification of relay schemes, tendering and evaluation of international bids, review of manufacturers' drawings and determination of relay settings. The transmission line relays included a) primary protection by impedance measuring static relays operating in permissive overreach mode, b) secondary protection provided by impedance measuring electromagnetic relays operating in a blocking mode. Both sets of distance relays had selective single-phase and/or three phase auto reclose capability. High impedance bus differential and breaker failure relays were also provided.

In addition to the above referenced substation design, Harza has also prepared a report for the Water and Power Development Authority of Pakistan, a section of which contained relaying recommendations for their future 500-kV substations and transmission lines.

The relaying recommendations were based on TNA and load flow studies done by Harza that established system parameters such as transient and sustained voltage levels in the system, frequency variations and requirements for 1 pole and 3 pole tripping and reclosing of breakers.

Based on the criteria established by TNA and load flow studies, detailed recommendations were drawn up for protection of transmission lines including type of trip and reclose features and carrier equipment, autotransformers, shunt connected reactors, bus, over-voltage and over and under frequency relays at selected locations in the system.

Iran Power Transmitting and Generating Company Relaying systems were designed for the 400-kV transmission system in Iran, including a switchyard at the Karun 1000-MW generating station and four receiving substations. The system was commissioned in 1978-1980.

The transmission line lengths varied from approximately 100 to 300 km. Harza provided the relay system design including specifications, bid evaluation, review of manufacturer's drawings, and supervision of commissioning. The relays specified include:

1) Impedance measuring distance relays operating in directional comparison carrier unblocking scheme
2) Power transformer differential relays with second harmonic restraint
3) Breaker failure relays
4) Bushar and reactor protective relays, etc.

Relay systems were specified for the Hrauneyjafoss switchyard ring bus, generating units and 220-kV transmission lines. Line lengths varied from approximately 50 to 100 km. Harza provided the relay system design and specifications, bid evaluation, review of manufacturers' drawings, and supervision of commissioning. The switchyard relays specified include:

1) Impedance measuring distance relays operating in permissive overreach mode
2) Power transformer differential relays with second harmonic restraint
3) Breaker failure relays, etc.

The substation was commissioned in 1981.

Relay systems were specified for the 220-kV Mossyrock switchyard and transmission lines. The transmission line lengths varied from 20 km to 35 km. Harza provided the relay system design and specifications, bid evaluation, review of manufacturer's drawings, relay settings and supervision of commissioning. The switchyard relays specified included

1) Impedance measuring distance relays operating in permissive overreach mode
2) Power transformer differential relays with second harmonic restraint
3) Breaker failure relay, etc.

The substation was commissioned in 1968-69

Harza's experience with the above referenced and similar projects has provided extensive knowledge of U.S. and foreign manufacturers' relay systems and hardware available for selection of essentially any relay protection scheme. State of the art techniques and developments for providing comprehensive protection of transmission lines and substation equipment are continuously being reviewed and analyzed. Harza has the background and proven capability to design, specify and commission any required relay schemes for the Susitna project including all related communication equipment.

Ebasco also is fully qualified to provide complete engineering and design services for substation and transmission line protective relays systems including derivation of related system settings. Ebasco has provided engineering and design services for HV and EHV protective relaying systems for many utilities in this country as well as abroad, including People's Republic of China. Ebasco's general protection philosophy is as follows:

Transmission line and substation elements shall be protected by two protective relay systems: the primary relay system and the backup relay system. Each of the relay systems shall be independently capable of detecting and initiating isolation of all faults within its zone of protection. The primary relay system shall provide high speed protection for faults within its zone of protection utilizing pilot relaying or differential relaying. The backup relay system shall provide protection for faults within its zone of protection utilizing pilot relaying, differential relaying or time coordinated protection. For faults external to the protected zone, the primary and backup relay system shall be designed either not to operate or to operate selectively with other relay systems, including breaker failure protection. Reclosing capabilities are provided as required by the system.

Primary and backup protective relay systems for transmission lines and substation elements shall be connected to seperate sets of current transformers, separate windings of coupling capacitor voltage transformers (if potential supply is required), and dc supplies from seperate batteries. Primary and backup protective relay systems shall be mounted on seperate relay boards.

Breaker failure protection shall be provided to trip all necessary local and remote breakers in the event that a breaker fails to clear a fault. This protection need not be duplicated.

Oscillograph and sequence of event recorder shall be used to permit analysis of system disturbances and protection equipment performance.

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The following are some of Ebasco's recent HV and EHV substation projects:

St Lucie Units Nos. 1 and 2 240kV switchyard, Florida Power and Light Company. Ebasco provided engineering, design and construction services for a 240kV, four bay, breaker-and-a-half substation and transmission lines relaying protection.

St. John River Power Park Units 1 and 2 230kV switchyard, Jacksonville Electric Co. Ebasco provided engineering, design and construction services for a 230kV, 3 bay, breaker-and-a-half substation and transmission lines relaying protection.

Laguna Verde Unit Nos. 1 and 2 400kV switchyard, Comision Federal de Electricidad. Ebasco provided engineering, design and construction services for a 400kV, 3 bay, breaker-and-a-half substation and transmission lines relaying protection, including single pole tripping and reclosing capabilities.

TECHNICAL COMPETENCE
EHV Insulation Systems, Surge Protection,& Lightning Strike Protection

D. EVALUATION CRITERIA
EXPERIENCE AND RECORD

D.1 Project One

D.2 Project Two

D.3 Project Three

HARZA-EBASCO

C.6 Design of EHV Insulation Systems, Surge Protection and Lightning Strike Protection

The Joint Venture's competence in the design of EHV insulation systems is exemplified by a number of successful EHV designs. The initial investigations were coordinated with system studies and results utilized to establish transmission line insulation requirements as well as substation equipment dielectric ratings that were incorporated into specifications and ultimately supply and construction contracts. Typical of these projects are the following:

For the 400 kV transmission system in Iran the insulation requirements for each of the four transmission lines were analyzed, considering the regional climatological conditions along with insulation coordination of the substations. Two of the lines were crossing mostly desert areas with frequent occurrences of sand and dust storms, and due to the close proximity of the lines to active oil fields, the air was heavily polluted. Insulation requirements for these lines were dictated by the 50 Hz withstand and for that reason insulators with high creepage distance were required. Because of the combined pollutants, dust and oil, special types of insulators having better characteristics than the fog type were used in these areas. Special leakage current monitoring devices were installed at key locations to monitor the level of contamination on the line.

The other two lines were crossing mountainous, high altitude, contamination-free areas. The insulation requirements of these lines were coordinated for both switching surge and lightning and were consistent with the BIL level of the station equipment. Gap and insulator requirements for the line were established to give a very low flashover probability during switching or breaker operations, consistent with operating requirements of the client.

Line shielding and tower footing resistances were coordinated for a flashover probability, due to shielding failures and back-flashovers not to exceed 1.5 per 100 miles per year.

Four 400/230 kV outdoor substations and a 400 kV switchyard were included in this project. Insulation coordination studies were undertaken for each of the substations. Equipment parameters coordinated with system study requirements were established and were included in separate supply contracts developed for the major equipment such as transformers, shunt reactors, breakers, etc. and contracts for construction of the substation and the switchyard.

For the Water and Power Development Authority transient network analyses, studies were carried out at the facilities of the McGraw Edison Company in Cannonsberg, Pennsylvania. The studies were done under the direction of the Harza systems studies section in June, 1982. Based on the transient and sustained voltages observed on the analyzer with the 500 kV system model, the insulation levels for the substation apparatus, line reactors and autotransformers were coordinated with the surge arresters. The coordination study used standard BIL and BSL levels and both conventional and metal oxide surge arresters.

On the Hayden-Blue River 345 kV Transmission Line the insulation for switching surges and lightning protection was studied as part of the line design. Gap requirements for the line were calculated based on 200 gaps in parallel and on overall flashover probability of 1/100. The switching surge level was established in a separate TNA study prepared by others. Evaluating the switching surge level and projected probability along with the appropriate corrections for Relative Air Density, the gap and insulator requirements for a single tower were established.

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Lightning performance was coordinated for both shielding failures and back-flashovers, not to exceed 1 per 100 miles per year. The tower shielding was designed so that only a small fraction of low-magnitude strokes were allowed to penetrate the phase wires, thus reducing the flashover probability to less than 0.5 per 100 miles per year. For the remainder of the strokes which would be intercepted by shield wires, the tower footing resistance was selected so that tower potential rise would be limited to a level consistent with back-flashover probability of less than 0.5 per 100 miles per year.

Line design work is over 50 percent complete and engineering is proceeding on this project, involving preparation of several contract supply and construction documents to complete the scope of services.

Bath County Pumped Storage Switchyard, Virginia. Harza performed system studies, conducted the insulation coordination study, established equipment dielectric ratings, prepared the equipment layouts and equipment specifications for the 500 kV SF-6 gas insulated four breaker ring bus. The design provides for outdoor switchgear adjacent to the powerhouse.

Yacyreta Switchyard, Argentina. Extensive studies were undertaken to establish the selection, location and arrangement of surge arresters in the 230 kV SF-6 gas insulated switchyard for this 20-unit generating station. The breaker-and-a-half switching scheme with SF-6 gas insulated breakers and bus was designed as an integral part of the step-up transformers for installation on the powerhouse transformer deck. Harza developed the conceptual design, conducted all studies and prepared design memoranda and contract documents.

During several years of involvement in the design of insulation systems and of performing insulation coordination for EHV transmission systems, Ebasco has documented their experiences and accomplishments in Engineering Design Guides. These documents are now invaluable in the design of reliable EHV insulation systems, surge protection systems and

lightning strike protection systems. Where unusual switching surge characteristics, high keraunic levels and system reliability requirements requires deviation from its standard practices, Ebasco designs surge protection systems and insulation systems to meet these special and unusual conditions.

Ebasco's recent experience is demonstrated in systems designed for the transmission projects listed below to provide them with surge protection and proper insulation systems.

Shearon Harris 500 kV and 230 kV air insulated substation with a capacity of 400 MVA and a service date of 1980 was engineered and designed for Carolina Power and Light.

Laguna Verde 400/230/34.5 kV Facilities. These facilities consist of a 450 kV switchyard with shunt reactors, a 230 kV switchyard with a 400 kV/230 kV autotransformer bank, 34.5 kV switchyard with a 230/34.5 kV transformer and associated 400 kV tie lines. Reliable insulation under severe atmospheric contamination conditions was of prime concern. The recommendations of an Ebasco study were implemented and resulted in the Ebasco designed (and constructed) 400 kV and 230 kV SF6 gas insulated switchyards, and hotline washing facilities for the remaining open air insulation. (This is documented in IEEE Paper A80-095-0).

Centromin - Peru 220 and 50 kV Facilities. The project consists of several 220 kV and 50 kV transmission lines, a 220 kV SF6 gas insulated and several 50 kV open air substations. One of the concerns was to provide reliable insulation for the switching surge and keraunic levels at high altitudes (up to 14500 ft. elevation). Ebasco studied, designed and specified the overall system (including a control center) and will be involved in the system check-out and acceptance tests.

D. EVALUATION CRITERIA
EXPERIENCE AND RECORD

1 Project One

D.2 Project Two

D.3 Project Three

TECHNICAL COMPETENCE
Design & Operational
Economics
Optimization

HARZA·EBASCO

C.7. Technical Competence
Optimization - Design
Operational Economics

Finding the best (optimum) design and obtaining the best operational economies for transmission systems requires attention to the first cost of the transmission facilities and minimizing line losses, minimizing life cycle cost, with due regard for environmental concerns. Life cycle costs to be minimized include first cost, electrical line losses, cost of outages and cost of maintenance.

First cost must be balanced between material, transportation and installation cost to result in an overall lowest installed cost. Line losses must be balanced between conductor size, type and structural loads. Cost of outages derive from short duration outages (switching, lighting, etc.) and longer term outages (e.g., loss of a line section due to environmental hazards). Cost of outages must be balanced with cost of a high reliability line design.

Cost of maintenance must be minimized by selecting appropriate standardized insulators and hardware and providing structural details that facilitate ease of maintenance.

To achieve the best design and operating economies requires attention to tower type, construction methods and span length as well as selection of the best conductor from the point of minimized losses.

The Joint Venture's computer programs have been developed for economic conductor size selection and for transmission line design.

Transmission Line Optimization Program optimizes conductor size and span length for a specified tower type in one run. The program uses an economic analysis based on a present worth of revenue required, including fixed charges on the capital investment, cost of line losses (both generation demand and energy cost), and cost of line

maintenance. Gradients for changes in conductor costs, tower cost and generating costs are calculated and the effect of these gradients on the optimum line design is evaluated. Separate runs can be made for different tower types and the optimum design for each tower type can be compared economically. Minor changes will be required for tower weight estimates and foundation estimates. This program can also provide as output complete transmission line cost estimates.

Economic Conductor Size Selection program selects a conductor size that gives minimum annual investment and operating costs, subject to transmission of a certain amount of power at a desired voltage level. The selection is made from a given set of feasible conductor sizes. The program calculates the annual investment cost, considering the cost of: towers and associated insulation and hardware; conductor material; shunt and/or series compensation; synchronous condensers or capacitor bank. Annual operating cost is calculated considering Corona and conductor resistance losses for the given loading pattern.

Production cost studies to determine total cost of energy delivered are part of the Joint Venture capabilities. Such studies would take into account seasonal, annual, and daily load duration curves as well as different modes of generator dispatch. Using computer programs such as TVA's WASP-SAGE or other commercially available programs, calculations can be made to determine the cost of energy production. These studies include such factors as fixed and variable operating and maintenance costs, depreciation and taxes, and fixed costs. Scheduling of units for maintenance as well as forced outages and loss of load probability can also be included in these studies. When hydroelectric plants are a major source of capacity, these studies will often include studies of reservoir operations and uncertainty of annual water replacement.

TECHNICAL COMPETENCE
Transmission Line Route Selection & Substation Siting

HARZA-EBASCO

C.8. Transmission Line Route Selection and Station Siting

The Joint Venture team, augmented by the independent firm of Jones and Jones, will bring extensive route selection and siting experience to the Susitna Transmission Line Project. The collective experience of the proposed project team covers the entire range of route evaluation responsibilities, including review of existing routing studies, evaluation and selection from among predetermined route alternatives, and the identification and selection of new corridors and routes from an open field. In addition to responsibilities for route selection, the members of the project team have successfully carried out responsibilities for full environmental analysis and public participation, as will be the case for the Susitna transmission lines. This experience has been gained in many diverse geographic areas and involved transmission lines through varied terrain and environments, including three very recent projects in Alaska.

The Joint Venture provides full interdisciplinary capabilities in environmental and engineering fields, and have employed these capabilities in transmission line routing as part of transmission feasibility and design studies or in conjunction with work on generating facilities. Envirosphere Company, the environmental consulting division of Ebasco, currently employs more than 30 professionals in the physical, biological, and social sciences at its Northwest regional office in Bellevue. Envirosphere has established a sound record in transmission line environmental analysis, having successfully completed several recent projects involving route identification and selection, public participation, impact analysis, and environmental report preparation. Jones and Jones brings to the study team expertise in visual resources, land-use evaluations, public participation, and graphics capabilities, all of which will be critical in evaluating the Susitna transmission alternatives. Jones and Jones has a proven and deserved position at the top of its field for its previous work on the visual, recreation and land use impacts of transmission lines. Envirosphere and Jones and Jones have collaborated on several recent projects, and have established a strong and successful working relationship.

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A list of the combined recent experience of Harza, Ebasco/Envirosphere, and Jones and Jones is presented in Table C-2. This list includes gas pipeline and other corridor studies in addition to transmission line studies, due to the functional similarities between various types of corridor studies. The fact that some of these other corridor studies involve Alaskan experience, such as the Jones and Jones work on the Northwest Alaskan Pipeline Project, is particularly relevant. Similarly, the North Slope Gas Feasibility Study that Ebasco is currently conducting requires consideration of route alternatives for both pipelines and transmission lines, and will include a separate report on corridor and facility siting.

Eleven of the projects listed in Table C-2 represent particularly relevant experience for the Susitna transmission project. For example, the Black Bear Lake, Eugene-Medford, Kaiparowits, and Yale projects were cases which involved complete routing processes requiring the identification and selection of new corridors and routes. Other studies, such as the Flathead Valley and Kake-Petersburg transmission projects, generally involved evaluation of predetermined routes within established corridors. Capsule descriptions of these projects and others that demonstrate capabilities in environmental analysis, suitability screening, and public participation are provided below.

TABLE C-2

RECENT HARZA/EBASCO/ENVIROSPHERE/JONES AND JONES
CORRIDOR STUDIES

CLIENT/PROJECT

Alaska Power Authority, Black Bear Lake Hydroelectric Project
Alaska Power Authority, Kake-Petersburg Intertie Feasibility Study
Alaska Power Authority, North Slope Gas Feasibility Study
Bonneville Power Administration, Flathead Valley Reinforcement Project EIS
Bureau of Land Management, Eugene-Medford 500 kV Transmission Line EIS
Florida Power and Light Co., Turnpike-Jensen-Crane Transmission Line Studies
Phillips Pipeline Co., Trenton-Conway Natural Gas Pipeline Routing Study
Allegheny Power Systems, Transmission Line
Arizona Public Service Authority, Kaiparowits Transmission Line
Bureau of Indian Affairs, Navajo Railroad Project EIS
Jacksonville Electric Authority, Eastport Transmission System
Minnesota Power and Light Co., Clay Boswell Transmission Line
Oglethorpe Power Corp., Transmission Lines
Pacific Power and Light Co., Yale Transmission System
Pennsylvania Power and Light Co., Transmission Line
South Carolina Electric and Gas Co., Transmission Line

Fluor/Northwest, Inc., Northwest Alaskan Pipeline Project Visual Resource Management Program

U.S. Army Corps of Engineers Alaska District, Susitna Hydropower Project Environmental Assessment

Oregon Public Utility Commissioner, Klamath Basin Transmission Assessment

Bonneville Power Administration, Substation Visual Simulation Techniques

Bonneville Power Administration, Longview-Portland Area Transmission Reinforcement EIS

Bonneville Power Administration, Measuring the Visibility of High Voltage Facilities in the Pacific Northwest

Bonneville Power Administration, Visual Impact of High Voltage Transmission Facilities in Northern Idaho and Northwestern Montana

U.S. Army Corps of Engineers Alaska District, Bradley Lake Hydropower Project Environmental Assessment

Battelle Pacific Northwest Laboratories, Measuring the Social Attitudes and Aesthetic and Ecological Considerations Which Influence Transmission Line Routing

Seattle City Light, Copper Creek Environmental Assessment of Visual and Recreation Effects

Nebraska Public Power District, Visual Recreation Affects of the 500 kV Mandan Project on the Recreation Facilities of the Missouri River

Black Bear Lake Project, Alaska Power Authority

Harza recently performed comprehensive transmission route evaluation and selection studies for the Power Authority's Black Bear Lake Hydroelectric Project on Prince of Wales Island. The project area is characterized by rugged terrain and numerous water bodies, presenting significant constraints to the siting of transmission lines and substations for the power project. Harza transmission engineers and environmental scientists developed alternative corridors for the project's 34.5 kV transmission line through field reconnaissance, agency contacts, review of federal and state guidelines, and office analysis. The alternative corridors were evaluated on the basis of elevation, wildlife, visual impact, and land use constraints, resulting in the identification of the alternative with the greatest compatibility with environmental, social and engineering concerns. Following the identification of a preferred route, more detailed investigations were made to define minor route adjustments to reduce adverse effects in certain sensitive areas.

Kake-Petersburg Intertie Feasibility Study, Alaska Power Authority

Ebasco/Envirosphere is conducting a feasibility study for the Power Authority on a proposed 69 kV transmission line to connect the village of Kake with the Tyee Hydroelectric Project. The project includes engineering and environmental studies of two alternative routes of approximately 60 miles, primarily across land managed by the U.S. Forest Service. The comprehensive environmental studies for the project include examination of geology and soils, terrestrial and aquatic ecology, land use, forestry, socioeconomics, recreation, cultural resources, and visual quality. The environmental assessment of the proposed intertie will also take into account the existing network of Forest Service access roads, and the potential effects of an underwater crossing on fishery resources and water transportation. A draft feasibility report and a separate routing report for this project were submitted in November of 1982. A public meeting was held early in the project to obtain scoping advice, and a second meeting will be held in December to present the feasibility report.

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Flathead Valley Reinforcement Project, Bonneville Power Administration

Envirosphere and Jones and Jones are currently completing a Draft Environmental Impact Statement and supporting work for the Bonneville Power Administration's proposed Flathead Valley Reinforcement Project in northwestern Montana. The project team analyzed the environmental impacts of two basic plans of service, each of which covered a route of approximately 60 miles in length parallel to existing lines, as well as a number of routing and design options for each basic plan. In addition to development of the EIS, the Envirosphere team prepared a supporting Study Documentation Report (SDR) and held a series of public information and comment workshops in the project area. The U.S. Forest Service, Fish and Wildlife Service, and Bureau of Indian Affairs were cooperating agencies for the EIS effort. The Envirosphere team conducted studies and prepared EIS and SDR materials for all resource areas, although input on threatened and endangered species, health and electrical effects, and cultural resources was provided through BPA. The major environmental issues associated with the proposed transmission line included effects on visual resources, agriculture, forestry, and wildlife, and the need for the project.

Eugene-Medford 500 kV Transmission Line EIS, Bureau of Land Management

Envirosphere and Jones and Jones are currently completing a joint effort to prepare a third party EIS for the Bureau of Land Management. The EIS is for a 145-mile 500 kV tranmission line between Eugene and Medford, Oregon, proposed by Pacific Power and Light Company. The complete range of physical, biological, and social science disciplines was involved in this project, with special emphasis on threatened and endangered species, wildlife, vegetation, soils, land use, socioeconomics, cultural resources, and aesthetics. Jones and Jones personnel were responsible for visual, recreation, land use and mapping tasks. The project team conducted routing studies to identify and

evaluate route alternatives for the terminal segments in the more heavily urbanized Eugene and Medford areas. Other tasks included technical investigations of the remainder of the route and the project alternatives, and the Draft and Final EIS. Public workshops were held during the routing study phase of the project. BPA and the Oregon Department of Energy have also had strong interests in this project, and are cooperating parties along with BLM and PP&L. Communication and coordination of project activities among all parties has therefore been a particularly important aspect of this project. Envirosphere and Jones and Jones personnel also provided testimony for the Oregon Energy Facility Siting Council (EFSC) environmental hearings on the site certificate application for the project.

Kaiparowits Transmission System, Arizona Public Services Company (APS)

Envirosphere was contracted by APS to determine the most environmentally suitable routings from the proposed Kaiparowits Plant (Kane County, Utah) to several substations in Arizona, and particularly to Phoenix, the major load center in the region. The 14-month effort was directed at inventory and synthesis of environmental data for a sensitive area covering 23,000 square miles, primarily concerning scenic vistas, visibility, protected flora and fauna, archaeologic sites, Indian reservations, and highly erodible terrain. These environmental factors were grouped into the four categories of physical systems, biological systems, the human environment and visual/scenic quality. The study area was partitioned into three grades of sensitivity with regard to each category, and the four sensitivity maps (one for each category) were overlayed to determine the entire range of potential corridors. Route segments were identified through this overlay process, after which a preferred route and several alternatives were selected by a computerized program which evaluated route segments on the basis of physiography, land use, archaeology, scenic quality, visual intrusion, erodibility, biotic communities, and game animals. Envirosphere's report to APS also included recommendations for mitigating visual and land use impacts.

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Yale Transmission System, Pacific Power and Light Company

Envirosphere completed an alternate corridor analysis for transmission facilities associated with PP&L's Yale Hydroelectric Project on the Lewis River near Vancouver, Washington. The initial phase of the project was a broad, regional analysis of environmental factors which resulted in the selection of variable-width alternate corridors. This was followed by a detailed local analysis in which a route with minimum environmental impact was identified. The environmental data collected for the detailed analysis were digitized subsequent to classification into the four categories of natural systems, land use, sociocultural values and aesthetic values. All environmental factors within each category were evaluated on the basis of numerically weighted criteria, with the ultimate product being a composite suitability map generated through a computerized overlay and mapping process. Computer maps of cost-sensitive engineering constraints were also used in selecting among alternate corridors, as construction cost was compared against the environmental score for each route.

Susitna River Environmental Assessment, Corps of Engineers

Jones and Jones was retained by the U.S. Army Corps of Engineers, Alaska District, to assess the effects of a four-dam development plan on the environmental, visual, and recreational resources of the Susitna River basin. This work contributed to the Corps' 1976 EIS on the Susitna Hydroelectric Project. The firm classified the 200-mile river corridor and its 5900 square miles of uplands, including the potential transmission link to the railroad corridor, into landscape units to spatially locate resources and effects and to facilitate site-specific recommendations. This classification was generated from a set of natural patterns of the major tributaries. Existing natural, cultural, and visual resources were quantitatively inventoried in each unit. The levels of these resources that would remain after hydropower development were also projected. The principal impacts assessed by

Jones and Jones included the loss of the unique whitewater of Devil Canyon, the visual effects of seasonal reservoir drawdown, and the secondary consequences of providing easy access to a large roadless area. Jones and Jones suggested a number of measures to totally or partially mitigate these effects and identified problem areas which required further study during project design.

Northwest Alaskan Pipeline Project - Visual Resource Management Program, Fluor/Northwest, Inc.

Jones and Jones was retained by Fluor/Northwest, Inc., project management contractor for the Northwest Alaskan Pipeline Company, to help devise the Visual Resource Management (VRM) Program for the proposed Northwest Alaskan Pipeline project. This program is one of a number of specific actions that federal agencies required to be taken during project design and construction to deal with the potential environmental impacts of the pipeline. It will minimize the adverse visual effects of the cleared pipeline corridor and related facilities by means of siting and construction practices such as the retention of forested buffer zones. Jones and Jones' responsibility for Phase I of the Visual Resource Management Program involved the visual quality evaluation of the landscapes along the entire Alaskan right-of-way.

Klamath Basin Transmission Assessment, Public Utility Commissioner of Oregon

The Oregon Public Utility Commissioner (PUC) retained Jones and Jones in 1978 to assess alternative routes through the Klamath Basin for a 500 kV transmission line between Malin and Medford, Oregon, proposed by Pacific Power and Light. An initial route proposal would have passed through two national wildlife refuges that are heavily used by migratory waterfowl, while citizen groups and local officials were concerned about potential adverse effects of alternative routes on their communities

The firm used a constraint analysis approach to identify alternative routes and their general effects on land use, visual resources, and engineering factors. Detailed consideration was then given to wildlife effects, housing and community resorces, including information developed in citizen workshops. The results were presented in formal testimony as well as in a written report.

The Klamath Basin Transmission Assessment was instrumental in resolving conflicts that had built up over several years of controversy and litigation. The Commission selected an alternative recommended by Jones and Jones, and Pacific Power and Light has now successfully completed the transmission line.

Substation Visual Simulation Techniques, Bonneville Power Administration

The visual appearance of substations and their potential effects on surrounding visual resources are important factors in the BPA route selection and design processes. Visual simulations are often necessary for adequate consideration of the visual effects of siting and design decisions, and can also aid communication and public understanding oconcerning proposed substations. In order to have a standard handbook for this type of work, BPA commissioned Jones and Jones to prepare a substation simulation report. The objectives of the report were 1) to identify the major visual components of substations and their potential impacts, 2) summarize the major visual considerations in substation design, and 3) discuss the alternative techniques for simulating the visual appearance of proposed substations. The report, completed in 1982, is designed for use by BPA staff, BPA planning and design consultants, and interested members of the general public.

Visual Impact of High Voltage Transmission Facilities in Northern Idaho and Northwestern Montana

In 1976, Jones and Jones assisted BPA in development of a visual impact model as a part of a study related to the integration of additional transmission capability from Libby Dam into the existing system serving northern Idaho and northwestern Montana. Jones and Jones provided base data for an 8,000-square mile study area, from which it developed an inventory of the visual characteristics of study area landscapes and assessed their visual quality. The firm then assessed the visual compatibility of transmission facilities with these landscapes, and verified by public testing that visual quality and visual compatibility are independent variables. The public testing involved slide presentations to a sample of conservation, industry, agricultural and civic organizations, in which the organization members evaluated the visual compatibility of transmission lines in various landscape types. Detailed maps of visual quality and compatibility in the study area were then prepared for digitizing and computer entry. Jones and Jones also developed information about the effects of distance and land use on viewer reactions to the visual appearance of transmission facilities, which BPA factored into its computer analysis of the visibility of route alternatives.

TECHNICAL COMPETENCE
Corona Mitigation &
Field Effects –
EHV Power
Systems

HARZA-EBASCO

C.9 Technical Competence in Mitigation of Corona and Field Effects of EHV Power Systems

Susitna transmission line design concepts will be developed considering the full range of corona and field effects. For example, ground clearances will be established so that ground gradient levels impose no danger to people or animals that cross the line either on the short or long term. Induced current and voltages on any vehicles operating under or in the vicinity of the line will be at levels that impose no danger to the vehicle, operators, or other people and animals in the vicinity. Conductor size, bundle configuration, hardware and phase spacing will be established so that corona effects impose no nuisance or interference of any kind to residents or anyone in the vicinity of the line. Along with the environmental considerations the corona and field effects will be evaluated from the economic perspective. A design concept deemed "best" will meet both environmental consideration and optimum cost.

Three of the most recent projects involving the investigation of the mitigation of corona and field effects are:

- o Basin Electric 345 kV and 500 kV Transmission Systems
- o Tri-State 345 kV Transmission System
- o Guri Hydroelectric Project - 765 kV

Basin Electric Power Corporation 345 kV and 500 kV Transmission Lines. The lines are constructed in the States of North and South Dakota. The line design parameters were developed considering both corona and field effects. Lateral profiles of ground field strength levels, radio noise levels, induced currents on vehicles including farm combines were prepared and were made available to Basin Electric for presentation in the various community hearings. Corona loss was considered in the economic selection of conductor and the shield wire design concept was developed considering the losses resulted from electromagnetic induction on the shield wires. Complete design manuals for both 345 kV and 500 kV systems were presented and approved by the Rural Electrification Administration.

Tri-State 345 kV Hayden Blue River Transmission Line. The line will be constructed on the mountainous areas of Colorado at altitudes ranging from 6,000 to 10,500 ft. The design concepts of the line were developed considering ground gradients, audible noise, radio noise, induced voltage and current on various vehicles. Corona effects were evaluated considering the changes in relative air density due to higher altitudes. A design manual for this project is nearly complete and should be finalized by early January, 1983.

Guri Hydroelectric Project. Harza designed the 765 kV lines that carry the power from the generator step-up transformers to the main switchyard of the power plant. Because of space limitations the lines consisted of five double circuits in close proximity with all 765 kV transformers located beneath the lines on top of the draft tube deck.

Limits on ground field strength levels and induced current flow levels resulting from grounding a charged insulated object were established using the latest available research results of EPRI. Electric field strength and induced current levels were established so that workers or visitors under or in the vicinity of these lines will not be exposed to short or long term health hazards. The mitigation of field effects was calculated considering phase configuration, operating conditions, ground clearances, and the different sizes of objects anticipated under the line. Each alternative was evaluated considering the overall economic impact. The alternative selected provided a safe design concept at an optimum cost.

Through proper conductor, equipment and hardware selection techniques in conjunction with adequate corona protection schemes, Ebasco has successfully mitigated corona on all their EHV transmission designs. Two in-house-computer programs are used to calculate the electrostatic field intensity and the electromagnetic field intensity caused by EHV transmission systems.

For the Jacksonville 240 kV line, Ebasco performed electrostatic and electromagnetic field intensity studies to establish allowable limits for the electromagnetic field intensity at the edge of the right-of-way and the maximum short circuit current that appears when an object under the transmission line is grounded suddenly.

For Comision Federal de Electridad, Mexico Ebasco engineered and designed the Laguna Verde 400 kV Substation, with mitigation of corona effects.

On the Centromin - Peru 220 kV System, which is now under construction, the question of corona was of major concern because the line is located at elevations of up to 14500 ft above sea level which causes low corona onset levels. Ebasco performed the necessary studies and selected the conductor, hardware and insulation to minimize the effect of corona (RIV, TVI, corona losses and line costs).

TECHNICAL COMPETENCE
Subartic Climate

D. EVALUATION CRITERIA
EXPERIENCE AND RECORD

1 Project One

D.2 Project Two

D.3 Project Three

HARZA-EBASCO

C.10. Experience in Subarctic Climates

The Joint Venture, its subcontractors and consultants have extensive experience working in subarctic climates, high-elevation and mountainous terrain.

Susitna transmission system design concepts will be developed that are appropriate to the subarctic conditions at the several substation locations and along the transmission lines.

The Harza subarctic experience is the result of 25 years of experience with power porjects in Iceland. This has provided full knowledge of the engineering and construction problems resulting from severe weather conditions.

Burfell Hydroelectric Development. Harza's work began in Iceland in 1957 with planning, engineering and economic studies that supported subsequent decisions to proceed with the Burfell Project. Extensive field investigations, carried out from 1959 through 1965, included topographic mapping, overburden soundings, diamond core borings, permeability testing, ground water measurements, locating and testing sources of natural construction materials, geologic mapping, hydrographic surveys, hydraulic measurements, route reconnaissance for roads and transmission lines, driving an exploratory tunnel, ice investigations and meteorological observations.

Out of these studies were developed the conditions and environmental criteria such as wind and ice loads for the design of the 230 kV transmission lines, substations, and switchyard for the Burfell Hydroelectric project in the subarctic climate. The contract documents for these electrical features were initiated in 1965.

Harza provided complete engineering and design services, prepared all contract documents for construction and procurement of equipment, and provided a resident staff of engineers and technicians during construction. Project construction began in 1966 and was essentially complete in 1969, when first commercial operating of the transmission lines and generating units were placed in service.

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Hrauneyjafoss Hydroelectric Project. The foregoing successful experience was invaluable in the initial planning, design, and preparation of specifications for the 230-kV outdoor switchyard for the Hrauneyjafoss project, design of which started in 1974.

Initially, an outdoor switchyard was selected following criteria established for Burfell. However, the rapid improvement of SF-6 technology, concomitant reduction in equipment costs, improved reliability of the SF-6 equipment, elimination of problems caused by snow drifts, elimination of salt contamination problems, ice and windload constraints, and improved personnel safety all led to the ultimate selection of an indoor 230-kV gas insulated substation. The substation is a 6-breaker 230-kV ring bus for 3 generating units and 3 transmission lines. A major factor in the decision to use an indoor versus outdoor SF-6 installation was the ability to service and maintain the equipment indoors, away from the Icelandic environment.

The SF-6 gas insulated indoor switchgear is housed in a building equipped with crane, gas monitoring, and other SF-6 test facilities. The switchgear is located between the powerhouse structure and main power transformers. Equipment costs were minimzed without sacrificing reliability and features of the gas insulated equipment, by selecting open-air type wave traps, arresters, and CCPDs for mounting on bridges above the power transformers.

The Hrauneyjafoss power station is currently in operation. The first generating unit was commissioned in 1981, the second in 1982, and the third is scheduled for January 1983.

Hayden-Blue River 345kV Transmission Project. Work on this project began in August, 1981 and will continue throughout design procurement with some assistance during construction. Snow legs will be designed for the towers in areas of high snow buildup (about ten feet) and increased ground clearance will be provided in areas where skiers habitually cross under the line. The design is now more than fifty

percent complete. Helicopter construction will be required as the line crosses Gore Pass at an elevation of about 10,000 feet, and towers are being designed so that sections will not exceed helicopter capabilities at high elevations.

Karun Hydroelectric and 400 kV Transmission Project. In addition to a hydroelectric generating plant on the Karun River, the assignment included design and construction assistance for four 400/230kv 200 MVA substations and 800 km of 400 kV transmission line. The major portion of the lines pass through unaccessible areas of the Zagros mountains. Two sections of line were in relatively flat salt desert. Considerable study of cloud icing and rime ice as well as solid ice on conductors was made. Lines designs were made to withstand without failure, three inches of radial ice on one side of a structure and no ice on the adjacent span. The lines would be at altitudes of up to 3,000 meters. Avalanche splitters were installed in some locations where possible damage was anticipated. Helicopters were used for material delivery including concrete, as well as for installion of pulling lines during tension stringing operations. The structures were designed to withstand seismic forces, as the mountains include active earthquake regions.

Alaska Experience. In addition, Harza has been selected by APA to execute three of its projects. These involve the engineering and design of the Black Bear Lake Hydroelectric Project, the feasibility study of the Chester Lake Hydroelectric Project and the assessment of energy alternatives for the Bethel region. The Bethel Regional Study includes the prefeasibility study of 138 kV transmission line between the Checkumenic Lake hydro site and the Bethel load center. The selected structure for the line is a guyed steel mast. This design was selected to account for problems of frost heave, helicopter construction and minimum of foundation requirements.

Ebasco Services Incorporated has had extensive project related engineering environmental licensing and logistics experience in Alaska. Ebasco has conducted various studies amongst which are the Railbelt Electric Supply Alternatives, the Grant Lake Hydroelectric, the Northeast/South Central Alaska Small Hydro Power Study and the Alaska Peninsula Kodiak and Aleutian Islands Small Hydro Power Study. Currently Ebasco is performing a study of alternatives for the use of North Slope Gas and also a study on the Kake-Petersburg Transmission Interconnection which consists of 47 miles of 34.5 kV transmission lines including 2 miles of submarine cable.

The Ebasco Environmental and Licensing Division (Envirosphere) has extensive experience of front end work to determine environmental acceptability of proposed projects. Ebasco also has continuous experience with the Federal Energy Regulatory Commission and other state and federal licensing processes.

Terror Lake Hydroelectric Project. Ebasco is currently responsible for the design of the powerhouse on the Terror Lake Hydroelectric Project and the 138 kV transmission line from Terror Lake to Kodiak. In addition, Ebasco is the construction manager for the Terror Lake Hydroelectric Project and transmission line.

The Terror Lake Hydroelectric Project is designed for a present output of 20 megwatts with a future rating of 30 megawatts. The transmission line from Terror Lake to Kodiak carries almost the whole of the station output and hence reliability is a prime consideration. The line is inaccessible by road and is designed for helicopter construction. It rises from approximately sea level to 1750 fet. Because of the adverse weather conditions, the line was designed for a 36 pound per square foot wind pressure on the coductors. The heavy ice loading is 1" radial ice below 500 ft and 1 1/2 inches radial ice on line sections above 500 ft elevation.

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Because of the high reliability required for this line and its inaccessibility (particularly during the winter season) the line is designed to be constructed with self-supporting steel pole structures. While this represnts a cost increase over a guyed structure, it was felt that the self-supporting structures would perform better and that the life cycle costs would compare vary favorably due to the decreased maintenance cost of the self-supporting structures. The self-supporting structures require a more detailed design of foundations and hence extensive geologic and survey data was obtained prior to finalization of line design. The foundation designs consist of H piles for the dead-end tower at Airport substation, spread footings mostly in the Kihuzyak Valley and rock anchors.

D. EVALUATION CRITERIA
EXPERIENCE AND RECORD

1 Project One

D.2 Project Two

D.3 Project Three

TECHNICAL COMPETENCE
EHV Submarine Cable

HARZA-EBASCO

C.11 Design of EHV Submarine Cable

The Joint Venture has the technical competence to design the 345 kV submarine cable crossing at the Knik Arm Inlet as outlined in the Acres Study. Ebasco pioneered many cable projects such as the first submarine installation of low pressure oil-filled cables in the United States. This project was a 115 kV cable crossing of the Columbia River near Portland,, Oregon. In addition, Ebasco furnished consulting services in the selection of the first low pressure oil-filled cables designed for 230 kV operation in the United States. This installation was located at the Huntley Steam Electric Station for Niagara Mohawk Power Corporation.

Since the development of the high pressure pipe-type cable system, Ebasco has been active in the installation of pipe-type cables in Florida, Louisiana, New York, Ohio and many other locations. Among these was the first high voltage pipe-type cable installation in which stop joints were eliminated. A recent example is the 69 kV pipe-type cable system for the Cerro Corporation which was recently installed to supply a mining facility in Chile.

Ebasco has underwater cable specialists who are experienced in high voltage cable applications. They are familiar with the current developments in EHV cable design by U.S. and foreign manufacturers. They are also knowledgeable about the terminations, switching equipment and surge arrestors necessary to protect the submarine cables.

The Joint Venture recognizes the environmental implications of burying submarine cables in the Knik Arm inlet bed. They have environmental specialists who are familiar with Alaska marine ecological systems which may be affected by the digging of the cable trench and the disposal of the excess trench material. They also have construction management personnel who are familiar with similar projects such as the Lake Champlain HV Submarine Cable Crossing from Burlington, Vermont to near Plattsburg, New York for Vermont Electric Power Company.

D. EVALUATION CRITERIA

Experience and Record of Performance

The Harza-Ebasco Joint Venture has experience in all aspects of the design and licensing of transmission line, substations, and control systems for electric utility bulk power, extra-high voltage transmission and control systems. In this section of our proposal we present three design projects that are similar to, or have major aspects that are similar to, the work required for the EHV transmission and control systems associated with the Susitna Hydroelectric Project.

The three specific design projects that have been selected are:

D-1 Hayden-Blue River 345-kV Transmission Line - Colorado
D-2 Terror Lake Hydroelectric Project Transmission Line - Alaska
D-3 Water and Power Development Authority 500-kV Transmission System - Pakistan

The project descriptions follow the format stipulated in the request for proposal letter.

D.1 HAYDEN BLUE RIVER 345 kV TRANSMISSION LINE

D.2 Project Two

D.3 Project Three

HARZA-EBASCO

D.1 Hayden-Blue River 345 kV Transmission Line

a. Project Description The Hayden-Blue River 345 kV single circuit transmission line will connect the Hayden Thermal Generating Plant northwest of Kremmling to Colorado Public Service Blue River Substation near Dillon, Colorado. The line is approximately 100 miles in length.

Tri-State Generation and Transmission Association has project responsibility. Ownership of the line is divided between Tri-State G&T, Colorado Ute, Platte River Authority and Western Area Power Administration. The line will be initially energized and operated at 230 kV in late 1984 until higher power transfer capability is required (probably about 1990). The Environmental Impact Statement is prepared by the Rural Electrification Administration in Washington, D.C. for the corridor selection. Final location of the centerline of the right-of-way is established by Tri-State G&T. Merrick & Company, Denver, were retained by Tri-State for surveying and provided Harza with plan-profile input for computer tower spotting.

About 25 miles of line pass through Forest Service lands and helicopter construction is required, since access is limited and vehicular traffic is prohibited. The line lies on the western side of the Continental Divide and will cross Gore Pass. Elevations range from 6500 to 11,000 feet and the terrain is rough. Temperatures range from -50° F to a maximum of 100° F. Extreme 50 years wind velocity has been accepted as 90 mph on conductors and 120 mph on towers. Maximum height of snow on the ground under conductors is established as 12 feet. Consideration is given to safety and reliability under heavy snow and avalanche conditions by study of tower location and structure application during final tower spotting.

It is believed that Harza's previous design and construction management experience on 400 kV transmission lines in Iran during early 70's was also instrumental in Harza's selection for the Hayden-Blue River Project.

b. Services performed On Hayden-Blue River Project Harza's work includes participation in final route selection, preparation of final design criteria and a comprehensive design manual, establishment of an optimum series of towers, tower and foundation design, tower testing, structure spotting on plan and profile sheets. Required specifications include soil testing and construction documents. Material furnished specifications include: tower steel, conductors and accessories and insulators and hardware.

Work has been divided into following tasks:

1 - Final route selection
2 - Design criteria and data
3 - Tower design and testing, foundation design
4 - Plan and profile
5 - Plans and specifications
6 - Project control and scheduling
7 - Advice during construction
8 - Project closeout

c. Project Schedule Harza was retained by Tri-State Generation and Transmission Association, Inc. for engineering the single circuit 345-kV transmission line in August 1981.

d. Client information

The client's address is:

Tri-State Generation and Transmission Association, Inc.
12076 Grant Street
P. O. Box 33695
Denver, Colorado 80233

The telephone number is (303) 452-6111
Project Coordinator and Project Manager is Ben Brickhouse and
Project Engineer is Adrian Rojas

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e. The initial estimate of design work is $450,000.

f. The type of contract for design work performed on this project is fixed-price.

g. Cost control is by control of man-hours according to specified subtasks, and the total number of man hours is an amount agreed upon with the Client. The project schedule is controlled according to mile stone chart and monthly progress reports which include per cent of work completed and man hours expended according to subtasks.

D.2 Project Two

D.3 Project Three

D.2 TERROR LAKE TRANSMISSION LINE

D.3 Project Three

HARZA-EBASCO

D.2 Terror Lake Transmission Line

a. Project Description Ebasco has recently completed the design of a 138 kV transmission line which will carry virtually all of the output from the Terror Lake Hydroelectric Project to the City of Kodiak. The only alternative source of power for the City of Kodiak is a diesel electric power plant and this transmission line, therefore, takes on special importance with respect to reliability.

The total length of the line is approximately 17.4 miles and it traverses a terrain which varies in elevation from approximately sea level to 1750 feet above sea level. The transmission corridor has no roads except near the Kodiak end and the line was designed to allow the use of helicopters for construction.

The line consists of a single circuit in delta configuration, two phases at the bottom cross arm level, one phase at the top cross arm level for tangent, small, medium and sectional structures. Large angle and full deadend structures are in horizontal configuration.

The tangent and small angle structures consist of single tubular steel poles. Medium angle and sectional (uplift) structures consist of two-legged tubular steel A-frames. Large angle and full deadend structures consist of four-legged tubular steel A-frames. The structures are fabricated of weathering steel.

The average span length is 900 feet and the maximum span length is 1500 feet. The structure heights vary from 40 to 106 feet above ground. The foundations consist of spread footings and rock anchors.

b. The service performed consisted of review of an earlier design, redesign preparation of new specifications and bidding documents and evaluation of bids.

c. Project schedule Review of the initial design was started in March, 1982. The final design was completed and specifications issued for bid on schedule on November 8, 1982.

d. Client information Location of the project, Kodiak Island, Alaska. Owner's name: Alaska Power Authority, J. Longacre, 334 West Fifth Avenue, Anchorage, Alaska 99501, (907) 276-0001.

e. Cost of design approximately $250,000. Related construction project costs $6,600,000 (estimated). Initial estimated project cost $4,724,000. (Construction commencement date - February 1983).

f. Type of contract for design work was cost plus fixed fee.

g. The method of cost and schedule control used was based on Ebasco's EPICS which is based on the Corps of Engineers earned value system.

D.3 WATER AND POWER DEVELOPMENT AUTHORITY 500 kV TRANSMISSION SYSTEM

HARZA-EBASCO

D.3 Water and Power Development Authority
500-kV Transmission System - Pakistan

Harza has been in the role of general consultant and design consultant on hydroelectric and power system transmission projects for this client since 1962. Our present assignment is the 500 kV Upgrading project, and involves the development of substation and system characteristics for four new 500 kV substations.

a. Project Description The Water and Power Development Authority is in the process of implementing a long range hydro generation and 500 kV transmission system expansion program. The initial backbone transmission system will consist of 830 circuit miles of single circuit 500 kV lines, and six 500/220 kV substations.

The 500 kV transmission lines will carry electric energy from the Tarbela hydro project in the north of the country to three load centers along the line and to the large load center in the south. The economics of the project are grounded in the cost savings realized by the displacement of energy generated from imported oil for thermal units by low cost hydro electric energy.

At the present time the Tarbela hydro station, substation, 205 miles of 500 kV transmission line and one 500/220 kV receiving substation are in operation at 500 kV. Another 330 miles of 500 kV line, is constructed and in initial operation at 220 kV. The remaining 295 miles of 500 kV are under construction.

The program schedule required the initial operation of the 500 kV lines at 220 kV to provide improved transmission system capability. By 1986 significant additional new hydro generation will come on line, and increased transmission capability will be requred. To meet the need for additional transmission capability, the 500 kV insulated lines will be upgraded from operation at 220 kV to operation at 500 kV.

The assignment for determination of salient design and operating characteristics for four 550/220 kV substations was awarded to Harza engineering in December 1981. Harza is in association with the National Engineering Services Limited-Pakistan on this assignment.

b. Services Performed The scope of services provided to the Water and Power Development Authority are described in the following:

"A comprehensive study is requred to check the behavior of the fully established 500 kV network in Pakistan. These Studies will not only establish the design criteria for the upgrading of Gatti-Multan-Guddu-Dadu-Jamshoro section, but will account for the future extensions and expansions of the 500 kV network which would be needed as the quantum of generation increases. The studies will also optimize the sizes of equipment required and carry out techno-economic comparison of various alternatives. These studies should include but not be restricted to the following:

A. System Studies

1. Load flow studies of the system up to the year 2000. These studies should accommodate the future generation expansion program and the future 500, 200 and 132 kV system loading.
2. Steady state and transient stability that will exist when several sections of the line are operated on 500 kV.
3. Power flow conditions during peak load and light load and during maximum and minimum hydel generation.
4. Optimize shunt reactor capacity.
5. Optimize series compensation if required, its location and size.
6. Resistor braking.
7. Three Phase and single phase reclosing.
8. Transient and sustained voltage conditions.
9. Recommendations on fast valving of steam turbines.

10. Recommend modifications on generator excitation.
11. System separation with automatic load/generator dropping.
12. Suggest network reinforcement.
13. Identify operating constraints.
14. Dynamic system performance.
15. System losses.

B. Design Criteria for Upgrading

Based on the results of the above studies, design criteria for the extension of Gatti substation and upgrading of the Multan-Guddu-Dadu and Jamshoro substations should be provided which should include but not be limited to the following:

1. Insulation coordination.
2. Substation lay-out.
3. Circuit breaker rating.
4. Circuit breaker pre-insertion resistor rating.
5. Surge arrester rating.
6. Shunt reactor rating.
7. Series compensation, type and rating (if required).
8. Fault current level.
9. Protective relaying for these stations and the peripheral stations.
10. Transformer ratings and specifications including off load/ on load taps on HV/LV side and the rating of tertiary winding.

ECONOMIC ANALYSIS

The Consultants should carry-out a techno-economic analysis of various design and establish their ranking on an annual cost basis."

Harza has overall responsibility and is lead firm for the work. However load flow studies and preparations of a layout of the 500 kV network for the year 2000 and an intermediate year in the period 1990-1992 is being done by the local associate firm.

c. Dates of Service. The assignment was awarded in December 1981 with a completion date of November 1982. The completion date was extended to February 1983 as part of a scope of services change. The work is more than 85 percent complete as of this time.

d. Client Information The client is the Water and Power Development Authority of Pakistan with main headquarters located in Lahore Pakistan.

The client project manager is:

Chief Engineer EHV
Malik Ashraf.

He can be contacted by Telex at:

44869 WAPDA PK.
Lahore, Pakistan

e. Project Cost The estimated construciton cost of the four 500/200 kV substations is $110,000,000. The cost of the engineering services being provided by Harza is $300,000. Work is proceeding within budget.

f. The Contract Type is a cost plus with ceiling.

g. Cost and Schedule Control Method. Harza is monitoring the engineering services expended on this assignment using its Work Planning and Review system. The project schedule is controlled according to a mile stone chart, and progress reports are submitted every two months. Progress reports include graphs and tables indicating man hours expended and total billing. The actual man hours and costs are compared against estimates submitted by the engineer every six months.

RECENT EXPERIENCE IN ALASKA

HARZA-EBASCO

ALASKAN EXPERIENCE SUMMARY

Client	Project	Scope	Start	Finish	Contact	Harza (H) Ebasco (E)
Alaska Power Authority	Black Bear Lake Cost Estimate	Independent feasibility level cost estimate of 6 MW hydro electric project in Southeast Alaska.	1/82	2/82	Brent Petrie (907) 277-7641	E
Kodiak Electric Association	Terror Lake Economic Evaluation Review	Independent review of economic comparison of Terror Lake and alternative projects.	1/82	1/82	John Longacre (907) 277-7641	E
U.S. Army Corps of Engineers, Alaska District	Northeast and Southcentral Alaska Small Hydro Reconnaissance Study	Preliminary reconnaissance for hydro sites near 67 Alaskan communities, including site visits to 21 of the communities.	3/81	3/82	Harlan Legare (907) 752-3461	E
Alaska Power Authority	Tyee Lake Hydro Feasibility Review and Cost Estimate	Feasibility review and independent cost estimate of a 20 MW hydroelectric project in SE Alaska.	4/81	10/81	John Stafford (907) 277-7641	E
Alaska Power Authority	Kake-Petersburg Transmission Line Cost Estimate	Independent cost estimate for 45-mile 34.5 kV transmission line interconnection in SE Alaska.	8/81	9/81	Remy Williams (907) 277-7641	E
Alaska Power Authority	Grant Lake Hydro Project Feasibility Study	Detailed feasibility study and FERC license application for a 7 MW hydroelectric project on Kenai Peninsula	9/81	2/83	Eric Marchegiani (907) 277-7641	E
Alaska Power Authority	Terror Lake Hydroelectric Cost Estimate	Site visit and feasibility level cost estimate of 20 MW hydroelectric plant on Kodiak	9/81	11/81	Remy Williams (907) 277-7641	E

ALASKAN EXPERIENCE SUMMARY

Client	Project	Scope	Start	Finish	Contact	Harza (H) Ebasco (E)
Alaska Power Authority	Kodiak Coal Fired Steam Plant Conceptual Engineering and Cost Estimate	Conceptual engineering, capital construction cost, and fuel costs for a 20 MW coal fired steam electric plant.	9/81	10/81	Remy Williams (907) 277-7641	E
Alaska Power Authority	Susitna Hydro Project Cost Estimate	Independent feasibility level cost estimate for a 1500 MW project.	10/81	12/82	Remy Williams (907) 277-7641	E
Alaska Power Authority	Bradley Lake-Kodiak Transmission Line	Conceptual engineering and cost estimate for a 120-mile transmission line, including a 45-mile submarine cable from Bradley Lake Hydro Project to Kodiak.	10/81	12/81	Remy Williams (907) 277-7641	E
Alaska Power Authority	Bradley Lake Hydro Cost Estimate	Feasibility level cost estimate of a 135 MW hydroelectric project and conceptual level cost estimate of 120-mile, 115 to 135 kV transmission line.	10/81	12/81	Remy Williams (907) 277-7641	E
U.S. Army Corps of Engineers, Alaska District	Alaska Peninsula, Aleutian Island and Kodiak Small Hydro Reconnaissance Study	Preliminary reconnaissance for hydro sites near 36 Alaskan communities, including site visits to 15 of the communities.	1/80	10/80	Loran Baxter (907) 752-3461	E
Batelle Northwest	Railbelt Power Alternative Study	Reconnaissance layouts and cost estimates for 400 MW Chakachamna and 100 MW Browne Hydroelectric Projects in South Central Alaska.	10/80	1/82	Jeff King (509) 376-4741	E
Alaska Power Authority	Kake-Petersburg Intertie	Feasibility study of 45 miles of transmission line and power system study of Tyee Lake-Wrangell-Petersburg 138 kV transmission line.	2/82	10/82	Remy Williams (907) 277-7641	E

ALASKAN EXPERIENCE SUMMARY

Client	Project	Scope	Start	Finish	Contact	Harza (H) Ebasco (E)
Alaska Power Authority	Terror Lake Construction Management & Engineering	Construction Management for 20 MW Hydroelectric Project and 17 mile 138 kV Transmission Line near Kodiak, Alaska	2/82	--	John Longacre (907) 277-7641	E
Alaska Power Authority	Terror Lake Power House Design	Review Power House Design and and Specifications for 20 MW Hydroelectric Project near Kodiak, Alaska	4/82	--	John Longacre (907) 277-7641	E
Alaska Power Authority	Terror Lake -- Kodiak 138 kV Transmission	Design 17 miles of 138 kV steel pole transmission line near Kodiak, Alaska	3/82	11/82	John Longacre (907) 277-7641	E
Alaska Power Authority	Chester Lake Hydroelectric Project	Hydroelectric project with an installed capacity of 2.5 megawatts near Metlakatla	10/81	--	Brent Petrie (907) 277-7641	H
Alaska Power Authority	Black Bear Lake Hydroelectric Project	Hydroelectric project with an installed capacity of 6 megawatts in Southeast Alaska	7/81	--	Brent Petrie (907) 277-7641	H
Alaska Power Authority	Bethel Area Power Plan Feasibility Assessment	Study of alternate sources of energy for Bethel and eleven surrounding villages	1/82	2/83	Don Baxter (907) 277-7641	H