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BEFORE THE PUBLIC UTILITIES COMMISSION

OF THE STATE OF HAWAII

In The Matter Of the Application Of HAWAIIAN ELECTRIC COMPANY, INC. for approval to commit funds in excess of $500,000 for Item Y48500, East Oahu Transmission Project.	DOCKET NO. 03-0417

OPENING BRIEF OF HAWAIIAN ELECTRIC COMPANY, INC.

EXHBITS "A" – "E"

AND

CERTIFICATE OF SERVICE

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OPENING BRIEF OF HAWAIIAN ELECTRIC COMPANY, INC.

This Opening Brief is respectfully submitted on behalf of HAWAIIAN ELECTRIC COMPANY, INC. ("HECO").

I. SUMMARY

HECO respectfully requests Commission approval to commit funds in excess of $500,000 (currently estimated at $55,644,000) for Item Y48500, East Oahu Transmission Project (the "EOTP" or the "46kV Phased Project"), in accordance with the provisions of Paragraph 2.3(g)(2) of General Order No. 7. HECO proposes to implement the project in two independent phases.

HECO proposes to place the 46kV lines underground that are being installed as part of this project. Pursuant to Section 269-27.6(a) of the Hawaii Revised Statutes ("H.R.S."), HECO requests that the Commission determine that the 46 kV lines shall be built "below the surface of the ground . . . ."

HECO respectfully requests that the Commission expeditiously approve HECO's application to install the proposed 46kV Phased Project. As summarized in this brief, HECO has demonstrated through its analysis that there are several transmission problems in the East Oahu area that can affect system reliability, and that the EOTP can best and most cost-effectively be installed within the time frame necessary to be able to address these problems.

Project Need

The need for the EOTP is addressed in the first, third and fourth issues established for this proceeding.

The first issue is "[w]hether HECO's proposed expenditures for Phases 1 and 2 of the East Oahu Transmission Project will provide facilities which are reasonably required to meet HECO's present or future requirements for utility purposes?" The transmission line overload load situations and substation reliability concerns addressed by the proposed project are detailed in Part IV.A of this brief. The effectiveness of the project in addressing these problems is detailed in Part IV.B.

The third issue is "[w]hether HECO's East Oahu Transmission Project is preferable to HECO's other 138kV and 46kV transmission system alternatives, comparing factors such as, but not limited to the following: (a) Cost; (b) Timeliness and Schedule; (c) Effectiveness; (d) Construction impacts; (e) Electromagnetic fields; (f) Other impacts, if any; (g) Public sentiment; and (h) The public welfare in general?" The selection of the proposed project, and the consideration of other 138kV and 46kV options, are detailed in Parts IV.C and IV.D of this brief. Public sentiment, construction impacts and electromagnetic fields are discussed in Part VI of this brief.

The fourth issue is "[w]hether HECO's East Oahu Transmission Project is preferable to other feasible non-transmission options?" HECO's consideration of non-transmission options is detailed in Part IV.D of this brief.

The only other party that presented evidence regarding the transmission line overload situations and substation reliability concerns was the Division of Consumer Advocacy, Department of Commerce and Consumer Affairs ("Consumer Advocate"), and as summarized in Part IV.E of this brief, the Consumer Advocate supports the need for the EOTP, with the exception of the Archer D transformer for Phase 2 of the project. As set forth in Part IV.E.1.c of this brief, one of the transmission contingencies that HECO is addressing by using the 46kV subtransmission system is the loss of the two 138kV transmission lines to the Pukele Substation and not just loss of a single 46kV circuit. The amount of load requiring back-up is greater for the Pukele Substation contingency compared to loss of a 46kV circuit. Therefore, transformer overloads would occur when the Archer Substation is used to serve the Pukele Substation load if both transmission lines feeding the Pukele Substation were suddenly unavailable. The addition of the Archer D transformer is needed to address this contingency.

Life of the Land's ("LOL") Statement of Position did not directly address the EOTP, although LOL appears to take the position that renewable energy options are feasible and preferable options. As addressed in Part IV of this brief, however, LOL failed to provide any details regarding its generalized claims (Part IV.E.2), and the extensive testimonies and studies submitted by HECO, and the testimony of the Consumer Advocate's consultant, demonstrate that the non-transmission options are <u>not</u> viable, cost-effective alternatives to address the problems addressed by the EOTP (Part IV.D).

Based on the reliable, substantial and probative evidence in the record, the EOTP will provide facilities that are "necessary or useful for public utility purposes", and will not provide facilities that "are unnecessary or are unreasonably in excess of probable requirements for public utility purposes . . . ." Thus, the commitment of expenditures for the project should be approved pursuant to paragraph 2.3(g)(2) of General Order No. 7.

Project Design

The second issue is "[w]hether HECO's selected routing, location, configuration and method of construction for Phases 1 and 2 of the East Oahu Transmission Project are reasonable?"

None of the parties that submitted testimony or participated in the evidentiary hearing have raised an issue with respect to the routing, location, configuration or method of construction for Phase 1 or Phase 2 of the project. The routing, location, configuration and method of construction are addressed in Part V and Exhibit "A" to this brief, and steps taken to mitigate construction impacts and to apply prudent avoidance with respect to electromagnetic fields are addressed in Parts VI. C, and VI. D, respectively. Comments received during the public input and environmental assessment phases of the project have been thoroughly considered and addressed by HECO, as discussed in Parts VI.A and VI.B of this brief, respectively.

Undergrounding 46kV Line Segments

The fifth and final issue is "[p]ursuant to the requirements of HRS § 269-27.6(a), whether all (as proposed by HECO) or part of the 46kV lines that are part of HECO's East Oahu Transmission Project should be placed, constructed, erected or built below the surface of the ground?"

As is addressed in Part V.C of this brief, there is no remaining issue regarding HECO's proposal to place underground all of the new 46kV line segments required for the project. As the record demonstrates, it generally would not be practical or prudent to construct the proposed new 46kV circuits overhead, given State and City laws governing portions of the route, engineering considerations, the history of this project and probable opposition to overhead construction, and the pressing need to resolve the East Oahu transmission system concerns. If certain sections of the new 46kV circuits were proposed for overhead construction, the potential for significant project delays and increased costs would be great. Any potential savings in engineering and construction costs associated with an overhead line proposal could easily disappear if approvals and permits for the project were delayed. Installing the various 46kV circuits underground provides the best opportunity to meet the underlying need for this project in a timely and cost-effective manner.

II. BACKGROUND

A. APPLICATION AND PUBLIC HEARING

HECO filed its Application, direct testimonies and exhibits in this Docket on December 18, 2003. The public hearing required by H.R.S. § 269-27.5 was held on September 1, 2004.

B. THE PARTIES AND PARTICIPANTS

As the applicant, HECO is a party to this proceeding. The Consumer Advocate is an *ex officio* party to this docket, pursuant to H.R.S. § 269-51 and Hawaii Administrative Rules § 6-61-62.

LOL filed a motion to intervene dated January 6, 2004. Palolo Community Council ("PCC"), Darlene Nakayama on behalf of Ho`olaulima O Palolo ("HOP"), Mālama O Mānoa ("Malama"), and Carol Fukunaga, Scott K. Saiki and Ann Kobayashi (collectively referred to as "Public Officials") filed motions to intervene on January 7, 2004. Kapahulu Neighbors, Michelle S. Matson, and Carolyn H. Walther filed motions to intervene dated January 7, 2004.

HECO filed (1) a response to the motion of LOL on January 13, 2004, (2) responses to the motions to intervene of HOP, Malama, and Kapahulu Neighbors on January 14, 2004, and (3) responses to the motions to intervene of Public Officials, Michelle S. Matson, Carolyn H.

Walther, and PCC on January 16, 2004.

Hearings on the motions to intervene of LOL and PCC were held on January 29, 2004. By Order No. 20860, filed March 23, 2004, the Commission granted the Motions to Intervene by LOL and the Public Officials. By Order No. 20861, filed March 23, 2004, the Commission denied the Motions to Intervene filed by PCC, HOP, Malama, and Kapahulu Neighbors (collectively referred to as "Participants"). Instead, Participants were granted participant status, subject to the limitations set forth in Order No. 20861.[1] By Order No. 20862, filed March 23, 2004, the Commission denied the Motions to Intervene filed by Michelle S. Matson and Carolyn H. Walther. By letter filed November 4, 2005, the former secretary of Kapahulu Neighbors informed the Commission that Kapahulu Neighbors no longer existed as a formal organization.

C. ISSUES

On April 23, 2004, the Parties and Participants filed their stipulated prehearing order, in response to Order No. 20860 (March 23, 2004).[2] On May 10, 2004, the Commission filed

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[1] Pursuant to Order No. 20861 (page 6), the participants' involvement in this proceeding was limited to, among other things: "(1) receipt of copies of all correspondence, filings, and briefs relating to this docket; and (2) a written statement of position, which shall be due on the date established in either the stipulated procedural order or the commission's procedural order, and which shall be limited to a total of 25 typewritten pages (not including exhibits)."

[2] On January 20, 2004, the Commission issued Order No. 20771, which ordered HECO and the Consumer Advocate to establish the issues, procedures, and schedule with respect to the proceeding, to be set forth in a stipulated prehearing order ("SPO"). The SPO was to be submitted for Commission approval within thirty days. On February 19, 2004, HECO filed a letter requesting an extension until March 18, 2004, which the Commission approved by Order No. 20845, filed March 10, 2004. The Commission also suspended the 90-day period for the Commission to act on HECO's application specified in Paragraph 2.3.g.2 of General Order No. 7, until further order of the Commission.

By Order No. 20860, filed on March 23, 2004, the Commission granted the motions to intervene by LOL and the Public Officials, and ordered the Parties and the Participants to meet informally to determine the issues, procedures, and schedule to be set forth in a SPO to be submitted within 30 days. On April 22, 2004, HECO requested an extension until April 23, 2004 since the Parties and the Participants reached agreement on the stipulated prehearing order, but needed additional time to obtain all of their signatures.

Order No. 20968 setting forth the issues in this case as follows:

1. Whether HECO's proposed expenditures for Phases 1 and 2 of the East Oahu Transmission Project will provide facilities which are reasonably required to meet HECO's present or future requirements for utility purposes?

2. Whether HECO's selected routing, location, configuration and method of construction for Phases 1 and 2 of the East Oahu Transmission Project are reasonable?

3. Whether HECO's East Oahu Transmission Project is preferable to HECO's other 138kV and 46kV transmission system alternatives, comparing factors such as, but not limited to the following:

    a) Cost;

    b) Timeliness and Schedule;

    c) Effectiveness;

    d) Construction impacts;

    e) Electromagnetic fields;

    f) Other impacts, if any;

    g) Public sentiment; and

    h) The public welfare in general.

4. Whether HECO's East Oahu Transmission Project is preferable to other feasible non-transmission options.

5. Pursuant to the requirements of HRS 269-27.6(a), whether all (as proposed by HECO) or part of the 46kV lines that are part of HECO's East Oahu Transmission

Project should be placed, constructed, erected or built below the surface of the ground?

D. TESTIMONIES AND EXHIBITS

HECO filed written direct testimonies and exhibits with its Application on December 18, 2003. Following identification of the issues, HECO filed supplemental written direct testimonies and exhibits on July 22, 2004.

The Consumer Advocate, LOL and the Public Officials submitted Information Requests ("IRs") to HECO on August 25, 2004. HECO responded to these IRs on October 6, 2004, and submitted its voluminous IRs response to a Public Officials' IR (PO-IR-2.a.) on October 7, 2004.[3] On October 18, 2004, additional electronic files were submitted in response to the Consumer Advocate's IRs. HECO submitted its confidential sealed responses to certain of these IRs on June 3, 2005.[4]

The Consumer Advocate, LOL and the Public Officials submitted Supplemental IRs ("SIRs") to HECO on November 8, 2004. HECO responded to these SIRs on December 15, 2004.

The Consumer Advocate filed written direct testimony and exhibits on June 21, 2005. LOL submitted a Statement of Position ("SOP") on June 22, 2005.

HECO submitted IRs to the Consumer Advocate and LOL on July 12, 2005 (as revised on July 15, 2005). The Consumer Advocate and LOL responded to the IRs (as revised) on August 2, 2005.

HECO filed written rebuttal testimonies and exhibits on August 30, 2005.

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[3] On October 11, 2004, HECO submitted an IR response that had been inadvertently omitted in its October 6, 2004 submittal.

[4] The Commission issued Protective Order No. 21850 on June 1, 2005, approving a Stipulation for Protective Order dated May 18, 2005.

The Consumer Advocate and LOL submitted Rebuttal IRs ("RIRs") to HECO on September 19, 2005. HECO responded to the RIRs on October 12, 2005.[5]

On October 11, 2005, LOL requested a time change and/or delay to the evidentiary hearing.

HECO, the Consumer Advocate and LOL filed Witness and Exhibit Lists on October 24, 2005.[6]

E. HECO/CONSUMER ADVOCATE STIPULATION

On October 28, 2005, HECO and the Consumer Advocate filed a Motion for Approval of Stipulation. In the Stipulation, HECO and the Consumer Advocate agreed that:

1. In this proceeding, a determination should be made as to whether HECO should be given approval to expend funds for the East Oahu Transmission Project, provided that no part of the East Oahu Transmission Project may be recovered from ratepayers unless and until the Commission grants HECO recovery in a general rate increase proceeding.

2. Any issue as to whether the pre-2003 planning and permitting costs, and related AFUDC should be included in the costs of the instant project has been reserved to and may be raised in the next general rate increase proceeding (or other proceeding) in which HECO seeks approval to recover the East Oahu Transmission Project costs.

3. Provided the Commission approves the Stipulation in its entirety, HECO and the Consumer Advocate withdraw from the evidentiary record in this docket specified portions of their filed testimonies, exhibits and responses to information requests relating to this issue.

4. Nothing in this Stipulation shall be construed to prevent the Consumer Advocate and HECO from discussing or addressing the subject of including the pre-2003 planning and permitting costs in the instant project costs prior to the hearing in the general rate increase proceeding in which HECO seeks recovery of the East Oahu Transmission Project costs.

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[5] By Order No. 21930 filed on July 20, 2005, the Commission approved the Parties' and Participants' amended regulatory schedule for this proceeding. Pursuant to this regulatory schedule, HECO's responses to the Parties' RIRs were due on October 11, 2005. On October 11, 2005, HECO requested a one day extension to file its responses. By Order No. 22104 filed November 4, 2005, the Commission approved HECO's request.

[6] On August 3, 2005, the Commission filed Amended Order No. 21954 amending Order No. 21930, issued on July 20, 2005, to require only the Parties to the docket to provide the Commission with a list of their witnesses (with a brief description of the testimony they will provide) and their exhibits not later than October 24, 2005.

5. This Stipulation shall apply solely to this proceeding, and is entered solely for the purposes of simplifying and expediting this proceeding.

6. The agreements in this stipulation are subject to Commission approval. If the Commission does not issue an order adopting the Stipulation in its entirety, HECO and/or the Consumer Advocate may withdraw from this Stipulation.

The Commission issued Order No. 22104 on November 4, 2005, in which the Commission approved, in part, the Stipulation and the agreements contained therein. The Commission accepted the withdrawal of the pre-2003 planning and permitting costs issue from this proceeding, but denied HECO and the Consumer Advocate's request to withdraw from the record certain portions of their filed testimonies, exhibits, and responses to IRs to this issue. Specifically, the Commission granted the Stipulation in its entirety with the exception of Paragraph 3 on Page 5 of the Stipulation, which was denied.

F. EVIDENTIARY HEARING

On November 4, 2005, the Commission filed Order No. 22103 following a prehearing conference held on November 1, 2005. Order No. 22103 provided terms controlling the evidentiary hearing, including the dates and times of the hearing, the Parties' agreement to dispense with opening and closing statements, the order of presentation and the Parties' acknowledgment that the Commission may ask each witness questions.

The evidentiary hearing began on November 7, 2005 and concluded on November 8, 2005. Fifteen witnesses for whom written testimonies (or an SOP in the case of LOL) were filed appeared at the hearing: HECO, the Consumer Advocate and LOL.

III. EOTP DESCRIPTION

A. PROJECT SCOPE

For the EOTP, HECO proposes to reconfigure and connect existing 46 kV circuits from Pukele Substation at the end of HECO's Northern 138kV transmission corridor with existing and new 46kV circuits at Archer Substation and Kamoku Substation in HECO's Southern 138kV transmission corridor. The project is planned in two independent phases.[7]

1. Phase 1

Phase 1 involves the installation of 0.5 mile of new underground ductline for 46kV subtransmission lines, and related work at seven substations (these substations include McCully, Makaloa, Kewalo, Kuhio, Waikiki, Ena, and Kapahulu Substations), to interconnect three 46kV circuits out of the Pukele Substation, at the end of HECO's Northern 138kV transmission corridor, to four 46kV lines connected to HECO's Southern 138kV transmission corridor. Phase 1 includes (1) the installation of six underground 46kV lines in the Ala Moana, McCully, Moiliili, and Kapahulu areas, (2) a 138kV/46kV transformer installation at the existing Kamoku Substation with associated protective relaying, (3) a 46kV/12kV transformer installation at the existing Makaloa Substation with associated switchgear, (4) various switching and reconnections on the existing 46kV and 12kV systems near Makaloa and McCully Substations, (5) the removal of existing 46kV and 12kV cables between Makaloa and McCully Substations, (6) the removal of an existing 46kV/12kV transformer and associated switchgear from the McCully Substation, and (7) modifications of various existing distribution substations in the Honolulu area.[8] HECO T-2 at 2-7; Tr. (11/07) at 26 (Wong); FEA (Vol. 1), Figure 1-1 and Chapter 3.

2. Phase 2

Phase 2 involves the installation of 1.9 miles of underground ductline for 46kV subtransmission lines, and related work at one substation, to interconnect four out of the five

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[7] See Part V of this brief.

[8] Items 3, 4, 5, and 6 in the above project description were made part of the proposed alternative through supplemental direct written testimonies and exhibits filed by HECO on July 22, 2004, in which HECO updated its proposal to take into account (1) its ability to utilize existing ducts for some of the new 46kV circuits to be installed as part of the project, and (2) the decision to extend a planned 46kV underground segment instead of using an existing overhead 46kV line on Pumehana Street. HECO ST-1 at 3-4; HECO ST-2 at 1.

remaining 46kV circuits out of the Pukele Substation to three other 46kV lines connected to HECO's Southern 138kV transmission corridor. Phase 2 includes (1) the installation of three underground 46kV lines in the new ductline in the Kakaako, Makiki, and McCully areas, predominantly along King Street, and (2) a 138kV/46kV transformer installation at the existing Archer Substation with associated protective relaying. HECO T-2 at 7-10; Tr. (11/07) at 26-27 (Wong); FEA (Vol. 1), Figure 1-1 and Chapter 3.

B. ROUTING

1. Phase 1

Phase 1 of the proposed 46kV Phased project includes four 46kV line segments, consisting of: (1) Two new 46kV underground circuits between the Makaloa Substation, located at the corner of Amana and Makaloa Streets, and the McCully Substation, located at the corner of Lime and Pumehana Streets[9]; (2) Two new underground 46kV circuits on Date Street to connect the new 138kV to 46kV transformer to be installed in the Kamoku Substation, which is located on the makai side of Date Street, to an existing 46kV circuit on the mauka side of Date Street[10]; (3) A new underground 46kV circuit on Pumehana Street to connect an existing 46kV circuit near McCully Substation to another existing 46kV circuit near the intersection of Date and Pumehana Streets[11]; and (4) A new underground 46kV circuit on Winam and Mooheau

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9 The total length of the proposed main ductline would have been approximately 3,450 feet. After further field inspections and engineering review, HECO has determined that approximately 70% (~2450 feet) of an existing ductline between the Makaloa Substation and the McCully Substation can be used to install the two new 46kV circuits, instead of installing a completely new ductline as originally proposed. HECO ST-1 at 9; HECO ST-2 at 1; HECO ST-7 at 1-4. The existing ductline follows the same route as the originally proposed new ductline.

10 The total length of the ductline is approximately 30 feet for one circuit and approximately 300 feet for the other circuit.

11 The total length of this ductline is approximately 720 feet.

Avenues to connect an existing 46kV circuit on Winam Avenue to another existing 46kV circuit on Mooheau Avenue.[12]

The scope of work for Phase 1 reflects two changes identified by HECO in its supplemental testimonies arising out of (1) the ability to utilize existing ducts for some of the new 46kV circuits to be installed as part of the project, and (2) a decision to extend a planned 46kV underground segment instead of using an existing overhead 46kV line on Pumehana Street. HECO ST-1 at 3. These changes are further addressed in Exhibit "A" to this brief.

2. Phase 2

Phase 2 connects three new 46kV underground circuits from the existing Archer Substation to circuits in the McCully Street area. The main ductline for the three new 46kV circuits begins at Archer Substation, extends on Cooke Street to King Street, and heads in the Diamond Head direction along King Street until the area fronting McCully Times Supermarket. The total length of the main ductline is about 8,325 feet. From the area fronting Times Supermarket, one of the 46kV circuits continues in the Diamond Head direction on King Street until McCully Street. At McCully Street, the ductline heads in the mauka direction until Young Street. The length of the additional ductline for this circuit is about 1,450 feet.

3. Alternate Routes

HECO examined alternative routes for Phase 1 that used Kapiolani Boulevard, and for Phase 2 that used Young Street and Beretania Street as alternatives to King Street. The disadvantages of the alternative routes, such as the inability to use an existing ductline, higher costs, traffic and parking impacts, potential conflicts with future plans for the alternate routes,

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[12] The total length of this ductline is approximately 420 feet.

and other practical constraints on the use of the alternatives, are addressed in Part V.B.3 of this brief.

C. UNDERGROUND PLACEMENT OF THE LINE SEGMENTS

HECO proposes to place the 46kV lines for this project underground. Moreover, as discussed in Part V.C of this brief, there is no issue among the parties regarding placement of the line segments underground.

Generally, it would not be practical or prudent to construct the proposed new 46kV circuits overhead, given State and City laws governing portions of the route, engineering considerations, the history of this project and probable opposition to overhead construction, and the pressing need to resolve the East Oahu transmission system concerns. If certain sections of the new 46kV circuits were proposed for overhead construction, the potential for significant project delays and increased costs would be great. Any potential savings in engineering and construction costs associated with an overhead line proposal could easily disappear if approvals and permits for the project were delayed. Installing the various 46kV circuits underground provides the best opportunity to meet the underlying need for this project in a timely and cost-effective manner.

D. SCHEDULE

The estimated project completion dates are mid-2007 for Phase 1 and early 2009 for Phase 2. Implementing the proposed project in two phases has been proposed to address near-term transmission problems in a more timely manner. FEA (Vol. 1) at 1-2; Tr. (11/07) at 10 (Joaquin), 24 (Wong). The schedule is addressed in more detail in Exhibit "A" of this brief.

E. CONSTRUCTION

A comprehensive construction work plan for the proposed project was provided in HECO-804, and the updated plan to use existing ductlines for part of Phase 1 was addressed in

HECO T-8. HECO's Final EA provided a detailed discussion of construction activities planned for the proposed Phased 46kV alternative. Final EA (Vol. 1), Sections 3.1.1 and 3.1.2.

The estimated time to complete the construction work for the proposed Phased 46kV alternative is 10 to 12 months for Phase 1 and 13 to 15 months for Phase 2. These estimates were developed in consultation with HECO's project management consultant, who specializes in the management of electrical utility construction projects. Like all HECO projects, this schedule was established by factors such as (1) looking at the project requirements and scope of work, (2) reviewing historical production data on similar projects, (3) accommodating external factors, such as permitting requirements, and (4) utilizing a crew structure that maximizes productivity while effectively mitigating construction impacts. HECO T-8 at 2; Tr. (11/07) at 172-73 (Harrington).

In developing the schedule, HECO recognized that, in most instances, the work will take place in a congested urban environment. Accordingly, a number of critical planning elements were considered in developing the construction schedules, including: traffic control, noise mitigation, dust control, access to businesses and homes, and community relations. HECO T-8 at 2-3.

The entire route for each alternative will be limited to the boundaries of existing city streets, which reduces the likelihood that unusual or unanticipated events will occur during construction. Should obstacles occur, flexibility (for contingencies) is included in the estimated construction schedules. HECO T-8 at 3.

HECO and its consultant have extensive experience in conducting projects such as this project, and HECO has developed plans to address impacts of the construction activities on traffic, noise, dust, and access to businesses and homes, and to respond to concerns raised by the community regarding the impacts of the construction activities. HECO T-8 at 1-2, 7. The planned construction activities and mitigation measures are addressed in more detail in Part VI.C of this brief.

F. PROJECT COST

The total initial installation cost of the proposed project is currently estimated at approximately $55,644,000. HECO ST-9 at 2; Tr. (11/07) at 180 (Oshiro). In terms of revenue requirements, the net present value (in 2003 dollars and assuming an 8.4% discount rate) of the revenue requirements for the project is approximately $55.5 million. HECO RT-9 at 3; HECO-R-902; HECO-R-903. The potential rate impact associated with the project for the typical residential customer is $0.73 in 2008, after Phase 1 is installed, and increases to $0.92 in 2010, after Phase 2 is installed. HECO RT-9 at 3; HECO-R-903; Tr. (11/07) at 182 (Oshiro). The total installation cost, revenue requirements, and potential rate impact of the 46kV Phased Project and the alternatives are discussed in Exhibit "A" to this brief.

IV. PROJECT NEED

A. EOTP PROJECT OBJECTIVES

1. System Background

Bulk power from Leeward Oahu power plants is transmitted to the East Oahu Service Area over two major transmission corridors.[13] The Northern Transmission Corridor extends from Kahe Power Plant to the Halawa Substation, Koolau Substation and the Pukele Substation, where it currently ends. With the completion of the two Waiau-CIP 138kV Transmission lines in

[13] The 138kV transmission system is shown in HECO-401. The 138kV transmission lines allow efficient transmission of large amounts of power from the power plants, where power is generated, to all major load centers. Transmission substations at these major load centers have transformers that "step down" the 138kV voltage to the 46kV sub-transmission voltage. HECO-402 shows HECO's 46kV transmission system. From there, local area substations further reduce the voltage from 46kV to HECO's 12kV and 4kV local distribution voltages. HECO T-4 at 2.

1995, the Southern Transmission Corridor was extended from the Kahe Power Plant to the Waiau Power Plant and Iwilei, School Street, and Archer Substations. The Southern Transmission Corridor was recently extended to the Kamoku Substation through the installation of two 138kV transmission lines from Archer Substation to Kewalo Substation and the installation of a 138kV transmission line from Kewalo Substation to Kamoku Substation. Application at 12; HECO T-4 at 2-3; HECO-403.

In West Oahu, the two corridors are linked together by transmission lines between power plants and substations connected to the Northern and Southern Corridors. However, no similar connection exists to provide reliable power to the East Oahu Service Area. HECO's plan has been to build upon existing facilities installed to serve the local load growth through the Archer-Kewalo-Kamoku projects and close the existing gap between the Northern Transmission Corridor and the Southern Transmission Corridor on the East Side of Oahu, providing added reliability to the Eastern and Windward portions of Oahu, which represents more than 50% of HECO's total load. Application at 12; HECO T-4 at 3-4; see Tr. (11/07) at 117 (Ishikawa).

2. Transmission Problems Addressed by the EOTP

The purpose of the East Oahu Transmission Project is to address several transmission problems concerning Oahu's 138kV transmission system in the eastern half of the island. First, an overload situation with one of the three 138kV transmission lines that transport power to the Koolau/Pukele Service Area in the Northern 138kV transmission corridor could occur beginning in 2006, whenever the other two lines are out of service ("Koolau/Pukele Overload Situation"). Second, an overload situation with one of the three 138kV transmission lines that transport power to the Downtown Area in the Southern 138kV transmission corridor could occur beginning in or about 2034, based on the planning assumption that the Honolulu Power Plant

("HPP") will continue to be in operation, whenever the other two lines are out of service ("Downtown Overload Situation").[14] Third, Pukele Substation, located at the end of the Northern 138kV transmission corridor, would be without power if the two 138kV transmission lines serving it were to be lost. Pukele Substation serves critical loads such as Waikiki, State Civil Defense, Hawaii Air and Army National Guard Headquarters, and the University of Hawaii ("Pukele Substation Reliability Concern"). And fourth, Archer Substation, Kewalo Substation and Kamoku Substation, all located in the Southern 138kV transmission corridor, would be without power if the two 138kV transmission lines serving Archer Substation were to be lost ("Downtown Substation Reliability Concern"). Kewalo Substation receives power from Archer Substation via two 138kV transmission lines, and Kamoku Substation receives power via one 138kV transmission line from Kewalo Substation. These substations serve critical loads such as the Honolulu Police Department Headquarters and the Hawaii Convention Center. See Application at 13-14; and Exhibit 5; HECO T-4 and studies cited therein; HECO-R-406 (updating timing of overload situations).

Detailed descriptions of these line overload situations and substation reliability concerns, with citations to the record in this docket, are included in Exhibit "B" to this brief. A summary, without the record citations, is included in the following subsections of the brief.

a. Pukele Substation Reliability Concern

Two 138kV transmission lines currently feed the Pukele Substation from the Koolau Substation in Kaneohe, on the windward side of Oahu. The two 138kV lines cross the Koolau Mountain Range to connect the Pukele Substation to the rest of the HECO system. The power transported from these two lines is stepped down to the sub-transmission voltage and transported

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[14] The availability of the HPP defers the overload problem. The Downtown Overload Situation is forecasted to occur in 2007 without the HPP in operation.

over eight 46kV feeders that branch out from Palolo Valley to distribution substations in Kahala, Kaimuki, Manoa, Makiki and Waikiki.

The Pukele Substation is the most heavily loaded 138kV substation in the HECO system. Based on 2002 Day Peak load conditions, the Pukele Substation supplied electricity to about 17% of the Oahu load (or approximately 192 MW of the daytime peak load).

If the two lines providing power to the Pukele substation are both out of service, approximately 93% of the customers serviced from the Pukele Substation will incur an outage. Most of HECO's customers in the area extending from Makiki to Waikiki, and from Koolau to Kaimuki, would be out of power until one of the two 138kV transmission lines could be restored to service. While many parts of the two lines have been renewed and upgraded, the two Koolau-Pukele 138kV transmission lines generally are more than 40 years old. Typically, a transmission line experiences an increase in forced outages as the line ages. Even with visual inspections and maintenance on the Koolau-Pukele 138kV transmission lines, forced outages will occur. These lines are subject to extreme weather conditions due to the high winds, heavy rains, and salt laden marine air that are prevalent in the coastal Koolau Mountain Range.

Until 2004, Hawaii was fortunate that the second of the two 138kV lines to Pukele Substation had not tripped out of service while the other line was out for maintenance, or out of service due to a forced outage. The latter situation very nearly occurred in 1994 and did occur in 2004. In addition, HECO has experienced simultaneous forced outages on multiple lines on other parts of the HECO system (outages that seemed even less likely to occur), and the impact of these events caused a large loss of service to the HECO customers. In the case of two major system outages, two lines tripped out at about the same time while another line was out of service for maintenance.

The Waikiki area includes large hotels and commercial shopping areas, and a power interruption to these loads would have a major impact on the local and state economies. In addition, many facilities essential to Hawaii's safety and security, such as the State Civil Defense, are also in this service area, as well as the University of Hawaii at Manoa and Kapiolani Community College.

Some customers with emergency generators on site may be able to meet limited power needs during an area blackout. However, typical emergency generators (at a hotel, for example) serve only critical loads such as elevators and emergency lighting. Ultimately the vast majority of customers within the Pukele service area, including most of Waikiki, would be without power until at least one of the two 138kV lines to the Pukele Substation was restored to service.

The duration of a forced outage of the Koolau-Pukele line will depend on the severity of the damage to the line. The duration could be instantaneous or within a minute as seen with the 1994 flashover incidents on the Koolau-Pukele lines, or could last days as in the case of the April 5, 2003 outage on the Koolau-Pukele #1 line.[15]

In the case of a prolonged interruption of power to the Pukele Substation, most of the customers served by the substation would continue to experience an outage for the duration of the power interruption. The load in certain segments of the Pukele service area could be manually switched to other 46kV back up circuits receiving power from the Koolau Substation. Based on 2002 Day Peak load conditions, about 20% of the total electricity demand of the Pukele Service Area could be restored to service after manual switching operations on the

[15] The Koolau-Pukele #1 138kV transmission line experienced a continuous outage (including the Evening Peak period) for 4½ days due to structure damage. Severe weather conditions could also cause a prolonged outage that could take weeks to repair.

existing 46kV system were implemented. These customers would experience a 2 to 4 hour outage until all the switching could be done to transfer them to these back up circuits.

b. Koolau/Pukele Line Overload Situation

There are three 138kV transmission lines providing power to the Koolau Substation. There are two 138kV transmission lines from the Koolau Substation that provide power to the Pukele Substation. Together these two substations provide power to about 30% of the load served by HECO on Oahu. Based on load flow analyses using the load projections in HECO's August 2002 load forecast, with one 138kV transmission line to the Koolau Substation out of service for maintenance, if a second 138kV Koolau transmission line becomes unavailable for any reason, the current flowing through the third 138kV Koolau transmission line was projected to exceed its emergency current carrying capacity rating during daytime peak load conditions in the year 2005. Using the 2004 actual system loads and escalating the loads using the May 2005 Peak Forecast, the Koolau/Pukele Line Overload is expected to occur in 2006, which demonstrates that the overload date for the Koolau/Pukele Line Overload has not changed and has remained in the 2005-2006 time frame.

This would violate HECO's Transmission Planning Criteria, which provides that no transmission component shall exceed its emergency rating with one generating unit on overhaul, one transmission line out for maintenance and loss of a second transmission line. If the current flowing through the remaining 138kV transmission line exceeds the emergency rating of the line, the conductor will heat up beyond normal operating parameters and could possibly break down and the line could suddenly be lost. Loss of the third 138kV transmission line feeding the Koolau/Pukele area would result in loss of electricity service to about 30% of HECO's customers, including sub-transmission substations that feed communities such as Kailua, Kaneohe, Kahala, McCully and Waikiki. The damage caused to the failed transmission line from the overload could lead to a continuous prolonged outage of the line in order to perform the repairs, placing HECO at risk of an additional overload situation.

In the event of a possible overload situation, an Energy Management System ("EMS") program will automatically shed load at the Koolau and Pukele Substations in pre-selected blocks in a pre-selected order associated with the most overloaded transmission line. The amount of load that HECO would have to shed during a line overload situation would vary, since the load in the Koolau/Pukele area varies throughout the day.

System Operation personnel may, at their discretion, take precautionary measures and intervene before the EMS overcurrent protection scheme that causes the load shed is activated, to avoid larger outages or maintain system integrity. The system operator has the ability to shed individual 12kV and 46kV distribution feeders in the Koolau/Pukele area to decrease the current flow until there is no longer an overload situation.

While the load-shedding process can prevent overload conditions, remedial action schemes such as load shedding should not be relied upon as a long-term solution to line overloading conditions, especially on an island utility system where there are no interconnections. In addition, relying on load shedding would not address other issues that are described such as the Pukele Substation Reliability Concern or the Downtown Substation Reliability Concern. Relying on remedial measures also would increase the risk for more significant transmission events to occur on the system. HECO has experienced several instances where multiple line outages occurred that resulted in island-wide blackouts or loss of service to nearly the entire island.

c. **Downtown Line Overload Situation**

There are two 138kV transmission substations serving the Downtown area, including the Iwilei Substation and the School Substation. Power to serve the Downtown area can also come from the HPP, when it is on line. Together, these two substations and the HPP (when on-line) provide power to about 25% of the load served by HECO at the time of the 2002 Day Peak. These two transmission substations are fed from three 138kV transmission lines providing power from the Halawa and Makalapa Substations. If one of the three 138kV transmission lines to Iwilei or School Substation is taken out of service for maintenance, and a second Downtown 138kV transmission line becomes unavailable, then the current flowing through the remaining Downtown 138kV transmission line was forecast to exceed the emergency current carrying capacity rating during daytime peak load conditions in the year 2024, assuming the HPP is on line. Again, this would result in a violation of HECO's Transmission Planning Criteria, because the current flowing through the third 138kV transmission line feeding the Downtown Substations would exceed the emergency rating of the line.

The availability of the HPP defers the overload problem.[16] When the HPP is operating, power from the plant feeds the neighboring areas and decreases the demand for power from the West Side, which decreases the current flowing through the three 138kV transmission lines feeding School Street and Iwilei Substations. If the HPP was not operating, the Downtown overload situation was forecast to be accelerated to 2009.

Using the 2004 actual system loads and escalating the loads using the May 2005 Peak Forecast, the Downtown Overload is forecasted to occur in 2007 without the HPP in operation and 2034 with the HPP in operation.

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16 HECO's current plan is to continue to operate the HPP beyond the 20-year planning period.

If the current flowing through the third remaining 138kV transmission line exceeds the emergency rating of the line, the conductor could heat up and could possibly break down and the line could suddenly be lost. Loss of the third 138kV transmission line feeding the Downtown area would result in loss of electricity service to about 25% of HECO's customers. The damage caused to the failed transmission line from the overload could lead to a continuous prolonged outage of the line in order to perform the repairs, placing HECO at risk of an additional overload situation. Unlike the Koolau-Pukele transmission lines, the Halawa-Iwilei, Halawa-School and the Makalapa-Airport-Iwilei 138kV transmission lines feeding the Downtown area 138kV substations do not have overcurrent protection schemes in place. Similar to the Koolau/Pukele overload situation, System Operation personnel may take precautionary measures and intervene by shedding load using 12kV and 46kV distribution feeders in the Downtown area to decrease the current flow through the remaining line to a level that does not exceed the emergency rating of the line.

d. <u>Downtown Substation Reliability Concern</u>

There are three downtown area substations with only two 138kV transmission feeds, including the Archer and the Kewalo Substations, and the Kamoku Substation has only one 138kV transmission feed.

The Archer Substation is one of the newer transmission substations on the HECO system, and is fed by two underground 138kV lines. These underground lines are considered relatively reliable and are relatively new, however, a catastrophic underground duct bank failure could result in loss of power to the Archer Substation for some time depending on the severity of the failure.

The Kewalo Substation is also one of the newest transmission substations and is located on Kona Street. Two 138kV underground transmission lines supply power to Kewalo Substation. Kewalo serves customers at the distribution voltage of 25 kV in the Kakaako area. A catastrophic failure to the underground duct bank could result in loss of power to the Kewalo Substation.

The Kamoku Substation is the newest transmission substation and is located on the corner of Date Street and Kapiolani Boulevard. Kamoku Substation is fed from one 138kV underground transmission line, which brings the power from Archer Substation via Kewalo Substation to Kamoku. The entire Kamoku Substation has a 25 kV back up system. If the 138kV transmission line feeding the substation should fail, then the Kamoku Substation load would be transferred to Kewalo Substation.

If the two 138kV feeds to Kewalo Substation experience an outage, then both the Kewalo and Kamoku Substations would be unable to serve the load. The Kewalo and Kamoku Substations provide service to portions of Ala Moana Shopping Center, several high-rise luxury condominiums in the area and the Hawaii Convention Center. A second 138kV transmission line to Kamoku Substation would increase the reliability of the substation and provide a second 138kV feed and a third path of electricity for the substation.

The concerns regarding the reliability of the three downtown substations are not as critical as the concerns regarding the Koolau-Pukele line overload and the Pukele Substation reliability. The underground lines serving the substations are relatively new, the line segments between the substations are shorter than the Koolau-Pukele 138kV lines, which reduces the exposure to outages, and the Pukele Substation is the most heavily loaded substation on the HECO system. Also, the two transmission lines serving the Pukele Substation cross the Koolau

Mountains. The very difficult access to the lines, their exposure to corrosive marine air, and the location of the two lines on a common right of way causes the Pukele transmission lines to be at a relatively higher risk for an extended outage than the transmission lines in other areas of the island.

e. Avoiding Catastrophic Outages

The primary goal for operating the generation and transmission systems is to keep the power flowing continuously to customers. If there are system disturbances, HECO tries to isolate the disturbances and minimize their effect on its customers. The installation of critical infrastructure in a timely manner provides a means to deal with these disturbances quickly and effectively. From a planning perspective, there are basically two types of reliability concerns that HECO continuously tries to guard against. The first type of reliability concern is a catastrophic power outage, where disturbances on the system could potentially throw the entire system into instability. The second type of reliability concern is a localized power outage, where the outage affects a limited area of the island.

The Koolau/Pukele Overload Situation involves potential transmission line overloads in HECO's 138kV Northern transmission corridor as soon as the present. As a result of the continued operation of the HPP, the Downtown Overload Situation, which involves potential transmission line overloads in HECO's 138kV Southern transmission corridor, is not expected to occur until after 2020. The overload situations are problems that increase the risks for catastrophic type power outages.

The Pukele Substation Reliability Concern involves the reliability of the Pukele Substation located at the end of the Northern transmission corridor. Pukele Substation now serves 16% of Oahu's power demand, including critical loads such as Waikiki, State Civil

Defense, the Hawaii Army and Air National Guard Headquarters, and the University of Hawaii. The Downtown Substation Reliability Concern involves the reliability of Archer Substation, Kewalo Substation and Kamoku Substation located at the end of the Southern transmission corridor. These substations serve critical loads such as the Honolulu Police Department Headquarters and the Hawaii Convention Center. The Pukele Substation Reliability Concern is of significant concern, due to factors such as the location of the two transmission lines providing power to the substation and the conditions to which the lines are subjected, the potential duration of a loss of power to the substation and to most of the customers served from the substation, and the potential impacts of an extended outage on the Pukele Substation service area.

3. Timing of Line Overload Situations

In the December 2003 Study update done for this project, the Koolau/Pukele Line Overload situation was estimated to occur in 2005, and the Downtown Line Overload Situation was estimated to occur in or about 2023 (with the HPP in operation) and to occur in 2006 (if the HPP becomes unavailable for some reason). These estimates were made based on the projected load growth rates in the August 2002 long-term load forecast, the available substation load data, and the configuration of the 46kV sub-transmission and 25 kV distribution systems as of 2002. See HECO T-4.

During the course of the proceeding, the estimated occurrence dates for the overload situations were updated to reflect later load forecasts that became available, later (and in some instances, corrected) substation load data, normal changes in the 46kV sub-transmission and 25kV distribution systems made in the 2002-2004 time frames, and improved assumptions regarding load transfer limits during line maintenance periods. See HECO ST-4 and HECO-R-406.

The updated results (based on HECO-R-406) are detailed in Exhibit "B" to this Opening Brief. The Koolau/Pukele Line Overload Situation is still considered to be urgent, and is estimated to occur in 2006, based on day peak data. As explained in the testimonies and as summarized below, this situation can already occur during the evening peak period if the planned or unplanned outage of one of the three lines serving the Koolau substation extends into the evening peak period, particularly during the second half of the year when evening peak loads are highest.

The Downtown Line Overload Situation, which is not urgent given the availability of the HPP, is not estimated to occur until approximately 2034 (with the HPP), but could occur in 2007 if HPP becomes unavailable for some reason.

4. Recent Events Emphasize the Need for the Project

Events since the filing of the EOTP Application have served to heighten the Pukele Substation Reliability Concern, and to emphasize the urgency of the Koolau Substation Overload Situation.

a. March 3, 2004 Pukele Substation Outage

On March 3, 2004, one of the two transmission lines serving the Pukele Substation was out for scheduled maintenance when the second transmission line went out of service and resulted in a power outage. Approximately 40,000 customers in the Honolulu/East Oahu area, including Waikiki, lost power. Approximately 39,000 customers were without power for 45 minutes to 2 hours; approximately 1,000 customers were without power for almost 4 hours. The sustained outage would have been prevented if the EOTP had been completed. Many of the customers affected on March 3, 2004 would not have seen any interruption in service, while the other affected customers would have experienced a momentary interruption of service lasting only seconds. HECO ST-4 at 11-12; FEA, Vol. 1 at 2-6.

As stated in HECO T-4 (page 35), prior to March 3, 2004, HECO had been fortunate that the second of the two 138kV lines to Pukele Substation had not tripped out of service while the other line was out for maintenance or out of service due to a forced outage. HECO T-4 (page 65) also emphasized the need to address the Koolau/Pukele Overload Situation and Pukele Substation Reliability Concern. The March 3, 2004 Pukele outage incident accentuates the need to proceed with the project. HECO ST-4 at 12.

b. June 20, 2005 Waiau-Koolau #1 138kV Line Failure

HECO RT-2 describes the failure to the Waiau-Koolau #1 138kV line that occurred on June 20, 2005. Upon inspection of the line, it was determined that a long splice on the B-phase of the line failed, which caused the B-phase conductor to fall. The location of the splice was in the Koolau Mountains in Kaneohe, just above the Likelike Highway.[17] The line failure and the upcoming system vulnerability that may result during the future work planned for this line provide a vivid illustration of the need for the proposed project. HECO RT-2 at 22-23.

The Waiau-Koolau #1 line is one of three 138kV transmission lines that provide power to the Koolau Substation.[18] There are also two 138kV transmission lines from Koolau Substation that provide power to the Pukele Substation. These lines traverse similar terrain and are exposed to similar weather conditions as the Waiau-Koolau #1 Line. Together the Koolau and Pukele substations provide power to 30% of the load served by HECO on Oahu. HECO RT-2 at 23.

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[17] HECO-R-201 shows a profile diagram of the line as it traverses from the summit of the Koolau Mountains into Kaneohe. The diagram also shows the location of the long splice. HECO-R-204 contains a video showing the downed conductor a day after the line failed.

[18] The route for the Waiau-Koolau #1 138kV line is shown in HECO-405, page 1. HECO-R-204 contains a video that shows some of the terrain, including the steep mountainous areas, that the Waiau-Koolau #1 138kV line traverses from the Waiau Power Plant to the Koolau Substation. HECO RT-2 at 22-23.

As shown in the videos contained in HECO-R-204, the area consists of steep mountainous slopes that are inaccessible by foot. A helicopter is the only way to inspect or repair the line and associated structures. At the summit of the Koolau Mountains, the weather is very unpredictable and can change rapidly depending on precipitation, wind, and visibility (due to clouds). When the summit is clouded in, which is often the case, visibility is zero, and helicopters are unable to approach the summit. Given these factors, it is difficult to schedule work and to precisely estimate how long an inspection or repair could take. It took eight days to restore the line, and could have taken much longer if the weather had been severe. When HECO replaced Structure 9 of the Koolau-Pukele #1 138kV line in 2000, a work crew had to spend the night on the summit of the Koolau Mountains. The video includes footage of that replacement project. HECO RT-2 at 23-24; HECO RT-4 at 14-15; HECO T-4 at 34-35.

At Structure 55/56 located at the summit of the Koolau Mountains, the insulators supporting the B-phase conductor were damaged. HECO-R-202 shows photos of the damaged insulators. In addition, two conductor kinks were discovered as shown in the photos in HECO-R-203. HECO RT-2 at 24.

The damaged insulator of Structure 55/56 at the summit of the Koolau Mountains was replaced and the failed splice was also replaced. The conductor kinks were not removed due to their location on an inaccessible portion of the conductor. As a consequence, the B-phase conductor was re-strung but at a lower tension than normal to avoid overstressing the kinked areas. The line was then put back into service on June 28, 2005. HECO RT-2 at 24.

During the restoration efforts, the Koolau Substation and Pukele Substation were being served by the Waiau-Koolau #2 and Halawa-Koolau 138kV lines. HECO RT-2 at 24. The concern with having only the Waiau-Koolau #2 and Halawa-Koolau 138kV lines in service was that if one of these lines were to unexpectedly go out of service during a peak load condition, there may be a risk of overloading the remaining line. HECO RT-2 at 25.

As a preventive measure, some load was shifted from the Koolau and/or Pukele Substations to the Archer Substation. This was done to lessen the loads on the Waiau-Koolau #2 and Halawa-Koolau 138kV lines so that if one of these lines was to go out of service, the remaining line would not experience an overload condition. HECO RT-2 at 25; HECO RT-4 at 16.

There were risks associated with this preventative action. The 46kV automatic transfer schemes had to be disabled for certain 46kV circuits that serve the Ala Moana to Waikiki area. By disabling the transfer schemes, no back up was available to these certain circuits in the event of a 46kV system disturbance. (If an outage had occurred on any of the primary circuits serving these transformers, customers served by these transformers would have experienced a prolonged outage. As a result of the switching, the reliability of service to the customers connected to these transformers at the 46kV level temporarily was decreased.) The transfer schemes had to be disabled to prevent loads from being transferred to certain 46kV circuits, which do not have the capacity to carry additional loads. Assuming this 46kV system risk mitigated a much larger 138kV outage risk associated with the entire Koolau Substation and Pukele Substation areas. HECO RT-2 at 25; HECO RT-4 at 16-18.

The conductor kinks remain a concern. The kinks weaken the physical strength of the conductor at those locations. Two industry experts were consulted and both concluded that the kinks should be removed but removal did not have to be done immediately. To address this concern, HECO is planning to re-conductor all three phases of the line from Structure 55/56 to

Structure 58. In addition, Structure 57[19] will be re-designed and replaced with a new structure designed for a 100 m.p.h. wind speed. The existing structure is currently designed for 56 m.p.h. wind speed. HECO RT-2 at 25-26.

HECO indicated that it is trying to schedule the work for 2006 during a low-peak period and in coordination with generating unit overhauls. However, the timing of obtaining permit approvals from the State Department of Transportation and State Department of Land and Natural Resources ("DLNR") may ultimately dictate when the work can occur. HECO RT-2 at 26.

The work to re-conductor all three phases of the 138kV line from Structure 55/56 to Structure 58 and replace Structure 57 is estimated to take approximately two weeks, although the weather conditions will ultimately dictate if the work will take longer or require less time. HECO RT-2 at 26.

The line will have to be out of service 24/7 for the duration of the work. By having the line out of service, there will be concerns similar to when the recent restoration efforts took place. Therefore, HECO intends to shift some load from Pukele Substation to Archer Substation to avoid overloading one of the two remaining 138kV lines to Koolau Substation if the one of the 138kV lines were to go out of service unexpectedly. HECO RT-2 at 26.

HECO also has other work eventually planned for the Waiau-Koolau #1 138kV line. Structure 55/56 at the summit of the Koolau Mountains and Structure 58 just off of Likelike Highway were installed in the late 1950's and were designed for a 56 m.p.h. wind speed (which was the General Order No. 6 requirement). After Hurricane Iniki in 1992, HECO changed its

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19 Structure 57 is a suspension structure located approximately one-third of the way down the span from the peak of the Koolau mountains that is comprised of structural cabling, concrete anchors and insulators mounted perpendicular to the conductor span to reduce sway.

138kV structures design standard to a 100 m.p.h. wind speed. Therefore, HECO intends to replace these structures with structures designed to the current standard. HECO-R-204 contains a video that shows a similar type of structure replacement work to that proposed at the summit of the Koolau Mountains. (The work in the video shows the replacement of Structure 9 of the Koolau-Pukele #1 138kV line in 2000.) HECO RT-2 at 26-27.

The work on Structure 55/56 and Structure 58 is estimated to take approximately seven months. HECO RT-2 at 27. The line will have to be taken out of service intermittently throughout this period although, the line may be restored to service at the end of each work day before the evening peak occurs. If the EOTP project is <u>not</u> in service before the structure 55/56 and 58 replacement project, then HECO would shift some load from the Pukele Substation to the Archer Substation, which would leave some areas in the Ala Moana to Waikiki area vulnerable to an outage as previously discussed. HECO RT-2 at 27.

There are other transmission lines related to this project that traverse similar terrain and are exposed to similar weather conditions as the Waiau-Koolau #1 138kV Line. The Waiau-Koolau #2 138kV Line, Halawa-Koolau 138kV Line, Koolau-Pukele #1 138kV Line, and Koolau-Pukele #2 138kV Line traverse similar terrain and are exposed to similar weather conditions as the Waiau-Koolau #1 138kV Line. HECO RT-2 at 28; HECO-405. HECO-R-204 contains a video that shows some of the terrain, including the steep mountainous areas, that the Koolau-Pukele #1 and Koolau-Pukele #2 138kV lines traverse from the Koolau Substation to the Pukele Substation. HECO RT-2 at 29.

When work is needed to be performed on these other lines, they need to be taken out of service as was done and is planned for the Waiau-Koolau #1 138kV Line. If the Waiau-Koolau #2 138kV Line or the Halawa-Koolau 138kV Line is taken out of service, then the transmission system is vulnerable to the Koolau/Pukele Overload Situation. If the Koolau-Pukele #1 138kV Line or the Koolau-Pukele #2 138kV Line is taken out of service, then the transmission system is vulnerable to the Pukele Reliability Concern. HECO RT-2 at 30.

c. Extended Outages Can Result in Overload Situations during Evening Peak Periods

HECO's daily profile consists of a Day Peak and an Evening Peak.[20] HECO utilizes a less conservative, but reasonable approach, of using the Day Peak Forecast for its analysis of the Koolau/Pukele Line Overload Situation. HECO's normal practice when performing maintenance on the lines to Koolau Substation is to return the maintained line back into service prior to the evening peak, which decreases the Koolau/Pukele Line Overload Situation during the Evening Peak.[21] However, HECO recognizes that there are situations where the line is not able to return to service prior to the Evening Peak. In HECO T-4, HECO identified 10 instances since 1996 where an outage on a 138kV transmission line extended beyond normal maintenance outage time, by a day or longer. This occurred more recently on April 5, 2003 during a failure of structure 19, which caused an outage of the Koolau-Pukele #1 transmission line for 4 and a half consecutive days. The June 20-28 Waiau-Koolau #1 Outage is an additional example of such an outage. HECO RT-4 at 15; HECO T-4 at 18-19; Tr. (11/07) at 118-19 (Ishikawa).

Based on Day Peak Loads, the Koolau/Pukele Overload Situation is an urgent situation that can occur in the 2006 time frame and should be addressed as HECO proposes by the Kamoku 46kV Underground Alternative – Expanded. The overload limit of the Koolau/Pukele

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[20] One peak, which typically occurs around 1:00 p.m., and is referred to as the "Day Peak", and a second typically occurs around 6:00 p.m. in the evening, and is referred to as the "Evening Peak". HECO T-4 at 18; see HECO-410.

[21] There are general guidelines that the HECO System Operators currently follow to minimize the risk of an overload condition. HECO typically schedules maintenance on the three lines to Koolau Substation during the first half of the year, because the load demand is lower during this period compared to the second half of the year. HECO T-4 at 28-29.

Line Overload occurs when the combined load of the Koolau Substation and the Pukele Substation is at or above 362 MW. Adding to the urgent situation is that the Koolau/Pukele Substation loads can exceed the 362 MW overload level during the Evening Peak period. (This has occurred on numerous occasions during the past few years.) Thus, when HECO experiences an extended outage (where the transmission line cannot be returned to service prior to the Evening Peak) of one of the 138kV transmission lines feeding the Koolau Substation, as was the case with the recent Waiau-Koolau #1 138kV transmission line incident described above, and a second 138kV transmission line is unavailable for any reason during the Evening Peak, HECO could experience an overload situation. HECO RT-4 at 19; Tr. (11/07) at 119 (Ishikawa); HECO T-4 at 28-30.

B. <u>OPERATIONAL EFFECTIVENESS OF THE EOTP</u>

The implementation of the EOTP would allow electrical loads currently being served exclusively from Pukele Substation, located at the end of the Northern 138kV transmission corridor, to also be served from Kamoku Substation and Archer Substation, located in the Southern 138kV transmission corridor. Essentially, this project allows load to be shifted among the three substations using 46kV lines, and also allows the substations to back up each other. These operating features will address the four transmission problems in varying degrees. HECO-R-406 at 18; FEA, Vol. 1 at 3-35; Application at 22.

First, some of Pukele Substation's existing electrical load would be shifted to Archer Substation and Kamoku Substation with the implementation of the project. This will reduce the overall Koolau/Pukele Service Area load, which will relieve the potential overload situation of the 138kV transmission lines transporting power to the area. HECO-R-406 at 18; FEA, Vol. 1 at 3-35; Application at 22.

Second, most of the loads transferred from Pukele Substation to Archer Substation and Kamoku Substation as a result of the implementation of this alternative, plus some existing load currently served by Archer Substation, could temporarily be shifted back to Pukele Substation when a transmission line providing power to the Downtown Area or generation from HPP is taken out of service for maintenance. This would reduce the load in the Downtown Area while the line is out of service, and defer the potential overload situation of the 138kV transmission lines transporting power to the area (or avoid accelerating the overload situation, depending on the amount of load that could be temporarily shifted). This load shift would only be done when there is a possibility that the overload situation would occur. After the line taken out for maintenance has been restored to service, load would be shifted back from Pukele Substation to the Downtown Area. HECO-R-406 at 18-19; FEA, Vol. 1 at 3-37; Application at 22.

Third, some of Pukele Substation's existing electrical load would be shifted to Archer Substation and Kamoku Substation with the implementation of this alternative. Therefore, if the two 138kV transmission lines serving Pukele Substation were to be lost, the loads that were transferred to Archer Substation and Kamoku Substation because of this alternative would not experience an outage. The loads that continue to be served by Pukele Substation even after the implementation of this alternative would experience a momentary outage (approximately six seconds) as these loads are automatically transferred to Archer Substation and Kamoku Substation (as well as to Koolau Substation). HECO-R-406 at 19; FEA, Vol. 1 at 3-37; Application at 22-23.

Fourth, if the two 138kV transmission lines that serve Archer Substation are lost, some of the loads served by Archer Substation, Kewalo Substation, and Kamoku Substation would experience an outage, but other Archer Substation loads would experience a momentary outage (approximately six seconds) as these loads are automatically transferred to Pukele Substation. HECO-R-406 at 19; FEA, Vol. 1 3-37; Application at 23.

Detailed descriptions of the effectiveness of the EOTP in addressing the line overload situations and substation reliability concerns, with citations to the record in this docket, are included in Exhibit "B" to this brief. A summary, without the record citations, is included in the following subsections of the brief.

1. Koolau/Pukele Overload Situation

With the installation of Phase 1, approximately 80 MW of existing load, which is or will be served from the Pukele Substation prior to Phase 1, will be transferred from the Northern Corridor to the Southern Corridor and will be served by the Archer and Kamoku Substations. The load shift is expected to remain in this configuration under normal operating conditions and will reduce the combined MW load demand from the Koolau and Pukele Substations to a level below 362 MW, which is the amount of combined load at Koolau and Pukele Substations that triggers an overload condition on the remaining line to Koolau Substation. The reduction in combined load with the implementation of Phase 1 will eliminate the Koolau/Pukele Overload Situation for the 20-year period studied.

2. Pukele Substation Reliability Concern

Under the existing configuration, loss of the two Koolau-Pukele 138kV transmission lines serving the Pukele Substation will cause an interruption of electricity service to customers. Most of HECO's customers in the area serviced by the substation, which extends from Makiki to Waikiki, and from Koolau to Kaimuki, would be out of power until one of the two 138kV transmission lines could be restored to service. (The remaining customers would experience a service interruption of up to six seconds as their service is automatically transferred to Archer Substation.)

If Phase 1 is installed, the customers transferred to circuits served by the Kamoku Substation and Archer Substation (representing 80 MW) would not experience a loss of electricity service if both the Koolau-Pukele 138kV transmission lines are unavailable (causing an outage of the Pukele Substation), therefore substantially increasing the reliability to the customers served by these circuits. In addition, if an outage of the Pukele Substation occurs, approximately 63 MW (not including the 80 MW of load that will be permanently shifted from Pukele Substation to Archer and Kamoku Substations) of the existing Pukele Substation will automatically be transferred to the Archer, Kamoku and Koolau Substations. The automatic transfer scheme requires up to 6 seconds for mechanical switches to open and close transferring the load from the primary circuits served from the Pukele Substation in the Northern Corridor to the back-up circuits served from the Kamoku and Archer Substations in the Southern Corridor. Therefore, customers included in the 63 MW block will experience up to a 6-second outage.

With respect to the remaining customers served from the Pukele Substation after Phase 1 is installed (representing 27 MW), during a prolonged outage of the Pukele Substation, HECO Troublemen will be sent out to perform manual switching in the field. The switching will transfer the remaining Pukele load to 46kV feeders at a different part of the Northern Corridor served by the Koolau Substation. The manual switching is expected to require approximately 2 to 4 hours to complete before service is restored to the remaining customers. Table 2 in HECO-R-406 describes the effectiveness of Phase 1 in addressing the Pukele Substation Reliability Concern.

3. Downtown Line Overload Situation

If the 80 MW transferred to Archer and Kamoku Substations continues to be served by these substations in situations in which two out of the three Downtown 138kV transmission lines could be out of service, the Downtown overload situation will be accelerated. However, with the installation of the EOTP, it is HECO's plan to shift approximately 71 MW back to the Pukele Substation if one of the Downtown 138kV lines is taken out of service for maintenance, or experiences a prolonged forced outage.

With the installation of Phase 1, the Pukele circuits will be reconfigured so that only a portion of the load transferred to Archer and Kamoku Substations can be transferred back to Pukele Substation from Archer and Kamoku Substations, because of the limitations on the 46 kV circuits and the automatic transfers that need to be considered. As a result, not all of the 80 MW of load shifted from Pukele Substation to the Downtown Substations can be transferred back to Pukele Substation when maintenance is being performed on one of the downtown transmission lines. Based on the planned circuit configuration, approximately 9 MW originally served by the Pukele Substation will not be transferred back from the Archer Substation.

The remaining 9 MW of load, which cannot be shifted, can be replaced by temporarily shifting (using manual shifting) approximately 14 MW of additional load from the Piikoi Substation to the Pukele Substation.

Based upon the 2004 Day Peak and the May 2005 Peak Forecast, if the HPP is not retired, the forecasted Downtown Line Overload Situation is forecasted for 2034.

If maintenance is required on the 138kV transmission lines feeding the Downtown Substations or if HPP generation is unavailable due to an outage and the Kamoku 46kV Underground Alternative – Expanded project is installed, 71 MW of load (which was originally served by the Pukele Substation) plus a portion of the Piikoi load would be shifted to the Pukele Substations. This would then cause the load at the Pukele Substation to exceed the 240 MVA limit beginning in 2024, which would be acceptable if all four 80 MVA transformers were in service. If a contingency then occurred on the distribution system where one of the transformers at the Pukele Substation were out of service, HECO could either reschedule the maintenance on the Downtown 138kV transmission line or HPP maintenance until the transformer at the Pukele Substation is placed back in service, or HECO could look into shifting only a portion of the Downtown load (through the use of manual switching on the 46kV system) to the Pukele Substation so the three remaining transformers at the Pukele Substation would not be overloaded and HECO could control the Downtown Line Overload Situation.

4. Downtown Substation Reliability

Phase 1 of the EOTP will improve service reliability to a portion of the Downtown Substation loads by providing a back-up source of power to 47% of the load served by the Archer, Kewalo and Kamoku Substations if Archer should lose its two 138kV transmission feeds.

5. Phase 2 of the Kamoku 46kV Underground Alternative - Expanded

Phase 2 involves the installation of an 80 MVA 138kV-46kV transformer at Archer Substation and three new underground 46kV circuits to connect the new circuits from the 80 MVA transformer at Archer Substation to three existing 46kV circuits terminating at the Pukele Substation.

The three new Archer circuits are essentially an extension of the three Pukele circuits to Archer Substation. The new transformer at Archer Substation and the three new circuits will allow the remaining Pukele Substation loads (which would require up to 2 to 4 hours to restore during a prolonged Pukele Substation outage even after the installation of Phase 1) to be automatically transferred from the Pukele Substation to Archer Substation within 6 seconds. The transfers will occur by activation of automatic transfer switches if the Pukele Substation should lose both Koolau-Pukele 138kV transmission lines. Transfers will take place through the EMS if various Pukele 46kV circuits require an outage. The three Pukele 46kV circuits will continue to be served by the Pukele Substation during normal operation after Phase 2 is installed.

The effectiveness of the EOTP Project after the implementation of Phase 2 in addressing the Koolau/Pukele Overload Situation, the Downtown Line Overload Situation and the Downtown Substation Reliability Concern remains the same as described with the implementation of Phase 1. Phase 2 improves on the effectiveness of the project in addressing the Pukele Substation Reliability Concern, because the remaining customers served by the Pukele Substation that would have experienced an outage lasting up to 2 to 4 hours will be interrupted for only 6 seconds or less (significantly less than 2 to 4 hours), which is the time required for the automatic transfer equipment to complete the switching. See Table 3 in HECO-R-406 for a summary of the effectiveness of Phase 2 to address the Pukele Substation Reliability Concern.

C. SELECTION OF THE EOTP

In selecting an alternative to address the transmission problems, various studies and reports were updated and developed. The major factors identified and considered to evaluate various alternatives and to compare them against each other were effectiveness, timeliness, cost, construction and other impacts, and public sentiment. Application at 21.

HECO selected the Kamoku 46kV Underground Alternative - Expanded to address the transmission problems and proposes to implement the project in two independent phases. (This phased 46kV option is referred to as the EOTP.) The first phase is now estimated to be implemented in 2007 to address the Koolau/Pukele Overload Situation in a timely manner and partially address the Pukele Substation and Archer Substation Reliability Concerns. The second phase is estimated to be implemented in 2009 to fully address the Pukele Substation Reliability Concern.

1. Background

HECO provided extensive information regarding the extended background for the EOTP, to show how the EOTP option was selected and why it is now the preferred option, and to facilitate an understanding of why a 46kV project is now recommended to address the four transmission problems, rather than the remaining 138 kV option. That background is summarized below.

A project to address the East Oahu transmission problems was first initiated as a result of a study conducted in July 1991 titled, "East Oahu 138KV Requirements."[22] This study was updated in August 1992 and in March 1998. Additional studies, which reached the same conclusions, were completed in December 2003 and filed as Exhibit 5 and Exhibit 6 to HECO's Application for this proceeding. HECO RT-4 at 2; HECO T-4 at 20-48; HECO RT-3 at 7.

The 1991 study outlined at least four concerns for the East Oahu Service Area, that remain relevant today including:

(1) The Koolau/Pukele Overload Situation;

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[22] The recommendation to install a 138kV line to the Pukele Substation was first introduced in Stone & Webster Management Consultant report, completed in February 1984, entitled "Hawaiian Electric Company, Investigation of July 13, 1983 Blackout." Additional detailed planning studies were conducted to confirm Stone and Webster's recommendation, and to identify specific system improvements. HECO commissioned and a detailed study was completed by Southern Electric International ("SEI") in January 1989. After completion of the SEI study, HECO conducted and completed the 1991 East Oahu 138 kV Requirements study (July 1991), which was updated in August 1992, and continued to conduct additional studies focused on serving the East Oahu load region.

(2) The Downtown Overload Situation;

(3) The Pukele Substation Reliability Concern; and

(4) The Downtown Substation Reliability Concern. HECO T-4 at 5.

A routing study was completed and a public scoping and input process was initiated. A key element of this process was the formation of a CAC made up of representatives from various neighborhoods. An outcome of the CAC was the reevaluation of alternatives to address the transmission problems. This reevaluation included numerous non-transmission options such as photovoltaic, wind, and pumped hydro storage energy sources. In addition, other 138kV alternatives and 46kV alternatives were also evaluated. Tr. (11/07) at 21 (Wong); HECO T-2 at 14-18; HECO T-4 at 5-6.

After evaluating numerous alternatives through technical studies and an extensive public input process, the partial underground/partial overhead, Kamoku-Pukele 138kV Transmission Line was selected as the preferred alternative to address the problems. The CDUP application process for the overhead portion of the alternative was then initiated. Planning studies were updated and an extensive EIS process ensued. Tr. (11/07) at 21-22 (Wong); HECO T-2 at 18-28; HECO T-4 at 6.

As discussed in HECO T-2, HECO vigorously pursued the permit for the overhead section for the Kamoku-Pukele 138kV Transmission Line via Waahila Ridge. After two environmental impact statements (1998, 2000) and a contested case hearing before the Board of Land and Natural Resources ("BLNR"), the BLNR denied the permit for the overhead section of the project in 2002. This essentially eliminated the only practical overhead 138kV transmission line alternative to pursue for the project. HECO T-1 at 11; Tr. (11/07) at 22 (Wong); HECO T-2 at 28-30.

As a result of the 2002 decision, a HECO Executive Team[23] was formed and the team requested an update of various studies and reports such as the March 1998 East Oahu Transmission Requirements Update Study. The East Oahu Transmission Project Alternatives Study Update (the "2003 East Oahu Alternatives Study Update"), which was prepared by HECO's Planning & Engineering Department, was finalized in December 2003. The purpose of the update study was to document the analyses and re-evaluate the 138kV and the 46kV transmission alternatives previously identified in the various East Oahu studies and include two other 46kV transmission alternatives that were derived as a result of the analyses. HECO T-4 at 6-7; Tr. (11/07) at 22-23 (Wong) ; HECO T-2 at 30-31.

The Executive Team directed the project engineers to identify new alternatives and to revisit past alternatives considered during the EIS process. In 1992-1994, through the CAC described in HECO T-2, fourteen 138kV line alternatives (11 Kamoku-Pukele 138kV alternatives with different alignments and configurations, a School-Pukele 138kV alternative, a Halawa-Pukele 138kV alternative and a Halawa-Koolau-Pukele 138kV alternative) and two 46kV line alternatives (a 46kV radial alternative and a 46kV network alternative) were identified and were described in the Final EIS. HECO selected one of the Kamoku-Pukele 138kV line alternatives, a 138kV partial underground, partial overhead transmission alternative from Kamoku Substation to Pukele Substations via Waahila Ridge as the preferred alternative. The Kamoku-Pukele 138kV Underground Alternative (using either high-pressure fluid-filled ("HPFF") or cross-linked polyethylene ("XLPE") cable technology) included in the 2003 East Oahu Alternatives Study was previously analyzed in the Final EIS. Two additional 46kV

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[23] The Executive Team is a cross-functional group comprised of various officers from different areas of HECO (including an officer from Hawaiian Electric Industries). The purpose of the Executive Team is to provide senior executive oversight of the East Oahu Transmission Project and ensure that the project continues to move forward until closure. HECO T-1 at 11.

alternatives, one an expanded version of the other, were also identified and included in the 2003 study. HECO T-4 at 8.

The 2003 East Oahu Alternatives Study Update continued to identify the four transmission concerns previously identified in the 1991 East Oahu Requirements Study, August 1992 update and March 1998 update. The Koolau/Pukele and Downtown overload dates have changed in each study update and HECO has been fortunate that the large load growth predicted in the early 1990's did not materialize at that time. The December 2003 update study, which used an August 2002 Load Forecast, projected that the overload situations in the Koolau/Pukele area would occur in the 2005 time frame and that HECO would need to install a transmission alternative to mitigate the overload situation very soon. Four 138kV alternatives and the 46kV network and 46kV radial alternatives, which were previously studied, were re-evaluated and two additional 46kV alternatives were identified and evaluated. HECO T-4 at 7.

The Executive Team also requested a study to analyze in more detail the possible options (other than constructing a new 138kV transmission line, or new 46kV sub-transmission circuits) for addressing the Koolau/Pukele line overload problem, even if the options would not resolve the Pukele service area reliability concern. The report, entitled the East Oahu Transmission Project: Alternatives to the Koolau/Pukele Transmission Line Overload Problem (the "East Oahu Transmission Project: Options to the Koolau/Pukele Transmission Line Overload Problem"), also was finalized in December 2003. HECO T-4 at 6.

Three alternatives were identified for further consideration and were carried forward into a public input process.[24] Three out of the four 138kV transmission alternatives and two out of

[24] Three of the eight alternatives with different degrees of effectiveness were presented to the community. The reasons for screening out the other 138kV and 46kV alternatives were straightforward, and HECO wanted to put forth alternatives that were viable taking into

the four 46kV alternatives were screened out by the HECO Executive Team.[25] HECO T-4 at 9. As discussed in HECO T-4, other alternatives such as distributed generation and live-line maintenance were also evaluated, but were screened out from further consideration. HECO T-1 at 12.

The three alternatives presented to the public and to the HECO Executive Team included:

(1) The Kamoku-Pukele 138kV Underground Alternative, shown in HECO-416, which requires the installation of a 3.6-mile 138kV underground line running from Kamoku Substation to Pukele Substation.

(2) The Kamoku 46kV Underground Alternative, which involves the installation of an 80 MVA 138-46kV transformer at Kamoku Substation, a new ductline with two new 46kV circuits installed running from Makaloa Substation to McCully Substation, a new circuit in the area of the intersection of Pumehana Street and Date Street near the Lunalilo Elementary School, two new 46kV underground circuits from the Kamoku Substation onto Date Street, one new 46kV underground circuit on Winam Avenue from Hoolulu Street to Mooheau Avenue in Kapahulu and modification of equipment at various distribution substations (a simplified diagram of the 46kV line connections for the Kamoku 46kV alternative is shown in HECO-417); and

(3) The Kamoku 46kV Underground Alternative - Expanded, which involves the same installations described in the Kamoku 46kV Underground Alternative and an additional 80 MVA 138-46kV transformer at Archer Substation and a new duct bank with three new 46kV circuits installed running from Archer Substation to existing 46kV circuits on King Street and McCully

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consideration the technical feasibility of the alternatives, the permits required which affect the schedule of the alternatives, and the costs for the alternatives. HECO T-4 at 9.

[25] In the case of the 138kV transmission alternatives, the School-Pukele, Halawa-Pukele and Halawa-Koolau-Pukele 138kV alternatives were not carried forward for public input for a number of reasons: (1) because when comparing each of the three alternatives to the Kamoku-Pukele 138kV alternative, the costs for these projects were higher, (2) all three alternatives required a greater amount of time for installation exposing the HECO system to a longer period of risk for overload conditions, (3) each of the three alternatives required the installation of more than one 138kV line, which would result in a longer time period for permit approvals, and (4) two of the 138kV alternatives, the Halawa-Pukele 138kV and the Halawa-Koolau-Pukele 138kV alternative, did not address the Downtown overload situation in the event the HPP was retired. The 46kV network and 46kV radial alternatives were not carried forward for presentation to the public, because in comparing these two alternatives to the 46kV Kamoku Underground alternatives, (1) the costs for the 46kV network and 46kV radial alternatives were higher than the costs for the 46kV Kamoku Underground alternatives, and (2) the 46kV network alternative required the installation of a 138kV transmission line, as well as an extensive amount of sub-transmission facilities and only partially addressed the Archer Substation reliability. HECO T-4 at 9-10, 48-53; see Application at 24-26; HECO-416; HECO-417; HECO-418.

Street. (A simplified diagram of the 46kV line connections for the Kamoku 46kV Underground - Expanded Alternative is shown in HECO-419.)[26] HECO T-4 at 48-49.

After the public input process was completed, a report on the public input process and finalized information regarding the various non-transmission options and results of the public input process were presented to the Executive Team at HECO. HECO T-4 at 10; HECO T-2 at 31-32; see HECO T-12.

The Executive Team was given the responsibility to select the alternative. Various studies and reports were updated and developed by HECO engineers and consultants for the Executive Team to review. In addition, the Executive Team attended a presentation by various subject matter experts, which led to further in-depth discussions regarding the studies and reports. From the various studies, reports, and discussions, major factors were identified and placed in a decision matrix, HECO-101, which was used as a tool by the Executive Team to analyze each alternative and to compare against one another. HECO T-1 at 12; HECO T-2 at 32.

2. Selection of Preferred Option

From an engineering standpoint, the Kamoku-Pukele 138kV Underground Alternative is the best long-term solution for solving all of the transmission overloads and reliability concerns outlined earlier. It was estimated, however, that this alternative could not be implemented until 2010. Thus, there would be a vulnerability period to the Koolau/Pukele Overload Situation (which was estimated to start in 2005) as this alternative was implemented. Application at 26; HECO T-4 at 50-54.

The Kamoku 46kV Underground Alternative would be adequate to reduce the Koolau/Pukele line overload situation, defer the Downtown Overload Situation for several years,

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26 The second alternative was the Kamoku 46kV Underground Alternative – Expanded, which is similar to Phases 1 and 2 of the current proposal. But, a major difference with this alternative as compared to the current proposal is that the two phases would have been installed simultaneously instead of in phases.

provide partial back-up of the load served by the Pukele Substation (although some customers would still incur a 6-second outage if the second Koolau-Pukele 138kV transmission line experienced a forced outage while the first Koolau-Pukele 138kV line was out for maintenance), and provide partial back-up of the load served by the Downtown Substations. If the HPP was not operational in the near future, this alternative would not be able to address the Downtown Overload Situation. It was estimated that this alternative could be implemented in 2006. The advantage of this alternative was that it could be installed sooner, although the duration of its effectiveness would not as long as that of the Kamoku-Pukele 138kV Underground Alternative. Application at 26-27; HECO T-4 at 56-59.

The Kamoku 46kV Underground Alternative - Expanded would effectively address the Koolau/Pukele Overload situation, defer the Downtown Overload Situation, and fully address the Pukele Substation and Archer Substation Reliability concerns. If the HPP was not operational in the near future, this alternative would not be able to address the Downtown Area Overload Situation. It was estimated that this alternative could be implemented in 2008 if the entire scope of work was done simultaneously. Thus, there would be a vulnerability period to the Koolau/Pukele Overload Situation (which was estimated to start in 2005) as this alternative was implemented. The advantage of the Kamoku 46kV Underground Alternative - Expanded was that it could be installed sooner than the Kamoku-Pukele 138kV Underground Alternative, although it would require more time to install this alternative than the non-expanded Kamoku 46kV Underground Alternative (unless this alternative was installed in two phases, as is now planned). The duration of its effectiveness would not be as long as that of the Kamoku-Pukele 138kV Underground Alternative, however, it would provide complete back up to the Pukele

Substation, which is one of HECO's primary concerns. Application at 27; HECO T-4 at 60-63; HECO T-1 at 12-13.

In addition to effectiveness, the major factors considered in evaluating the alternatives were timeliness, construction and other impacts, and public sentiment. HECO T-1 at 12.

(1) Timeliness. This factor deals with the estimated time it would take to implement an alternative factoring in uncertainty. As discussed in HECO T-6, the Kamoku-Pukele 138kV Underground Alternative had the longest schedule with implementation initially estimated in 2010. The Kamoku 46kV Underground Alternative had the shortest schedule with implementation initially estimated in 2006. The Kamoku 46kV Underground Alternative - Expanded was estimated for implementation in 2008. HECO later determined that this alternative could be implemented in two phases, with the first phase initially being targeted for completion by the end of 2006. Of the three alternatives, the 138kV alternative appeared to have the highest degree of schedule uncertainty due to the permits and approvals required. HECO T-1 at 13.[27]

(2) Construction and Other Impacts. This factor deals with the short-term construction impacts, as well as other impacts identified through the public input process. Construction impacts such as traffic, noise, and dust were identified for each alternative. As discussed in HECO T-8, there were some differences between the alternatives regarding construction impacts. However, proven techniques can be applied to each alternative to mitigate the respective short-term impacts. Although occurring in different locations, construction and other impacts were similar among the three alternatives presented in the public input process. Therefore, these

[27] See Opening Brief, Exhibit "A", which summarizes HECO's testimonies regarding scheduling, including the update information provided in HECO ST-6, HECO RT-6 and at the hearing by Mr. Wong.

impacts were not as significant considerations in selecting the proposed project as compared to effectiveness, timeliness, cost, and public sentiment. Application at 27-28.[28]

Other impacts that were considered were aesthetics and EMF. Aesthetic impacts are considered minimum to none because the three alternatives propose all underground line construction. As discussed in HECO T-6, only the pumping facility associated with the HPFF cable technology of the Kamoku-Pukele 138kV Underground Alternative could potentially have had aesthetic impacts to consider. HECO T-1 at 13-14.

As indicated in HECO T-10, there are differences in the EMF levels expected to result from the alternatives considered. At the same time, as discussed in HECO T-11, as the Commission found in Docket No. 7256, and as has been indicated by the reported findings in significant subsequent studies, the scientific community that has been researching the matter has not established a causal link between EMF and adverse health effects. As discussed in HECO T-12, HECO also recognized that there are concerns about EMF among some members of the public, particularly where lines pass through residential areas. There are generally fewer concerns, however, where lines are placed underground (as HECO proposes for this project), given the rapid fall off in EMF levels for underground lines as the distance increases between the lines and the point of measurement. Given these considerations, the differences did not warrant selection of a specific alternative, such as the 138kV line alternative (either the HPFF alternative or less expensive XLPE alternative, which has higher EMF levels than the HPFF alternative) in light of the other factors considered. HECO does, however, plan to exercise "prudent avoidance" in designing the 46kV cable installation, as is discussed in HECO T-11 (which addresses the concept as defined by the Commission and the Hawaii Department of Health), and

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[28] See Opening Brief, Part VI.C which summarizes the information provided by HECO regarding mitigation of construction impacts for the project.

HECO T-2 (which addresses implementation of prudent avoidance in the case of this project). HECO T-1 at 14-15.[29]

(3) Cost. As discussed in HECO T-9, capital costs, revenue requirements and estimated monthly residential rate impacts were developed for each alternative. The Kamoku-Pukele 138kV Underground Alternative had the highest capital cost at approximately $110 million to $122 million. The Kamoku 46kV Underground Alternative had the lowest capital cost at approximately $41 million. The Kamoku 46kV Underground Alternative - Expanded had an estimated capital cost of $59 million. HECO T-1 at 15.[30]

(4) Public Sentiment. As discussed in HECO T-12, a public input process was conducted to solicit feedback on the three alternatives. Business community participants in the process noted that improved power reliability was important to Waikiki and surrounding areas but cost was also a concern. Other concerns expressed by participants were related to construction impacts, the need for the project, and EMF. HECO T-1 at 15.[31]

Balancing all the issues, the Kamoku 46kV Underground Alternative - Expanded was selected over the Kamoku-Pukele 138kV Underground Alternative and Kamoku 46kV Underground Alternative. Furthermore, it was recommended that the selected alternative be implemented in two independent phases and that a voluntary environmental assessment be done for the project. Implementing the proposed project in two phases will address near-term transmission problems such as the Koolau/Pukele Overload Situation and a part of the Pukele Substation Reliability Concern, which includes Waikiki, in a timely manner. Application at 28.

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[29] See Opening Brief, Part VI.D, which summarizes the testimonies presented on behalf of HECO regarding EMF.

[30] See Exhibit "A" to this brief, which summarizes the updated cost information presented in this proceeding.

[31] See Opening Brief, Part VI.A, which summarizes HECO's testimony regarding public sentiment.

The two phases are independent of each other, as each one addresses very specific concerns. The completion of the first phase, now targeted for 2007, will eliminate the potential transmission line overloads in HECO's 138kV Northern transmission corridor starting in 2006 (Koolau/Pukele Overload Situation). In addition, the completion of the first phase would avoid blackouts of Waikiki, State Civil Defense, and the Hawaii Army and Air National Guard Headquarters that would result if one of the lines serving Pukele Substation located at the end of 138kV Northern transmission corridor were out for maintenance and the second line was lost for any reason (Pukele Substation Reliability Concern). The completion of the second phase, now targeted for 2009, will back up other parts of the Pukele Substation service area, which includes the University of Hawaii. HECO T-1 at 16.

Implementing the 46kV Expanded option in two phases allows Phase 1 construction to be completed in 2007 instead of 2009. In addition, Phase 1 should be isolated from any schedule uncertainties associated with Phase 2. This is critical because the timely installation of Phase 1 addresses the potential overload of the transmission lines providing power to the Koolau Substation, which in turn provides all the power to the Pukele Substation, and minimizes the risk that a catastrophic type power outage will occur. Phase 1 will partially address the Pukele Reliability concern which affects Waikiki and surrounding areas. Phase 2 will address the remaining areas still vulnerable to the Pukele Reliability concern (outside of Waikiki). Phase 2 also has the potential to provide complete back-up of the customer load served by the Archer Substation, thereby addressing a significant portion of the future reliability concern for the Downtown Substations. Tr. (11/07) at 25 (Wong).

3. **<u>The EOTP Is Now the Preferred Option</u>**

The proposed project is not HECO's ideal solution to address the East Oahu transmission problems from an engineering viewpoint. The ideal solution to address the East Oahu transmission problems would have been the installation of the Kamoku-Pukele 138kV Transmission Line via Waahila Ridge. This alternative would have involved the installation of a 3.8-mile partial underground/partial overhead transmission line from Kamoku Substation to Pukele Substation. The underground section would have been located in the urban areas and the overhead section in the mountainous areas (Waahila Ridge). This particular transmission line would have closed the gap in the transmission system between the 138kV Northern and Southern transmission corridors and provided a third 138kV line to Pukele Substation. It would allow HECO to transfer load between transmission substations seamlessly,[32] and is a more robust option because it can address the four transmission problems for a longer period of time and under other planning contingencies such as unavailability of the HPP. The 138kV option also would more completely address the Downtown Substation Reliability Concern. Thus, all the East Oahu transmission problems would have been addressed effectively. HECO T-1 at 10-11; HECO T-4 at 64; HECO RT-4 at 37; Tr. (11/07) at 129-30 (Ishikawa).

The recommendation to install the 46kV option takes into account the changes in circumstances that have taken place, including changing assumptions, which are normally expected when performing planning studies and updates over a 12-year period, and external factors such as permitting limitations. HECO RT-4 at 37.

HECO is recommending the 46kV Phased Option, because there are other factors that HECO considered in deciding to pursue the 46kV Phased Option. The preferred partial

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[32] Load transfers on the 46kV system would require power outages lasting up to 6 seconds because the 46kV system is a radial system relying on automatic transfer schemes for reliability. Tr. (11/07) at 130 (Ishikawa).

underground/partial overhead 138kV Kamoku-Pukele alternative is no longer available. The remaining 138kV option is an all-underground alternative through Palolo Valley. Updated studies show the Koolau/Pukele Line Overload Situation is urgent and can occur in the 2006 time frame. The 46kV Phased Project has an advantage over the remaining 138kV all-underground Kamoku-Pukele alternative, because Phase 1 can address the Koolau/Pukele Line Overload Situation in a more timely manner (although the duration of its effectiveness is not as long). In addition, the phased Kamoku 46kV Alternative - Expanded option fully resolves the Pukele Substation Reliability Concern, although the back-up is not seamless as the 138kV solution would have been (i.e., some customers would still incur a 6-second outage if the second Koolau-Pukele 138kV transmission line experienced a forced outage while the first Koolau-Pukele 138kV line was out for maintenance). From a technical perspective, the Kamoku 46 kV Underground Alternative - Expanded option is not as effective as the 138kV underground alternative in addressing the Downtown Line Overload and the Downtown Substation Reliability Concern.[33] Due to slower forecast growth rates, however, the Downtown Line Overload Situation is deferred past the 2030 period if the HPP is not retired. Cost is another factor and the cost for the 46kV Phased Project is over $60 million less than the remaining 138kV all underground Kamoku-Pukele alternative. In addition, the 138kV alternative has a higher

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[33] For the 46kV alternatives, some amount of human intervention will be required by System Operations before one of the three transmission lines serving the Downtown service area is removed from service for maintenance. Some loads would temporarily need to be shifted back to the Pukele Substation during these times. All switching operations for shifting load from the Downtown to Pukele service area can be done remotely via the EMS from the load dispatch office. If switching operations are done properly and unexpected equipment failures are not experienced, customers should not experience an interruption in service while this shifting occurs. This alternative would also require that all 46kV circuits involved in the load shift be in service at the time of the Downtown 138kV line maintenance. HECO T-4 at 64.

The HECO Transmission Planning Criteria have guidelines on manual intervention when planning for the system. Section IV.3 states that "[m]anual intervention will not be required to meet these conditions." HECO-406, Page 3. This means that HECO generally selects alternatives that do not require manual intervention, which would be the case with the 138kV alternative. HECO T-4 at 64.

schedule uncertainty and HECO also considered public sentiment. Thus, the remaining all-underground 138kV underground alternative would be the most expensive and time consuming to implement, leaving critical areas of Oahu at risk of blackouts for a much longer period of time. Tr. (11/07) at 130-31 (Ishikawa); HECO RT-4 at 46-47, 50-51; HECO T-4 at 10-11, 53, 61-65; HECO-421; HECO T-1 at 16-17.

D. OTHER OPTIONS CONSIDERED

1. Background

In addition to the 138kVand 46kV alternatives identified above, other options were considered to address the transmission problems. These options can be categorized into two broad categories: (1) Options that might address all of the East Oahu Transmission problems collectively; and (2) Options that might only address the Koolau/Pukele Overload Situation. Application at 29.

In 1995, CH2M Hill (HECO's contractor for the EIS for the proposed Kamoku-Pukele 138kV Transmission line), with input from HECO and the Community Advisory Committee established for the project in early 1993, conducted a review and analysis of alternatives to a 138 kV transmission line between the Kamoku and Pukele Substations. The 1995 CH2M HILL Alternatives Study was included in the Final EIS (in Volume 2) as Appendix C1. (This study also evaluated a number of 138kV and 46kV line alternatives to installing a 138kV transmission line between the Kamoku and Pukele Substations.) The study was updated in April 2000, and the update is contained in Section 10-A of the Final EIS (in Volume 1A). The study update reflects the results of a Review of the Distributed Generation Alternatives to the Kamoku-Pukele Line ("DG Alternatives Study") completed by HECO in March 2000. The results of the 1995 alternatives analysis, as updated in 1995, are described on pages 3-49 through 3-62 of the Final EIS. Application at 29; HECO T-4 at 12, 66.

The 1995 Alternatives Study, as updated in 2000, reviewed the feasibility and practicality of the installation of generating facilities in the Koolau/Pukele service areas that use renewable resources, the implementation of such large amounts of demand side management and load management measures, and the installation of substantial amounts of distributed generation ("DG") in the Koolau/Pukele service area to displace the need for a 138kV transmission line connecting the Pukele and Kamoku Substations. Application at 29-30.

The four transmission concerns included the Koolau/Pukele and Downtown Overload Situations, the Pukele Substation Reliability Concern, and the Downtown Substation Reliability Concern. In general, the analysis concluded that, for reasons related to cost, feasibility, practicality and effectiveness, the transmission line was the preferred alternative. For example, none of the options could resolve the Pukele Substation Reliability Concern, unless the entire load (for approximately 60,000 service accounts) in the Pukele service area could be displaced, or backed up in the event of a loss of the two 138 kV transmission lines currently providing power to the Pukele substation. The analysis indicated why displacing or backing up the Pukele service area load would be infeasible and/or impractical (due to factors such as the lack of available sites), particularly in the near-term, or cost-prohibitive if the siting and other feasibility issues could be resolved. Application at 30; HECO T-4 at 12-13.

HECO also analyzed in more detail the possible options (other than constructing a new 138kV transmission line, or new 46kV sub-transmission circuits) for addressing the Koolau/Pukele Overload Situation, even if the options would not resolve the Pukele Substation Reliability Concern. The options analyzed include increasing the current carrying capacity of existing lines (at least for planning purposes), and reducing the Koolau/Pukele service area load (or peak load) by targeting additional DSM, load management, DG and combined heat and power ("CHP") system penetration in the service area (beyond that expected to result from current programs and efforts). The analysis was included in the study finalized by HECO's Planning & Engineering Department in December 2003 entitled "East Oahu Transmission Project: Options to the Koolau/Pukele Transmission Line Overload Problem" ("Koolau/Pukele Overload Options Study"). Application at 30-31; HECO T-4 at 13-14, 71-72.

2. Options Considered to Address All Four East Oahu Transmission Problems

Some of the options considered to address all of the East Oahu Transmission problems collectively were:

(1) Live Line Maintenance. HECO retained a consultant, EDM International, Inc. ("EDM"), to review the potential for and practicability of doing "live line maintenance" on Oahu. Live line maintenance (which is generally referred to as "live working" in the industry) involves doing maintenance work on (and even replacing) distribution and transmission facilities without de-energizing the distribution and transmission lines. EDM and its Project Team, including Andy Stewart, Dr. George Gela of EPRISolutions, Inc., and Thomas Harrington and Louis Benedict of TLH Management Services Inc., were asked to analyze in more detail the potential for doing live working ("LW") on the 138kV transmission lines serving the Koolau and Pukele substations, since the Koolau overload situation and the Pukele reliability concern generally (although not exclusively) arise when a transmission line has to be taken out of service (i.e., be de-energized) for maintenance. The Project Team's conclusions are summarized in the testimony of Mr. Stewart in HECO T-5. Application at 31; HECO T-4 at 13, 85-86; HECO T-5.

In the case of HECO's 138kV system as it is currently configured, LW has, at best, very limited applicability, particularly for the lines serving the Koolau and Pukele Substations, due to constraints imposed by climate, terrain, and facility conditions. These constraints render LW impracticable for all but a very small percentage of the needed maintenance activities. The very frequent occurrence of rain and periods of fog, high humidity and unpredictable winds often will prevent the safe use of LW. Remote structures, particularly in the Koolau mountain areas, cannot be accessed by heavy equipment and/or do not have sufficiently large flat areas for use of heavy equipment such as insulated aerial devices with outriggers. Helicopter use is often hindered by fog, rain and strong winds. Many structures lack sufficient mechanical strength to support additional loading posed by climbing and conductor supports (strain sticks) needed for removal of insulators, and would need to be refurbished before LW should be attempted. Few of HECO's lines were designed with the goal of facilitating LW. In particular, none of the lines serving the Koolau and Pukele Substations, which are more than 40 years old, were designed for LW. For this reason, LW is not possible in many situations without prior retrofitting of the existing lines. Taking the lines out of service to retrofit the structures would place the Pukele service area at risk of the very double outage that LW would be attempting to avoid. Also, in most cases LW on HECO's system will be more time consuming and costly than de-energized maintenance. Application at 31-32; HECO T-4 at 86-87; HECO T-5.

(2) Renewable Resources. In general, the 1995 Alternatives Study, as updated in 2000, found that renewable resource generating plants were not a viable alternative due to the lack of suitable sites, the large land requirements, the non-firm nature of wind and solar resources, and the costs and need for interconnection lines if suitable sites could be found and battery energy

storage systems were added to firm up the resources. Application at 32; see HECO T-4 at 67, 85.

(3) Distributed Generation. DG refers to the installation of small generating units located at or near the load demands. Various technologies such as internal combustion engines ("ICE") (which in Hawaii are often diesel generators), fuel cells, micro-turbine generators, and renewable energy generators (wind and photovoltaic) are oftentimes suggested for DG applications. The purpose of the DG Alternatives Study completed by HECO in March 2000 was to review the suitability of using DG as an alternative to the installation of the Kamoku-Pukele 138 kV transmission line. In principle, installation of DG resources can defer the need for new transmission and distribution ("T&D") capacity by providing customers with a nearby redundant source of electricity that otherwise would have been provided by T&D upgrades. For DG to provide the same reliability improvements as the Kamoku-Pukele line, it was estimated that at least 200 MW of distributed generation would have to be installed up front in the neighborhoods of Manoa, Palolo, Waialae/Kahala, Kaimuki, Kapahulu, McCully/Moiliili, and Waikiki (of which 39 MW was already assumed to be installed). The review concluded that DG was not a suitable alternative to the Kamoku-Pukele line due to the cost of this option, as well as uncertainties with land, fuel supply, interconnection, and permitting with the installation of small generating units in the Pukele Substation service area. Application at 32-33; see HECO T-4 at 67-71, 83.

HECO formulated a variety of scenarios to implement DG as a practical alternative to the Kamoku-Pukele 138kV transmission line project, all of which assumed that at least 39 MW of emergency capacity already exists and would be available for this purpose in the Pukele substation service area. These scenarios included the installation of all ICEs, all-microturbines, all-fuel cells, and a portfolio (combination) of ICEs, microturbines, and fuel cells. Application at 33.

The least costly DG scenario was the installation of all ICEs, which had an estimated capital installed cost ranging from $81 million to $161 million. The DG scenarios with the installation of all fuel cells and all microturbines had estimated capital installed costs ranging from $161 million to $805 million, and from $145 million to $258 million, respectively. The portfolio of ICEs, microturbines, and fuel cells scenario ranged from $122 million to $343 million. (HECO estimated that the actual capital costs would probably be in the middle of the ranges, because of expected variations in the site-specific and customer-specific installation requirements.) Application at 33-34.

The other practical issues associated with the implementation of a DG portfolio that cause it to be an impractical alternative, included:

(a) Fuel Supply – Most of the DG technologies discussed utilize natural gas as fuel, which is not available in Hawaii. Synthetic natural gas, a petroleum product, is only available in certain areas of the Pukele Substation Service Area. DG technologies that utilize propane or diesel will require the installation of fuel storage tanks throughout the Pukele Substation Service Area.

(b) Siting – The Pukele Substation Service Area is highly urbanized and developed. Therefore, finding adequate space for the DG installations and associated fuel infrastructure, on or near the customer's site, will be difficult given Hawaii's high land cost and competing land uses.

(c) Operations and Maintenance – The operation and maintenance of hundreds to thousands of DG installations will be a significant resource challenge and added expense.

(d) Electrical Interconnection – The implementation of DG, on the scale and magnitude needed to replace the Kamoku-Pukele line, would be unprecedented. Therefore, there are numerous electrical interconnection issues that need to be resolved before DG on this scale could be implemented, such as power quality, system protection, control/communication, and electrical switching issues.

(e) Permitting – The installation of DG would involve various permits and approvals, depending on the locations and size of the installations. These approvals will require that noise, visual, water discharge, hazardous waste, and emissions impacts are fully addressed.

(f) Other Costs – When one of three transmission lines feeding the Koolau Substation Area is outaged for maintenance, only a portion of the 200 MW of distributed generation will be needed to forestall the overloading problem that occurs when a second line is lost. The required DG output may reach 40 MW, which was estimated to cost $300,000 to $2 million annually in fuel. When one of the two transmission lines feeding Pukele Substation is outaged for maintenance, however, all 200 MW of DG will be required to prevent the Pukele customers from being blacked out if the remaining transmission line is outaged too. Running all 200 MW of DG was estimated to cost from $1.6 million to $10 million annually for fuel. The cost of DG fuel is more expensive than centralized power plant fuel. Even though DG can help reduce transmission line losses by requiring the use of less fuel at the centralized power plants, the cost of utilizing more expensive DG fuel will offset any savings realized from reduced line losses.

(g) Load Diversity – The 200 MW customer load served by Pukele Substation is a "coincident" value that takes into account the fact that not all customer loads peak at the same time. If DG is implemented in a manner such that each customer or small block of customers have their own DG device, then the DG devices will not be able to share loads among each other. Based on the customer composition in the Pukele Substation Service Area, 350 MW of DG capacity might have to be provided instead of 200 MW. This load diversity issue could significantly escalate the costs for implementing DG and, thus, make it even more impractical. Application at 34-35.

(4) DSM and LM. HECO implemented five energy-efficiency DSM programs, including two residential and three commercial and industrial ("C&I") programs, in 1996 after Commission approval. (The programs are identified in Section 3.5.11 of the Revised FEIS.) The five programs were included in HECO's first integrated resource plan ("IRP Plan"), which was approved by the Commission in 1995. Modifications to the DSM programs were proposed in HECO's second IRP Plan filed in January 1998, but the existing programs have continued in effect (with modifications to reflect changes in the City and County of Honolulu's model energy code) as a result of stipulations approved by the Commission. Energy-efficiency DSM programs attempt to encourage customers to conserve electrical use by providing financial incentives for the installation of more efficient electrical equipment, or solar water heaters. Application at 35.

HECO has filed applications for and received approval of two load management ("LM") programs, including a Residential Direct Load Control Program, filed June 6, 2003 in Docket No. 03-0166, and a C&I Direct Load Control Program, filed December 11, 2003 in Docket No. 03-0415. The LM programs target peak load reduction, rather than energy conservation. Under the programs, participating customers will receive a financial incentive in exchange for allowing their water heating load (in the case of residential customers) and a specified portion of their demand in the case of C&I customers to be interrupted when there is insufficient generation to meet a projected peak demand, and when HECO's system frequency decreases to a specified level (due to the trip of a generating unit). The purpose of the programs is to help defer the need for peaking generation and possibly to displace the need to operate as much spinning reserve. Application at 35.

The impacts of the DSM measures implemented to date pursuant to the five energy efficiency DSM programs were reflected in the actual load data through 2003, and the forecasted future impacts of the energy-efficiency DSM programs were reflected in the forecasted loads in the August 2002 sales and peak load forecast. These impacts, and the impacts of the LM programs (which were assumed to be implemented in 2004 for purposes of the plan), were addressed in HECO's 2002 Evaluation Report, filed December 31, 2002 in Docket No. 95-0347, which was filed as an evaluation of HECO's Second IRP Plan (which was filed on January 30, 1998). Application at 36.

The 1995 Alternatives Study, as updated in 2000, indicated that the transmission overload problems might be deferred for a few years by even more aggressive (but not necessarily cost-effective) DSM programs, but the problems would only reappear due to overall load growth in the service areas, the customer mix, and the already high saturation goals for the approved DSM programs. Application at 36-37.

With the exception of more efficient commercial lighting and solar water heating, which are already included in the program, most DSM resources in Hawaii can only be cost-effectively implemented when existing equipment (e.g., motors, air conditioners) and residential appliances are at or near the end of their useful lives. While there may be high technical potential for increased efficiency, the implementation rate of such measures is limited by the high capital cost of installing new end use equipment. Application at 37.

The 1995 Alternatives Study, as updated in 2000, recognized that DSM and LM programs could not address the Pukele reliability concern, since these resources could not provide either the Pukele substation with a reliable and cost-effective source of electricity equivalent to its peak load, or eliminate all of the customer load in the Pukele service area. Application at 37.

3. Options Considered To Address Koolau/Pukele Overload Situation

Some of the options considered in the Koolau/Pukele Overload Options Study to only address the Koolau/Pukele Overload Situation were:

(1) Increase Conductor Capacity Options. Increasing conductor capacity involves the implementation of various techniques, materials, and equipment to increase the line capacities of the existing transmission lines. These alternatives were not considered viable to address the Koolau/Pukele Overload Situation.

The options to increase the current carrying capacity of transmission lines can be problematic and would place the HECO system at an increased risk of experiencing an overload situation. For example, the re-conductoring option would require that large, heavier conductors be installed to replace the existing conductors on the three 138kV transmission lines serving the Koolau Substation, and various structure and poles supporting the conductors may have to be strengthened or replaced. The process would be time consuming, difficult and expensive, particularly given the logistics of stringing new conductors in the mountainous areas traversed by the lines. The work would necessitate prolonged outages of the lines, which would increase the possibility of an overload occurring if a second line serving the Koolau Substation becomes unavailable for any reason. Application at 37-38; HECO T-4 at 72-78.

(2) Reduced Demand Options. Reduced demand involves the implementation of initiatives and programs such as DSM programs to reduce power demand at customer sites. These alternatives were not considered viable to address the Koolau/Pukele Overload Situation. These alternatives rely on targeted market penetration of DSM and LM initiatives and programs in the Koolau/Pukele Area. At this time, there is not enough reliable data to determine whether an adequate market exists for these programs to be effective for the overload situation. Application at 38; HECO T-4 at 78.

(3) DG Options. DG was not considered viable to address the Koolau/Pukele Overload Situation because of the uncertainties with land, fuel supply, interconnection, and permitting with the installation of small generating units in the Koolau/Pukele Area. Application at 38; HECO T-4 at 38; HECO T-4 at 78-79, 81-82.

(4) Combined Heat and Power Options. CHP systems are a form of DG that utilize waste heat from the power generation process as energy (heat or steam) for heating or cooling purposes. The advantage of a CHP system over conventional electric generating units is the increased efficiency obtained when the captured waste heat is put to useful purposes. The thermal efficiency of fuel usage typically ranges from 85% to 90% for a CHP system compared to 35% to 40% for conventional central station generating units. Application at 38; HECO T-4 at 82-83.

HECO and its electric utility subsidiaries serving the counties of Maui and Hawaii, filed an application on October 10, 2003 in Docket No. 03-0366 requesting approval of each company's proposed CHP Program and related tariff provision (Schedule CHP, Custom-Sited Utility-Owned Cogeneration Service). Under the CHP Program and Schedule CHP, the companies proposed to offer CHP systems to eligible utility customers on the islands of Oahu, Maui and Hawaii as a regulated utility service. (The companies also indicated that they would request approval on a contract-by-contract basis for CHP system projects that fell outside the scope of the proposed program.) If the program was approved, HECO anticipated that the program would accelerate the rate at which CHP systems are installed on Oahu, and projected that HECO and third parties would install 10 MW by the end of 2006, and another 15 MW could be installed by the end of 2010, which was higher than the assumed rate for DG penetration in HECO's August 2002 load forecast of 1 MW per year. The 2003 East Oahu Alternatives Study includes an analysis of the possible impact of such an aggressive CHP Program on the load forecast used for the EOTP analyses. Application at 39; HECO T-4 at 14-15.

How much of this forecasted amount would be installed in the Koolau/Pukele area would be uncertain, although the Koolau/Pukele offers greater opportunities compared to residential communities on the Leeward or Windward areas of Oahu. Even if it was assumed that all of the forecasted CHP installations occurred in the Koolau/Pukele area, the 42 MW required in 2022 would be inadequate to meet the 47 MW required to resolve the Koolau/Pukele Overload Situation. This option assumed for planning purposes that there was a potential for CHP installations at commercial and industrial sites within the Koolau/Pukele Service Area in addition to those already forecasted to be installed as a result of HECO's filed CHP program and third party efforts. Application at 39; HECO T-4 at 82-83.

CHP options were not considered viable to address the transmission overload situation, given the expected difficulties and cost of acquiring the additional CHP needed. (Moreover, as the Commission is aware from other proceedings, including Docket No. 03-0371, the installation rates for CHP systems, regardless of ownership, have not proceeded at the rates forecast.)

(5) Combined Alternatives. In theory, it might be possible to defer, but probably not eliminate, the Koolau/Pukele Overload Situation through some combination of targeted DSM, DG, and CHP installations in the Koolau/Pukele service area. However, there would be substantial uncertainty as to whether the objective could be achieved, given the practical problems with substantially increasing the amount of DSM, DG and/or CHP installed in the area in the near-term, particularly in light of the fact that the overload problem is already at risk of occurring during evening peak periods. The total cost of deferring the overload problem using such measures would probably exceed the cost of the preferred 46kV expanded alternative (which will fully address the Pukele Substation Reliability Concern, with the exception of the customers that will still incur 6-second interruptions). And, the DSM, DG and CHP option would not address the Pukele Substation Reliability Concern (with the possible exception of the customers with on-site DG or CHP, assuming their loads could be islanded), or help with the Downtown Overload Situation if the Honolulu Power Plant is unavailable for any reason. Application at 40; HECO T-4 at 84.

4. Summary

The question is not really whether HECO should pursue cost-effective DSM and CHP programs, or add cost-effective renewable resources, or maintain and improve the reliability of its transmission system. HECO should pursue all of these objectives. HECO is aggressively promoting the installation of cost-effective DSM measures through its Commission-approved DSM programs and is seeking approval for enhanced energy efficiency DSM programs, and implementing new LM programs. HECO sought approval of a major CHP program, which was intended to place HECO and its subsidiaries at the forefront of utilities promoting the installation of energy efficient CHP systems. HECO and its subsidiaries, including its new renewable energy subsidiary, are actively seeking to acquire capacity and energy generated from renewable resources at both the utility and customer (through solar water heating) levels. Nonetheless, neither DSM, nor CHP (and DG), nor renewable resources can eliminate or cost effectively address the East Oahu transmission problems and concerns that will be addressed by the proposed 46 kV project. Application at 40-41; HECO T-4 at 15-16.

E. THE OTHER PARTIES

1. The Consumer Advocate

a. Summary

The Consumer Advocate's position was presented by Mr. Michael Kiser, President, MK Solutions, Inc., the Consumer Advocate's consultant. CA-T-1. Based on his review of the studies shown in CA-T-1 (pages 19- 21) and analysis of HECO's load flow cases, Mr. Kiser confirmed that the Koolau/Pukele Line Overload Situation exists, although he took the position that the situation may not be as urgent as HECO has concluded. CA-T-1, at 28. In CA-T-1 (page 41), he concluded that there is a possibility that the Downtown Overload Situation could occur and recognized that the continued operation of the HPP is a factor in supporting this conclusion. He also agreed that there is concern about the reliability of the Pukele Substation, explaining that both 138kV transmission lines feeding the Pukele Substation follow the same general route to the substations and the conductors are approximately 40 years old. CA-T-1 at 41-42. In the case of the Downtown Substation Reliability Concern, he concluded that the Downtown Substation Reliability Concern is even greater than HECO presents in its testimony. CA-T-1 at 57. See HECO RT-4 at 3-4.

Mr. Kiser's testimony concludes that the Koolau/Pukele Overload Situation supports the need for system improvements on HECO's electric system. As noted above, he characterizes the

Koolau/Pukele Line Overload Situation as not as urgent as HECO has determined, and contends that there are some measures HECO could take without installing any additional facilities to defer the overload for the short-term. (The timing of the Koolau/Pukele Line Overload Situation is discussed in Part IV.A of the Opening Brief, and load flows in Mr. Kiser's analysis of the timing are addressed in subpart b, below.) He also concludes that there is a possibility of a Downtown Line Overload and confirms that the uncertainty of the continued operation of the HPP is a factor in the Downtown Line Overload Situation. Additionally, he believes that HECO should make it a priority to plan for a system that is flexible and can serve customers reliably even if the HPP is retired. Finally, he concluded that the Pukele Reliability Concern and the Downtown Substation Reliability Concern fully support the need to make electric system improvements.

Mr. Kiser concluded that the Kamoku 46kV Underground Alternative - Expanded provides the benefits to the HECO system as HECO represented in this proceeding, and recommended that the project should be approved by the Commission, with certain exceptions. In relevant part, he also contended that the installation of the new 138-46kV, 80 MVA transformer "D" at Archer Substation is not necessary at this time. (In addition, he initially took the position that two sections of proposed 46kv underground circuit reconfigurations should be constructed overhead, or that HECO should consider overhead construction. At the hearing, taking into consideration HECO's rebuttal testimonies and responses to information requests, the Consumer Advocate agreed with the underground construction of all of the 46kV line systems.)

As is discussed in subpart c, below, the new Archer Substation transformer is needed in Phase 2 of the project to prevent transformer overloads at the Archer Substation that could occur if the Pukele Substation is lost.

b. The Consumer Advocate's Analysis of the Koolau/Pukele Line Overload Situation

Upon review of HECO's load flow cases representing HECO's current system without improvements, Mr. Kiser argued that the Koolau/Pukele Line Overload is not as urgent a situation as HECO concludes. As a result of his analysis of HECO's 46kV switching diagrams provided under protective order as Attachment 1 in response to CA-IR-15, he contended that HECO's existing system can be re-configured to shift approximately 22 MW of load from the Pukele Substation to the Archer Substation to further defer the Koolau/Pukele Line Overload Situation. In addition, he asserted that HECO can utilize existing switches between the Downtown Substation and the Pukele and Koolau Substations during maintenance to defer the Downtown Line Overload Situation beyond 2022. HECO RT-4 at 5-6.

HECO's analysis accurately represents the urgency of the Koolau/Pukele Line Overload. An updated analysis of the Koolau/Pukele Line Overload Situation using the corrected May 2005 Peak Forecast, confirms that the Koolau/Pukele Line Overload will occur in 2006. HECO-R-406; Exhibit "B" to Opening Brief at 8-11, 18-19. This is only one year later than the analysis using the previous forecast, so the Koolau/Pukele Line Overload is still considered urgent. HECO's analysis of Mr. Kiser's methodology of determining an overload condition revealed that it is based on inappropriate criteria and therefore can fail to accurately predict an overload situation in a timely manner. HECO's position is that the Consumer Advocate's methodology should not be used to determine if and when line overloads will occur. HECO's methodology of using simulated line currents is a more appropriate basis to determine the line overload dates. HECO RT-4 at 6-14.

With respect to the Koolau/Pukele Overload, there are some steps in the interim that HECO can take since Phase 1 is not expected to be installed in 2006. The McCully 5 transformer, which is currently fed from the Pukele Substation could be served from the Archer Substation with some minor rewiring work to keep the auto transfer scheme in service for this transformer. In addition, the Manoa 1 transformer could be moved to the Archer Substation with some additional work. Tr. (11/07) at 119-20 (Ishikawa).

However, HECO cannot simply shift 22 MW of load from the Pukele Substation to the Archer Substation or from the Archer and School Substations to the Pukele and Koolau Substations by opening and closing switches, as the Consumer Advocate seemed to suggest. Although the load shifting may be technically feasible if additional 46kV facilities were installed, the Consumer Advocate reached conclusions based upon overly simple analyses of the HECO 46kV system using the switching diagrams provided in response to CA-IR-15. Mr. Kiser should have, but did not (1) analyze the impact on the 46kV backup circuits under no contingencies, (2) identify the overloads on the 46kV back-up circuits under 46kV line contingencies, or (3) consider the affect on the 46kV automatic transfer schemes in its proposed switching scenarios. The Consumer Advocate did not sufficiently consider planning complexities on the 46kV system, including consideration for outages and maintenance when planning the 46 kV system. HECO RT-4 at 6-7, 20-30; Exhibit "B" to Opening Brief at 20-24.

c. **<u>Need for the Archer D Transformer</u>**

As described in HECO T-2, pages 1-10, HECO T-4, pages 50-53 as revised for changes in HECO ST-2, pages 2-8 and HECO ST-4, pages 2-4, the scope of the project includes installation of 138-46kV 80 MVA transformers at Kamoku Substation and at Archer Substation. Additional ductlines, cables, switches, taps and reconfigurations are also required. HECO RT-4 at 64.

For Phase 2, HECO will need to install the 138-46kV transformer at the Archer Substation (the "Archer D transformer") to prevent transformer overloads that could occur when using the 46kV system to address the transmission contingency of loss of the two 138kV lines to the Pukele Substation. In addition, HECO is proposing to install three new underground circuits from the Archer Substation connecting to the existing Pukele 5, 6 and 7 circuits served by the Pukele Substation. The three new 46kV circuits can be viewed as extensions of existing Pukele circuits making connections to the Archer Substation. If the transmission lines feeding the Pukele Substation were unavailable, an automatic transfer scheme would initiate which would open and close switches at the Archer and Pukele Substations. Phase 2 would address the remainder of the Pukele Substation Reliability Concern because all of the customers served by the Pukele Substation would be transferred to the Southern Corridor and interruption of service is decreased to 6 seconds or less. Tr. (11/07) at 127 (Ishikawa).

Because of the ties made between the Archer Substation and the Pukele Substation, Phase 2 could potentially provide complete back-up of the Archer Substation if both transmission lines feeding the Archer Substation were unavailable. Tr. (11/07) at 129 (Ishikawa).

One of the transmission contingencies that HECO is addressing by using the 46kV subtransmission system is the loss of the two 138kV transmission lines to the Pukele Substation and not just loss of a single 46kV circuit. The amount of load requiring back-up is greater for the Pukele Substation contingency compared to loss of a 46kV circuit. Therefore, transformer overloads would occur when the Archer Substation is used to serve the Pukele Substation load if both transmission lines feeding the Pukele Substation were suddenly unavailable. The addition of the Archer D transformer will address this contingency.

In response to CA-RIR-35, HECO provided an illustration in order to explain why the Archer D transformer was required. CA-RIR-35 shows two scenarios and both scenarios look at the load on the Archer transformers under the Pukele Substation Contingency. The first scenario assumes all of the proposed facilities for the 46kV Phased Option are installed with the exception of the Archer D transformer. The load on each of the three Archer transformers and on the Kamoku transformer are shown. The two boxes outlined in red highlight that the load on the Archer C transformer will exceed its normal rating and the load on the Archer A will exceed its emergency rating. Scenario 2 shows the loads on each of the transformers with the Archer D transformer and the loads do not exceed either the normal or the emergency limit for the year studied. This analysis was performed for forecasted load in 2009, which is the year Phase 2 is expected to be installed. It is expected that loads will continue to <u>increase</u> from 2009 which will increase the need for the Archer D transformer. Tr. (11/07) at 128-29 (Ishikawa).

Given the technical nature of this issue, HECO is providing a more detailed description of the need for the transformer in Exhibit "C" to this brief, based on the evidence that is already part of the record.

<u>Consumer Advocate's Analysis</u>

The Consumer Advocate is recommending approval of the EOTP and the proposed facilities involved with the project except for the installation of the 138-46kV, 80 MVA transformer at Archer Substation. HECO RT-4 at 64.

Mr. Kiser reviewed HECO's load flow cases and performed a substation utilization analysis. He determined that the combined load of Archer Substation and Pukele Substation is estimated to be 264 MVA in 2007, and to reach 277 MVA in 2022. The utilization analysis in CA-112 shows that if the Archer substation needed to provide complete back-up to the Pukele

Substation up until the year 2022, the Archer Substation with a combined transformer capacity of 330 MVA has an adequate amount of transformation. The analysis does not show, however, the combined MVA rating of the Archer Substation drops to 220 MVA under an N-1 contingency, or compare this to the 246 MVA of combined Archer and Pukele load. This scenario is still within the single contingency scenario for 46kV sub-transmission planning because loss of Pukele Substation is a transmission constraint, the sub-transmission system is forced to accommodate. Thus, the fourth transformer at Archer Substation is needed. HECO RT-4 at 64-65.

In CA-T-1, page 91, Mr. Kiser represented that approximately 54 MW could be shifted from the Pukele Substation to the Koolau Substation to reduce the Archer Substation load. In response to HECO/CA-IR-52, he explained that the basis for this information is from Table 3-5, which can be found on page 3-38 of HECO's FEA. The reference was reviewed, but there was no mention of the ability to shift approximately 54 MW of load from the Pukele Substation to the Koolau Substation. Thus, HECO assumed that Mr. Kiser was referencing the ability to transfer approximately 53 MW of the existing Pukele Substation load to the Koolau Substation through manual switching, which requires primary troubleman to go out into the field and perform the switching. The 53 MW was in reference to HECO's ability to backup the remaining Pukele Substation load that was not shifted permanently to the Archer and Kamoku Substations or automatically transferred onto Archer and Kamoku Substations as part of the EOTP Phase 1. HECO RT-4 at 65.

Switching approximately 53 MW of load onto the Koolau Substation, however, would create a situation where the loads being served by the Koolau Substation would be served by a primary 46kV circuit originating from the Koolau Substation, but there would be no backup circuit. Thus, an outage on a 46kV circuit serving the load that is temporarily shifted to the Koolau Substation would create an outage situation. HECO RT-4 at 66.

In addition, there are other planning considerations involved in determining the need for the fourth transformer at Archer Substation. In looking at total MVA, Mr. Kiser did not consider that the 80 MVA transformers do not feed into a common network bus and each 80 MVA transformer has designated 46kV circuits transporting the power from the 80 MVA transformer to the distribution substations. For instance, Archer A transformer feeds the Archer 41 and the Archer 42A circuit. The Archer B transformer feeds the Archer 43 and Archer 44A circuits. The Archer C transformer feeds the Archer 46 and future Archer 45 circuit. Currently, installing the Archer 45, 47, and 48 circuits and connecting them to the Archer A, B and C transformers cannot be done, because the substation is not designed as a common network bus. Additional costs would be required to configure the substation in a network, because the 46kV busses would need to be robust enough to accommodate the current flow for the multiple circuits connected to a network of three transformers. HECO RT-4 at 66; see Opening Brief, Exhibit "C".

Therefore, the Archer 138-46kV, 80 MVA transformer as proposed in this project is needed and the cost for this transformer should be included in the cost for the proposed project. HECO RT-4 at 66.

2. Life of the Land

a. LOL'S Statement Of Position

LOL did not file written testimony addressing the issues in this docket. Rather, LOL submitted a document entitled "Statement of Position" signed by Henry Q Curtis, its Vice President for Consumer Issues. As a result, HECO generally did not submit rebuttal testimonies responding to the LOL Statement of Position ("SOP"). Submitting testimonies in response to the LOL SOP would not have served a useful purpose in this proceeding, since the SOP did not mention or address the proposed East Oahu Transmission Project, which is the subject of this proceeding.

b. <u>LOL's Claims Regarding Non-Transmission Options</u>

The only issue that the SOP attempted to address was "whether the proposal 'is preferable to other feasible non-transmission options'." The SOP claimed that "[o]ur analysis will show that it is not." However, the SOP only contained generalized claims regarding environmental impacts of oil-fired or fossil fuel-fired generation (i.e., oil spills and global warming), health impacts of pollutants emitted by electric power plants, economic impacts (i.e., generalized comments on what LOL terms "engineering costs," the economic multiplier effect, and portfolio analysis), the Hawaii State Constitution, and types of renewable energy options. The extensive testimonies and studies submitted by HECO, and the testimony of the Consumer Advocate's consultant, demonstrate that the non-transmission options are not viable, cost-effective alternatives to address the problems addressed by the EOTP. HECO RT-1 at 22.

HECO did attempt to elicit details regarding LOL's generalized claims. For example, the SOP (page 2 of its unnumbered SOP) states that in "Part 5 we give an overview of renewable energy and energy efficiency options which could supply all of the electrical needs within the state." By "overview," LOL means that it provides a few paragraphs on solar energy, wind, wave power, sea water air conditioning, combined heat and power (cogeneration), and demand-side management. In HECO/LOL-IR-2, HECO requested that LOL provide its resource plan that identifies the specific resources (including the specific components, their location, cost, and permitting requirements, the timeframe for permitting, acquiring and installing the components, the extent to which commercially available components of the size and type included in LOL's resource plan have been installed in other locations, the sources relied upon for the foregoing information, and other information necessary for the Commission to evaluate the cost, feasibility and impacts of LOL's resource plan) that would "supply all of the electrical needs of Oahu" using the options identified in Part 5. HECO also submitted information requests regarding some of the renewable options referred to by LOL. LOL provided no details whatsoever regarding any resource plan, or components of such a resource plan. HECO RT-1 at 22-23.

As discussed in Part IV.D of this brief, HECO considered and/or analyzed a number of non-transmission options that might address some or all of the transmission system concerns to be addressed by the EOTP. First, as part of the planning and permitting for a 138 kV transmission line between the Kamoku and Pukele Substations, HECO undertook and/or commissioned an extensive analysis of potential options in 1995, and updated the analyses in 2000. HECO considered distributed generation, DSM measures, and other non-transmission options, in studies performed by CH2MHill and HECO in June 1995, March 2000 and April 2000 as part of the EIS process. These studies concluded that the partial underground/partial overhead 138kV Kamoku-Pukele Line was the preferred options when considering the cost, feasibility, practicality and effectiveness of these options. In its December 2003 study, HECO built upon the conclusions of the previous analysis and reexamined the options of reconductoring, demand side management, distributed generation, combined heat and power and a combination of options to address only the Koolau/Pukele Line Overload Situation. The options in the study were eliminated for reasons such as cost, feasibility, practicality and uncertainty in addressing the Koolau/Pukele Line Overload Situation. Even in a hypothetical situation where the feasibility, practicality and uncertainty issues could be resolved, the considered options would not address additional transmission problems such as the Pukele Substation Reliability Concern. Tr. (11/07) at 121-22 (Ishikawa).

Mr. Kiser agreed that non-transmission options cannot, in and of themselves, solve all of the system constraints at this time. CA-T-1 at 116; Tr. (11/08) at 288-89 (Kiser). He also agreed that it is possible for load management, DSM, CHP and DG to solve line overload problems; however, the programs cannot be installed quickly enough to address the Pukele Substation Reliability Concern. Mr. Kiser also pointed out that CHP/DG programs are in the early stages of development, costs are uncertain and implementation schedules for these programs are uncertain and, therefore, non-transmission options to the Kamoku 46 kV Underground Alternative - Expanded option cannot offer similar benefits as the proposed EOTP does at this time. Thus, he appeared to agree with HECO's strategy to continue to pursue these programs and watch their development and update studies in the future to incorporate the results of HECO's progress with these programs. HECO RT-4 at 62.

c. **LOL's Other Claims**

No assumption should be made as to whether HECO agrees or disagrees with any particular statement in LOL's SOP. HECO has not submitted testimonies in response to the SOP, because it does not meaningfully address the proposed East Oahu Transmission Project, or the issues identified by the Commission for this docket. (Transmission and sub-transmission lines, and related facilities, are not power plants that generate electricity – they transmit power from generating facilities to customers, whether the power is generated from oil-fired resources or from renewable energy resources such as wind farms.) HECO has responded and will continue to respond to the generalized comments made by LOL when it is appropriate to do so in the context of dockets or processes in which they may be more relevant. HECO RT-1 at 23.

HECO did provide comments regarding some of the unsubstantiated statements in LOL's SOP, however. In particular, LOL's implications that HECO's facilities are a threat to the environment and that HECO does not support renewable energy development were briefly addressed. HECO RT-1 at 23-24.

In regards to the environment, HECO's facilities are designed and operated to meet or exceed State and Federal regulations. HECO is continually improving processes and procedures to achieve environmental excellence. HECO employees are trained in air quality requirements, spill prevention control and countermeasures, storm water runoff, and proper handling and disposal of hazardous wastes. HECO conducts periodic exercises with the State, U.S. Coast Guard, and the Clean Island Council to train for emergency scenarios involving oil spills. HECO RT-1 at 24.

In regards to renewable energy, HECO and its subsidiaries continue to support renewable energy that is reasonably priced and reliable for its customers. HECO with its subsidiaries continue to be the national leader in renewable energy through sun, wind, geothermal, and biomass resources. HECO's continued commitment to support renewable energy is reflected in HECO's third Integrated Resource Plan, filed in Docket No. 03-0253. The preferred plan shows a mix of resources that include demand-side management, combined heat and power, distributed generation, renewable supply-side resources, and conventional supply-side resources. See HECO RT-1 at 24.

F. TRANSMISSION PLANNING ISSUES

HECO retained an expert transmission system planner, Mr. Randall Pollock, Senior Vice President, Power Engineers, Inc., to provide an overview of the transmission (and sub-transmission) planning process, to review HECO's updated studies and conclusions regarding the need for the EOTP, and to assess HECO's planning process. A more detailed overview of the transmission system planning process, with focus on the EOTP project, is contained in the testimonies of Mr. Pollock and Ms. Ishikawa, and is summarized in Exhibit "D" to this brief.

Mr. Pollock reviewed HECO's planning process and concluded that HECO has conducted and is conducting a proper planning process.

To assess if HECO's planning process is proper, he reviewed the relevant planning studies HECO has completed from 1984 through 2003. HECO-R-301 summarizes his review of the studies. See HECO RT-3 at 5-20. Because conducting system studies is an ongoing process, with current studies building on, updating, and re-evaluating past studies, it is important to look at the continuum of studies over a long period, rather than to focus on individual aspects of the study process. His review of the studies conducted indicates that HECO has conducted a proper study process and has properly addressed 138kV transmission, 46kV sub-transmission and distribution system issues in the various studies. Tr. (11/07) at 64 (Pollock); see HECO RT-3 at 4-5, 35-36.

These studies include both HECO's internally prepared studies and engineering studies completed by experienced consulting firms. Taken as a whole, these studies provide a comprehensive analysis and recommendations to address the problem areas on HECO's system that were identified as needing resolution to provide for a reliable system in East Oahu and to comply with system planning criteria. Tr. (11/07) at 64-65 (Pollock); HECO T-3 at 21.

His assessment indicates that HECO's planning process is and has been a proper and comprehensive planning process, and that HECO's planning process is conducted consistent with current electric utility industry practices. Tr. (11/07) at 65 (Pollock); See HECO RT-3 at 3-4, 20.

The testimony of the Consumer Advocate's consultant also addressed a number of transmission planning issues. The issue raised by him as to the prudency of HECO's planning prior to 2003 to address the East Oahu transmission problems (and the inclusion of planning and permitting costs incurred prior to 2003 ("pre-2003 planning and permitting costs") in the cost of the EOTP) has been deferred to a future rate case by the Consumer Advocate/HECO Stipulation approved (in relevant part) by the Commission in Order No. 22104 issued November 4, 2005.[34] The other issues raised by Mr. Kiser, with the exception of his approach to equipment utilitization (and his suggestion that the Archer D transformer is not required), generally did not affect his favorable recommendation as to approval of the EOTP. Thus, HECO's responses to these other issues are relatively brief and are included in Exhibit "D" to this brief.

V. PROJECT DETAILS

A. DESCRIPTION OF PROJECT

HECO proposes to implement the project in two independent phases, Phase 1 and Phase 2. Phase 1 includes: (1) the installation of six underground 46kV lines in the Ala Moana, McCully, Moiliili, and Kapahulu areas, (2) a 138kV/46kV transformer installation at the existing Kamoku Substation with associated protective relaying, (3) a 46kV/12kV transformer installation at the existing Makaloa Substation with associated switchgear, (4) various switching and reconnections on the existing 46kV and 12kV systems near Makaloa and McCully Substations, (5) the removal of existing 46kV and 12kV cables between Makaloa and McCully Substations, (6) the removal of an existing 46/12kV transformer and associated switchgear from

[34] The Commission accepted the withdrawal of the pre-2003 planning and permitting costs issue from this proceeding, but denied HECO and the Consumer Advocate's request to withdraw from the record certain portions of their filed testimonies, exhibits, and responses to information requests relating to this issue. Specifically, the Commission granted the Stipulation in its entirety with the exception of Paragraph 3 on Page 5 of the Stipulation, which was denied.

the McCully Substation, and (7) modifications of various existing distribution substations in the Honolulu area. Phase 2 includes: (1) the installation of three underground 46kV lines in the Kakaako, Makiki, and McCully areas, and (2) a 138kV/46kV transformer installation at the existing Archer Substation with associated protective relaying. A detailed description of Phase 1 and Phase 2, with citations to the record in this docket, is included in Exhibit "A" to this brief.

B. PROJECT ROUTE

1. Phase 1

Phase 1 of the proposed 46kV Phased Project includes four 46kV underground line segments. One segment consists of two new 46kV underground circuits between the Makaloa Substation, located at the corner of Amana and Makaloa Streets, and the McCully Substation, located at the corner of Lime and Pumehana Streets. There is an existing ductline that exits Makaloa Substation onto Makaloa Street and heads in the Diamond Head direction, past the Daiei store until Kalakaua Avenue. At Kalakaua Avenue, the ductline heads in the makai direction along Kalakaua Avenue for a short distance until the intersection with Fern Street. The ductline then proceeds in the Diamond Head direction along Fern Street until the intersection of Fern and Hauoli Streets. The ductline then heads in the makai direction along Hauoli Street, until turning in the Diamond Head direction onto Lime Street. The ductline would then continue a short distance along Lime Street and end at a new manhole fronting McCully Substation. The total length of this existing ductline is approximately 3,450 feet. HECO proposes to install one of the new 46kV underground circuits in this existing ductline between Makaloa and McCully Substations. The other new 46kV underground circuit will be installed in a new underground ductline from Makaloa Substation to Poni Street along Makaloa Street. The total length of the new ductline is approximately 1,000 feet. The new ductline and associated 46kV circuit would transition into the existing ductline at Poni Street at which point, the new 46kV circuit would continue in the existing ductline all the way to McCully Substation. HECO T-7 at 1-3; HECO ST-7 at 1-3; HECO-701; HECO-ST-201; Final EA (Vol. 1) at Figure 1-1 and Chapter 3; Tr. (11/07) at 159 (Morikami).

A second segment involves Date Street. On Date Street, two new underground 46kV circuits are required to connect the new 138kV to 46kV transformer to be installed in the Kamoku Substation, which is located on the makai side of Date Street, to an existing 46kV circuit on the mauka side of Date Street. The total length of the ductline is approximately 30 feet for one circuit and approximately 300 feet for the other circuit. HECO T-7 at 8-9; HECO-701; Tr. (11/07) at 160 (Morikami); Final EA (Vol. 1) at Figure 1-1 and Chapter 3.

A third segment involves Pumehana Street. On Pumehana Street, a new underground 46kV circuit is required to connect an existing 46kV circuit near McCully Substation to another existing 46kV circuit near the intersection of Date and Pumehana Streets. The total length of this ductline is approximately 720 feet. HECO T-7 at 9; HECO ST-7 at 5-6; HECO-701; HECO-ST-202; Tr. (11/07) at 160 (Morikami); Final EA (Vol. 1) at Figure 1-1 and Chapter 3.

A fourth segment involves Winam and Mooheau Avenues. On Winam and Mooheau Avenues, a new underground 46kV circuit is required to connect an existing 46kV circuit on Winam Avenue to another existing 46kV circuit on Mooheau Avenue. The total length of this ductline is approximately 420 feet. HECO T-7 at 9; HECO-701; Tr. (11/07) at 160 (Morikami); Final EA (Vol. 1) at Figure 1-1 and Chapter 3.

2. **Phase 2**

Phase 2 of the proposal connects the three new 46kV underground circuits from the existing Archer Substation to the McCully Street area. In Phase 2, the main ductline for the three new 46kV circuits begins at Archer Substation located at HECO's Ward Avenue facility. The ductline exits Archer Substation onto Cooke Street and then heads in the mauka direction onto King Street. The ductline then heads in the Diamond Head direction along King Street until the area fronting McCully Times Supermarket. The total length of the main ductline is about 8,325 feet. From the area fronting Times Supermarket, one of the 46kV circuits continues in the Diamond Head direction on King Street until McCully Street. At McCully Street, the ductline heads in the mauka direction until Young Street. The length of the additional ductline for this circuit is about 1,450 feet. From the area fronting the McCully Times Supermarket, the second 46kV circuit branches off the main ductline and terminates in the sidewalk area fronting the parking lot of the McCully Times Supermarket. The length of the additional ductline for this circuit is approximately 40 feet. A ductline for the third 46kV circuit branches off the main ductline at the same location as the second circuit ductline and terminates in the sidewalk area fronting American Savings Bank. The length of the additional ductline for this circuit is approximately 50 feet. HECO T-7 at 10-11; HECO ST-7 at 7-8; HECO-701; Final EA at Figure 1-1 and Chapter 3; Tr. (11/07) at 161 (Morikami).

3. Alternative Routes Studied

a. Phase 1

For Phase 1, HECO examined alternative routes that used Kapiolani Boulevard. In the Kapiolani Boulevard alternative route, the ductline would exit Makaloa Substation onto Makaloa Street, then head in the Diamond Head direction until either Kaheka Street or Kalauokalani Way. Either Kaheka Street or Kalauokalani Way can be used to get to Kapiolani Boulevard. Along Kaheka Street or Kalauokalani Way, the ductline would head in the makai direction until Kapiolani Boulevard. The ductline would then head in the Diamond Head direction on

Kapiolani Boulevard until Pumehana Street. The ductline then heads mauka on Pumehana Street until Lime Street to HECO's McCully Substation. HECO T-7 at 7-8; HECO ST-7 at 4-5; HECO RT-7 at 2-3; HECO-ST-701; Final EA (Vol. 1) Figure 3-10; Tr. (11/07) at 162-63 (Morikami).

The alternatives that use Kapiolani Boulevard were not selected, because there are a number of significant disadvantages to using Kapiolani Boulevard. First, with the use of an existing ductline between the Makaloa and McCully Substations, no trenching would be required for approximately 70% of the route. (HECO anticipates a cost savings of approximately $800,000 by using existing ducts. Tr. at (11/07) at 162 (Morikami).) In comparison, on the alternative routes using Kapiolani Boulevard, there is no existing ductline that can accommodate the two new 46kV circuits so HECO would have to do trenching work for 100% of the route. This means that for the alternative routes using Kapiolani Boulevard, trenching work would result in increased costs and traffic impacts. HECO T-7 at 7-8; ST-7 at 4-5; HECO-ST-701; Final EA (Vol. 1) Figure 3-10; Tr. (11/07) at 162-64 (Morikami).

Second, the Kapiolani Boulevard alternative could result in more traffic impacts. Kapiolani Boulevard is subject to significantly more traffic than Makaloa, Fern, Hauoli and Lime Streets, especially at the intersection of Kalakaua Avenue and Kapiolani Boulevard. HECO T-7 at 7-8; HECO ST-7 at 4-5; HECO-ST-701; Final EA, Figure 3-10; Tr. (11/07) at 164 (Morikami).

Third, Kapiolani Boulevard is full of existing underground utilities (e.g., electrical, water, sewer, gas, telephone, drainage, traffic signals) and it would be very difficult to design and construct a new ductline there. HECO T-7 at 7-8; HECO ST-7 at 4-5; HECO-ST-701; Final EA (Vol. 1) Figure 3-10; Tr. (11/07) at 164 (Morikami). The presence of existing underground utilities along Kapiolani Boulevard makes it difficult to design and construct for several reasons.

Each underground utility line requires a minimum separation distance between them for operation and maintenance purposes. Recent engineering drawings from the City show very little space to install manholes needed for the proposed 46kV ductline on Kapiolani Boulevard. It is likely that HECO would need to obtain waivers of the minimum separation between utility lines from the Board of Water Supply and other City agencies in order to install the required 46kV manholes. In general, waivers are granted only when there are no other options available to locate the lines. HECO T-7 at 7-8; ST-7 at 4-5; HECO-ST-701; Final EA (Vol. 1) Figure 3-10; Tr. (11/07) at 164 (Morikami).

In addition, there appears to be a section on Kapiolani Boulevard (near the intersection with Atkinson Drive) where there is no corridor available at the typical depth for a 46kV underground ductline. HECO would have to install the ductline approximately seven feet deeper to avoid the conflicts with the existing lines which would result in increased costs and time to construct the line. Based on these known conditions on Kapiolani Boulevard, HECO estimated that the design and construction costs would be about $1.6 million more for the Kapiolani Boulevard when compared to the proposed route. HECO ST-7 at 4-5; HECO-ST-701; Final EA (Vol. 1) Figure 3-10; Tr. (11/07) at 165 (Morikami).

Further, in reviewing the use of the alternative alignments, HECO determined that there may be potential conflicts with the City's proposed Bus Rapid Transit ("BRT") project. HECO understands that the BRT project is no longer being pursued by the City. However, HECO is aware that Kapiolani Boulevard is still under consideration as the route of a proposed rail system. If HECO were to install a ductline on Kapiolani Boulevard, costs could increase substantially because of the possible relocation of existing utilities and having to dig deeper trenches in order to resolve potential conflicts. HECO ST-7 at 4-5; HECO-ST-701; Final EA (Vol. 1) Figure 3-10; Tr. (11/07) at 165-66 (Morikami).

b. Phase 2 Alternative Routes

HECO evaluated alternative routes to using King Street for Phase 2 of the proposed 46kV Phased Project. HECO evaluated Young Street and Beretania Street (using an underground or overhead configuration) as alternatives to King Street. Due to disadvantages with the alternative routes, King Street was the preferred route. See HECO T-7 at 13-15; HECO-701; HECO ST-7 at 7-8; HECO-ST-702; Tr. 167-68 (Morikami).

HECO examined Young Street and Beretania Street as alternative routes for the three new 46kV underground circuits from Archer Substation to McCully Street. However, these alternative alignments were not selected as the proposed underground route alignment, because they had disadvantages that include (1) construction of a ductline along Young Street would require more traffic control and coordination because there is only one lane of traffic flow in each direction, and (2) a Beretania Street route would result in a longer distance to interconnect the new 46kV circuits from Archer Substation with the existing 46kV circuits near and on McCully Street. HECO T-7 at 14.

In addition, with respect to the Young Street alternative, on-street parking appears to be a premium for the numerous businesses and residents on Young Street. There are approximately 176 on-street parking spaces on Young Street between Victoria Street and McCully Street, most of which are used on any given day and time. Due to the width of Young Street, existing on-street parking on both the mauka and makai sides of the street would have to be prohibited during construction of a new ductline. This is necessary to maintain traffic flow in both directions on Young Street. Between Victoria Street and McCully Street, the installation of a new ductline on King Street would require on-street parking to be prohibited on just one side of the street. Therefore, fewer parking spaces would be impacted on King Street versus Young Street. HECO ST-7 at 7.

Further, for the majority of the project area on King Street, there are no residential apartment buildings or houses directly adjacent to the street. In areas where there are no residential buildings, there is a greater likelihood of obtaining a noise variance from the State Department of Health to construct this portion of the project at night to avoid potential traffic disruption. This opportunity is unlikely to exist for Young Street due to the numerous residential apartment buildings and houses directly adjacent to Young Street for nearly the entire project area. HECO ST-7 at 7-8.

Moreover, because King Street is already an improved street with underground utilities, whereas Young Street may be modified with the City's proposed Young Street Park Boulevard project, the coordination with the City on HECO's ductline installation or any future relocations would be easier for King Street as compared to Young Street. The width of King Street (five to six lanes) allows more flexibility to install new ductlines to avoid existing underground utility facilities. HECO ST-7 at 8.

HECO also examined routes along Young Street and Beretania Street as alternative routes for possible overhead construction of the three new 46kV circuits. However, an overhead alignment of three new 46kV circuits along either Young Street or Beretania Street is not practical for a number of reasons[35]:

(1) Like the proposed King Street route, the first one-third of a route alignment utilizing either Young Street or Beretania Street must be located underground due to State and City laws

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[35] HECO T-7 at 14-15.

(the State's Hawaii Community Development Authority Kakaako Community Development District, and the City's Thomas Square/Honolulu Academy of Arts Special Design District).

(2) Young Street is a relatively narrow road with existing 12kV overhead lines along the route. The addition of 60 to 70 foot steel poles on both sides of Young Street to accommodate three new 46kV circuits and the existing 12kV circuits give rise to engineering concerns for conflicting lines and significant visual impacts.

(3) An overhead alignment along Young Street would be subject to coordination with the City's proposed Young Street Park Boulevard Project, in which plans call for possible undergrounding of existing utilities and planting of canopy trees. (4) All existing 46kV lines along Beretania Street in the area from Pensacola Street to Alexander Street are underground. With the addition of new 60 to 70 foot steel poles on Beretania Street, public opposition to the visual impacts would likely occur which could result in costly project delay. (5) Like King Street and Kalakaua Avenue, Beretania Street is also subject to the same City ordinance (Section 14-22.1, ROH) that requires utilities to be placed underground when the specified streets are improved under certain circumstances. (6) Both Young and Beretania Streets have several large trees of unknown species that extend and overhang into the roadway at various locations between Pensacola Street and McCully Street, requiring either removal or significant initial trimming to accommodate construction.

C. UNDERGROUNDING

1. Introduction

HECO proposes to place the 46kV lines for this project underground. Moreover, as discussed below, there is no issue among the parties regarding placement of the line segments underground. H.R.S. Section 269-27.6(a), provides that:

> Notwithstanding any law to the contrary, whenever a public utility applies to the public utilities commission for approval to place, construct, erect, or otherwise build a new forty-six kilovolt or greater high-voltage electric transmission system, either above or below the surface of the ground, the public utilities commission shall determine whether the electric transmission system shall be placed, constructed, erected, or built above or below the surface of the ground; provided that in its determination, the public utilities commission shall consider:
>
> (1) Whether a benefit exists that outweighs the costs of placing the electric transmission system underground;
> (2) Whether there is a governmental public policy requiring the electric transmission system to be placed, constructed, erected or built underground and the governmental agency establishing the policy commits funds for the additional costs of undergrounding;
> (3) Whether any governmental agency or other parties are willing to pay for the additional costs of undergrounding;
> (4) The recommendation of the division of consumer advocacy of the department of commerce and consumer affairs, which shall be based on an evaluation of the factors set forth under this subsection; and
> (5) Any other relevant factors.

Subsections (b) and (c) of H.R.S. Section 269-27.6, which apply to 138kV or greater lines, do not apply to this project.

For the most part, it would not be practical or prudent to construct the proposed new 46kV circuits overhead, given State and City laws governing portions of the route, engineering considerations, the history of this project and probable opposition to overhead construction, and the pressing need to resolve the East Oahu transmission system concerns. If certain sections of the new 46kV circuits were proposed for overhead construction, the potential for significant project delays and increased costs would be great. Any potential savings in engineering and construction costs associated with an overhead line proposal could easily disappear if approvals and permits for the project were delayed. Installing the various 46kV circuits underground provides the best opportunity to meet the underlying need for this project in a timely and cost-effective manner.

The Consumer Advocate's consultant, Mr. Kiser, agreed that the proposed route for the 46kV underground line is reasonable. However, he initially recommended that HECO further investigate whether the segments for Pumehana Street and Winam Avenue should be constructed overhead, which would result in potential savings of $408,000 to ratepayers. CA-T-1 at 122-23.

HECO addressed this matter in its rebuttal testimonies and responses to rebuttal information requests. At the evidentiary hearing, Mr. Kiser acknowledged that after reviewing HECO's testimony concerning EMF and possible project delays, the Consumer Advocate's position was that it is more appropriate to pursue an all underground project at this time. Tr. (11/08) at 270 (Kiser).

2. H.R.S. Section 269-27.6(a) Requirements Are Satisfied

The requirements of H.R.S. Section 269-27.6 are satisfied by this project. The 46kV lines are being placed underground. HECO is paying 100% of the estimated cost to underground the 46kV lines. HECO is not aware of any other relevant factors in the decision to place the 46kV lines underground.

a. Phase 1

With respect to the Makaloa Substation to McCully Substation segment, there are three existing 46kV circuits between Makaloa and McCully Substations. All three of these circuits are located underground and share a single common ductline. This existing ductline follows the same route proposed for the two new 46kV circuits. It appears that the existing three 46kV circuits between these substations were originally placed underground in a single common ductline because constructing three 46kV circuits overhead would have been difficult, if not impractical, due to existing tall buildings abutting the right-of-way and narrow roadways along significant portions of the route. Once installed, the two new 46kV circuits will replace the existing three 46kV circuits, which will be cut and removed from the existing ductline. In the course of upgrading existing underground circuits, HECO generally has not proposed overhead construction for the replacement circuits, which in effect would convert existing underground circuits to overhead. A proposal to convert existing underground circuits to overhead would likely give rise to public opposition, increasing the risk of costly project delay. The ability to reuse the six existing ducts would substantially reduce the extent of construction impacts and trenching in roadways along the proposed alignment and could reduce the cost of placing the two new 46kV circuits underground. HECO T-7 at 3-5. HECO anticipates a cost savings of approximately $800,000 by using existing ducts. Tr. (11/07) at 162 (Morikami).

In addition, there are currently no other overhead electrical lines on Makaloa Street from Makaloa Substation to Kalakaua Avenue, except for a section of approximately 250 feet of overhead 12kV lines on Makaloa Street. These overhead 12kV lines sit atop 50-foot wood poles between Kalauokalani Way and Kalakaua Avenue. If an overhead installation were proposed, the two new 46kV circuits would likely be installed on new steel poles ranging in height from 60 to 80 feet. Public opposition to the visual impacts of such an overhead line is anticipated given the history of this project, which could result in significant project delays and increased costs. HECO T-7 at 5-6; HECO-701.

Further, overhead connections into both Makaloa and McCully Substations are not technically feasible due to space constraints and existing infrastructure limitations. HECO T-7 at 5-6; HECO-701.

Moreover, an overhead alignment on Kalakaua Avenue may be subject to a City

Ordinance (Section 14-22.1, ROH) that requires public utility companies to place their utility lines and related facilities underground whenever the following streets are improved under certain circumstances: King Street, Beretania Street, Kapiolani Boulevard, Kalakaua Avenue, Ward Avenue, and Keeaumoku Street. For planning purposes, it is recognized that the City may attempt to enforce this ordinance in the future, although it is uncertain when the City may request that overhead lines on Kalakaua Avenue be placed underground, and questions remain whether the City has the requisite authority to require such undergrounding. However, by placing the circuits on Kalakaua Avenue underground during initial construction, HECO would be able to avoid: (1) future congestion and competition for underground construction space which, based on past experience, drive up costs; (2) additional future construction-related impacts from undergrounding the same project within the same alignment; and (3) removal of critical circuits from service for lengths of time during future underground construction of the same circuits. HECO T-7 at 6; HECO-701.

With the exception of certain limited sections of the proposed route alignment that must be placed underground due to engineering reasons, the approximate engineering and construction cost to otherwise install the two new 46kV circuits overhead between Makaloa and McCully Substations was estimated to be $1.9 million. At the time HECO filed its direct testimonies, the approximate engineering and construction cost to install the same two circuits all-underground as proposed was estimated to be $3.4 million. (As discussed in HECO's supplemental direct testimonies, HECO determined that it could use existing ductlines, rather than having to construct new ductlines, for a portion of Phase 1, which would decrease the engineering and construction cost to install the circuits in an underground alignment.) However, notwithstanding the higher engineering and construction costs, it is not practical or prudent to construct these two proposed 46kV circuits overhead given the factors discussed above. Among the considerations, public opposition would be increased by an overhead proposal given the history of this project, which could inhibit meeting the electrical system needs in a timely manner and increase costs significantly. HECO T-7 at 7; HECO-701.

For the Kamoku substation to Date Street segment, it would be impractical to bring the 46kV circuits out of the Kamoku Substation in an overhead alignment, as the Kamoku Substation is an enclosed substation. HECO T-7 at 7; HECO-701.

HECO proposes to install the Pumehana Street to Date Street and Winam Avenue to Mooheau Avenue segments underground as well. For the Pumehana Street segment, the engineering and construction cost estimate to install this segment overhead is approximately $159,000; to install it underground is approximately $478,000. The cost differential was estimated to be approximately $319,000. For the Winam/Mooheau Avenue segment, the engineering and construction cost estimate to install this segment overhead was approximately $112,000; to install it underground was approximately $370,000. The cost differential was estimated to be approximately $258,000. Tr. (11/07) at 169 (Morikami).

HECO proposes to install the Pumehana Street to Date Street and Winam Avenue to Mooheau Avenue segments underground given that the other 46kV lines installed as part of the project are being placed underground, the relatively small incremental engineering and construction cost of placing these two segments underground in comparison to the total cost of the project, and the adverse impact if the schedule for Phase 1 is delayed. The cost savings from constructing these two line segments overhead could easily disappear if the approvals and permits for the project were delayed due to public opposition to the overhead alignment. The combined Koolau and Pukele service areas comprise 30% of Oahu's electrical demand, and an all-underground proposal should reduce project opposition and provide a better opportunity to improve system reliability in a timely manner. HECO T-7 at 9-10; HECO-701.

b. **Phase 2**

Phase 2 was proposed in an underground alignment for a number of reasons. First, State and City laws (the State's Hawaii Community Development Authority Kakaako Community Development District, and the City's Thomas Square/Honolulu Academy of Arts Special Design District) require the placement of new lines underground along Cooke Street and King Street between Archer Substation and Pensacola Street, approximately one-third of the entire length of these circuits. HECO T-7 at 11.

Second, there are currently no overhead electrical lines running along King Street from Cooke Street to McCully Street. The possibility of obtaining approvals in a timely manner to install three new overhead 46kV lines on King Street appears to be remote, given that lines on King Street were previously placed underground. If an overhead installation were considered on King Street (beginning from Pensacola Street to McCully Street), two of the proposed new 46kV circuits would likely be installed on new 60 to 70 foot steel poles located on one side of King Street. The third new 46kV line would likely be installed on smaller wood poles on the other side of King Street. Based on past experience of this project, public opposition to the visual impacts of such an overhead route alignment is anticipated, which could result in significant delays to project approval and permitting. Such delays would not only increase project costs, but would further inhibit HECO's ability to install needed infrastructure in a timely manner to maintain the reliability of the electrical system in the East Oahu area. HECO T-7 at 11-12.

Third, like the section of the Phase 1 route alignment on Kalakaua Avenue, an overhead alignment on King Street may be subject to a City Ordinance (Section 14-22.1, ROH) that requires public utility companies to place their utility lines and related facilities underground whenever certain streets, including King Street, are improved under certain circumstances. Portions of King Street (e.g., from Cooke Street to McCully Street) were improved years ago (e.g., public right-of-way improved, including placing overhead lines underground). Such improvements may have been done at the City's initiative under the improvement district ordinances in which both public and private funds are spent for improvements of the public right-of-way, including utility funds for the placement of overhead lines underground. With significant investment already made over the years to improve this portion of King Street, a proposal to add three new 46kV overhead lines would likely result in opposition from both the public and City government. By proposing to place the new circuits on King Street underground during initial construction, HECO would be able to avoid: (1) future congestion and competition for underground construction space which, based on past experience, drive up costs; (2) additional future construction-related impacts from undergrounding the same project within the same alignment; and (3) removal of critical circuits from service for lengths of time during future underground construction of the same circuits. HECO T-7 at 12-13.

As noted above, approximately one-third of the proposed route alignment along Cooke and King Streets must be placed underground due to State and City laws. At the time HECO's direct testimonies were filed, the approximate engineering and construction cost to install the remainder of the three new 46kV circuits overhead along King Street from Pensacola Street to McCully Street was estimated to be $5.2 million. At the time HECO's direct testimonies were filed, the approximate engineering and construction cost to install the same three circuits all-underground as proposed was estimated to be $8.6 million. However, notwithstanding the higher engineering and construction costs, it is not practical or prudent to construct these three proposed

46kV circuits overhead given the factors discussed above. Among other considerations, public opposition would be increased by an overhead proposal given the history of this project, which could seriously inhibit meeting the electrical system needs in a timely manner and increase costs significantly. HECO T-7 at 13.

VI. PUBLIC SENTIMENT AND PROJECT IMPACTS

A. PUBLIC INPUT

1. Background

As is detailed in the "need" section of this brief (Part IV), a project to address the East Oahu transmission problems was first initiated as a result of a study conducted in July 1991. The study identified the four transmission problems that are being addressed by the proposed project: (1) the Koolau/Pukele Overload Situation, (2) the Downtown Overload Situation, (3) the Pukele Substation Reliability Concern, and (4) the Downtown Substation Reliability Concern. HECO T-4 at 5.

A routing study was completed and a public scoping and input process was initiated. A key element of this process was the formation of a Community Advisory Committee, or "CAC," made up of representatives from various neighborhoods. After evaluating numerous alternatives through technical studies and an extensive public input process, the partial underground/partial overhead, Kamoku-Pukele 138kV Transmission Line was selected as the preferred alternative to address the problems.

A Conservation District Use Permit or "CDUP" application process for the overhead portion of the alternative was then initiated. Planning studies were updated and an extensive environmental impact statement (EIS") process ensued. Tr. (11/07) at 21-22 (Wong); HECO T-2 at 18-28; HECO T-4 at 6. After two environmental impact statements and a contested case hearing before the Board of Land and Natural Resources ("BLNR"), the BLNR denied the permit for the overhead section of the project in 2002. This essentially eliminated the only practical overhead 138kV transmission line alternative to pursue for the project. HECO T-1 at 11; Tr. (11/07) at 22 (Wong); HECO T-2 at 28-30.

As a result of the 2002 decision, a HECO Executive Team was formed and the team requested an update of various studies and reports. The Executive Team directed the project engineers to identify new alternatives and to revisit past alternatives considered during the EIS process. Three alternatives ultimately were identified for further consideration and were carried forward into a public input process: (1) the Kamoku-Pukele 138kV Underground Alternative, (2) the Kamoku 46kV Underground Alternative, and (3) the Kamoku 46kV Underground Alternative – Expanded.

2. Public Input Process

Although not required by statute, HECO developed a public input process for the three alternatives considered for the 46kV Phased Project.[36] HECO T-12 at 1; Tr. (11/07) at 226 (Alm); HECO T-1 at 7.

The Executive Team realized that continuing to obtain public input would be essential in moving the project forward. An apparent lack of transparency in HECO's decision-making process appeared to be a significant criticism of the earlier process of selecting the Waahila Ridge alternative. HECO realized after the CDUP decision that it needed to be more transparent in its planning process and, therefore, to invite more public input to help HECO in selecting the

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[36] Under H.R.S. §269-27.6, whenever a public utility applies to the Commission for approval to construct a new 46 kV or greater electric transmission system, the Commission shall determine whether the electric transmission system should be constructed above or below the surface of the ground, after considering several factors. In making the determination for new 138kV or greater high-voltage transmission systems, the Commission must consider additional factors including the breadth and depth of public sentiment with respect to an above ground versus underground system. Based on the proposed project, 138 kV transmission lines will not be involved, thus the Commission is not required by that specific statute to consider the breadth and depth of public sentiment. HECO T-12 at 1; HECO T-1 at 7-8.

alternative that would be presented to the Commission. HECO T-12 at 2; Tr. (11/07) at 226 (Alm).

Thus, after HECO identified three alternatives to address the continuing East Oahu transmission concerns, HECO voluntarily created a process for gathering public comment for its new proposed alternatives before one of the alternatives was selected. HECO's public input process was designed to obtain public input from the general public as well as from the communities more directly impacted by construction of the proposed new facilities and benefited by the improvement to electric service reliability that such facilities would bring. To obtain input from the more directly impacted communities, HECO reinstituted the CAC that had been established in 1993 during the Kamoku-Pukele 138kV transmission line routing study, and expanded the CAC to include (1) all of the neighborhood boards in the Pukele service area in order to represent the residents, (2) a set of well-known commercial groups to represent the businesses in the Pukele service area, and (3) the University of Hawaii, which has two large facilities (the Manoa campus and the Kapiolani Community College campus) in the Pukele service area. In addition, HECO invited the three groups (Life of the Land, Malama O Manoa, and the Outdoor Circle) which had formally intervened in the proceeding concerning HECO's CDUP application. After the process began, two groups from Palolo (Palolo Community Council and Ho'o Laulima O Palolo) wanted to join the CAC and were subsequently added. HECO T-12 at 2-3; Tr. (11/07) at 227 (Alm).

HECO conducted four public meetings (including meetings in the Leeward/Central, Honolulu and Windward communities) and two CAC meetings to gather input from the community. HECO engaged two well-known and respected professional facilitators to assist HECO in designing the public process and facilitating the public meetings. HECO also engaged

3Point Consulting ("3Point") to design a survey instrument to capture input on the alternatives presented at the meetings and to write a report documenting the public process and summarizing public comments. Exhibit 11 to the Application; HECO T-12 at 3-5; Tr. (11/07) at 227 (Alm).

The public meetings entailed a presentation on HECO's three proposed alternatives, including a description of the reliability concerns, the physical route for the three alternatives, and the project costs, rate impacts, construction and other impacts of each alternative. HECO also responded to questions that were raised by the public and participants. The public's comments are summarized in 3Point's report. Exhibit 11 to the Application; HECO T-12 at 4; Tr. (11/07) at 227 (Alm).

3Point's report provides a detailed account and description of the most common themes expressed regarding HECO's process. In summary, HECO learned:

- The issue of the need for the project remains the subject of much skepticism and disagreement.

- The opposition to a 138kV transmission line was strenuous and the opposition will seek out every legal option to defeat or delay the process.

- The community in Palolo feels that they are already carrying a significant infrastructure burden for the rest of the island and is very resistant to any option involving their neighborhood.

- Reliability is a very big issue, especially for Waikiki. Outage tolerances are very low for the business community, however cost is also a concern.

- Concerns were raised about the construction impact of the alternatives and the electric and magnetic fields ("EMF").

Exhibit 11 to the Application; HECO T-12 at 6; Tr. (11/07) at 228 (Alm).

The public sentiment was considered in the evaluation of alternatives and the selection of the proposed 46kV Phased Project. HECO considered the significant time that would be required to pursue the 138kV transmission line alternative, the impact on the Palolo community, and the strong concern about reliability expressed by the business community. HECO T-12 at 6-7; Tr. (11/07) at 228 (Alm); HECO T-1 at 15.

HECO informed the public of its selected alternative prior to filing its Application. On October 8, 2003, HECO issued a press release indicating that it had selected the Kamoku 46 kV Underground Alternative-Expanded (the 46kV Phased Project), which would be built in two phases. HECO-1201; HECO T-12 at 7.

HECO received comments regarding the alternative selected. There continued to be public interest regarding the need for the project, and concerns regarding project alternatives, community impacts, route selection and other impacts. Requests were made for HECO to conduct an Environmental Assessment ("EA") for the project following the McCully/Moilili neighborhood meeting. Based on the continued substantial public interest regarding this project, and its unique history, HECO voluntarily decided to conduct an EA. HECO T-12 at 7; Tr. (11/07) at 229 (Alm): HECO T-1 at 4-5.

B. ENVIRONMENTAL ASSESSMENT PROCESS

In its application, HECO requested that the Commission be the accepting agency for an EA of the proposed project voluntarily prepared by HECO and submitted to the Commission in accordance with H.R.S. Chapter 343. HECO stated in its Application that based on its "past experience with permitting and construction of other underground subtransmission or distribution lines rated 46kV and below within existing roadways, which HECO has the right to use under its franchise, the preliminary schedules for the two 46kV alternatives . . . assumed that an EA would not be required by a permitting agency." Application at 46. However, HECO decided to voluntarily conduct an EA to address public concerns related to project alternatives, community impacts and project need, and requests for HECO to conduct an EA, all of which were raised during HECO's community meetings.

In Order No. 20968 (May 10, 2004), the Commission acknowledged that there was significant public interest in and concern over the proposed project. The Commission found that it was in the public interest for the Commission to act as the accepting authority under H.A.R. § 11-200-4(b) for the voluntarily prepared EA, without deciding that the proposed project required an EA under Chapter 343. The Commission provided, however, that if it was determined that another agency or agencies also had jurisdiction over the proposed project, responsibility for such compliance would be determined under H.A.R. § 11-200-4(b). The Commission required that HECO file with the Commission by May 17, 2004, a listing detailing the following information: (1) all the various permits and approvals necessary to complete the proposed project; (2) the agencies to which HECO must apply for such permits and approvals; and (3) the timing of such applications for permits and approvals. HECO filed this listing with the Commission on May 17, 2004.

HECO provided the Draft EA to the Commission on August 12, 2004. The Commission issued an anticipated Finding of No Significant Impact determination on September 2, 2004. Notice of the availability of the Draft EA for public comment was published in the September 8, 2004 edition of OEQC's "The Environmental Notice." The public comment deadline expired on October 8, 2004.

HECO provided the Final EA ("FEA") to the Commission on January 7, 2005. The FEA evaluated impacts to land use, infrastructure, roads and traffic, public health and safety, soils and topography, water resources, air quality, cultural resources, visual and aesthetic resources, biological resources, and the socioeconomic environment. It also evaluated electric and magnetic fields associated with the 46kV Phased Project. No substantial direct, secondary, or cumulative impacts were identified in the FEA.

The Commission issued a FONSI on April 8, 2005. Notice of the FEA and FONSI was published in the April 23, 2005 edition of OEQC's "The Environmental Notice."

C. CONSTRUCTION

1. Mitigating Construction Impacts

A comprehensive construction work plan for the proposed project was provided in HECO-804, and the use of existing ductlines in Phase 1 was addressed in HECO ST-8. HECO's Final EA provided a detailed discussion of construction activities planned for the proposed 46kV Phased Project. Final EA (Vol. 1), Sections 3.1.1 and 3.1.2. No issue regarding these construction activities has been raised by the testimonies submitted by the other parties.

HECO recognized that, in most instances, the trenching work for the underground line segments will take place in a congested urban environment. Accordingly, a number of critical planning elements were considered in developing the construction schedules, including traffic control, noise mitigation, dust control, access to businesses and homes, and community relations. HECO T-8 at 2-3.

HECO and its project management consultant, Tom Harrington, have extensive experience in conducting trenching projects, and HECO has developed plans to address impacts of the construction activities on traffic, noise, dust, and access to businesses and homes. In addition, HECO has developed a plan to respond to concerns raised by the community regarding the impacts of the construction activities. HECO T-8 at 1-2, 7; Tr. (11/07) at 172-73 (Harrington).

Mitigation of construction impacts was considered in estimating the time to complete the construction work for the proposed 46kV Phased Project. As with all construction projects, HECO's planning and the corresponding construction management effort took into consideration factors such as impacts with respect to traffic, noise, possible dust, and access to businesses and residents. With respect to generally mitigating the construction impacts, for Phase 1, by using the proposed route and existing ductlines, HECO will not have to trench for approximately 70% of the route between the Makaloa and McCully substations. HECO T-8 at 7; Tr. (11/07) at 173 (Harrington). This should significantly reduce the impact of construction activities.

a. <u>Traffic Impacts</u>

HECO mitigates traffic impacts in several ways. All work zones and sequencing[37] will be in accordance with traffic control plans approved by the City & County of Honolulu. HECO T-8 at 7-8; Tr. (11/07) at 173-74 (Harrington).

In addition, all traffic control plans include various mitigation measures, such as scheduling and use of contraflow lanes and detours. HECO T-8 at 7-8; Tr. 173-74 (Harrington). Scheduling means that work will be scheduled to avoid rush hour drive time, and night shifts will be utilized where permitted. HECO T-8 at 7-8; Tr. (11/07) at 174 (Harrington).

Contraflow lanes will be established to facilitate thru-traffic when construction work is being performed. On the narrower streets, such as Winam Avenue, detours may be placed to direct traffic around the work by another route if the use of the contraflow lanes becomes ineffective. However, local access will be provided continuously. HECO T-8 at 7-8; Tr. (11/07) at 174 (Harrington).

b. <u>Noise Impacts</u>

HECO does not anticipate that construction noise will be an issue, as it has seldom been a source of complaints on similar projects. Mr. Harrington testified that, in hundreds of projects

[37] Sequencing refers to how the work is arranged both in lengths of sections and when the sections are placed on the construction schedule. Tr. (11/07) at 173-74 (Harrington).

over thirteen years with HECO, he has never received a noise complaint related to daytime work. Tr. (11/07) at 174-75 (Harrington).

HECO has several measures designed to mitigate noise impacts. HECO will mitigate noise impacts by complying with the noise permit and noise variance permit for the construction activities. For day work, which is assumed for a majority of the ductline construction work for Phase 1, HECO plans to obtain a Noise Permit from the Department of Health. HECO T-8 at 8; Tr. (11/07) at 174-75 (Harrington).

For night work, which is assumed for a majority of the ductline construction and cable installation work on Phase 2 and a majority of cable installation work on Phase 1, HECO plans to obtain a Noise Variance Permit from the Department of Health. This permit provides guidelines regarding acceptable noise levels for work at night. HECO T-8 at 8; Tr. (11/07) at 175 (Harrington).

In addition to the permit requirements, HECO will direct the contractor to take additional actions to suppress the noise. These actions typically include disconnecting backup alarms on vehicles, adding noise attenuating mufflers, and strictly enforcing speed limits for all haul-off and redi-mix trucks, and scheduling noisier work (e.g. pavement saw cutting and excavation) for earlier hours. HECO will also continuously monitor activities to ensure compliance with the Noise Variance Permit. HECO T-8 at 8; Tr. (11/07) at 175 (Harrington).

c. <u>Dust Impacts</u>

HECO does not anticipate that dust from construction activities will be an issue as it seldom has been on similar projects. All construction will be performed and staged from paved surfaces. In addition, there will be no excavated soil stored on site. The excavated material will be removed immediately from the site. Further, backfill will be accomplished using a cemented flowable fill, which is transported in and placed with redi-mix trucks. HECO T-8 at 8-9; Tr. (11/07) at 176 (Harrington).

d. Access

HECO has pro-active measures designed to allow access to businesses and residents along the construction route. Access to all businesses along the construction work zones will be maintained continuously throughout the entire construction project. This will be accomplished with various methods, such as scheduling the work during off-hours, segmenting the trenching, bridging the trench with steel plates during active work hours, installing additional advisory signs, and assigning additional Special Duty police officers to direct and assist motorists with access to the business. All businesses will be contacted prior to start of construction to seek input regarding their expectations and traffic requirements. HECO T-8 at 9; Tr. (11/07) at 176 (Harrington).

Access to residential properties will be maintained much the same as with the businesses. However, there will be situations where the closure of the driveway may be required. In this situation, the work will be scheduled to accommodate the resident, such as scheduling the construction activities while the person is at work. All residents along the construction work zones will be contacted prior to ductline construction to discuss the schedule and HECO will seek to determine if there are any special-need situations, most notably any medical conditions which require additional provisions to assure access. HECO T-8 at 9; Tr. (11/07) at 177 (Harrington).

e. Providing Construction Information To The Affected Neighborhoods

HECO plans to keep the community informed of the construction activities. All businesses and residential customers along the route will be contacted prior to start of the initial construction work in their area. This contact will include letters, followed up with a door to door contact along the route, and a distribution of informational flyers in neighborhood. In addition, HECO's construction manager will attend all Neighborhood Board meetings for the duration of the project to provide updates and/or responses to any question or complaints by the community. As in past projects, HECO's construction manager will maintain an ongoing dialogue with one or several of the board members. HECO T-8 at 9-10; Tr. (11/07) at 177-78 (Harrington).

In addition, a 24/7 project hotline number will be established. It will be dedicated to the project, and the number and contact information will be published widely and frequently. All calls will be given immediate attention and responded to as soon as possible. HECO T-8 at 9-10; Tr. (11/07) at 177-78 (Harrington).

2. Coordination With Other Construction Projects

During HECO's environmental assessment process, there was a suggestion that HECO coordinate its 46kV ductline project with the Board of Water Supply's water project on Kapiolani Boulevard. HECO's understanding was that the Board of Water Supply and the City were planning to start construction of their projects in February 2006. Based on HECO's latest schedule for Phase 1, HECO plans to start construction during the latter part of 2006, so scheduling the projects concurrently did not appear viable. However, even if there was a possibility to construct the projects concurrently, there are a number of technical constraints to using Kapiolani Boulevard (see Part III.B3 of this brief), as well as higher costs and additional challenges in mitigating traffic impacts. HECO RT-7 at 1-3; HECO ST-601; Tr. (11/07) at 166 (Morikami).

For example, costs would be higher and traffic would be worse, because HECO's electrical line and the other utility lines have minimum separation distances requirements and minimum depth and cover requirements, which must be satisfied for operational and maintenance needs. Having new water, sewer and electrical lines installed in the same trench would result in higher costs for everyone due to an increase of excavated and backfilled material that must be used to comply with the requirements. Having to use wider and possibly deeper trenches in order to accommodate the lines would impact traffic due to more lane closures and extended work duration for each section of the project. HECO ST-7 at 4-5; HECO-ST-701; Tr. 167 (Morikami).

3. <u>Horizontal Directional Drilling</u>

At the request of the City's Facility Maintenance Department, horizontal directional drilling ("HDD") was considered as an optional installation method for installing three 46kV circuits in King Street from Cooke Street to McCully Street as part of Phase 2 of the 46kV Phased Project. HECO retained Power Engineers to prepare a report, "The Hawaiian Electric Company, Inc., East Oahu Transmission Project Phase 2–46kV Lines, Horizontal Drilling Feasibility Study", which evaluated the feasibility of installing three 46kV circuits in King Street from Cooke Street to McCully Street using HDD technology. HECO ST-8 at 5; FEA, vol. 1 at 3-30; FEA, vol. 2 at Appendix A.

HDD is a construction method that uses a drill rig to install underground pipes or casings. Drilling would follow a pre-planned underground profile, which would be designed to avoid conflicts with existing utilities and known sensitive areas below the ground surface. Therefore, drilling profiles would typically be designed to be deep enough to avoid any known potential conflicts. When HDD is used, trenching is typically limited to areas where the drill enters and exits the ground and areas of a project where drilling is not feasible. Heavy equipment is required at both the entry and exit pits located at each end of the drilling bore, and this equipment must generally remain in position while the installation progresses to completion. HECO ST-8 at 4; FEA, vol. 1 at 3-30 and 3-31.

The HDD alternative offers no significant advantages over conventional trenching for Phase 2. Cable ampacity impacts, workspace limitations, and traffic disturbances are significant constraints in utilizing HDD on King Street. Furthermore, uncertainty in securing needed permits and approvals for allowing the equipment and the pipe assembly to remain on the roadway around the clock until the drilling and pulling operations are complete for a given segment did not support further consideration of this alternative. FEA (Vol. 1) at 3-34.

D. EMF

The projected magnetic field levels related to the 46kV Phased Project are within the range of magnetic field levels found at numerous locations in the local environment.[38] Descriptions of these magnetic fields, and HECO's prudent avoidance measures to mitigate these fields, are summarized in Exhibit "E" to this brief. Exhibit "E" also summarizes the extensive record provided in this proceeding with respect to EMF research regarding magnetic field exposures and human health. A brief summary, without record citations, is included in the following subsections of the brief.

1. Magnetic Field Evaluation for the 46kV Phased Project

HECO retained Enertech Consultants of Santa Clara, Inc. ("Enertech") to perform a magnetic field evaluation for the 46kV Phased Project. J. Michael Silva is the President of Enertech and is a research engineer specializing in assessing exposure to extremely low frequency electric and magnetic fields.[39]

[38] Electric fields from power lines are generally well below levels that would cause harmful effects, and must be low in order to meet electrical safety standards.

[39] A discussion of Mr. Silva's education and experience is included in Exhibit "E" to this brief.

Enertech's Magnetic Field Evaluation, dated July 22, 2004 ("Magnetic Field Evaluation"), examined present and future levels of magnetic fields at various locations associated with the proposed project, and measured and calculated magnetic fields for existing and proposed electrical facilities. The evaluation concluded that existing magnetic field levels from HECO facilities are typical of levels from similar facilities throughout the State of Hawaii.

Enertech also calculated magnetic field levels for 2009 forecasted normal and Pukele outage conditions for each of the eleven project segments. The difference in projected magnetic field levels between the existing and proposed power line configurations under 2009 forecasted loading can decrease slightly, remain unchanged, or increase depending upon the project segment. For Enertech's Segment 'I' (where no 46kV power lines presently exist), the projected magnetic field generally remains unchanged since the proposed underground 46kV power lines would only be utilized under Pukele outage conditions. For Segment 'E' (east of Kamoku Substation where modifications to an existing overhead 46kV power line are proposed), the range of projected magnetic field levels decreases slightly since the 2009 forecasted load is somewhat lower for the proposed configuration than for the existing configuration. At all other segment locations, the projected magnetic field increases due to the proposed power line configuration under 2009 forecasted loading conditions. While the largest magnetic field increases typically occur within street locations, projected magnetic field levels can also increase at sidewalk locations. Under proposed 2009 Pukele outage conditions, the projected magnetic field increases at all segment locations.

In addition, Enertech's Magnetic Field Evaluation examined present and future magnetic field levels at various institutions along the proposed project. Six different institutions are located within 100 feet of the 46kV Phased Project. Based on an evaluation of the projected magnetic fields for 2009 loading conditions, four of these institutions would have no projected magnetic field under normal operating conditions, since the underground power lines along this segment will only be loaded during Pukele outage conditions (and even then the projected field at the closest building edge is less than 1 mG). For the Kaplan Test Preparation Center, projected 2009 magnetic field levels of 0.0 mG with the existing power line configuration would increase to about 1.1 mG with the proposed configuration under normal loading. For the Lunalilo Elementary School, projected 2009 magnetic fields of about 4.0 mG with the existing power line configuration would decrease to about 3.3 mG with the proposed configuration under normal loading (due to some field cancellation).

There is a wide variety of EMF levels and sources encountered in everyday life that are comparable to EMF due to electric power facilities. EMF is created whenever electricity is present. Examples include household wiring, electric transmission and distribution facilities, lighting, appliances, transportation, amusement park rides, video arcades, office or industrial equipment, and even some toys.

To illustrate this, magnetic field measurements of everyday environments were performed by Enertech at ten different locations in Honolulu. Measured magnetic fields ranged from 0.1 mG to over 99 mG. The sources for many of these magnetic field were common appliances and electrical devices, such as refrigeration units in supermarkets, electric stoves in food preparation areas, library security gates, escalators, vending machines, display counters, video games, cash registers, and ATM machines.

2. **Prudent Avoidance**

HECO follows a policy of "Prudent Avoidance" in its transmission facility planning and has applied prudent avoidance in planning for the 46kV Phased Project. HECO's prudent avoidance approach is consistent with the Hawaii Department of Health and the Commission's prudent avoidance approach.

a. Prudent Avoidance in Hawaii

On January 19, 1994, the Hawaii State Department of Health ("DOH") issued a statement entitled "DOH Policy Relating to Electric and Magnetic Fields from Power-Frequency Sources." This statement replaces an earlier one issued on April 3, 1991. The 1994 statement reads as follows:

> The Department of Health, in response to continuing but inconclusive scientific investigation concerning EMF from low-frequency power sources, recommends a "prudent avoidance" policy. "Prudent avoidance" means that reasonable, practical, simple, and relatively inexpensive actions should be considered to reduce exposure.
>
> A cautious approach is suggested at this time concerning exposure to EMF around low-frequency sources, such as electric appliances and power lines. The existing research data on possible adverse health effects, including cancer, are inconclusive and not adequate to establish or quantify a health risk. For example, the biological mechanisms that might underlie any apparent relationship between EMF and cancer have yet to be clearly defined. Also, some epidemiological studies suggest that, if these fields increase the risk of cancer, it is a very small increase. Other epidemiological studies suggest that there is no increased risk.
>
> The Department of Health will continue to collect and evaluate information on possible health hazards associated with electric and magnetic fields. If adequate data ever become available to establish what levels may be harmful, appropriate standards will be established.

A definition of prudent avoidance (which was put forth by the U.S. Environmental Protection Agency) was adopted by the Commission in its Decision and Order No. 13201, issued April 7, 1994, in Docket No. 7256 as follows:

> Prudent avoidance is an approach to making decisions about risks. This decision-making process is based on judgment and values, can be applied to groups and individuals, and can be considered for all aspects of our lives, not just EMFs. Prudent avoidance applied to EMFs suggests adopting measures to avoid EMF exposures when it is reasonable, practical, relatively inexpensive and simple to do so. This position or

> course of action can be taken even if the risks are uncertain and even if safety issues are unresolved. D&O 13201 (p. 35)

The Commission subsequently reaffirmed its adoption of this definition of "prudent avoidance" to EMF in both its Decision and Order No. 13517 (August 29, 1994) ("D&O 13517") in Docket No. 94-0043 and Decision and Order No. 15037 (September 27, 1996) ("D&O 15037") in Docket No. 96-0016. Both of these decisions state,

> In Decision and Order No. 13201, Docket No. 7256 (1994), we concluded that a causal link between EMF and adverse health effects has yet to be established by the scientific community. We acknowledged that a few studies appear to have established an association between EMF exposure and the occurrence of certain cancers. However, we found that the results of these studies have yet to be accepted by the scientific community as proof that exposure to EMF causes cancer or other disease. Nevertheless, we expressed our expectation that a utility will exercise prudent avoidance with respect to EMF. We adopted the United States Environmental Protection Agency's definition of prudent avoidance as set forth in their Questions and Answers about Electric and Magnetic Fields (EMF), 402-R-92-009 (1992). As defined there, prudent avoidance applied to EMFs means adopting measures to avoid EMF exposures "when it is reasonable, practical, relatively inexpensive and simple to do."

(See D&O 13517 at 9; D&O 150037 at 10.) The Hawaii Supreme Court has approved the Commission's adoption and application of the "prudent avoidance" policy and has acknowledged the Commission's recognition that the "health effects of EMF are uncertain." In re Hawaiian Electric Company, Inc., 81 Haw. 459, 918 P.2d 561 (1996).

Since the Commission's D&O 13517 was issued in 1994, there have been several additional large epidemiological studies and the National Institute of Environmental Health Sciences ("NIEHS") laboratory research confirming that cancer is not increased in laboratory animals exposed long-term to EMF.

b. The 46kV Phased Project

EMF mitigation, or reduction in EMF levels, can be achieved for multiple circuit power lines with similar loads by optimizing the cable placement and phasing arrangement within the cable ducts. Enertech studied cable placement and phasing arrangement for the multiple circuit 46kV underground lines for optimum reduction of EMF levels. The results of Enertech's EMF calculations for optimum circuit and phasing arrangements for multiple circuit 46kV cables shows that use of optimum phase placement in the cable ducts can reduce EMF levels by a maximum amount of about 87% when all circuits have identical loads.

HECO has applied prudent avoidance in its engineering design for ductlines with multiple circuits by optimizing the cable placement and phasing arrangement within the cable ducts. Reduction of EMF levels has been achieved in the engineering design for these new ductlines by utilizing horizontal ductbanks with reversed phasing in the two following locations: (1) the segment of Phase 1 of the 46kV Phased Project between Poni Street and McCully Substation; and (2) the segment of Phase 2 on King Street between Cooke Street and McCully Times Supermarket.

HECO has also implemented prudent avoidance in the route planning for the 46kV Phased Project. EMF levels from power lines drop off rapidly with distance, meaning that reduction of EMF levels might be achieved by locating the lines closer to the middle of the roadways to reduce EMF levels at the near edge of the roadways. Along King Street, between Cooke Street and McCully Times Supermarket, the power line will be located away from the makai curb. Along all other project segments, the power lines cannot be located near the center of the street due to constraints imposed by existing utilities.

3. <u>EMF Research</u>

The NIEHS EMF-RAPID program has concluded that the probability that EMF is a health hazard is relatively small and the evidence is insufficient to warrant aggressive regulatory actions.

In 1999, the National Academy of Sciences National Research Center ("NRC") stated,

> The results of the EMF-RAPID program do not support the contention that the use of electricity poses a major unrecognized public-health danger.... In view of the negative outcomes of the EMF-RAPID replication studies, it now appears even less likely that MFs [Magnetic Fields] in the normal domestic or occupational environment produce important health effects, including cancer. [NRC, 1999, pp.78 and 8]

The U.S. EPA has stated that neither the EPA nor any other federal regulatory agency has established a standard for EMF because the scientific evidence is inadequate to determine if magnetic fields are harmful, and if they are, at what levels. U.S. EPA, 1992, Questions and Answers About Electric and Magnetic Fields (EMF).

4. <u>EMF Exposure and Human Health</u>

Dr. Linda Erdreich[40] testified that, in her expert opinion, EMF exposures at typical environmental levels are not harmful to people, whether they are exposed from transmission lines, other power line sources, or other sources in homes. Based on Dr. Erdreich's review of the magnetic field levels expected to occur with the proposed project, the EMF levels expected to occur with the proposed line will not have an unreasonable adverse effect on public health, safety, and welfare. Dr. Erdreich also testified that the weight of the evidence does not support a conclusion that exposure to EMF at the levels associated with the proposed project would have adverse effects on human health, compromise normal function, or cause cancer.

Dr. Stuart Aaronson[41] testified that there has been an extensive assessment of the question whether exposure to power frequency electric and magnetic frequency fields could be associated with an increased risk of cancer. From his review of this literature, including the

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40 Dr. Erdreich is a Ph.D. in epidemiology with 25 years of experience in conducting and evaluating scientific research to identify factors that affect human health. A discussion of Dr. Erdreich's education and experience is included in Exhibit "E" to this brief.

41 Dr. Aaronson is Professor and Chairman of the Department of Oncological Sciences at Mount Sinai School of Medicine in New York. A discussion of Dr. Aaronson's education and experience is included in Exhibit "E" of this brief.

reports of nationally constituted scientific review groups, he concludes that there is no convincing or consistent evidence that power lines pose a cancer risk. He noted that:

(1) The results of animal experiments are overwhelmingly negative. As a whole, they provide no consistent or convincing evidence of any relationship between EMF and cancer, including brain cancer, breast cancer and leukemia.

(2) There is a massive amount of literature regarding controlled exposures of normal cells to EMF. These assays are overwhelmingly negative. Of the few studies that do report evidence for genotoxicity, most contain a mixture of positive and negative results, or ambiguous results, and none of them have been replicated. They provide no basis for concluding that power frequency EMF is genotoxic.

(3) There have been a great many laboratory experiments aimed at assessing possible biologic effects of power frequency fields that might conceivably cause them to act as cancer promoters or to enhance the effectiveness of genotoxic agents. The cell studies have produced no consistent or convincing evidence that power frequency electric or magnetic fields promote the development of cancer.

(4) Numerous laboratory studies have examined the relationship of exposure to magnetic fields and the initiation or promotion of leukemia. Near life long exposure to magnetic fields does not increase the risk of leukemia or lymphoma in animals.

VII. CONCLUSION

Based on the foregoing and the entire record herein, HECO respectfully requests Commission approval to commit funds in excess of $500,000 (currently estimated at $55,644,000) for the EOTP, in accordance with the provisions of Paragraph 2.3(g)(2) of General Order No. 7.

HECO proposes to place the 46kV lines underground that are being installed as part of this project. Pursuant to Section 269-27.6 (a) of the H.R.S., HECO respectfully requests that the Commission determine that the 46 kV lines shall be built "below the surface of the ground . . . ."

DATED: Honolulu, Hawaii, February 13, 2006.

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EXHIBIT "A"

PROJECT DESCRIPTION, SCHEDULE AND COST

I. PROJECT DESCRIPTION

A. Phase 1

Phase 1, 46kV Underground Lines

This item involves the installation of six new underground 46kV circuits. In addition, this item involves changing sources and reconnecting existing 12kV circuits in and around the Makaloa and McCully substations and their respective service areas. This would allow the removal of the existing 46kV underground circuits from the existing ductline between the Makaloa and McCully substations, 12kV underground circuits from Poni Street to McCully substation, and other 12kV circuits in the service areas of these substations. The following is a general description of the work involved for this item.

(1) One 46kV circuit is required to connect the existing Archer 46 underground 46kV circuit at Makaloa Substation with the existing Pukele 2 overhead 46kV circuit near McCully Substation. This would be accomplished by installing this circuit in an existing ductline between Makaloa and McCully Substations. Another 46kV circuit is required to connect the existing Archer 41 underground 46kV circuit at Makaloa Substation to the McCully Substation. This would be accomplished by installing this circuit in a new ductline from Makaloa Substation to Poni Street, which would transition into the existing ductline at Poni Street and continue in the existing ductline all the way to McCully Substation. The route of the existing ductline begins at Makaloa Substation on Makaloa Street near Ala Moana, continues in the Koko Head direction through Kalakaua Avenue, Fern Street, Hauoli Street, and Lime Street, then terminates at McCully Substation on the corner of Lime Street and Pumehana Street in McCully. The route of the new ductline follows the existing ductline on Makaloa Street from Makaloa Substation to Poni Street. At Poni Street, the new ductline would be connected to the existing ductline. Overhead reconnections of existing overhead 46kV circuits in and around McCully Substation are also required, which includes the replacement of an existing wood pole with a new wood pole in the same location. FEA (Vol. 1) at 3-3 – 3-4.

The total length of the proposed main ductline would have been approximately 3,450 feet. As discussed below, after further field inspections and engineering review, HECO determined that approximately 70% (~2450 feet) of an existing ductline between the Makaloa Substation and the McCully Substation can be used to install the two new 46kV circuits, instead of installing a completely new ductline as originally proposed. HECO ST-1 at 9; HECO ST-2 at 1; HECO ST-7 at 1-4. The existing ductline follows the same route as the originally proposed new ductline.

From Poni Street to McCully Substation, the existing ductline can be used to install the two new 46kV circuits. From Makaloa Substation to Poni Street, the existing ductline could only accommodate the installation of one of the 46kV circuits because existing 12kV circuits in the ductline must remain. Therefore, a new ductline from Poni Street to McCully Substation would need to be constructed to accommodate the second 46kV circuit.[1]

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[1] The existing ductline currently contains three 46kV circuits and 12kV circuits occupying six ducts in a common ductline. The existing circuits would be removed from the existing ductline to provide duct space for the new 46kV circuits. The two new 46kV circuits are higher capacity cables and are essentially an upgrade to the existing three 46kV circuits. Once installed, the two new 46kV circuits

(2) One 46kV circuit is required to connect the new Archer 46 underground 46kV circuit near McCully Substation with the existing Pukele 2 overhead 46kV circuit at the intersection of Date Street and Pumehana Street in McCully. An underground ductline would be constructed along Pumehana Street from the existing manhole fronting McCully Substation to a new wood pole (which replaces an existing wood pole in same location) on Date Street carrying the existing Pukele 2 overhead 46kV circuit. FEA (Vol. 1) at 3-4.

(3) Two 46kV circuits are required in separate ductlines to connect the new 138kV-46kV, 80MVA transformer at Kamoku Substation to the existing Pukele 4 overhead 46kV circuit on Date Street fronting Kamoku Substation in Moiliili. Existing ductlines in Kamoku Substation would be utilized to route the circuits out of the enclosed substation. Once outside of the enclosed substation, new ductlines would be constructed to new wood poles (which replace existing wood poles in the same location) carrying the Pukele 4 overhead 46kV circuit on Date Street fronting the Kamoku Substation. The existing span of 46kV overhead conductors between these two wood poles would be removed. FEA (Vol. 1) at 3-4.

(4) One 46kV circuit is required to connect the existing Pukele 4 overhead 46kV circuit on Mooheau Avenue with the existing Pukele 8 overhead 46kV circuit near the intersection of Mooheau Avenue and Winam Avenue in Kapahulu. An underground ductline would be constructed from a new wood pole (which replaces an existing wood pole in the same location) on Mooheau Avenue that carries the existing Pukele 4 overhead 46kV circuit to a new wood pole (which replaces an existing wood pole in the same location) on Winam Avenue carrying the existing Pukele 8 overhead 46kV circuit. FEA (Vol. 1) at 3-4.

(5) Existing 12kV circuits in ductlines between Makaloa and McCully Substations would be rerouted to make the ductlines available for new 46kV circuits. In order to ensure that 12kV vaults on Kalakaua Avenue are still served when the 12kV circuits are rerouted, an existing 12kV switch would be relocated from an overhead pole on Kalakaua Avenue to an overhead pole on Fern Street at the intersection with Punahou Street. The existing poles would be replaced with slightly thicker poles, and approximately five feet of new underground ductline would be constructed in the sidewalk on Kalakaua Avenue to link the overhead circuits and the underground vaults. FEA (Vol. 1) at 3-13.

(6) Currently, a 12kV circuit originating from the McCully Substation, known as the McCully Substation Shopping Center 12kV circuit, serves loads in and around Ala Moana Shopping Center, including parts of Keeaumoku Street, Kapiolani Boulevard and Kona Street. This circuit would be removed from the existing ductline to make room for the new 46kV circuits. In order to serve the loads currently served by this 12kV circuit, a new 46kV/12kV transformer and switchgear would be installed at the Makaloa Substation as the new source of the McCully Substation Shopping Center 12kV circuit. FEA (Vol. 1) at 3-13.

(7) An existing 12kV circuit originating from McCully Substation is known as the Kona Street 12kV circuit. The route of the Kona Street 12kV circuit currently proceeds from the McCully substation in the Ewa direction along Lime Street, mauka on Hauoli Street, then Ewa

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will replace the existing three 46kV circuits, which will be cut and removed from the existing ductline. To remove the existing 12kV circuits, modifications to the 12kV system in the area are required. However, on Makaloa Street, between Makaloa Substation and Poni Street (Daiei parking structure), the 12kV circuits must remain in the existing ductline. Thus, there would only be enough ducts available in the ductline for one of the proposed 46kV circuits. Therefore, Change #1 would still involve the construction of a new ductline from Makaloa Substation to Poni Street for the other proposed 46kV circuit. HECO ST-2 at 2-3.

on Fern Street, and mauka on Kalakaua Avenue to Makaloa Street where it proceeds to Kaheka Street. At Kaheka Street, the circuit turns makai on Kaheka and then Ewa on Kapiolani Boulevard. At Keeaumoku Street the line heads makai and then both Koko Head and Ewa on Kona Street. A second section of the circuit exits McCully Substation on Pumehana Street and heads makai until Kapiolani Boulevard. It continues on Kapiolani Boulevard until it turns makai on Atkinson Drive. This 12kV circuit would be rerouted in available spare ducts along Pumehana Street and Kapiolani Boulevard. An idle section of circuit would be removed along Kapiolani Boulevard from Kalauokalani Way to Kaheka Street to make this section of duct available, and the new 12kV circuit would be installed from a manhole on Pumehana Street fronting the McCully Substation to a manhole in Kapiolani Boulevard at Kaheka Street. This would be the new route for the Kona Street 12kV circuit. FEA (Vol. 1) at 3-13 – 3-14.

(8) Three 46kV circuits and 12kV circuits currently occupy a ductline between the Makaloa and McCully Substations. To prepare for removal of these existing 46kV and 12kV circuits, a 12kV circuit would be reconnected in the existing underground manholes along Makaloa Street. The existing 12kV and 46kV circuits would be removed from the ductline between Makaloa and McCully Substations. FEA (Vol. 1) at 3-14.

Phase 1 Update

In its supplemental testimonies, HECO identified two changes to Phase 1 of the two-phase project, arising out of (1) the ability to utilize existing ducts for some of the new 46kV circuits to be installed as part of the project, and (2) a decision to extend a planned 46kV underground segment instead of using an existing overhead 46kV line on Pumehana Street. HECO ST-1 at 3. These changes are reflected in the project scope described above.

Change #1 resulted from the ability to use six existing ducts in a common ductline for a significant portion of the route for the two new 46kV underground circuits between the existing Makaloa and McCully Substations, instead of installing a completely new ductline as originally proposed. HECO ST-1 at 9; HECO ST-2 at 1; HECO ST-7 at 1-4.[2]

As part of Phase 1, HECO planned to install two new 46kV circuits in a new underground ductline between the existing Makaloa and McCully Substations. As noted in HECO T-7 (pages 3-5), however, there is an existing ductline between these two substations, which follows the same route as the proposed new ductline that might be used for the proposed circuits. At the time the application was filed, it was unclear whether the existing ducts could be utilized for the new 46kV circuits. After further field inspections and engineering review, HECO concluded that utilizing the existing ductline appears feasible. HECO ST-2 at 4-5; HECO ST-7 at 3; HECO ST-8 at 1-3. As a result, Change #1 involves the utilization of this existing ductline, where practical, for the proposed circuits. HECO ST-2 at 2; HECO ST-7 at 1-4.

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[2] The existing ductline currently contains 46kV and 12kV underground circuits. Change #1 involves the removal of these existing circuits from the existing ductline to provide duct space for the new 46kV circuits. To remove the existing 12kV circuits, modifications to the 12kV system in the area are required. However, on Makaloa Street, between Makaloa Substation and Poni Street (Daiei parking structure), the 12kV circuits must remain in the existing ductline. Thus, there would only be enough ducts available in the ductline for one of the proposed 46kV circuits. Therefore, Change #1 would still involve the construction of a new ductline from Makaloa Substation to Poni Street for the other proposed 46kV circuit. HECO ST-2 at 2-3.

In summary, Change #1 allows one of the two new proposed 46kV circuits to be installed in the existing ductline from Makaloa Substation to McCully Substation. The other new proposed 46kV circuit will be installed in a new ductline from Makaloa Substation to Poni Street, then transition into the existing ductline at Poni Street and continue in the existing ductline all the way to McCully Substation. HECO ST-2 at 3; HECO-ST-201.

The advantages associated with Change #1 are that (1) Phase 1 will involve approximately 2,450 feet less of new ductline construction and half as many new ducts as compared to the original proposal, (2) trenching is eliminated on Kalakaua Avenue, which was an area of concern for traffic disruption, (3) trenching is avoided in certain narrow residential streets, and (4) engineering and construction costs are reduced. HECO ST-2 at 3-4; HECO ST-8 at 3-4.[3]

Change #2 resulted from further review of the use of an existing overhead 46kV line on Pumehana and Lime Streets to electrically connect the existing Pukele 2 46kV overhead circuit on Date Street to the existing Archer 46 46kV underground circuit at McCully Substation. HECO ST-1 at 1, 5-8; HEC ST-7 at 5-6. For the proposed 46kV circuit connections on Pumehana Street, HECO now plans to connect the existing circuits in the area in a manner that maintains the current operating condition of essentially zero electric current flow on the existing overhead 46kV circuit on Pumehana Street adjacent to Lunalilo Elementary School. In the original proposal, the operating condition of the existing overhead circuit would have changed significantly. HECO ST-1 at 9.

Phase 1 Makaloa Substation

This item involves work at the existing Makaloa Substation located on Makaloa Street near Ala Moana. This activity includes the installation of one 46kV/12kV, 10/12.5 MVA, low sound level transformer; one 15kV two circuit switchgear; one 6 foot by 14 foot handhole; and one set of 46kV interrupters. Site development work includes installation of approximately 250 feet of three 5-inch concrete-encased ducts all within the substation property. FEA (Vol. 1) at 3-14 – 3-15.

Phase 1, Kamoku Substation

This item involves work at the existing Kamoku Substation located on Date Street in Moilili, which is an enclosed facility. This activity includes the installation of one 138kV/46kV, 80 MVA, standard sound level transformer with cooling equipment; 138kV circuit breakers; protective relaying; 46kV gas insulated switchgear ("GIS"); and control cables. Site development work includes one 24 foot by 39 foot transformer pad, 126 linear feet of 22-foot high transformer vault walls, one 18.5 foot by 21 foot switchgear pad and 250 feet of 5-inch ducts all within the substation property. FEA (Vol. 1) at 3-15.

[3] There are two disadvantages with Change #1, although the advantages substantially outweigh the disadvantages. First, there will be no spare duct available for the new circuits in sections of the project where the existing ductline would be utilized. The lack of a spare duct would only become a problem, however, if there were a cable failure that significantly damages the ductline, which is a rare occurrence. Second, modifications of the existing 12kV system in the area are required to make the existing ductline between Makaloa and McCully Substations available for the two new 46kV underground circuits. HECO ST-2 at 4.

Phase 1, Distribution Substation Modifications

This item involves modifications at the following existing distribution substations:

(1) McCully Substation - This item involves the replacement of three existing 46kV switches (4684, 4909, 4794) with new switches rated at 46kV, 800 amperes, the replacement of existing 4/0 bus sections between switches 4794 and 4752 with 750 kcmil aluminum conductors to achieve a continuous bus rating of 800 amperes, and the installation of a termination structure complete with 46kV terminators and lightning arrestors under switch 4909. This work also involves the removal of the existing McCully #4 46kV/12kV, 10/12.5 MVA transformer and two-circuit 15kV switchgear. FEA (Vol. 1) at 3-15.

(2) Makaloa Substation – In addition to the work at the Makaloa Substation previously discussed, this item involves the replacement of existing 4/0 bus sections between switches 4498 and 5405 and switches 4928 and 6089 with 750 kcmil aluminum conductors to achieve a continuous bus rating of 800 amperes, and installing three new three-phase 46kV group operated switches with associated steel work. FEA (Vol. 1) at 3-15.

(3) Kewalo Substation - This item involves the installation of 750 kcmil aluminum conductors between switches 4919 and 5311 to achieve a continuous bus rating of 800 amperes. FEA (Vol. 1) at 3-15.

(4) Kuhio Substation – This item involves the replacement of three existing hydraulic operators with new motor operators including all associated control duct installations, battery banks, cabinets, and wiring and the installation of one 46kV switch interrupter. FEA (Vol. 1) at 3-15 – 3-16.

(5) Waikiki Substation – This item involves the replacement of six existing hydraulic operators with new motor operators including all associated control duct installations, battery banks, cabinets, and wiring and the installation of two 46kV switch interrupters. FEA (Vol. 1) at 3-16.

(6) Ena Substation – This item involves the replacement of seven existing hydraulic operators with new motor operators including all associated control duct installations, battery banks, cabinets, and wiring and the installation of three 46kV switch interrupters. FEA (Vol. 1) at 3-16.

(7) Kapahulu Substation – This item involves the replacement of nine existing hydraulic operators with new motor operators including all associated control duct installations, battery banks, cabinets, and wiring and three 46kV switch interrupters. FEA (Vol. 1) at 3-16.

B. Phase 2

Phase 2, 46kV Underground Lines

This item involves the installation of three new underground 46kV circuits (Archer 45, Archer 47, and Archer 48) to connect a new 138-46kV, 80MVA transformer at Archer Substation to three existing 46kV circuits (Pukele 7, Pukele 6 and Pukele 5) terminating at the Pukele Substation. FEA (Vol. 1) at 3-21. This portion of Phase 2 includes the following activities:

(1) New cable trays in Archer Substation would be installed to route the circuits out of the enclosed substation located on HECO's Ward Avenue facility near the corner of Cooke Street and King Street in Kakaako. FEA (Vol. 1) at 3-21.

(2) Once outside of the enclosed substation, a new ductline carrying the three new underground 46kV circuits (Archer 45, Archer 47, and Archer 48) would be constructed and routed through HECO's property onto Cooke Street. On Cooke Street, the ductline proceeds mauka until King Street then proceeds in the Diamond Head direction on King Street until Hauoli Street, fronting the McCully Times Supermarket. FEA (Vol. 1) at 3-21.

(3) Near the King Street and Hauoli Street intersection, the Archer 48 underground 46kV circuit branches off into a separate ductline that terminates at a new wood pole (which replaces an existing wood pole in the same location) located on King Street fronting the McCully Times Supermarket parking lot. The wood pole would carry the existing Pukele 5 overhead 46kV circuit, which will be connected to the new Archer 48 circuit at this point. FEA (Vol. 1) at 3-28.

(4) Also near the King Street and Hauoli Street intersection, the Archer 47 underground 46kV circuit branches off into a separate ductline that terminates at a new wood pole (which replaces an existing wood pole in the same location) located on King Street fronting American Savings Bank. The wood pole would carry the existing Pukele 5 overhead 46kV circuit, which will be connected to the new Archer 47 circuit at this point. FEA (Vol. 1) at 3-28.

(5) The Archer 45 underground 46kV circuit continues in the Diamond Head direction on King Street in a separate ductline until McCully Street then proceeds in the mauka direction until Young Street. At Young Street, the ductline will terminate at a new wood pole (which replaces an existing wood pole in the same location) carrying the existing Pukele 7 overhead 46kV circuit, which will be connected to the new Archer 45 circuit at this point. FEA (Vol. 1) at 3-28.

Phase 2, Archer Substation

This item involves the installation of a new 138-46 kV, 80 MVA transformer with associated protective relaying at the existing Archer Substation located on HECO's Ward Avenue facility near the corner of Cooke Street and King Street in Kakaako. FEA (Vol. 1) at 3-29. Site development work includes knocking out a CMU wall at Archer Substation to install the transformer and then replacing the wall, one 12' X 18' transformer pad, 485 cubic yards of rock fill, 35 feet of 6-5" ducts and 50 feet of 3-3" ducts. FEA (Vol. 1) at 3-29.

II. PROJECT SCHEDULE

A. Estimated Schedule

EOTP Schedule

The estimated project completion dates are mid-2007 for Phase 1 and early 2009 for Phase 2. Implementing the proposed project in two phases has been proposed to address near-term transmission problems, such as Koolau/Pukele Overload Situation, and part of the Pukele Substation Reliability Concern which includes Waikiki, in a more timely manner. FEA (Vol. 1) at 1-2; Tr. (11/07) at 10 (Joaquin), 24 (Wong).

The proposed project is essentially the Kamoku 46kV Underground Alternative – Expanded implemented in two phases. Since the filing of the Application in this docket, the schedule submitted with the Application for the current proposal has changed. In the Application, it was assumed that the proceeding approval process could be completed in early 2005. This would have led to completing Phase 1 in 2006 and Phase 2 in 2008. HECO T-6 at

17-18. The proceeding approval process is taking longer than anticipated and is now estimated to be completed in 2006. Therefore, Phase 1 is now estimated to be completed in 2007 and Phase 2 in 2009. The construction durations for the phases have remained the same. HECO ST-6 at 1-4; HECO ST-601; Tr. (11/07) at 24 (Wong).[4]

The phasing of the Kamoku 46kV Underground Alternative – Expanded has a significant effect on the timing, and therefore, the effectiveness of this alternative. Implementing the 46kV Expanded option in two phases allows Phase 1 construction to be completed in 2007 instead of 2009. In addition, Phase 1 should be isolated from any schedule uncertainties associated with Phase 2. This is critical because the timely installation of Phase 1 addresses the potential overload of the transmission lines providing power to the Koolau Substation, which in turn provides all the power to the Pukele Substation, and minimizes the risk that a catastrophic type power outage will occur. HECO T-6 at 16-19; HECO-602; Tr. (11/07) at 25 (Wong).

Further, Phase 1 will partially address the Pukele Reliability Concern, which affects Waikiki and surrounding areas. It is estimated that Phase 2 construction can be completed in 2009. Phase 2 will address the remaining areas still vulnerable to the Pukele Reliability Concern (outside of Waikiki). Phase 2 also has the potential to provide complete back-up of the customer load served by the Archer Substation, thereby addressing a significant portion of the future reliability concern for the Downtown Substations. HECO T-6 at 16-19; HECO-602; Tr. (11/07) at 25 (Wong).

HECO has taken steps to limit the schedule uncertainties for the current proposal in addition to phasing the proposal. HECO is proposing that all 46kV line segments be constructed underground. In addition, to address an area for potential delay in the implementation of Phase 1, HECO changed the underground connection proposed for Pumehana Street. HECO ST-202; Tr. (11/07) at 26 (Wong). (See Section V.C of the Opening Brief.)

Estimated Schedules for Alternatives

HECO developed schedules for the three alternatives presented to the community in 2003 and assessed the schedule uncertainties associated with the alternatives.[5] In HECO's direct testimonies, HECO estimated that for the (1) Kamoku-Pukele 138kV Underground Alternative, permitting and engineering activities could be completed in 2007 or 2008 and construction completed in 2009 or 2010, (2) Kamoku 46kV Underground Alternative, permitting and engineering activities could be completed in 2005 and construction completed in 2006, and (3) Kamoku 46kV Underground Alternative – Expanded, permitting and engineering activities could

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4 The start and completion date of Phase 2 may be impacted by potential scheduling conflicts with various City-initiated projects planned for installation on King Street.

5 Uncertainty in the permitting and approval process has grown dramatically over the years, making it substantially more difficult to estimate the permitting and approval time for a major utility infrastructure project that generates public concern and/or controversy. HECO T-6 at 7-8; HECO-602. Nonetheless, HECO developed schedules for the three alternatives presented to the community in 2003 and assessed the schedule uncertainties. The Kamoku 46kV Underground Alternative had the least amount of uncertainty. The 138kV underground option had the most schedule uncertainty. The Kamoku 46kV Underground Alternative – Expanded had more uncertainty than the Kamoku 46kV Underground Alternative but not nearly as much uncertainty as the 138kV underground option. HECO-602 (which is a HECO interoffice correspondence concerning the estimated permitting and engineering schedules for the three alternatives); HECO T-6 at 8-16; Tr. (11/07) at 23 (Wong).

be completed in 2006 and construction completed in 2008. HECO T-6 at 21; HECO-602. HECO did not update the schedules for the three options considered in 2003. If HECO had updated the schedules based on the longer proceeding approval process, the Kamoku 46kV Underground Alternative would be estimated to be completed in 2007. This is similar to Phase 1 of the current proposal. The Kamoku-Pukele 138kV Underground Alternative would be estimated to be completed in 2011 at the earliest. The Kamoku 46kV Underground Alternative – Expanded would be estimated to be completed in 2009. Tr. (11/07) at 24 (Wong).

B. Construction Schedule

Construction Schedule for Project

The estimated time to complete the construction work for the proposed Phased 46kV alternative is 10 to 12 months for Phase 1 and 13 to 15 months for Phase 2. These estimates were developed in consultation with HECO's consultant, Tom Harrington, who is a project management consultant specializing in the management of electrical utility construction projects. Like all HECO projects, this schedule was established by factors such as (1) looking at the project requirements and scope of work, (2) reviewing historical production data on similar projects, (3) accommodating external factors, such as permitting requirements, and (4) utilizing a crew structure that maximizes productivity while effectively mitigating construction impacts. HECO T-8 at 1-2; Tr. (11/07) at 172-73 (Harrington).

Construction Schedule for Alternatives

HECO also developed construction schedule estimates for the three alternatives presented to the community in 2003 (i.e., Kamoku-Pukele 138kV Underground Option, Kamoku 46kV Underground Alternative, and Kamoku 46kV Underground Expanded Alternative). HECO T-8 at 2-5; HECO-801, HECO-802; HECO-803.

III. PROJECT COSTS

HECO developed estimates of installed costs, revenue requirements and rate impacts for the 46kV Phased Project, as well as the three alternatives that were presented to the community in 2003.[6] The total initial installation cost of the 46kV Phased Project is currently estimated at approximately $55,644,000. This estimate reflects implementation of Change #1 and Change #2[7] and the revised project schedule.[8] HECO ST-9 at 2; Tr. (11/07) at 180 (Oshiro). In terms of

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6 The three alternatives included (1) the Kamoku-Pukele 138kV Alternative, using (a) HPFF type cable, or (b) XLPE type cable, (2) the Kamoku 46kV Alternative, and (3) the Kamoku 46kV Alternative – Expanded. The 46kV Phased Project (i.e., EOTP) is the Kamoku 46kV Alternative – Expanded, with the work done in two separate phases.

7 Change #1 proposes to utilize existing ductlines instead of constructing a new ductline for a significant portion of the route for the two new 46kV underground circuits proposed between Makaloa and McCully Substations. Change #2 proposes to connect existing 46kV circuits near Pumehana Street in an alternative manner than originally proposed. HECO ST-2 at 2-8.

8 The revised project schedule currently estimates Phase 1 in service in 2007 and Phase 2 in 2009. HECO ST-6 at 4.

revenue requirements, the net present value (in 2003 dollars and assuming an 8.4% discount rate) of the revenue requirements for the 46kV Phased Project is $55.5 million. HECO RT-9 at 3; HECO-R-902; HECO-R-903. The potential rate impact associated with the 46kV Phased Project for the typical residential customer's monthly bill is $0.73 in 2008, after Phase 1 is installed, which increases to $0.92 in 2010, after Phase 2 is installed. HECO RT-9 at 3; HECO-R-903; Tr. (11/07) at 182 (Oshiro).

A. Total Installation Cost

46kV Phased Project

The total initial installation cost[9] of the 46kV Phased Project is currently estimated at approximately $55,644,000. This estimate reflects implementation of Change #1 and Change #2 and the revised project schedule. HECO ST-9 at 2; Tr. (11/07) at 180 (Oshiro). HECO provided cost estimates in HECO-R-902. The major permits or approvals that were assumed to contribute to this cost estimate include: (1) City Conditional Use Permit (CUP) – minor; and (2) Commission review and approval. HECO ST-9 at 2; HECO T-9 at 7; and HECO T-6 at 15-19.

In its Application filed on December 18, 2003, HECO estimated the initial installation cost for the 46kV Phased Project at approximately $55,424,000. The implementation of Change #1 and Change #2, and the revised schedule postponing the in service date for Phase 1 until mid-2007 and for Phase 2 until early 2009 (about six months later than the estimated completion dates assumed in the Application), resulted in an increase of approximately $220,000. HECO ST-9 at 2-4; HECO ST-6 at 4; HECO ST-901; Tr. (11/07) at 181 (Oshiro).

Change #1 decreased the total initial installation cost by approximately $1,390,000. Utilizing the existing ductline between the existing Makaloa and McCully substations eliminated trenching, which reduced the cost for the project. Change #2 increased the total initial installation cost by approximately $258,000 because it required a longer ductline on Pumehana Street, increasing the cost of the project. The revised schedule (i.e., later in service date) increased costs by approximately $1,354,000 due to increased Allowance for Funds Used During Construction and due to the effects of inflation. HECO ST-9 at 2-4; HECO ST-6 at 4; HECO-ST-901; Tr. (11/07) at 181 (Oshiro).[10]

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9 Initial installation cost estimates include (a) planning costs, (b) permit and approval costs, including environmental assessment or environmental impact statement costs, (c) materials costs, (d) labor costs, (e) land costs, and (f) allowance for funds used during construction ("AFUDC"). The permitting and approval costs include activities associated with securing the necessary permits and approvals associated with a particular alternative. The planning costs category for the 46kV Phased Project include the costs that were incurred prior to (and that led to) the selection of the proposed project. HECO T-9 at 3-4.

10 The same assumptions were used to estimate the initial installation costs of Change #1 and Change #2 as were used for the original proposal, except for the ductline installation costs on Makaloa Street (Change #1) and Pumehana Street (Change #2). Since the Application filing, more detailed information was obtained on some of the proposed routes, which indicated that the previous cost estimate should be refined to better account for the actual field conditions. For Makaloa Street, it was confirmed that numerous underground utilities occupy the street. With little space left for a new ductline, HECO facilities will have to be located deeper than was previously estimated. In addition, soil conditions are poor along Makaloa and Pumehana Streets requiring HECO to over excavate and create a base of fine gravel in a fabric filter to support the ductline. The engineering and construction costs for Change #1 and Change #2 were developed to account for the identified field

The City and County of Honolulu's ("City") policy regarding repaving City Streets has changed several times since the Application was filed on December 18, 2003. HECO's Supplemental Direct Testimony filed on July 22, 2004, addressed the cost impacts of the City's former curb-to curb repaving policy. HECO RT-9 at 3-4; Tr. (11/07) at 182 (Oshiro).

On September 30, 2004, the City Managing Director issued the current policy for trenching work on City owned or maintained roadways, which required the repaving of the trench width plus an additional one foot on each side for a trench aligned longitudinally to the travel way. The September 2004 policy superseded the previous policy that required curb-to-curb repaving. The September 2004 policy remains in effect at this time. As a result of the change in the City's policy, a cost estimate that includes the cost impacts of curb-to-curb paving is no longer necessary. HECO RT-9 at 4; HECO-R-904; Tr. (11/07) at 182 (Oshiro).

Alternatives

As discussed in more detail below, HECO estimated the total installation costs associated with the project alternatives presented to the community in 2003 as follows: (1) (a) $122.1 million for the Kamoku-Pukele 138kV Underground Alternative using HPFF type cable, and (b) $109.5 million for the Kamoku-Pukele 138kV Underground Alternative using XLPE type cable; (2) $40.6 million for the Kamoku 46kV Alternative; and (3) $58.7 million for the Kamoku 46kV Alternative – Expanded. HECO T-9 at 5-7.

These estimates of the total installation costs for the alternatives were based on the following in-service dates assumptions: (1) Kamoku-Pukele 138kV Underground Alternative, 2010; (2) Kamoku 46kV Underground Alternative, 2006; and (3) Kamoku 46kV Alternative – Expanded, 2008. HECO T-9 at 4; HECO RT-9 at 3; HECO ST-9 at 1; HECO T-6 at 12 and 15.

The total initial installation cost associated with the Kamoku-Pukele 138kV Underground Alternative using HPFF type cable was estimated at approximately $122.1 million. The following major permits or approvals that contributed to this cost estimate were assumed: (1) City Development Plan Public Facilities Map Amendment ("PFMA") or City Revision of the Public Infrastructure Map ("PIM"); (2) Commission review and approval; (3) Easement acquisition from the City's Department of Budget & Fiscal Services, Purchasing Division; and (4) Chapter 343 Environmental Impact Statement. The major materials included in this estimate consist of the following: 8" steel pipe, 5" steel fluid return pipe, 138kV HPFF cable, manholes, joints, terminators and the costs associated with the 138kV pressurizing plant that will be required for this alternative. Major equipment required within the transmission substations includes 138kV GIS circuit breakers and relay and control equipment. HECO T-9 at 5; HECO T-6 at 11-12; HECO-901 at 2 and 10, Tables 1 and 3.

The total initial installation cost associated with the Kamoku-Pukele 138kV Underground Alternative using XLPE type cable was estimated at approximately $109.5 million. The following major permits or approvals that contributed to this cost estimate were assumed: (1) City PFMA and PIM; (2) Commission review and approval; and (3) Chapter 343 Environmental Impact Statement. The major materials included in this estimate consist of the following: 138kV duct bank, 138kV XLPE cable, manholes, splice and terminators. Similar to the HPFF alternative, major equipment required within the transmission substations includes 138kV GIS

conditions. If the same assumptions used for Makaloa and Pumehana Streets in the Application were used to develop the initial installation cost estimates for Change #1 and Change #2, the cost estimate for the project would be understated. HECO ST-9 at 3.

circuit breakers and relay and control equipment. HECO T-9 at 5-6; HECO T-6 at 11-12; HECO-901, at 2 (Tables 2 and 3), and 10.

The total initial installation cost associated with the Kamoku 46kV Alternative was estimated at approximately $40.6 million. The following major permits or approvals that contributed to this cost estimate were assumed: (1) City Conditional Use Permit (CUP) – minor; and (2) Commission review and approval. HECO T-9 at 6; HECO T-6 at 13-15; HECO-901 at 10.

The major materials included in the estimate for the Kamoku 46kV Alternative consisted of the following: 46kV duct bank, 46kV XLPE cable, manholes, splices, terminators and riser poles. Major equipment required within the transmission substations includes 138-46kV 80 MVA transformers, 138kV GIS circuit breakers and relay and control equipment. Major equipment required within the distribution substations consists of the following: 46kV disconnect switches, 46kV switch interrupters, motor operators, 48 VDC battery banks and battery cabinets. HECO T-9 at 7; HECO-901 at 2 through 4 (Tables 4 and 5).

The total initial installation cost associated with the Kamoku 46kV Alternative – Expanded was estimated at approximately $58.7 million. The following major permits or approvals that contributed to this cost estimate were assumed: (1) City Conditional Use Permit (CUP) – minor; and (2) Commission review and approval. HECO T-9 at 7; HECO T-6 at 13-15; HECO-901 at 10. The major materials included in this estimate consist of the same items assumed for purposes of the Kamoku 46kV Alternative. HECO T-9 at 7; HECO-901 at 2-4 (Tables 4 and 5).

B. Annual Revenue Requirements

As discussed below, based on cost estimates and other assumptions, HECO calculated annual revenue requirements for the 46kV Phased Project and the three alternatives. The net present value in 2003 dollars of the revenue requirements for the 46kV Phased Project (assuming an 8.4% discount rate) is $55.5 million. The net present values of the revenue requirements of the three alternatives in 2003 dollars (assuming an 8.4% discount rate) are as follows: (1) (a) $95.2 million for the Kamoku Pukele 138kV alternative using HPFF cable, and (b) $87.1 million for the Kamoku Pukele 138kV alternative using XLPE cable; (2) $44.9 million for the Kamoku 46kV Underground Alternative; and (3) $56.1 million for the Kamoku 46kV Alternative – Expanded. HECO RT-9 at 3; HECO T-9 at 3, 15-16; HECO-901 at 13; HECO-R-902 at 2.

Methodology

Based on cost estimates and assumptions, HECO calculated annual revenue requirements for the 46kV Phased Project and the three other alternatives over a 50-year study period. This 50-year period is not the definitive life of the projects, but rather is a period in which the alternatives can be compared over a definitive duration. Transmission, subtransmission and substation systems have different life expectancies due to the difference in technology and physical characteristics. Therefore, HECO's analysis identified specific cost factors that may be applicable to only certain alternatives during certain years and attempted to maintain consistency in its assumptions. HECO T-9 at 3.

For each project evaluated, the revenue requirements included the following types of costs: (1) capital costs, (2) removal and new cycle costs, (3) operation and maintenance costs, and (4) transmission line losses costs.[11]

HECO used various sources of information to develop the cost estimates for the alternatives, including estimates and actual costs from previous HECO projects, and estimates from industry consultants and material suppliers. HECO T-9 at 3; Tr. (11/07) at 180 (Oshiro).

Capital Costs

The capital costs were escalated for inflation based on the year the addition is expected to be placed into service. Capital costs include AFUDC. A revenue requirement factor is applied to the capital costs. The revenue requirement factor includes the following: depreciation, interest expense, preferred stock dividends, return on common equity, income taxes, and revenue taxes. HECO T-9 at 14.

Removal and New Cycle Costs

For each alternative, removal costs were calculated on the basis of the major material that would have to be removed at the end of their expected life. Removal costs for the underground segments were calculated on a per foot basis and include removal of the cable for the XLPE system. Removal costs for the substation equipment include the removal of the equipment. Based on HECO's experience and engineering practice, all ducts, steel pipes, manholes, foundations and structural improvements are expected to remain in usable condition beyond the 50-year evaluation period. HECO T-9 at 7-9.

The costs associated with new materials installed to replace initially installed materials that have reached the end of their life expectancy ("New Cycle" costs) were included in the cost estimates. It was assumed for consistency that all materials with an expected finite life would be replaced at the end of the predetermined life expectancy regardless of condition. HECO T-9 at 9.

Detailed removal and new cycle costs were included in the cost input data shown in HECO-901 (Attachment 1 at 10-11) and in HECO-ST-901 (Attachment 2 at 5).

O&M Costs

The costs associated with the operation and maintenance ("O&M") of these alternatives was included in the evaluation. O&M costs will be required to maintain the integrity of the system and ensure proper performance. In an effort to maintain consistency, O&M costs were determined using historical HECO costs as reported in the FERC Form No. 1: Annual Report of Major Electric Utilities. HECO T-9 at 9-10; HECO-901 at 6 (Table 7).

HECO maintains separate O&M records for 138kV underground lines versus 138kV overhead lines. However, the O&M costs for the 138kV underground lines are combined with the O&M costs for the 46kV underground lines. (The O&M costs for 138kV overhead lines are

[11] Line relocation costs were not included because HECO's analysis following consultation with government agencies indicated that any conflicts should not require HECO to relocate installed duct lines in the future. No additional costs associated with visual mitigation were included. All new lines included in the alternatives are proposed for underground construction in existing paved roadways. HECO T-9 at 11-14. The 138kV pressurizing plant required for the Kamoku-Pukele 138kV Underground Alternative with HPFF cables would be designed in accordance with local building code and designed to match the surrounding area. HECO T-9 at 13.

also combined with the O&M costs for 46kV overhead lines.) In 2002 and 2003, the O&M costs for the 138kV and 46kV underground lines were approximately $9,181/mile and $12,480/mile, respectively. HECO RT-9 at 2-3; HECO-R-901.[12]

For the transformer installations at transmission substations (Kamoku and Archer) associated with the 46kV alternatives, O&M costs were calculated on a per MVA basis. The result was $630/MVA. HECO T-9 at 10; HECO-901 at 6 (Table 7).

An annual cost of $3,400 per transmission substation site was included for an annual inspection, and an annual cost of $2,100 per distribution substation site was included for inspection and adjustments. HECO T-9 at 10.

O&M expenses were calculated to account for inflation and include revenue taxes on the expense (calculated by applying a revenue requirement factor). T-9 at 14.

Line Losses Costs

Transmission system losses were calculated for each alternative and compared to the Kamoku-Pukele 138kV Underground Alternative with HPFF cables. For the analysis, the system peak loss and MWh or energy losses were calculated. HECO T-9 at 10-11.

HECO-901, page 12, shows calculated transmission line losses in dollars for the alternatives relative to the Kamoku-Pukele 138kV Underground Alternative with HPFF cables. HECO T-9 at 11.

The capacity cost related to the transmission line losses was calculated by applying a capital and fixed O&M rate ($/MW) to the incremental system peak loss (MW). The energy cost related to the transmission losses is calculated by applying a fuel and variable O&M rate ($/MWh) to the annual incremental MWh energy loss. HECO T-9 at 14.

Results

The net present value in 2003 dollars and assuming an 8.4% discount rate of the revenue requirements for the 46kV Phased Project is $55.5 million. HECO RT-9 at 3; HECO-R-902; HECO-R-903.

The net present value of the annual revenue requirements for the Kamoku Pukele 138kV alternative using HPFF cable, in 2003 dollars and using an 8.4% discount rate was $95.2 million. HECO T-9 at 15; see HECO-901 at 13.

The net present value of the annual revenue requirements for the Kamoku Pukele 138kV alternative using XLPE cable, in 2003 dollars and using an 8.4% discount rate was $87.1 million. HECO T-9 at 15; HECO-901 at 13.

The net present value of the annual revenue requirements for the Kamoku 46kV alternative, in 2003 dollars and at an 8.4% discount rate was $44.9 million. HECO T-9 at 15; HECO-901 at 13.

The net present value of the annual revenue requirements for the Kamoku 46kV Alternative - Expanded, in 2003 dollars and at an 8.4% discount rate was $56.1 million. HECO T-9 at 16; HECO-901 at 13.

The net present value of the annual revenue requirements for each of the alternatives not

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12 HECO's rebuttal testimony provided updated and revised information regarding O&M costs for the 46kV Phased Project. The impact of the revision on the cost analysis was minimal. HECO RT-9 at 1-3; HECO-R-901; see response to CA-IR-26.

selected was not updated to reflect the updated O&M estimates discussed above. However, the impact of the revision on the cost analysis was minimal for the 46kV Phased Project. HECO RT-9 at 2. Any revision of the net present value of the annual revenue requirements for each of the three alternatives would also have been minimal and would not have affected the selection of the 46kV Phased Project as the preferred alternative.

The annual revenue requirements for the 46kV Phased Project are shown and totaled for the 50-year study period in HECO-R-902 at 2, and the annual revenue requirements for each of the three alternatives are shown and totaled for the 50-year study period in HECO-901 at 13. The present value of the total annual revenue requirements for each of the three alternatives is provided at various discount rates (i.e., 0%, 3%, 8.4% and 12%)[13] in HECO-ST-901 and the present value of the total annual revenue requirements for the 46kV Phased Project is presented at HECO RT-9 at 3, HECO-R-902 and HECO-R-903.

C. Rate Impact Of The 46kV Phased Project And Alternatives

HECO calculated the potential rate impact on each of HECO's rate classes for the proposed project and each of the alternatives that were not selected. The revenue requirements were allocated to the different rate classes (Schedule R, G, J, H, P, F) based on the demand cost allocation factors used in HECO's 1995 test year rate case (Docket No. 7766) which were used to develop the rates then in effect at the time the rebuttal testimonies were filed.[14] (See HECO-901, page 8, for a brief description of these rate schedules.) HECO T-9 at 17.

The allocated revenue requirements were then converted into cents per kWh by dividing them by the sales forecast for the respective years for the different rate classes. The results represent the estimated rate impacts for the different classes. Rate impacts were derived for the year the alternative is placed in service until 2013. For purposes of determining the rate impact on the typical residential customer of the various alternatives, a typical residential customer is assumed to use 667 kwh/month. HECO T-9 at 17-18.

In the years after the 46kV Phased Project is installed (Phase 1, 2007 and Phase 2, 2009), the potential rate impact on a typical residential customer's monthly bill would be an increase of $0.73 in 2008, after Phase 1 is installed. After Phase 2 is installed, the rate impact on a typical

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13 Discounting a stream of payments with a 0% discount rate is equivalent to no discounting. Therefore, the total annual revenue requirements discounted at 0% is equal to the total non-discounted annual revenue requirements (i.e., present value and future value are the same).

The 3% discount rate approximates the inflation rate for O&M and capital expenditures assumed throughout this comparison.

The 8.4% discount rate represents HECO's weighted average after-tax cost of capital assumed in this comparison.

The 12% discount rate was used to show the results of discounting the stream of payments with a discount rate greater than 8.4%.

HECO T-9 at 14-15.

14 These demand cost allocation factors were derived from the cost of service study used and approved in Docket No. 7766. The cost of service study provides the mechanism to classify, categorize and allocate the costs of serving the different rate classes, since the costs are not recorded or reported by cost type such as customer-related cost, energy-related cost, or demand-related cost, nor are they reported by rate class schedules. HECO's cost of service study methodology is based on the National Association of Regulatory Utility Commissioners Cost Allocation methodology, which classifies transmission costs as demand-related costs. HECO T-9 at 17.

residential customer's monthly bill would be an increase of $0.92 in 2010. HECO RT-9 at 3; HECO-R-903; Tr. (11/07) at 182 (Oshiro).

For the three alternatives, the estimated rate impacts on typical customers in the various rate schedules are shown in HECO-901 at 14-20. The incremental rate impact per month for the Kamoku-Pukele 138kV Underground Alternative using HPFF type cable would be an increase of $1.97 in 2011. HECO T-9 at 18; HECO-901 at 14. The incremental rate impact per month for the Kamoku-Pukele 138kV Underground Alternative using XLPE type cable would be an increase of $1.86 in 2011. HECO T-9 at 18; HECO-901 at 15. The incremental rate impact per month for the Kamoku 46kV Underground Alternative would be an increase of $0.70 in 2007. HECO T-9 at 18; HECO-901 at 16-17.[15]

[15] The incremental rate impact per month on the typical residential customer for the three alternatives was not updated to reflect the updated O&M estimates discussed in section III.B above. However the impact of the revision on the cost analysis was minimal for the 46kV Phased Project. HECO RT-9 at 2.

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EXHIBIT "B"

EAST OAHU TRANSMISSION PROBLEMS, TIMING OF THE OVERLOADSITUATIONS AND EFFECTIVENESS OF THE EOTP

I. SYSTEM BACKGROUND

Transmission lines at varying voltages are used to transport power to the customer. Currently the highest voltage used by HECO to transport power is the 138kV transmission system. The 138kV transmission system is shown in HECO-401. The 138kV transmission lines allow efficient transmission of large amounts of power from the power plants, where power is generated, to all major load centers. Transmission substations at these major load centers have transformers that "step down" the 138kV voltage to the 46kV sub-transmission voltage. HECO-402 shows HECO's 46kV transmission system. From there, local area substations further reduce the voltage from 46kV to HECO's 12kV and 4kV local distribution voltages. HECO T-4 at 2.

Bulk power from Leeward Oahu power plants is transmitted to the East Oahu Service Area over two major transmission corridors. The Northern Transmission Corridor extends from Kahe Power Plant to the Halawa Substation, Koolau Substation and the Pukele Substation, where it currently ends. With the completion of the two Waiau-CIP 138kV Transmission lines in 1995, the Southern Transmission Corridor was extended from the Kahe Power Plant to the Waiau Power Plant and Iwilei, School Street, and Archer Substations. The Southern Transmission Corridor was recently extended to the Kamoku Substation through the installation of two 138kV transmission lines from Archer Substation to Kewalo Substation and the installation of a 138kV transmission line from Kewalo Substation to Kamoku Substation. Application at 12; HECO T-4 at 2-3; HECO-403.

In West Oahu, the two corridors are linked together by transmission lines between power plants and substations connected to the Northern and Southern Corridors. However, no similar connection exists to provide reliable power to the East Oahu Service Area. HECO's plan has been to build upon existing facilities installed to serve the local load growth through the Archer-Kewalo-Kamoku projects and close the existing gap between the Northern Transmission Corridor and the Southern Transmission Corridor on the East Side of Oahu, providing added reliability to the Eastern and Windward portions of Oahu, which represents more than 50% of HECO's total load. Application at 12; HECO T-4 at 3-4; see Tr. (11/07) at 117 (Ishikawa).

II. EAST OAHU TRANSMISSION PROBLEMS

The purpose of the East Oahu Transmission Project ("EOTP") is to address several transmission problems concerning Oahu's 138kV transmission system in the eastern half of the island, including:

(1) The Koolau/Pukele Overload Situation;
(2) The Downtown Overload Situation;
(3) The Pukele Substation Reliability Concern; and
(4) The Downtown Substation Reliability Concern.

Pukele Substation Reliability Concern

Two 138kV transmission lines currently feed the Pukele Substation from the Koolau Substation in Kaneohe, on the windward side of Oahu. The two 138kV lines cross the Koolau Mountain Range to connect the Pukele Substation to the rest of the HECO system. The power transported from these two lines is stepped down to the sub-transmission voltage and transported over eight 46kV feeders that branch out from Palolo Valley to distribution substations in Kahala, Kaimuki, Manoa, Makiki and Waikiki.[1] Application at 14; HECO T-4 at 33.

The Pukele Substation is the most heavily loaded 138kV substation in the HECO system. Based on 2002 Day Peak load conditions, the Pukele Substation supplied electricity to about 17% of the Oahu load (or approximately 192 MW of the daytime peak load).[2] FEA, Vol. 1 at 2-5; see Application at 14; HECO T-4 at 33.

If the two lines providing power to the Pukele substation are both out of service, approximately 93% of the customers serviced from the Pukele Substation will incur an outage. Most of HECO's customers in the area extending from Makiki to Waikiki, and from Koolau to Kaimuki, would be out of power until one of the two 138kV transmission lines could be restored to service. While many parts of the two lines have been renewed and upgraded, the two Koolau-Pukele 138kV transmission lines generally are more than 40 years old. Typically, a transmission line experiences an increase in forced outages as the line ages. Even with visual inspections and maintenance on the Koolau-Pukele 138kV transmission lines, forced outages will occur. These lines are subject to extreme weather conditions due to the high winds, heavy rains, and salt laden marine air that are prevalent in the coastal Koolau Mountain Range. Application at 14; HECO T-4 at 33-34.

Until 2004, Hawaii was fortunate that the second of the two 138kV lines to Pukele Substation had not tripped out of service while the other line was out for maintenance, or out of service due to a forced outage. The latter situation very nearly occurred in 1994 and did occur in 2004. In addition, HECO has experienced simultaneous forced outages on multiple lines on

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1 Prior to 1994, the two Koolau-Pukele transmission lines were part of two longer transmission lines, the 19.4-mile Waiau-Koolau-Pukele 138kV line and the 15.7-mile Halawa-Koolau-Pukele 138kV line. Longer lines are more exposed to fault conditions, and under the old substation configuration, faults on the Koolau bus would result in having to de-energize one of the two Pukele substation feeds depending on the location of the fault on the Koolau bus. In 1994, HECO installed additional breakers at Koolau Substation to segment the two lines into the following:

(1) Halawa-Koolau-Pukele 138kV transmission line
- (a) 9.6-mile Halawa-Koolau line, and
- (b) 6.1-mile Koolau-Pukele #1 line

(2)Waiau-Koolau-Pukele 138kV transmission line
- (c) 13.3-mile Waiau-Koolau line, and
- (d) 6.1-mile Koolau-Pukele #2 line.

HECO T-4 at 44-45.

2 In the past, the Pukele Substation was even more heavily loaded. Since the completion of the Archer Substation, some of the customers previously served by the Pukele substation were moved to Archer Substation. If the Pukele Substation were to lose both 138kV transmission feeds, the transferred customers would not see an interruption in electricity service. The practice of transferring loads from the Pukele Substation is limited by the existing 46kV system and is already reaching its limitations without additional transmission facilities. HECO T-4 at 44.

other parts of the HECO system (outages that seemed even less likely to occur), and the impact of these events caused a large loss of service to the HECO customers. In the case of two major system outages, two lines tripped out at about the same time while another line was out of service for maintenance. Application at 14-15; HECO T-4 at 35-37; HECO ST-4 at 11-12.

The Waikiki area includes large hotels and commercial shopping areas, and a power interruption to these loads would have a major impact on the local and state economies. A blackout of Waikiki would be reported around the world and an extended outage would create a "third world" image for Hawaii's main resort area at a time when Hawaii is positioning itself as a safe, secure domestic destination for relaxation and rejuvenation. In addition, many facilities essential to Hawaii's safety and security, such as the State Civil Defense, are also in this service area, as well as the University of Hawaii at Manoa and Kapiolani Community College. A blackout at the University of Hawaii could impact research and experiments involving millions of dollars. A blackout that incapacitates the Hawaii National Guard and Civil Defense facilities at Diamond Head could have a serious effect on Hawaii's safety and security. Application at 15; HECO T-4 at 38-39.

Some customers with emergency generators on site may be able to meet limited power needs during an area blackout. However, typical emergency generators (at a hotel, for example) serve only critical loads such as elevators and emergency lighting. Ultimately the vast majority of customers within the Pukele service area, including most of Waikiki, would be without power until at least one of the two 138kV lines to the Pukele Substation was restored to service. Application at 15; HECO T-4 at 38.

The duration of a forced outage of the Koolau-Pukele line will depend on the severity of the damage to the line. The duration could be instantaneous or within a minute as seen with the 1994 flashover incidents on the Koolau-Pukele lines, or could last days as in the case of the April 5, 2003 outage on the Koolau-Pukele #1 line. The Koolau-Pukele #1 138kV transmission line experienced a continuous outage (including the Evening Peak period) for 4½ days due to structure damage. Severe weather conditions could also cause a prolonged outage that could take weeks to repair. Application at 15-16; HECO T-4 at 39-40.

In the case of a prolonged interruption of power to the Pukele Substation, most of the customers served by the substation would continue to experience an outage for the duration of the power interruption. The load in certain segments of the Pukele service area could be manually switched to other 46kV back up circuits receiving power from the Koolau Substation. Based on 2002 Day Peak load conditions, about 20% of the total electricity demand of the Pukele Service Area could be restored to service after manual switching operations on the existing 46kV system were implemented. These customers would experience a 2 to 4 hour outage until all the switching could be done to transfer them to these back up circuits. FEA, Vol. 1 at 2-8; see Application at 16; HECO T-4 at 40-41.

Koolau/Pukele Line Overload Situation

There are three 138kV transmission lines providing power to the Koolau Substation. There are two 138kV transmission lines from the Koolau Substation that provide power to the Pukele Substation. Together these two substations provide power to about 30% of the load served by HECO on Oahu. Based on load flow analyses using the load projections in HECO's August 2002 load forecast, with one 138kV transmission line to the Koolau Substation out of service for maintenance, if a second 138kV Koolau transmission line becomes unavailable for any reason, the current flowing through the third 138kV Koolau transmission line was projected to exceed its emergency current carrying capacity rating during daytime peak load conditions in the year 2005. FEA, Vol. 1 at 2-8 and Figure 2-5; see Application at 16-17; HECO T-4 at 20-21.

Using the 2004 actual system loads and escalating the loads using the May 2005 Peak Forecast, the Koolau/Pukele Line Overload is expected to occur in 2006, which demonstrates that the overload date for the Koolau/Pukele Line Overload has not changed and has remained in the 2005-2006 time frame. HECO-R-406 at17.

This would violate HECO's Transmission Planning Criteria, which provides that no transmission component shall exceed its emergency rating with one generating unit on overhaul, one transmission line out for maintenance and loss of a second transmission line. If the current flowing through the remaining 138kV transmission line exceeds the emergency rating of the line, the conductor will heat up beyond normal operating parameters and could possibly break down and the line could suddenly be lost. Loss of the third 138kV transmission line feeding the Koolau/Pukele area would result in loss of electricity service to about 30% of HECO's customers, including sub-transmission substations that feed communities such as Kailua, Kaneohe, Kahala, McCully and Waikiki. The damage caused to the failed transmission line from the overload could lead to a continuous prolonged outage of the line in order to perform the repairs, placing HECO at risk of an additional overload situation. Application at 17; HECO T-4 at 21-22.

In the event of a possible overload situation, an Energy Management System ("EMS") program will automatically shed load at the Koolau and Pukele Substations in pre-selected blocks in a pre-selected order associated with the most overloaded transmission line. The program is activated by an overcurrent protection scheme, which will shed load if the current flowing through the Koolau 138kV lines goes above 1640 amps, the emergency rating of the Koolau 138kV transmission lines. Once load is shed, currents are rechecked to see if they have returned to normal, and if the current is still above 1640 amps, additional circuits will be shed. The amount of load that HECO would have to shed during a line overload situation would vary, since the load in the Koolau/Pukele area varies throughout the day. Application at 17; HECO T-4 at 22.

The emergency rating of the conductor is an engineering value based on conductor size, material, and design wind conditions, but does not account for other factors in the field such as: actual weather conditions, the number of conductor splices, the age and condition of conductors, the accuracy of current transformers in the overcurrent protection scheme, and the terrain where the line is installed. Therefore, the Supervising Load Dispatcher or any higher-ranking System Operation personnel may, at their discretion, take precautionary measures and intervene before the overcurrent protection scheme is activated, to avoid larger outages or maintain system integrity. The system operator has the ability to shed individual 12kV and 46kV distribution feeders in the Koolau/Pukele area to decrease the current flow until there is no longer an overload situation. Application at 17-18; HECO T-4 at 22.

While the load-shedding process can prevent overload conditions, remedial action schemes such as load shedding should not be relied upon as a long-term solution to line overloading conditions, especially on an island utility system where there are no interconnections. In addition, relying on load shedding would not address other issues that are described such as the Pukele Substation Reliability Concern or the Downtown Substation Reliability Concern. Relying on remedial measures also would increase the risk for more significant transmission events to occur on the system. For example, if a relay were to operate improperly, triggering other transmission lines to trip and causing a cascading sequence of events (including the shutting down of generating facilities, as designed, to protect vital equipment from long-term or permanent damage), this could lead to major outages and possibly an island-wide blackout. HECO has experienced several instances where multiple line outages occurred that resulted in island-wide blackouts or loss of service to nearly the entire island. HECO T-4 at 23-25; FEA, Vol. 1 at 2-10 – 2-11.

Downtown Line Overload Situation

There are two 138kV transmission substations serving the Downtown area, including the Iwilei Substation and the School Substation. Power to serve the Downtown area can also come from the Honolulu Power Plant ("HPP"), when it is on line. Together, these two substations and the HPP (when on-line) provide power to about 25% of the load served by HECO at the time of the 2002 Day Peak. These two transmission substations are fed from three 138kV transmission lines providing power from the Halawa Substation via the Halawa-Iwilei 138kV transmission line and the Halawa-School 138kV transmission line, and from Makalapa Substation via the Makalapa-Airport-Iwilei 138kV transmission line. If one of the three 138kV transmission lines to Iwilei or School Substation is taken out of service for maintenance, and a second Downtown 138kV transmission line becomes unavailable, then the current flowing through the remaining Downtown 138kV transmission line was forecast to exceed the emergency current carrying capacity rating during daytime peak load conditions in the year 2024, assuming the HPP is on line. Again, this would result in a violation of HECO's Transmission Planning Criteria, because the current flowing through the third 138kV transmission line feeding the Downtown Substations would exceed the emergency rating of the line. FEA, Vol. 1 at 2-13 and Figure 2-7; see Application at 18-19; HECO T-4 at 25.

The availability of the HPP defers the overload problem.[3] When the HPP is operating, power from the plant feeds the neighboring areas and decreases the demand for power from the West Side, which decreases the current flowing through the three 138kV transmission lines feeding School Street and Iwilei Substations. If the HPP was not operating, the Downtown overload situation was forecast to be accelerated to 2009. FEA, Vol. 1 at 2-13; see Application at 19; HECO T-4 at 25-26.

Using the 2004 actual system loads and escalating the loads using the May 2005 Peak Forecast, the Downtown Overload is forecasted to occur in 2007 without the HPP in operation and 2034 with the HPP in operation. HECO-R-406 at 17.

If the current flowing through the third remaining 138kV transmission line exceeds the emergency rating of the line, the conductor could heat up and could possibly break down and the line could suddenly be lost. Loss of the third 138kV transmission line feeding the Downtown area would result in loss of electricity service to about 25% of HECO's customers. The damage

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3 HECO's current plan is to continue to operate the HPP beyond the 20-year planning period. In 2002 and 2003 major sections of the turbine blades were replaced in Honolulu 9 and a substantial amount of work was performed. In 2003 major sections of turbine blades were replaced in Honolulu 8, the generator was rewound and a substantial amount of work was performed. With these repairs and continued maintenance of the HPP, HECO expects the HPP to continue to operate beyond the 2024 time frame. HECO RT-4 at 46-47. HECO also relies on the HPP for voltage support during some line contingency situations. HECO T-4 at 26.

caused to the failed transmission line from the overload could lead to a continuous prolonged outage of the line in order to perform the repairs, placing HECO at risk of an additional overload situation. Unlike the Koolau-Pukele transmission lines, the Halawa-Iwilei, Halawa-School and the Makalapa-Airport-Iwilei 138kV transmission lines feeding the Downtown area 138kV substations do not have overcurrent protection schemes in place. Similar to the Koolau/Pukele overload situation, the Supervising Load Dispatcher or any higher-ranking System Operation personnel may, at their discretion, take precautionary measures and intervene by shedding load using 12kV and 46kV distribution feeders in the Downtown area to decrease the current flow through the remaining line to a level that does not exceed the emergency rating of the line. FEA, Vol. 1 at 2-15; see Application at 19; HECO T-4 at 26-27.

Downtown Substation Reliability Concern

There are three downtown area substations with only two 138kV transmission feeds, including the Archer and the Kewalo Substations, and the Kamoku Substation has only one 138kV transmission feed. Application at 19-20; HECO T-4 at 46; HECO-415.

The Archer Substation is one of the newer transmission substations on the HECO system, and is fed from the Iwilei and School Street Substations by two underground 138kV lines. These underground lines are considered relatively reliable and are relatively new, however, a catastrophic underground duct bank failure could result in loss of power to the Archer Substation for some time depending on the severity of the failure. Installing a third line to the substation would increase the reliability of the substation. Application at 20; HECO T-4 at 46-47.

The Kewalo Substation is also one of the newest transmission substations and is located on Kona Street. Two 138kV underground transmission lines supply power to Kewalo Substation. Kewalo serves customers at the distribution voltage of 25 kV in the Kakaako area. A catastrophic failure to the underground duct bank could result in loss of power to the Kewalo Substation. A third 138kV transmission line to Kewalo Substation would increase the reliability of the substation. Application at 20; HECO T-4 at 47.

The Kamoku Substation is the newest transmission substation and is located on the corner of Date Street and Kapiolani Boulevard. Kamoku Substation is fed from one 138kV underground transmission line, which brings the power from Archer Substation via Kewalo Substation to Kamoku. The entire Kamoku Substation has a 25 kV back up system. If the 138kV transmission line feeding the substation should fail, then the Kamoku Substation load would be transferred to Kewalo Substation. Application at 20; HECO T-4 at 47.

If the two 138kV feeds to Kewalo Substation experience an outage, then both the Kewalo and Kamoku Substations would be unable to serve the load. The Kewalo and Kamoku Substations provide service to portions of Ala Moana Shopping Center, several high-rise luxury condominiums in the area and the Hawaii Convention Center. A second 138kV transmission line to Kamoku Substation would increase the reliability of the substation and provide a second 138kV feed and a third path of electricity for the substation. Application at 20-21; HECO T-4 at 47.

The concerns regarding the reliability of the three downtown substations are not as critical as the concerns regarding the Koolau-Pukele line overload and the Pukele Substation reliability. The underground lines serving the substations are relatively new, the line segments between the substations are shorter than the Koolau-Pukele 138kV lines, which reduces the exposure to outages, and the Pukele Substation is the most heavily loaded substation on the

HECO system. Also, the two transmission lines serving the Pukele Substation cross the Koolau Mountains. The very difficult access to the lines, their exposure to corrosive marine air, and the location of the two lines on a common right of way causes the Pukele transmission lines to be at a relatively higher risk for an extended outage than the transmission lines in other areas of the island. FEA, Vol. 1 at 2-13; Application at 21; HECO T-4 at 48.

Avoiding Catastrophic Outages

The primary goal for operating the generation and transmission systems is to keep the power flowing continuously to customers. If there are system disturbances, HECO tries to isolate the disturbances and minimize their effect on its customers. The installation of critical infrastructure in a timely manner provides a means to deal with these disturbances quickly and effectively. From a planning perspective, there are basically two types of reliability concerns that HECO continuously tries to guard against. The first type of reliability concern is a catastrophic power outage, where disturbances on the system could potentially throw the entire system into instability. The second type of reliability concern is a localized power outage, where the outage affects a limited area of the island. Tr. (11/07) at 11 (Joaquin); HECO T-1 at 8-9.

A catastrophic power outage has the potential of taking down the entire system for many hours. A significant amount of customers could be without power for many hours until the system can be restored. A localized outage is limited to a certain area and is unlikely to cause the entire system to become unstable and cause loss of generation. Certain localized power outages also are of significant concern, however, because of the number of customers affected, the duration of the outages, and the impact of the outages on the impacted customers and the State. Tr. (11/07) at 11-12 (Joaquin); HECO T-1 at 9.

The Koolau/Pukele Overload Situation involves potential transmission line overloads in HECO's 138kV Northern transmission corridor as soon as the present. As a result of the continued operation of the Honolulu Power Plant, the Downtown Overload Situation, which involves potential transmission line overloads in HECO's 138kV Southern transmission corridor, is not expected to occur until after 2020. The overload situations are problems that increase the risks for catastrophic type power outages. Tr. (11/07) at 12-13 (Joaquin).

The Pukele Substation Reliability Concern involves the reliability of the Pukele Substation located at the end of the Northern transmission corridor. Pukele Substation serves 16% of Oahu's power demand, including critical loads such as Waikiki, State Civil Defense, the Hawaii Army and Air National Guard Headquarters, and the University of Hawaii. The Downtown Substation Reliability Concern involves the reliability of Archer Substation, Kewalo Substation and Kamoku Substation located at the end of the Southern transmission corridor. These substations serve critical loads such as the Honolulu Police Department Headquarters and the Hawaii Convention Center. The Pukele Substation Reliability Concern is of significant concern, due to factors such as the location of the two transmission lines providing power to the substation and the conditions to which the lines are subjected, the potential duration of a loss of power to the substation and to most of the customers served from the substation, and the potential impacts of an extended outage on the Pukele Substation service area. Tr. (11/07) at 13-14 (Joaquin); HECO T-1 at 10.

III. HECO'S UPDATED FORECAST OF KOOLAU/PUKELE LINE OVERLOAD SITUATION AND DOWNTOWN AREA LINE OVERLOAD SITUATION[4]

Based on the analysis on Exhibit 5 of the Application, which utilized unadjusted loads at the time of the 2002 Day Peak and used the growth rates in the August 2002 Long-term Sales and Peak Forecast, the Koolau/Pukele Line Overload Situation was forecasted to occur in 2005 and the Downtown Area Overload was forecasted to occur in 2023 with the Honolulu Power Plant in operation and 2006 without the Honolulu Power Plant. CA-IR-11 described several changes on the 46 kV sub-transmission system, which affected the Koolau/Pukele Area and Downtown Area loads. The 46 kV sub-transmission changes did not change the forecasted year for the Koolau/Pukele Overload, which remained in 2005, however, the Downtown Area Overload was accelerated to 2021 with the Honolulu Power Plant and to 2005 without the Honolulu Power Plant.

HECO updated the information provided in response to CA-IR-11 in HECO-R-406, including the recorded 2004 Day Peak and the May 2005 Peak Forecast. Previous analyses used 2002 and 2003 Day Peaks and the August 2002 Peak Forecast. HECO-R-406 also corrects the 2002 Day Peak data for the reporting error of the 46 kV transformer load at Iwilei Substation as described on page 2 of this exhibit. This correction does not affect the Koolau/Pukele Area load, but decreases the load for the Downtown Area.[5]

Changes in 46kV Subtransmission System Configuration

As is indicated in the draft Environmental Assessment and HECO's Final Environmental Assessment, HECO's 2002 Day Peak occurred on July 30, 2002 and the 2003 Day Peak occurred on July 27, 2003. Changes have occurred in between the time of the 2002 Day Peak and 2003 Day Peak that had an effect on the loads at Pukele Substation and Archer Substation. At the time of the 2002 Day Peak, Pukele Substation served 192 MW, and Archer Substation served 90 MW. Through normal distribution planning activities, several changes have and will occur to the 46kV sub-transmission system, which will change how the Pukele Substation and Archer Substation are loaded. Some of the changes described below were completed prior to the 2003 Day Peak and an additional change, which was implemented in November, 2004, subsequent to the 2004 Day Peak:

(1) McCully Transformer #1 (McCully 1) was removed from McCully Substation and installed at Waialua Substation to meet the growing load demand in this area. The load that McCully 1 served was redistributed onto two other McCully transformers. At the time of the 2002 Day Peak, McCully 1 served 4.3 MW. Approximately one-half of this load was moved from McCully 1 to McCully Transformer #5 (McCully 5) and the other one-half of the load was moved from McCully Transformer #6 (McCully 6). McCully 5 and McCully 6 are served from the Pukele Substation using the Pukele 4 and Pukele 2 46kV circuits, respectively. McCully 1 was served from the Archer Substation using the Archer 41 circuit, and the removal of McCully 1 shifted 4.3 MW of load from Archer Substation to the Pukele Substation.

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4 Extracted From HECO-R-406.

5 Included in HECO-R-406, pages 4-7 are MW loads for the Downtown, Koolau/Pukele, Central, West areas and the HECO System at the time of the monthly Day Peak from September 1999 – December 2004.

(2) In order to minimize the impact of shifting McCully 1 load to other McCully transformers served from the Pukele Substation, switching was done at McCully Substation to transfer the load from McCully 6, which was served by the Pukele 2 46kV circuit, to the Archer 43 46kV circuit. The McCully 6 transformer work was completed on November 1, 2004, which transferred approximately 6 MW of load from McCully 6, which was served by the Pukele 2 46kV circuit, to the Archer 43 46kV circuit.

(3) For the same reasons as described for McCully 1, McCully Transformer #3 (McCully 3) was removed from McCully Substation and relocated to Makakilo Substation to meet the growing load demand in the Makakilo area. At the time of the 2002 Day Peak, McCully 3 served 2.1 MW of load, and 1.7 MW of this load was redistributed to McCully Transformer #2 (McCully 2) and 0.3 MW of the load, which served the Convention Center, was moved to the 25kV distribution system (which is served from Kewalo or Kamoku Substation). McCully 3 was served from the Pukele Substation using the Pukele 5 46kV circuit. McCully 2 is served from the Archer Substation using the Archer 43 46kV circuit, and the removal of McCully 3 shifted 1.7 MW of load from Pukele Substation to Archer Substation.

(4) At the time of the 2002 Day Peak, Aina Koa Substation was served by two 46kV circuits from the Koolau Substation. If one of the 46kV circuits is unavailable, the second 46kV circuit would serve the load demand of the entire Aina Koa Substation. Having 46kV circuits from two transmission substations feed a distribution substation is a preferred way of operating the 46kV system, and existing switches on the 46kV system made it relatively easy and low cost to serve one of the two transformers at Aina Koa Substation from the Pukele Substation and the second Aina Koa transformer from Koolau Substation. This shifted 8 MW of load from Koolau Substation to Pukele Substation. This shift had no impact on the combined Koolau/Pukele Area load, but altered the allocation of the load between the two substations.

(5) A portion of the Hawaii Convention Center load was served from McCully 5, McCully 6 and McCully 3. Approximately 0.5 MW from each of McCully 5 and McCully 6 was transferred to the 25kV system (which is served from Kewalo or Kamoku Substation). This decreased the load on McCully 5 (which is served from Pukele Substation) and McCully 6 (which was served from Pukele Substation, but is now served from Archer Substation after the McCully 6 switch referred to above) by about 0.5 MW for each transformer. The Downtown Substation load served by Kewalo and Kamoku Substations was increased by 0.5 MW, because this load was shifted from McCully 5 to the 25 kV system. The 0.5 MW of load shifted from McCully 6 to the 25kV system is part of the 6 MW of load that was shifted when the McCully 6 transformer was transferred to the Archer Substation. (In effect, 5.75 MW has been shifted to Archer Substation and 0.5 MW has been shifted to the 25kV system served by Kewalo and Kamoku Substations.)

These are normal changes in the sub-transmission (46kV) and distribution (12kV and below) system configurations that are made from time-to-time as a result of distribution planning to better balance circuit and transformer loads, address circuit reliability issues, and optimize use of the utility grid. In many instances, the changes are made by manually opening or closing existing circuit switches.

Adjusted Substation Loads

At the time of the 2002 Day Peak (which occurred on July 30, 2002), the load for the Koolau/Pukele area was 346 MW, or 30% of the load served by HECO, and the load for the Downtown area was 304 MW, or 26% of the HECO service load. The Koolau/Pukele area load of 346 MW included 192 MW (or 16.4% of the HECO service load) served by Pukele Substation, and 154 MW (or 13.2% of the HECO service load) served by Koolau Substation. The load flows for the December 2003 reports (Exhibit 5 and Exhibit 6 of the Application) reflect load data at the time of the 2002 Day Peak prior to changes on the distribution system.

At the time of the 2002 Day Peak (as adjusted for the distribution system changes), the load for the Koolau/Pukele area was 342 MW, or 29.5% of the load served by HECO, and the load for the Downtown area was 298 MW, or 25.7% of the HECO service load. The Koolau/Pukele area load of 342 MW included 196 MW (or 16.9% of the HECO service load) served by Pukele Substation, and 146 MW (or 12.6% of the HECO service load) served by Koolau Substation.

At the time of the 2003 Day Peak (as adjusted for the distribution system changes), the load for the Koolau/Pukele area was 352 MW, or 30% of the load served by HECO, and the load for the Downtown area was 297 MW, or 25% of the HECO service load. The Koolau/Pukele area load of 352 MW included 209 MW (or 18% of the HECO service load) served by Pukele Substation, and 143 MW (or 12% of the HECO service load) served by Koolau Substation. The 46kV system load flows reflect loads for the Archer Substation and Pukele Substation at the time of the 2003 Day Peak and are included in HECO-R-406.

A review of the 2003 Day Peak data was performed because the load demand on the Pukele Substation appeared to be higher than what was typically recorded for previous years. The high demand on the Pukele Substation was caused by temporary switching on the 46kV sub-transmission system. In addition, the load demand at the Kewalo Substation was inadvertently left out of the calculated Downtown Area load. Therefore, at the time of the 2003 Day Peak (adjusted for the temporary load shift and including the Kewalo Substation data), the Koolau Pukele area was 352 MW (or 29.9% of the load served by HECO), and the load for the Downtown area was 301 MW (or 25.6% of the HECO service load.) The Koolau/Pukele area load of 352 MW included 200 MW (or 17% of the HECO service load) served by the Pukele Substation, and 152 MW (or 12.9% of the HECO service load) served by the Koolau Substation.

To project the service area day peak loads for the December 2003 transmission planning studies supporting the need for the 46kV Phased Project, the service area loads at the time of (i.e., coincident with) the system Day Peak for 2002 (which occurred on July 30, 2002) were projected to grow at the forecast growth rates for the system Day Peak in HECO's latest long-term forecast at the time (the August 2002 Long-Term Sales and Peak Forecast).

Actual load growth rates may differ from those forecast for a number of reasons, such as changes in the population growth, economic growth and customer electricity consumption factors that drive electricity load growth. Changes in load growth rates from those forecast may impact the timing of the Downtown Overload Situation, but will not impact the Pukele and Downtown Substation Reliability Concerns (which result from the number of lines serving the substations, rather than the growing loads on the lines), and are unlikely to defer the Koolau/Pukele Overload Situation (due to the loads already experienced on the lines serving the area).

The adjusted loads for the Koolau/Pukele service area were 342 MW in 2002 and 352 MW in 2003. (The unadjusted loads were higher.) The overload level is 362 MW. Also, HECO's latest Long-Term Sales and Peak Load Forecast, completed in February 2004 as part of its integrated resource planning process, forecasts higher, not lower, growth rates in the near-term. While it may be possible to slow the rate of load growth in the area through the use of energy conservation measures and distributed generation (which are reflected to varying degrees in the load forecasts), it is not expected that these measures will eliminate load growth.

Based on the 2002 Day Peak loads (adjusting the 2002 Day Peak load for a double counting error of the 46kV transformer load at Iwilei Substation) and the August 2002 projected load growth rates for the Day Peak, the Downtown Overload Situation was forecast to occur in 2026 with HPP operating, and 2011 without HPP. The 2002 load for the Downtown area, if subsequent 46kV configuration changes and 25kV distribution circuit additions had already been implemented, would have been higher by 5 MW. If the forecast loads for the Downtown area were based on the adjusted 2002 load (which was 5 MW higher) and the same projected load growth rates, then the forecast overload years for the Downtown Overload Situation would move up to 2025 with the HPP operating and 2009 without HPP.

Based on the 2004 Day Peak load, which occurred on August 17, 2004, the load for the Koolau/Pukele area was 356 MW, or 30% of the load served by HECO, and the load for the Downtown area was 303 MW, or 25% of the HECO service load. The Koolau/Pukele area load of 356 MW included 194 MW (or 16% of the HECO service load) served by Pukele Substation, and 162 MW (or 14% of the HECO service load) served by Koolau Substation. At the time of the 2004 Day Peak, the load from the McCully 6 transformer had not been shifted. It should be noted that the 2004 Day Peaks for the Koolau/Pukele area are 6 MW higher than the 2003 adjusted Day Peak.

The work done to the McCully 6 transformer as described earlier would have shifted approximately 6 MW from the Pukele Substation to the Archer Substation. Therefore, the Koolau/Pukele area load with the McCully 6 load shift would have been 350 MW, which included 188 MW (or 16% of the HECO service load) served by the Pukele Substation and 162 MW (or 14% of the HECO service load) served by the Koolau Substation. The adjustment decreased the Koolau/Pukele load demand by 2 MW less than the adjusted 2003 Day Peak load demand.

Using the 2004 actual system loads and escalating the loads using the May 2005 Peak Forecast, the Koolau/Pukele Line Overload is expected to occur in 2006, which demonstrates that the overload date for the Koolau/Pukele Line Overload has not changed and has remained in the 2005-2006 time frame. The Downtown Overload is forecasted to occur in 2007 without the Honolulu Power Plant in operation and 2034 with the Honolulu Power Plant in operation.

Distribution Planning Considerations

For distribution planning purposes, a substation with four 80 MVA transformers, which is how the Pukele Substation is configured, is capped at 240 MVA. This is to account for an N-1 contingency on the distribution system. If the load is capped at 240 MVA, the entire 240 MVA of load can still be served because if one transformer at the Pukele Substation is lost, the other three remaining transformers will be able to serve the load for that substation.

The Pukele Substation load at the time of the 2004 Day Peak was 204 MW (188 MW with the aforementioned shift of McCully 6 load on November 1, 2004, subsequent to the 2004 Day Peak). This load was escalated based on the May 2005 Peak Forecast forecasted Evening Peak growth rates because the load at the Pukele Substation is higher during the Evening Peak hours compared to the Day Peak hours. The escalated load at the Pukele Substation will reach the 240 MVA limit in the year 2024. Beginning in the year 2025 it was assumed that future load growth in the Pukele service area will be served by the Downtown Area Substations of Archer, Kewalo and Kamoku Substations. The load growth of the Downtown Area Substations and the added load from the Pukele Substation (because the Pukele Substation was capped at 240 MVA) forecasted that the Downtown Line Overload would occur in 2034 with Honolulu Power Plant ("HPP") and 2007 without HPP.

IV. OPERATIONAL EFFECTIVENESS OF THE EOTP

The implementation of the EOTP would allow electrical loads currently being served exclusively from Pukele Substation, located at the end of the Northern 138kV transmission corridor, to also be served from Kamoku Substation and Archer Substation, located in the Southern 138kV transmission corridor. Essentially, this project allows load to be shifted among the three substations using 46kV lines, and also allows the substations to back up each other. These operating features will address the four transmission problems in varying degrees.

First, some of Pukele Substation's existing electrical load would be shifted to Archer Substation and Kamoku Substation with the implementation of the project. This will reduce the overall Koolau/Pukele Service Area load, which will relieve the potential overload situation of the 138kV transmission lines transporting power to the area.

Second, most of the loads transferred from Pukele Substation to Archer Substation and Kamoku Substation as a result of the implementation of this alternative, plus some existing load currently served by Archer Substation, could temporarily be shifted back to Pukele Substation when a transmission line providing power to the Downtown Area or generation from HPP is taken out of service for maintenance. This would reduce the load in the Downtown Area while the line is out of service, and defer the potential overload situation of the 138kV transmission lines transporting power to the area (or avoid accelerating the overload situation, depending on the amount of load that could be temporarily shifted). This load shift would only be done when there is a possibility that the overload situation would occur. After the line taken out for maintenance has been restored to service, load would be shifted back from Pukele Substation to the Downtown Area.

Third, some of Pukele Substation's existing electrical load would be shifted to Archer Substation and Kamoku Substation with the implementation of this alternative. Therefore, if the two 138kV transmission lines serving Pukele Substation were to be lost, the loads that were transferred to Archer Substation and Kamoku Substation because of this alternative would not experience an outage. The loads that continue to be served by Pukele Substation even after the implementation of this alternative would experience a momentary outage (approximately six seconds) as these loads are automatically transferred to Archer Substation and Kamoku Substation (as well as to Koolau Substation).

Fourth, if the two 138kV transmission lines that serve Archer Substation are lost, some of the loads served by Archer Substation, Kewalo Substation, and Kamoku Substation would experience an outage, but other Archer Substation loads would experience a momentary outage (approximately six seconds) as these loads are automatically transferred to Pukele Substation.

Koolau/Pukele Overload Situation

With the installation of Phase 1, approximately 80 MW of existing load (based on 2002 Day Peak loads, as adjusted to account for the distribution circuit re-configuration activities from 2002-2004 discussed above), which is or will be served from the Pukele Substation prior to

Phase 1, will be transferred from the Northern Corridor to the Southern Corridor and will be served by the Archer and Kamoku Substations. The load shift is expected to remain in this configuration under normal operating conditions and will reduce the combined MW load demand from the Koolau and Pukele Substations to a level below 362 MW, which is the amount of combined load at Koolau and Pukele Substations that triggers an overload condition on the remaining line to Koolau Substation. The reduction in combined load with the implementation of Phase 1 will eliminate the Koolau/Pukele Overload Situation for the 20-year period studied.

Pukele Substation Reliability Concern

Under the existing configuration, loss of the two Koolau-Pukele 138kV transmission lines serving the Pukele Substation will cause an interruption of electricity service to customers. Most of HECO's customers in the area serviced by the substation, which extends from Makiki to Waikiki, and from Koolau to Kaimuki, would be out of power until one of the two 138kV transmission lines could be restored to service. (The remaining customers would experience a service interruption of up to six seconds as their service is automatically transferred to Archer Substation.)

If Phase 1 is installed, the customers transferred to circuits served by the Kamoku Substation and Archer Substation (representing 80 MW, based on 2002 Day Peaks, as adjusted) would not experience a loss of electricity service if both the Koolau-Pukele 138kV transmission lines are unavailable (causing an outage of the Pukele Substation), therefore substantially increasing the reliability to the customers served by these circuits. In addition, if an outage of the Pukele Substation occurs, approximately 63 MW (based on 2002 Day Peak loads, as adjusted, and not including the 80 MW of load that will be permanently shifted from Pukele Substation to Archer and Kamoku Substations) of the existing Pukele Substation will automatically be transferred to the Archer, Kamoku and Koolau Substations. Customers on the Pukele 3 and some customers on the Pukele 6 and Pukele 8 46kV circuits will automatically be transferred to the new Kamoku and Archer circuits at the different distribution substations served by the Pukele circuits. (For instance, if the Pukele 3 46kV circuit suddenly loses its feed from the Pukele Substation, automatic switching will occur at Kapahulu and Kaimuki Substations to transfer the load from the Pukele 3 46kV circuit onto the new Kamoku circuit.) Customers served by the Aina Koa Substation fed from the Pukele 1 46kV circuit will be transferred to circuits served by the Koolau Substation. The automatic transfer scheme requires up to 6 seconds for mechanical switches to open and close transferring the load from the primary circuits served from the Pukele Substation in the Northern Corridor to the back-up circuits served from the Kamoku and Archer Substations in the Southern Corridor. Therefore, customers included in the 63 MW block will experience up to a 6-second outage.

With respect to the remaining customers served from the Pukele Substation after Phase 1 is installed (representing 27 MW based on 2002 Day Peaks, as adjusted), during a prolonged outage of the Pukele Substation, HECO troublemen will be sent out to perform manual switching in the field. The switching will transfer the remaining Pukele load to 46kV feeders at a different part of the Northern Corridor served by the Koolau Substation. The manual switching is expected to require approximately 2 to 4 hours to complete before service is restored to the remaining customers. Table 1 describes the effectiveness of Phase 1 in addressing the Pukele Substation Reliability Concern.

Table 1.

Kamoku 46 kV Underground Alternative
Pukele Reliability Concern
Substation Impact Comparison

No Interruption	6-sec. Interruption	2 to 4 hour Outage
McCully	Aina Koa (portion)	Kahala
Ena (portion)	Ena (portion)	Waialae
Waikiki (portion)	Waikiki (portion)	Pukele
Kapahulu (portion)	Kapahulu (portion)	Manoa
Kapiolani (portion)	Kapiolani (portion)	Woodlawn
Kaimuki (portion)	Kaimuki (portion)	UH-Quarry
Kuhio	Moiliili	East-West Center

Downtown Line Overload Situation

If the 80 MW transferred to Archer and Kamoku Substations continues to be served by these substations in situations in which two out of the three Downtown 138kV transmission lines could be out of service, the Downtown overload situation will be accelerated. However, with the installation of the EOTP, it is HECO's plan to shift approximately 71 MW back to the Pukele Substation if one of the Downtown 138kV lines is taken out of service for maintenance, or experiences a prolonged forced outage.

The sub-transmission system utilizes overhead and underground sub-transmission lines to serve distribution transformers, which transform the power from a voltage of 46 kV to a 12 kV distribution voltage. Each 46 kV circuit can serve a limited number of 46-12kV transformers, because the 46 kV circuit is limited by its current carrying capacity. As a general rule of thumb, a 46 kV circuit utilizing a 556.6 MCM aluminum conductor can serve approximately eight transformers carrying approximately 8 MVA of load for a total of 64 MVA per 46 kV circuit. If, for example, each transformer only carried 4 MVA of load, then the 46 kV circuit could possibly serve additional transformers. In planning for the distribution system, automatic transfers also must be considered. To allow for automatic transfers in the event of a line outage, switches are installed that would automatically initiate a transfer of electrical load from one feeder to the other feeder if a feeder was lost. For instance, Waikiki Transformer #2 (Waikiki 2) will be served from the Pukele Substation with the installation of Phase 1. If a loss of service should occur at the Pukele Substation or the Pukele 5 46kV circuit, the Waikiki 2 load at Waikiki Substation being served by Pukele Substation would automatically be transferred onto the Archer 41 46kV circuit. Therefore, when designing how many 46-12 kV transformers Archer 41 will serve, both the normal transformer loads (transformers that will normally be served by Archer 41), and the load which will be automatically transferred from another circuit to Archer 41, must be considered.

With the installation of Phase 1, the Pukele circuits will be reconfigured so that only a portion of the load transferred to Archer and Kamoku Substations can be transferred back to Pukele Substation from Archer and Kamoku Substations, because of the limitations on the 46 kV circuits and the automatic transfers that need to be considered. As a result, not all of the 80 MW of load shifted from Pukele Substation to the Downtown Substations can be transferred back to Pukele Substation when maintenance is being performed on one of the downtown transmission lines. Based on the planned circuit configuration, approximately 9 MW originally served by the Pukele Substation will not be transferred back from the Archer Substation.

The remaining 9 MW of load, which cannot be shifted, can be replaced by temporarily shifting additional load from the Piikoi Substation (located between the Archer and Pukele Substations) to the Pukele Substation. Based on 2002 Day Peak loads, Piikoi Transformer #2 (Piikoi 2) and Piikoi Transformer #3 (Piikoi 3) served 14 MW of load demand. Piikoi Substation is served by the Archer Substation prior to and after Phase 1 using the Archer 43 and Archer 42 46kV circuits. Using the existing 46kV system, manual switching can be performed at Piikoi Substation to serve the two Piikoi transformers from Pukele Substation using the Pukele 5 circuit. When the switching is performed, 14 MW, which was not originally served by Pukele Substation, will be shifted from Archer to Pukele Substation. This action will shift the remaining 9 MW of load from the Downtown Area Substations to the Pukele Substation and also shift an additional 5 MW of load (which is now on the Downtown Area Substations because of the various 46kV and 25kV distribution changes) from the Downtown Area Substations to the Pukele Substation. This will return the HECO 46 kV system to its 2002 Day Peak load condition where the Downtown Line Overload Situation is projected to occur in the year 2006 using the August 2002 HECO Base Forecast and assuming HPP is retired.

Based upon the 2004 Day Peak and the May 2005 Peak Forecast, if the HPP is not retired, the forecasted Downtown Line Overload Situation is forecasted for 2034. With the installation Phase 1 of the Kamoku 46kV Underground Alternative - Expanded, the normal state would be to shift approximately 80 MW of load from Pukele Substation to Archer and Kamoku Substations. Therefore, the Pukele Substation load will decrease to 108 MW. If the 108 MW is escalated using the forecasted Evening Peak growth rates, the Pukele Substation will not reach the 240 MVA limit in the 20-year planning period studied and load from the Pukele Substation will not be shifted to the Downtown Area Substations.[6]

If maintenance is required on the 138kV transmission lines feeding the Downtown Substations or if HPP generation is unavailable due to an outage and the Kamoku 46kV Underground Alternative – Expanded project is installed, 71 MW of load (which was originally served by the Pukele Substation) plus a portion of the Piikoi load would be shifted to the Pukele Substations. This would then cause the load at the Pukele Substation to exceed the 240 MVA limit beginning in 2024, which would be acceptable if all four 80 MVA transformers were in service. If a contingency then occurred on the distribution system where one of the transformers at the Pukele Substation were out of service, HECO could either reschedule the maintenance on the Downtown 138kV transmission line or HPP maintenance (which would not require HECO to shift the 71 MW of load plus the Piikoi load to be shifted to the Pukele Substation) until the

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6 HECO T-4 explained that the installation of the Kamoku 46kV Underground Alternative – Expanded and shifting a portion of the existing load from the Piikoi Substation to the Pukele Substation would defer the Downtown Line Overload by approximately 3 years from 2023 to 2026. In determining the deferral, HECO T-4 continued to cap the Pukele Substation at 240 MVA even with the installation of the Kamoku 46kV Underground Alternative - Expanded, which was in error.

transformer at the Pukele Substation is placed back in service, or HECO could look into shifting only a portion of the Downtown load (through the use of manual switching on the 46kV system) to the Pukele Substation so the three remaining transformers at the Pukele Substation would not be overloaded and HECO could control the Downtown Line Overload Situation.

If the 240 MVA cap at the Pukele Substation is not considered and a portion of the Piikoi load is transferred from the Downtown Area Substations to the Pukele Substations when maintenance is being performed on the 138kV transmission lines feeding the Downtown Area Substations or if HPP generation is unavailable due to an outage, the Downtown Line Overload Situation is forecasted to occur beyond 2028. In addition, if the Downtown Overload Situation continues to develop as projected after the 2024 time frame, HECO could create the flexibility (with minor circuit modifications that are not currently planned) to shift additional load to Pukele Substation when a Downtown Area transmission line is taken out of service for maintenance, which could defer the overload situation for up to a few years.

Downtown Substation Reliability

Phase 1 of the EOTP will improve service reliability to a portion of the Downtown Substation loads by providing a back-up source of power to 47% of the load served by the Archer, Kewalo and Kamoku Substations if Archer should lose its two 138kV transmission feeds.

Phase 2 of the Kamoku 46kV Underground Alternative - Expanded

Phase 2 involves the installation of an 80 MVA 138kV-46kV transformer at Archer Substation and three new underground 46kV circuits (Archer 45, Archer 47 and Archer 48) to connect the new circuits from the 80 MVA transformer at Archer Substation to the three existing 46kV circuits (Pukele 7, Pukele 6 and Pukele 5) terminating at the Pukele Substation.

The three new Archer circuits are essentially an extension of the three Pukele circuits to Archer Substation. The new transformer at Archer Substation and the three new circuits will allow the remaining Pukele Substation loads (which would require up to 2 to 4 hours to restore during a prolonged Pukele Substation outage even after the installation of Phase 1) to be automatically transferred from the Pukele Substation to Archer Substation within 6 seconds. The transfers will occur by activation of automatic transfer switches if the Pukele Substation should lose both Koolau-Pukele 138kV transmission lines. Transfers will take place through the EMS if various Pukele 46kV circuits require an outage. The Pukele 5, 6 and 7 46kV circuits will continue to be served by the Pukele Substation during normal operation after Phase 2 is installed.

The effectiveness of the EOTP Project after the implementation of Phase 2 in addressing the Koolau/Pukele Overload Situation, the Downtown Line Overload Situation and the Downtown Substation Reliability Concern remains the same as described with the implementation of Phase 1. Phase 2 improves on the effectiveness of the project in addressing the Pukele Substation Reliability Concern, because the remaining customers served by the Pukele Substation that would have experienced an outage lasting up to 2 to 4 hours will be interrupted for only 6 seconds or less (significantly less than 2 to 4 hours), which is the time required for the automatic transfer equipment to complete the switching. See Table 2 for a summary of the effectiveness of Phase 2 to address the Pukele Substation Reliability Concern.

Table 2.

Kamoku 46 kV Underground - Expanded Alternative
Pukele Reliability Concern
Substation Impact Comparison

No Interruption	6-sec. Interruption		2 to 4 hour Outage
McCully	Aina Koa (portion)	Kahala	None
Ena (portion)	Ena (portion)	Waialae	
Waikiki (portion)	Waikiki (portion)	Pukele	
Kapahulu (portion)	Kapahulu (portion)	Manoa	
Kapiolani (portion)	Kapiolani (portion)	Woodlawn	
Kaimuki (portion)	Kaimuki (portion)	UH-Quarry	
Kuhio	Moiliili	East-West Center	

V. HECO'S METHODOLOGY FOR DETERMINING LINE OVERLOADS IS APPROPRIATE

Upon review of HECO's load flow cases representing HECO's current system without improvements, Mr. Kiser argued that the Koolau/Pukele Line Overload is not as urgent a situation as HECO concludes. As a result of his analysis of HECO's 46kV switching diagrams provided under protective order as Attachment 1 in response to CA-IR-15, he contended that HECO's existing system can be re-configured to shift approximately 22 MW of load from the Pukele Substation to the Archer Substation to further defer the Koolau/Pukele Line Overload Situation. In addition, he asserted that HECO can utilize existing switches between the Downtown Substation and the Pukele and Koolau Substations during maintenance to defer the Downtown Line Overload Situation beyond 2022. HECO RT-4 at 5-6.

HECO's analysis accurately represents the urgency of the Koolau/Pukele Line Overload. An updated analysis of the Koolau/Pukele Line Overload Situation using the corrected May 2005 Peak Forecast, confirms that the Koolau/Pukele Line Overload will occur in 2006. This is only one year later than the analysis using the previous forecast, so the Koolau/Pukele Line Overload is still considered urgent. HECO's analysis of Mr. Kiser's methodology of determining an overload condition revealed that it is based on inappropriate criteria and therefore can fail to accurately predict an overload situation in a timely manner. HECO's position is that the Consumer Advocate's methodology should not be used to determine if and when line overloads will occur. HECO's methodology of using simulated line currents is a more appropriate basis to determine the line overload dates. HECO RT-4 at 6-14.

In CA-T-1, page 27, Mr. Kiser maintained that the Halawa-Koolau line only begins to exceed its emergency rating of 392 MW during the double contingency situations where both Waiau-Koolau #1 and Waiau-Koolau #2 138 kV transmission lines are out of service. He also asserted that if only one of the two Waiau to Koolau 138 kV transmission lines and the Halawa-Koolau 138kV transmission line are out of service at the same time, the line rating of the remaining Waiau-Koolau 138kV transmission line would not be exceeded. (CA-T-1, at 27-28.) In CA-T-1, pages 30-31, however, Mr. Kiser acknowledged that the Koolau/Pukele Line Overload Situation occurs as HECO represents for all three combinations of double contingency situations, but contended that the overloads occur at later dates than demonstrated in HECO's analysis. See CA-T-1, at 31 and responses to HECO/CA-IR-19 and HECO/CA-IR-20. HECO RT-4 at 7-8.

For example, Mr. Kiser acknowledged that the Waiau-Koolau #1 line will overload in 2012 if the Waiau-Koolau #2 and Halawa-Koolau lines are not available. Similarly, the Waiau-Koolau #2 line will overload in 2012 if the Waiau-Koolau #1 and Halawa-Koolau lines are not available. This contradicts the first statement that no overload occurs on the Waiau-Koolau #2 138kV transmission line if the Halawa-Koolau and Waiau-Koolau #1 are out of service and that no overload occurs on the Waiau-Koolau #1 138kV transmission line if the Halawa-Koolau and Waiau-Koolau #2 138kV transmission line are out of service. In HECO/CA-IR-14, HECO asked Mr. Kiser to clarify the time period for which the contention is accurate by asking him to identify the years the he analyzed to support his statement. He responded that he had analyzed from 2007 up to 2022 using the load flow cases HECO provided. Thus, based on the response to HECO/CA-IR-14, the Consumer Advocate appeared to be claiming that Koolau/Pukele Lines are not overloaded for the entire 20-year planning period unless both Waiau-Koolau lines are unavailable, yet the testimony in CA-T-1, page 31, acknowledged line overloads in 2012. HECO RT-4 at 8-9.

An overload does occur on the Waiau-Koolau #2 138kV transmission line if the Halawa-Koolau and Waiau-Koolau #1 are out of service and an overload occurs on the Waiau-Koolau #1 138kV transmission line if the Halawa-Koolau and Waiau-Koolau #2 138kV transmission line is out of service. Mr. Kiser acknowledged this conclusion on page 31 of CA-T-1 and clarifies his position in response to HECO/CA-IR-19 and HECO/CA-IR-20. HECO RT-4 at 9.

Based upon the same assumptions and input files as HECO's, his analysis shows an overload of the Halawa-Koolau line occurring in 2007, an overload of the Waiau-Koolau #1 line in 2012 and an overload of the Waiau-Koolau #2 line in 2012. HECO RT-4 at 9. Based on the response to HECO/CA-IR-16, HECO determined that the later overload dates were due to Mr. Kiser's use of a less conservative criterion for when a line overload occurs in the load flow simulation than HECO uses in its load flow simulation. HECO RT-4 at 10-11.

The best approach for planning is for the criterion to identify overloads by using the current flowing through the line, even if the overload occurs at only one end of a line segment. This method identifies line overloads earlier than the Consumer Advocate's approach. By identifying an overload sooner than later, decisions can be made based on the applicable criteria and knowledge of the real world condition of the line segment in question and solutions that may require long lead times to complete due to permitting and scheduling uncertainties can be implemented in a timely manner. HECO RT-4 at 11-12.

Mr. Kiser's methodology did not address the fact that one end of a transmission line could reach its thermal limit and be at risk of permanent damage and failure before the other end of the transmission line reaches its limit. Thus, using Mr. Kiser's definition of a line overload could result in failure of the conductor even though his model does not consider an overload to have occurred. In contrast, HECO's methodology of calculating the forecasted current flowing through the transmission line and comparing this to the current carrying capacity of the line is reasonable and identifies an overload situation sooner rather than later. Identifying overload situations earlier than later allows enough time to implement solutions that may have long lead times due to permitting and scheduling uncertainties. HECO RT-4 at 13.

HECO's analysis supports its position that the Koolau/Pukele Line Overload is an urgent situation. Based on the August 2002 Peak Forecast, the Koolau/Pukele Line Overload was expected to occur in 2005. As provided in HECO-R-406, HECO updated the analysis using the May 2005 Peak Forecast. Although, in general, the May 2005 forecast has a higher growth rates than the August 2002 forecast, the updated analysis also took into consideration 46 kV loads that were shifted from Pukele Substation to Archer Substation in 2004 since the completion of the December 2003 study. Using the 2004 recorded day peak, the May 2005 Peak Forecast, and updated load shifting, the Koolau/Pukele Line Overload Situation is forecasted to occur beginning in 2006, which is deferred by one year compared to HECO's previous analysis. However, the Koolau/Pukele Line Overload Situation is still considered an urgent situation given the estimated completion date for Phase I of EOTP. HECO RT-4 at 14.

VI. HECO'S ABILITY TO DEFER THE OVERLOAD SITUATION IS LIMITED

Load Shifting Capability on the Existing 46kV Subtransmission System

With respect to the Koolau/Pukele Overload, there are some steps in the interim that HECO can take since Phase 1 is not expected to be installed in 2006. The McCully 5 transformer, which is currently fed from the Pukele Substation could be served from the Archer Substation with some minor rewiring work to keep the auto transfer scheme in service for this transformer. In addition, the Manoa 1 transformer could be moved to the Archer Substation with some additional work. Tr. (11/07) at 119-20 (Ishikawa).

However, HECO cannot simply shift 22 MW of load from the Pukele Substation to the Archer Substation or from the Archer and School Substations to the Pukele and Koolau Substations by opening and closing switches, as the Consumer Advocate seemed to suggest. Although, the load shifting may be technically feasible if additional 46kV facilities were installed, the Consumer Advocate reached conclusions based upon overly simple analyses of the HECO 46kV system using the switching diagrams provided as Attachment 1 in response to CA-IR-15. Mr. Kiser should have, but did not (1) analyze the impact on the 46kV backup circuits under no contingencies, (2) identify the overloads on the 46kV back-up circuits under 46kV line contingencies, or (3) consider the affect on the 46kV automatic transfer schemes in its proposed switching scenarios. The Consumer Advocate did not sufficiently consider planning complexities on the 46kV system, including consideration for outages and maintenance when planning the 46 kV system. HECO RT-4 at 6-7, 20-30.

In CA-T-1, pages 31-35 and pages 39-40, Mr. Kiser contended that HECO has the ability to open and close various switches and shift loads between the Koolau/Pukele area and the Downtown Substation area in order to defer overload situations. In general, however, he did not perform significant analysis to support his claim. When asked if any analysis to support the claim that "[t]here is no reason that this load cannot be moved to Archer at this time" (CA-T-1, Page 31, lines 12-16), he maintained in response to HECO/CA-IR-23 that "[n]o analysis is necessary." See also response to HECO/CA-IR-22. Further, in response to HECO/CA-IR-18, he also acknowledged he did not consider the effects of maintenance or construction projects on the 46kV system his analysis. Mr. Kiser's analysis of load shifting was insufficient to support his claims.

There are several types of analysis needed to support shifting load to another substation either permanently or during a line maintenance situation, such as the EOTP contemplates during 138kV line maintenance on the Koolau/Pukele Lines and the 138kV lines serving the Downtown Substations. HECO RT-4 at 20.

The 46kV subtransmission system is a radial system that utilizes automatic transfer schemes from one 46kV circuit to another in order to provide added reliability should a 46kv circuit become unavailable. Before any load shifting can be done, an analysis must be performed on how the load shift will affect the power flowing through the 46kV circuits under normal and automatic transfer situations. The 46kV switching diagrams provided as Attachment 1 in response to CA-IR-15 contain information about the conductor used for each 46kV circuit. The conductor information is used to determine how much current can flow through the circuit without overloading the circuit. It also should be noted that many of the 46kv circuits are not made up of the same size conductor. For example, the Archer 46 circuit is made up of 1500

MCM AL cable, 750 MCM AL cable, 600 MCM cable and 4/0 overhead conductor. Each of the segments has a different current carrying rating and, therefore, different capabilities with respect to the amount of power that can flow through the cable/conductor. HECO RT-4 at 20-21.

Because of the size of the 46kV system (i.e., there are numerous circuits compared to the 32 transmission lines), in order to perform analysis of the 46kV system in a timely manner, estimates generally are used in place of running load flows. These general estimates take into account the maximum load that a 46/12 kV transformer can carry, as well as the maximum load the lowest rated cable on a circuit can carry. For instance, one of the more limiting cables on the 46kV system in the Pukele/Archer area is the 600 MCM cable which can typically carry power equal to approximately two and one-half 46/12 kV 10MVA transformers. A distribution planner will look at a load shifting scenario by ensuring that the 600 MCM segment of a cable will not be carrying more than the load of two or three 46/12 kV 10 MVA transformers. (Based on normal ampacity ratings for a 600 MCM copper cable and 46kV voltage, the cable would be able to carry a load equal to 20 MVA or two transformers loaded at 8 MVA plus one transformer loaded at 4 MVA). When looking at the load on the cable, the distribution planner will consider how automatic transfer schemes affect the load on the cable. Another example of the general estimates used in distribution planning was explained in response to CA-IR-11, pages 12-13, where it states, "as a general rule, a 46kV circuit utilizing a 556.6 MCM aluminum conductor can serve approximately 8 transformers carrying approximately 8 MVA of load for a total of 64 MVA per 46kV circuit." HECO RT-4 at 21-22.

The automatic transfer scenarios also must be analyzed on the 46kV system. When analyzing load shifting scenarios, opening and closing switches to transfer the load is just a portion of the analysis that should be done. The distribution planner will look at a 46 kV circuit and count how many 46/12kV transformers are already being served by the 46kV circuit. The distribution planner will then add the amount of 46/12kV transformers the circuit will be required to carry if the primary 46kV circuits for these transformers are suddenly unavailable. In its responses to HECO/CA-IR-25 and HECO/CA-IR-32, Mr. Kiser explained how he would use the existing switches on the 46kV system to transfer loads. However, he did not analyze the automatic transfer schemes, which could limit how much load can be transferred. HECO RT-4 at 22; see example provided in HECO RT-4 at 22-23.

An automatic transfer scheme is used on the 46kV subtransmission system to transfer loads, served by a 46/12kV transformer, from its primary 46kV circuit to a backup 46kV circuit. The automatic transfer is triggered when the primary 46kV circuit serving a 46/12kV transformer is suddenly unavailable. Relays and equipment at the distribution substation will detect loss of the primary 46kV circuit and will automatically open and close switches within the substation to transfer the load onto the back-up 46kV circuit. HECO RT-4 at 23.

When an automatic transfer scheme is triggered, it results in an outage. Unlike the 138kV network system, the automatic transfer schemes do not provide a seamless transition from the primary 46kV circuit to the back-up 46kV circuit. Triggering an automatic transfer process will result in an outage of up to 6 seconds. The 6-second outage includes the estimated time for the relays and equipment to detect a loss on the primary circuit and for switches to automatically complete their open and close processes. The customer may experience longer outage times for certain pieces of customer equipment that may require additional time to reset and restart. For instance lighting systems may require additional time before the lights perform at full brightness. HECO RT-4 at 23-24.

When automatic transfer schemes are disabled, the reliability of service to the customers served by the specific transformers is temporarily decreased. Instead of experiencing only a 6 second outage, customers could experience an extended outage. The duration of the extended outage would vary depending on each outage situation. For instance, in some cases, service might not be restored to the customer until the primary 46kV circuit is placed back into service, whereas in another case, a primary troubleman would be dispatched in the field to perform manual switching to place distribution transformer loads on their back-up 46kV circuits. HECO RT-4 at 24.

Load Shifting to Defer the Koolau/Pukele Line Overload

In CA-T-1, page 31, Mr. Kiser contended that HECO could shift an additional 13 MW from the Pukele Substation to the Archer Substation to defer the Koolau/Pukele Line Overload. The 13 MW was referenced in HECO T-4, page 38, and represents the approximate load served by the Pukele Substation that will automatically transfer to another 46kV circuit not served by the Pukele Substation upon loss of the two 138kV transmission lines feeding the Pukele Substation. HECO RT-4 at 24-25.

The 13 MW of load represents two transformers: the McCully 5 and the Aina Koa 1 10 MVA transformers. The McCully 5 transformer is currently served by the Pukele 4 46kV circuit and the Aina Koa 1 10 MVA transformer is currently served by the Pukele 1 46kV circuit. Mr. Kiser was correct in stating that the McCully 5 transformer's load could be shifted to the Archer 46 circuit by opening switch 5074 and closing switch 5396. In order to do this, however, HECO would also have to do some minor rewiring at McCully Substation to provide an automatic transfer scheme for the McCully 5 transformer in its new configuration. (It should be noted that HECO shifted this load recently during the Waiau-Koolau #1 splice failure as described in HECO RT-2. HECO is also considering permanently shifting the McCully 5 transformer load to Archer Substation in order to decrease the possibility of incurring a Koolau/Pukele Line Overload during the reconductoring of the single span between Tower 55/56 and Tower 58 on the Waiau-Koolau #1 138kV transmission line (tentatively scheduled for 2006)). HECO RT-4 at 25-16; HECO-R-405.

If the McCully 5 transformer is permanently moved to the Archer 46 circuit some work will need to be done to modify the automatic transfer scheme. Without implementing the modifications on the automatic transfer scheme, upon loss of the Archer 46 circuit, the McCully 5 transformer would not have a backup circuit to switch to and the customers served by the McCully 5 transformer could experience a prolonged outage. The modifications would ensure that upon loss of the Archer 46 circuit, the McCully 5 transformer would automatically be transferred back to the Pukele 4 circuit (with the up to 6-second delay inherent in the automatic transfer scheme). HECO RT-4 at 26.

By shifting McCully 5 transformer load to the Archer 46 circuit, the Koolau/Pukele Line Overload would be deferred by approximately one year. Although the overload is deferred, the duration of the deferral is only one year and the Koolau/Pukele Line Overload is still an urgent situation. HECO RT-4 at 26-27.

The load on the Aina Koa 1 10 MVA transformer cannot be moved to the Archer Substation, as proposed by the Consumer Advocate. As shown on page 4 of Attachment 1 in response to CA-IR-15, the Aina Koa 1 10 MVA transformer is currently served by the Pukele 1 46kV circuit. If the Pukele 1 circuit is unavailable, the Aina Koa 1 10 MVA transformer will automatically be transferred to the Wailupe-Aina Koa 46kV circuit that is currently serving the Aina Koa 1 3.75 MVA transformer. In HECO T-4, page 38, HECO stated that about 7% (approximately 13 MW) of load would automatically be transferred to Archer Substation upon loss of the 138kv transmission feeds to the Pukele Substations. This statement should be corrected to say "Under the current 46kV subtransmission system, some automatic load transfers will occur to enable Archer Substation and Koolau Substation to pick-up about 7% or about 13 MW of the 192 MW total Day Peak load currently served by the Pukele Substation." Under the existing system, the Aina Koa 1 10 MVA transformer would be automatically transferred to the Koolau Substation. This transfer has no effect on deferring the Koolau/Pukele Line Overload Situation, since the Aina Koa 1 10 MVA transformer load would be served by the Koolau Substation. HECO RT-4 at 27.

In addition, Mr. Kiser, claimed in CA-T-1, page 34, that three circuits from Archer could be tied to the Pukele circuits without system modifications, which would transfer approximately 22 MW of load served by the Pukele Substation to the Archer Substation. It is possible to perform some of the switching and load shifts; however, performing the load shifts would disable some of the 46kV automatic transfer schemes which would affect the reliability of the 46kV system. Therefore, this switching would only be considered on a temporary basis under emergency conditions (as a precaution, similar to how HECO responded the Waiau-Koolau #1 situation) and is not a candidate to be implemented on a permanent basis to defer the Koolau/Pukele Line Overload. HECO RT-4 at 27-28; see example provided in HECO RT-4 at 28.

HECO also addressed the other two switching examples cited by the Consumer Advocate in response to HECO/CA-IR-25; which cannot be done because it would overload the subtransmission circuits.

First, the Consumer Advocate contended that the Waikiki 2 transformer could be transferred to the Archer 42A circuit. Performing the suggested switching would affect the reliability of all four Piikoi transformers, because the automatic transfers between the Archer 44A, Archer 42A and Pukele 5 would need to be disabled, which would eliminate any backup 46kV circuits for these transformers. The proposed switching would affect the reliability of the Piikoi 3 and 4 transformers, which are served by the Archer 42A circuit. If the proposed switching was done, the portion of the Pukele 5 circuit interconnecting at the Piikoi Substation would become a part of the Archer 42A circuit. Upon loss of the Archer 42A circuit, the Piikoi transformers 3 and 4 could not automatically be transferred to the 44A circuit, because the connection of the Archer 42A circuit is in between Piikoi transformer 1 and 2, and transformer 3 and 4, and there would be no isolation of the Archer 42A circuit. In addition, if the switching were done to place the Waikiki 2 circuit onto the Archer 42A circuit, the automatic transfer of the Piikoi 1 and 2 transformers would be disabled. If the auto transfer were not disabled and the Archer 44A circuit experienced an unexpected outage, the Piikoi 1 and 2 transformers would automatically transfer to the Archer 42A circuit and would overload the 600 MCM cable going back to the Archer Substation with load from all 4 Piikoi transformers plus the load from the Waikiki 2 transformer. With the switching suggested by Mr. Kiser, even under normal conditions for the Archer 42A circuit and with the Waikiki 2 transformer connected to this circuit, upon loss of the Pukele 2 46kV circuit, the Waikiki 1 transformer would automatically transfer to the Archer 42A circuit, and this would result in an overload on the Archer 42A circuit (which would be serving the Piikoi 3 and 4, and Waikiki 1 and 2 transformers). HECO RT-4 at 28-29.

The third suggested switching scenario, which is to transfer the McCully 5 transformer onto the Archer 46 circuit can be done, and is a project that HECO is looking to implement in light of the Waiau-Koolau #1 reconductoring project scheduled for 2006. HECO RT-4 at 29-30.

In summary, there is not an additional 22 MW to switch to the Archer Substation to defer the Koolau-Pukele Line Overload Situation. The load served by the McCully 5 transformer could be moved to the Archer Substation, which would defer the Koolau-Pukele Overload Situation by only one year. HECO would still characterize the Koolau/Pukele Line Overload Situation as urgent even with the one-year deferral. The other switching suggestions are not possible to implement in a permanent manner and, therefore, would not defer the Koolau/Pukele Line Overload Situation. HECO RT-4 at 30.

Load Shifting to Defer the Downtown Line Overload

In CA-T-1, pages 39-40, Mr. Kiser suggested that 46kV ties from the Downtown Substation to the Pukele and Koolau Substations could be done during maintenance periods to defer the Downtown Line Overload Situation. Again, he identified switching in response to HECO/CA-IR-32, but he did not perform an analysis on the power flowing through the cables or the automatic transfer schemes in order to determine if the plan was valid. None of the switching suggestions could be implemented even under a maintenance situation. HECO RT-4 at 30-33.

Additional detailed analysis of 46kV circuits and automatic transfers would be required in order to create plans to address the Downtown Overload, which may require that additional facilities be installed. HECO RT-4 at 33.

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EXHIBIT "C"

NEED FOR ARCHER D TRANSFORMER

EOTP includes the use of the 46kV subtransmission system to address the transmission system contingency of loss of both Koolau-Pukele 138kV lines. EOTP relies upon Archer substation to backup the 46kV load served by Pukele substation upon the loss of both Koolau-Pukele 138kV lines. In contrast, HECO's sub-transmission planning criteria provides backup capacity upon the loss of a single 46kV circuit. The amount of load requiring back-up is greater for the Pukele Substation contingency compared to the subtransmission criteria of a loss of a 46kV circuit. In order to ensure sufficient 138kV-46kV transformation capacity at Archer for this transmission system contingency, a fourth transformer, the Archer D transformer, is required for Phase 2 of the EOTP 46kV Phased Project.

In CA-T-1, Mr. Kiser's analysis of the transformation available at the Archer Substation was incomplete. Mr. Kiser summed the load served by the Archer Substation under the Pukele Substation Reliability contingency for the years 2009 and 2021 and compared the summed load to the sum of the emergency ratings (capacity) for the three Archer transformers. It should also be noted that the system utilization study, to which Mr. Kiser[1] refers includes the simplistic calculations of summing the load on the transformers and comparing this to the emergency ratings of the three Archer transformers. The analysis is not complete and results in an incorrect conclusion, because the simplified calculations can only be used for this purpose if the transformers at the Archer Substation are installed in a network configuration. Review of the 46kV switching diagram provided in response to CA-IR-15 shows that HECO's distribution substations, including the Archer Substation, are not networked. Each transformer serves the load for specific 46kV circuits under normal and N-1 46kV contingencies. HECO RT-4 at 66.

Although networking the bus at Archer substation could technically avoid the need for a fourth transformer in the near-term, networking would require the replacement of existing substation equipment as they will need to be sized for higher load currents that could occur in a networked system. In order to network the Archer Substation to utilize the capacity of the three 138-46kV transformers to serve both the Archer and Pukele loads under the loss of the two 138kV lines to the Pukele Substation, HECO would need to build a new Archer transmission substation as the existing Archer substation structure is too small to modify the substation into a network configuration and accommodate the higher current rated components. In combination, these requirements to convert Archer substation to a network configuration are estimated to cost significantly more than the cost of a fourth 138kV-46kV transformer at Archer substation (Archer D). Therefore, maintaining Archer substation in a radial configuration and the installation of an Archer D transformer along with other proposed work in Phase 2 of EOTP is the preferred solution to addressing the transmission contingency of loss of both Koolau-Pukele 138kV transmission lines.

HECO's response to CA-RIR-35 provides an example of how HECO designs the substation equipment for a radial 46kV system. The radial design is coordinated using the MVA rating of the transformer down to the rating of individual feeders the transformer is feeding. Using a network design of the 46kV system would increase the cost of the equipment used in substations, because equipment would need to be sized for higher load currents that could occur in a networked system. In order to network the Archer Substation to utilize the capacity of the three 138-46kV transformers to serve both the Archer and Pukele loads under the loss of the two 138kV lines to the Pukele Substation, HECO would need to build a new Archer transmission

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1 Tr. (11/8) at 266 (Kiser).

substation, which would cost substantially more than installing one 138-46kV Archer D transformer; as proposed by HECO. In addition, a networked 46kV system would require HECO to develop models of the 46kV system that would be used for planning the system, because a networked 46kV is more complex to analyze than a radial 46kV system.

Included in page 4 of this exhibit, is a table from the response to CA-RIR-35, which shows loads for Archer transformers and Kamoku transformers in the year 2009 under two scenarios. The first scenario (tabulated in the first column of data) is based upon having only the three existing transformers at Archer Substation upon completion of the Kamoku 46kV Underground Alternative - Expanded project. The second scenario (tabulated in the second column of data) is based upon having a fourth transformer at Archer Substation (Archer D) upon completion of the Kamoku 46kV Underground Alternative - Expanded as proposed. The 2009 load demand served by each 46kV circuit was included in the file "dp09_eotp46ph2_emerg.raw" provided in response to CA-IR-11. Under the first scenario, the table shows (assuming no 46kV subtransmission contingency, i.e., where all three transformers at the Archer Substation are in service) that if HECO loses the Pukele Substation and all its load is transferred to Archer Substation, there will be loads on the three Archer Substation transformers that exceed both the normal (83 MVA) and emergency (110 MVA) transformer ratings of Archer A and the normal (83 MVA) rating of Archer C. In contrast, under the second scenario with the Archer D transformer, there is no exceedence of either the normal or the emergency rating on any of the transformers under the same outage conditions (loss of Pukele Substation, transfer of its load to Archer Substation, and all Archer transformers in service). Thus, the table shows that HECO will require the Archer D transformer in order to prevent overloading Archer Substation in the situation where there is a loss of the Pukele Substation.

HECO used the 2009 case and the forecasted load data, because this was the first year in which Phase 2 of the Kamoku 46kV Underground project was to be in service. The load served by the Archer Substation is expected to grow in the years beyond 2009. The table estimates the results in 2022, using the 2009 load demand from the load flow case "dp09_eotp46ph2_emerg.raw" provided in response to CA-IR.-11, as escalated by the growth rate contained in the August 2002 forecast. (The escalation can be derived from Exhibit 5 to the Application. Table C-1. In order to develop the loads at the Archer Substation under the Pukele Substation Reliability contingency for the year 2022, the 2009 Archer Substation loads in CA-RIR-35 is then multiplied by 1.1084.) The third column in the table, titled "2022 Using August 2002 Escalation", shows the load demand served by the Archer substation under the Pukele contingency without the fourth transformer. Both the Archer A and Archer C transformer will exceed their emergency ratings of 110 MVA for the Archer transformers assume a 1% loss in life. With the Archer D transformer installed, the sixth column with the same "2022 Using August 2002 Escalation" title shows the 2022 load demand served by the Archer Substation under the Pukele contingency with the Archer D transformer. The Archer C and D transformers begin to reach their normal load limits, but there are no emergency loads at or above the emergency ratings for the transformers.

Mr. Kiser suggests in CA-T-1 that once the Pukele Substation Reliability contingency occurs, HECO could switch additional load from the Pukele Substation to other substations such as the Koolau Substation. As explained in HECO RT-4, pages 65-66, there is load that could be manually switched from the Pukele Substation to the Koolau Substation. This is the same load that would require up to 2 to 4 hours to manually switch to the Koolau Substation under Phase 1 of the 46kV Phased Project. It is unclear, however, what the Consumer Advocate is advocating in this situation. Mr. Kiser points out that in order to switch the 54 MW from the Pukele Substation to the Koolau Substation, manual switching would be required, as HECO has indicated.[2] Mr. Kiser points out that this may be acceptable since this is considered an emergency situation. HECO is proposing to install the additional 46kV circuits and the Archer D transformer as part of 46kV Phased Project in order to reduce the outage time for the customers that must be manually switched. If the equipment is installed, this would provide the ability for these circuits to be switched automatically, which would reduce the outage time from 2 to 4 hours down to 6 seconds or less.

Mr. Kiser suggests that switches in the field along the 46kV circuits could be added in order to automatically switch load from the Pukele Substation to the Koolau Substation, which would avoid sending crews in the field to perform the switching.[3] There is a difference between automatic switching, remote switching and manual switching. Automatic switching such as the automatic transfer schemes occur in a matter of seconds and is done through relaying and communication between relays. Automatic switching schemes do not require dispatcher action to complete, therefore the implementation time to complete the switching is done quickly (up to 6 seconds). In considering an automatic switching scheme, HECO reviews the size of the transformers and the 46kV circuits to ensure there is adequate capacity under normal conditions and considering these automatic transfer schemes. This is important since these schemes take place automatically and it would be poor planning and designing to implement an automatic process, which could place the 46kV system in an overload condition, and would require manual or remote switching to correct for the overload. Adding the Archer D transformer and adding additional 46kV lines as proposed in Phase 2 of the 46kV Phased Project will allow HECO the ability to have adequate capacity to perform the automatic switching. Remote switching also requires communication between the switches and the system controlling the switches, which could be HECO's Energy Management System ("EMS"). As explained by Ms. Ishikawa,[4] most of the 46kV system is not on SCADA, which means that various 46kV switches cannot be controlled through the EMS or automatically through relaying as suggested by Mr. Kiser. In addition, remote switching requires dispatcher action to implement the switching by executing the command through the EMS. The switch in the field will receive the signal from the EMS and implement the action (either close or open). The required time to implement the switching would depend on how quickly the dispatcher could implement the switching and must include knowledge of what has occurred on the system. Remote switching would require at the minimum, several minutes or more to implement and increases the outage time to the customer compared to the 6 seconds or less with an automatic transfer scheme. As discussed before, HECO can perform manual switching to switch the remaining Pukele load to the Koolau Substation, which would require up to 2 to 4 hours to implement because crews must be sent out in the field to perform the switching. Installing the Archer D transformer and the proposed circuits as part of the Phase 2 of the 46kV Phased Project would reduce the outage time for these customers from 2 to 4 hours down to 6 seconds or less.

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2 Tr (11/8) at 267 (Kiser).

3 Tr. (11/8) at 267-68 (Kiser).

4 Tr. (11/7) at 139-40 (Ishikawa).

Group	Without Archer D TSF Circuit	2009 Load Load (MVA)	2022 Using August 2002 Escalation Load (MVA)	With Archer D TSF Circuit	2009 Load Load (MVA)	2022 Using August 2002 Escalation Load (MVA)
Archer A	Archer 41	44.72	49.24	Archer 41	44.72	49.57
	Archer 42A	18.81	20.71	Archer 42A	18.81	20.85
	Archer 48	51.77	57.00			0.00
	Total	115.30	126.96		63.53	70.42
Archer B	Archer 43	21.94	24.16	Archer 43	21.94	24.32
	Archer 44A	27.20	29.95	Archer 44A	27.20	30.15
	Total	49.14	54.11		49.14	54.47
Archer C	Archer 45	22.13	24.37	Archer 45	22.13	24.53
	Archer 46	52.62	57.94	Archer 46	52.62	58.32
	Archer 47	25.41	27.98			
	Total	100.16	110.29		74.75	82.85
Archer D		264.60	291.35	Archer 47	25.41	28.16
				Archer 48	51.77	57.38
	Total				77.18	85.55
Kamoku	Kamoku 41	45.32	50.23	Kamoku 41	45.32	50.23
	Kamoku 42	26.69	29.58	Kamoku 42	26.69	29.58
	Total	72.01	79.82		72.01	79.82
	Grand Total	336.61	371.17		336.61	373.10

Notes:

1. Normal continuous rating for 80MVA transformers is 80 MVA.
2. Emergency rating for 80MVA transformers is 110 MVA.

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EXHIBIT "D"

TRANSMISSION PLANNING

I. TRANSMISSION PLANNING OVERVIEW

HECO retained an expert transmission system planner, Mr. Randall Pollock, Senior Vice President, Power Engineers, Inc. ("Power Engineers"), to provide an overview of the transmission (and sub-transmission) planning process, to review HECO's updated studies and conclusions regarding the need for the EOTP, and to assess HECO's planning process.

Mr. Pollock has been actively working as an engineer in the electric utility industry for over 30 years, 9 years for an electric utility, Pacificorp, and 24 years for Power Engineers, an internationally recognized consulting firm for electric utility engineering. He has completed load forecasts and electrical system planning studies, designed transmission lines and substations, done project cost estimates and cash flows, specified and procured electric system equipment and materials, worked side by side with electric system operations, and provided construction management, project management and general consulting services for electric utility projects. As one of Power Engineers' most experienced engineers, Mr. Pollock functions as a Senior Project Manager for electrical utility projects and also mentors younger engineers. In the 24 years that he has been with Power Engineers, the company has grown from a small regional firm with about 20 employees to a 600+-person firm with offices throughout the U.S. and internationally. Tr. (11/07) at 61-62 (Pollock); HECO T-3 at 1-4; HECO-300.

A. Transmission System Planning Overview

The planning process for electric utility systems must be comprehensive and address a number of system, operational, and financial issues:

(1) Decisions must be made well in advance of the projected need date because permitting and construction of facilities and/or implementation of projects can take many years.

(2) Decisions are long-term. Utility infrastructure will, with regular maintenance and component replacement, remain in service indefinitely, for all practical purposes.

(3) Because planning decisions contemplate the installation of facilities such as substations, generation plants, and transmission lines that have a very long life, consideration must be given to the future electrical system as a whole, in addition to the solution of the most immediate problems.

(4) The analysis must be forward looking, with load forecasts based on the information available at the time of the study.

(5) The system analysis is based on the measured and projected electrical load at each substation and existing/planned generation additions.

(6) To facilitate financial and operational planning, the study recommendations that result based on specific load levels are translated to dates (year of need) based on the load forecast.

(7) The technical analysis is conducted based on previously approved planning criteria, applied with judgment, to arrive at recommendations.

(8) Recommendations that result from the study must balance system performance, including reliability, against cost.

(9) The study process is an ongoing activity to take into account the changes over time to the forecasted load levels in any given year. Thus, planning studies must be performed on a regular basis to keep up with changes. HECO T-3 at 4-5; Tr. (11/07) at 62-63 (Pollock).

Planning studies are necessarily forward looking, and are based on information relevant at the time of the preparation of the study. Historical information and information from previous studies may be used to the extent it is useful in making and evaluating forward-looking projections. Load forecasts based on known development plans, economic factors, and historical load growth are needed. Detailed data on the historical and forecasted loads on individual substations and transmission and distribution lines are needed in order to construct a system model. With this data, a system model is constructed to serve as a tool to analyze the system. HECO T-3 at 5.

The primary analytical tool for modeling system performance is load flow analysis. Load flow analysis is performed with the aid of computers and determines the flow of electricity (loading) through lines and transformers along with voltages on the system. HECO T-3 at 5-6.

The results of the load flow studies allow the planning engineer to identify which system elements (lines, transformers or circuit breakers for example) will become overloaded under normal (all elements in service, "best case") and during outage conditions. The outage conditions studied include taking each system element out of service (a single contingency) and determining the resulting system voltages and load flows. Additionally, the system is studied with multiple system elements out of service (multiple contingencies, "worst case") which in general will result in a greater loss of system load. HECO T-3 at 6.

Costs must be weighed against future system performance, which includes reliability, in virtually every planning study. A power system that serves large loads, as well as loads that are particularly important to a community's financial well being, warrants a more robust system to avoid the direct economic impact and social disruption that result from power outages. The consequences of an outage of a particular system element, such as a transmission line, transformer, circuit breaker, or combinations of several of these items, must be considered in recommending system improvements. For example, the loss of a transmission line serving a 200 MW load would be more important than a distribution line serving 2 MW of load. One can afford to spend more money to make the transmission line more reliable (less susceptible to outages) than for the distribution line. Similarly, the loss of a residential load is not as critical as the loss of a commercial load. One reason is because residential customers can typically defer activities until the power is restored, whereas for commercial customers the opportunity to conduct a transaction is lost, and may never be recovered. In general, higher reliability systems will cost more to construct, and so the more costly improvements must be reserved for instances where critical or larger blocks of load are affected. HECO T-3 at 6-7.

In HECO's case, long-term transmission planning analyses covering time periods ranging from 6 to 20 years and short-term analyses covering a period of five years or less are conducted. The analyses utilize load flow programs, which model the characteristics of the actual 138kV system. The load flow simulations are forward looking simulations and are used to determine voltages at substation busses and the amount of current flowing through the 138kV transmission lines based upon load forecasts at the substations and various configurations of the HECO system. Transmission Planning Criteria violations and transmission concerns are identified. Solutions are formulated and load flow simulations are used to test the solutions against HECO's Transmission Planning Criteria. Transmission projects are recommended using the HECO Transmission Planning Criteria as a minimum guideline. Recommendations are also based upon other factors including (1) engineering design criteria, (2) operational experience, (3) risks involved and (4) financial constraints. HECO T-4 at 4.

B. Development of System Planning Criteria

Electric system planning criteria form the basis for planning and evaluating an electrical system. The currently approved planning criteria have been developed over time and are based on successful utility practice and lessons learned from outages.

The development of planning criteria is an ongoing process and the criteria are continually subject to review and discussion to address the many issues associated with operation of the high voltage electrical system. Over the past decades, the system has become more "interconnected" and new technologies have been introduced. As a result, the complexity of planning and operating the system has increased dramatically. While the basic planning criteria are well established, the increased complexity of the system combined with the improvements in technology necessitates a continual refinement of the planning process. HECO T-3 at 9.

In HECO T-3, Mr. Pollock highlighted several major U.S. outages over the past 40 years and discussed a number of the lessons learned from the outages as related to the system planning process. He also described the blackout on the Oahu transmission system which occurred on July 13, 1983. Lessons learned from that outage and mainland outages include that the HECO planning process must address the impacts of single and multiple contingency outages in compliance with the planning criteria. Tr. (11/07) at 65 (Pollock); HECO T-3 at 7-8.

The lessons learned noted with each description below represent only a fraction of the lessons learned from each outage, and are presented in the context of this discussion regarding planning criteria. HECO T-3 at 9.

(1) Northeast Blackout (1965) - The system must be designed to withstand the more probable outages so that the power system remains stable. HECO T-3 at 9-10.

(2) New York City Blackout (1977) - Stronger interconnections with neighboring systems are beneficial in maintaining system reliability and stability. HECO T-3 at 10. As an isolated island system, HECO does not have interties with other systems, but it can strengthen the interties between the North and Southern transmission corridors.

(3) Western States Cascading Outage (1994) - Multiple contingency events do occur and should be addressed in system planning studies. HECO T-3 at 10.

(4) Western States Outage (1996) - Planning and designing for N-1 contingencies is not enough. Rare multiple contingency outages do happen and in some cases the cost of the resultant outage can be unacceptably high, both financially and socially. Multiple contingency outages (outages of more than one system element) must be included in system planning studies. HECO T-3 at 11.

(5) Northeast/Midwest US Blackout (2003) - There are many lessons to be learned from this outage. A few relevant to this discussion include: (a) Rare multiple contingency outages do happen and in some cases the cost of the resultant outage can be unacceptably high, both financially and socially; (b) In addition to studying the more probable single contingency outage scenarios, multiple contingencies (outages of more than one system element) must be included in system planning studies, recognizing that while they may have a low probability of occurrence they still can and do happen; and (c) The interconnected system is extremely complex, and reliable computer systems and real time communications between adjoining system operators are critical to maintain system integrity. HECO T-3 at 11-13.

HECO's Oahu transmission system has experienced outages similar to the outages described as part of Mr. Pollock's "lessons learned" examples. For example, on July 13, 1983, a combination of unusual events triggered what ultimately resulted in a system wide blackout on Oahu. Key lessons learned from this outage are similar to the lessons learned in other areas of the country: outages that have a low probability of occurrence do in fact occur, and should not be minimized in the planning process. Rather, these "less probable" outages must be addressed in planning studies. HECO T-3 at 14.

The electric system planning criteria as set forth by the NERC (an acronym for the North American Electric Reliability Council) describe the basic industry accepted system planning criteria. The NERC was established subsequent to the 1965 blackout that affected much of the northeast and Canada. One of the key purposes in the establishment of NERC was to formulate specific standards for system planning, to improve the performance of the electric system and prevent blackouts. Tr. (11/07) at 65-66, 75-78, 82-84 (Pollock); HECO T-1 at 8, 14-15.

Transmission system planning criteria have developed over time based on successful utility practice and as a result of lessons learned from major and minor outages. These planning criteria, developed from experience, form the basis for planning and evaluating the performance of the electrical system. As electrical transmission systems grow, new complexities are continually introduced into the planning and operations of the system. As the complexity of the transmission system increases, new problems crop up and the system planning process must respond to these new demands, to assure the continuation of a robust and reliable transmission system. While 100% reliability (no outages) is unattainable, the system must be planned, designed, and operated to withstand foreseeable and reasonable contingencies without loss of load, and to provide for overall system integrity during the more extreme and less probable outages. Past outage experience has taught the industry that extreme events do occur, despite everyone's best efforts. Thus, the system must be robust enough to withstand not only the more probable outages, but also to remain stable during the more extreme and less probable outage scenarios, even if this means some loss of customer load. HECO T-3 at 18-19.

The NERC planning criteria that have been developed since 1965 and that are in current use are deterministic, as opposed to probabilistic. Deterministic criteria are rule based, and outline specific criteria or rules, that govern system performance under the various normal and outage system scenarios described in the criteria. There are no NERC standards that describe probabilistic transmission planning criteria. The current industry accepted approach to the system planning process is to apply the approved deterministic criteria to configure a system that complies with those criteria. Tr. (11/07) at 65-66, 89-94 (Pollock); HECO T-1 at 15-20.

C. <u>HECO's Planning Criteria and the Application of HECO's Criteria to the EOTP</u>

HECO's planning criteria were formulated based on NERC and other mainland reliability council experience. As a result of review of the HECO transmission planning criteria, Mr. Pollock concluded that the HECO planning criteria are appropriate for the Oahu system and are consistent with NERC Planning Standards, and as with the NERC criteria, are deterministic. Tr. (11/07) at 67 (Pollock); HECO T-3 at 20, 28.

With respect to application of the planning criteria to the EOTP, the criteria require that planned maintenance activities be accounted for in the system planning process. For example, a concern is that in considering the two 138kV lines feeding the Pukele Substation, if one line is out for maintenance and then the second line fails, that an outage to the customers served from the Pukele substation will occur. While the HECO planning criteria do not specifically require that all loads continue to be served under this contingency scenario, it must be understood that the criteria are written for the system as a whole, and that engineering judgment must be applied when conducting system studies. Tr. (11/07) at 67-68 (Pollock).

Planning criteria specify the minimum standard of performance across the entire system, not maximum requirements, and it is expected that each utility identify specific situations that warrant system improvements that may exceed the system-wide planning criteria. Tr. (11/07) at 68 (Pollock).

With regard to the Pukele Reliability Concern, the Pukele service area is important because it serves 16% of the Oahu load, including the economically important Waikiki area. The two Koolau 138 kV lines feeding the Pukele substation are more than 40 years old, and maintenance activities on these lines are difficult due to the limited and sometimes hazardous access to the Koolau Mountains. The lines are also exposed to higher winds and corrosive weather in the mountains. These issues cause these lines to be at a relatively higher risk than the transmission lines in other areas of the island. Because of the geographical location of these 138kV lines and the relative size and importance of the load served by Pukele, providing for an alternate source of supply to the Pukele Substation during the maintenance scenario described is warranted. Tr. (11/07) at 68-69 (Pollock).

D. Not All Substations Need Three Lines

HECO's transmission planning criteria do not require that all substations be served by three 138kV transmission lines, so that no customers lose service if a line trips out of service while another line is out of service for maintenance. Section IV.3 of HECO's transmission planning criteria requires that with any transmission line out of service for maintenance and then a second line fails unexpectedly, no transmission component will exceed its emergency rating. The criteria goes on to say that the purpose of this criterion is to help assure that the system will survive and that all loads may not continue to be served. HECO T-3 at 21-22; HECO T-4 at 41-42.

HECO's planning criteria do not require that it be able to maintain service to all customers in the event of this type of double contingency transmission line outage; HECO recognizes that it may be necessary to drop customers in order to prevent catastrophic system failure under certain emergency conditions. As a result, the criteria recognize that it may be acceptable, in some instances, for some customers to temporarily incur outages when two transmission lines are out of service. In other words, it may be acceptable to have substations receiving power from only two 138kV lines, where customers receiving primary service through that substation will incur outages when both lines are out of service (if they do not receive alternate service through another substation during the outage). HECO T-3 at 22; HECO T-4 at 41-42.

The HECO criteria are actually less demanding than the NERC criteria with respect to double contingencies. The NERC Planning Standards require that important loads continue to be served with a single line outage occurring when one line is out for maintenance, whereas the HECO criteria do not require that all loads continue to be served for this contingency. At the same time, planning criteria generally are intended to set minimum guidelines, rather than maximum requirements, and reliability concerns not explicitly addressed by the criteria can and should be considered by HECO's transmission system planners. This is particularly important in the case of HECO, which is not interconnected to other systems. HECO T-3 at 23-25.

Mainland utility systems are designed based on providing system reliability, with dependence on neighboring systems as a fundamental part of the stratagem, in order to develop a reliable power system at the lowest overall cost. Since there are no "neighboring systems" on Oahu, it makes sense that HECO's criteria may not be as strict as those on the Mainland, but that HECO needs to be conservative and take care in the application of its criteria. HECO T-3 at 25.

That does not invalidate HECO's concern about improving the reliability of its Pukele substation. Transmission planning criteria, including HECO's criteria, generally establish minimum guidelines, not maximum requirements. While it is not practical, and therefore not standard practice, for transmission planning criteria to address all double contingencies, it is good engineering and operating practice (i.e., prudent transmission planning practice) to plan and design utility systems to withstand double contingencies without loss of customer load, where important customer loads are involved, and double contingencies are reasonably foreseeable. HECO T-3 at 22, 25-26.

Thus, the statement in the HECO criteria that "all loads may not continue to be served" is not intended to imply that failing to serve the electrically large and important Downtown core business district and the Waikiki tourism based loads is an acceptable outcome should a transmission line fail while another line is out for maintenance. By way of contrast, the loss of a smaller amount of primarily residential load may be an acceptable outcome based upon the relative impact of the outages. In this way the planning process can allow experience and judgment to be applied to the system planning process to treat the various load centers with consideration as to size, importance and other factors. HECO T-3 at 22-23, 26, 28; HECO T-4 at 41-42.

Among the various factors considered in evaluating the reliability of service to a particular 138kV substation, HECO examines the size of the electrical demand being served, the criticality of the electrical demand, and alternative means readily available to serve the demand within the substation's service area in the event the transmission lines are unavailable. HECO T-4 at 42.

In this case, HECO has proposed the EOTP, in part, because of the importance of the Waikiki load and the fact that the Pukele substation is the most heavily loaded substation on Oahu. The Pukele substation serves a large portion of the Oahu load (approximately 16%), including the important Waikiki commercial and hotel loads, as well as the residential and commercial loads inland. The two 138kV lines feeding the Pukele substation are more than 40 years old, and maintenance activities on these lines take more time and are more difficult than for 138kV lines along City and State roadways in town, due to the limited and sometimes hazardous access to the Koolau Mountains. The lines are also exposed to higher winds and corrosive weather in the mountains. The very difficult access to the lines as they cross the Koolau Mountains, their exposure to corrosive marine air, and the location of the two lines on a common right of way, cause these lines to be at a relatively higher risk than the transmission lines in other areas of the island. HECO T-3 at 27, 29.

The reliability of other transmission substations served by only two 138kV transmission lines, for example the Wahiawa Substation and Archer Substation, is of less concern, for a number of reasons. Wahiawa Substation supplies around 10% of the island electricity demand, however, the service area is primarily rural and residential in nature. Further, most of that electricity demand is backed-up by the existing 46kV system in the area. At present, if one transmission line to Wahiawa Substation is out of service for maintenance and the other line fails, approximately four-fifths of the service area's electricity demand will automatically transfer to other 46kV circuits in the area, with those customers experiencing a momentary outage of only 6 seconds. Thus, only one-fifth of the service area electricity demand would remain without electricity until one of the 138kV lines to Wahiawa Substation is restored. HECO T-4 at 42-43.

The Archer substation serves about 8% of the system load, and is located in downtown Honolulu, but only receives power, at present, from two 138kV transmission lines. As a result, there is a concern with respect to the Archer reliability situation. (Archer would have received power from a third 138kV line had HECO been able to complete the Kamoku-Pukele 138kV line.) However, the Archer reliability concern is not as critical as the Pukele reliability concern because (1) the two 138kV lines feeding the Archer Substation are approximately 14 years old compared to the over 40 year old Koolau-Pukele Lines; (2) the two 138kV lines Archer feeds are only two miles long, which reduces the exposure to outages compared to the Koolau-Pukele lines, which are approximately three times longer; (3) the Archer 138kV feeds are underground lines, generally, overhead lines are more vulnerable to adverse weather conditions and objects contacting the line, and require more frequent repair, while underground lines tend to have less frequent outages, however faults or problems with underground lines are harder to detect, and take longer and are more costly to repair; and (4) the Pukele Substation is the most heavily loaded substation on the HECO system and serves approximately twice the load of the Archer Substation. HECO T-4 at 43-44.

E. System Planning Process Overview

Mr. Pollock reviewed HECO's planning process and concluded that HECO has conducted and is conducting a proper planning process.

To assess if HECO's planning process is proper, he reviewed the relevant planning studies HECO has completed from 1984 through 2003. HECO-R-301 summarizes his review of the studies. See HECO RT-3 at 5-20. Because conducting system studies is an ongoing process, with current studies building on, updating, and re-evaluating past studies, it is important to look at the continuum of studies over a long period, rather than to focus on individual aspects of the study process. His review of the studies conducted indicates that HECO has conducted a proper study process and has properly addressed 138kV transmission, 46kV sub-transmission and distribution system issues in the various studies. Tr. (11/07) at 64 (Pollock); see HECO RT-3 at 4-5, 35-36.

These studies include both HECO's internally prepared studies and engineering studies completed by experienced consulting firms. Taken as a whole, these studies provide a comprehensive analysis and recommendations to address the problem areas on HECO's system that were identified as needing resolution to provide for a reliable system in East Oahu and to comply with system planning criteria. Tr. (11/07) at 64-65 (Pollock); HECO T-3 at 21.

Mr. Pollock's assessment indicates that HECO's planning process is and has been a proper and comprehensive planning process, and that HECO's planning process is conducted consistent with current electric utility industry practices. Tr. (11/07) at 65 (Pollock); See HECO RT-3 at 3-4, 20.

F. Studies Supporting Need for the EOTP

The recommendation to install a 138kV line to the Pukele Substation was first introduced in Stone & Webster Management Consultant report, completed in February 1984, entitled Hawaiian Electric Company, Investigation of July 13, 1983 Blackout. The Pukele Substation Reliability Concern was introduced in September 1986 Pukele 138KV Source Reliability Improvement Study, updated in October 1991. HECO T-4 at 44-46; HECO RT-4 at 2; HECO RT-3 at 7.

Additional detailed planning studies were conducted to confirm Stone and Webster's recommendation, and to identify specific system improvements. HECO commissioned and a detailed study was completed by Southern Electric International ("SEI") in January 1989. The study, HECO Transmission and Distribution Study 1989-2008, specifically incorporated transmission, sub-transmission and distribution. The stated objective of this report was to "Evaluate the HECO electrical system over a 20 year period, assess future operating voltages for transmission, sub-transmission and distribution service, and develop alternative transmission, sub-transmission and distribution expansion plans which will provide for reliable service on the Island of Oahu over the next 20 years." The study also recommended construction of an underground/overhead transmission corridor between Pukele and Archer and through the Kamoku site. HECO RT-3 at 7-8.

After completion of the SEI study, HECO conducted and completed the 1991 East Oahu 138 kV Requirements study (July 1991), which was updated in August 1992, and continued to conduct additional studies focused on serving the East Oahu load region. For example, the Long Range Transmission Study, 1993-2013, completed by HECO in March 1994, recommended that the Archer – Pukele 138kV Circuit or an Alternative Project be constructed. HECO RT-3 at 8.

HECO also considered alternatives other than construction of a third line into Pukele to solve the identified system problems. The Kamoku – Pukele 46kV Alternatives Study, completed in August 1994, assessed the viability of 46kV alternatives to solve the problems identified in the previous studies, consistent with the recommendation from the Long Range Transmission Study, 1993-2013 and the SEI prepared HECO Transmission and Distribution Study 1989-2008. HECO RT-3 at 8-9.

The 1994 Kamoku – Pukele 46kV Alternatives Study evaluated 46kV radial and network alternatives against the previously studied 138kV Kamoku-Pukele alternatives. The 46kV alternatives studied considered load transfers and switching options, as well as other issues, to solve the identified system problems. The study was based on the information available in 1994 regarding loads, load forecasts and generation retirements/additions, including the planned retirement of the Honolulu Power Plant ("HPP"). The results of the analysis summarized in the Executive Summary indicate that the 46kV Alternatives did not technically provide the same benefits as the 138kV Kamoku-Pukele transmission line, and other considerations detracted from the desirability of the 46kV alternatives. The study stated on page 19 that: "Overall, the Kamoku-Pukele 138kV line is more cost effective than the 46kV alternatives since it resolves all of the problems for a significantly longer period of time at a substantially lower cost. The 138kV line has more lasting value than any of the 46 kV alternatives." HECO RT-3 at 9-10.

In June 1995, CH2M Hill published the Kamoku – Pukele 138kV Transmission Line Alternatives Study, which was commissioned by HECO. Both 138kV and 46kV alternatives were evaluated and reviewed. Other non-transmission alternatives were evaluated as well. HECO RT-3 at 10-11.

In 1998, HECO completed the East Oahu Transmission Requirements Updated Study, taking into account changes in load growth, load distribution and generation addition/retirement dates. A significant difference in the assumptions underlying this study was that the HPP was not planned for retirement until beyond the end of the 2017 study period. In the earlier studies, the HPP was planned to be retired in 1994 (1992 Update Study) or 2004 (1994 Alternative Study) and so would not have been available in those studies to support the East Oahu, Downtown and Waikiki areas during contingencies, particularly the Downtown Line Overload Situation. The 1998 study results reflected analysis of the East Oahu electrical system with the HPP in place and available to support the system during contingency and other conditions. HECO RT-3 at 11-12.

Even with the changed assumption that the HPP would be available beyond the 2017 study period, the 138kV transmission alternative, which would have solved all of the identified transmission system concerns by completing the East Oahu 138kV loop and connecting the southern and northern 138kV transmission corridors, was still evaluated to be the preferred alternative, the same as in past studies in which the HPP was assumed to be retired at an earlier date. HECO RT-3 at 13-14.

The 1998 study evaluated four 138kV and one 46kV Network alternatives that were each capable of solving the identified transmission problems. The 138kV Kamoku-Pukele line was evaluated to be the preferred technical method to solve all of the identified problems at the lowest cost. HECO RT-3 at 14-16.

After the denial of HECO's application to utilize conservation district lands for the 138kV line route from Kamoku to Pukele via Waahila Ridge by the BLNR in 2002, HECO completed the East Oahu Transmission Project, Alternatives Study Update in 2003. With the 138kV overhead line route through Waahila Ridge removed from consideration due to the denial of the CDUP by the BLNR, an update to the study to provide service to the East Oahu area was needed. A re-analysis of the East Oahu system without the preferred Waahila ridge 138kV line routing alternative, and including both 138kV and 46kV alternatives, resulted in the recommendation of the less robust 46kV Alternative – Expanded option. The 46kV Alternative - Expanded option is less robust than the 138kV alternative because, while it provides needed system improvements in a reasonable time frame, it is not as effective or as long lasting a solution when compared to the 138kV alternatives. The 46kV solution does solve for a time, some, but not all of the system problems, at a lower cost than the more robust and longer lasting (from a system viewpoint) 138kV alternative. A key difference between the 138kV Waahila Ridge line routing alternative and the lowest cost 138kV alternative in the 2003 study is the use of all underground construction, which is substantially more expensive than a partial underground/partial overhead alternative. HECO RT-3 at 16-17, citing HECO T-4 at 53, 64-65.

II. RESPONSES TO THE CONSUMER ADVOCATE'S COMMENTS

A. Introduction

The testimony of the Consumer Advocate's Consultant, Mr. Michael Kiser, President, MK Solutions, Inc., addressed a number of transmission planning issues. The issue raised by him as to the prudency of HECO's planning prior to 2003 to address the East Oahu transmission problems (and the inclusion of planning and permitting costs incurred prior to 2003 ("pre-2003 planning and permitting costs")) in the cost of the EOTP has been deferred to a future rate case by the Consumer Advocate/HECO Stipulation approved (in relevant part) by the Commission in Order No. 22104 issued November 4, 2005.[1]

The other issues raised by Mr. Kiser, with the exception of his approach to equipment utilitization (and his suggestion that the Archer D transformer is not required), generally did not affect his favorable recommendation as to approval of the EOTP. Thus, HECO's responses to these other issues are relatively brief.

B. HECO's Transmission, Subtransmission and Distribution Process and IRP

In response to Consumer Advocate comments on pages 82 to 83 of CA-T-1, HECO explained how it has incorporated transmission planning analysis into its IRP process. A transmission analysis was completed for the IRP-3 report, which can be found under the link to the www.heco.com website. In addition, HECO-R-403 contains the information about Transmission Planning presented to the April 23, 2004 IRP Integration Technical Committee Meeting. The information included alternatives to relieve identified transmission problems such as load shifting capabilities (which the Kamoku 46 kV Underground Alternative – Expanded incorporates as part of its resolution of transmission problems), reduction of load through distributed generation ("DG"), combined heat and power ("CHP") and demand side management ("DSM"), and transmission options. HECO RT-4 at 60-61.

One important factor in transmission planning analysis includes the location of generation and the location of load. Generation connected to the transmission system affects the flow of electricity on the transmission system depending on its connection. In order for load flow analysis to be performed, a location for generating units must be assumed. Generation such as DG or CHP can affect the load of the transmission analysis, because these technologies decrease the amount of load served in the area. If assumptions for these are changed, the load flow results will change. Analyzing multiple generation plans over 20 years under N-1 and N-2 transmission line contingencies would require a large number of power flow simulations and an equal amount of time to produce the analysis. In IRP-3, HECO selected a few representative cases, for which transmission analysis could be done because the generation cases could be grouped into three similar groups. Relying on this analysis to justify transmission projects would not provide enough support for a project. Detailed studies would need to be prepared such as those that HECO had done with the July 1991 East Oahu 138kV Requirements Study, the August 1992 update, the August 1994 Kamoku-Pukele 46kV Alternatives Study, the March 1998 East Oahu Transmission Requirements Study Update and the December 2003 East Oahu Transmission Requirements Alternatives Study Update. HECO RT-4 at 61.

HECO also has included analysis of DG, CHP, DSM and other non-transmission options when conducting its planning analysis. The IRP-3 report explains the consideration for load reduction options such as DSM, DG and CHP. HECO RT-4 at 61.

HECO explained why it generally is not practical to incorporate subtransmission and distribution planning into its IRP process. The Distribution Planning Department at HECO plans for the 46kV system and below, which includes both the subtransmission system and the

[1] The Commission accepted the withdrawal of the pre-2003 planning and permitting costs issue from this proceeding, but denied HECO and the Consumer Advocate's request to withdraw from the record certain portions of their filed testimonies, exhibits, and responses to information requests relating to this issue. Specifically, the Commission granted the Stipulation in its entirety with the exception of Paragraph 3 on Page 5 of the Stipulation, which was denied.

distribution system. The IRP-3 report explains that the nature of the assumptions used to plan the 46kV system are different from planning the transmission system. Detailed plans for the 46kV system are short-term (three to five years) and will change based on customers choice to move forward with projects. Customer decisions to move forward with projects are based on other conditions such as economic factors and customers choices. Therefore, including subtransmission and distribution into the long-term planning framework of IRP would be difficult. (Information on the distribution planning process presented on April 23, 2004 to the IRP Integration Technical Committee Meeting is included as HECO-R-404.) HECO RT-4 at 62-63.

In summary, HECO includes transmission plans in its IRP process based upon analysis of several finalist generation plans and to the extent it can, these transmission plans will also include sub-transmission assumptions. The determination of what is included and not included in the IRP Framework is outside the scope of this proceeding and should be discussed in the context of the IRP filings. HECO RT-4 at 63-64.

C. HECO 46kv Sub-transmission Planning Criteria Do Not Require 46kV Back-up Circuits to Separate Transmission Substations

HECO's sub-transmission planning criteria as currently written and approved do not require 46kV back-up circuits to separate transmission substations. HECO prefers to do this when practical, but the practice is not a requirement of the sub-transmission planning criteria. It does, however, add to system reliability to have distribution substations fed from separate transmission substations, rather than two feeds from the same transmission substation. HECO makes a determination on a case-by-case basis whether this is practical. At present, roughly one-half of the more than 120 distribution substations meet this guideline.

Mr. Kiser appeared to claim that HECO has not complied with its sub-transmission planning criteria, because some of the East Oahu distribution substations are not supplied from separate transmission substations. That is not the case, and HECO has not misapplied its sub-transmission planning criteria. The fact that there are 60 or more distribution substations that are not backed up from a separate transmission substation is a good indicator that it is not always warranted or practical to do so. Tr. (11/07) at 69-70 (Pollock); see HECO RT-3 at 22-25.

D. Role of Equipment Utilization Calculations in the Planning Process

A reading of Mr. Kiser's testimony with regard to equipment utilization calculations provides the impression that he considers maximizing utilization to be a primary objective of planning, and that he believes that HECO does not adequately consider equipment utilization in its planning process. Tr. (11/07) at 70 (Pollock); see HECO RT-3 at 29-30, citing CA-T-1 at 61, 63-64.

As Mr. Pollock testified, optimizing system equipment utilization is definitely a goal, among others, for system planning, but it is not the main objective of system planning. As an example, if all 138/46kV transformers were planned to be fully loaded or utilized under normal conditions, there would be no capacity available to deal with a transformer failure when it occurred or to accommodate the forecasted load growth. When a new transformer is added to the system, it is either in anticipation of forecasted load growth or to deal with a contingency scenario. This means that when additional new transformer capacity is added, the total available system transformer capacity is increased, and the percentage utilization of all of the transformers is decreased, since the load level is unchanged. As time goes on and the load increases, all of the transformers become more heavily loaded, or more fully utilized. Tr. (11/7) at 70-71 (Pollock).

In addition to considering equipment utilization, the planner must also account for all of the financial, operational, and system issues that may effect the study recommendations. The main objective of the planning process is to configure a system that meets the system planning criteria under both normal and contingency scenarios over the entire 20-year planning horizon. Tr. (11/07) at 71 (Pollock); HECO RT-3 at 30-32, 34-35.

Based on Power Engineer's review and assessment of HECO's planning process, Mr. Pollock concluded that HECO does consider system utilization when conducting its system planning, in a manner consistent with industry practice. Tr. (11/07) at 71 (Pollock); HECO RT-3 at 32-34.

E. Substation Utilization

HECO reviewed Mr. Kiser's analysis on transmission line and transmission substation utilization described in CA-T-1, pages 73-77. HECO's position is that his analysis of transmission line and substation utilization is not robust enough to draw conclusions about HECO's system. Based on HECO's transmission planning criteria, which the Consumer Advocate found to be reasonable and consistent with the NERC Planning Standards in CA-IR-1, page 67, the system also needs to account for single and double contingency situations. The analysis provided in CA-107 only considered the power flow through the transmission lines based on a normal system configuration with all transmission lines in service. Mr. Kiser recognized this point in his response HECO/CA-IR-45. In addition, he contended that HECO is adequately utilizing the Koolau/Pukele Substations and under-utilizing the Archer, School, Kewalo and Kamoku Substations, based on an analysis he conducted of transformer loadings at the transmission substations under normal operating conditions. The analysis does not take into consideration (1) the service periods for which the substations have been built and (2) that older substations, such as Koolau and Pukele, are now fully loaded, because the load increased over time. Comparing older substations with newer substations such as the Archer, Kewalo, Kamoku Substations is not a valid basis for concluding that the newer facilities are underutilized. Eventually as load is added to the system, utilization of these downtown substations will increase, just as the loads at Koolau and Pukele increased over time. HECO RT-4 at 55.

HECO regularly looks at its subtransmission system and incorporates projects to assisting with known transmission system problems as well as serving the loads on the distribution system. For instance, since the Archer Substation has been built, the following distribution substations have been transferred to Archer Substation, which contributed towards deferring the Koolau/Pukele Line Overload Situation.

- Piikoi 3 transformer served by the Pukele 5 circuit has been transferred to the Archer Substation.
- Piikoi 4 transformer, which is served by the Archer Substation and which was not placed at the Pukele Substation
- Makaloa 3 and 4 are now served by the Archer 46 circuit but were originally served by the Pukele 8 and Pukele 4 circuits respectively.
- Makaloa 1 and 2 were served by the Pukele 8 and Pukele 2 circuit; Makaloa 2 is now served by the Archer 43 circuit. Makaloa 1 was removed.

- The McCully 4 transformer was originally served by the Pukele 4 circuit and is now served by the Archer 46 circuit.
- As explained in response to CA-IR-11, the McCully 6 transformer load was switched from the Pukele 2 circuit to the Archer 43 circuit in 2004.
- The McCully 2 transformer is now served by the Archer 41 circuit and was served previously by the Pukele 7 circuit.
- The McCully 3 transformer was recently relocated to the Makakilo area to serve distribution load growth. The load from McCully 3 was distributed to the 25kV distribution system and the Archer 41 circuit via the McCully 2 transformer.
- HECO has placed new loads in the Downtown area into the new 25kV system at Kewalo and Kamoku Substations. HECO RT-4 at 53-54.

All of these changes in shifting load from the Pukele Substation to the Archer Substation and the 25kV system have been implemented based on utilizing as much of the existing 46kV infrastructure as possible to minimize the costs. Additional load could be shifted, however additional 46kV infrastructure or 25kv infrastructure would be required such as HECO is proposing in the EOTP. HECO RT-4 at 54.

F. <u>HECO's 25kV Distribution System</u>

Mr. Kiser also volunteered comments regarding HECO's 25kV distribution system, and claimed that the decision to install a 25kV system was based on a study titled "The Kakaako Master Plan," which the Consumer Advocate consultant claimed was too narrowly focused and did not consider transmission or generation considerations. HECO RT-4 at 59.

The intent of the Kakaako Master Plan was to study the distribution system and determine the maximum Kakaako load in order to provide a long-term vision for the distribution system even if load development will have varying schedules based on economic, political and technological situations. The determination of the study was to address serving customers at the distribution level and to decide if there was justification to migrate towards a 25kV system versus continuing with the standard 12kV system. It is important to note that the 46kV system operates at the subtransmission level. Mr. Kiser's testimony appears to incorrectly imply that HECO created a 25kV system in place of a 46kV system. In addition, the utilization of Kewalo and Kamoku Substations are low due to slower load growth rates than were forecasted. However, as new loads are developed, these new loads are being installed served using the 25kV system. HECO RT-4 at 59-60.

EXHIBIT "E"

EMF

I. MAGNETIC FIELD EVALUATION

The projected magnetic field levels related to the 46kV Phased Project are within the range of magnetic field levels found at numerous locations in the local environment. HECO retained Enertech Consultants of Santa Clara, Inc. ("Enertech") to perform a magnetic field evaluation for the 46kV Phased Project. HECO ST-11 at 1. J. Michael Silva is the President of Enertech and is a research engineer specializing in assessing exposure to extremely low frequency electric and magnetic fields. His qualifications are set forth more fully in his *curriculum vitae* (HECO-1000) and in Appendix "A" to this exhibit.

Enertech's Magnetic Field Evaluation, dated July 22, 2004 ("Magnetic Field Evaluation") examined present and future levels of magnetic fields at various locations associated with the proposed project, and measured and calculated magnetic fields for existing and proposed electrical facilities. HECO ST-10 at 1-2; HECO-ST-1001. The Magnetic Field Evaluation incorporated the two changes in Phase 1 of the project. HECO-ST-1001 at 15; Tr. (11/07) at 193-94 (Silva). Enertech also prepared an Addendum to Magnetic Field Evaluation, dated December 22, 2004, to evaluate magnetic field levels associated with the two alternative alignments considered for a portion of Phase 1 of the 46kV Phased Project. FEA, vol. 2 at Appendix D2.

Enertech conducted magnetic field measurements at eleven selected segments associated with the proposed project to characterize field strengths due to existing electrical facilities. Existing electric facilities surveyed included 12kV, 25kV, 46kV, and 138kV power line facilities. In addition to field measurements, magnetic field calculations were also performed for 2009 forecasted normal and Pukele outage conditions for eleven different project segments. EMF levels associated with the installation of new transformers within certain substations, manholes in the streets, and risers on wooden poles at sidewalk locations were evaluated by measuring EMF due to comparable existing facilities. In addition to measuring and calculating magnetic fields for electrical facilities associated with the proposed project, magnetic field measurements were performed at ten different locations in Honolulu. These measurements were performed to provide a range of magnetic field levels encountered in everyday locations and for comparison with the magnetic field levels associated with the proposed 46kV Phased Project. HECO ST-10 at 2; HECO ST-1001 at 10, 50; Tr. (11/07) at 187 (Silva).

Enertech's Magnetic Field Evaluation concludes that existing magnetic field levels from HECO facilities are typical of levels from similar facilities throughout the State of Hawaii. Existing magnetic field levels along the eleven segments measured by Enertech range from a few tenths of a milligauss (mG) to over 25 mG, depending upon location. For streets and sidewalks where no overhead or underground power lines were immediately present, measured magnetic field levels ranged from a few tenths of a mG to about 2 mG. Sidewalk locations with overhead power lines were measured and typically ranged from about 1 mG to about 5.5 mG. Street and sidewalk locations with underground power lines typically ranged from about 1 mG to a maximum of over 25 mG directly above the underground power line in the street. HECO ST-10 at 2-3; HECO ST-1001 at 19; Tr. (11/07) at 187 (Silva).

Enertech also calculated magnetic field levels for 2009 forecasted normal and Pukele outage conditions for each of the eleven project segments. The difference in projected magnetic field levels between the existing and proposed power line configurations under 2009 forecasted loading can decrease slightly, remain unchanged, or increase depending upon the project segment. For Enertech's Segment 'I' (where no 46kV power lines presently exist), the projected magnetic field generally remains unchanged since the proposed underground 46kV power lines would only be utilized under Pukele outage conditions. For Segment 'E' (east of Kamoku Substation where modifications to an existing overhead 46kV power line are proposed), the range of projected magnetic field levels decreases slightly since the 2009 forecasted load is somewhat lower for the proposed configuration than for the existing configuration. At all other segment locations, the projected magnetic field increases due to the proposed power line configuration under 2009 forecasted loading conditions. While the largest magnetic field increases typically occur within street locations, projected magnetic field levels can also increase at sidewalk locations. Under proposed 2009 Pukele outage conditions, the projected magnetic field increases at all segment locations. HECO ST-10 at 3; HECO ST-1001 at 10, 50; Tr. (11/07) at 187 (Silva).

If the 46kV Phased Project is implemented, the proposed underground circuits would have little effect on EMF levels at nearby institutions. Enertech's Magnetic Field Evaluation examined present and future magnetic field levels at various institutions along the proposed project. Several institutions are located near portions of the 46kV Phased Project, including day care centers, pre-schools and schools, hospitals, churches, and retirement homes. Distance measurements were taken to determine the closest building edge to the proposed project. Using these distance measurements, the projected magnetic fields for 2009 loading conditions were evaluated for each of these institutions. Six different institutions are located within 100 feet of the 46kV Phased Project. Four of these institutions would have no projected magnetic field under normal operating conditions, since the underground power lines along this segment will only be loaded during Pukele outage conditions (and even then the projected field at the closest building edge is less than 1 mG). The two closest institutions are the Kaplan Test Preparation Center and the Lunalilo Elementary School. For the Kaplan Test Preparation Center, projected 2009 magnetic field levels of 0.0 mG with the existing power line configuration would increase to about 1.1 mG with the proposed configuration under normal loading. For the Lunalilo Elementary School, projected 2009 magnetic fields of about 4.0 mG with the existing power line configuration would decrease to about 3.3 mG with the proposed configuration under normal loading (due to some field cancellation). There are five additional institutions located within 200 feet of the 46kV Phased Project. Of these, two institutions have projected magnetic fields of about 0.6 mG or less under Pukele outage conditions, and three institutions would have no projected magnetic field under normal operating conditions (since the underground power lines are only loaded during Pukele outage conditions and have negligible projected magnetic field influence of about 0.1 mG). Beyond 200 feet, the projected magnetic field influence from the proposed 46kV Phased Project is negligible. HECO ST-10 at 3-4; HECO ST-1001 at 11, 51.

The proposed substations, manholes, and risers of the 46kV Phased Project will be similar to existing facilities and have very low EMF levels at a relatively short distance away. The magnetic field from a substation transformer or manhole is typically reduced by about 90% at a distance of about 20 feet from the facility (for transformers, magnetic fields due to these sources are typically reduced to ambient levels at the substation perimeter). For risers, the magnetic field is typically reduced by over 90% at a distance of about 3 feet from the riser. HECO ST-10 at 5; HECO ST-1001 at 11, 51.

There are various common sources of EMF. EMF is created whenever electricity is present. Household wiring, electric transmission and distribution facilities, lighting, appliances, transportation, amusement park rides, video arcades, office or industrial equipment, and even some toys are all examples of common sources of EMF. HECO T-10 at 9; Tr. (11/07) at 185-86 (Silva).

Exposure to EMF results from a variety of situations and sources routinely encountered in everyday life. An individual's exposure to EMF will be composed of the many common sources at home, work, businesses, school, recreation, and other locations. Exposures to appliances and other electric devices can range from brief to more lengthy periods of time. For example, a clock radio, air conditioner, fan or even water pipes (with ground currents) located near a bed or living room chair can bring people near everyday field sources for long periods of time. A number of typical employment and other locations, for example, near a cash register, service counter, display case, or video games, could result in field exposures. In summary, there is a range of magnetic field exposures and variety of sources encountered in everyday activities HECO ST-10 at 9; Tr. (11/07) at 185-86 (Silva).

Enertech also measured magnetic fields. There is a wide variety of EMF levels and sources encountered in everyday life that are comparable to EMF due to electric power facilities. Magnetic field measurements of everyday environments were performed at ten different locations in Honolulu. These measurements were performed to characterize the range of magnetic field levels encountered in everyday Honolulu locations and for comparison with the magnetic field levels associated with the proposed 46kV Phased Project. Measured magnetic fields ranged from 0.1 mG to over 99 mG. Many of these magnetic field sources are common appliances and electrical devices, such as refrigeration units in supermarkets, electric stoves in food preparation areas, library security gates, escalators, vending machines, display counters, video games, cash registers, and ATM machines. HECO ST-10 at 5; HECO ST-1001 at 12, 52; HECO ST-11A at 18; Tr. (11/07) at 187-88 (Silva).

II. PRUDENT AVOIDANCE

HECO follows a policy of "Prudent Avoidance" in its transmission facility planning and has applied prudent avoidance in planning for the 46kV Phased Project. EMF exposure mitigation was considered in the routing of the proposed lines. HECO will also apply prudent avoidance in its engineering design for ductlines with multiple circuits by implementing the EMF mitigation measures identified by Mr. Silva. EMF mitigation can be achieved in engineering design by optimizing cable placement and phasing arrangement within the cable ducts. HECO intends to implement these mitigation recommendations, which can reduce EMF levels for multiple circuit power lines. HECO T-2 at 10; HECO T-11 at 6; HECO-ST-11 at 8.

HECO's prudent avoidance approach is consistent with the Hawaii Department of Health and the Commission's prudent avoidance approach. On January 19, 1994, the Hawaii State Department of Health ("DOH") issued a statement entitled "DOH Policy Relating to Electric and Magnetic Fields from Power-Frequency Sources." This statement replaces an earlier one issued on April 3, 1991. The 1994 statement reads as follows:

> The Department of Health, in response to continuing but inconclusive scientific investigation concerning EMF from low-frequency power sources, recommends a "prudent avoidance" policy. "Prudent avoidance" means that reasonable, practical, simple, and relatively inexpensive actions should be considered to reduce exposure.

> A cautious approach is suggested at this time concerning exposure to EMF around low-frequency sources, such as electric appliances and power lines. The existing research data on possible adverse health effects, including cancer, are inconclusive and not adequate to establish or quantify a health risk. For example, the biological mechanisms that might underlie any apparent relationship between EMF and cancer have yet to be clearly defined. Also, some epidemiological studies suggest that, if these fields increase the risk of cancer, it is a very small increase. Other epidemiological studies suggest that there is no increased risk.
>
> The Department of Health will continue to collect and evaluate information on possible health hazards associated with electric and magnetic fields. If adequate data ever become available to establish what levels may be harmful, appropriate standards will be established.

HECO-1101.

A definition of prudent avoidance (which was put forth by the U.S. Environmental Protection Agency) was adopted by the Commission in its Decision and Order No. 13201, issued April 7, 1994, in Docket No. 7256 as follows:

> Prudent avoidance is an approach to making decisions about risks. This decision-making process is based on judgment and values, can be applied to groups and individuals, and can be considered for all aspects of our lives, not just EMFs. Prudent avoidance applied to EMFs suggests adopting measures to avoid EMF exposures when it is reasonable, practical, relatively inexpensive and simple to do so. This position or course of action can be taken even if the risks are uncertain and even if safety issues are unresolved. D&O 13201 (p. 35)

HECO ST-11 at 6.

The Commission subsequently reaffirmed its adoption of this definition of "prudent avoidance" to EMF in both its Decision and Order No. 13517 (August 29, 1994)("D&O 13517") in Docket No. 94-0043 and Decision and Order No. 15037 (September 27, 1996) ("D&O 15037") in Docket No. 96-0016. Both of these decisions state,

> In Decision and Order No. 13201, Docket No. 7256 (1994), we concluded that a causal link between EMF and adverse health effects has yet to be established by the scientific community. We acknowledged that a few studies appear to have established an association between EMF exposure and the occurrence of certain cancers. However, we found that the results of these studies have yet to be accepted by the scientific community as proof that exposure to EMF causes cancer or other disease. Nevertheless, we expressed our expectation that a utility will exercise prudent avoidance with respect to EMF. We adopted the United States Environmental Protection Agency's definition of prudent avoidance as set forth in their

> Questions and Answers about Electric and Magnetic Fields (EMF), 402-R-92-009 (1992). As defined there, prudent avoidance applied to EMFs means adopting measures to avoid EMF exposures when it is reasonable, practical, relatively inexpensive and simple to do."

(See D&O 13517 at 9; D&O 150037 at 10.) The Hawaii Supreme Court has approved the Commission's adoption and application of the "prudent avoidance" policy and has acknowledged the Commission's recognition that the "health effects of EMF are uncertain." In re Hawaiian Electric Company, Inc., 81 Haw. 459, 918 P.2d 561 (1996); HECO ST-11 at 7.

Since the Commission's D&O 13517 was issued in 1994, there have been several additional large epidemiological studies and the National Institute of Environmental Health Sciences ("NIEHS") laboratory research confirming that cancer is not increased in laboratory animals exposed long-term to EMF. These studies also demonstrate that EMF exposure does not appear to change normal cells to cancerous cells. Scientists have tried for many years in a variety of ways to demonstrate clearly that EMF can cause cancer. The research has failed to show this. This failure of repeated efforts to demonstrate cause and effect is the best science can do to prove the negative, to demonstrate that there's not an adverse effect on human health from EMF. Tr. (11/07) at 208 (Erdreich).

Optimum Phase Placement

HECO's use of optimum phase placement in the cable ducts will prudently avoid EMF by reducing EMF levels up to 87%. Various factors influence the intensity of EMF from a source. In general, magnetic fields are a function of the load current (measured in amperes), the physical configuration, phasing and, importantly, the distance away from the source. The intensity of EMF diminishes with distance, sometimes very quickly. HECO ST-10 at 8; Tr. (11/07) at 186-87 (Silva).

EMF levels drop very quickly with distance away from underground cables due to the close spacing between the electrical conductors. The attenuation rate is more rapid for underground in comparison with overhead lines, which have greater conductor spacing. In addition, where any transmission line has adjacent multiple circuits, the phasing of nearby conductors can be configured so as to cause a partial cancellation of EMF and result in an overall reduction of EMF levels. HECO T-10 at 12; Tr. (11/07) at 188 (Silva).

The 46kV underground transmission lines for the 46kV Phased Project would utilize Cross-Linked Polyethylene (XLPE) cables (three cables per electrical circuit) placed within underground PVC ducts and encased in concrete. Depending on the project segment, locations would utilize either single, double, or triple circuit 46kV cables to achieve the necessary load transfer capability. HECO T-10 at 11.

Enertech performed an evaluation of mitigation options for the 46kV Phased Project. EMF mitigation, or reduction in EMF levels, can be achieved for multiple circuit power lines with similar loads by optimizing the cable placement and phasing arrangement within the cable ducts. Optimized placement of multiple circuit cables can achieve a partial cancellation of EMF and result in reduced EMF levels when circuits are similarly loaded. The maximum EMF cancellation occurs when all circuits have identical loads and their individual phases are placed in an optimum manner in adjacent ducts. In general, multiple circuits will not always have simultaneous identical loads, so that EMF reduction is less when circuit loads are not the same. HECO T-10 at 14; App. Exh. 8.

Enertech studied cable placement and phasing arrangement for the multiple circuit 46kV underground lines for optimum reduction of EMF levels. A variety of cable placements and phasing arrangements were studied for the 46kV circuit cable sections to determine the optimum phase configuration for EMF reduction. For the 46kV double circuit configuration, the optimal design is to arrange each circuit horizontally within the duct, with one circuit directly above the other circuit, and with unlike or opposite phasing. For the 46kV triple circuit configuration, the optimal design is to arrange each circuit vertically within the duct, with one circuit directly adjacent to the other circuit, and with a specific phasing arrangement. The optimum phasing option is not available for the single circuit 46kV cables because there is no adjacent circuit to create partial EMF cancellation. HECO T-10 at 14-15; Application Exh. 8 at Section 5.4.

The results of Enertech's EMF calculations for optimum circuit and phasing arrangements for multiple circuit 46kV cables shows that use of optimum phase placement in the cable ducts can reduce EMF levels by a maximum amount of about 87% when all circuits have identical loads. HECO T-10 at 15; Tr. (11/07) at 188-89 (Silva).

HECO has applied prudent avoidance in its engineering design for ductlines with multiple circuits by optimizing the cable placement and phasing arrangement within the cable ducts. Reduction of EMF levels has been achieved in the engineering design for these new ductlines by utilizing horizontal ductbanks with reversed phasing in the two following locations: (1) the segment of Phase 1 of the 46kV Phased Project between Poni Street and McCully Substation; and (2) the segment of Phase 2 on King Street between Cooke Street and McCully Times Supermarket. FEA, vol. 1 at 4-98; HECO T-2 at 10; Tr. (11/07) at 196 (Bonnet).

HECO will continue to identify and implement actions to reduce EMF levels wherever possible. Utilization of phasing arrangements to optimize reduction of EMF levels will be analyzed for the following segments where new circuits are placed near existing underground or overhead lines: (1) the segment of Phase 1 on Makaloa Street between Amana Street and Poni Street; (2) the segment of Phase 1 on Pumehana Street between Lime and Date Streets; and (3) the segment of Phase 1 on Winam Avenue between Hoolulu Street and Mooheau Avenue; and (4) for the two 46kV lines exiting Kamoku Substation and running east and west on Date Street. In each of these areas, the existing circuits may or may not be configured in a manner which would allow implementation of phasing to achieve magnetic field cancellation with the new underground circuits. HECO will use computer modeling which examines factors such as the physical and electrical properties of existing overhead and underground circuits, including proximity to new circuits, loading of the existing and future power lines and current direction to determine whether, and to what extent, cancellation of magnetic fields can be achieved. HECO will phase the new circuits to reduce cancellation of magnetic fields in those areas where prudent avoidance measures are feasible and productive. FEA, vol. 1 at 4-100.

Route Planning

HECO's route planning for the 46kV Phased Project also prudently avoids EMF. HECO has also implemented prudent avoidance in the route planning for the 46kV Phased Project. EMF levels from power lines drop off rapidly with distance, meaning that reduction of EMF levels might be achieved by locating the lines closer to the middle of the roadways to reduce EMF levels at the near edge of the roadways. This requires detailed engineering and consultation with the City and County of Honolulu permitting agencies to determine if physical space is available to locate the 46kV ductlines closer to the middle of the roadways and whether locating the lines there would cause conflicts with future facilities planned by government or private entities. HECO T-2 at 10-11; FEA, vol. 1 at 4-100; Tr. (11/07) at 196 (Bonnet).

Prudent avoidance of EMF has been applied in the routing of the proposed lines. Along King Street, between Cooke Street and McCully Times Supermarket, the power line will be located away from the makai curb. Along all other project segments, the power lines cannot be located near the center of the street due to constraints imposed by existing utilities. FEA, vol. 1 at 4-100.

III. STEEL PIPES AND OVERHEAD LINES

The Consumer Advocate's suggestion to use steel pipes and overhead lines should not be adopted. The Consumer Advocate suggested the use of steel pipes for the 46kV Phased Project to reduce EMF while at the same time acknowledging that this would increase project cost significantly. CA-T-1 at 106.[1] However, placing individual 46 kV cables in steel pipe will not reduce EMF if the pipe is isolated from ground or grounded at one point (single point grounding). Single point grounding is standard HECO practice because it optimizes cable capacity. To reduce EMF, the pipe would need to be grounded at both ends; this is not standard HECO practice because the resulting heating would be too severe for practical applications. Also, placing all three phase cables in one steel pipe creates losses in the pipe, increases proximity effect losses in the cable system (resulting in a loss of cable rating). Also, a much larger steel pipe diameter would be required to accommodate all three cables in a single pipe. HECO RT-10 at 3-4; Tr. (11/07) at 189-90 (Silva).

The Consumer Advocate's suggestion that the proposed underground 46 kV segments from Pumehana Street to Date Street and from Winam Avenue to Mooheau Avenue segments, be constructed as overhead instead of underground segments was withdrawn during the hearing. Tr. (11/08) at 270 (Kiser). However, there is a difference in magnetic field levels between overhead and underground construction. In general, directly above an underground circuit the magnetic field level may be equal to or even higher than an overhead line due to proximity to the energized circuit. But the magnetic fields drop off more quickly with distance away from the underground line than the overhead line due to the difference in conductor spacing (i.e., the conductors in an overhead line are spaced much farther apart than in an underground line and this affects magnetic field attenuation with distance). HECO RT-10 at 4-5; Tr. (11/07) at 190-91 (Silva).

[1] The Consumer Advocate was unable to identify any support for his testimony that "it could be possible to install the underground circuits in steel casing (or conduit)" other than the testimony of HECO's witness, Mr. Silva. HECO/CA-IR-55(c). Mr. Silva, however, only testified regarding the use of low-carbon steel pipe in the design of High-Pressure Fluid Filled (HPFF) cables for a 138kV underground transmission line. Mr. Silva nowhere testified that the 46kV Phased Project could utilize steel casing.

IV. EMF STANDARDS, GUIDELINES, POLICIES, PUBLICATIONS AND RESEARCH

The NIEHS EMF-RAPID program has concluded that the probability that EMF is a health hazard is relatively small and the evidence is insufficient to warrant aggressive regulatory actions. In 1992, Congress mandated an EMF research program, which was managed by NIEHS. In 1998, the NIEHS convened a Working Group to evaluate the results of this research program and other EMF research. They concluded that the epidemiologic data was limited, but they categorized EMF as possibly carcinogenic. Using the methods routinely applied by of the National Toxicology Program ("NTP") of the National Institutes of Health, the NIEHS concluded that EMF exposure would not be listed in the NTP Report on Carcinogens as a "known human carcinogen" or as "reasonably anticipated to be a human carcinogen." HECO ST-11A at 12. The NIEHS recommended in its 1999 report to Congress,

> The NIEHS suggests that the level and strength of evidence supporting ELF-EMF exposure as a human health hazard are insufficient to warrant aggressive regulatory actions; thus, we do not recommend actions such as stringent standards on electric appliances and a national program to bury all transmission and distribution lines. Instead, the evidence suggests passive measures such as a continued emphasis on educating both the public and the regulated community on means aimed at reducing exposures. NIEHS suggests that the power industry continue its current practice of siting power lines to reduce exposures and continue to explore ways to reduce the creation of magnetic fields around transmission and distribution lines without creating new hazards.

PO-IR-2, Attachment 7 at 50-51; Tr. (11/07) at 206-07 (Erdreich).

The epidemiological and laboratory data published after the NIEHS report was completed in 1998 have provided additional evidence that EMF does not contribute to childhood cancer. Laboratory studies published after the NIEHS report, some of which were part of the research program and available for review by the NIEHS, provide evidence for a lack of carcinogenicity, or provide no basis to conclude that EMF affects the development or promotion of cancer. HECO ST-11A at 13-14; FEA, vol. 1 at 4-89.

In June 2002, the NIEHS published a brochure on questions and answers on EMF and health. The status of EMF and health is summarized by NIEHS as:

> Over the past 25 years, research has addressed the question of whether exposure to power-frequency EMF might adversely affect human health. For most health outcomes, there is no evidence that EMF exposures have adverse effects. There is some evidence from epidemiology studies that exposure to power-frequency EMF is associated with an increased risk for childhood leukemia. This association is difficult to interpret in the absence of reproducible laboratory evidence or a scientific explanation that links magnetic fields with childhood leukemia (p. 57).

HECO ST-11A at 16-17; PO-IR-2, Attachment 6 at 58.

The National Academy of Sciences National Research Center has found that the results of the EMF-RAPID program do not support the contention that the use of electricity poses a major unrecognized public-health danger. In 1999, the National Academy of Sciences National Research Center ("NRC"), after reviewing and evaluating the research conducted under the DOE/NIEHS National EMF Research and Public Information Dissemination (EMF-RAPID) Program, stated,

> The results of the EMF-RAPID program do not support the contention that the use of electricity poses a major unrecognized public-health danger.... In view of the negative outcomes of the EMF-RAPID replication studies, it now appears even less likely that MFs [Magnetic Fields] in the normal domestic or occupational environment produce important health effects, including cancer. [NRC, 1999, pp.78 and 8]

FEA, vol. 1 at 4-88; PO-IR-2, Attachment 6 at 54.

The U.S. EPA. has acknowledged that the scientific evidence is inadequate to determine if magnetic fields are harmful. The U.S. EPA issued a booklet "Questions and Answers About Electric and Magnetic Fields (EMF)" (402-R-92-009) in December 1992. This document stated that neither the EPA nor any other federal regulatory agency has established a standard for EMF because the scientific evidence is inadequate to determine if magnetic fields are harmful, and if they are, at what levels. FEA, vol. 1 at 4-85.

Guidelines or limits set by ICNIRP and ACGIH

Two organizations have occupational EMF standards or guidelines. The International Commission on Non-Ionizing Radiation Protection ("ICNIRP") and the American Conference of Governmental Industrial Hygienists ("ACGIH") both have EMF exposure guidelines. The ICNIRP has an occupational exposure limit of 4,167 mG (for the general public the continuous exposure level is 833 mG), and the ACGIH has a limit of 10,000 mG. The proposed 46kV Phased Project would have EMF levels far below the EMF standards of ICNIRP and ACGIH. HECO T-10 at 15-16; HECO ST-10 at 5-6; HECO ST-1001 at 12, 48-49, 52.

The United States Government does not have EMF standards, nor does the State of Hawaii. HECO T-10 at 15; Tr. (11/07) at 189 (Silva).

International Scientific Organizations

Several organizations outside of the United States have sponsored comprehensive reviews of EMF research by multidisciplinary groups of scientists. The International Agency for Research on Cancer ("IARC"), the International Commission on Nonionizing Radiation Protection ("ICNIRP"), the Health Council of the Netherlands ("HCN"), the National Radiological Protection Board of Great Britain ("NRPB") have all convened large groups of independent scientists with different expertise (epidemiologists, toxicologists, biologists, neurobiologists, physicists, etc.) to review the body of literature surrounding EMF and health. HECO ST-11A at 14; FEA, vol. 1 at 4-89 to 4-90.

IARC reviewers evaluated the animal data and concluded that they were "inadequate" to support a risk for cancer. The scientists stated that the EMF data does not merit the category "carcinogenic to humans" or the category "probably carcinogenic to humans," nor did they find that "the agent is probably not carcinogenic to humans." Many hypotheses have been suggested to explain possible carcinogenic effects of electric or magnetic fields; however, no scientific explanation for carcinogenicity of these fields has been established (IARC 2002). HECO ST-11A at 14; FEA, vol. 1 at 4-89 to 4-91.

The Working Group concluded that the epidemiologic studies do not provide support for an association between childhood leukemia and residential magnetic fields at intensities less than 4 mG. Overall, magnetic fields were evaluated as "possibly carcinogenic to humans" (Group 2B), based on the statistical association of higher-level residential magnetic fields with childhood leukemia. Other agents and mixtures have been classified as 2B as well, including coffee, pickled vegetables, and gasoline engine exhaust. HECO ST-11A at 14-15; FEA, vol. 1 at 4-90; Tr. (11/07) at 205-06 (Erdreich).

In the rating system used by IARC, the recognition of an association between exposure and cancer in epidemiology studies is considered "limited evidence" of carcinogenicity. A rating of "limited evidence" for epidemiology studies, even without any evidence from laboratory studies that an exposure might pose a cancer risk, requires that the exposure be categorized as a "possible carcinogen," even though chance, bias and confounding cannot be ruled out with reasonable confidence (IARC, 2002). HECO ST-11A at 15; FEA, vol. 1 at 4-90.

The IARC Working Group did not regard the association between magnetic fields and childhood leukemia as reflecting a causal association because there was insufficient evidence from epidemiology studies that magnetic fields cause cancer in humans, insufficient evidence that magnetic fields cause cancer in laboratory studies of animals, and no evidence for a mechanism to lead to cancer. HECO ST-11A at 15; FEA, vol. 1 at 4-90.

The assessments by the NIEHS, IARC, ICNIRP, NRPB, and HCN agree that there is little evidence that EMF is associated with adverse health effects, including most forms of adult and childhood cancer, heart disease, Alzheimer's disease, depression, and reproductive effects. However, all of the assessments concluded that epidemiology studies in total suggest a possible association between magnetic fields at higher exposure levels (annual average greater than 4 mG) and childhood leukemia. All agree that the experimental laboratory data do not support a causal link between EMF and any adverse health effect, including leukemia, and have not concluded that EMF is, in fact, the cause of any disease. These organizations have not recommended exposure limits or required measures to reduce exposures since they have not concluded that a causal relationship between EMF and adverse health effects exists. HECO ST-11A at 15-16; FEA, vol. 1 at 4-90 to 4-91.

V. <u>EMF AND HUMAN HEALTH</u>

Epidemiology

Dr. Linda S. Erdreich is a Ph.D. in epidemiology with 25 years of experience in conducting and evaluating scientific research to identify factors that affect human health. She is a Senior Managing Scientist at Exponent, Inc., a research and consulting firm with a broad spectrum of expertise in science and technology. HECO ST-11A at 1; Tr. (11/07) at 200-01 (Erdreich). Her qualifications are set forth more fully in her *curriculum vitae* (HECO-ST-1100A) and in Appendix "B" to this exhibit.

Dr. Erdreich testified that, in her expert opinion, EMF exposures at typical environmental levels are not harmful to people, whether they are exposed from transmission lines, other power line sources, or other sources in homes. Electric and magnetic fields can be harmful at very high levels, but not at the levels associated with power lines. With certain electric appliances, the user is exposed to magnetic fields that can be tens to hundreds of times higher than transmission line fields. Electric fields from power lines are generally well below levels that would cause harmful effects, and must be low in order to meet electrical safety standards. HECO ST-11A at 20; Tr. (11/07) at 201, 212 (Erdreich).

Based on Dr. Erdreich's review of the magnetic field levels expected to occur with the proposed project, the EMF levels expected to occur with the proposed line will not have an unreasonable adverse effect on public health, safety, and welfare. The weight of the evidence does not support a conclusion that exposure to EMF at the levels associated with the proposed project would have adverse effects on human health, compromise normal function, or cause cancer. HECO ST-11A at 21; Tr. (11/07) at 202 (Erdreich).

Dr. Erdreich's conclusion is based on her knowledge of the relevant scientific literature, the results of expert scientific panels that have examined epidemiologic and laboratory research on 60-Hz electric and/or magnetic fields and health, and the field levels anticipated from the operation of this transmission line, as identified by Enertech Consultants. The weight-of-evidence analysis Dr. Erdreich conducted follows procedures used by scientists, scientific organizations, and regulatory agencies worldwide. Dr. Erdreich evaluated each of the individual epidemiologic studies of magnetic fields and health in order to assess the strengths and limitations of each, and assign more weight to those with better design. She assessed the epidemiologic studies collectively, and considered the results of the controlled laboratory research studies in cells and in animals, including those of long-term exposure of laboratory animals to magnetic fields. The Hill Criteria for causality guided her review. Dr. Erdreich considered that the epidemiology studies reported only weak, inconsistent associations, and there is no convincing evidence of a dose-response relationship. The laboratory data do not provide sufficient evidence that the association is biologically plausible. HECO ST-11A at 21; Tr. (11/07) at 202-04.

Dr. Erdreich therefore testified that there is insufficient evidence to conclude that there is a causal relationship between magnetic field exposure and childhood leukemia (or other cancer), based on these data, taking into account the fact that there is neither a plausible mechanism nor a biologic basis to support such an association. HECO ST-11A at 21-22; Tr. (11/07) at 204-05 (Erdreich).

Dr. Erdreich also testified that the projected magnetic field values at the curb given in Enertech's 2004 report represent calculated values at a particular location and cannot be meaningfully compared to estimates of long-term exposure to magnetic fields referenced in epidemiologic studies. HECO ST-11A at 19. Exposure measures the magnetic field levels encountered by a person as averaged over a specific period of time. For example, it takes about a second to measure a magnetic field. Over that second, the exposure and the measurement would be the same, i.e., the value displayed on the meter. However, readings every second over an entire year, when those 31,536,000 measurements are averaged, would represent average annual exposure to magnetic fields. HECO ST-11A at 18-19.

An individual's exposure to magnetic fields reflects the contribution from all of the magnetic field sources encountered in all the locations where she spends time. Because people typically spend most of their time at home, the sources there are frequently the major determinant of their time averaged exposures. HECO ST-11A at 19.

Estimates of long-term exposure to magnetic fields are of interest because the strongest data supporting the existence of any health effect from magnetic fields are reports of associations between estimates of magnetic field exposure and childhood leukemia. This association is based primarily upon two published statistical evaluations of the epidemiology studies of childhood leukemia and long-term exposures (Greenland et al 2000; Ahlbom et al, 2000). The 4 mG referred to in these studies is an estimated long-term average exposure. The goal of these epidemiology studies has been to estimate the average exposure of an individual over an extended period, not the fluctuating level at any single spot, whether it is in the playground, a school, or a place in the home. HECO ST-11A at 19-20.

Thus, a calculated or measured magnetic field greater than 4 mG in a playground, school or even a small area within a residence would not necessarily suggest that a child would have an average exposure greater than 4 mG. HECO ST-11A at 20.

Oncology

Dr. Stuart Aaronson, M.D. is Professor and Chairman of the Department of Oncological Sciences at Mount Sinai School of Medicine in New York. Tr. (11/07) at 213-214 (Aaronson). Dr. Aaronson's qualifications are set forth in his curriculum vitae (HECO-ST-1100B) and are summarized in Appendix "C" to this exhibit.

Dr. Aaronson testified that there has been an extensive assessment of the question whether exposure to power frequency electric and magnetic frequency fields could be associated with an increased risk of cancer. From his review of this literature including the reports of nationally constituted scientific review groups, he concludes that there is no convincing or consistent evidence that power lines pose a cancer risk. HECO ST-11B at 3; Tr. (11/07) at 215 (Aaronson).

Cancer is caused by alterations in DNA. DNA is the genetic structure of a cell. Mutations can occur spontaneously during cell replication. Most of these DNA alterations do not lead to cancer. However, mutations that alter the functions of certain genes can be sufficient to initiate a cancer. These genes are called oncogenes and tumor suppressor genes. HECO ST-11B at 4; Tr. (11/07) at 215 (Aaronson).

Oncogenes accelerate the cell division. Tumor suppressor genes act as brakes on abnormal growth. But that brake function can be inactivated by mutation. In many cancer models, mutations of both oncogenes (creating an abnormal acceleration of cell growth) and of tumor suppressor genes (inactivating the brake on abnormal cell growth) are believed to be required. HECO ST-11B at 4; Tr. (11/07) at 215 (Aaronson).

The genetic changes that characterize cancer can be spontaneous, or can be induced by an agent. Agents that are capable of inducing genetic changes that can cause cancer are called "carcinogens." HECO ST-11B at 5; Tr. (11/07) at 215-16 (Aaronson).

Cancer promoters are agents that act on genetically damaged cells to produce cancer. Promoters do not directly damage DNA, but instead indirectly bring about further genetic change by causing increased cell proliferation (thus accelerating the occurrence of spontaneous mutations) or by inhibiting cell functions, such as those involved in the normal repair of DNA damage. HECO ST-11B at 5; Tr. (11/07) at 216 (Aaronson).

Exposures to power frequency EMF do not directly damage DNA. It is generally accepted that the energy in power frequency EMF is insufficient to cause changes in the chemical structure of DNA. HECO ST-11B at 5; Tr. (11/07) at 216 (Aaronson).

Many laboratory studies have looked at whether power frequency EMF could cause or promote cancer development. Long term studies in which animals are exposed to EMF are referred to as "*in vivo*" studies, Latin for "in life, or alive." Studies of cancer-related changes in genes or other cellular processes observed in isolated cells in culture are called *in vitro* studies. HECO ST-11B at 5-6; Tr. (11/07) at 216 (Aaronson).

Animal studies have been performed to assess a possible link between EMF and cancer. There have been several large, well conducted long term studies (called bioassays) in which laboratory mice and rats have been chronically exposed to doses of 60-Hz EMF much higher than those of power frequency fields for long periods, in some cases for their entire lifetimes. HECO ST-11B at 6; Tr. (11/07) at 217 (Aaronson).

These types of animal studies have a proven record for predicting the carcinogenicity of chemicals, physical agents, and other suspected cancer-causing agents. In fact, these tests are used by the National Toxicology Program to assess agents for possible carcinogenic activity. HECO ST-11B at 6; Tr. (11/07) at 217 (Aaronson).

In vivo testing of EMF has been performed since the Commission addressed EMF in the Waiau-CIP proceeding in 1994. EMF has now been tested by one of the most rigorous tests utilized by the National Toxicology Program. In addition, grants funded by the NIEHS over the past several years through a peer review process have assessed this question. EMF has now been tested thoroughly for possible cancer causation in animals. Tr. (11/07) at 217-18 (Aaronson).

Typically, one group of animals is exposed to a controlled, high 60-Hz magnetic field and another group of the same size is not so exposed. Such experiments have been performed with animals that are in normal health at the beginning of the experiment; with animals that have been bred to be particularly susceptible to cancer; and with animals that have been administered a known carcinogen. Thus, the *in vivo* tests were designed both to assess the potential of EMF as a complete carcinogen and as a promoter of cancer. The controlled exposures were to fields ranging from 10 to over 10,000 milligauss. HECO ST-11B at 6; Tr. (11/07) at 218 (Aaronson).

The results of these animal experiments are overwhelmingly negative. As a whole, they provide no consistent or convincing evidence of any relationship between EMF and cancer, including brain cancer, breast cancer and leukemia. HECO ST-11B at 6-7; Tr. (11/07) at 218 (Aaronson).

In vitro laboratory studies also looked at whether power frequency EMF might cause or promote cancer. A great many studies of different types have been performed. Some of these studies have looked for evidence that power frequency EMF is "genotoxic," that is, that it damages DNA directly; others have looked for evidence that EMF promotes the development of cancer. HECO ST-11B at 7; Tr. (11/07) at 218-19 (Aaronson).

There is a massive amount of literature regarding controlled exposures of normal cells to EMF. These assays are overwhelmingly negative. Of the few studies that do report evidence for genotoxicity, most contain a mixture of positive and negative results, or ambiguous results, and none of them have been replicated. They provide no basis for concluding that power frequency EMF is genotoxic. HECO ST-11B at 7; Tr. (11/07) at 219 (Aaronson).

There have been a great many laboratory experiments aimed at assessing possible biologic effects of power frequency fields that might conceivably cause them to act as cancer promoters or to enhance the effectiveness of genotoxic agents. The cell studies have produced no consistent or convincing evidence that power frequency electric or magnetic fields promote the development of cancer. HECO ST-11B at 8; Tr. (11/07) at 219 (Aaronson).

Numerous laboratory studies have examined the relationship of exposure to magnetic fields and the initiation or promotion of leukemia. Near life long exposure to magnetic fields does not increase the risk of leukemia or lymphoma in animals. HECO ST-11B at 8; Tr. (11/07) at 219-20 (Aaronson).

Dr. Aaronson concluded that based on his assessment of the published literature, including the reports of nationally constituted scientific review groups, there is no convincing or consistent evidence that power lines pose a cancer risk. HECO ST-11B at 8; Tr. (11/07) at 220 (Aaronson).

Appendix A – J. Michael Silva Qualifications

J. Michael Silva is a research engineer, specializing in assessing exposure to extremely low frequency electric and magnetic fields (EMF). He is President of Enertech Consultants of Santa Clara, Inc. ("Enertech"). Enertech is a 22-year old consulting and scientific research firm that specializes in applied research projects, engineering, exposure assessment, and the development of EMF measurement instrumentation and computer modeling software. HECO T-10 at 1. Mr. Silva's resume summarizing his prior work experience was marked as HECO-1000 in this proceeding.

Mr. Silva has a Bachelor of Science degree in Engineering from the University of Alabama and a Master of Science in Engineering from Auburn University. He has a professional engineering license in Electrical Engineering in California, and is also a registered professional engineer in the states of Alabama, Connecticut, Massachusetts, Pennsylvania, Nebraska, and Texas. HECO T-10 at 1; Tr. (11/07) at 185 (Silva).

Mr. Silva is a Senior Member of the Institute of Electrical and Electronics Engineers ("IEEE"). Within that organization, he served for about ten years as the Secretary of the Power Engineering Society's Corona & Field Effects Subcommittee. He is also a member of the IEEE Design and Environmental Considerations Working Group and the AC Fields Working Group. He is also a member of the Bioelectromagnetics Society ("BEMS") and the Institute of Navigation ("ION"). He has also served as a scientific publication reviewer (referee) for papers submitted to scientific journals for publication, including IEEE, BEMS, Journal of Exposure Analysis and Environmental Epidemiology and the American Journal of Epidemiology. HECO T-10 at 1-2.

Mr. Silva has received special recognition for his work involving EMF exposure assessment. At the University of Southern California, he was the Lloyd Hunt Distinguished Lecturer in Power Engineering. He has also been a guest lecturer at the Ohio State University Electrical Engineering colloquium - Distinguished Lecture Series, and he was invited as a guest lecturer at the University of Texas at Austin Power System Seminar Lecture Series and also at the Power Distribution Conference. He was selected in 1978 to represent the United States in technical meetings with the former Soviet Union, he was a member of the IEEE team that wrote the US National Standard for how to measure EMF. He has also received recognition awards for his work on IEEE and international technical papers and his work on technical committees. HECO T-10 at 2; Tr. (11/07) at 185 (Silva).

Mr. Silva worked at the Southern Company from 1971 until 1977 in electric transmission line design. As supervising engineer, he was responsible for the detailed design of high voltage electric transmission lines from 46kV to 500 kV on the Southern Company's electric transmission system in Alabama, Florida, and Mississippi. These responsibilities included development of the engineering details and design specifications necessary for construction of these lines. He was also responsible for conducting studies of the electrical environment in the vicinity of high voltage electric transmission lines and substations, including EMF calculations and measurements. In 1977, he was appointed Project Manager of the Alternating Current and Direct Current Research Program for the Electric Power Research Institute ("EPRI") in Palo Alto, California. He was responsible for AC and DC electric transmission line research at several facilities located across North America. These research projects included design considerations for electric lines, evaluations of electric and magnetic fields, field induction, spark discharge and corona studies, instrumentation for field measurements, and many other technical areas. HECO T-10 at 2-3.

From 1979 to early 1982, Mr. Silva worked at a consulting engineering firm in Pittsburgh, Pennsylvania. His duties included managing and conducting several transmission line projects and various transmission line design and engineering jobs nationwide. In early 1982, he founded Enertech Consultants, a scientific research and consulting firm with offices in California and in Massachusetts. Enertech performs scientific research, develops EMF modeling software, and design, manufacturers and sells EMF measurement instrumentation in 42 countries. HECO T-10 at 1.

The majority of Mr. Silva's work over the past 32 years was related to electric power facilities or EMF studies and assessments at locations throughout the United States and in other countries. HECO T-10 at 3.

Enertech performs work related to electric and magnetic fields in three broad areas. First, they conduct applied research projects involving EMF exposure assessment. In this area they have worked on several major projects, including studies conducted by researchers for Johns Hopkins University, the University of North Carolina, EPRI, the California Department of Health Services, the U.S. Department of Energy, and the National Cancer Institute. Second, they develop instrumentation for accurate measurement of EMF and conduct a variety of measurement programs throughout the world. Third, they develop computer software for calculating EMF levels, analyzing measurement data and modeling EMF environments and exposure. HECO T-10 at 4; Tr. (11/07) at 184-85 (Silva).

Mr. Silva worked as a member of a research team on a large study of electric utility workers. Enertech's role has been to characterize the magnetic field exposure encountered by these electric utility workers. In a Nationwide Residential Study, he was responsible for the measurement of magnetic fields in about 1,000 homes in 25 utility service areas. For the California Department of Health Services Enertech completed another large project involving a comprehensive 3-year survey of EMF in California Schools and a study of teachers' exposure and sources. As part of a large childhood epidemiological study conducted by the National Cancer Institute, Enertech's research team was involved in the effort to measure magnetic fields in homes in eleven states and included wire coding on over 1,300 homes. And, they completed a study for the EMF RAPID Program of the National Institute of Environmental Health sciences involving personal exposure measurements for over 1,000 randomly selected Americans located throughout all 50 states. And he recently completed a three-year EMF measurement program for the United Nations at their headquarters buildings in New York City. HECO T-10 at 4-5.

Enertech has performed EMF measurements and exposure assessments or EMF consulting work for a number of clients in the United States, Europe, Australia, and Canada including the California Department of Health Services, the EPRI, CISCO Systems, the U.S. Department of Justice, a variety of electric utilities, Stanford University, the Montecito and Selma Unified School Districts in California, the Jefferson County School District in Colorado, Mesa School District in Arizona, City of Austin, Texas, Kaiser Permanente Hospitals, Bay Area Rapid Transit, Davies Medical Center, University of California at San Francisco Medical Center, the Metropolitan Water District in Los Angeles, Microsoft, Walt Disney Company, Washington University, Roadway Powered Electric Vehicle Project, U.S. Department of Energy, San Diego Transit Authority, U.S. Air Force, United Nations, the state of Wisconsin Public Service Commission, the state of Nevada Public Utility Commission, and many other clients. HECO T-10 at 5.

Appendix B – Dr. Erdreich's Qualifications

Dr. Erdreich works in Exponent, Inc.'s Health Group, which focuses primarily on the application of epidemiology methods to address a variety of topics in the health sciences. She has done a great deal of work evaluating potential biological and health impacts of electrical facilities, such as transmission lines, substations, and electrified railroad lines. HECO ST-11A at 1.

Dr. Erdreich's *curriculum vitae* (HECO-ST-1100A) summarizes her prior work experience. Throughout her career she has been responsible for the assessment of the health impacts of environmental agents, including chemicals and electric and magnetic fields (EMF). HECO ST-11A at 1-2.

Dr. Erdreich worked at the U.S. Environmental Protection Agency ("EPA"), where she conducted research to develop methods for setting exposure limits for chemicals to protect human health. These methods have been applied, for example, to the development of standards for water quality. The process of identifying potential effects and the exposure levels at which they occur is called health risk assessment. Health risk assessment is the process of determining, from scientific data, whether exposure to a specific factor in the environment is related to disease, and identifying what level of exposure is necessary to cause or affect the risk of disease. This process relies on a variety of data from toxicological (laboratory) and epidemiologic studies. HECO ST-11A at 2.

Dr. Erdreich received a B.A. in Biological Sciences and a M.Ed. in Science Education from Temple University, in Philadelphia, Pennsylvania. Subsequently she was awarded an M.S. in Biostatistics and Epidemiology (1977), and a Ph.D. in Epidemiology from the University of Oklahoma (1979). HECO ST-11A at 2.

Dr. Erdreich is a member of the Society for Epidemiologic Research, the Bioelectromagnetics Society, and the Institute of Electrical and Electronic Engineers. She is a Fellow of the American College of Epidemiology. HECO ST-11A at 2.

Dr. Erdreich has been an adjunct associate professor in the Department of Environmental and Community Medicine at the Robert Wood Johnson Medical School in New Jersey since 1992. She held a similar position at the University of Cincinnati in Ohio from 1982 to 1989. HECO ST-11A at 2-3.

Dr. Erdreich has 25 years experience in analyzing and conducting research to assess the potential biological and health impacts of EMF. She is actively involved in advising various parties regarding health issues related to electrical facilities such as transmission lines, substations, and electrified railroad lines. HECO ST-11A at 3.

Dr. Erdreich has been asked to review research concerning transmission lines for federal agencies. She has also worked with the U.S. National Institute of Occupational Health and Safety ("NIOSH"), the Oak Ridge National Laboratories, the U.S. Department of Energy ("USDOE"), and the U.S. Federal Rail Administration ("FRA") to review and evaluate health issues related to EMF from other sources. Dr. Erdreich has consulted with the Medical Services Division at the United Nations in New York. HECO ST-11A at 3; Tr. (11/07) at 200-01 (Erdreich).

Dr. Erdreich is a member of the Institute of Electrical and Electronics Engineers ("IEEE"), an international technical organization, and she participates in IEEE committees that develop exposure limits, or standards. One of these committees develops exposure limits, or standards, for EMF in the low frequency range 0 to 3000 Hz, the range that includes fields from power lines and other electrical sources. She has published papers in scientific journals, and has prepared book chapters and technical reports. She routinely serves as a reviewer for scientific journals that specialize in epidemiology and public health research, and others that specialize in electromagnetic energy. HECO ST-11A at 3; Tr. (11/07) at 201 (Erdreich).

Appendix C – Dr. Aaronson's Qualifications

Dr. Stuart Aaronson is a Professor and Chairman of the Department of Oncological Sciences at Mount Sinai School of Medicine in New York. As part of his duties and activities in those positions he is the head of a research department focused on understanding of the causes of cancer with the goals of developing better approaches to prevention and treatment of this disease. He is responsible for hiring faculty members and is involved in strategic planning of Mount Sinai's cancer initiatives. In addition, he has his own research group, which studies molecular alterations and signaling pathways involved in cancer. Tr. (11/07) at 214 (Aaronson); HECO ST-11B at 1.

Dr. Aaronson's prior work experience is stated in his curriculum vitae (HECO-ST-1100B). Briefly, he became Chief, Laboratory of Cellular and Molecular Biology in the National Cancer Institute ("NCI") in 1977. His laboratory at the NCI made critical discoveries concerning the molecular basis of cancer. Specifically, he was involved in the discovery of the first normal function of a cancer gene (oncogene), the identification of oncogenes of human cancers, and the discovery of important signaling molecules involved in normal cell proliferation and differentiation. They identified a number of molecular mechanisms, which activate cellular genes to become oncogenes. Dr. Aaronson was recruited in 1993 to lead the Ruttenberg Cancer Center, a research department now formally designated as the Department of Oncological Sciences, at Mount Sinai, where he has been involved in building a nationally recognized cancer program. He is responsible for hiring faculty members, developing disease focused multidisciplinary cancer research efforts, and serving as a senior academic leader within the Mount Sinai School of Medicine. He has his own grant-supported research program as well. This program involves investigation of cancer genes and the signaling pathways in which they act as well as the multistep process of carcinogenesis. In the course of his work, Dr. Aaronson trains graduate and medical school students as well as postdoctoral investigators in the area of cancer biology. He has published over 520 articles primarily related to cancer and has more than 50 patents or patent applications arising from his discoveries, one of which has led to an approved drug and with others of which are at different stages of clinical development. HECO ST-11B at 1-2; Tr. (11/07) at 214 (Aaronson).

Dr. Aaronson is presently a member of the American Association for Cancer Research, and serves as a member of its Public Relations and Communications Committee. He also serves as a Member of the National Neurofibromatosis Foundation Research Advisory Board. He is an Associate Editor or Editorial Board member of a large number of cancer focused scientific journals. These include Cancer Research, Oncogene, International Journal of Cancer, and Cancer and Metastasis Reviews. He serves on the Scientific Advisory Boards of the Kimmel Cancer Center, Thomas Jefferson University, and the Georgetown University Breast Cancer Specialized Program of Research Excellence ("SPORE"). He has previously served as organizer of a number of scientific meetings including the Princess Takamatsu Symposium. He has served as an elected officer of scientific societies including Councilor of the Society for Experimental Biology and Medicine and President of the Harvey Society. HECO ST-11B at 2-3; Tr. (11/07) at 214 (Aaronson).

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CERTIFICATE OF SERVICE

I hereby certify that I have this date served a copy of the foregoing **OPENING BRIEF OF HAWAIIAN ELECTRIC COMPANY, INC., EXHIBITS "A"-"E"**, together with this Certificate of Service, by hand delivery and/or mailing a copy by United States mail, postage prepaid, to the following:

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