HISTORY
OF THE
GREEK POWER PROGRAM

UNITED STATES OPERATIONS MISSION TO GREECE
CONSTRUCTION, INDUSTRY & TRANSPORTATION DIVISION
POWER BRANCH, D. M. SIMMONS, CHIEF

MAY 31, 1954

BEST AVAILABLE

HISTORY OF THE GREEK POWER PROGRAM

BY

D. M. SIMMONS

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Athens,
May 31, 1954

HISTORY OF THE GREEK POWER PROGRAM
BY D. M. SIMMONS

PART I - GENERAL

FOREWORD:

The following is an attempt to sketch the history of the enormous contribution of the United States of America to the Kingdom of Greece in giving them an up-to-date intergrated, interconnected modern power system all in the short space of 5 years. Such a system, if it were successfully financed, would usually require some 40 or 50 years to build up. This program was under the auspices of the Economic Cooperation Administration (ECA), implementing the Marshall Plan. In October 1951, the functions of the Economic Cooperation Administration were changed and a new organization called the Mutual Security Agency (MSA) was set up. More recently the organization was changed again to the Foreign Operations Administration in Washington (FOA) and the former ECA/MSA Mission here has become the United States of America Operations Mission to Greece (USOM/G).

The purpose of this report is to describe the entire power program up to about June 30, 1954. The writer, Dr. D.M. Simmons, Chief of the Power Branch of the CIT Division, was for most of his life Director, vice president and chief engineer of the General Cable Corporation, New York. I have one difficulty in writing this report, namely that I was assigned to this job on February 17, 1953. I have been in close personal touch with everything from that time on and indirectly with what took place in the past. Naturally during my stay in Athens, I have had a wealth of comments and information on the early days. In particular, my predecessor Mr. W. Seymour, who was here as Chief of the Power Branch from July 17, 1950 to September 30, 1952 has prepared a very helpful report of the happenings up to June 30, 1952 and I have used his report frequently.

The purpose of this report is not to write a dramatic or literary masterpiece but, for the help of those who may later desire to study the power program and its development in Greece to assemble all the pertinent facts so that they may be found as far as possible in one report.

GENERAL BACKGROUND:

The power system of Greece was undoubtedly one of the most backward of the systems in any European country. In 1950 for instance, the electric energy developped per person was approximately 2100 for the U.S.A., 1107 for Great Britain, 600 for Italy and in Greece less than 100. After the war, the Greek power system consisted of a semi-modern but good power company in the Athens area, namely the Athens-Piraeus Electricity Company Ltd., with a total installed capacity in 2 plants in Athens of 134,000 kilowatts.

Apart from this system, the amount of available power was extremely limited consisting of almost entirely small diesel electric stations burning very expensive imported fuel in all the major cities and some of the small ones. Even the cities of Salonika, Patras and Volos had very limited diesel capacity. The situation was so critical in Salonika that some years ago 5 mine sweepers were anchored to the quay and the power they generated was added to the diesel power in the city; even today two of these mine sweepers are in service.

There is an additional factor that made the situation even worse. Not only was the power in the small cities very expensive but the local small stations usually operated for only a few hours per day. A recent study shows that there is a total of about 292 such small diesel plants totaling only 67,700 kw: this figure is not a real figure, for the reason that these plants are idle so much of the time. Also the diesel engines are old and cannot produce rated capacity; in some cases this is only 50% of rating. The power shortage was a matter of extreme urgency for the entire economy of Greece.

In 1948 the Government of Greece submitted to the OEEC as part of its recovery program a proposal for the development of power projects and related transmission and distribution facilities. This proposal was accepted in principle by the OEEC and included in the 4 year development program 8 hydro electric plants totaling 537,000 kw as follows:

Ladhon	60,000 kw	Megdova	12,000 kw
Vodas	20,000 kw	Aliakmon	120,000 kw
Louros	20,000 kw	Vouraicos	45,000 kw
Acheloos	220,000 kw	Lisse	40,000 kw

As a basis for appraising the power program proposed by Greece in 1948, ECA and the Greek Government employed Ebasco Services Inc., of New York under a contract dated November 30, 1950 to investigate and report on an electric power program and on water utilization for the Kingdom of Greece. After an extensive survey, Ebasco rendered its final report under date of January 1950 entitled "Electric Power Program, Kingdom of Greece". This report recommended a comprehensive, nation-wide power development program and indicated several alternate initial programs. Ebasco's contract limited its studies to developments on the Vodas, Ladhon, Acheloos and Louros rivers only as well as thermo power development. In addition to project recommendations, it dealt with the organization and management principles of the power program. It included forecasts of power requirements and estimates of costs and rates. This report recommended hydro and lignite-burning steam plants capable of generating 343,000 kw, more than double the existing power production of the nation. It also of course included transmission lines, sub-stations, distribution etc..

Funds, however were limited and it was decided that the proposed program was too great. Finally about one half of the original Ebasco plan was approved by ECA and the Greek Government for an estimated total cost of $83,777,000 for materials, equipment and the construction. The Greek Government filed Project Application Letters on the following basis:

Project No. 1 - Vodas Hydroelectric Generating plant and Related Transmission Lines and Distribution System-(Agra)-

Project No. 2 - Ladhon Hydroelectric Generating Plant and Related Transmission Lines and Distribution System.

Project No. 3 - Eubean Gulf Thermal Electric Generation Plant and Related Transmission and Distribution System-(Aliveri)

Project No. 6 - Louros Hydroelectric Generating Plant and Related Distribution System.

These project applications were approved by ECA/Washington in the spring of 1950.

The following is the total generating capacity of the above four installations:

Agra	40,000 kw
Ladhon	50,000 kw
Aliveri steam plant (on Eubean gulf)	80,000 kw
Louros	5,000 kw
Total.	175,000 kw

After approval of the program by ECA/Washington, Greece proposed to carry out its commitment to employ a firm of American engineers. After extended discussions with representatives of ECA and representatives of various engineering firms, it was decided to obtain competitive proposals for the furnishing of the required consulting engineering and management surveys. Inquiries were sent out May 8, 1950 to outstanding engineering firms of the U.S.A. Of the proposals received, the proposal submitted by Ebasco Services Inc., was judged to be the most advantageous.

Thereafter, negotiations proceeded toward the development of a definitive agreement between Ebasco and the Kingdom of Greece. These negotiations were carefully followed by ECA/Washington which made several suggestions as to the substantive content of the final agreement, Greece was represented in these negotiations, which were carried out in Washington, by Messrs. G. Pezopoulos, I. Maggioros, K. Kyriacos and Th. Makris. As the negotiations reached their final stage, Mr. L Karavidas came from Greece with specific authorization from the Greek Government to execute the agreement on its behalf, and on July 7, 1950 a letter of committment was issued to Ebasco by the Greek Government accepting Ebasco's final proposal and authorizing it to commence work immediately. The Management Agreement was finally executed in Washington on July 20, 1950 and was effective July 7, 1950. The agreement contemplated the construction of a power system of a total estimated cost of $83,777,000. The termination date is July 31,1955.

Under the terms of the Management Agreement, and pursuant to earlier discussions with ECA/Greece, the Government of Greece proceeded to develop and enact legislation to establish an independent public corporation to manage, develop, and operate the new power system. After extensive discussion between the Mission and Government representatives, the first major piece of legislation was enacted by Parliament on August 2, 1950 in the form of Law 1468/1950. In several respects this legislation followed the lines recommended by a committee of the Greek Government in its "Report on the Power Agency".

In order to carry out the power program prior to the establishment of the Public Power Corporation, the Minister of Coordination by decision dated August 8, 1950 established in his Ministry the Power Program Implementation Service whose members were: Messrs. I. Karavidas, as head, I. Maggioros, G. Pezopoulos, K. Kyriacos and Th. Makris with Mr. G. Gounaris as secretary. This Service was responsible for supervising the work being done by Ebasco during the interim period and for representing the Government in connection with the power program in dealing with other agencies of the Government, Ebasco and ECA. On February 27, 1951 the first meeting of the board of directors of the Public Power Corporation was held, thereby placing that agency in operation in accordance with the requirements of law and displacing the Implmentation Service. The board consisted of four full-time members and three part-time members, the former including Messrs. I. Karavidas, G. Pezopoulos, V. Flambouriaris and Gounaris and the latter including Messrs. A. Demetrakopoulos, P. Galanis and Sinos. Mr. A. Demetrakopoulos was chairman of the board and Mr. I. Karavidas its delegated counsel. As one of its first decisions the board established the framework of its power organization, with Mr. W.H. Burke, Ebasco's principal representative in Greece, as general manager. From that date Ebasco ceased to operate in its own name in Greece, and its American employees became members of the Public Power Corporation. Mr. Charles F. Terrell later replaced Mr. Burke as general manager following the latter's resignation.

ORGANIZATION OF THE PPC:

Pursuant to the provision of Law 1468/1950, as amended by Compulsory Law 1672/1951, and the provisions of the Cooperative Electric Power Program Agreement between the Greek Government and ECA, the Greek Government established the Public Power Corporation, which is a public corporation owned by the Greek State and which is vested with the necessary authority and jurisdiction to develop and operate a nation wide electric utility system for Greece.

Under the provisions of law establishing the Public Power Corporation, the corporation is to enjoy complete administrative independence and is not to be subjected to the direct or indirect control of any governmental agency insofar as internal administrative or management matters are concerned. PPC is financed through the State Budget and is subject to its control. It is, however, subject to the supreme inspection of

the Ministry of Industry, the inspection of the Representative Assembly, which is a group of twenty-seven governmental, judicial, labor and business leaders, and to examination by an Auditing Board which is to be appointed by the Government and which is to have headquaters at the Auditing Chamber.

The organization of the PPC is regulated by a Royal Decree dated January 28, 1951 and entitled "Re: The Organization of the Administration of the Public Power Corporation". The Board of Directors, which consists of seven members, is charged with the responsibility of determining the policy to be followed by the PPC and deciding on matters of more general importance. Members of the Board are appointed for a term of five years by Royal Decree issued on proposal of the President of the Cabinet and the Ministry of Industry. Members may be removed for serious violation of the provisions of laws and regulations governing the functioning of the PPC as well as for any damage or neglect affecting the interests of the PPC. Removal is made by Royal Decree issued at the proposal of the President of the Cabinet and the Minister of Industry upon opinion of the Representative Assembly. The first members of the Board of Directors were appointed by Royal Decree dated February 1, 1951 and the PPC commenced its operations with the first meeting of the Board held on February 27, 1951.

The management of the PPC is divided between the Electric Power Division and the Lignite Division. The General Manager of each of these Divisions, under the supervision of the Board of Directors, is vested with the authority and responsibility of donducting the operations of his respective division within the framework of the general policies established by the Board of Directors. For and during the validity of the Ebasco Management Agreement, the chief representative of Ebasco in Greece will act as the General Manager of the Electric Power Division and will conduct the business and operations of the Electric Power Division within the framework of the provisions of that Agreement.

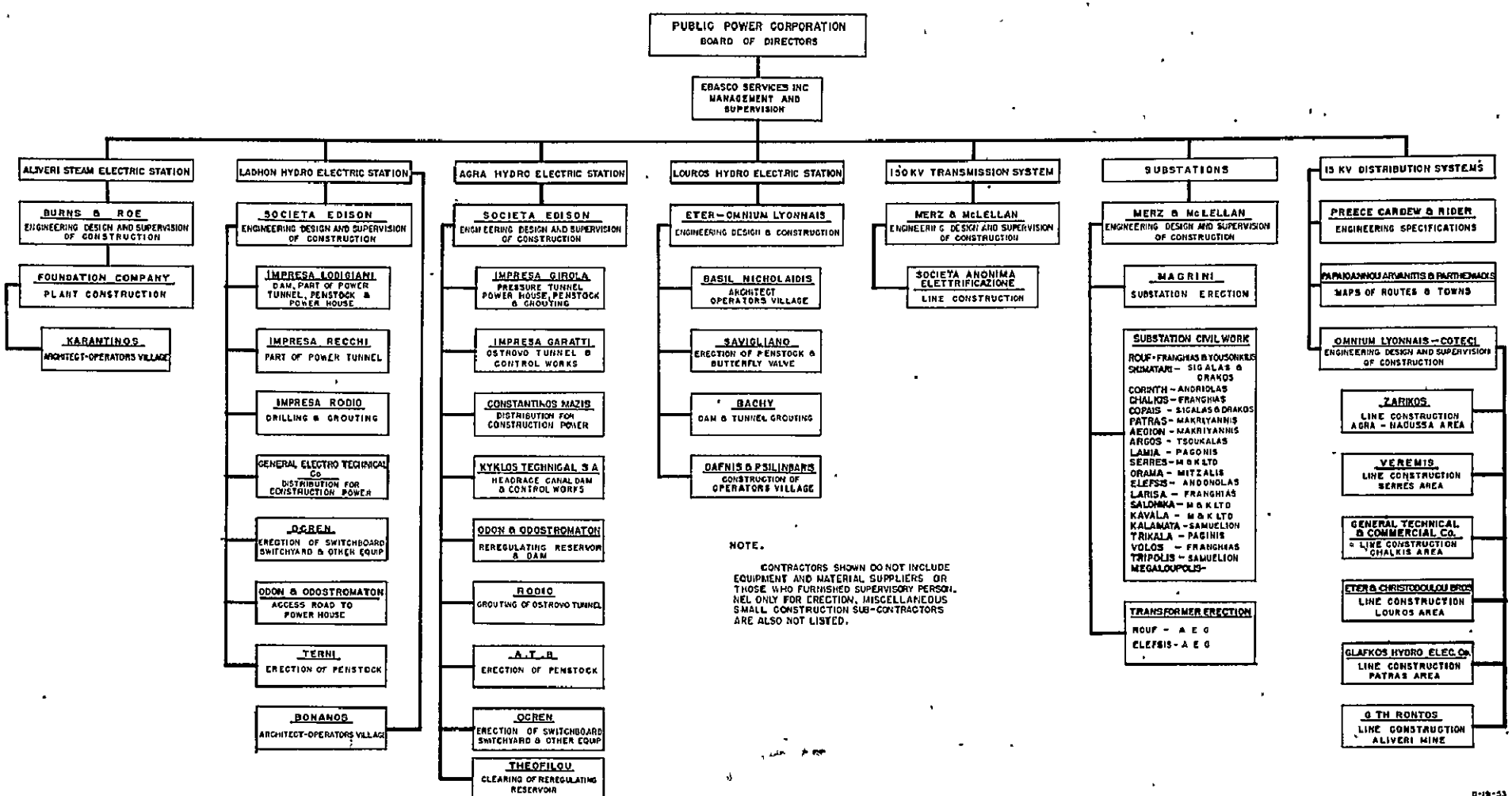
CONTRACTORS:

Under the terms of the Ebasco Management Agreement, it was agreed that Ebasco would not engage in the work of engineering, procurement or direct supervision of construction for the projects, and thus it has been necessary for the PPC to enter into contracts with other organizations to carry out this work. These contractors and sub-contractors are shown in the attached table:

GOVERNMENT OF KINGDOM OF GREECE

PUBLIC POWER CORPORATION – ELECTRIC POWER DIVISION

CONSTRUCTION PRIME CONTRACTORS AND SUB-CONTRACTORS



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BEGINNING OF WORK IN GREECE:

After the signing of the Management Agreement between Ebasco and the Greek Government the first group of Ebasco representatives arrived in Greece on July 31, 1950 and began immediately to set up an organization to start work on the authorized program. Previous to their arrival, the Minister of Coordination had issued a proclamation that actual construction work on the three hydro plants and the steam electric plant would be started with dedication ceremonies at each location.

Immediately upon arrival, the Ebasco engineers prepared inquiries for obtaining competitive bids from local contractors to undertake the initial construction activities of these projects. The initial work on the three hydro plants consisted of beginning the construction of access roads to the power plant sites, while at the steam electric station drilling operations for the exploration of subsurface conditions to determine the type of foundations required was the first work started.

On August 17, 1950 ceremonies were conducted at all four locations. Large crowds of people from each locality participated in the ceremonies together with officials of the Greek Government, the ECA Mission, Ebasco and by the Greek Orthodox Church, followed by talks by representatives of the Greek Government, local officials and ECA representatives.

Additional personnel of Ebasco Services Incorporated began arriving in Greece in the month of August 1950 and have continued to come to Greece as they were required for the various phases of the program. By June 30, 1951 37 representatives of Ebasco were in Greece.

The following table shows the number of people working on the power program in Greece for the period July 31, 1950 to April 31, 1954.

	Americans & Others	Greeks	Total
July 31, 1950	6	7	13
December 31, 1950	29	96	125
December 31, 1951	200	2,257	2,457
December 31, 1952	678	4,774	5,452
December 31, 1953	953	3,879	4,832
April 31, 1954	839	3,708	4,547

As a matter of record it might be of interest to give here the maximum number of employees every employed which was in July 1953 with the personnel totalling 6,472 divided as follows:

American	British	French	Italian	German	Greek	Total
67	26	37	1,045	4	5,293	6,472

In order that there would be as little delay as possible, survey work in connection with the various projects was immediately begun under the direction of Ebasco Services Incorporated; as contracts were executed for the engineering and construction of the projects the work already accomplished was turned over to the contractor.

A survey was also begun to determine the construction equipment available in Greece that could be used in the construction of the various projects. Such equipment as was found suitable was collected, rehabilitated and stored so that it would be available for transfer to the contractors on each project.

PROJECT AGREEMENTS AND THEIR NUMBERING:

The various projects in the power program were set up and described, and were given final estimating totals in a series of Project Agreements between the ECA/Greece and the Greek Government.

Table I gives the ECA Project Agreement numbers, the subject and the estimated total cost.

TABLE I

ECA/G Numbering of Project Agreements

ECA/G No.	Subject	Original Estimate
385	Management and Administrative	--
411	Aliveri Steam Station	$16,204,000
423	Agra Hydroelectric Station	9,442,000
424	Ladhon Hydroelectric Station	15,219,000
425	Louros Hydroelectric Station	3,124,000
426	Transmission Substations and Distribution & General Utility Plant	39,788,000
427	Aliveri Lignite	10,331,000
483	Training of Greeks in U.S.A.	

We gave on page 3 a list of the four Project Application Letters filed by the Greek Government. Unfortunately when Washington approved these projects, it completely changed the content of each project and gave new numbers which we shall call the ECA/W numbers. These projects are shown in Table II taken from Part I (A) of the Management Agreement.

TABLE II

ECA/Washington Titles and Numbering of Projects

ECA Project No.	Title
IX	New 68,000 kilowatt Chalkis Thermal Electric Generating Station in Eubean Gulf area (burning lignite).
X	150 kilovolt Electric Transmission Lines, 150 to 15 and 22 kilovolt Substations and Distribution systems, supplied by Chalkis Thermal Electric Station, i.e. the East Central Greece and Athens-Piraeus areas. (Distribution systems in the Athens-Piraeus area not included).
XI	New 40,000 kilowatt Agra Hydroelectric Generating Station on the Vodas River.
XII	150 kilovolt Electric Transmission Lines 150 to 15 kilovolt Substations and Distribution systems, supplied by the Agra Hydroelectric Station, i.e. the Macedonia and Thrace areas.
XIII	New 50,000 kilowatt Ladhon Hydroelectric Generating Station on the Ladhon River.
XIV	150 kilovolt Electric Transmission Lines, 150 to 15 kilovolt Substations and Distribution systems, supplied by the Ladhon Hydroelectric Station, i.e. the Peloponnesus and Athens-Piraeus areas. (Distribution systems in Athens-Piraeus area not included).
XV	New 5,000 kilowatt Louros Hydroelectric Generating Station on the Louros River.
XVI	Electric Transmission Lines, Substations and Distribution systems, supplied by the Louros Hydroelectric Station serving surrounding area of Epirus.
Pending	General Utility Plant i.e., Buildings, Offices, Shops, Warehouses, Laboratories, Transportation and Maintenance Equipment etc..
XX	Management and Administrative.
XXI	The Larissa-Agra 150,000 volt line and Terminal Substations.

Projects XX and XXI were added to the original Agreement.

The Project Agreement Numbers listed in Table I have been in general use here; the ECA/Washington Roman numbers are used only by Washington. Unfortunately, the numbering system is still further complicated. Additional numbering system is still further complicated. Additional numbering systems are now being used by the Greek Government. During fiscal year 1952-1953 whereas the old PA Nos. were used for all foreign purchases, a new numbering system covering a range of numbers 1280 to 1300 was set up for projects covering local purchases. In fiscal year 1953-1954, the old PA numbers were dropped, the 1952/1953 1200 numbers were maintained for local purchases and a new series of numbers was added for purchases involving foreign exchange. These new numbers run from about 1900 to 2000 which look like dates but are actually project numbers.

Table III will outline this very complicated structure of numbers. We have gone into this detail because it seems to us that this numbering would be absolutely unintelligible without a detailed description.

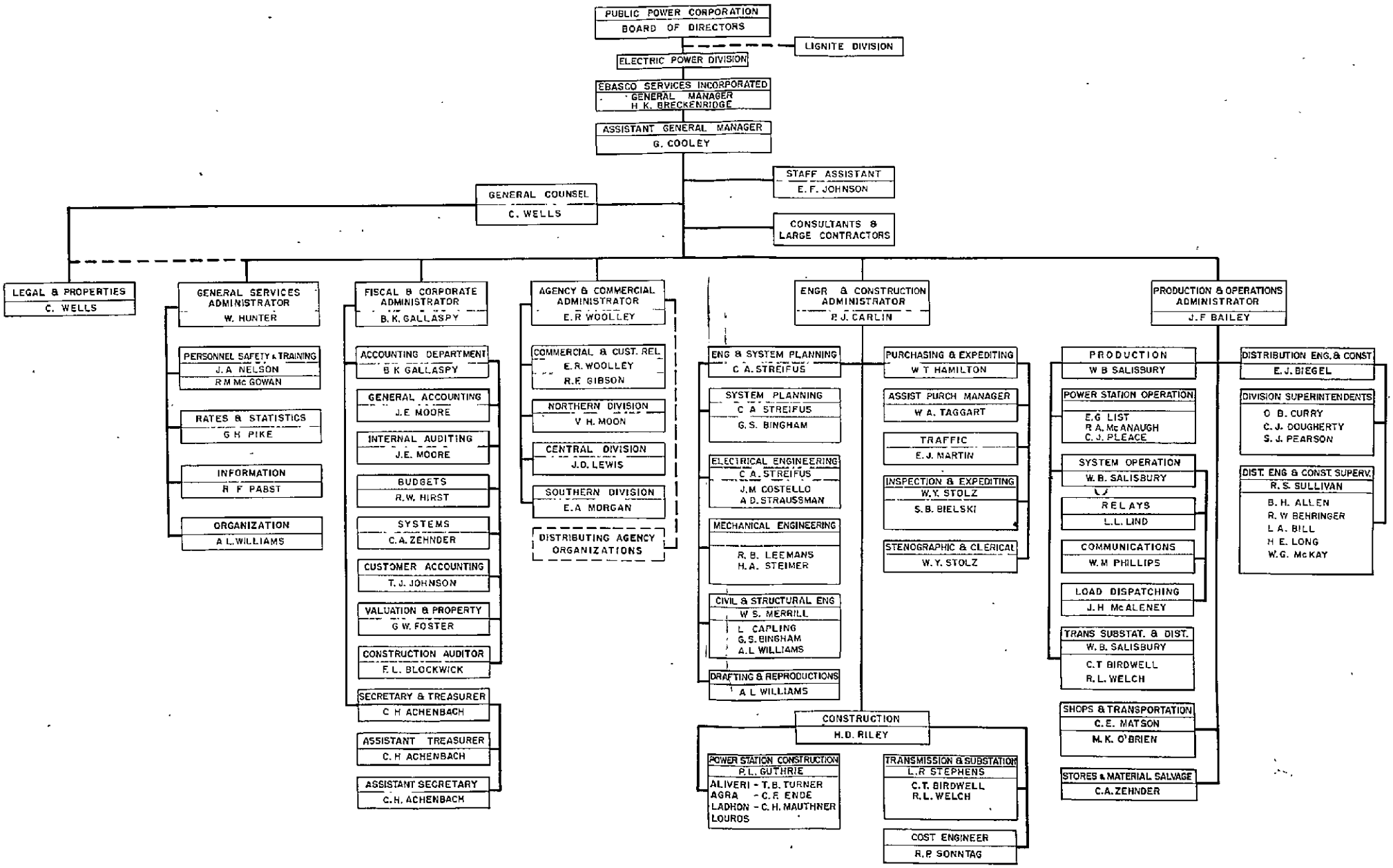
TABLE III

Present Numbering of Project Agreements and Tripartite Decision

Project	From 1948-1952 Local & Foreign and 1952-1953 - Foreign	From 1952-1953 Local	From 1953-1954 Local	From 1953-1954 Foreign
Management	385	(1285 Adm.& Op. (1288 Work.Cap. (1287 Pay for Lig.	1285 1286 1287	1285 - -
Aliveri	411	1288	1288	1954
Agra	423	1289	1289	1953
Ladhon	424	1290	1290	1952
Louros	425	1291	1291	1951
T & D	426	1292	1292	1950
Lignite	427	(1293 Lig. Mines (1294 Adm. & Op.	1293 1294	- 1294
Larissa-Agra Line	-	-	-	1886
Training Program	483	-	-	2074

GREEK POWER PROGRAM

ATHENS STAFF OF EBASCO SERVICES INCORPORATED



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PUBLIC POWER COPRORATION PERSONNEL:

We have given above the names of the Greek members of the Board of Directors. In this section will be added the present members of the Ebasco personnel of the Management group. As stated above Mr. Charles F. Terrell succeeded Mr. Burke as General Manager. In July 1953, Mr. Terrell was very ill and never returned to his job as General Manager. For some 9 months Mr. G. Cooley, the Assistant General Manager, became Acting General Manager, until the arrival of Mr. H.K. Breckenridge on February 15, 1954, when the latter became General Manager of PPC, with Mr. Cooley again being Assistant General Manager. The attached organization chart lists the main positions in the PPC, together with names of Ebasco personnel filling them.

SUPPLEMENTAL AGREEMENTS TO THE MANAGEMENT AGREEMENT:

The original Management Agreement effective July 7, 1950, has in the meantime had seven Supplemental Agreements added to it.

The following will list these supplements giving the number, date and subject.

No. 1, July 7, 1950 - Travel expenses allowed Greeks in foreign countri
No. 2, July 7, 1950 - Travel and subsistence of Ebasco personnel.
No. 3, July 7, 1950 - Living allowances for Ebasco personnel.
No. 4, June 1, 1951 - A new part IX of Management Agreements sets up a study by PPC of Hellenic American General Lignite Products Co's proposal on a briquetting and power plant at Ptolemais.
No. 5, Nov. 1, 1951 - Covers the Training Program of Greek personnel.
No. 6, Dec. 28,1953 - Increase the reimbursables and fixed fee to Ebasco by $155,000 in connection with the design and construction of the new 150,000 volt tie-line which will interconnect the Larissa sub-station and the Agra station.
No. 7, Jan. 21,1954 - Increase the reimbursables and fixed fee to Ebasco by $47,000 in connection with the increase in height of the Ladhon dam by 20 meters.

PART II

THE PUBLIC POWER CORPORATION PROJECTS IN DETAIL:

A great deal of data and statistics could be given on each of the 7 main PPC projects, namely, the four power stations, the 150,000 volt transmission system, the substations and the distribution system.

YUGOSLAVIA
BULGARIA
TURKEY
ALBANIA
AEGEAN SEA
IONIAN SEA
SERRES
DRAMA
KAVALA
40 000 KW
AGRA
EDESSA
NAOUSSA
VERRIA
KARIOTISSA
SALONIKA
PTOLEMAIS
KOZANI
TRIKALA
LARISA
LOUROS
5.000 KW
MEGDOVA
84.000 KW
VOLOS
FARSALA
LAMIA
ACHELOOS
180.000 KW
AITOLIKON
LEVADIA
CHALKIS
ALIVERI
80.000 KW
PATRAS
AEGION
ELEFSIS
ROUF
ATHENS
APEGO
151.000 KW
LECHAINA
AMALIAS
PYRGOS
LADHON
50.000 KW
CORINTH
OLYMPIA
ARGOS
TRIPOLIS
KALAMATA
N
KINGDOM OF GREECE
ELECTRIC POWER PROGRAM
PUBLIC POWER CORPORATION
0 20 40 60 80
KILOMETERS
LEGEND
HYDRO PLANT
STEAM PLANT
SUBSTATION
150 KV TRANSMISSION LINE
FUTURE " "
APROVED " "
PROPOSED " "
15 KV DISTRIBUTION LINE
4-8-53

The most useful and simplest approach to this problem, however, appears to be a combination of statistics amply supplemented with construction photographs. This is the procedure which we will follow for each of the 7 projects. Attached hereto is a map of the whole PPC power system. For the case of each of the three hydro plants, there will be given in addition a diagram of the project.

ALIVERI STEAM PLANT - Burns and Roe Inc., - Foundation Co. Engineers and Contractors.

This plant went into service on July 2, 1953 supplying power from the first unit to the Athens-Piraeus Electricity Co. It was officially dedicated by H.M. the King of Greece on August 1, 1953.

The second unit went into service on October 13, 1953. At the present time the load has been as high as the rating, namely 80,000 kva with both units in operation. It is turning out now more than 1,250,000 kwh per day displacing energy which would otherwise be produced by imported fuel oil and is supplying more than 50% of the energy used in Athens area.

The main thought and purpose in the design of this plant has been to avoid the use of expensive, imported fuels. The plant is completely fired by lignite from lignite mines belonging to PPC and adjacent the plant.

The following page gives the dimensions and numerical statistics concerning the Aliveri project.

ALIVERI THERMAL ELECTRIC PROJECT

Burns & Roe Inc. - Foundation Co.
Engineers and Constructors

PLANT SITE AREA: 339 stremmas

POWER PLANT DIMENSIONS:
40 m wide - 70 m long - 30 m high

TURBINE GENERATORS:
Two units 40.000 kw each; steam conditions 60 atm. 485° C; 50,000 KVA 0.8 p.f. 3000 r.p.m.
Manufacturer: A.E.G., Germany

CONDENSERS:
Two units 2800 sq.m. each; with condensate & C.W. Pumps.
Manufacturer: A.E.G., Germany

BOILERS:
Four units (90 T/hr each); steam conditions 65 atm. 487° C
Manufacturer: Babcock & Wilcox, U.S.A.

STOKERS:
Four units spreader type traveling grates front ash discharge
Manufacturer: Detroit Stoker Corp., U.S.A.

BOILER FEED PUMPS:
Four units two motor-driven, two steam-turbine-driven
Manufacturer: Pacific Pumps U.S.A., 900 H.P. Motors and 1000 H.P. Turbines Drives - Westinghouse, U.S.A.

VALVES:
Manufacturers: Chapman U.S.A.
Manning Maxwell Moore U.S.A.
Powell U.S.A.

LIGNITE HANDLING EQUIPMENT:
Conveyors and crushers for 300 T per hour
Manufacturer: Kampnagel, Germany

ASH HANDLING EQUIPMENT:
300 T Capacity; pneumatic ash removal system.
Manufacturer: Allen-Sherman-Hoff, U.S.A.

FUEL OIL STORAGE TANK: (EMERGENCY ONLY)
8600 T Capacity; reinforced concrete

INSTRUMENTS & CONTROLS:
Complete Automatic Combustion Control System & Instrumentation
Manufacturer: Republic Flow Meters, U.S.A.

SWITCHYARD:
Two main transformers, 40/50 MVA each, 15 KV/150 KV
Manufacturer: A.E.G. Germany
Three oil circuit breakers
Manufacturer: Magrini, Italy
Two auxiliary transformers, 3750/4687 KVA, 15000/3150 V
Manufacturer: C.G.E., Italy

SWITCHGEAR & CONTROL BOARDS:
Manufacturer: General Electric, U.S.A.

CRANE:
30/5 T Capacity, outdoor gantry type
Manufacturer: Colby, U.S.A.

STACKS:
Two, 50 m high, reinforced concrete, brick lined
Subcontractor: Mathios, Greece

EVAPORATORS:
Two Units, 5500 Kg/hr each
Manufacturer: Lummus Co., U.S.A.

EXTRACTION FEED WATER HEATERS:
Six Units, U-Tube type
Manufacturer: Lummus, Co., U.S.A.

PIPING:
Steel, fabricated
Manufacturer: Mitchell, U.S.A.

WATER TREATMENT PLANT:
50 gpm Na - H Zeolite system
Manufacturer: Graver, U.S.A.

OPERATORS VILLAGE:
27 houses (one, two and three bedroom)
Canteen, Single men's quarters
Total - 29 Buildings

ALIVERI STEAM PLANT

No. 467 1/12/54 Conveyers & Plant looking S.

ALIVERI

No. 1334 5/6/54 Powerplant.

ALIVERI STEAM PLANT

No. 466 1/12/54 Operators' Village.

ALIVERI STEAM PLANT

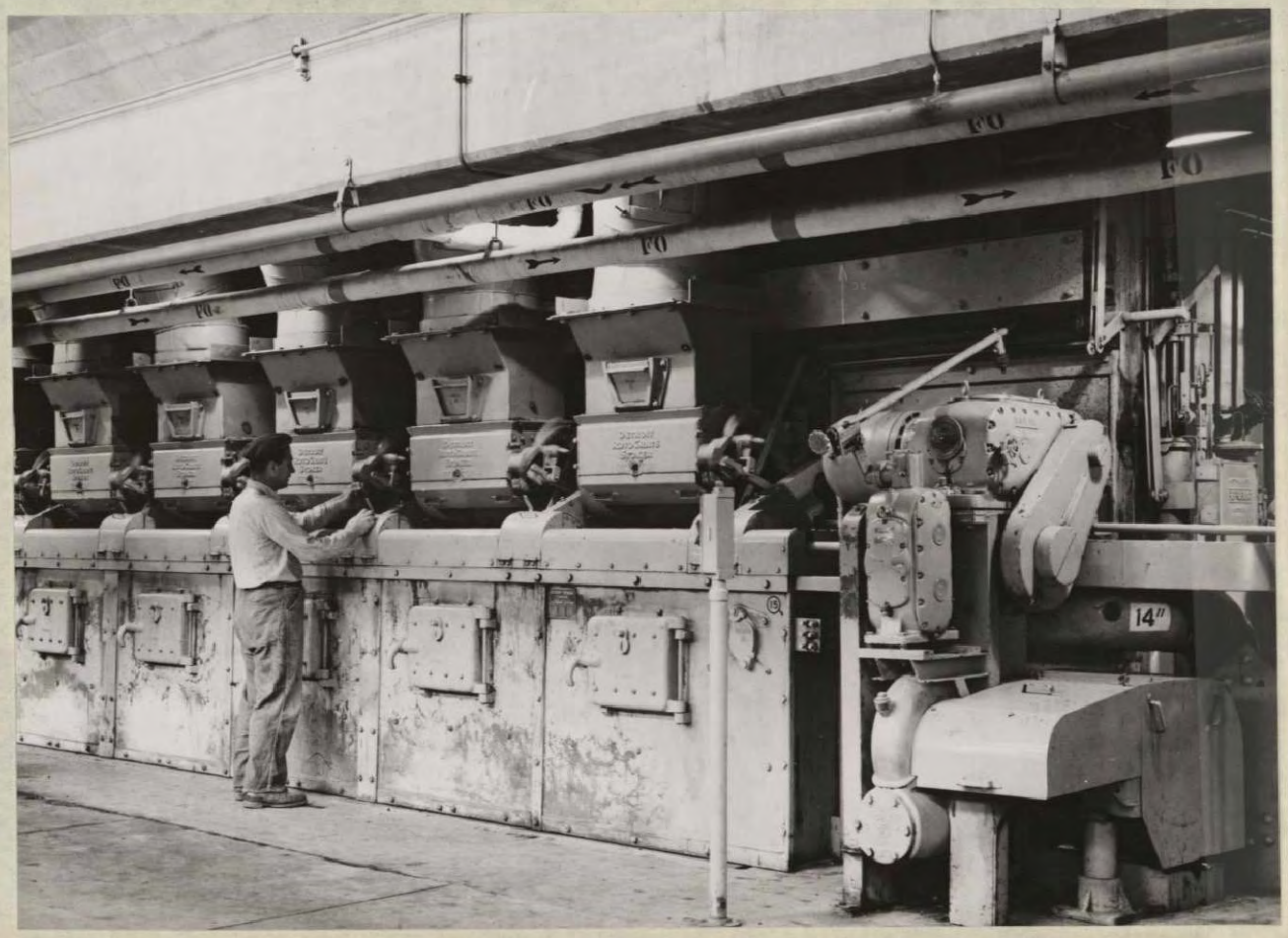
No. 465 1/12/54 Switchyard

ALIVERI STEAM PLANT

No. 437 12/5/53 General view looking S.E.

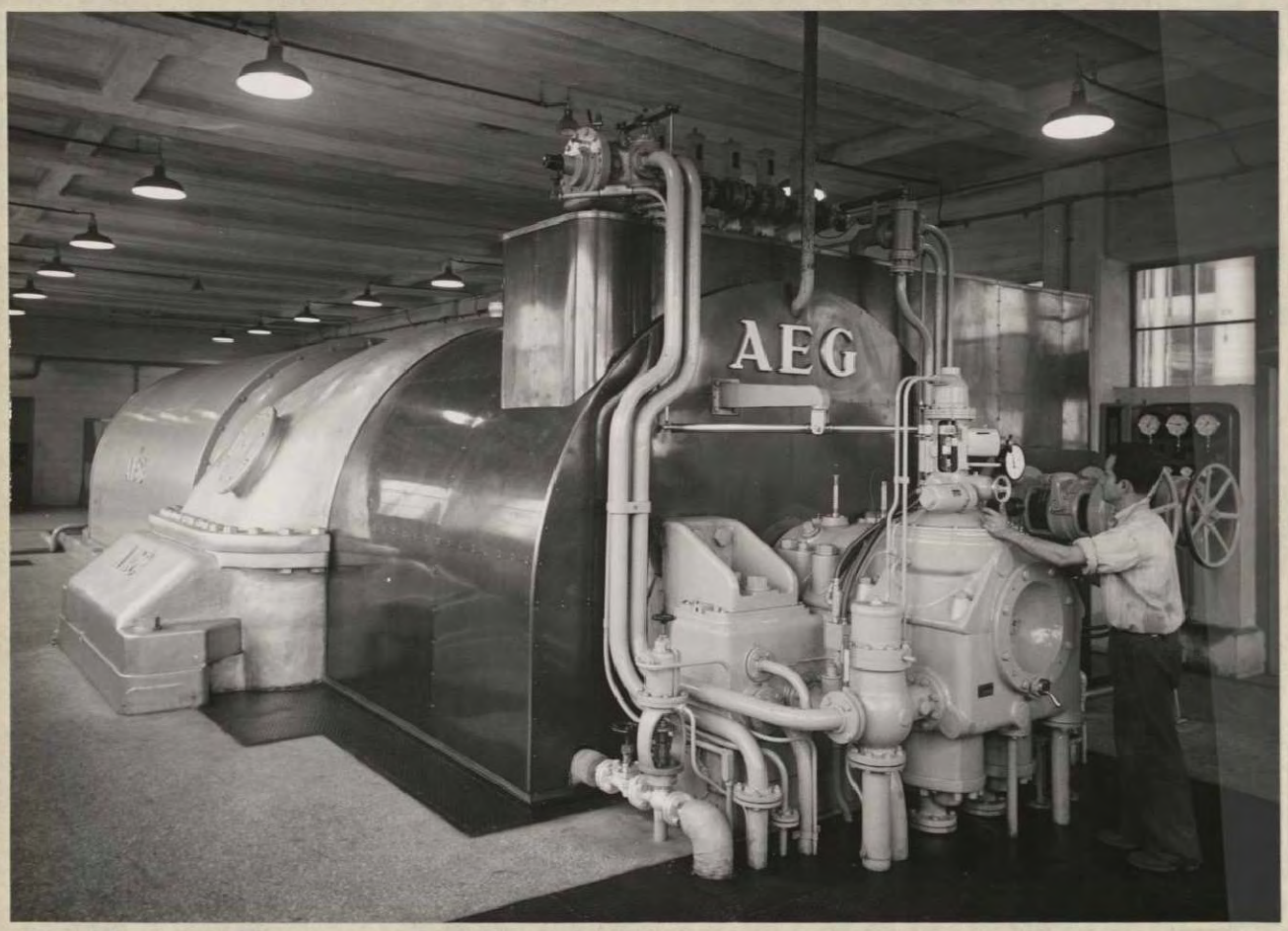
ALIVERI STEAM PLANT

No. 451 12/5/53 Stoker - Boiler No. 1.



ALIVERI STEAM PLANT

No. 452 12/5/53 Unit No. 1



ALIVERI STEAM PLANT

No. 386 8/1/53 H.M. The King-Dedication.

ALIVERI STEAM PLANT

No. 385 8/1/53 Dedication- General View.

ALIVERI STEAM PLANT

No. 373C 6/7/53 Aerial View.

ALIVERI STEAM PLANT

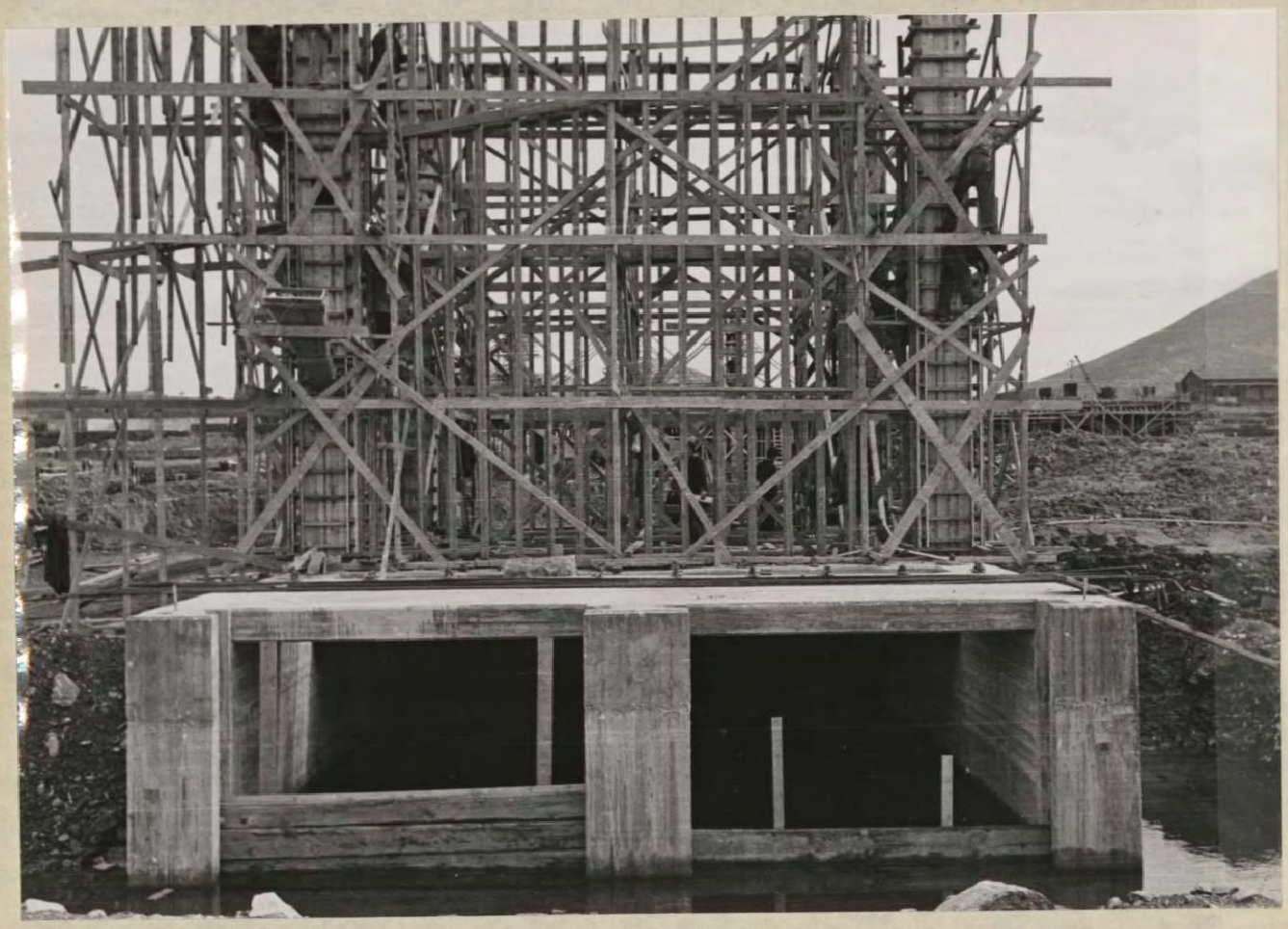
No. 197C 10/23/52 Aerial View.

ALIVERI STEAM PLANT

No. 101 7/24/52 View looking S.

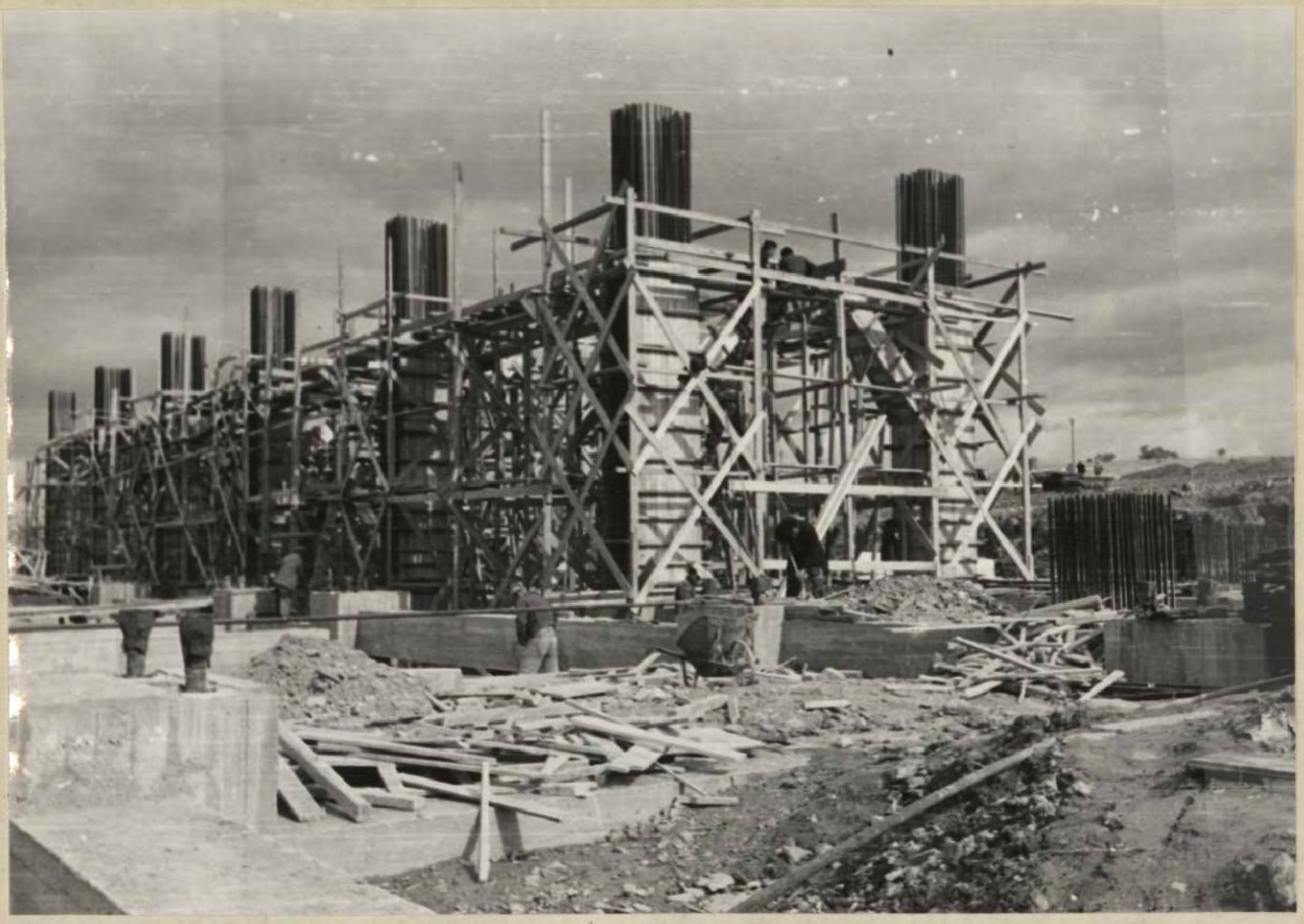
ALIVERI STEAM PLANT

No. 64 12/28/51 Powerhouse Foundations.



ALIVERI STEAM PLANT

No. 40 10/30/51 Powerhouse Basement.



AGRA HYDROELECTRIC PLANT - General Contractor-Societa Edison:

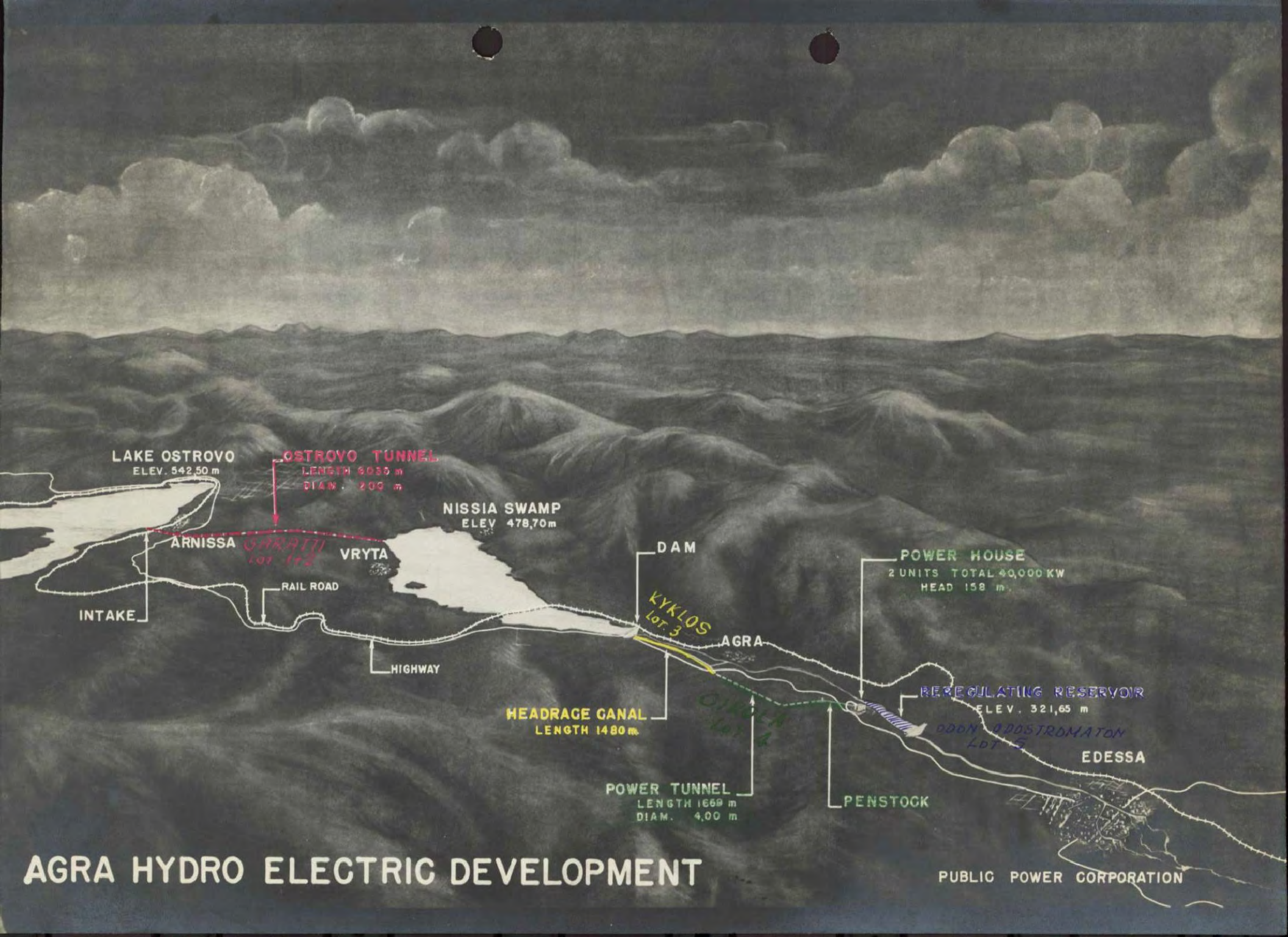
This is a rather unusual plant. The differences of elevation required for the necessary head have been supplied by nature. There is no dam except a simple wier about two meters high.

The water starts in lake Ostrovo which has no outlet; there seems to be an enormous underground flow of water. The water level is about 30 feet higher than normal. It is planned to use the stored water to fit operating conditions in the next two or three years. In the meantime the Agra-Larissa 150,000 volt line will connect this northern system including Agra with the main PPC system. A free-flow tunnel is being built to take water from lake Ostrovo to lake Nissia which has no inlet and out of which flows the Vodas river fed by springs. The Ostrovo water therefore, both the present impounded water and future flow will be contributed to the Agra power plant through lake Nissia. (See map). The local farmers are trying to save as much of the lake land as is possible, since it is partially suitable for cultivation and crops have been raised about once in 6 years, saving perhaps 1/3 of the original lake Nissia which is more of a swamp than a lake.

The water from lake Nissia flows through intake works whence it flows through an open concrete-lined headrace canal of trapezoidal cross-section. The water is then fed through a power pressure tunnel whence it enters the steel penstock and flows into the plant with its two 20,000 kw hydroelectric generator units. At the top of the penstock there is a subterranean surge tank with an overflow chamber above ground.

The Vodas river continues to the small city of Edessa where it breaks into four channels of limited capacity which form four water falls. If the flow of water from the power plant exceeds 35 cubic meters per second, the town of Edessa would be flooded. It was therefore necessary to have a large reregulating reservoir with two control gates and a spillway (see statistics, map and photographs).

At some later date it is proposed to use the head of the Vodas river and its falls below the town of Edessa to develop an additional 60,000 kw making the ultimate total of this project 100,000 kw.


LAKE OSTROVO
ELEV. 542,50 m
OSTROVO TUNNEL
LENGTH 6035 m
DIAM. 200 m
NISSIA SWAMP
ELEV 478,70m
ARNISSA
VRYTA
RAIL ROAD
INTAKE
HIGHWAY
DAM
KYKLOS
LOT 3
AGRA
POWER HOUSE
2 UNITS TOTAL 40,000 KW
HEAD 158 m.
REREGULATING RESERVOIR
ELEV. 321,65 m
HEADRACE CANAL
LENGTH 1480 m
EDESSA
POWER TUNNEL
LENGTH 1669 m
DIAM. 4,00 m
PENSTOCK
AGRA HYDRO ELECTRIC DEVELOPMENT
PUBLIC POWER CORPORATION

AGRA HYDROELECTRIC PROJECT
GENERAL CONTRACTOR - SOCIETA EDISON

STATISTICS

OSTROVO RESERVOIR

Length-19 km. Initial area-75 sq. km.

Volume above elevation 530-9000000.000 m^3

Reclaimed land above elevation 530-22 km^2

Volume between elevations 530 and 520 (for regulation)400,000,000 $m.^3$

OSTROVO TUNNEL

Lined, free flow tunnel

Length-6035 m. Diameter-2.0 m. Max Capacity-10 m^3/sec.

Subcontractor- Garatti, Italian

LAKE NISSIA RESERVOIR

Average flow of Vodas River-4.3 m^3/sec.

Normal operating level-478.7.Length-7 km. Area at 478.7-6.3 sq km.

Volume between elevations 478.70 and 478.40 - 1,700,000 m^3 .

Subcontractor - Kyklos, Greek.

LAKE NISSIA DAM

Earth fill dam.

Maximum height-3.5 m. Length-324 m. Crest elevation-480.2

Subcontractor - Kyklos, Greek.

INTAKE AND HEADRACE CANAL

Concrete lined canal, trapezoidal cross section.

Length-1480 m. Capacity-35 m^3/sec.

Subcontractor - Kyklos, Greek

AGRA HYDROELECTRIC PROJECT
STATISTICS

POWER TUNNEL

Lined pressure tunnel, circular cross section.

Length-1669 m. Diameter-4.00 m. Capacity-35 m3/sec.

Subcontractor - Girola, Italian.

SURGE TANK

Shaft. Height-19.0 m. Diameter-8,00 m. Max. water level-483.0

Expansion and feeding chamber. Area 22,2 m by 18.2 m. Height-5.50 m.

Suboontractor - Girola, Italian.

PENSTOCK

Steel pipe, mostly in open.

Length-437.00 m. Diameter 3.30 to 2.90 m.

Valves. Butterfly valve, diameter-3.30 m. Air valve, diameter-0.63 m.

Manufacturer - Acciaieria & Tubificio di Brescia, Italian.

Subcontractor - Girola, Italian.

POWERHOUSE

Main building. Reinforced concrete structure with steel roof trusses, volume-16,800 m3

Control house. Reinforced concrete structure - volume 1500 m3

Developed head - 158 m gross. Capacity 35 m3/sec.

Turbines. Two single runner, Francis type, vertical shaft turbines- 20,000 kw output each, at 428 rpm.

Manufacturer - Riva, Italian.

Generators. Two synchronous, three phase, 15.75 kv., vertical shaft generators for 22300 KVA (25600 KVA with temperature rise of 80 C). Frequency-50 cycles.

Manufacturer - Tecnomasio Italiano Brown Boveri, Italian.

Switchgear and Protective Relays - 11 panels.

Manufacturer - Ocren, Italian.

AGRA HYDROELECTRIC PROJECT
STATISTICS

Cooling system. Closed cooling system by means of heat exchangers, one cooling tank in the powerhouse and another on the hillside.

Traveling crane. Two bridges, each 16 m. span and 52 tons lifting capacity.

Manufacturer - Gentilli Brighi & Co, Italian.

Subcontractor - Girola, Italian.

Subcontractor - Ocren (electrical installation), Italian.

TAILRACE

Lined tunnel. Horseshoe cross section.

Lenght-60 m. Radius 2.70 m. Capacity-35 m^3/sec.

Maximum dynamic level - 321.65, for 35 m^3/ sec.

Minimum dynamic level-319.67, for 35 m^3/sec.

Subcontractor - Girola, Italian.

SWITCHYARD

One three phase transformer

Rating 40000 KVA with natural air cooling.

Rating 50000 KVA with forced air cooling.

Frequency, 50 cycles.

No-load voltage ratio, 161,250/165,750/15750 V.

Oil circuit Breakers - Three 15 KV, 2000 amp, 900 MVA.
Two 15. KV, 600 amp, 200 MVA.

Manufacturer. Magrini S.P.A , Italian.

Auxiliary Transformer - One 15.75 kv/400, 300 KVA, 3. phase

Manufacturer. - Ocren, Italian

Manufacturer. - Tecnomasio Italiano Brown Boveri, Italian.

Subcontractor - Girola, Italian

Subcontractor - Ocren (electrical), Italian.

AGRA HYDROELECTRIC PROJECT
STATISTICS

REREGULATING RESERVOIR

Max. water level, 321.65.

Length-850 m. Area, full-0.1 sq. km.

Volume, full-400,000 m^3.

Subcontractor - Theofilou (clearing), Greek.

REREGULATING DAM

Earth fill dam. Volume-27.000 m^3

Maximum height-9.00m. Length 179 m. Crest elevation-323.0

Subcontractor - Odon Odostromaton, Greek.

YEARLY OUTPUT

48,000,000 kwh

WSM:AT:mnp:cg

8 Feb. 1954

AGRA

No. 205 - 1194 12/30/53 Powerhouse, showing Unit No. 1

AGRA

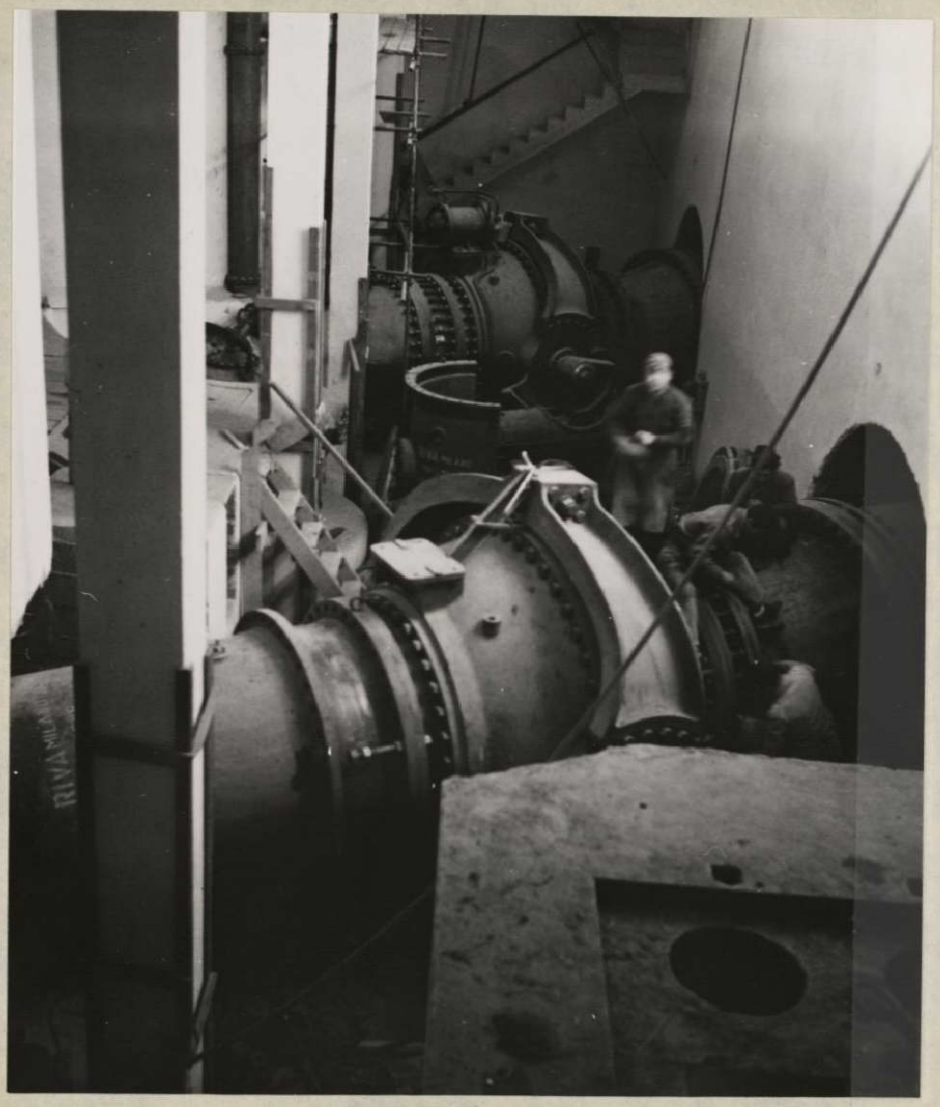
No. 205 - 1009 10/8/53 Looking down penstock

AGRA

No. 205 - 1125 11/18/53 General View

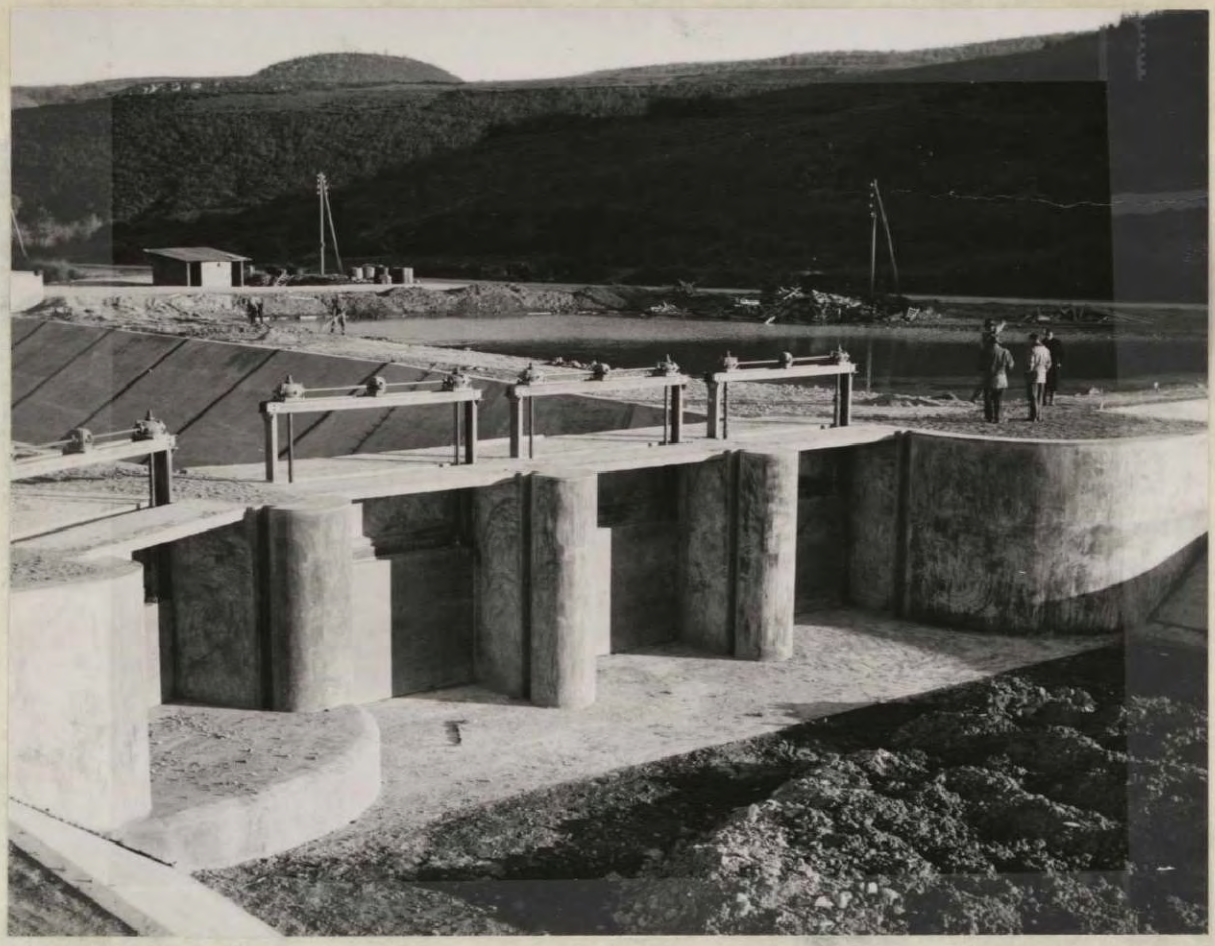
AGRA

No. 205 - 1113 11/18/53 Interior, showing Roto valve



AGRA

No. 205 - 1102 11/18/53 Intake to Headrace Canal

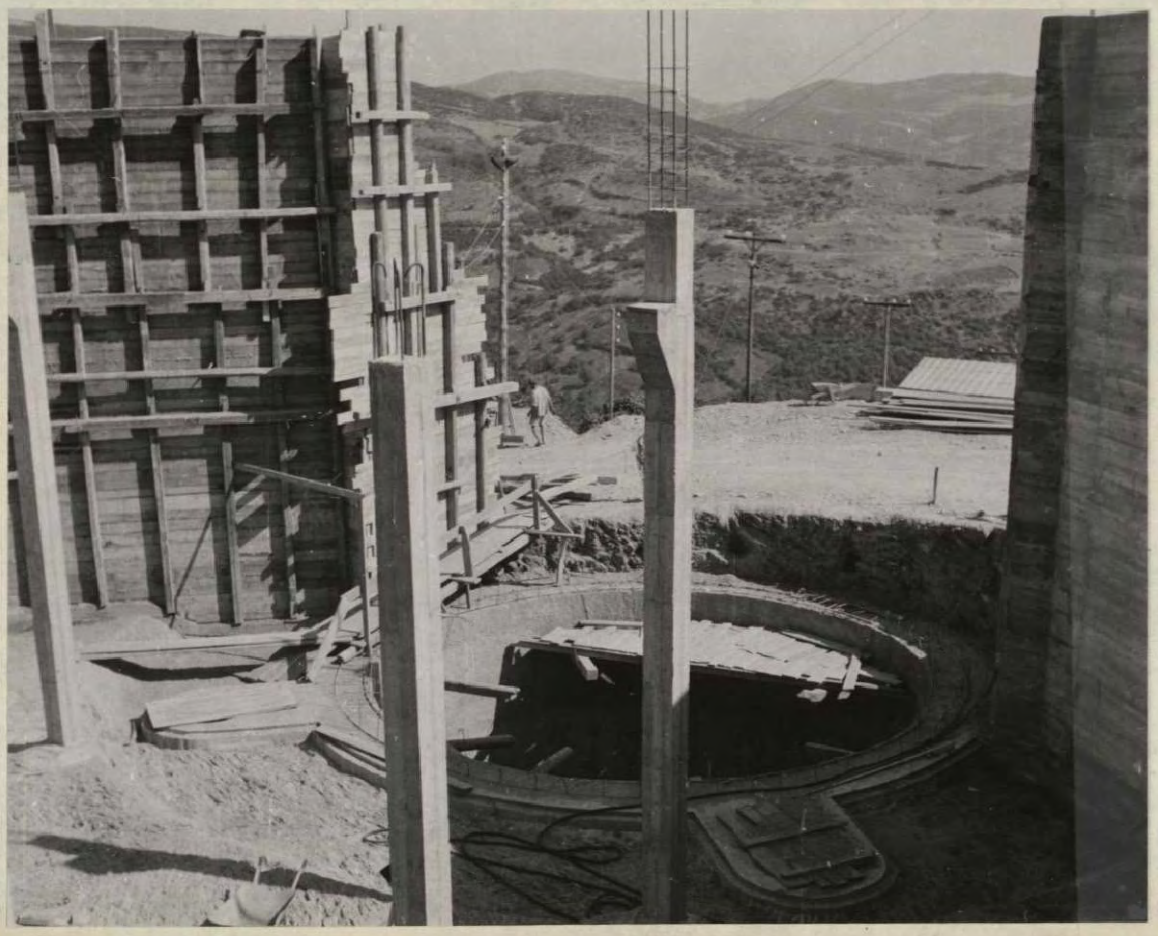


AGRA

No. 205 - 1030 10/8/53 Reregulating dam

AGRA

No. 205 - 924 8/28/53 Expansion chamber. Top of surge tank in center

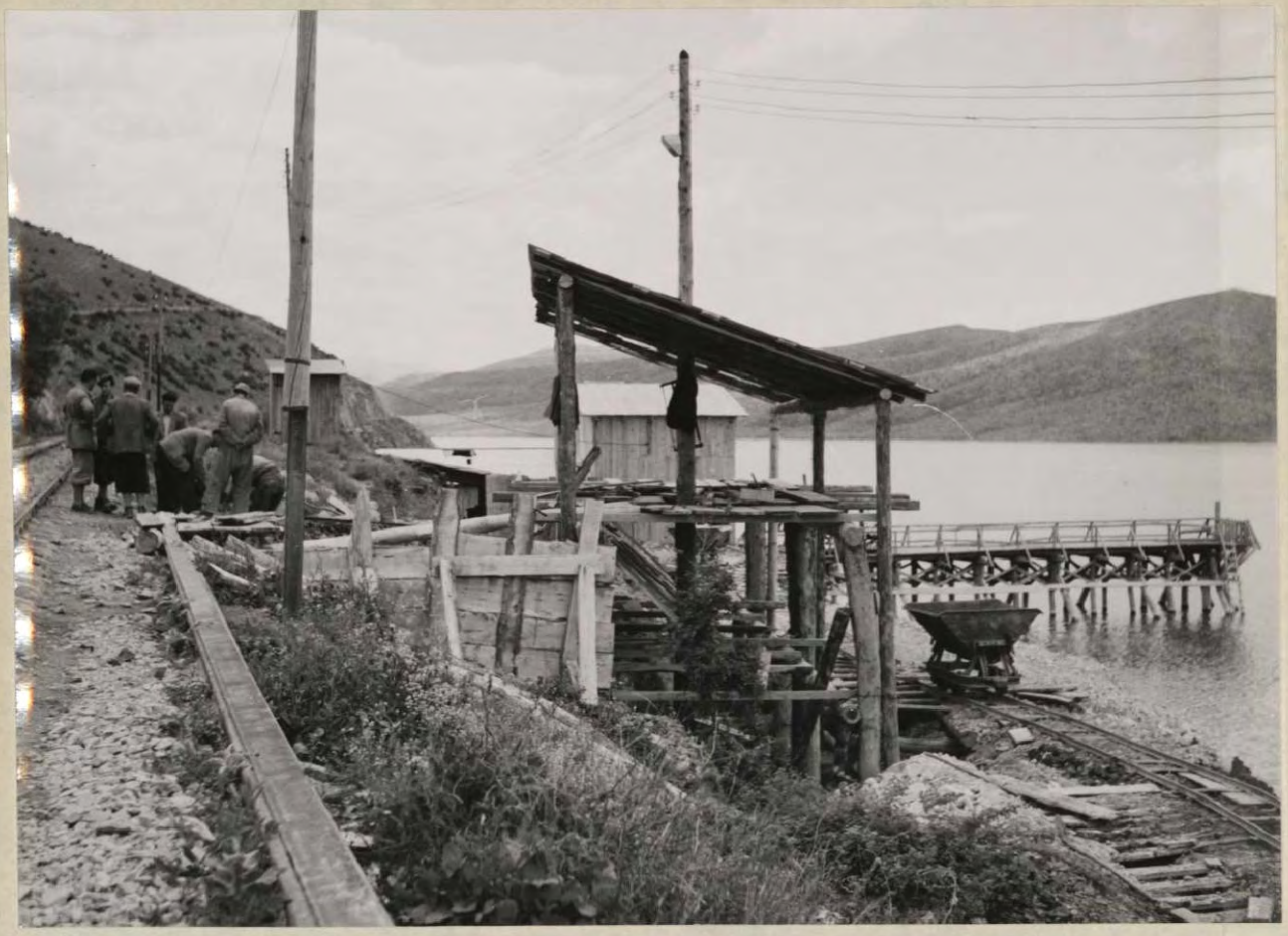


AGRA

No. 205 - 916 8/27/53 General view of plant and penstock

AGRA

No. 205 - 406 5/4/53 Lake Ostrovo and inlet works to free flow tunnel

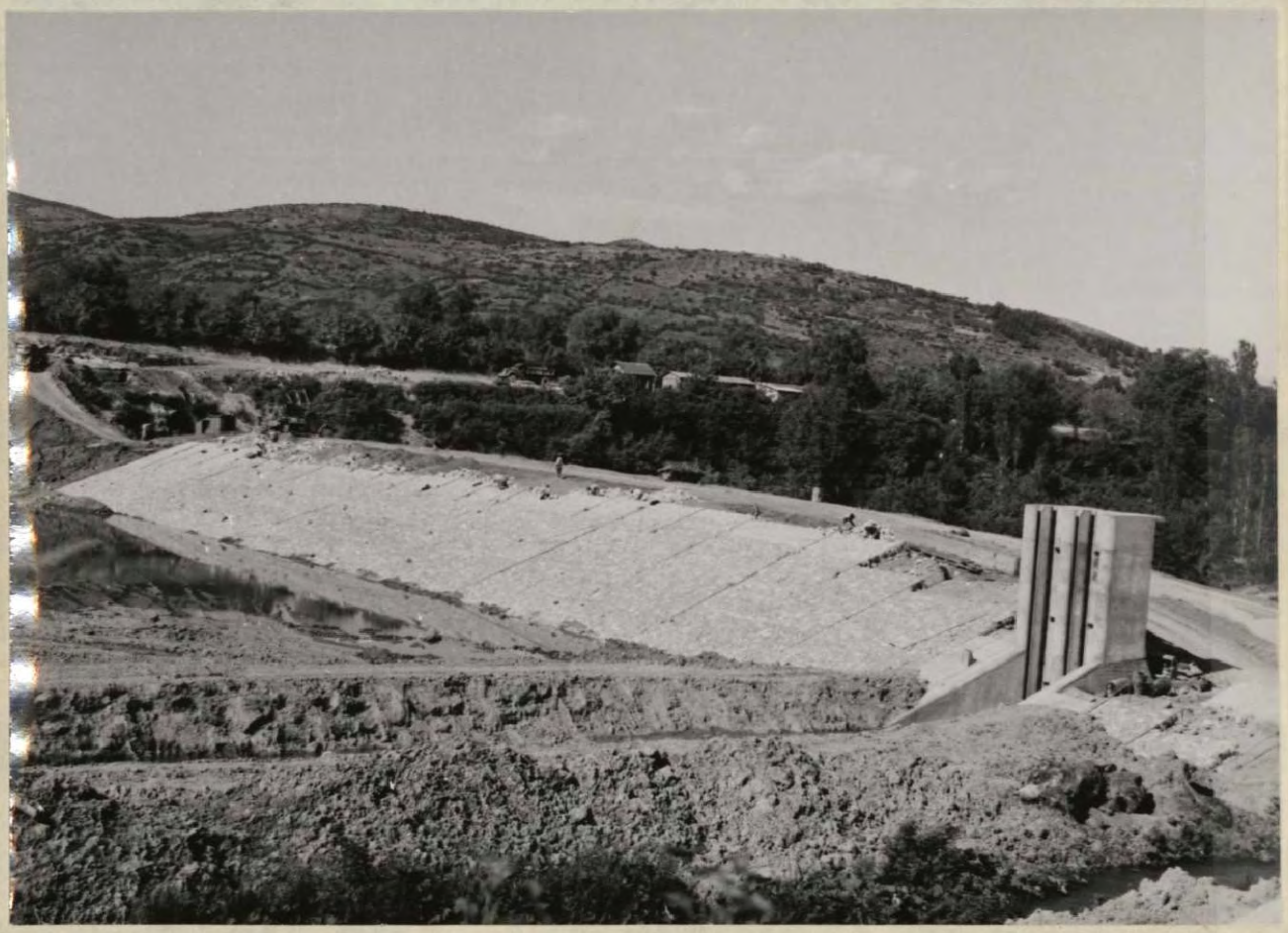


AGRA

No. 205 - 393 5/4/53 Headrace canal

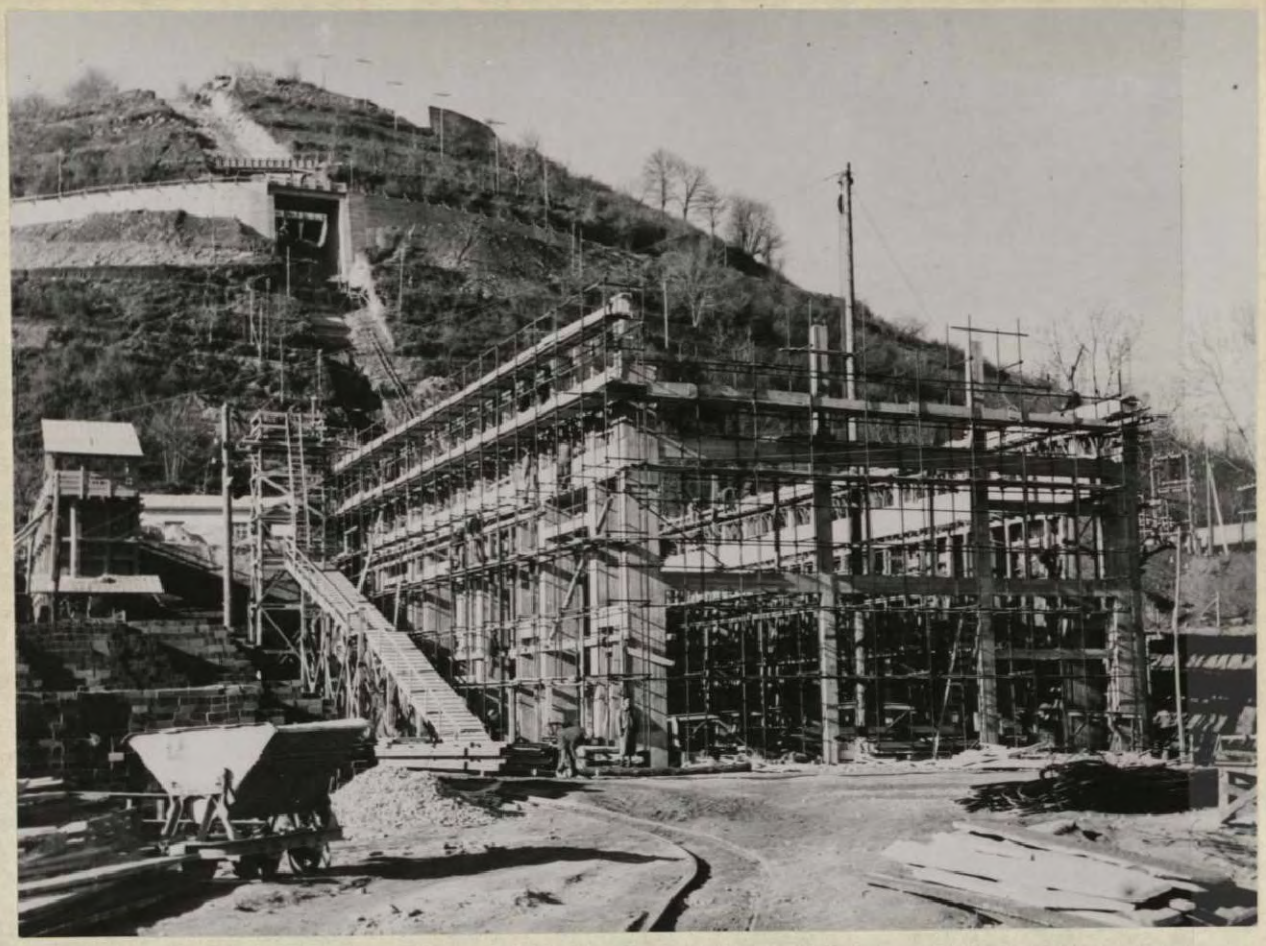
AGRA

No. 205 - 475 5/4/53 Reregulating dam



AGRA

No. 205-22 2/26/53 Powerhouse.

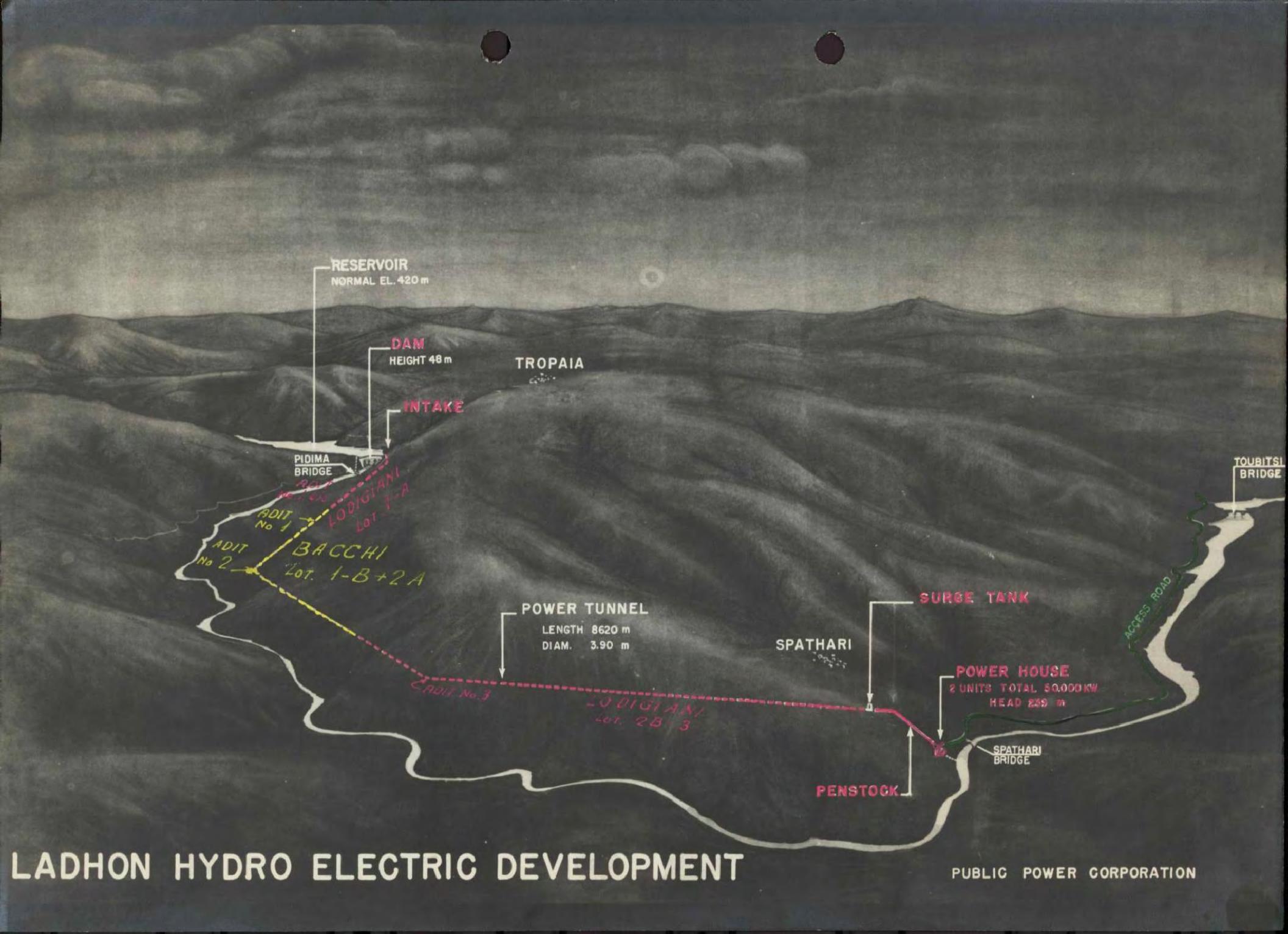


LADHON HYDROELECTRIC PROJECT - General Contractor - Societa Edison:

The Ladhon plant in central Peloponesus is the largest of the hydro plants with a total installed capacity of 50,000 kw in two units.

Its component parts are much simpler than Agra, consisting basically of a special, hollow gravity-type concrete dam about 48.0 meters high which stores up to 50,000,000 cubic meters of water. The water flows about 9 km through a lined pressure tunnel to the penstock and then down into the power plant with its two 25,000 kw units. It discharges directly into the Ladhon river.

The surge tank arrangements are somewhat complicated in that there is a 65 meter vertical surge tank shaft. At the top of this shaft is a very large and extensive chamber cut out of solid rock with a vaulted roof. At the bottom of this surge chamber is a large chamber for the purpose of supplying water when additional water is needed quickly.



LADHON HYDRO ELECTRIC DEVELOPMENT

PUBLIC POWER CORPORATION

LADHON HYDROELECTRIC DEVELOPMENT
GENERAL CONTRACTOR - SOCIETA EDISON

STATISTICS

RESERVOIR

Elevation of normal storage-420.0

Length - 15 km. Area-6.00 sq. km.

Storage - 50,000,000 m^3.

DAM

Hollow, gravity type concrete dam. Total volume-25,000 m^3.

Maximum height - 48.0 m. Length at top-104 m.

Top Elevation-422.40. Spillway crests at elevations-415.2 and-417.0.

Subcontractor - Lodigiani, Italian.

POWER TUNNEL

Lined pressure tunnel.

Length - 8620 m. Diameter-3.9 m. Capacity - 35 m^3/sec.

Subcontractor - Lodigiani, Italian - 4536 m.

Subcontractor - Recchi, Italian - 4084 m.

SURGE TANK

Shaft. Height - 65.0m. Diameter-6.0 m. Max. water level 437.00 m.

Supply chamber. Volume-2050 m^3.

Expansion Chamber. Volume-2850 m^3.

Minimum water level - 389.0.

Subcontractor-Lodigiani, Italian.

PENSTOCK

Steel pipe. In open-319.1.m In tunnel-102.70m

Length-414 m. Diameter-3.30 to 2.00 m.

Valves. Butterfly valve, diameter - 3.30 m. Air valve, diameter-0.63 m.

Manufacturer - Cofors (Terni), Italian.

Subcontractor - Lodigiani, Italian.

LADHON HYDROELECTRIC PROJECT
STATISTICS

POWERHOUSE

Main building. Reinforced concrete structure with steel roof trusses, volume-15,100 m^3.

Control house. Reinforced concrete structure, volume-1400 m^3.

Developed Head - 239 m. gross. Capacity 34 m^3/sec.

Turbines - Two single runner, Francis type, vertical shaft turbines 25000 kw output each at 428 rpm.

Manufacturer - Franco Tosi, Italian.

Generators - Two synchronous, three phase, 15,75 Kv., vertical shaft generators for 27778 KVA (32000 KVA with temperature rise of 80°C). Frequency, 50 cycles.

Manufacturer - Comp. Generale di Electricita, Italian.

Cooling system. Closed cooling system by means of heat exchangers and a cooling tank in the Powerhouse and another on the hillside.

Switchgear - Protection Relays. 11 panels.

Manufacturer - Ocren. Italian.

Travelling crane. Two bridges, each 15.40 m. span and 70 tons lifting capacity.

Subcontractor - Lodigiani, Italian

Subcontractor - Ocren (electrical installation), Italian.

TAILRACE

Lined tunnel. Horseshoe cross section.

Length - 72 m. Radius - 2.70 m. Capacity - 35 m^3/sec.

Maximum operating level-183.50, for 35 m^3/sec.

Normal operating level - 181.10.

Subcontractor - Lodigiani, Italian.

LADHON HYDROELECTRIC PROJECT
STATISTICS

SUBSTATION

Two three phase transformers.

Rating 26000 KVA with natural air cooling.

Rating 32500 KVA with blast air cooling.

Frequency - 50 cycles.

No-voltage ratio, 15750/161,250-168.750 V.

Manufacturer - Industrie Elettriche di Legnano, Italian.

Three oil circuit breakers-150 KV, 600 amp 2000 MVA.

Manufacturer. Scarpa Magnano, Italian.

Two-auxiliary transformers-15.75 kv/400 300 KVA-three phase.

Manufacturers. Ocren, Italian.

Subcontractor-Lodigiani, Italian.

Subcontractor - Ocren (electrical) Italian.

SWITCHYARD

150 kv take-off substructures and equipment.

YEARLY OUTPUT

350,000,000 kwh.

W.S.M:AT:ez

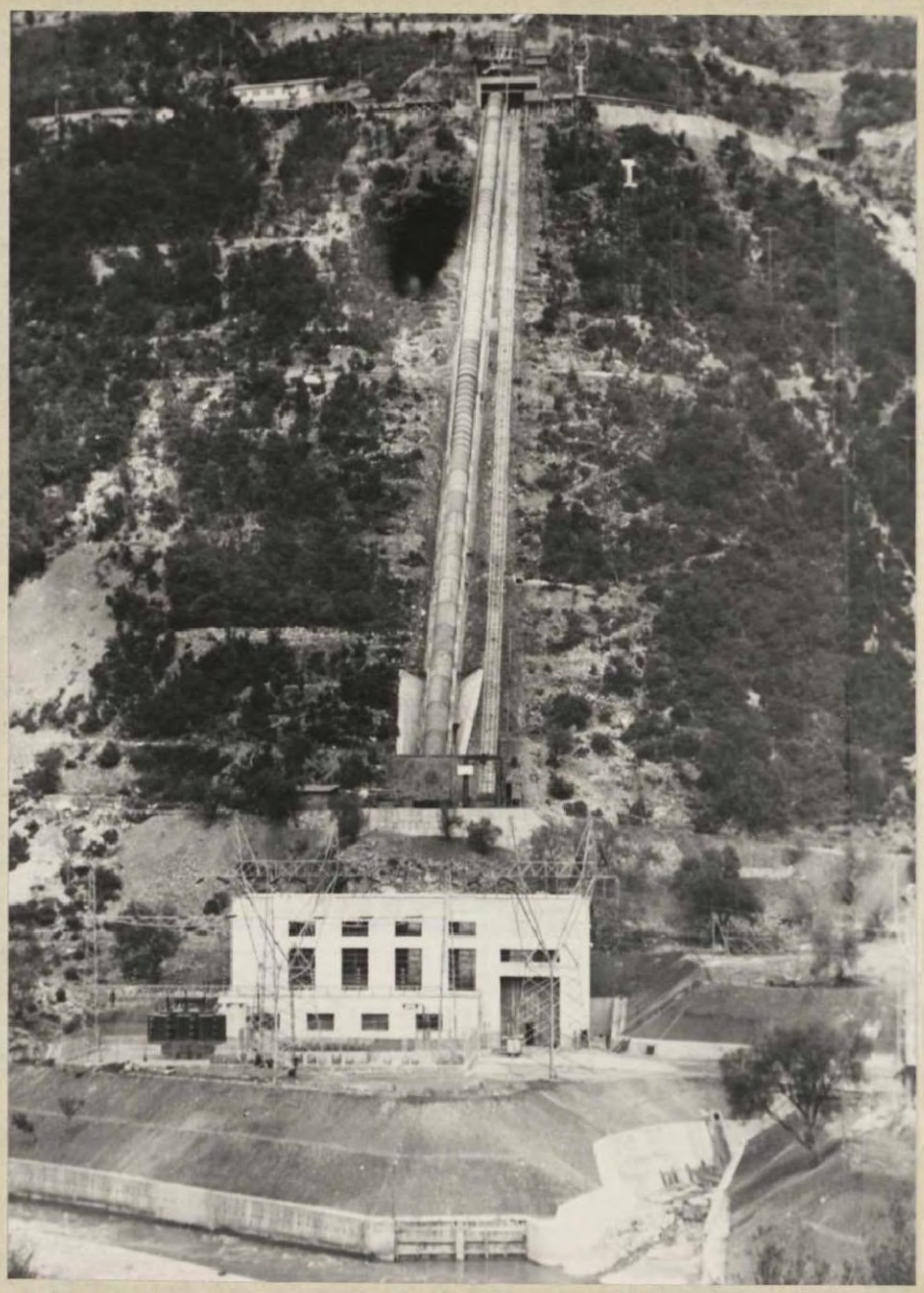
8 Feb. 1954

LADHON

No. 206-1412 4/8/54 Powerhouse and Substation

LADHON

No. 206-1418 4/8/54 Penstock, Plant and Substation

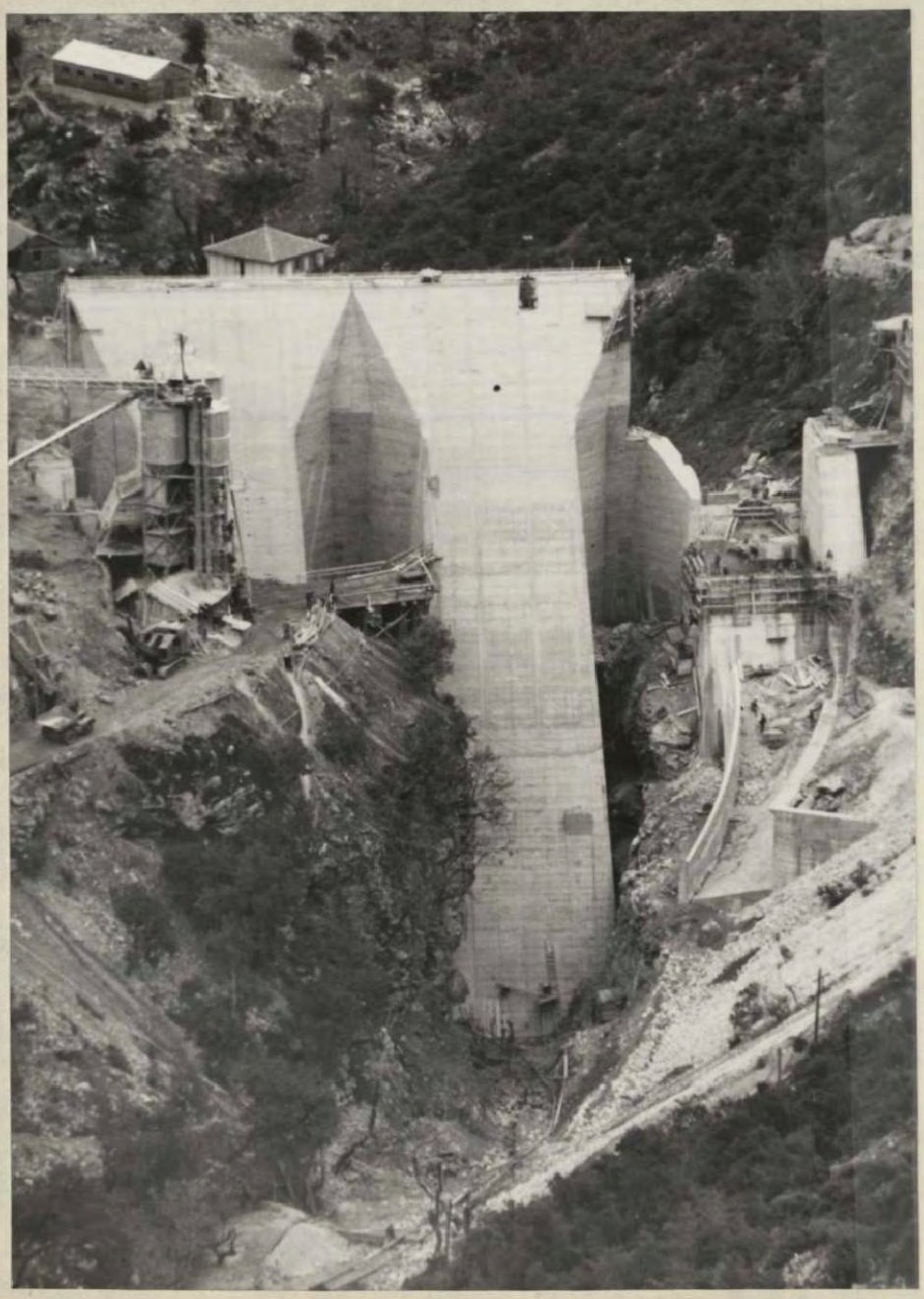


LADHON

No. 206-1415 4/8/54 Powerhouse Interior

LADHON

No. 206-1322 4/8/54 Dam Site. Downstream view showing Dam & left Spillway.

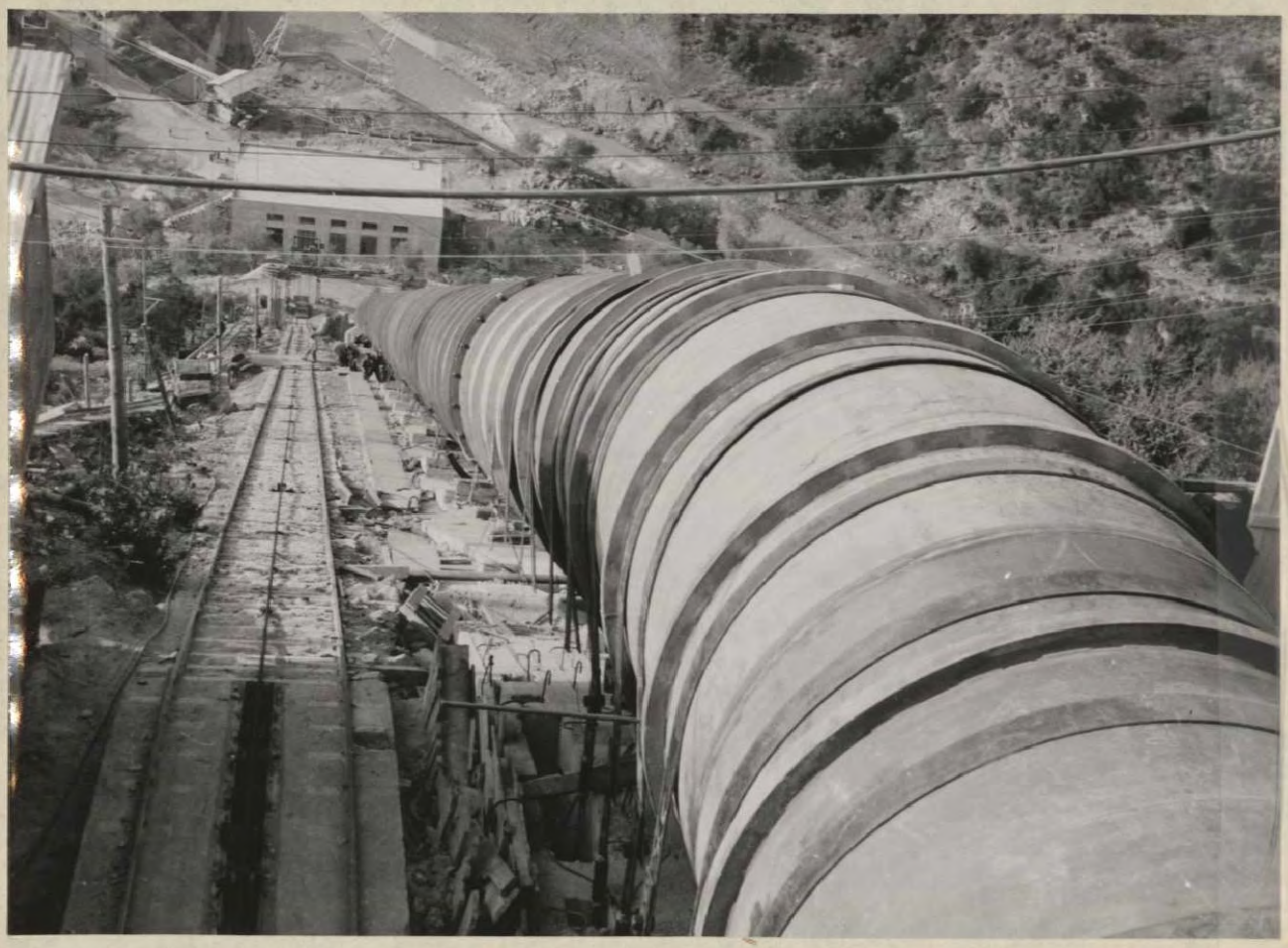


LADHON

No. 206-1267 3/10/54 Dam: General View

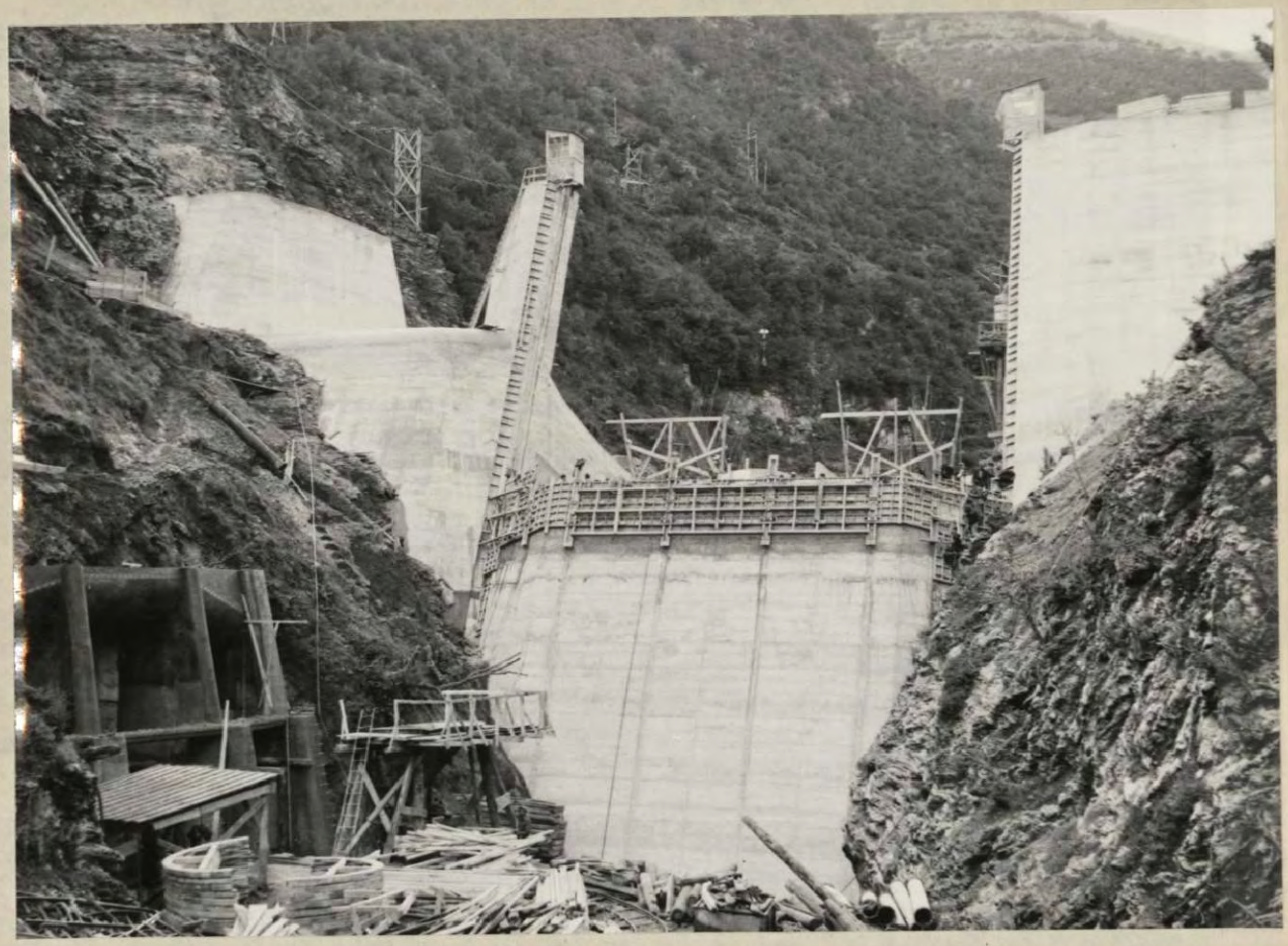
LADHON

No. 206-1155 12/10/53 Penstock, looking down at Plant



LADHON

No. 206-1150 12/10/53 Looking Downstream at Element No. 2 of Dam



LADHON

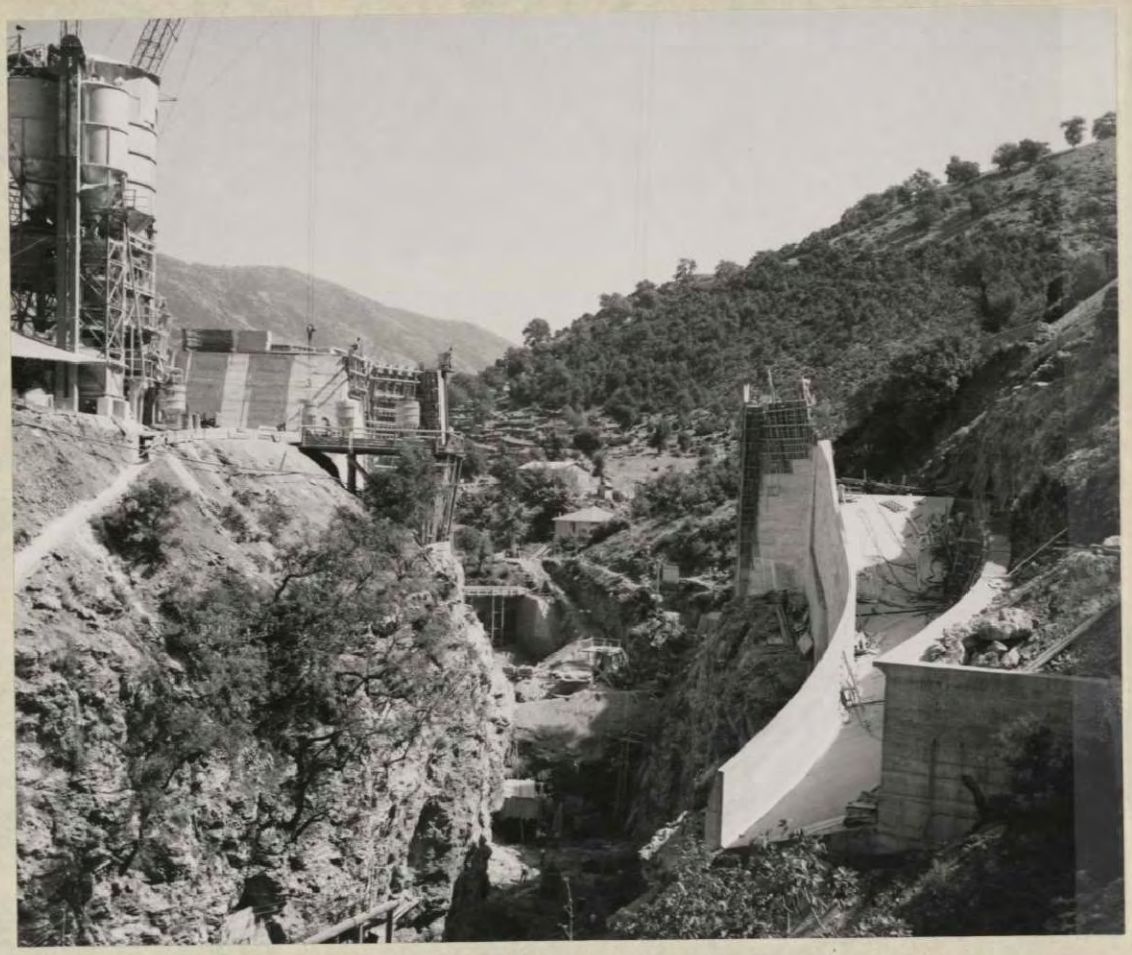
No. 206-1058 10/14/53 Power Tunnel Intake

LADHON

No. 206-1093 10/14/53 Expansion Chamber

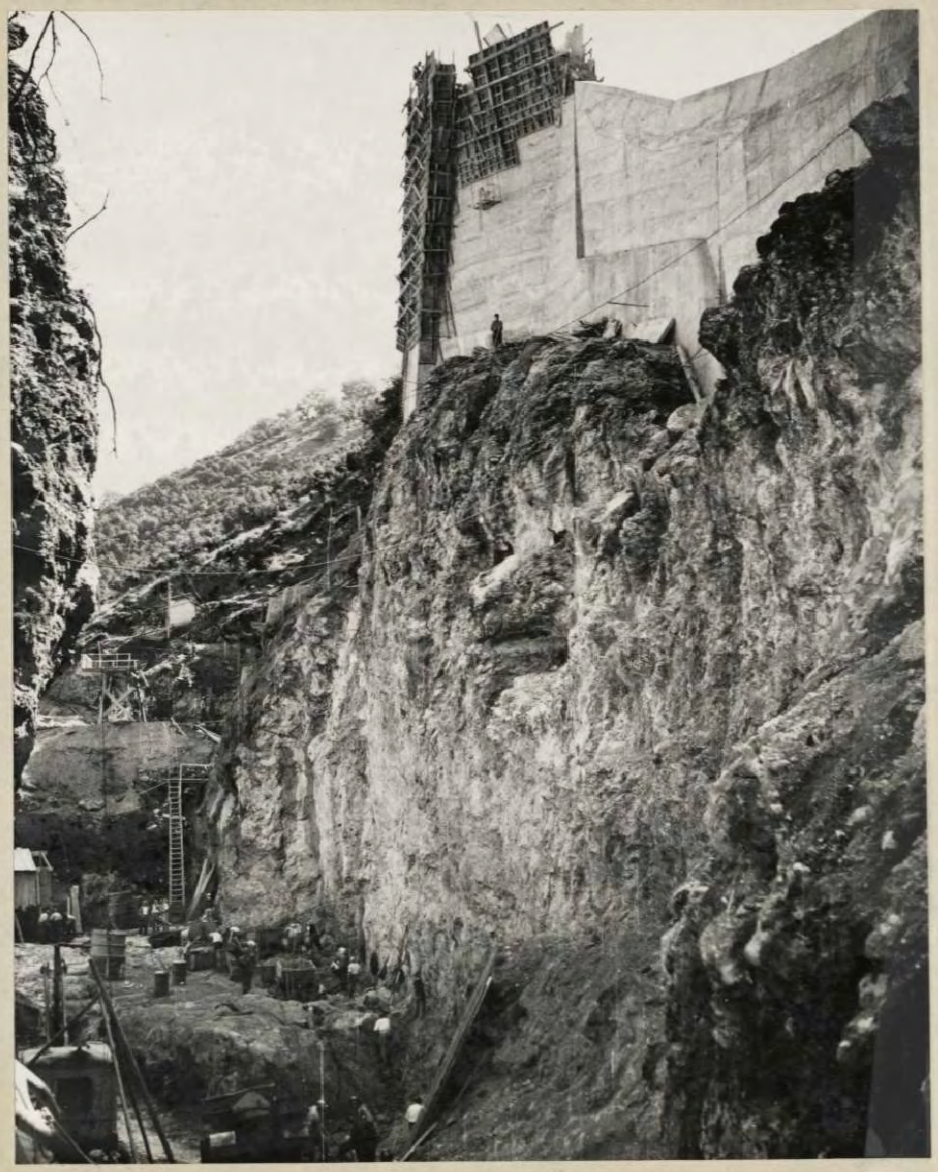
LADHON

No. 206-991 9/20/53 Looking upstream, Spillway



LADHON

No. 206-636 9/20/53 Excavating for Dam



LADHON

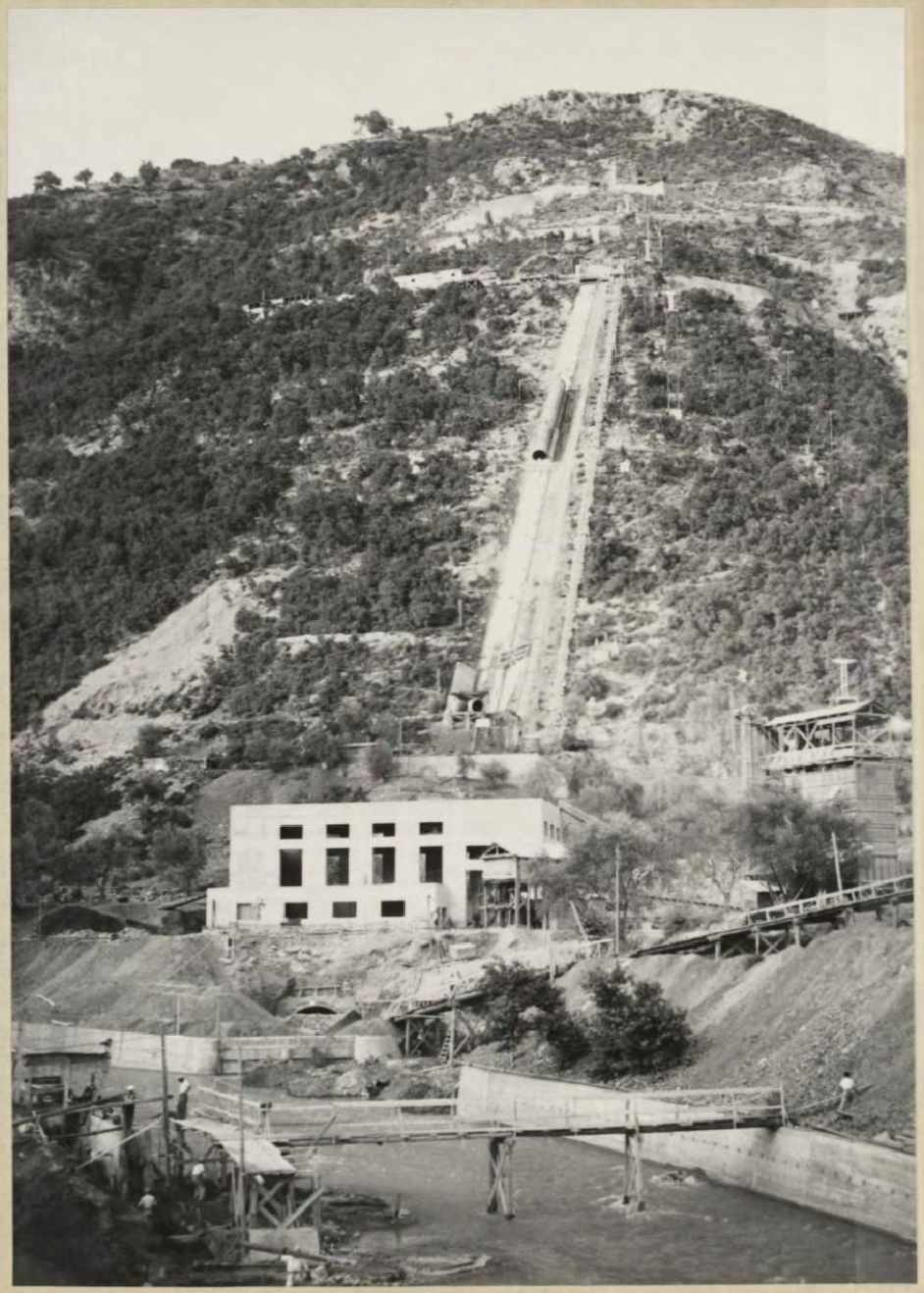
No. 206-932 8/27/53 General View of Dam, Cofferdam, Cranes, etc..

LADHON

No. 206-966 8/27/53 River Diversion: Showing Cofferdam and Diversion Tunnel

LADHON

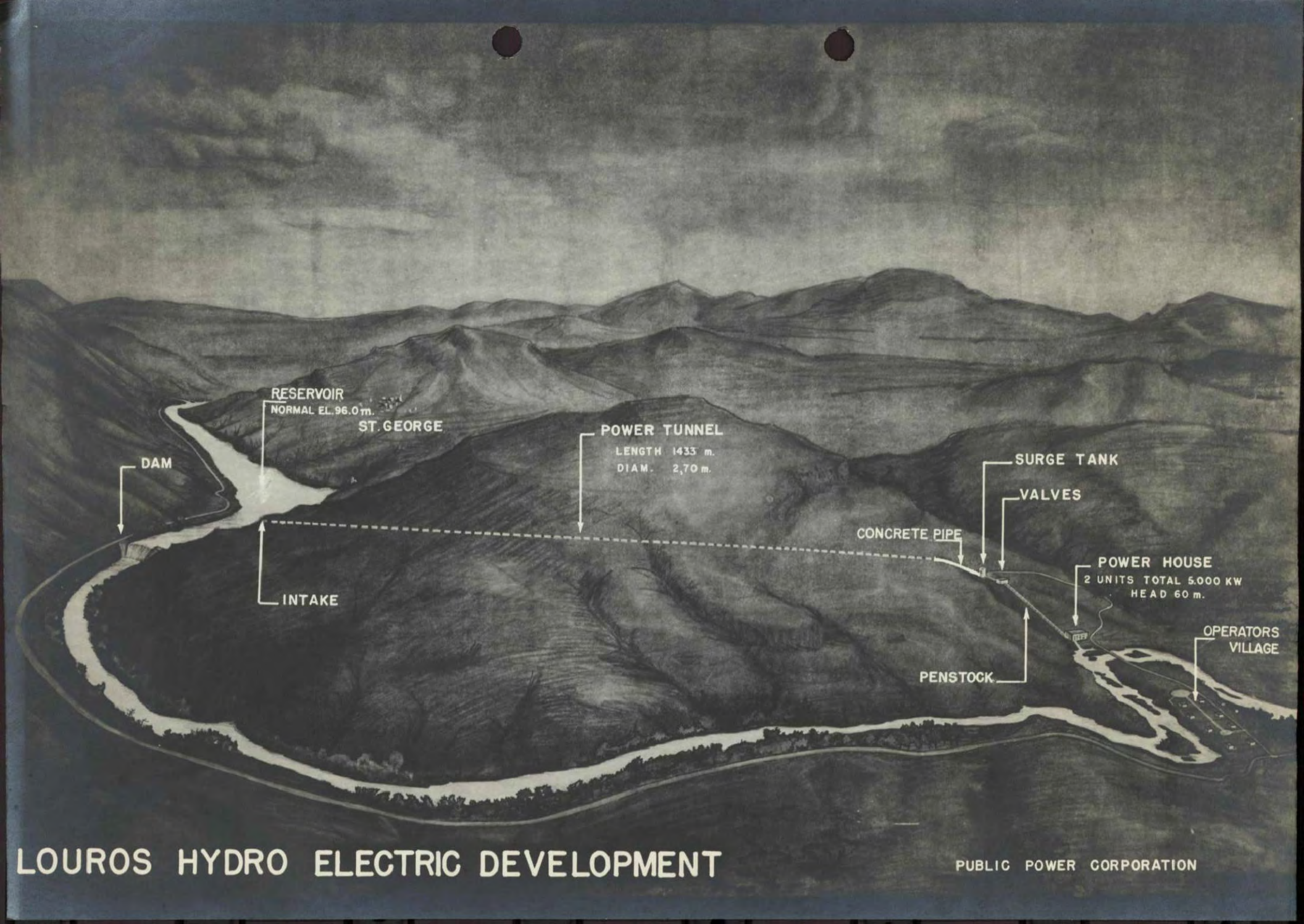
No. 206-958 8/27/53 Construction of Penstock and Plant



LOUROS HYDROELECTRIC PLANT - General Contractor - Eter-Omnium Lyonnais.

This is the baby of the system with a total capacity of 5,000 kw in two units. It is located in the Epirus in the west of Greece, south of Albania. It is not contemplated at the present time to connect the Louros system with the main PPC power system but rather to distribute more or less locally at the generator voltage of 15,000 volts.

As can be seen from the diagram, the general lay-out is very simple, with a dam, a tunnel feeding water into penstock and the plant. At the top of the penstock is a surge tank of reinforced concrete built above ground.


RESERVOIR
NORMAL EL. 96.0 m.
ST. GEORGE
DAM
POWER TUNNEL
LENGTH 1433 m.
DIAM. 2,70 m.
SURGE TANK
VALVES
CONCRETE PIPE
POWER HOUSE
2 UNITS TOTAL 5.000 KW
HEAD 60 m.
INTAKE
OPERATORS VILLAGE
PENSTOCK
LOUROS HYDRO ELECTRIC DEVELOPMENT
PUBLIC POWER CORPORATION

LOUROS HYDROELECTRIC PROJECT
GENERAL CONTRACTOR - ETER-OMNIUM LYONNAIS
(For Engineering and Construction)

STATISTICS

RESERVOIR

Length - 1400 m. at elevation 96.0.

Area - 150,000 m^2.

Usable volume - 370,000 m^3.

DAM

Arched, gravity type concrete dam. Volume-12,300 m^3.

Maximum height - 22,00 m. Length at top - 97 m.

Spillway elevation - 96.0, length-75 m.

TUNNEL

Concrete lined. Horseshoe shaped cross section

Length - 1433 m. Equivalent diameter - 2.7 m.

Capacity - 11.3 m^3/sec.

REINFORCED CONCRETE PIPE

Circular cross section.

Length - 177 m. Diameter - 2.70 m.

Capacity - 11.3 m^3/sec.

SURGE TANK

Restricted orifice type.

Tank diameter - 10.0 m. Height - 18.3 m.

Maximum water level elevation - 104.12.

PENSTOCK

Steel pipe. Length - 186 m. Diameter - 2.40 to - 2.10 m.

Valves. Butterfly valve, diameter - 2.40 m. Air valve, diameter - 0.60 m.

Manufacturer. Societa Savigliano, Italian.

POWERHOUSE

Main building. Reinforced concrete structure with steel roof trusses, volume - 4,400 m^3.

Control house. Reinforced concrete structure, volume - 1,500 m^3.

Developed head - 60.5 m. gross. Flow - 11.3 m^3/sec.

LOUROS HYDROELECTRIC PROJECT
STATISTICS

Turbines. Two single runner, Francis type, horizontal shaft turbines 3840 HP output at 500 rpm.

Manufacturer - De pretto Escher Wyss, Italian.

Generators. Two synchronous, three phase, 15,75 KV horizontal shaft generators for 3125 KVA. Frequency 50 cycles.

Manufacturer - Oerlikon, Swiss.

Control Boards. Consisting of 6 panels.

Manufacturer. S.A. Costruzion Electromeccaniche, Italian.

Travelling crane. One bridge, 10.25 m. span and 30 tons lifting capacity.

Manufacturer - Ceretti Tanfani, Italian.

Future extension - One more identical generating unit.

TAILRACE

Open canal, trapezoid cross section.

Length - 45.00 m.

Tailwater elevation - 35.5.

SWITCHYARD

Two generator bays. Two 15 kv line bays.

Station Service Transformer. Outdoor aircooled 100 KVA, 15750/400/231 Volts three phase, 50 cycles.

Manufacturer. Ateliers de Constructions Electriques de Charleroi, Belgian.

Oil Circuit Breakers. Four 3-phase breakers, 25 KVA 320 amp, 160 MVA outdoor.

Type C 35. Compressed air operated.

Manufacturer. Magrini S.P.A., Italian.

Space available for a possible future 150 kv transformer and 150 kv line.

DISTRIBUTION LINES

120 km of 15 KV distribution line.

OPERATORS' VILLAGE

Eight houses and other facilities.

YEARLY OUTPUT

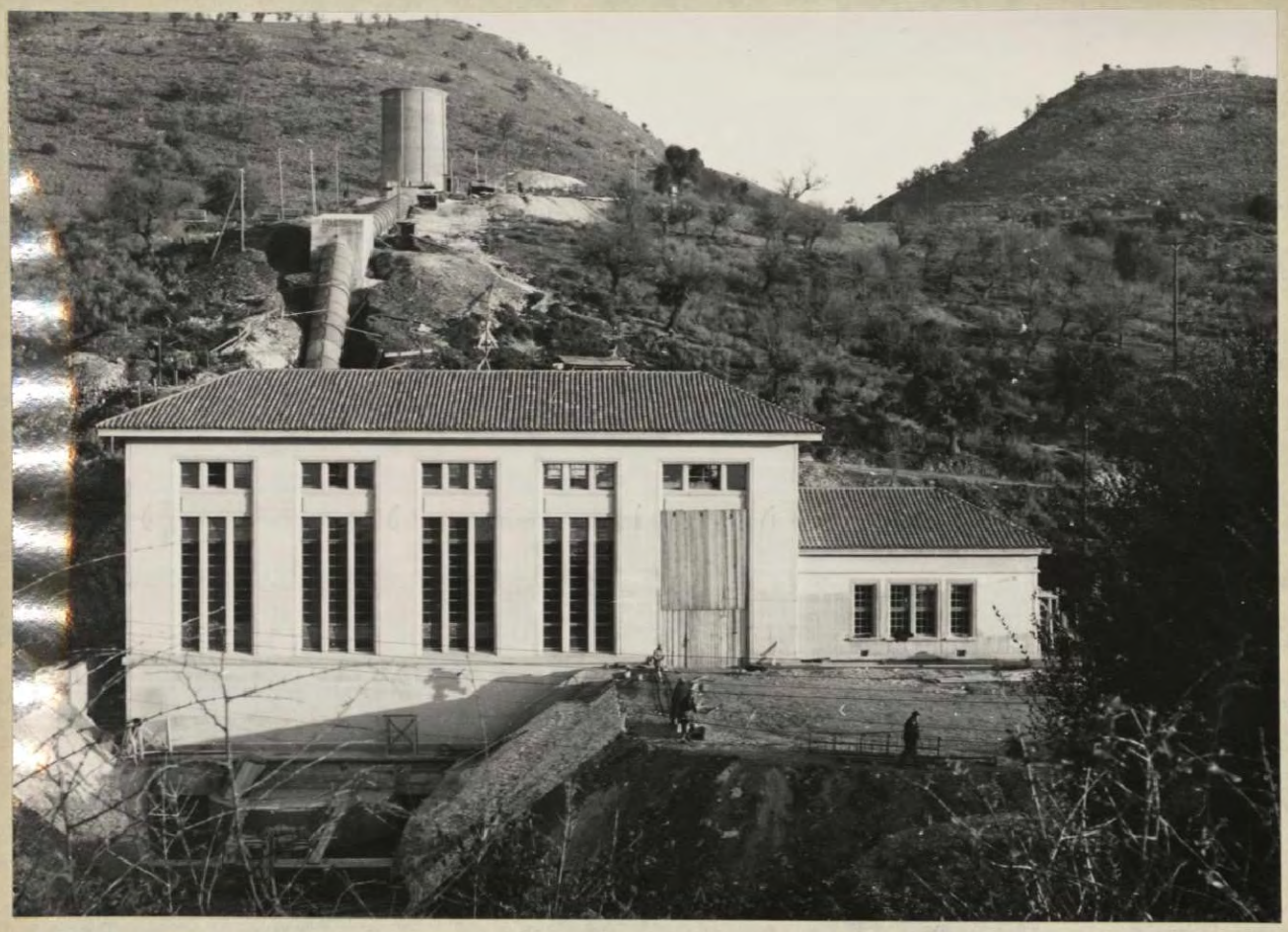
28,000,000 kwh.

AT:mnp:hg

February 19, 1954

LOUROS

No. 207 - 650 1/25/54 Exterior.



LOUROS

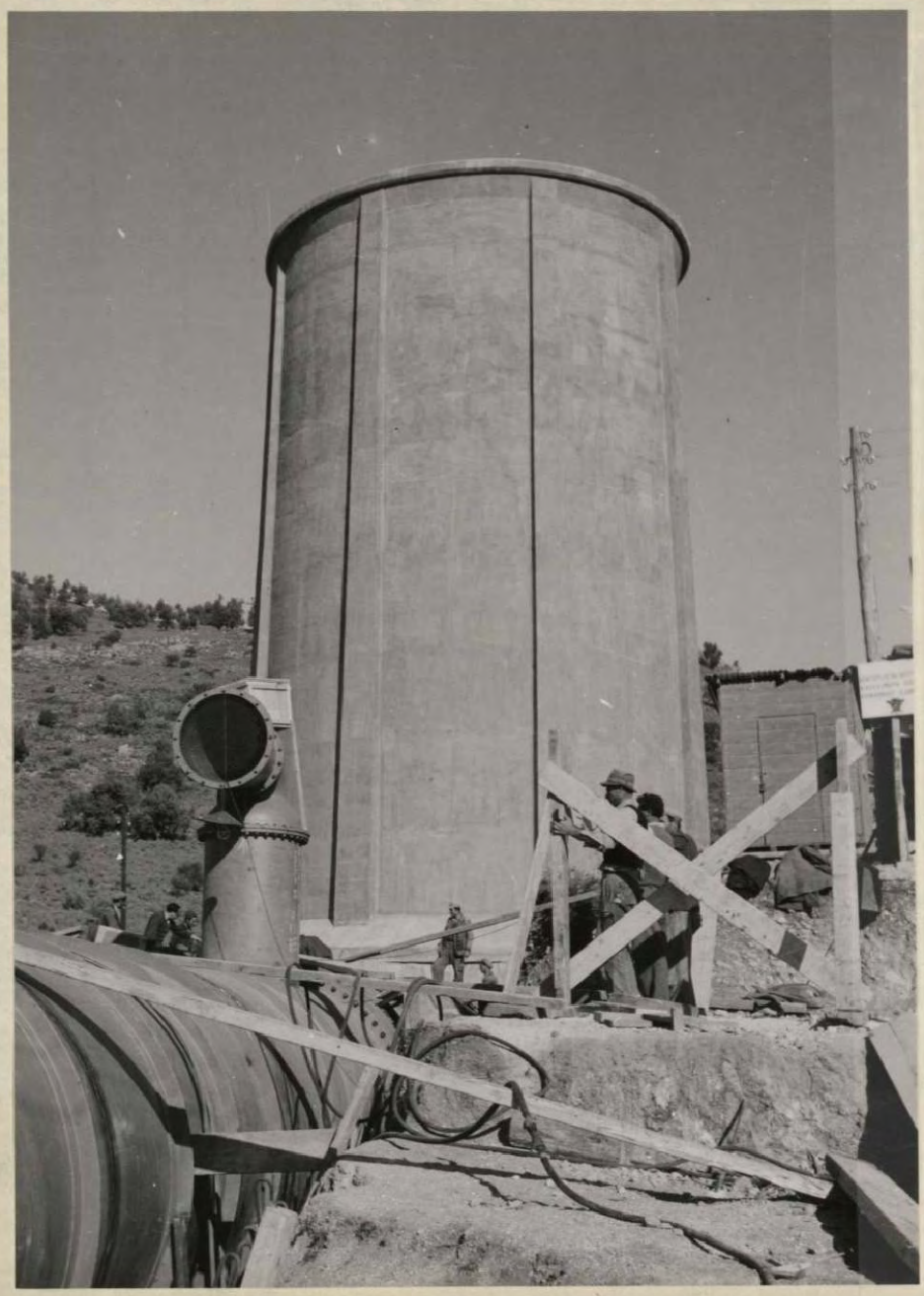
No. 207 - 1233 1/25/54 The Dam Spilling.

LOUROS

No. 207 - 1289 3/20/54 Interior.

LOUROS

No. 207 - 1136 12/4/53 Surge Tank.



LOUROS

No. 207 - 1143 12/4/53 Reservoir Half Full.

LOUROS

No. 207 - 1088 10/16/53 Excavation and Penstock Tubes.

LOUROS

No. 207 - 1068 10/16/53 Concrete Pressure Pipe & Surge Tank.

LOUROS

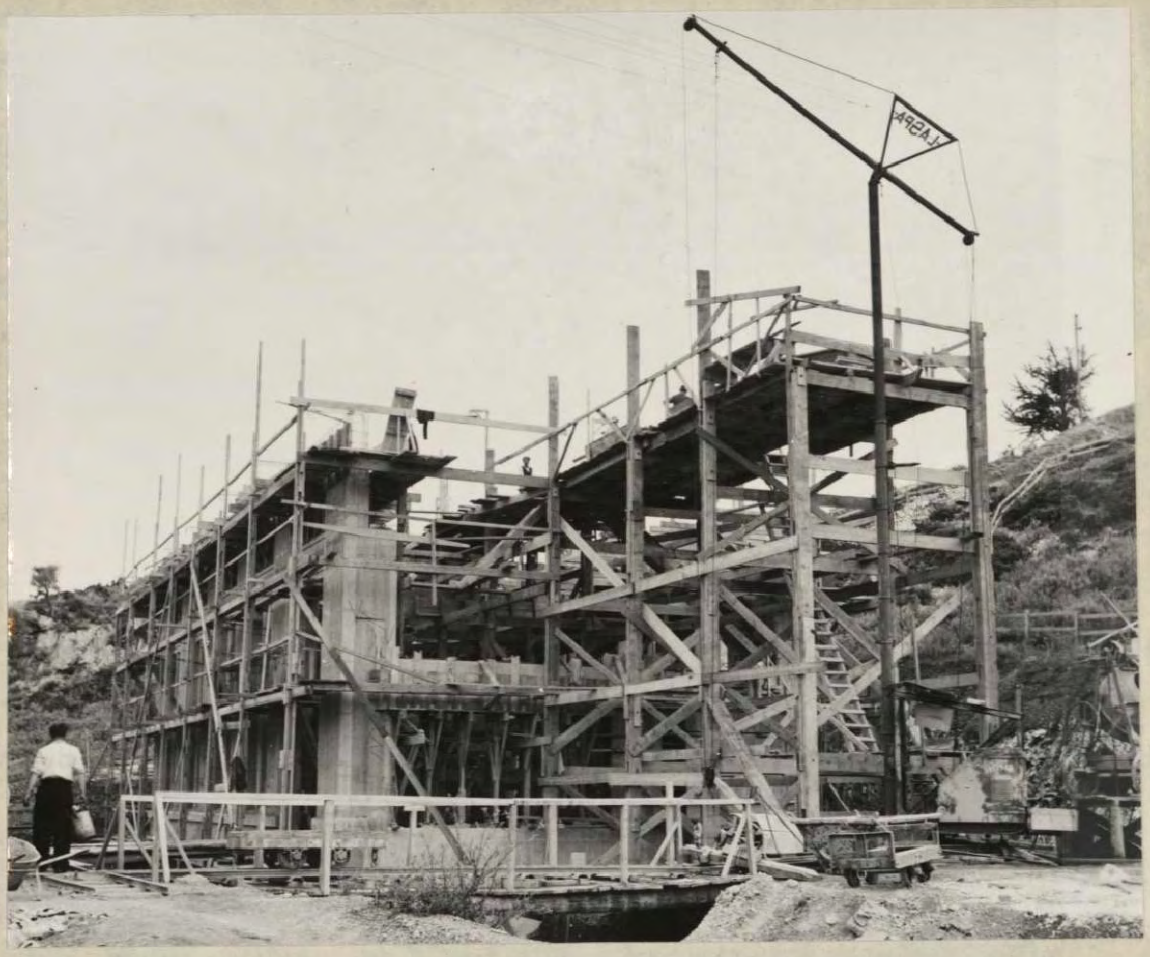
No. 48.02 8/30/53 Parts of Turbines.

LOUROS

No. 207 - 48,08 8/30/53 Surge Tank.

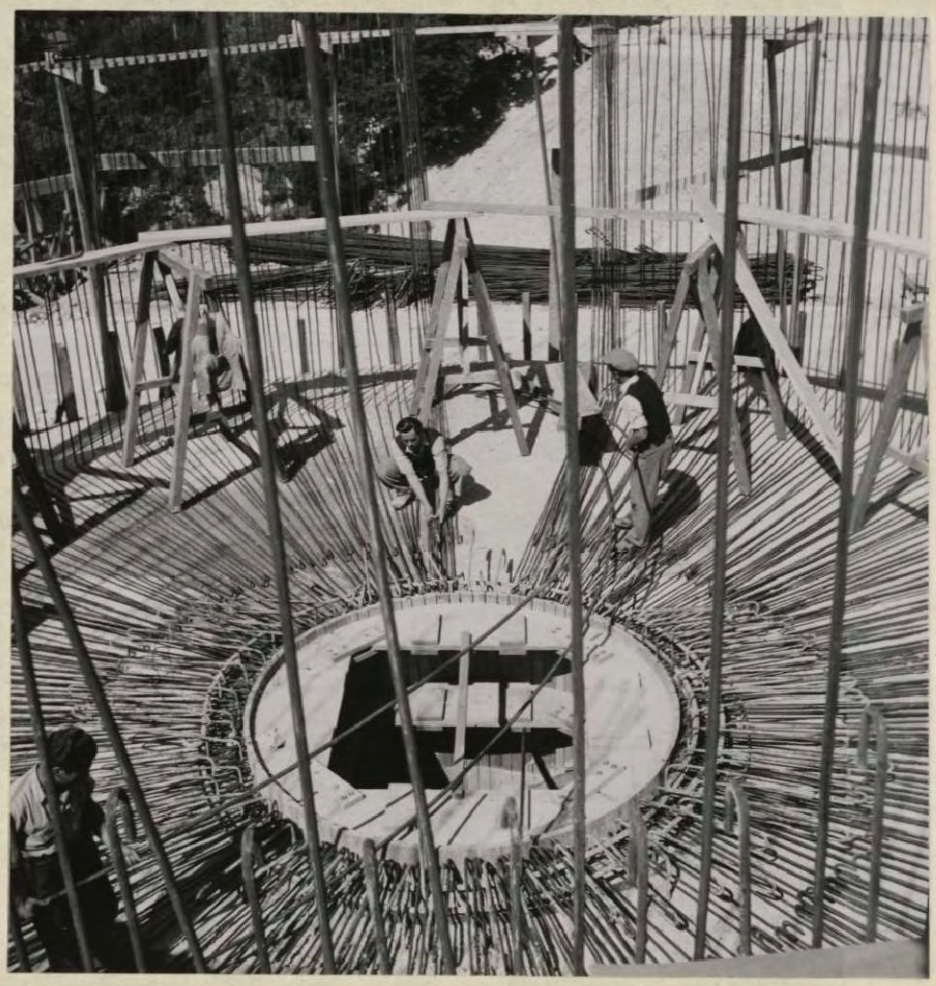
LOUROS

No. 207 - 468 6/6/53 Power Plant.



LOUROS

No. 207 - 370 4/28/53 Reinforcing Steel on Base of Surge Tank.



150 KV TRANSMISSION LINE

DESCRIPTION	Total Route Length km	Number of Towers	A C S R Conductor MCM	Ground wire 3/8" Diam.	Counter poise 1/4" Diam.
Rouf - Aliveri	119	353	636	Galv. Steel	Steel
Rouf - Patras	206	607	636 and 336,4	"	"
Corinth - Ladhon	158	455	336,4	"	"
Megalopolis-Kalamata	44	133	336.4	"	"
Skimatari - Larissa	228	664	636 and 336,4	"	"
Larissa - Trikala	56	166	336,4	"	"
Larissa - Volos	57	164	336,4	"	"
Salonica - Agra	87	258	336,4	"	"
Salonica - Kavala	170	484	336,4	"	"
TOTAL	1125	3284			

Design - Loading

1" ice + 4 lbs/sq. ft wind at 0° F

Maximum Working Tension

For 636 Mcm (400.000 cm. copper equivalent) 9120 lbs = 40% Break Strenght, Aliveri-Lamia-Skimatari-Rouf-Elefsis

For 336 4 Mcm (4/0 AWG copper equivalent) 6650 lbs = 50% " " All other lines

For 3/8" G. Wire on 636 Mcm conductor lines, 4430 lbs

For 3/8" G. " " 336,4 " " " 5100 "

Clearances

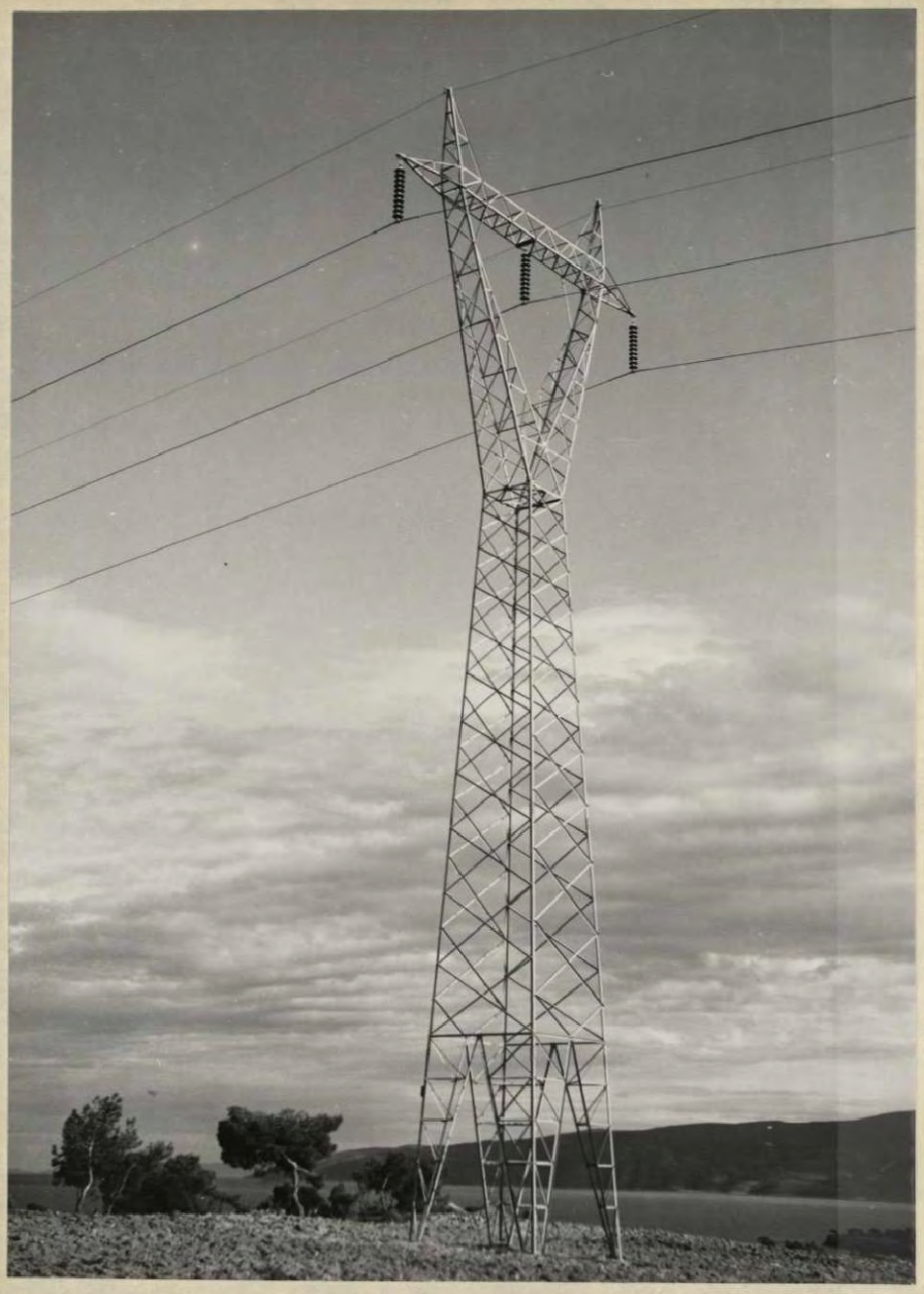
1. Generally 26 Ft.
2. Over railroad 40 Ft.
3. Over paved or gravel highways 30 Ft.
4. Over foreign wires, small buildings and olive or valuable trees 15 Ft.

SUPPLIERS

1. Steel tower conductors, ground wire counterpoise S.A.E. (SOCIETA ANONIMA ELETTRIFICATIONE), ITALY
2. Insulator fittings - SALVI Italy
3. Hardware fittings - VOLPATO, ITALY
4. Insulator disks - OHIO BRASS U.S.A.
5. Carrier Communication and Protection Manufacturers - Siemens Germany

150,000 VOLT TRANSMISSION LINE

No. 1278 - Suspension Tower.



150,000 VOLT TRANSMISSION LINE

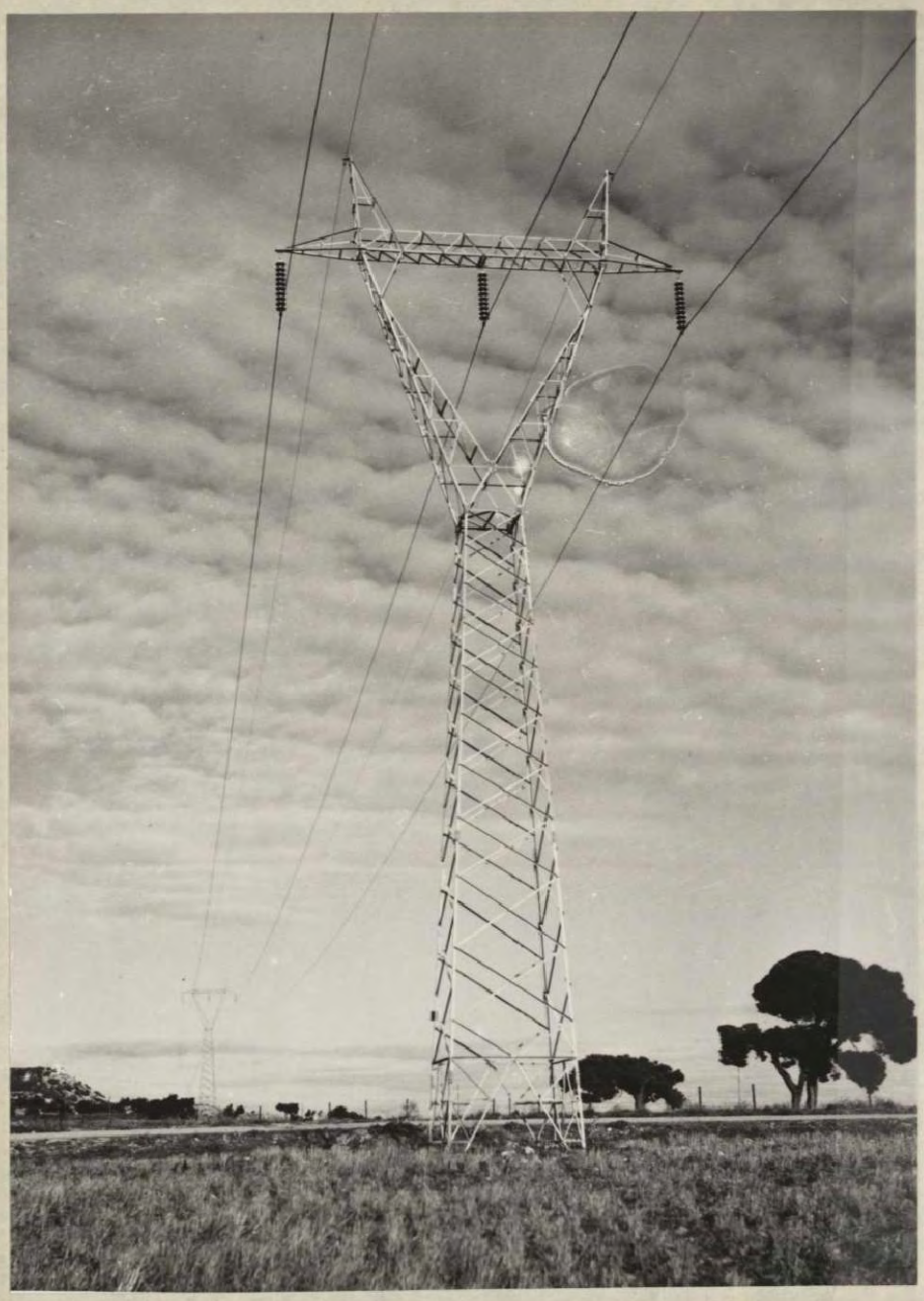
No. 1327 - 150 kv and 15 kv at crossing at Chalkis.

TRANSMISSION LINES

No. 310-427 4/27/54
View of Salonika - Kavala Line.

150,000 VOLT TRANSMISSION LINE

No. 1277 Suspension Tower at Corinth Canal.



150,000 VOLT TRANSMISSION LINE

No. 1316- Dead-end Tower.

ALL STEP DOWN TRANSMISSION SUBSTATIONS
GENERAL DATA

CONSULATING ENGINEERS: MERZ & McLELLAN, England

A.

Item	LOCATION	TYPE	SITE AREA Stremmas	TRANSFORMER CAPACITY MVA	150kv OIL CIRC. BREAK.	150kv DISC. SWIT-CHES	15kv OUT GOING LINES	REMARKS
1	AEGION	A	5.518	5	-	3	3	
2	ARGOS	A	5.276	3	-	3	2	
3	CHALKIS	A	5.133	10	-	1	4	
4	COPAIS	A	5.676	5	-	3	3	
5	CORINTH	B	15.200	5	3	7	2	
6	DRAMA	A	5.670	5	-	2	3	
7	ELEFSIS	B	19.502	40	2	5	-	
8	KALAMATA	A	5.480	5	-	1	2	
9	KAVALA	A	5.797	5	-	1	3	
10	KARIOTISA	-	6.880	-	-	-	-	FUTURE SUBST.
11	LAMIA	AB	15.380	3	-	3	3	
12	LARISA	B	19.988	5	1	6	3	
13	MEGALOPOLIS	SW.ST	5.530	-	-	3	-	
14	NEA CHALKIDON	-	23.240	-	-	-	-	FUTURE SUBST.
15	PATRAS	AB	12.496	10	-	1	4	
16	ROUF	B	26.074	40	2	5	-	
17	SALONIKA	B	15.600	40	1	6	8	
18	SERRES	A	5.375	5	-	2	4	
19	SKIMATARI	SW.ST and A	15.900	5	3	7	2	
20	TRIKALA	A	5.375	5	-	1	3	
21	TRIPOLIS	A	6.240	3	-	3	2	
22	VOLOS	AB	12.080	10	-	1	4	
	TOTAL	-	243.410	209	12	64	55	

B. SUBSTATION SITE AREA

TYPE "A" SUBSTATIONS	:	55.540 (Stremmas)
SWITCHINGSTATIONS	:	136.320 "
FUTURE KARIOTISA and NEA CHALKIDON	:	30.120 "
TOTAL	:	243.410

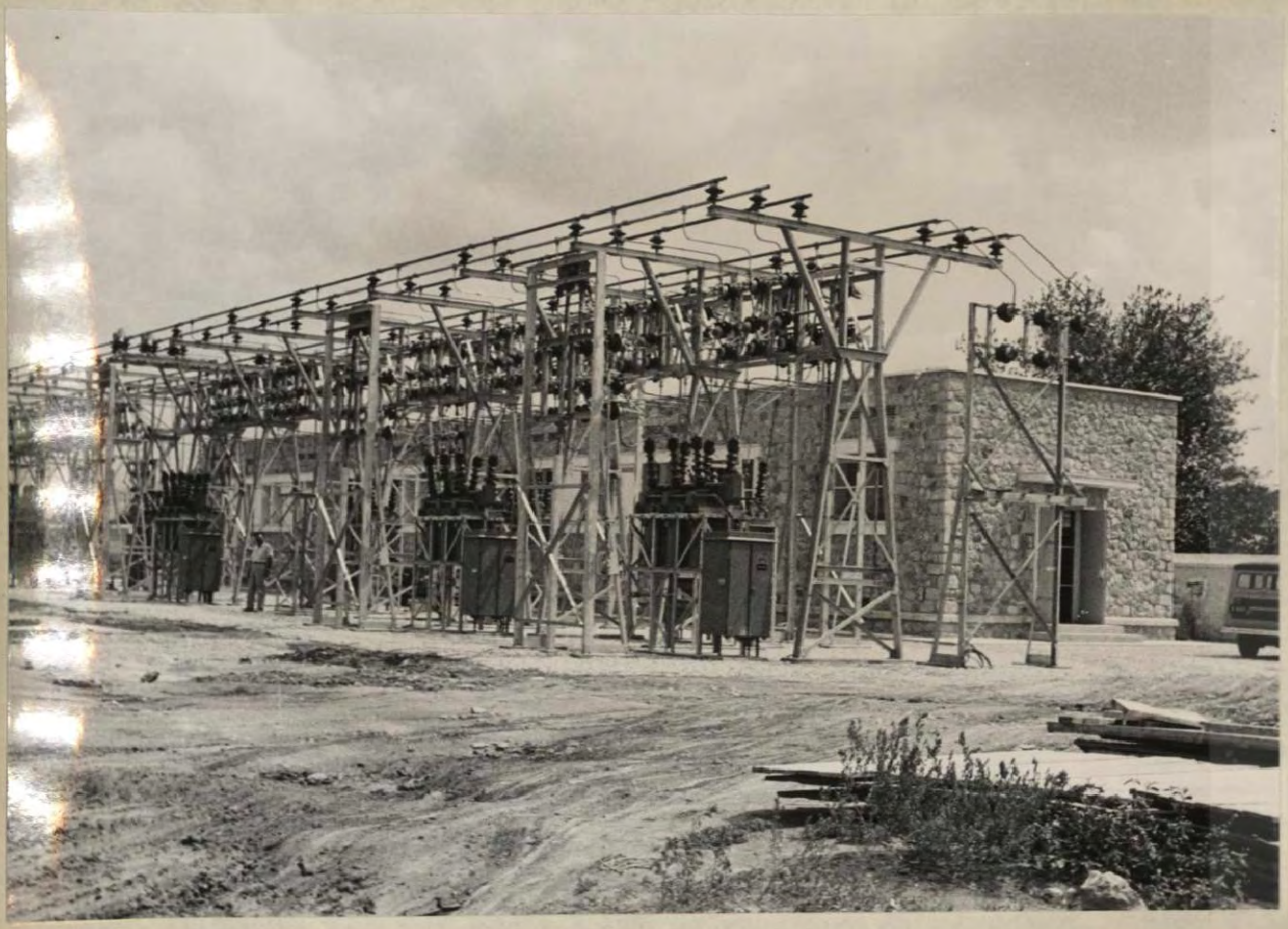
C. SUPPLIERS

1. 3-5-10 and 20 MVA Main Power Transformers - Costruzioni Elettomeccaniche, Italy
2. 40 MVA Main Power Transformer - Allgemeine Elektricitats Gesellshaft - Germany
3. 150KV oil circuit Breakers - 150kv DIS. switches and Switch Boards - Magrini Societa Per Azioni Italy
4. Insulators - Ohio Brass Company, U.S.A.
5. 22KV oil circuit Breakers - English Electric Cº Ltd, England
6. 15KV oil circuit Breakers - Magrini Societa Per Azioni, Italy
7. Metering Equipment - C.G.S.(Magrini) - Electrical and General Engineers.
8. Oil Filtering and Testing equipment - The Metafiltration Cº Ltd England
9. Carrier current protection and communication - Siemens, Italy and Germany
10. Special Trailer. Rated carrying capacity 75 tons - F.W. Neukirch A.G., Germany
11. Steel Structures - Societa Anonima Elettrificazione, Italy
12. Civil works - Local contractors.
13. Lighting and Heating - Local contractors.

/ks/mm/ez

150,000 VOLT SUBSTATIONS

No. 418-14 8/31/53 Rouf



150,000 VOLT SUBSTATIONS

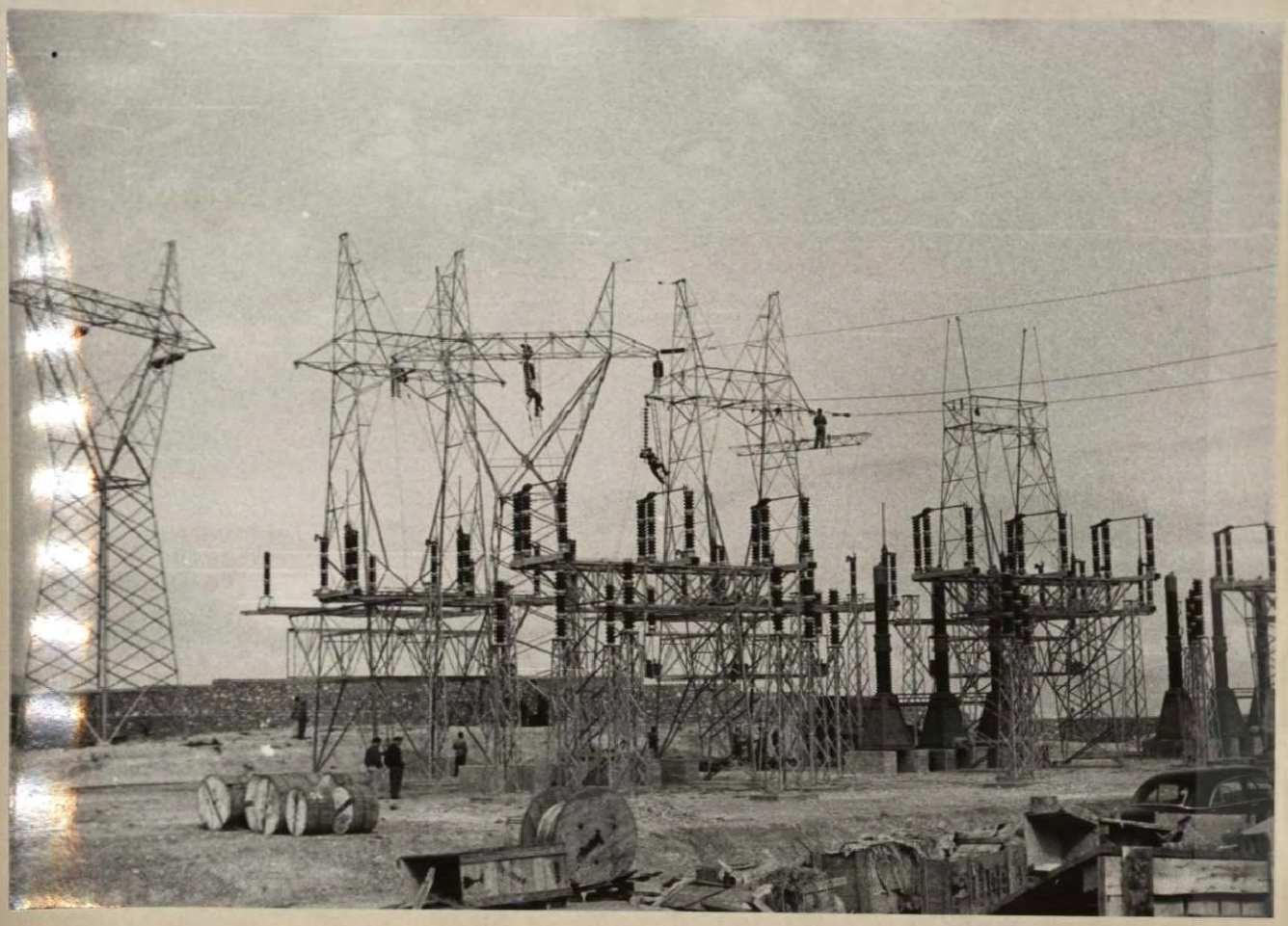
No. 418-15 8/31/53 Rouf

150,000 VOLT SUBSTATIONS

No. 706-3 2/2/54 Salonika.

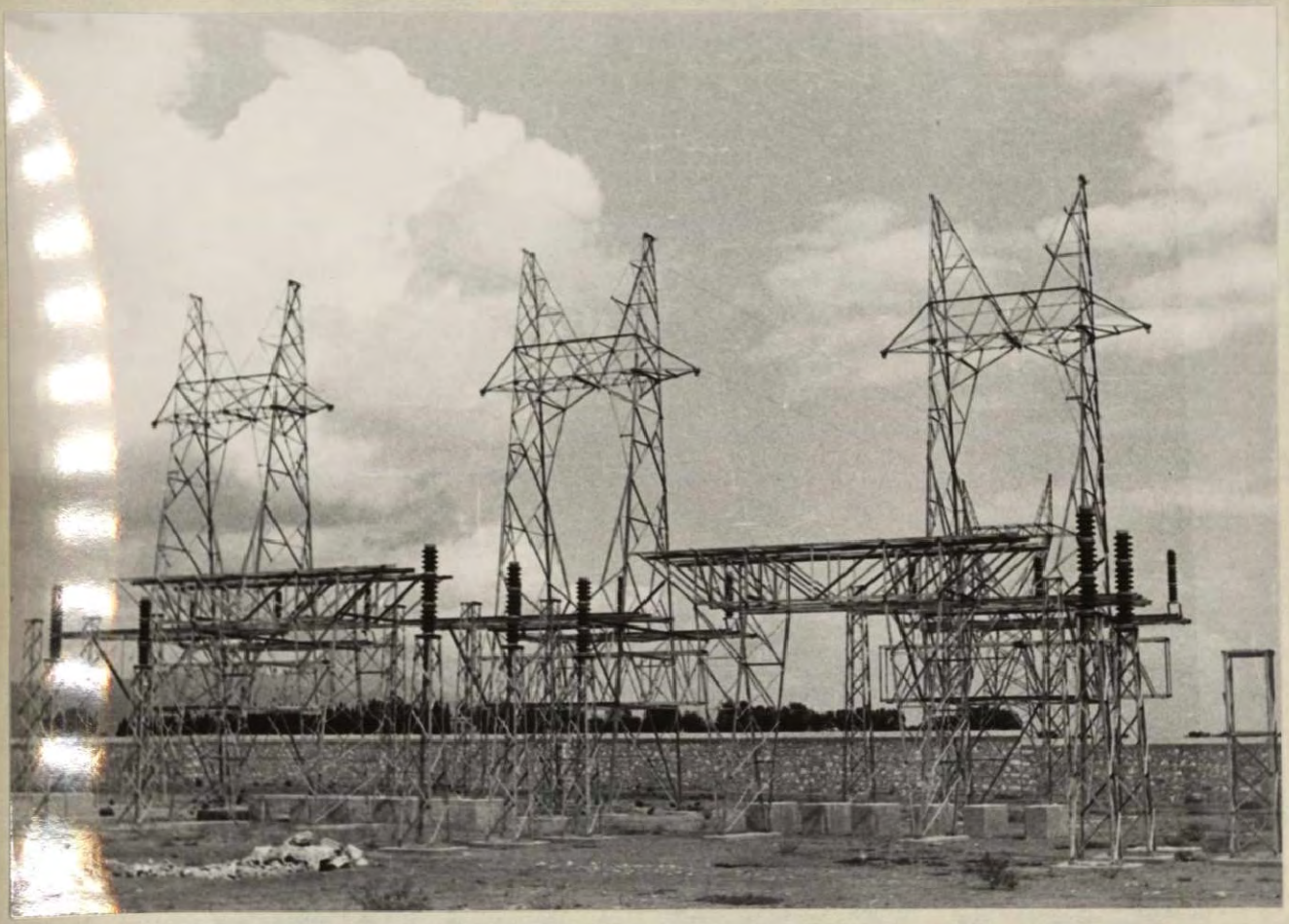
150,000 VOLT SUBSTATIONS

No. 421-1 11/16/53 Skimatari



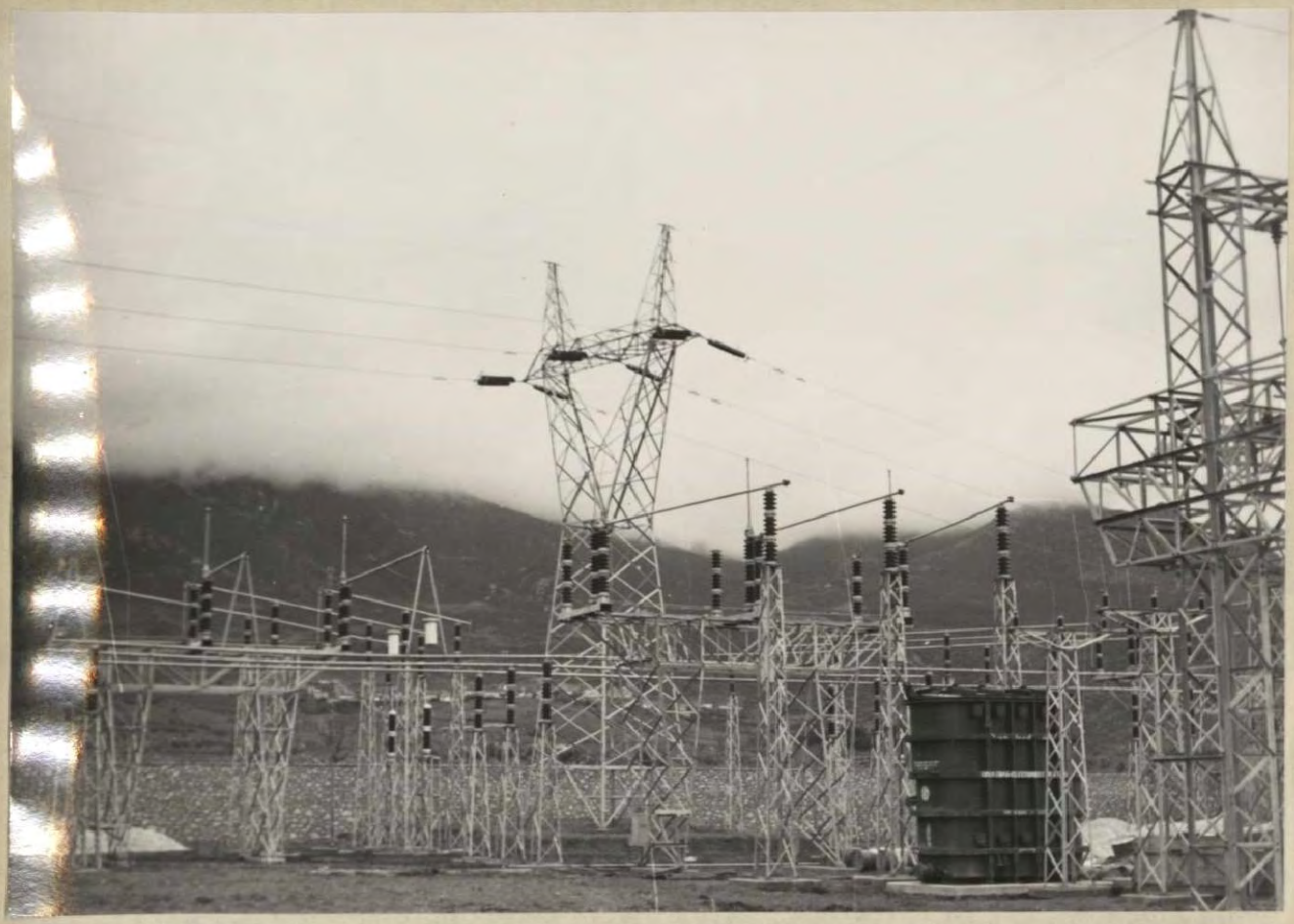
SUBSTATIONS

No. 407-4 8/26/53 Corinth.



SUBSTATIONS

No. 730-3 3/12/53 Copais.



15 KV DISTRIBUTION LINES

STATISTICS

A. DESIGN LOADING

I. Conductor loading: The loading on conductors shall be assumed to be the resultant loading per meter of the conductor obtained by combination of the weight of conductor including the weight of the ice - covering per meter of the conductor and the horizontal wind pressure on the projected area of the cylindrical surface of the ice - covered conductor, per meter of the conductor, to which resultant a constant shall be added.

The following values are used:

Radial thickness of ice	6.5 mm
Weight of ice per cu.cm.	0.912 gr
Horizontal wind pressure (on ice-covered conductors)	20 kg/m^2
Temperature	-10° C
Constant to be added to the resultant in kg per meter	0.3

II. Loads on line supports:

a) Vertical loads shall be their own weight plus the superimposed weight which they support including all conductors ice-coated, together with the effect of any difference in elevation of supports. The weight of ice upon supports is to be ignored.

b) Transverse loading. In computing the stresses in poles, towers and guys, the greater loading resulting under the conditions in (1) and (2) below shall be taken:

(1) Horizontal wind pressure, at right angles to the direction of the line, of 60 KG per sq. meter on projected area of cylindrical surfaces of all supported conductors and on surfaces of supporting structures.

(2) Horizontal wind pressure, at right angles to the direction of the line, of 20 kg/m^2 on projected area of cylindrical surfaces of all supported conductors, ice-covered, with a layer of 6.5 mm radial thickness, and on the surfaces of supporting structures without ice-covering.

15 KV DISTRIBUTION LINE
STATISTICS

B. MAXIMUM WORKING TENSION

For 16	sq.mm.	copper	equivalent	A.C.S.R.	552 kg	(57%	of	ult.	strength)
35	"	"	"	"	1245 "	(60%	"	"	")
50	"	"	"	"	1390 "	(49%	"	"	")
70	"	"	"	"	1665 "	(39%	"	"	")
95	"	"	"	"	2250 "	(40%	"	"	")

C. CLEARANCES

I. Minimum Vertical Clearance of 15 KV Lines

Conductors crossing over:

roads	7.0 m
railroad rails	8.0 m
areas accessible to pedestrians only	6.0 m
trees after trimming	2.5 m
communication wires	1.3 m
open supply wires, 0 to 15000 volts	0.75 m

Conductors along:

roads in urban areas	6.5 m
roads in rural areas	6.0 m

Note: The above are basic clearances and apply under the following conditions:

(a) Temperature 16° C, no wind
(b) Span lengths not greater than 75 meters
(c) Fixed supports for the conductors.

For spans of more than 75 meters the basic clearances shall be increased by 1 centimeter for each meter in excess of 75 meters.

II. Minimum Clearance from buildings of 15 KV lines

Horizontal	2.00 meters
Vertical above	3.00 meters
Vertical below	3.00 meters

Note: These are basic clearances for 50 m spans and shall be increased by 1 cm for each meter of span over 50.

D. SUPPLIERS

1. Treated Wooden Poles Stubs & Log Anchors Poles 9 - 15 m. long	GRANIKEVERKEN, FORSALJINKA - KOUTON, SWEDEN & ZOURESSLI BROS, GREECE
2. ACSR Conductor & Tie Wires	A.B. SVENSKA METALLWERKEN, SWEDEN
3. Wooden Crossarms	STANDARD ELECTRIC CORP., U.S.A.

15 KV DISTRIBUTION LINE-STATISTICS

4. Insulators Pin-type & Tension-type	DOULTON, ENGLAND ELECTROCERAMIQUE, FRANCE
5. Galvanized Steel Guy Wire	CORDERIES & CABLERIES BELGES S.A., BELGIUM
Anchor Rods	DERVAUX, FRANCE
Strain Plate	COUPPAS & CO., GREECE
3-bolt Clamps for Guy Wire	KOUYOULIS, GREECE
Wood guy Insulators	SAIVA, ITALY
6. 15 KV - Fuse Cutouts	E.M.P., ENGLAND
" - Air Break Switches	DEVAG, GERMANY
" - Disconnecting Switches	DELLE, FRANCE
" - Lighting Arresters	A.S.E.A., SWEDEN
7. Dead end bolted Clamp for ACSR	SVENSKA ALUM. CO., SWEDEN
Double tube torsion sleeves for ACSR	SVENSKA ALUM. CO., SWEDEN
ACSR Compression deadends & joints	SALVI & CO., ITALY
Suspension Angle Clamps for ACSR	SALVI & CO., ITALY
Split-bolt Connectors for ACSR	PIRAIKI ORICHALKOURGIA, GREECE
Universal Connectors	PIRAIKI ORICHALKOURGIA, GREECE
2 or 3 bolt Connectors for ACSR	MARFAL, FRANCE
Bolts	DERVAUX, FRANCE
Studs	STAMATOPOULOS, GREECE
X-arm brace, steel and Extended Arm Brace	COUPPAS & CO. LTD, GREECE
Extension Links	KYPRIOTIS, GREECE
Washers	PARVILLEE FRERES, FRANCE DERVAUX, FRANCE BOULONERIES DE LIEGE, BELGIUM
8. Distribution Transformers 15000/400-231 V (15 - 500 KVA)	ALSTHOM, FRANCE SIEMENS, GERMANY ELIN, AUSTRIA A.E.G., GERMANY
9. Special 2-winding Transformers (300 - 2500 KVA)	BROWN BOVERI, SWITZERLAND

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15,000 V. DISTRIBUTION LINES

No. 9 May 1954 Pin-Type Pole.

15,000 VOLT DISTRIBUTION CIRCUITS

No. 1336 May 1954 Angle Pole.

15,000 VOLT DISTRIBUTION CIRCUITS

No. 1478 May 1954 Dead-End Pole.

SECONDARY DISTRIBUTION LINES 220/380 V

STATISTICS

A. DESIGN LOADING

Same as for Primary Lines

B. MAXIMUM WORKING TENSION

Copper Conductors

Street Ltg. -	16 sq. mm.	238 Kg	(34% of Ult. strength)
Main -	35 "	353 "	(24% " " ")
	50 "	435 "	(21% " " ")
	70 "	541 "	(18% " " ")

Aluminum Conductors

16 sq. mm.	Copper Equiv.	242 Kg	(52% of Ult. Strength)
35 "	" "	358 "	(38% " " ")
50 "	" "	442 "	(31% " " ")
70 "	" "	544 "	(27% " " ")

Note: All conductors used in Urban Short Span Construction are strung according to the Universal Sag Chart CC 5 of the PPC Distribution Construction Standards, regardless of their size, material or voltage.

C. CLEARANCES

I. Maximum Vertical Clearance of 220/380 V lines Conductors Crossing Over:

roads	6.0 m
railroad rails	7.0 m
areas accessible to pedestrians only	5.0 m
trees after trimming	1.5 m
communication wires	1.0 m
open supply wires 220/380 volts	0.60 m
open supply wires 15 KV (Not recommended)	(0.75 m)

Conductors along:

roads in urban areas	5.5 m
roads in rural areas	5.0 m

Note: The above are basic clearances and apply under the following conditions:

(a) Temperature 16°C, no wind
(b) Span lengths not greater than 75 meters
(c) Fixed supports for the conductors

For spans of more than 75 meters the basic clearance shall be increased by 1 centimeter for each meter in excess of 75 meters.

SECONDARY DISTRIBUTION LINES 220/380 V
STATISTICS

II. Minimum Clearance from buildings of 220/380 V lines

Horizontal	1.25 meters
Vertical above	2.50 "
Vertical below	1.25 "

Note: These are basic clearances for 50 m spans and shall be increased by 1 cm for each meter of span over 50.

D. SUPPLIERS

1.	Treated Wooden Poles, Stubs & Log Anchors Poles 9-15 m long	GRANIKEVERKEN, FORSALJINKA - KOUTON, SWEDEN & ZOURELLI BROS, GREECE
2.	Copper Conductors & Ties	LAMITREF, BELGIUM SVENSKA METALVERKEN, SWEDEN
	Aluminum Conductors	KABEL & DRAHTVERKE, AUSTRIA
	Ties for Aluminum wires	A.B. SVENSKA METALLVERKEN, SWEDEN
3.	Spool-type Secondary Insulators & Galvanized Clevis, links and pins	ANCIENS ETABLIS PARVILLEE FRERES, FRANCE TRIANTAFILOPOULOS, GREECE
4.	Galvanized Steel Guy Wire	CORDERIES & CABLERIES BELGES SA, BELGIUM
	Anchor rods	DERVAUX, FRANCE
	Strain plate	COUPPAS & CO., GREECE
	3-bolt clamps for guy wire	KOUYOULIS, GREECE
5.	Split bolt connectors for Copper & All Aluminum wires	BRIT. INSULATED CALLENDERS, ENGLAND PIRAIKI ORICHALKOURGHIA, GREECE
	2 & 3-bolt connectors for copper	KOUGIOULIS, GREECE
	2 & 3-bolt connectors for all aluminum	MAFRAL, FRANCE
	Dead end boil type clamp & Automatic line splices	LINE MATERIAL, U.S.A.
	Double tube torsion sleeves for copper	RICHARD BERGNER, GERMANY
	Double tube torsion sleeves for aluminum	AWCO, U.S.A.
	Sleeve twisters	SVENSKA ALUM. COMPANY, SWEDEN AWCO, U.S.A.
	Copper Conductor Terminals & Universal Connectors	PIRAIKI ORICHALKOURGHIA, GREECE
	Alum. Bell Mouthed Tubes	AWCO, U.S.A.
	Ground Rods & Protective Strips	KYPRIOTIS BROS, GREECE ANGELOPOULOS-KOTZIAS, GREECE
	Eye bolts & Bolts & Rag Bolt with hook	DERVAUX, FRANCE
	Second Rack on house & extension brackets	COUPPAS & CO., LTD., GREECE

SECONDARY DISTRIBUTION LINE 220/380 V
STATISTICS

Rag bolts	STAMATOPOULOS, GREECE
Secondary bracket in house	SAE, ITALY
Steel tubes	COUPPAS & CO., GREECE
Fuse fixing bracket	COUPPAS & CO., GREECE
Thimbles	KYPRIOTIS BROS, GREECE
Steel Channels for Platform and Steel Angles for Platform	BOULONERIES DE LIEGE, BELGIUM
Machine Bolts	DERVAUX, FRANCE
6. Meter Enclosures	IZOLA, GREECE
Single phase Meters	LANDIS & GYR, SWITZERLAND
Secondary fuses mounted on frame	GARDY, FRANCE
Secondary Concentric Cable	JEUMONT, FRANCE
Secondary Distribution Cable	C.C.E.L.G. FULGOR, ITALY
Voltage transformers H.T.	CO. COMPTEUR MONTROUGE, FRANCE
Current transformers H.T.	LANDIS & GYR, SWITZERLAND ALSTHOM, FRANCE
Current transformers L.T.	GALILEO, ITALY SMITH HOBSON, ENGLAND
Service Boxes	SALVA, ITALY
Transformer platform	COUPPAS & CO., GREECE
Secondary Fuse Boxes	SALVA, ITALY
Instrument Transformers	GALILEO, ITALY C.G.E., ITALY
3-phase Watt-hour Meters & Strip Chart Demand Meters & Test Terminal blocks	LANDIS & GYR, SWITZERLAND
Outdoor Metering Outfit	C.G.S., ITALY
Single phase Service Meters & 3-phase Meters 220/380 10A	L.M. ERICSON, SWEDEN
D-50 A with Demand Ind.Meters	A.E.G., GERMANY
Meters 110 V - 5 A, through instrument transformer	LANDIS & GYR, SWITZERLAND
Sec. Concentric Cable 1-core & Sec. Concentric Cable 3-core	STE ALSACIENNE DE CONSTRUCTION MECHANIQUES, FRANCE

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Dec. 30, 1953

PART III

MAJOR DIFFICULTIES CAUSING DELAY

The following tabulation gives the original and present estimated completion dates of each project.

Estimated Completion Dates

	Original	Present	Remarks
Aliveri			
Unit 1	Nov, 1952	2 July 1953	Actual
Unit 2		31 Oct. 1953	Actual
Agra (not including Ostrovo Tunnel)	31 Dec. 1953	30 June 1954	
Agra (including Ostrovo Tunnel)	31 May 1954	30 June 1955	Possibility of improving this date.
Ladhon	31 May 1954	31 Jan. 1955	
Louros	Nov. 1953	19 Mar. 1954	Actual
Substations	Feb. 1954	30 Sept. 1954	
Transmission Lines	Feb. 1954	31 Mar. 1954	Actual
Distribution System	1 May 1955	1 May 1955	

ALIVERI STEAM STATION:

The original date set for completion of the Aliveri Steam Electric Station as set forth in the Contract with Burns and Roe Inc., was November 1952. In the winter of 1951-1952 it was foreseen that major equipment could not possibly be delivered in time to meet that date and trial operation of Unit No. 1 was then scheduled for March 30, 1953 and trial operation of Unit No. 2 for June 30, 1953.

A steel strike in the United States was a contributing factor to much later delivery of power piping than had been foreseen, the actual delivery taking place in January and February 1953 and it became necessary to move the date for Unit No. 1 back, first to April 30, 1953 and then to May 15, 1953, with a corresponding delay for Unit No. 2.

The last major delay factor for Unit No. 1 was installation of instruments and controls much of which could not be done until the power piping had been erected. Also the supply of experienced instrumentation pipe fitters was limited.

Unit No. 1 was first turned over under steam pressure on June 20, 1953 and it was "on the line" July 2, 1953. The intervening time, which may be considered normal, was used for inspection of all bearings, drying out the windings and final adjustments.

Unit No. 2 was first started on October 1, 1953 and after the usual inspections, adjustments and drying out was placed "on the line" October 13, 1953. Unit No. 2 could have been placed in operation at an earlier date. However, since the demand for power had not become critical it was decided not to push it, but to proceed with improving operation of Unit No. 1 and with making changes to Unit No. 2 which actual operating experience with Unit No. 1 was showing to be advisable. A matter of safety was also taken into account.

Each Unit has one motor driven boiler feed pump and one steam driven. One spare barrel assembly was provided for the four pumps. During early operation of Unit No. 1 the barrel of one pump had become damaged and it was returned to the United States for repair. During preliminary operation one of the Unit No. 2 boiler feed pump barrels was also seriously damaged by foreign matter entering it. While it was possible to operate the Unit on one pump it was considered much safer not to do so, but to wait until both pumps were in good order.

There was one serious trouble at Aliveri which has not, as yet, caused delay but it must be cured if the station is to run at full capacity with a high load factor; namely the original ash disposal system was inadequate.

It is generally accepted that no two deposits of lignite have the same characteristics. The Aliveri lignite having never been used before under similar conditions, there was no performance data available on it and for the design of the ash handling system of the Aliveri SES it was therefore necessary to make certain assumptions. These assumptions were based upon generally accepted past experience with other lignites. Under actual operating conditions it was found that while the total weight of ash produced was close to what was expected the volume was about twice as great. In other words the actual specific gravity was about one half the assumed specific gravity and the ash handling system was therefore inadequate on a volummetric basis. It is worthy of note that the stoker manufacturer, working independently of the ash disposal system manufacturer, misjudged the volume of ash by the same amount. In the case of the stokers it was a simple matter to rectify the misjudgement by changing the size of drive sprockets and thereby doubling the speed of the grates.

To rectify the handing and disposal of the additional ash, engineering studies are underway and a result of the studies at this point is that the system be supplemented by the use of a hydraulic sluicing system. This system requires disposal of ash in the bay for which approval has recently been obtained. This approval was originally refused by the Greek Government and was not given until it was proven that other solutions would not work.

THE THREE HYDRO PLANTS, AGRA, LADHON AND LOUROS:

By far the greatest delay has been in the underground sections of the hydro plants due to extraordinary defficult conditions of rock quality.

Delays incurred in the construction of the three hydroelectric plants in the program can be attributed principally to unforeseen difficulties encountered in underground work, i.e., tunnel excavation and lining and foundations for dams, power houses, anchor blocks etc..

Limited exploratory work accomplished prior to preparation of plans and specifications did not indicate the difficulties that would be encountered during actual construction. Time lost on such exploratory work would have been prohibitive and knowledge from such work would not have been absolute.

The underground work on the three hydroelectric projects constituted a major portion of the costs and therefore the additional work involved to overcome adverse conditions contributed largely or almost entirely to the delays.

With the exception of Louros, tunnel excavation proved difficult and costly due to unstable ground and excess quantities of water. To overcome the above, special tunneling methods and obtaining adequate delivery dates and installation of pumping equipment to remove large inflows of water were required.

Original estimates were based on the use of steel and timber supports in only a small percentage of the tunnels whereas the nature of the ground has dictated use of tunnel supports in over 60% of the tunnel sections excavated. In addition air slacking and swelling of the excavated portion has made necessary thelining of tunnel sections as excavation proceeds. Thickness of lining has had to be materially increased in practically all tunnel sections. The above greatly delayed the work with corresponding increases in costs.

Similar unstable ground conditions and excess quantities of water requiring additional excavation and additional concrete have delayed virtually all foundations including dams, power houses and anchor blocks. In addition to the above, a delay was encountered at the outset of the work due to difficulties in obtaining funds and inadequacy of the funds when obtained to get the program under way as it was

necessary to establish substantial advances to bring contractors personnel and equipment to Greece.

We should also mention that delays were incurred due to time required in obtaining of letters of credit and for job site delivery of some major items of equipment.

150 KV TRANSMISSION LINES:

Construction of 1125 kilometers of 150 kilovolt steel tower transmission lines was performed by Societa Anonima Electrificazione, s.p.A of Milan, Italy. Contracts were awarded in May 1951 and February 1952 for the construction of these lines with an original estimated completion date for all transmission lines of February 1954. Major construction of the transmission lines was completed in early April 1954 slightly behind schedule, due to extremely bad weather conditions during January and February 1954 and due also to a change in priorrity of construction of the various lines. The total estimated cost of the transmission lines is about 5 per cent above the original estimate, due in part to increased cost of land and land rights, increased depths of counterpoise installations and changes to the construction schedule after construction had started. The contractors performance was excellent, both in quality and quantity of work and in the cooperative attitude throughout the construction period.

150 KV SUBSTATIONS:

The 150 kv substations construction program was originally scheduled for completion in February 1954. Present estimates are that major construction will be completed in September 1954. A number of factors have contributed to this delay, including design changes in equipment furnished, difficulty in establishing letters of credit and in obtaining various export and import permits, delays in material deliveries, and a substantial delay in civil works construction during the winter of 1953-1954 due to extremely bad weather conditions. The total estimated cost of the 150 kv substations has been increased approximately 14 per cent over the original estimate. This increase is due, in part, to additions to the original plan and to the facilities provided, to a general price increase over the period of construction, and to the factors discussed above as contributing to delays in the substations program.

PART IV

COST OF THE PROJECT

The total cost of the complete project according to estimates of today is $117,388,000. This sum is broken down into dollars and other currencies in dollar equivalents as per the following table:

Dollars	$13,654,000
Drachmae (dollar equivalent)	49,585,000
EPU Funds (dollar equivalent)	16,939,000
Italian Reparations (dollar equivalent)	37,210,000
	$117,988,000

Note that the Italians as a matter of reparations are paying about 32% of the entire project.

The original estimate of the cost of construction, exclusive of management fees etc., as shown in the original project agreements, was $83,777,000.- Today's estimates of the same work is $100,474,000 or an increase of $16,697,000.-

The above increase however, is hardly a fair comparison. Some items in today's estimates have been reduced from the original projet agreement. For instance, the Aliveri station was originally estimated as $16,204,000 and today's figure is $16,074,000. However, almost the entire increase came from the unexpectedly high costs of the Agra and Ladhon hydroelectric stations, whose difficulties have been described in PART III. The original estimate for Agra was $9,442,000 and today's estimate is $16,626,000 or an increase of $7,184,000. The original for Ladhon was $15,219,000 whereas the present figure is $23,000,000 or an increase of $7,781,000. Therefore, the total increase of present-day estimates as compared to the original figures for these two plants alone is $14,965,000. Subtracting this figure from the total increase of $16,697,000 (sp) it is apparent that the total increase, exclusive of the large increased costs of Agra and Ladhon, is $1,732,000 or about 2% more than anticipated.

The additional costs can be attributed principally to the same reasons as mentioned above under delaying factors. In addition to this all contracts contain an escalation clause to protect the contractors in the event of forced salary increases not contemplated when bids were submitted and to cover increased costs of materials.

Devaluation of the drachma occurring in April 1953 has materially affected material costs and also dictated automatic escalation when wages were increased by Government decree shortly after devaluation.

Another factor that contributed to increased costs was the fact that skilled tunnel workers in sufficient number to meet the schedules were not available in Greece. As a result it was necessary to bring more than 600 workers from Italy.

It should also be pointed out that initial estimates were based on preliminary engineering designs. As final designs materialized, it was evident that numerous changes to meet adverse conditions were necessary thus increasing cost. Numerous small items have also contributed to increased cost; however, the enumeration of each item would be too lengthy for a report of this nature.

PART V

ACTIVITIES OF THE POWER BRANCH OTHER THAN WITH THE PUBLIC POWER CORPORATION

ATHENS-PIRAEUS ELECTRICITY COMPANY:

This was by far the largest power company of Greece as mentioned above operating in the Athens-Piraeus Area. We have granted them two loans fundamentally to increase their distribution facilities, primarily in order to enable them to receive and distribute Aliveri power when this plant went into service.

The first loan No. 10,013, dated May 11, 1949 totalled $5,856,084.54. The loan also included some 14,000 kw of generator capacity and some high and low pressure boilers. The duration is 25 years and the interest 5%.

The second loan was Loan No. 803 dated June 9, 1951 for $2,917,846.68. The duration is 25 years and the interest 5%. This again was for miscellaneous equipment such as poles, cable, transformers and switchgear.

LOANS TO SMALL UTILITIES:

During the early days starting in 1949 and continuing to February 1953, largely in 1951 we received a very large number for requests for loans from small utilities scattered around Greece; largely municipalities, small power companies or even small manufacturing plants. The total number of loans granted during that period were 17 of a total of value of $476,651, of average value of $28,030.

PART VI

THE FUTURE

The PPC has already put its Aliveri and Louros plants into service and is receiving revenue from them as well as from the Salonika system which the PPC took over from the Ministry of Industry on May 1, 1953. It is expected that the Agra plant will go into service in July 1954 (without the Ostrovo tunnel) and the Ladhon plant is expected to go into service in February 1955.

It can thus be seen that the PPC has now an income of its own. Naturally there will be future expansions, especially of the distribution system and these future expansions will undoubtedly be financed in the normal commercial channels, out of income and out of Government and commercial loans.

A few of the future projects will be mentioned, i.e., projects that have been approved or that are very active, since the original program was set up in 1950.

THE AGRA-LARISSA 150,000 VOLT TRANSMISSION LINE:

This 100-mile line has recently been approved for construction by the PPC and inquiries for materials have been sent out. This is a very important line as it connects the northern system with the central and southern systems of the PPC as originally planned.

THE HIGH DAM AT LADHON:

The original plan was to build a dam about 28 meters high until it had been tried out and the quality of the rock had been proved, when some years from now, the dam would be increased by 20 meters in height.

This year, however, it was decided that the rock was satisfactory and it was obviously economical to add the extra 20 meters during the present construction of the dam. This project has been approved and the dam is almost completed.

This will increase the capacity by 5,000 kw, its average energy output by 33,000,000 kwh. It will increase the firm energy from 98,000,000 kwh per year to 175,000,000 kwh and it will increase the water storage 12-fold.

LADHON-AMALIAS 150,000 VOLT TRANSMISSION LINE:

The original plan was to build a line from Ladhon to Pyrgos, Amalias and up to Patras and then along the north shore of Peloponnesus to Corinth. When, however, the program was reduced in 1950 the line from Ladhon through Pyrgos, Amalias to Patras was postoponned. Recently it has been more and more apparent that the rich region around the Pyrgos and Amalias should have power. An application has been filed to build this line 42 miles long from Ladhon to Amalias at once.

THE MEGDOVA PROJECT:

There is a very interesting potential site for hydroelectric power on the Megdova river, south of Karditsa, this being a combination of power and irrigation project. This was never in the original proposal of Ebasco.

This project however has become very active and for the last month the Greek Government has been negotiating with a French company to construct and finance the project.

The anticipated output of the Megdova dam and power plant is 84,000 kw.

THE PTOLEMAIS PROJECT:

By far the largest known deposit of lignite in Greece is at Ptolemais between Kozani and the Agra plant. During the past years there have been numerous and sundry proposals, basically to build a power plant of about 40,000 kw burning lignite and using part of its output for the production of lignite briquettes, the balance of the power going to the PPC who would operate the steam plant. There have been several changes of the relative amounts of power as between the manufacture of briquettes and the use of power by PPC. There have also been planned a fertilizer plant, coking plant etc., at this location. The matter is under active study now but no decision has been made.

THE ACHELOOS PROJECT:

The original Ebasco recommendation included a large hydro plant on the Acheloos river north of Agrinion. This plant was to have three initial units of 60,000 kw each making a capacity of 180,000 kw and an ultimate capacity of 240,000 kw. Note that the proposed original 180,000 kw is more than the present total planned system of 175,000 kw in the four new plants.

Due to its great expense however this project was not included in the program and at the present time is inactive.

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