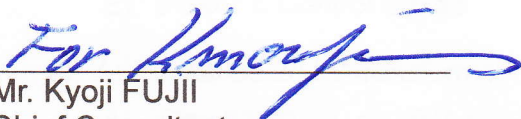


A-5 技術協議録(Field Report)

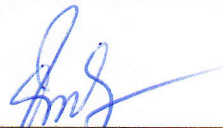
**TECHNICAL MEMORANDUM
FOR
THE 1st PREPARATORY SURVEY
ON
THE PROJECT FOR IMPROVEMENT OF POWER SUPPLY
IN
THE REPUBLIC OF DJIBOUTI**

**AGREED UPON BETWEEN
ELECTRICITE DE DJIBOUTI (EdD)
AND
JICA PREPARATORY SURVEY TEAM**

Djibouti, 19th September 2013



Mr. Kyoji FUJII
Chief Consultant
JICA Preparatory Survey Team
Yachiyo Engineering Co., Ltd.



Mr. Ismael DIALLO
Director of Interconnection Project
Electricite de Djibouti

Electricite du Djibouti (hereinafter referred to as "EdD") and JICA Preparatory Survey Team for the Project for Improvement of Power Supply in the Republic of Djibouti (hereinafter referred to as "the Team") had series of technical discussion to form a mutual understanding on the scope of the Project and pending items to be fulfilled by the both parties before the commencement of second field survey. Both parties agreed to record the following points as a conclusion of the discussions.

1. Clarification of requested components

The details of requested components at the time of the first field survey are clarified as follows:

(1) 63kV transmission lines

1) Overhead line

From PK12 substation to Nagad, double circuits

2) Underground cable

From Nagad to Boulaos substation, single circuit

3) Connection point at Nagad

EdD requested JICA to include Nagad switching station instead of Nagad connection point which simply connects overhead lines and underground cables without switching function. The relevance of the request will be evaluated by the Team and reported to JICA for its consideration. The results will be informed to EdD at the beginning of the second field survey.

(2) Expansion of PK12 Substation

1) Additional 230/63 kV transformer

- A) One 230/63 kV, 63 MVA transformer
- B) One set of 230kV switchgear for the transformer including circuit breaker, disconnecting switches, instrument transformers, arrestor, etc.
- C) One set of 63kV switchgear for the transformer including circuit breaker, disconnecting switches, instrument transformers, arrestor, etc.
- D) Protection and supervisory equipment including existing panel modification
- E) Power & Control cables

2) Additional 63/20 kV transformer

- A) One 63/20 kV, 40 MVA transformer
- B) One set of 63kV switchgear for the transformer including circuit breaker, disconnecting switches, instrument transformers, arrestor, etc.
- C) Protection and supervisory equipment including existing panel modification
- D) Power & Control cables
- E) (Existing 20 kV SWGR will be utilized for receiving the secondary power of the transformer)

- 3) Additional 63 kV Transmission Line Bays
 - A) Expansion of 63 kV substation building for 6 bays
 - B) 63 kV double bus expansion to the new building for 6 bays
 - C) Four sets of 63kV switchgear for 4 transmission lines (outgoing for Nagad and Dorale) in the new building including circuit breakers, disconnecting switches, instrument transformers, arrestors, etc.
 - D) Protection and supervisory equipment including existing panel modification
 - E) Power & Control cables
 - F) Gantry for 2 new transmission lines for Nagad

- 4) Additional 20 kV Capacitor Bank
 - A) 12.6 Mvar Capacitor Bank for 20 kV bus
 - B) Supervisory equipment modification
 - C) Power & Control cables
 - D) (Existing 20 kV SWGR will be utilized for connecting the capacitor.)

(3) Modification of Boulaos Substation

- 1) Modification for new underground cable transmission line
 - A) One 63 kV circuit breaker and instrument transformers
 - B) Protection and supervisory equipment including existing panel modification
 - C) Cables
 - D) (Existing bay in the 63 kV substation building with primary equipment will be utilized except circuit breaker and instrument transformer.)

2. Data and information requested

The following data and information shall be collected by EdD and provided to the Consultant at the beginning of the second field survey which is scheduled from 19th October 2013.

(1) Transmission

Urban development Master plan of the Djibouti city
(Railway, New Airport and Transmission line)

(2) Substation

Boulaos substation

The specifications of the existing equipment for 63 kV Boulaos substation which will be utilized for new underground cable transmission line to PK12 should be provided such as ones of line switch, instrument transformer those of which can be obtained from their name plates and ones of insulator and bus bar material & size.

And the bus bar and equipment arrangement drawing for the above mentioned transmission line bay should be provided for the detailed design of circuit breaker and instrument transformer replacement.

(3) General

Meteorological Data (average of past 10 years)

3. Preparation of presentation materials

The Team shall prepare presentation materials which describe the outline and contents of the requested Japan's grant aid project and submit them to EdD at the beginning of the second field survey.

(End)

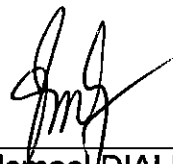
**TECHNICAL MEMORANDUM
FOR
THE 2nd PREPARATORY SURVEY
ON
THE PROJECT FOR IMPROVEMENT OF POWER SUPPLY
IN
THE REPUBLIC OF DJIBOUTI**

**AGREED UPON BETWEEN
ELECTRICITE DE DJIBOUTI (EdD)
AND
JICA PREPARATORY SURVEY TEAM**

Djibouti, 5th November 2013



Mr. Kyoji FUJII
Chief Consultant
JICA Preparatory Survey Team
Yachiyo Engineering Co., Ltd.



Mr. Ismael DIALLO
Director of Interconnection Project
Electricite de Djibouti

Electricite du Djibouti (hereinafter referred to as "EdD") and JICA Preparatory Survey Team for the Project for Improvement of Power Supply in the Republic of Djibouti (hereinafter referred to as "the Team") had series of technical discussion to form a mutual understanding on the scope of the Project, priority order and technical specifications of project components and items to be undertaken by each party. Both parties agreed to record the following points as a conclusion of the discussions.

1. Components of the Project and their priority order

Table-1 shows the results of priority evaluation conducted by the Team. Upon strong request of EdD and considering the importance of electricity supply to railway which connects Djibouti and Ethiopia, both sides reevaluated and agreed on the priority order of Project components as shown in Table-2.

If the result of detailed cost estimation exceeds the ceiling of the Project budget, component(s) will be dropped from the scope of the Project until estimated project cost falls below the ceiling in accordance with the priority order shown in Table-2.

Table-1 Priority evaluation by the Team

Evaluation criteria	Evaluation results				
	PK12 S/S 230/63kV transformer	63kV transmission line	PK12S/S 63/20kV transformer	PK12 S/S 20kV Capacitor bank	Nagad switching station
① Urgency in terms of power supply capacity and/or quality (): year when addition of equipment is required and reasons	4 (2020, overload)	5 (2018, overload/ end of 2015, power supply for railway)	3 (2022, overload)	5 (2018, low voltage)	3 (end of 2015, power supply for railway)
② Benefit (direct/ indirect)	5	5	4	4	4
③ Correlation with other donors' assistance or investment projects	5	5	3	3	5
④ Consistency with strategy on power import from Ethiopia	5	4	3	4	3
⑤ Project cost	3	3	5	5	5
⑥ Necessary permits and period required for granting them	5	3	5	5	5
⑦ Contribution to improving power supply reliability	5	5	3	3	4
⑧ Environmental and social impact	5	4	5	5	5
Sum of evaluation points	37	34	31	34	34
Priority order	1	2	3	2	2

Table-2 Priority order of Project components agreed by Both Sides

Priority order	Project components
1 (Highest)	Construction of 63kV transmission line from PK12 substation to Boulaos substation via Nagad
2+	Expansion of PK12 substation by procurement and installation of a 230/63kV transformer and related equipment
2	Construction of Nagad switching station
2-	Expansion of PK12 substation by procurement and installation of a 63/20kV transformer and related equipment
3 (Lowest)	Procurement and installation of capacitor banks for PK12 substation on 20kV side

2. Items to be undertaken by each party

Even after coming back to Japan from the second field survey, the Team needs some more information to complete the study. Some works such as "Resettlement Action Plan survey" and "Topographic and Soil Investigation" are subcontracted to local consultants. In order for the smooth and timely information collection and following design and cost estimation, EdD and the Team shall undertake items described in Table-3.

Table-3 Items to be undertaken by each party

	EdD	The Team
(1) Monitoring of works sub-contracted to local consultants		
1) Abbreviated RAP (Resettlement Action Plan) survey	<ul style="list-style-type: none"> ● Monitor the progress of survey ● Provide necessary assistance to a local consultant for the smooth implementation the survey ● Inform the Team of any delay, problem and disputes if observed 	<ul style="list-style-type: none"> ● Provide necessary instruction to a local consultant
2) Topographic survey and soil investigation	<ul style="list-style-type: none"> ● Monitor the progress of survey ● Provide necessary assistance to a local consultant for the smooth implementation the survey 	<ul style="list-style-type: none"> ● Provide necessary instruction to a local consultant
(2) Railway project	<ul style="list-style-type: none"> ● Inform the Team of the progress and details of railway project, particularly, <ul style="list-style-type: none"> ➢ Layout of Nagad railway station ➢ Electrical system design and equipment arrangement for Nagad station 	<ul style="list-style-type: none"> ● Incorporate the information into project design if necessary
(3) Urban planning	<ul style="list-style-type: none"> ● Obtain necessary permits and approvals for 63kV transmission line route from PK12 to Boulaos via Nagad 	
(4) EIA	<ul style="list-style-type: none"> ● Confirm whether EIA is required for the Project or not ● If required, take necessary measures to obtain EIA permit and/or license 	<ul style="list-style-type: none"> ● Provide information on project components and locations

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3. Basic plan and technical specifications

Design conditions to be applied to and basic plan of the Project components are shown in Annex-I. Detailed technical specifications of major equipment and materials to be procured and installed under the Project are shown in Annex-II. Outline design drawings such as single line diagram and plot plan of each substation, an elevation and floor plan of switchgear houses at PK12 substation and Nagad switching station, etc. are shown in Annex-III.

Transmission line route, the location on Nagad switching station and railway traction substation which are used as the basis of outline design and cost estimation are shown in Table-4 and Attachment.

Table-4 GPS Coordinates of transmission line, railway traction substation and Nagad switching station

Facility	GPS Coordinates		
	Point	Latitude	Longitude
Overhead transmission Line	TL1	11°33'33.90"N	43° 3'25.20"E
	TL2	11°33'28.60"N	43° 3'13.00"E
	TL3	11°33'03.90"N	43° 3'03.40"E
	TL4	11°32'35.60"N	43° 3'13.20"E
	TL5	11°32'14.20"N	43° 3'31.40"E
	TL6	11°31'58.50"N	43° 3'54.10"E
	TL7	11°31'38.20"N	43° 6'38.00"E
	TL8	11°31'36.62"N	43° 7'3.06"E
	TL9	11°31'36.90"N	43° 7'23.30"E
	TL10	11°31'41.18"N	43° 7'32.40"E
	TL11	11°31'44.45"N	43° 7'43.90"E
	TL12	11°31'39.53"N	43° 7'55.04"E
Railway traction substation	TSS1	11°31'39.47"N	43° 7'54.60"E
	TSS2	11°31'37.57"N	43° 7'53.01"E
	TSS3	11°31'35.86"N	43° 7'55.25"E
	TSS4	11°31'37.75"N	43° 7'56.76"E
Nagad switching station	TSS1	11°31'39.47"N	43° 7'54.60"E
	SWS2	11°31'42.21"N	43° 7'56.82"E
	SWS3	11°31'40.39"N	43° 7'59.22"E
	SWS4	11°31'37.60"N	43° 7'56.99"E

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4. Tentative Implementation Schedule

Tentative implementation schedule of the Project supposing that the Exchange of Notes (E/N) will be concluded in May 2014, is shown in Annex-IV. The schedule is provisional and might be changed later. However, the construction period shall be within 24 months after the E/N according to the Japan's Grant Aid scheme.

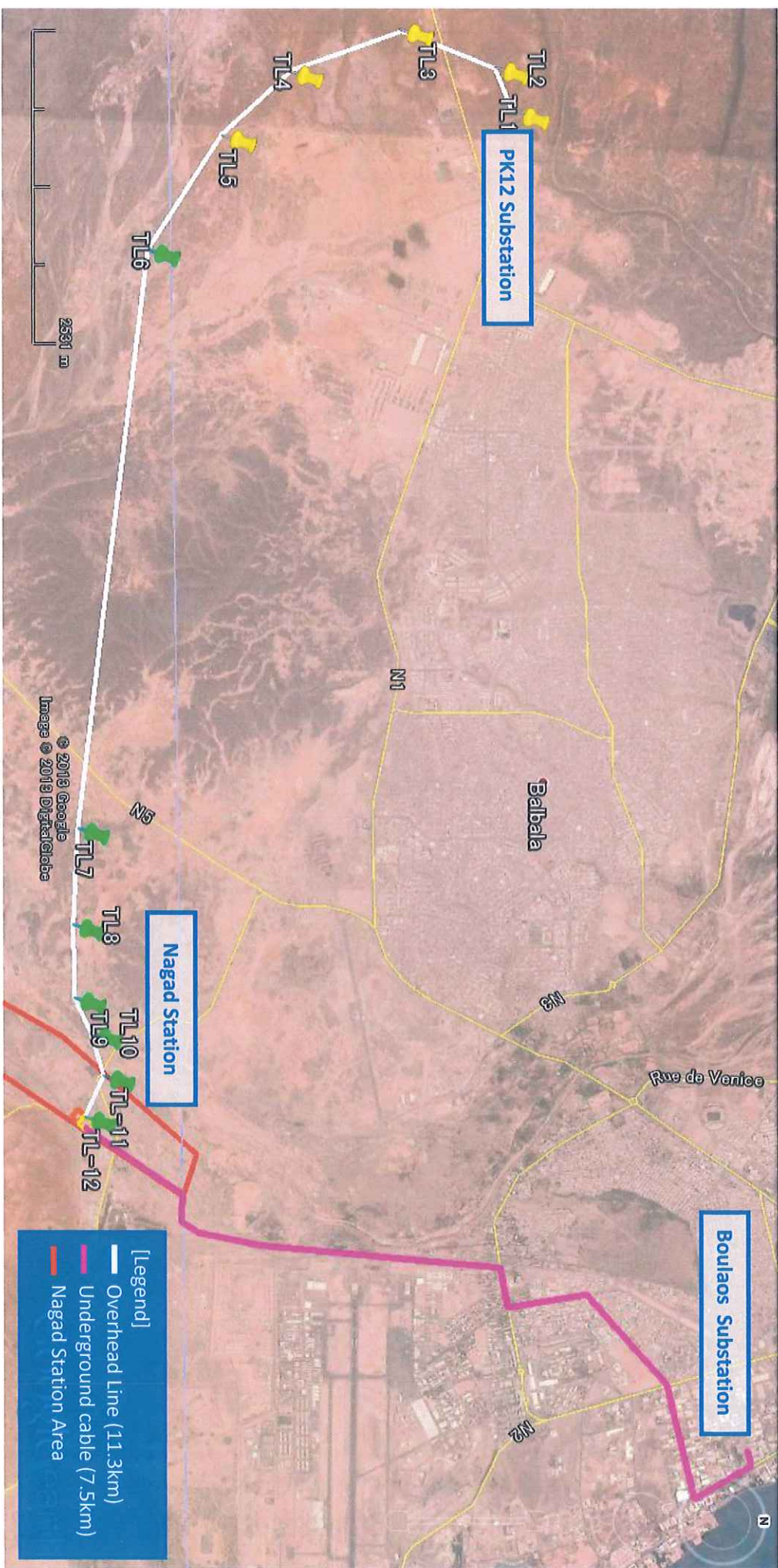
Attachment

- Annex-I: Transmission Line Route
- Annex-II: Design Conditions and Basic Plan
 - (1) Design conditions
 - (2) Applicable codes/Standards and Unit
 - (3) Basic Plan
- Annex-III: Technical Specifications
- Annex-IV: Outline Design Drawings
- Annex-V: Tentative Implementation Schedule



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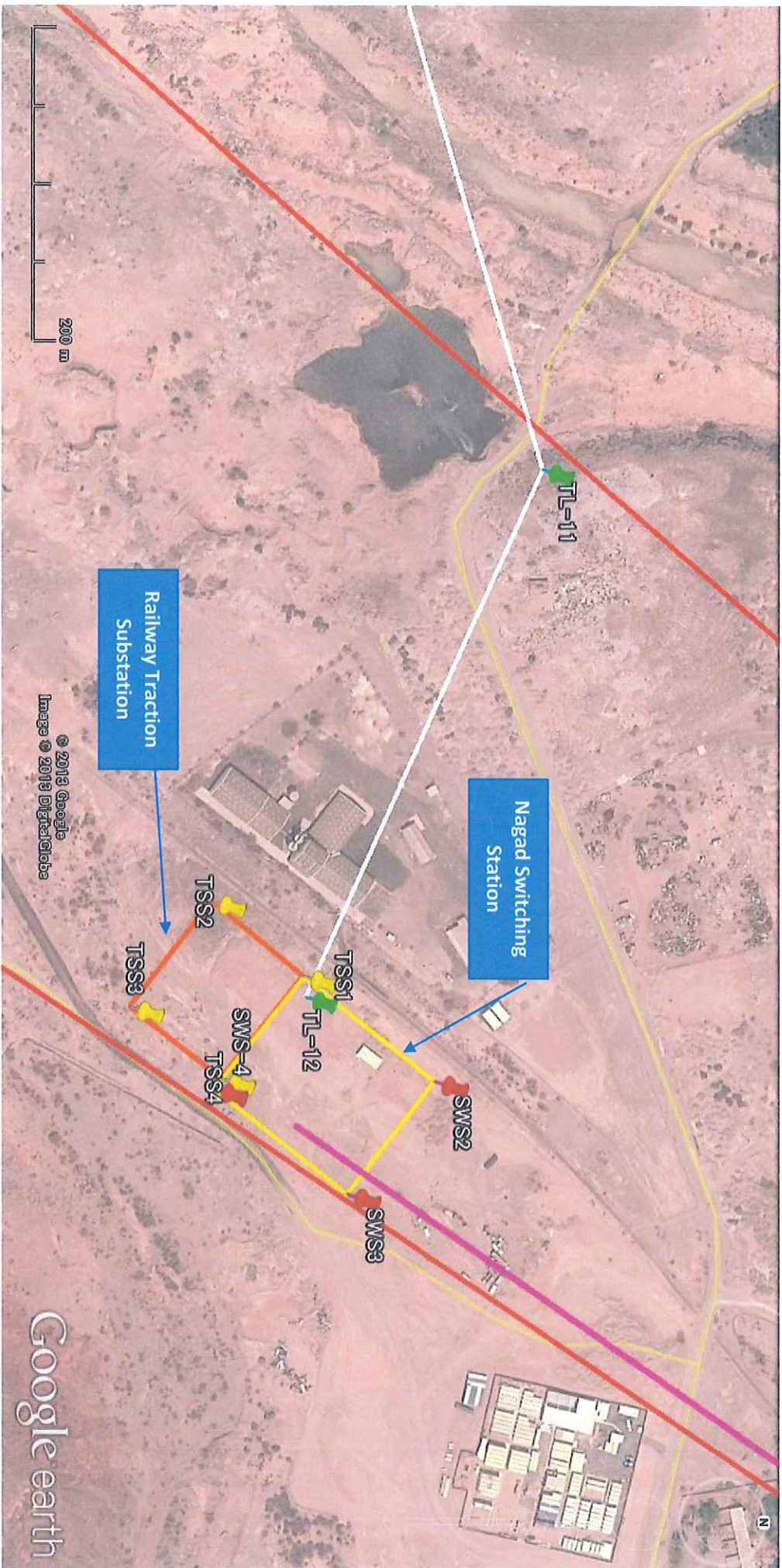
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Transmission Line Route

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Location of Nagad Switching Station

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Design Conditions and Basis Plan

(1) Design Conditions

Design conditions to be applied to the Project are described as follows.

(i) Climatic Conditions

Natural conditions for equipment and facilities design are described as follows.

Table 1 Expansion of PK12 S/S Weather condition

Region		Djibouti
Altitude		Less than 1,000m
Ambient Temperature	Average maximum	46.5°C
	Maximum	55°C
	Minimum	16.0°C
Average Maximum Humidity		87.1%
Max. Wind Velocity		66knots (34m/s) (See Note 1)
Rainfall (Maximum Monthly)		903mm
Maximum Solar Radiation		1100 W/m ²
Earth quake loading		0.15G
Soil Bearing Capacity		5 ton/m ²

(Note)

1. The maximum wind velocity to be applied to the design is estimated based on the past records of mean wind velocity measured at meteorological stations in Djibouti. The highest mean wind velocity in Djibouti which was recorded for the past 10 years (from 2002 to 2012) by Djibouti Meteorological Agency and Ethiopia-Djibouti interconnection project data.

(ii) Basic Electrical Design Conditions

Basic conditions for designing electrical equipment and materials are described as follows.

Table 2 Condition of the electrical system

Item	Transmission System		Distribution System	Station Service Power	
	Nominal Voltage	230kV	63kV	20kV	380-220V AC
Maximum Voltage	245kV	72.5kV	24kV	+10 %	+10 %
Frequency	50Hz			N/A	
Maximum Short Circuit Capacity	31.5kA (1sec.)	20kA (1sec.)	12.5kA (1sec.)	N/A	
Lightning Impulse Withstand Voltage (LIWV)	1,050kV	325kV	125kV	N/A	
Earthing System	Effective Earthing System			N/A	
Minimum Creepage Distance of Insulator	31mm/kV (See Note 1)			N/A	
Minimum Clearance of Conductor	(See Note 2)			N/A	
Phase to Ground (mm)	3,000	1,000	500	N/A	
Phase to Phase (mm)	4,000	1,800	900	N/A	

Item	Transmission System	Distribution System	Station Service Power
Clearance and Wayleave	(See Note 3)		
Protection Class (IP)	(See Note 4)		
SCADA and Communication Systems	(See Note 5)		

(Notes)

1. Since the project sites are located about 6 km away from the coast, contamination by sea water should be taken into consideration. Therefore, minimum creepage distance of insulator is 31mm/kV (Heavily salted area).
2. The minimum clearance of conductor for transmission and distribution lines shall be determined in accordance with relevant standards (IEC 60071.2) and regulations. The minimum clearance of conductor for 20kV switchgear cubicles shall be determined by manufacturer's standards.
3. The height and clearance of transmission and distribution lines shall be determined in accordance with the requirements of EdD, Djibouti National Roads Agency, etc. described as follows. However, in case that special arrangement is required, EdD shall consult with relevant parties to obtain necessary permission.

Table 3 Distance from conductor of the distribution lines and transmission lines

Item	63kV
Height of Conductor	
General Area (m)	6.5
Road (m)	8.0
Railway (m)	10.0
Waterway, Fairway (m)	6.5
Width of Wayleave (m)	24.0
Clearance between conductor and Buildings(m)	5.0
Power supply circuits up to 230KV (m)	4.0
Power supply circuits 230kV (m)	6.0
Clearance between supporting structure and road center	30.0
Clearance between supporting structure and railway (m)	30.0

4. Protection class (IP) for 20kV switchgear cubicles, low voltage panels, control panels and protection relay panels are as follows.

Indoor: IP20

5. Extension and modification of SCADA (Supervisory Control and Data Acquisition) and communication systems (optical fiber systems) for substations shall be designed and provided by this project.

(2) Applicable Codes/Standards and Units

With regard to the Project design, relevant international standards such as IEC and ISO and Japanese standards are applied to the major functions of equipment and facilities in conformity with the existing electrical equipment and facilities in Djibouti. For the system of units, the International System of Units (SI) is applied.

When IEC or ISO Recommendations or DIN, BS, VDE Standards are referred to, the edition shall be that current at the Date of Tender, together with any Amendments issued to that date.

- International Electrotechnical Commission (IEC): Applied to major functions of electrical products in general
- International Standardization Organization (ISO): Applied to performance evaluation of industrial products in general

- Japanese Industrial Standard (JIS): Applied to industrial products in general
- Japanese Electrotechnical Commission (JEC): Applied to electrical products in general
- Standards for Japan Electrical Manufacturer's Association (JEM): Same as above
- Japanese Electrical Wire and Cable Maker's Association (JCS): Applied to electric wire and cables
- Institute of Electrical and ENGINEERs Inc. (IEEE): Applied to electrical products in general
- Deutsches Institut fuer Normung (DIN): Same as above
- British Standards Institution (BS): Same as above
- Verband Deutscher Elektrotechniker (VDE): Same as above
- Comite Consultatif International Telegraphique et Telephonique (CCITT): Applied to Optical fiber
- Relevant Technical Standards on Electrical Installation: Applied to electrical work in general
- Document Technique Unifié (DTU): Applied to construction work

(3) Basic Plan of Components

(i) Expansion of PK12 Substation (S/S)

(a) Outline of the Components

One (1) 230/63 kV, 63 MVA step down transformer and its associated 230 kV outdoor switchgear, 63 kV indoor switchgear and control, supervisory and protection facilities shall be installed to convey imported electric power from Ethiopia to Djibouti to meet the increasing electricity demand. Furthermore, one (1) 63/20 kV, 40 MVA distribution step down transformer and its associated 63 kV indoor switchgear, 20 kV cables and control, supervisory and protection facilities shall be installed as well for the demand of neighbor customers.

Since the new double circuits transmission lines from PK12 S/S to new Nagad switching station (S/S) is requested to be constructed as a component, new two (2) bays for the lines shall be installed including the expansion of 63 kV switchgear building which is designed to accommodate future four (4) more bays in future. Those of new transmission line bays also require switchgear and control, supervisory and protection facilities.

As the electricity import has being increased and the domestic diesel generators are little contributing electric power to the Djibouti grid, reactive power is predicted insufficient to keep the voltage within allowable tolerance. Therefore, one (1) set of 12.6 Mvar indoor capacitor bank shall be installed in also newly constructed capacitor bank building to connect 20 kV distribution bus through circuit breaker.

The dead end gantry for new 63 kV overhead double circuits transmission lines mentioned above shall be installed at adjacent to the substation boundary and cable pit shall be constructed from new expanded 63 kV switchgear building to the gantry for power cable installation.

The new cable pit for low voltage and control cables from expanded 63 kV switchgear building to the existing control building shall be constructed to secure the cable route for additional six (6) bays because of insufficient cross sectional vacant area in the existing buried sleeves between the switchgear building and control building.



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(b) Technical Specifications of Major Equipment and Materials

Regarding electrical system and layout of the substation refer to attached drawings (DWG. No. E-01, E-02, E-03 and C-03 (Plan 2) in Annex-II).

Technical specifications of major equipment and materials are shown in Table-1 of the Attachment.

(ii) Expansion of Boulaos Power station (63 kV S/S)**(a) Outline of the Components**

The existing unused bay in the 63 kV substation building in which the switchgear has been installed since early 1980s will be utilized for new underground cable transmission line from Nagad S/S so that the circuit breaker, instrument transformers and their associated aluminum bus bar plates shall be replaced with new ones. The removal and dispose of them shall be conducted by Djibouti side and the installation of new facilities shall be made by Japan side. Lightning arrestors shall be additionally installed in the bay to protect equipment against surge entry.

The control, supervisory and protection panels shall be newly installed in the relay room adjacent to the bay and the necessary modification of the mosaic control panel in the central control room of the main building shall be made for remote control and monitoring.

The communication network for voice and data including protection relay signal shall be enlarged with Nagad S/S through the fiber optical cable which will be laid together with 63 kV transmission power cables.

(b) Technical Specifications of Major Equipment and Materials

Regarding electrical system and layout of the substation refer to attached drawings (DWG. No. E-01, E-04, E-05 and C-05 in Annex-II).

Technical specifications of major equipment and materials are shown in Table-2 of the Attachment.

(iii) Construction of Nagad S/S**(a) Outline of the Components**

The 63 kV new switching station shall be constructed to interconnect the double circuits transmission lines from PK12 S/S and the single circuit underground cable line from Boulaos P/S both of which will be newly installed together and to supply electricity for the railway substation. The switchgear shall be installed in the building as same design policy as other substations in Djibouti city to avoid quick corrosion and deterioration against the coast environment.

The dead end gantry for two (2) overhead lines shall be constructed for PK12 S/S lines and cable pit between the gantry and switchgear building shall be made for power cable installation.

The control, supervisory and protection facilities shall be installed with the micro SCADA communication network and data of the station will be managed by the SCADA system which is planned to have the gateway interface with National Grid Control Center that will be constructed in neat future. The wide area communication network shall be enlarged including Nagad S/S through OPGW and fiber optic cable those of which will be laid with transmission lines among PK12 S/S, Boulaos P/S and Nagad S/S.

The transmission lines between PK12 S/S and Nagad S/S which is overhead line for full length shall have the rapid single phase auto reclosing function using the communication signal between protection relays of both stations. However, the line which is utilizing cable outside of station shall not apply the auto reclosing function.

The grounding system shall design to secure the human safety and to protect the facilities against the earth fault current so that the resistance of the substation site shall be determined in accordance with the IEEE 80-2000 standard.

(b) Technical Specifications of Major Equipment and Materials

Regarding electrical system and layout of the substation refer to attached drawings (DWG. No. E-01, E-06, E-07 and C-04 in Annex-II).

Technical specifications of major equipment and materials are shown in Table-3 of the Attachment.

(iv) Construction of 63kV Transmission Lines

(a) Outline of the Components

63 kV transmission line of double circuits and 11 .3 km long shall be constructed between PK12 substation and Nagad switching station.

The line passes through mostly flat lands as shown in Route Map of Transmission Line in Annex-III.

As for the design of 63kV transmission line, the maximum wind velocity of 66 knots (34m/s) is applied. The wind and gravity load of OPGW (optical grounding wire) shall be taken into consideration for the design of supporting structure such as transmission towers for completion of the Project.

Standard span length of support shall be 350 m and the sag is around 3%.

The material and size of conductors and overhead earthing wires are AAAC ASTER 366 and OPGW 100sq, respectively.

(b) Technical Specifications

Technical specifications of major materials are shown in Table-4 of the Attachment.

(v) Construction of 63kV Underground Line

(a) Outline of the Components

63 kV underground line of single circuit, about 7.5 km long shall be constructed between Nagad Switching station and the existing Boulaos S/S

The line passes through an urban area as shown in Route Map of Underground Line in Annex-III.

As for the design of 63 kV Underground line, EdD's standards (1x800sqmm2 XLPE single core with armored) shall be applied basically.

The standard depth of laying for underground cables shall be 1400mm.

(b) Technical Specifications

Technical specifications of major materials are shown in Table-5 of the Attachment.

(vi) Construction of Nagad-Boulaos S/S Underground communication Line

(a) Outline of the Components

Underground communication line, about 7.5 km long shall be constructed between Nagad Switching station and the existing Boulaos S/S

The line passes along 63 kV underground cables through an urban area as shown in Route Map of Underground Line in Annex-III.

As for Type and Number of optical fibers, EdD's standards (Loose Tube Fiber Optic Cable – Dry Core – Armored – Double Sheath, 24fibers) shall be applied basically.

(b) Technical Specifications

Technical specifications of major materials are shown in Table-6 of the Attachment.



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Technical Specifications for Major Equipment and Materials

Table 1 Expansion of PK12 S/S

No.	Item / Equipment	Specifications	Quantity
1	230/63kV Transformer 1) Type 2) Rated primary voltage 3) Rated secondary voltage 4) Rated Capacity 5) Cooling type 6) Number of phases 7) Frequency 8) Tap voltage 9) Number of taps 10) Step voltage 11) Winding connection 12) Impedance 13) Others	Outdoor, oil immersed, with on-load tap changer 230 kV 63 kV 50.4/63 MVA ONAN/ONAF 3 50Hz 230 kV +10 % to -10 % 17 taps 1.25% Primary : Star (neutral lead out) Secondary : Star (neutral lead out) Third : Delta YNyn0(d11) 13.5 % at 63 MVA Parallel operation with existing two transformers (%Z=13.56 % & 13.46 %) shall be considered.	1 Set
2	230 kV Circuit Breaker 1) Type 2) Rated voltage 3) Rated lightning impulse withstand voltage 4) Frequency 5) Rated current 6) Rated short-circuit breaking current 7) Rated duration of short circuit	Outdoor, SF6 gas insulated 230 kV 1,050 kV 50Hz 3,150 A 31.5 kA 3 s	1 Set
3	230 kV Disconnecting Switch 1) Type 2) Rated voltage 3) Rated lightning impulse withstand voltage 4) Number of phase 5) Frequency 6) Rated current 7) Rated short-time withstand current 8) Rated duration of short circuit 9) Accessory	Outdoor, pantographic, motor operation type 230 kV 1,050 kV 3 50Hz 2,000 A 31.5 kA 3 s Operating box	2 Sets
4	230 kV Current Transformer 1) Type 2) Highest Voltage 3) Rated lightning impulse withstand voltage 4) Rated primary current 5) Rated secondary current 6) Thermal short time current 7) Number of cores 8) Rated output 9) Accuracy	Outdoor 245 kV 1,050 kV 200-400-800 A 1 A 31.5 kA (1 s) 5 (one for measuring and four for protection) 30 VA or above 0.2 and 10P30	6 Sets
5	230 kV Lightning Arrestor 1) Type 2) Rated voltage 3) Discharge current 4) Accessory	Outdoor, metal oxide type 198 kV 20 kA Discharge current monitor with counter for each arrestor	3 Sets

No.	Item / Equipment	Specifications	Quantity
6	230 kV Switchgear connecting materials 1) Conductors 2) Connecting materials 3) Post insulators 4) Steel supports 5) Marshaling kiosk	A1 36mm diameter conductor wire, etc. Clamps, connectors and fittings Creepage distance: 31 mm/kV or above For DSs, CTs, LAs, and post insulators Outdoor, stainless steel enclosed	1 Lot
7	63/20kV Transformer 1) Type 2) Rated primary voltage 3) Rated secondary voltage 4) Rated Capacity 5) Cooling type 6) Number of phases 7) Frequency 8) Tap voltage 9) Number of taps 10) Step voltage 11) Winding connection 12) Impedance 13) Others	Outdoor, oil immersed, with on-load tap changer 63 kV 20 kV 32/40 MVA ONAN/ONAF 3 50Hz 63 kV +12.5 % to -12.5 % 21 taps 1.25% Primary : Star (neutral lead out) Secondary : Star (neutral lead out) Third : Delta YNyn0(d11) 12 % at 40 MVA Parallel operation with existing transformer (%Z=11.96 % at tap 11 at 40 MVA) shall be considered.	1 Set
8	63 kV Circuit Breaker 1) Type 2) Rated voltage 3) Rated lightning impulse withstand voltage 4) Number of phase 5) Frequency 6) Rated current 7) Rated short-circuit breaking current 8) Rated duration of short circuit 9) Rated operating sequence	Indoor, SF6 gas insulated 63 kV 325 kV 3 50Hz 1,250 A 20 kA or above 3 s O - 0.3 s - CO - 3 min. - CO Single phase rapid auto reclosing function shall be required for two transmission lines only.	4 Sets
9	63 kV Disconnecting Switch 1) Type 2) Rated voltage 3) Rated lightning impulse withstand voltage 4) Number of phase 5) Frequency 6) Rated current 7) Rated short-time withstand current 8) Rated duration of short circuit 9) Accessory 10) Remarks	Indoor, motor operation type 72.5 kV 325 kV 3 50Hz 800 A 20 kA 1 s Operating box For bus connection	8 Sets

No.	Item / Equipment	Specifications	Quantity
10	63 kV Disconnecting Switch with Earth Switch 1) Type 2) Rated voltage 3) Rated lightning impulse withstand voltage 4) Number of phase 5) Frequency 6) Rated current 7) Rated short-time withstand current 8) Rated duration of short circuit 9) Accessory 10) Remarks	Indoor, motor operation type 72.5 kV 325 kV 3 50Hz 800 A 20 kA 1 s Operating box For line feeder connection	4 Sets
11	63 kV Current Transformer 1) Type 2) Highest Voltage 3) Rated lightning impulse withstand voltage 4) Rated primary current 5) Rated secondary current 6) Thermal short time current 7) Number of cores 8) Rated output 9) Accuracy	Indoor 72.5 kV 325 kV 400-800 A 1 A 20 kA (1 s) 4 (one for measuring and three for protection) 30 VA 0.5 and 10P30	12 Sets
12	63 kV Voltage Transformer 1) Type 2) Highest Voltage 3) Rated lightning impulse withstand voltage 4) Rated primary voltage 5) Rated secondary voltage 6) Number of cores 7) Rated output 8) Accuracy 9) Remarks	Indoor, Capacitor type 72.5 kV 325 kV $63/\sqrt{3}$ kV $100/\sqrt{3}$ V 2 100 VA 0.2/3P and 3P For line feeder	6 Sets
13	63 kV Lightning Arrestor 1) Type 2) Rated voltage 3) Discharge current 4) Accessory	Metal oxide type 60 kV 10 kA Discharge current monitor with counter for each arrester	24 Sets
14	63 kV Power cable 1) Type 2) Highest voltage 3) Nominal conductor cross section 4) Place to be used 5) Cable sealing end	Single core aluminum conductor, XLPE insulated, armored and PVC or PE outer sheath 72.5 kV 800 sq. mm - From 63 kV SWGR to gantry for transmission lines (approx. 1,500 m) - From 230/63 kV Tr. to 63 kV SWGR (approx. 100 m) - From 63/20 kV Tr. to 63 kV SWGR (approx. 100 m) With necessary accessories: 24 sets	1 Lot

No.	Item / Equipment	Specifications	Quantity
15	63 kV Switchgear connecting materials 1) Conductors 2) Connecting materials 3) Post insulators 4) Steel supports 5) Marshaling kiosk	Al 100mm*10mm plates for main and branch buses Al 36mm diameter conductor wires, etc. Terminals, connectors, etc. Creepage distance: 31 mm/kV or above For LA, DS, cable, post insulators, etc. Metal enclosed panel for each bay	1 Lot
16	Dead end gantry 1) Type 2) Size 3) Remarks	Galvanized steel structure, for two transmission lines Width: 14 m (2*7 m span) Overall Height: 10.5 m from foundation Horizontal beam height: 8 m from foundation For 2 circuits 63 kV transmission lines to Nagad S/S	1 Set
17	20 kV Disconnecting Switch with Earth Switch 1) Type 2) Rated voltage 3) Rated lightning impulse withstand voltage 4) Number of phase 5) Frequency 6) Rated current 7) Rated short-time withstand current 8) Rated duration of short circuit 9) Accessory	Outdoor, hand operation type 24 kV 125 kV 3 50Hz 1,250 A 20 kA 1 s Operating box	1 Set
18	20 kV Lightning Arrestor 1) Type 2) Rated voltage 3) Discharge current 4) Accessory	Metal oxide type 24 kV 10 kA Discharge current monitor with counter for each arrester	3 Sets
19	20 kV Grounding Resister 1) Type 2) Rated voltage 3) Resistance 4) Short-time rating	Outdoor, metal enclosed 20/ $\sqrt{3}$ kV 40 ohm 10 s	1 Set
20	20 kV Capacitor Bank 1) Type 2) Rated voltage 3) Highest voltage 4) Bank power 5) Accessories 6) Cable entry	Indoor type 20 kV 24 kV 12.6 Mvar (2 * 6.3 Mvar) Inrush reactor bottom	1 Set
21	20 kV Power cable 1) Type 2) Highest voltage 3) Nominal conductor cross section 4) Place to be used 5) Cable sealing end	Single core copper conductor, XLPE insulated and PVC or PE outer sheath 24 kV 500 sq. mm - From 63/20 kV Tr. to 20 kV SWGR (approx. 1,000 m) - From 20 kV SWGR to Capacitor Bank (approx. 80 m) With necessary accessories: 24 sets	1 Lot

No.	Item / Equipment	Specifications	Quantity
22	20 kV Switchgear connecting materials 1) Conductors 2) Connecting materials 3) Steel supports	Al 36mm diameter conductor wires, Copper plates, etc. Terminals, connectors, etc. For LA, DS and cables	1 Lot
23	Bay Control Panels 1) Type 2) Bays to be controlled 3) Main equipment to be mounted 4) Remarks	Indoor, self-stand and front side operation panel - 230/63 kV transformer bay: one - 63/20 kV transformer bay: one - 63 kV transmission line: two Bay Control Unit (BCU), control switches with indicator, selector switch, transformer tap voltage control unit (transformer bay panel only) The configuration and man-machine interface shall be same as the existing control panels.	1 Lot
24	Mimic Control Panel modification 1) Type 2) Modification of existing panel 3) Additional Panel 4) Main equipment to be mounted 5) Remarks	Indoor, self-stand and front side operation panel The following bays of control and monitoring function shall be additionally equipped. - No. 3 230/63 kV transformer bay - No. 2 63/20 kV transformer bay The additional panel shall be installed beside the existing panel. The width shall be determined to equip additional six 63 kV bays with the same man-machine interface as the existing one. Supervisory equipment of 63kV double bus for six bays and two bays for transmission lines shall be mounted and the space for future four bays shall be secured. Control switches with indicator, mimic symbols, meters (P, Q, I & V) The supervisory function shall be well coordinated with the bay control panels.	1 Lot
25	Micro SCADA system modification 1) Modification 2) Remarks	Supervisory function for the expanded four bays and 20 kV capacitor bank shall be additionally included. a) Communication hardware The existing network shall be expanded to connect new BCUs, protection relays and necessary communication equipment such as I/O modules HUB, network cables, connectors, etc. b) Software The supervisory software shall be modified to accommodate the new four bays and 20 kV capacitor bank. Easy accommodation of future 63 kV four bays shall be considered.	1 Lot
26	Transformer Protection Relay Panel 1) Type 2) Protection 3) Configuration 4) Digital relay communication 5) Transformers to be protected	Indoor, self-stand and front side operation panel Digital relay with differential and over current base function Duplex, two sets of one independent protection panel per one transformer IEC 61850 for micro SCADA communication - No. 3 230/63 kV transformer - No. 2 63/20 kV transformer	2 Sets

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No.	Item / Equipment	Specifications	Quantity
27	Transmission Line Protection Relay Panel 1) Type 2) Protection 3) Auto reclosing 4) Configuration 5) Digital relay communication 6) Transmission lines to be protected	Indoor, self-stand and front side operation panel Digital relays with distance (impedance detection) and over current base function Single phase rapid auto reclosing and three phase auto reclosing shall be equipped. Communication through optic fiber (OPGW) with Nagad S/S shall be prepared. Single, one protection panel per one transmission line IEC 61850 for micro SCADA communication - No. 1 transmission line to Nagad S/S - No. 2 transmission line to Nagad S/S	2 Sets
28	230 kV Bus Protection Panels modification 1) Type 2) Protection 3) Configuration 4) Modification	Indoor, self-stand and front side operation panel Bus bar differential protection with breaker failure protection (Siprotec 7SS52, Siemens is under use) Duplex, two sets of one independent protection panel Modification for additional 230/63 kV transformer feeder - Additional bay units and necessary equipment - Panel inside wiring - Central unit modification - Necessary connection with the bay control and protection relay panels	1 Lot
29	63 kV Bus Protection Panel modification 1) Type 2) Protection 3) Configuration 4) Modification with additional panel installation 5) Remarks	Indoor, self-stand and front side operation panel Bus bar differential protection with breaker failure protection (Siprotec 7SS52, Siemens is under use) Single In order to accommodate additional four 63 kV feeders for the bus protection panel, additional one panel shall be installed beside the existing panel. - Additional bay units and necessary equipment - Panel inside wiring - Central unit modification - Necessary connection with the bay control and protection relay panels Four feeders in future shall be considered in the design of new additional panel.	1 Lot
30	D.C. Distribution Panel modification 1) Type 2) Modification	Indoor, self-stand and front side operation panel Additional D.C. control power supply for new facilities of additional bays -MCCBs, terminal blocks, wiring, name plates, etc.	1 Lot
31	A.C. Distribution Panel modification 1) Type 2) Modification	Indoor, self-stand and front side operation panel Additional A.C. power supply for new facilities of additional bays and buildings -MCCBs, terminal blocks, wiring, name plates, etc.	1 Lot

No.	Item / Equipment	Specifications	Quantity
32	Communication Facilities 1) General 2) Modification 3) Fiber optical cable 4) Fiber optical cable connection box	Additional communication network shall be installed through fiber optical cable (OPGW) between PK12 S/S, Nagad S/S and Boulaous P/S. Voice and data communication including protection relay signal shall be secured among said stations. Necessary equipment for Communication panels (Rack-1 & 2) to accommodate additional network shall be equipped. Lose tube fiber optic cable, dry core, armored and double sheath (IEC 60794-3-10) - Number of fibers: 24 - Place to be used: From the gantry of Nagad transmission line to communication room in the control building (approx. 200 m) - Necessary accessories for connection of cables Boxes for connection between optical fibers (OPGW, fiber optical cable)	1 Lot
33	Others 1) Low voltage cables 2) Grounding materials 4) Lighting and sockets system 4) Cabling materials	- Power cables XLPE insulated - Control cables PVC insulated shield type - Copper conductors and PVC insulated cables 70sq. mm and 120sq. mm -Earthing rod 1.5 m length -Connectors -Lighting fixtures and accessories -Switches, sockets and accessories -Conduits, junction boxes and fittings -Cable trays -Cable hangers	1 Lot





Table 2 Expansion of Boulaos P/S (63 kV S/S)

No.	Item / Equipment	Specifications	Quantity
1	63 kV Circuit Breaker 1) Type 2) Rated voltage 3) Rated lightning impulse withstand voltage 4) Number of phase 5) Frequency 6) Rated current 7) Rated short-circuit breaking current 8) Rated duration of short circuit 9) Remarks	Indoor, SF6 gas insulated 63 kV 325 kV 3 50Hz 1,250 A 20 kA or above 3 s The existing old circuit breaker will be replaced with the breaker specified above.	1 Set
2	Combined Instrument transformer 1) Type 2) Highest voltage 3) Rated lightning impulse withstand voltage 4) Frequency 5) Thermal short time current 6) Voltage transformer 7) Current transformer 8) Remarks	Indoor 72.5 kV 325 kV 50 Hz 20 kA (1 s) - Rated primary voltage: $63/\sqrt{3}$ kV - Rated secondary voltage: $100/\sqrt{3}$ kV - Number of cores: 2 - Rated output: 50 VA - Accuracy: 0.5 and 3P - Rated primary current: 400 - 800 A - Rated secondary current: 1 A - Number of cores: 3 (one for measuring and two for protection) - Rated output: 30 VA - Accuracy: 0.5 and 10P30 The existing old instrument transformers will be replaced with the ones specified above.	3 Sets
3	63 kV Lightning Arrestor 1) Type 2) Rated voltage 3) Discharge current 4) Accessory	Metal oxide type 60 kV 10 kA Discharge current monitor with counter for each arrester	3 Sets
4	63 kV Switchgear connecting materials 1) Conductors 2) Connecting materials 3) Post insulators 4) Steel supports 5) Marshaling kiosk	Al 80mm*5mm or greater plates for branch buses Terminals, connectors, etc. Creepage distance: 31 mm/kV or above: 3 sets For instrument transformers, LA, post insulators and disconnecting switch operating mechanism Metal enclosed panel	1 Lot
5	D.C distribution panel modification 1) Type 2) Modification 3) Equipment to be mounted	Indoor, self-stand front door panel Additional control power supply for the new transmission line bay facilities Molded case circuit breaker, terminal block and wiring	1 Lot

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No.	Item / Equipment	Specifications	Quantity
6	Bay Control Panel 1) Type 2) Bays to be controlled 3) Main equipment to be mounted 4) Remarks	Indoor, self-stand and front side operation panel 63 kV transmission line to Nagad S/S Bay Control Unit (BCU), control switches with indicator, selector switch, annunciation windows, meters (P, Q, V & I), energy meter, etc. The configuration and man-machine interface shall be same as the existing Palmeraie transmission line control panels.	1 Set
7	Transmission Line Protection Relay Panel 1) Type 2) Protection 3) Configuration 4) Transmission line to be protected	Indoor, self-stand and front side operation panel Digital relays with distance (impedance detection), current differential and over current base function Communication through optic fiber (OPGW) with Nagad S/S shall be prepared. Single, one protection panel per one transmission line Transmission line to Nagad S/S (Cable Line)	1 Set
8	Mimic Control Panel modification 1) Type 2) Modification 3) Main equipment to be mounted	Indoor, mosaic block self-stand type Supervisory function in the plant control room for new transmission line shall be achieved. Control switches, meters(I, V), annunciation windows, etc.	1 Lot
9	Communication Facilities 1) General 2) Modification 3) Fiber optical cable 4) Fiber optical cable connection box	Additional communication network shall be installed through fiber optical cable (OPGW) between PK12 S/S, Nagad S/S and Boulaous P/S. Voice and data communication including protection relay signal shall be secured among said stations. Necessary equipment for Communication panel (SDH (Synchronous Digital Hierarchy) cabinet) to accommodate additional network shall be equipped. Loose tube fiber optic cable, dry core, armored and double sheath (IEC 60794-3-10) - Number of fibers: 24 - Place to be used: From the relay room of 63 kV SWGR building to the relay room adjacent to control room in the building (approx. 130 m) - Necessary accessories for connection of cables Boxes for connection between optical fibers	1 Lot
10	Others 1) Low voltage cables 2) Grounding materials 3) Cabling materials	- Power cables XLPE insulated - Control cables PVC insulated shield type - PVC insulated cables - Connectors - Conduits, junction boxes and fittings - Cable trays - Cable hangers	1 Lot




Table 3 Construction of Nagad S/S

No.	Item / Equipment	Specifications	Quantity
1	63 kV Circuit Breaker 1) Type 2) Rated voltage 3) Rated lightning impulse withstand voltage 4) Number of phase 5) Frequency 6) Rated current 7) Rated short-circuit breaking current 8) Rated duration of short circuit 9) Rated operating sequence	Indoor, SF6 gas insulated 63 kV 325 kV or above 3 50Hz 1,200 A or above: 5 sets 2,000 A or above: 1 set (Bus coupler) 16 kA or above 1 s O - 0.3 s - CO - 1 min. - CO (2 sets) Single phase rapid auto reclosing function shall be required for two transmission lines only. O - 1 min. - CO - 3 min. - CO (4 sets)	6 Sets
2	63 kV Disconnecting Switch 1) Type 2) Rated voltage 3) Rated lightning impulse withstand voltage 4) Number of phase 5) Frequency 6) Rated current 7) Rated short-time withstand current 8) Rated duration of short circuit 9) Accessory 10) Remarks	Indoor, motor operation type 72 kV or above 325 kV or above 3 50Hz 800 A or above 16 kA or above 1 s Operating box For bus connection	12 Sets
3	63 kV Disconnecting Switch with Earth Switch 1) Type 2) Rated voltage 3) Rated lightning impulse withstand voltage 4) Number of phase 5) Frequency 6) Rated current 7) Rated short-time withstand current 8) Rated duration of short circuit 9) Accessory 10) Remarks	Indoor, motor operation type 72 kV or above 325 kV or above 3 50Hz 800 A or above 16 kA or above 1 s Operating box For line feeder connection	5 Sets
4	63 kV Current Transformer 1) Type 2) Highest Voltage 3) Rated lightning impulse withstand voltage 4) Rated primary current 5) Rated secondary current 6) Thermal short time current 7) Number of cores 8) Rated output 9) Accuracy 10) Remarks	Indoor 72 kV or above 325 kV or above 400-800 A: for feeder 1,000-2,000 A: for bus coupler 1 A 16 kA or above (1 s) 4 (one for measuring and three for protection) 30 VA 0.5 and 10P30 Current transformers mounted in the busing pockets of circuit breaker can be acceptable instead of the independent installation type specified above.	18 Sets

No.	Item / Equipment	Specifications	Quantity
5	63 kV Voltage Transformer 1) Type 2) Highest Voltage 3) Rated lightning impulse withstand voltage 4) Rated primary voltage 5) Rated secondary voltage 6) Number of cores 7) Rated output 8) Accuracy 9) Remarks	Indoor, Capacitor type 72 kV or above 325 kV or above 63/ $\sqrt{3}$ kV 100/ $\sqrt{3}$ V 2 100 VA 0.5 and 3P For bus and line feeder	21 Sets
6	63 kV Lightning Arrestor 1) Type 2) Rated voltage 3) Discharge current 4) Accessory	Metal oxide type 60 kV 10 kA Discharge current monitor with counter for each arrestor	21 Sets
7	63 kV Switchgear connecting materials 1) Conductors 2) Connecting materials 3) Post insulators 4) Steel supports 5) Marshaling kiosk	Aluminum conductor plates for main and branch buses, Continuous current - 2,000 A or above (main bus & bus coupler) - 800 A or above (feeder) Configuration of the main bus bar shall be double and their length shall be sufficient for eight bays. Terminals, connectors, etc. Creepage distance: 31 mm/kV or above For LA, DS, cable, post insulators, etc. Metal enclosed panel for each bay	1 Lot
8	63 kV Power cable 1) Type 2) Highest voltage 3) Nominal conductor cross section 4) Place to be used 5) Cable sealing end	Single core aluminum conductor, XLPE insulated, armored and PVC or PE outer sheath 72 kV or above 800 sq. mm - From 63 kV SWGR to the gantry for two Nagad S/S transmission lines (approx. 450 m) With necessary accessories: 12 sets	1 Lot
9	Dead end gantry 1) Type 2) Size 3) Remarks	Galvanized steel structure, for two transmission lines Width: 14 m (2*7 m span) Overall Height: 10.5 m from foundation Horizontal beam height: 8 m from foundation For 2 circuits 63 kV transmission lines to PK12 S/S	1 Set
10	20kV Switchgear cubicle 1) Type 2) Rated voltage 3) Rated current 4) Primary circuit protection 5) Rated short-time withstand current 6) Load break switch 7) VT 8) Meter 9) Lightning arrestor 10) Purpose	Indoor cubicle 24 kV 600 A or above Power fuse: 10 A, 12.5 kA or above 12.5kA or above (1 sec.) 600 A or above 3 phase -Primary voltage: 63/ $\sqrt{3}$ kV -Secondary voltage: 100/ $\sqrt{3}$ V Voltage indication of each phase 24 kV, 10kA Incoming from distribution line Outgoing to Auxiliary transformer for station service	1 Set

No.	Item / Equipment	Specifications	Quantity
11	20 kV Power cable 1) Type 2) Highest voltage 3) Nominal conductor cross section 4) Place to be used 5) Cable sealing end	Single core copper conductor, XLPE insulated, armored and PVC or PE outer sheath 24 kV 70 sq. mm - From 20 kV distribution line dead end pole vicinity of the switching station outside to 20 kV switchgear cubicle in the control building (approx. 200 m) - From 20 kV switchgear cubicle to Auxiliary Transformer (approx. 30 m) With necessary accessories: 12 sets	1 Lot
12	20kV Auxiliary Transformer Cubicle 1) Type 2) Transformer	Indoor cubicle -Dry type -Insulation class: F or H -Cooling: AN -phase: 3 -Capacity: 250 kVA (tentative) -Primary voltage:20 kV +5% to -5% tap, 2.5% step -secondary voltage: 3 phase 4 wires, 400-230 V -Winding connection primary: delta, secondary: star (neutral lead out)	1 Set
13	Low voltage Distribution Panel 1) Type 2) Voltage 3) Power circuit protection 4) Meters to be mounted	Indoor type 3 phase 4 wires, 380/220V Molded case circuit breakers V, I and energy(Wh)	1 Panel
14	Battery (125 V and 48 V) 1) Type 2) Voltage 3) Number of cell 4) Capacity (tentative)	Lead acid, seal type 125V and 48 V - 60 cells for 125V - 23cells for 48V - 600 AH/10 h for 125V - 200 AH/10 h for 48V	1 Set each
15	Battery Charger (125 V and 48 V) 1) Type 2) Charger rating (tentative) 3) Meters to be mounted	Indoor, thirstier type - D.C.125 V (133.8V max.) 70A - D.C.48 V (51.3 V max.) 30A - A.C. input: V and I - D.C. output: V and I	2 Sets each
16	D.C. Distribution Panel 1) Type 2) Voltage 3) Power circuit protection	Indoor type D.C. 125 V Molded case circuit breakers	1 Panel
17	Bay Control Panels 1) Type 2) Bays to be controlled 3) Main equipment to be mounted 4) BCU	Indoor, self-stand and front side operation panel - 63 kV transmission line: five - 63 kV bus coupler: one Future consideration for space - 63 kV transmission line: one - 63/20 kV transformer: one Bay Control Unit (BCU), control switches with indicator, selector switch, mimic bus, energy meter, etc. IEC 61850 interface for micro SCADA communication	1 Set

No.	Item / Equipment	Specifications	Quantity
21	Transmission Line Protection Relay Panel(3) 1) Type 2) Protection 3) Digital relay communication 4) Transmission line to be protected	Indoor, self-stand and front side operation panel Digital relays with distance (impedance detection) and over current base function IEC 61850 interface for micro SCADA communication - No.1 Transmission line to Railway S/S - No.2 Transmission line to Railway S/S	1 Set
22	63 kV Bus Protection Panel 1) Type 2) Protection 3) Digital relay communication 4) Remarks	Indoor, self-stand and front side operation panel Bus bar differential protection with breaker failure protection IEC 61850 interface for micro SCADA communication Two feeders in future shall be considered in the design.	1 Set
23	Communication Facilities 1) General 2) Communication panel 3) Telephone 4) Fiber optical cable 5) Fiber optical cable connection box	Additional communication network shall be installed through fiber optical cable (OPGW) between PK12 S/S, Nagad S/S and Boulaous P/S. Voice and data communication including protection relay signal shall be secured among said stations. SDH cabinet with communication equipment and necessary accessories Two telephone sets for voice communication among substations Lose tube fiber optic cable, dry core, armored and double sheath (IEC 60794-3-10) - Number of fibers: 24 - Place to be used: From the gantry of PK12 transmission line to communication room in the control building (approx. 120 m) and from the Boulaos P/S transmission line bay of 63 kV SWGR building to communication room in the control building (approx. 60 m) - Necessary accessories for connection of cables Boxes for connection between optical fibers (OPGW, fiber optical cable)	1 Lot
	Others 1) Low voltage cables 2) Grounding materials 3) Lighting and sockets system 4) Cabling materials	- Power cables XLPE insulated - Control cables PVC insulated shield type - Copper conductors and PVC insulated cables -Earthing rod 1.5 m length -Connectors -Lighting fixtures and accessories -Switches, sockets and accessories -Conduits, junction boxes and fittings -Cable trays -Cable hangers	1 Lot

Table 4 Construction of 63kV transmission line

No.	Item / Materials	Specifications	Quantity
1	Type of support	Self-Supporting, lattice type steel towers with body and leg extensions	1 lot
2	Type and size of conductor	AAAC ASTER 366	1 lot
3	Type of optical fiber composite overhead ground wire (OPGW)	Stainless steel tube embedded in extruded aluminum	1 lot
	Section area of optical fiber composite overhead ground wire (OPGW)	100 mm ²	
	a) Mode	Dual Window Single Mode Fiber (ITU-T G.652)	
	b) Wavelength (nm)	1550	
	c) Number of optical fibers	48	
4	Type and number of suspension insulator	Disc type (aprox. 250mm), 6 pieces per unit	1 lot

Table 5 Construction of 63kV Underground line

No.	Item / Materials	Specifications	Quantity
1	Type	Single core cable with armored directly buried under the ground	1 lot
2	Conductor and insulation	Aluminum conductor and XLPE insulation	
3	Size of cable	800mm ²	

Table 6 Construction of Nagad-Boulaos SS communication line

No.	Item / Materials	Specifications	Quantity
1	Type of fiber cable	Loose Tube Fiber Optic Cable – Dry Core – Armored – Double Sheath	1 lot
	a) Mode	Dual Window Single Mode Fiber (ITU-T G.652)	
	b) Wavelength (nm)	1550	
	c) Number of optical fibers	24	

DRAWING LIST

- E-1 Djibouti General Transmission Single Line Diagram
- E-2 PK12 Substation Single Line Diagram
- E-3 PK12 Substation General Arrangement
- E-4 Boulaos Power Station 63 kV Substation single Line Diagram
- E-5 Boulaos Power Station 63 kV Substation Arrangement
- E-6 Nagad Switching Station Single Line Diagram
- E-7 Nagad Switching Station General Arrangement

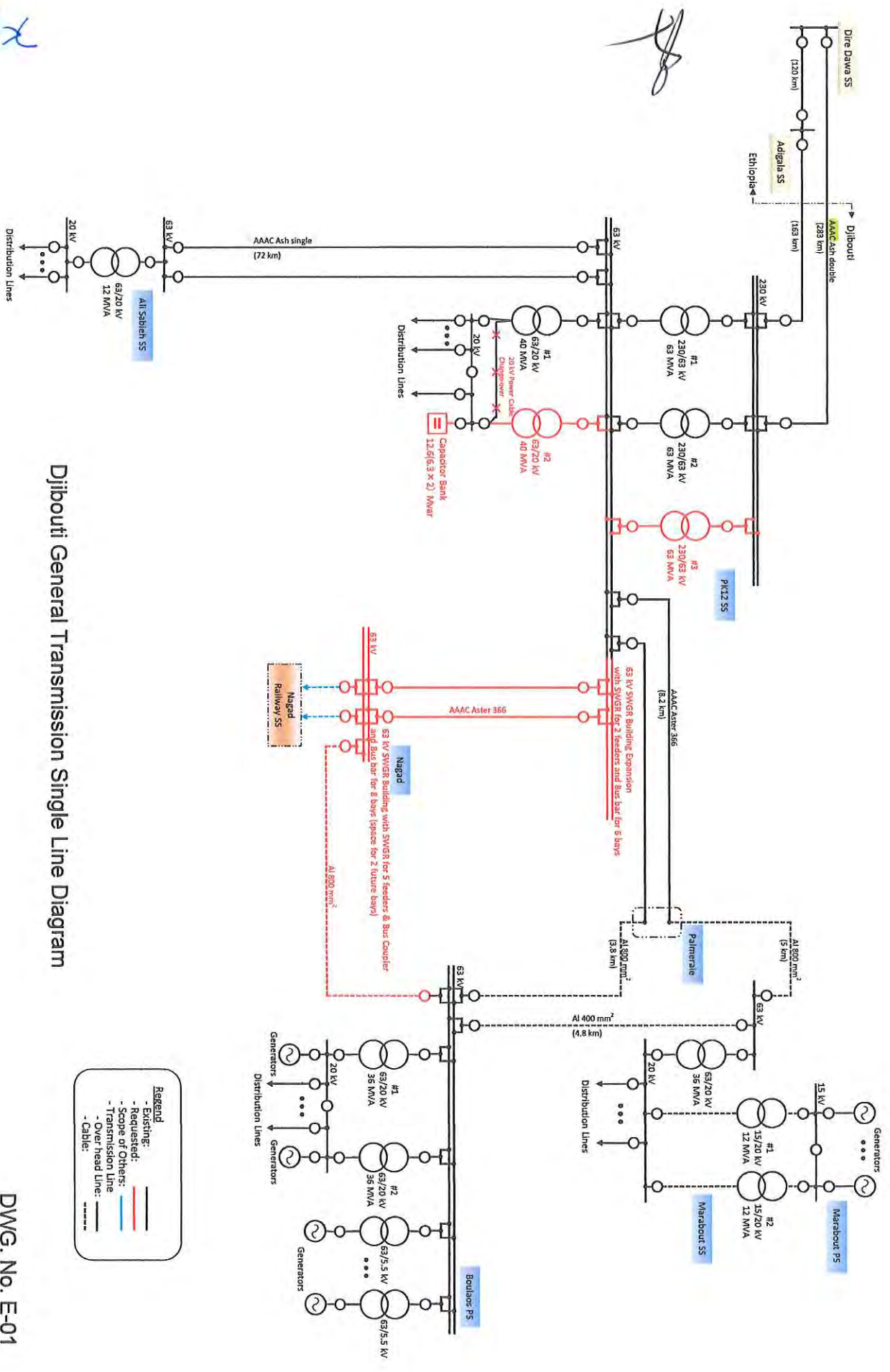
- T-1 63kV Self-Supporting lattice type steel towers with body and leg extensions (Tension Type)
- T-2 63kV Self-Supporting lattice type steel towers with body and leg extensions (Suspension Type)

- D-1 PK12 SITE PLAN
- D-2 PK12 SWITCHGEAR BUILDING PROFILE
- D-3 GROUND & FIRST FLOOR PLAN
- D-4 ROOF PLAN, SECTION
- D-5 ELEVATION, SECTION
- D-6 PK12 CONDENSER BUILDING PROFILE
- D-7 GROUND FL. & ROOF PLAN, ELEVATION, SECTION
- D-8 NAGAD SITE PLAN
- D-9 NAGAD SWITCHGEAR BUILDING PROFILE
- D-10 GROUND & FIRST FLOOR PLAN
- D-11 ROOF PLAN, SECTION
- D-12 ELEVATION, SECTION
- D-13 NAGAD CONTROL BUILDING PROFILE
- D-14 GROUND & ROOF PLAN
- D-15 ELEVATION, SECTION
- D-16 NAGAD GUARD HOUSE PROFILE
- D-17 GROUND FL. & ROOF PLAN, ELEVATION, SECTION



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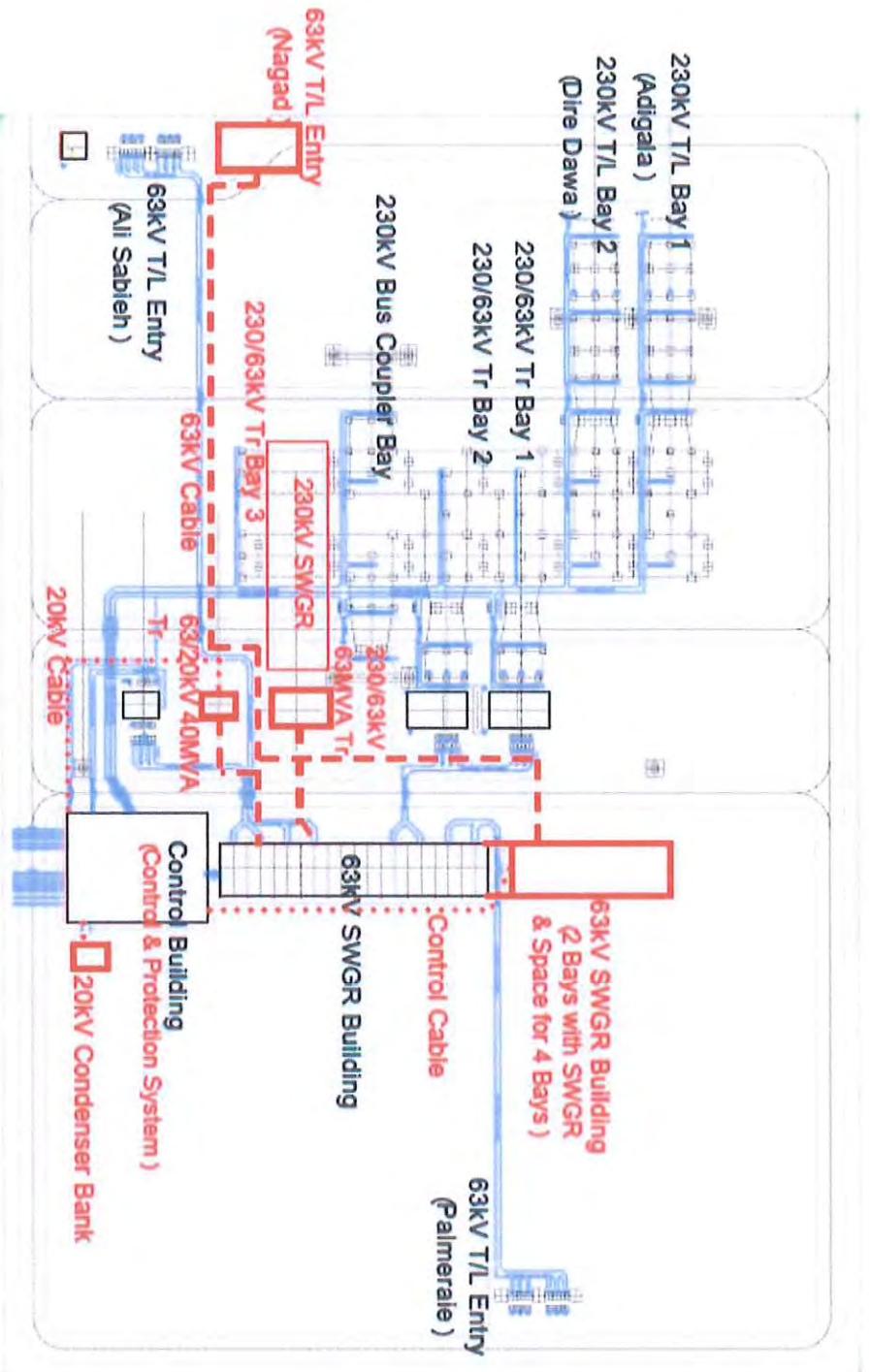
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Djibouti General Transmission Single Line Diagram

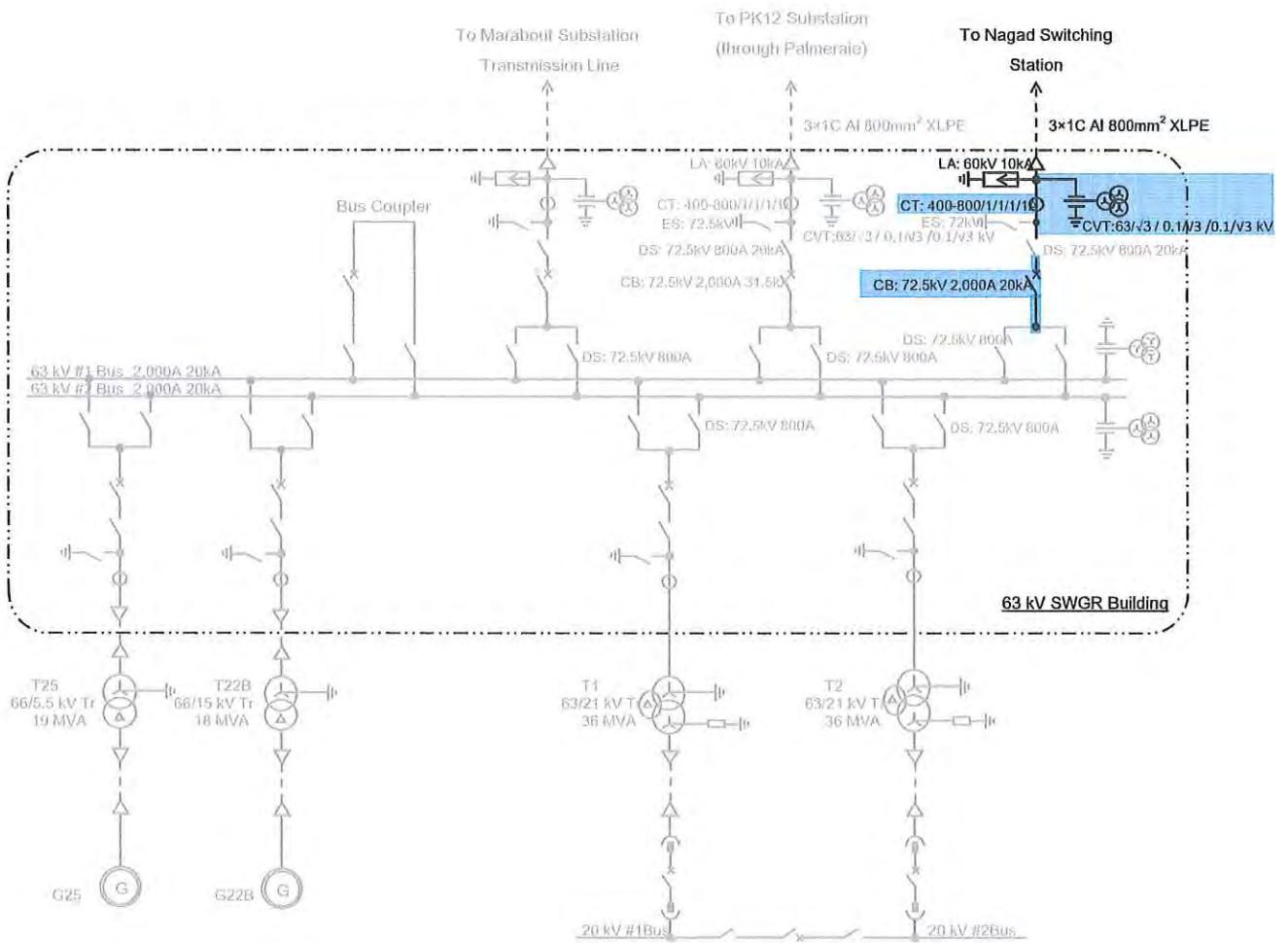
DWG. No. E-01

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PK12 Substation General Arrangement

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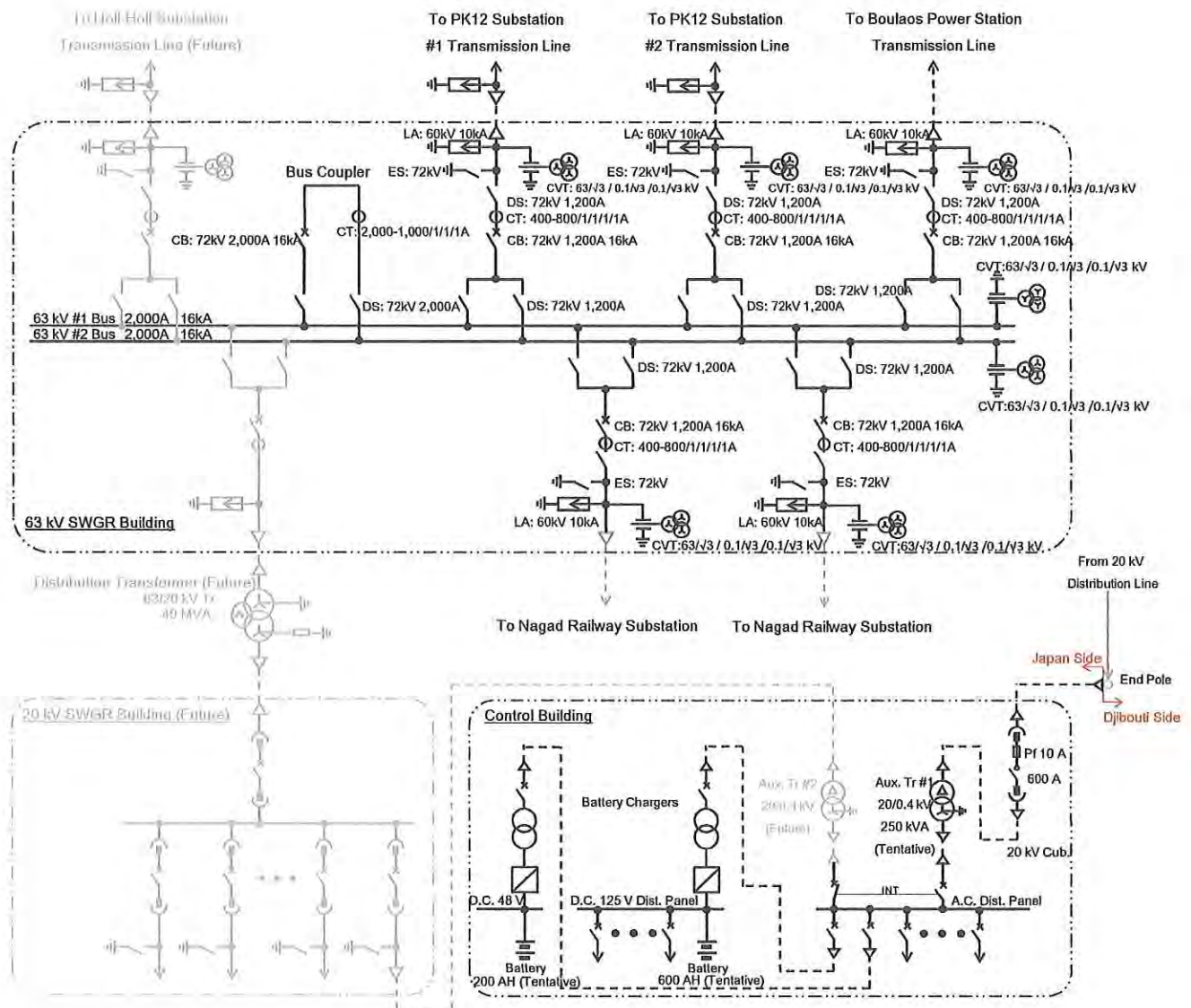
Note;
 1. The equipment marked with shall be replaced with new ones.
 CB: 72.5 kV, 2000 A, 31.5 kA
 VCT: 63/43 / 0.1/1/3 / 0.1/1/3 kV, 400-800/1/1/1 A
 Bus bars for new equipment connections: Al 80mm x 5mm or greater

Legend	
- Scope of works:	—
- Existing:	—
- Transmission Line	—
- Over head line :	—
- Under ground cable :	- - -
- Building inside:	⋮

Boulaos Power Station 63 kV Substation single Line Diagram

DWG. No. E-04

7/7



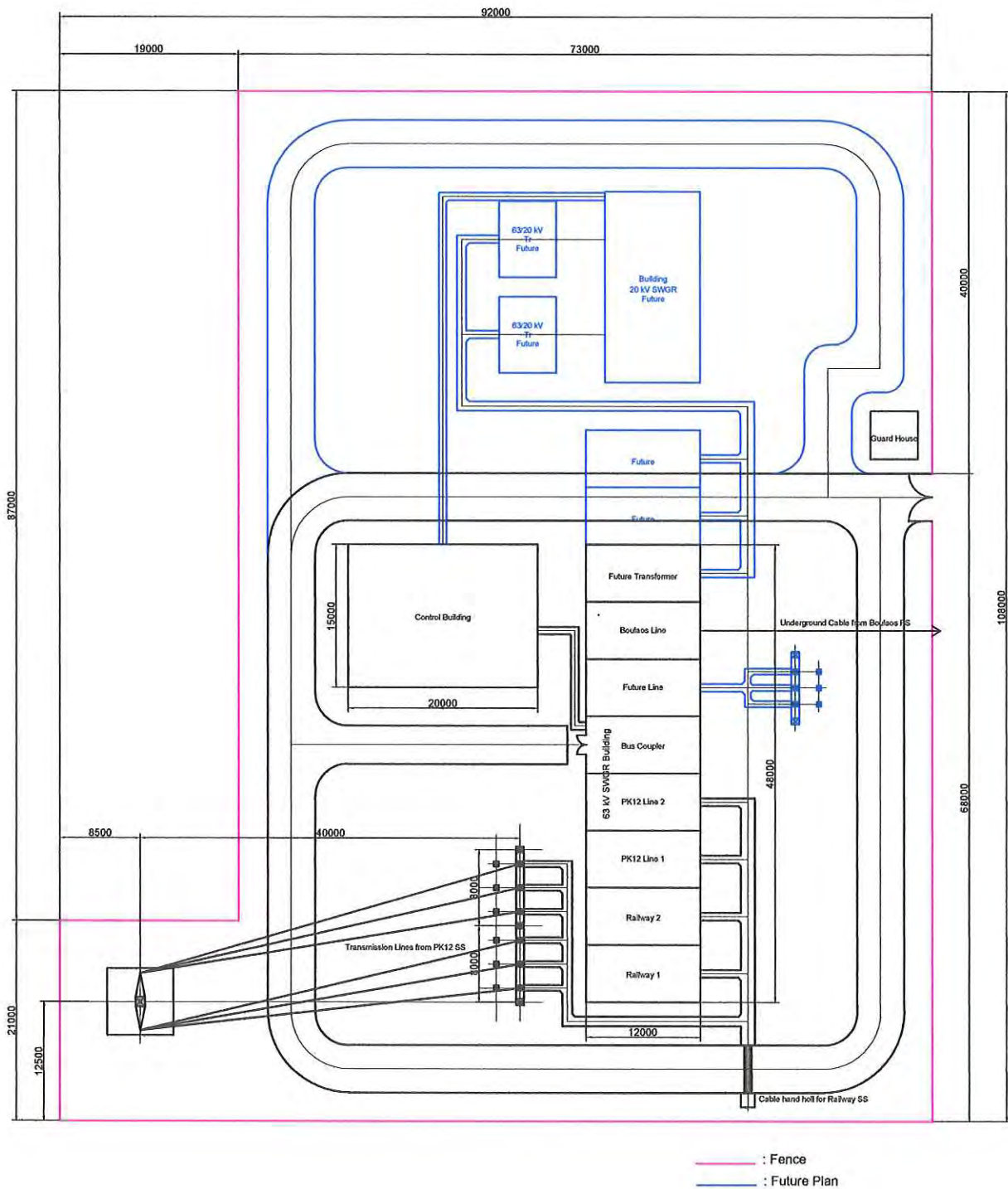
Note:
 1. The house service power will be received from 20 kV EdD Distribution Line.
 The installation of end pole adjacent to the fence of Nagad Switching Station and the preparation of 20 kV distribution lines to the end pole will be conducted by Djibouti side.

Legend

- Scope of works: ———
- Scope of Others (incl. future): - - - - -
- Transmission Line
 - Over head line : ———
 - Under ground cable : - - - - -
- Building inside: [Dashed Box]

Nagad Switching Station Single Line Diagram

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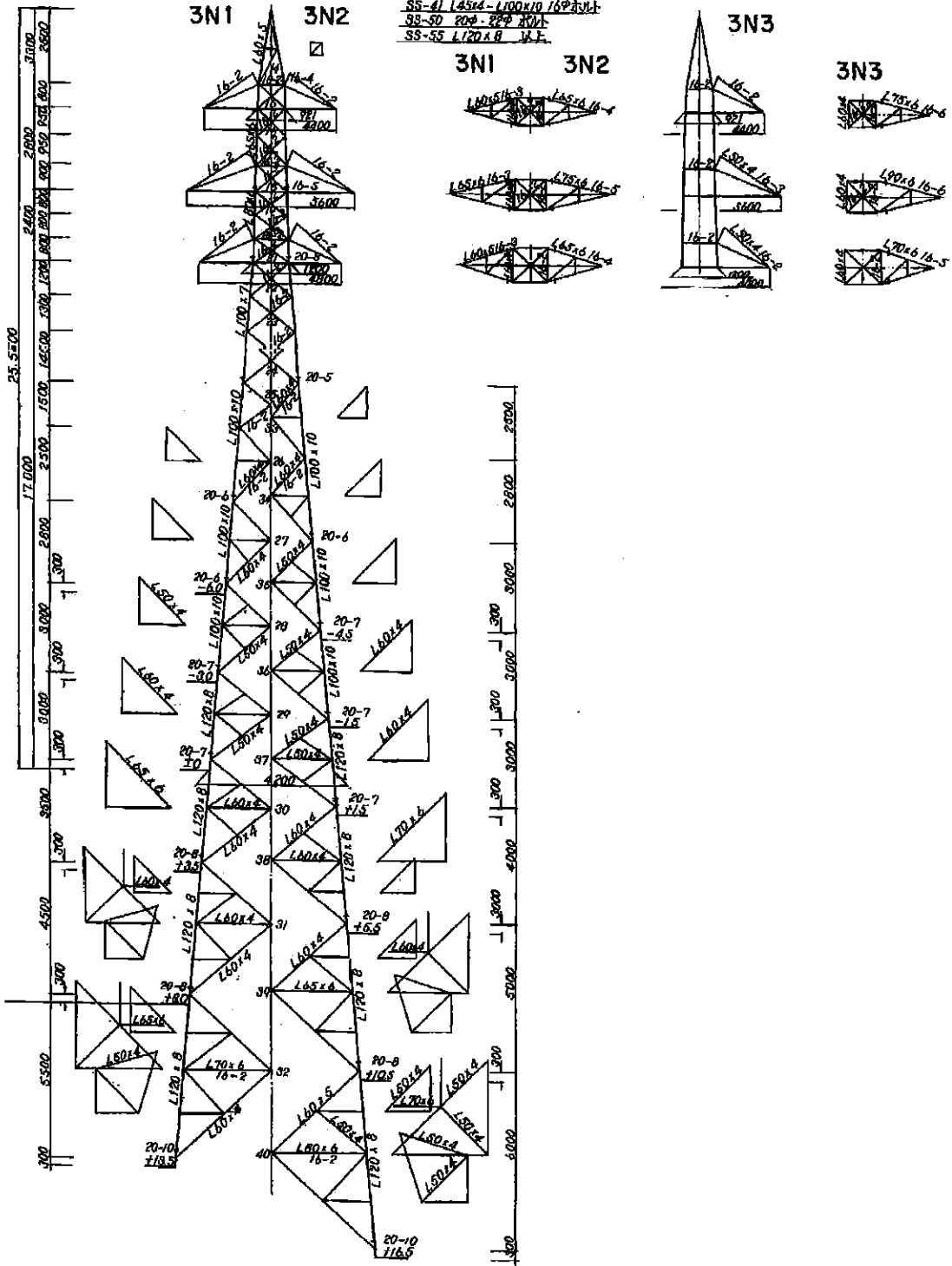
Nagad Switching Station General Arrangement

DWG. No. E-07

K7

3N1. 3N2. 3N3 型

- 注)
 1. 垂入鋼材 L45×4
 2. 垂入鋼材 16-1
 3. 鋼材
 SS-41 L45×4-L100×10 16φ鋼材
 SS-50 20φ-22φ鋼材
 SS-55 L120×8 16φ



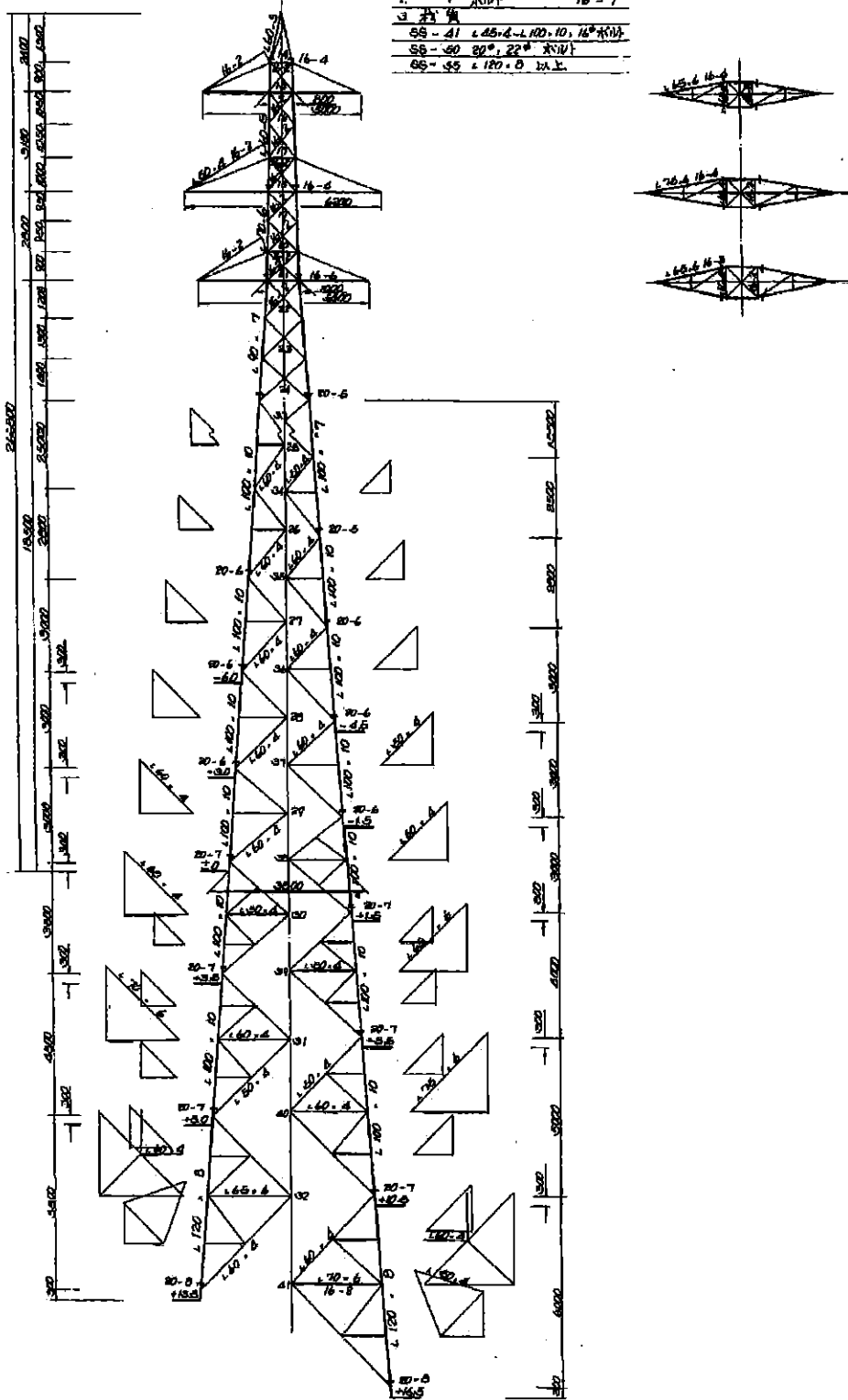
63kV Self-Supporting lattice type steel towers with body and leg extensions
 (Tension Type)

DWG. No. T-01

727

202 型

1. 無銘入部材	L45.4
2. 材種	16-1
3. 材寸	
SS-41 L45.4-L100.10, 16 [#] 木吊	
SS-50 32 [#] , 22 [#] 木吊	
GS-55 L100.0 以上	

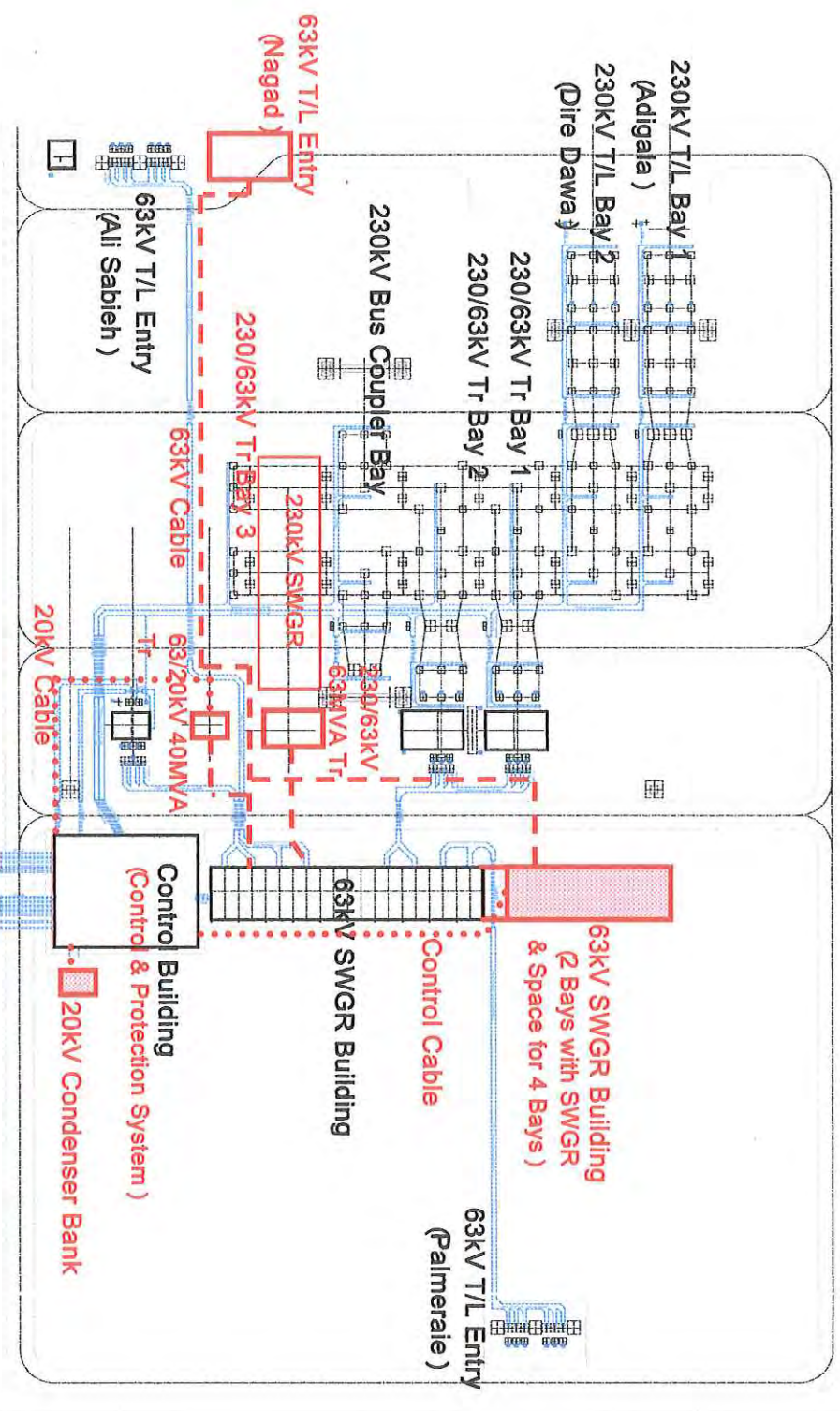


63kV Self-Supporting lattice type steel towers with body and leg extensions
(Suspension Type)

DWG. No. T - 02

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PK12 Substation Site Plan

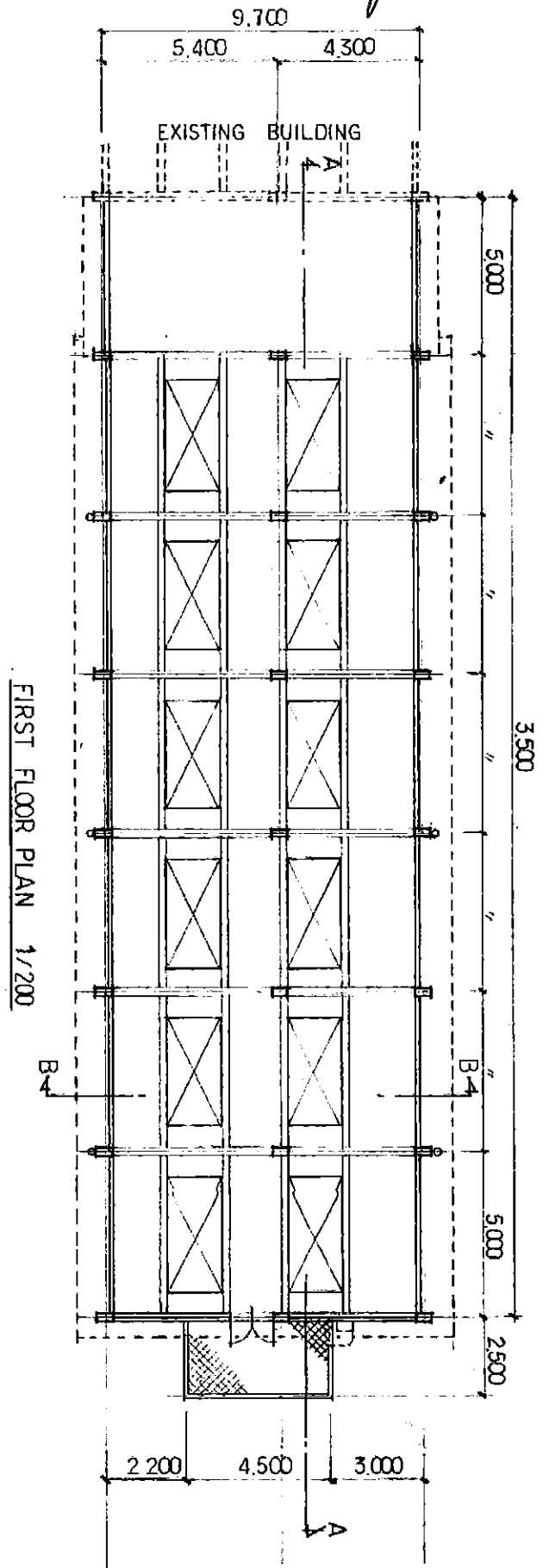
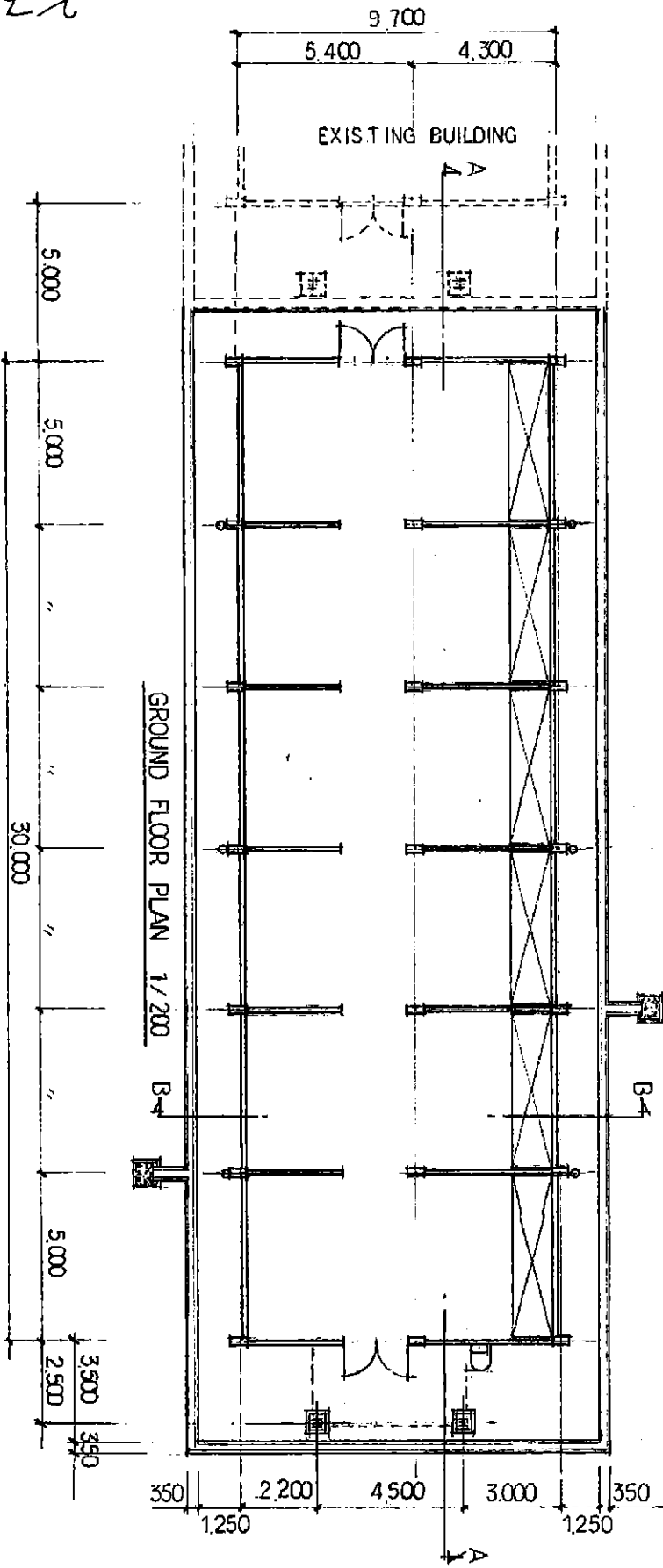
PK12 SWICTGEAR BUILDING PROFILE

1. STRUCTURE AND NUMBER OF STORY : REINFORCED CONCRETE STRUCTURE 2 STORY
2. FOUNDATION TYPE : SPREAD FOUNDATION
3. ALLOWABLE BEARING CAPACITY : 75 KN/m²
4. BUILDING FACILITY :
 ELECTRIC SERVICE : LIGHTING FIXTURE
 MECHANICAL SERVICE : ROOF DRAIN, DRAIGE DITCH

1. GENERAL	
BILDING AREA	339.50 m ²
TOTAL FLOOR AREA	630.50 m ²
FOUNDATION STRUCTURE	REINFORCED CONCRETE CONSTRUCTION
UPPER GROUND STRUCTURE	REINFORCED CONCRETE CONSTRUCTION
2. EXTERIOR FINISHING	
TOP ROOF	CONCRETE SLAB WATER-PROOF COATING
EXTERIOR WALL	CONCRETE BLOCK t-150 MORTAR TROWEL PAINTUNG FINISH (EP FOR EXTERNAL)
3. INTERIOR FINISHING	
ITEM (G AND 1 ST . FLOOR)	FINISHING / SPECIFICATION
FLOOR	CEMENT TROWELLING
WALL	EP PAINTING FINISH ON MORTAR
CEILING	EP PAINTING FINISH

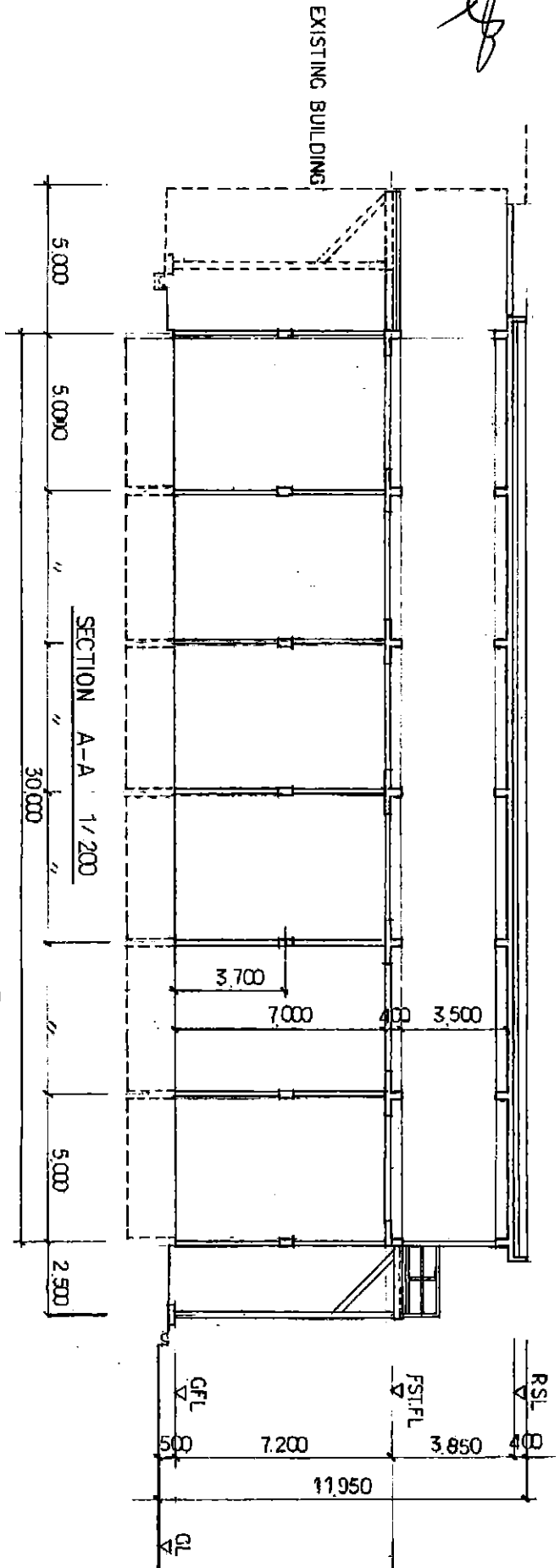
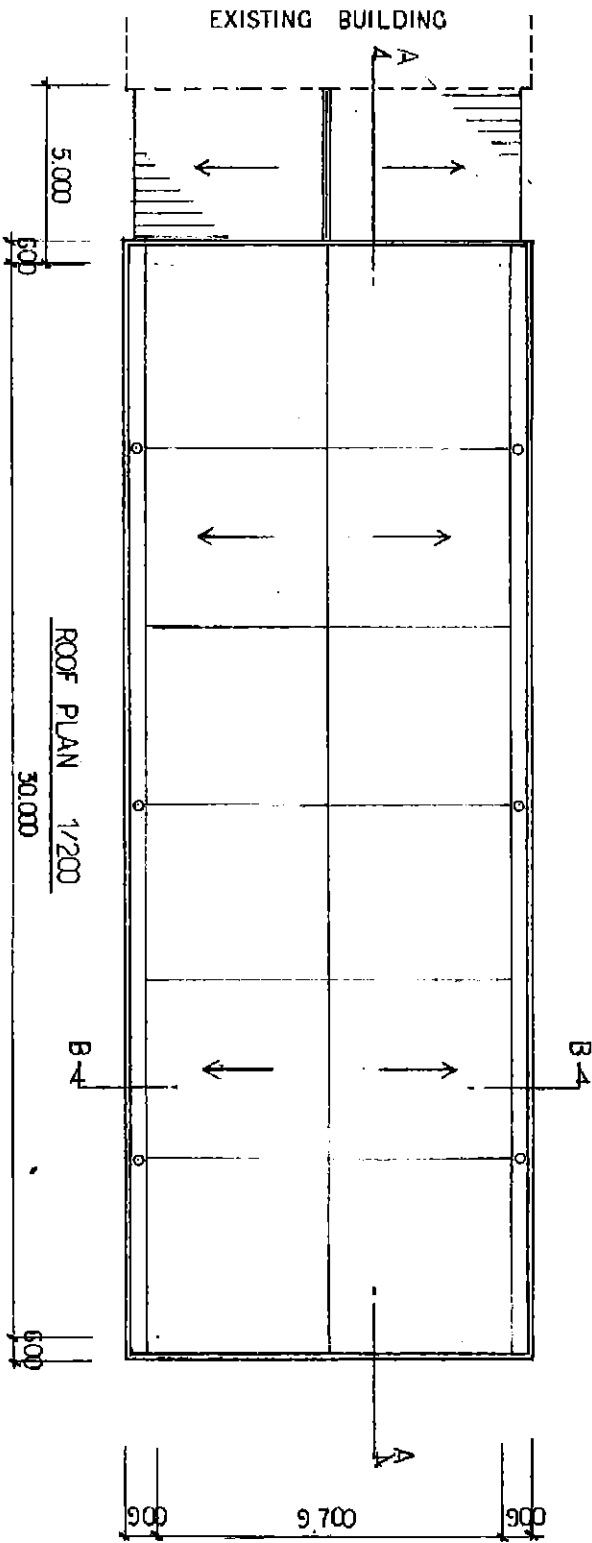
K7

4x



PK12 SWITCHGEAR BUILDING

42

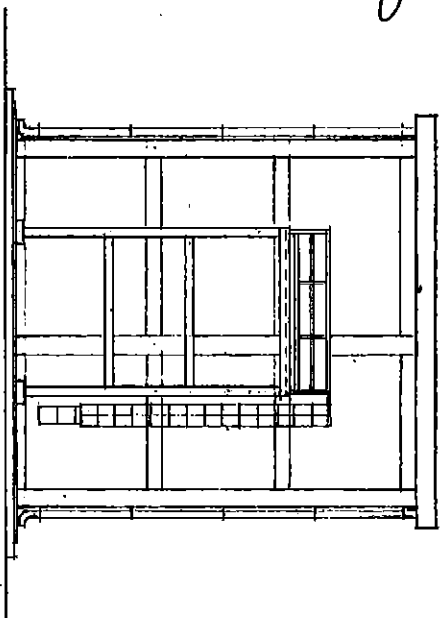


PK12 SWITCHGEAR BUILDING

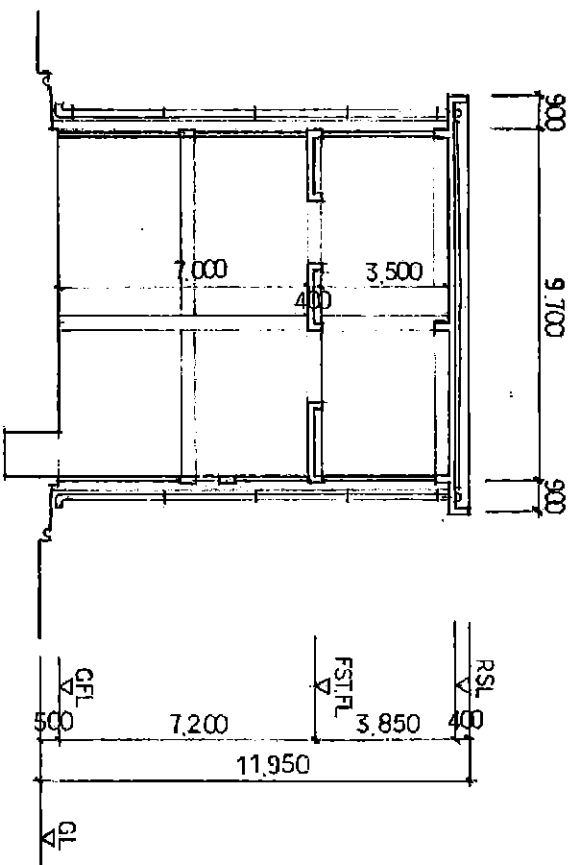
D-4

4x6

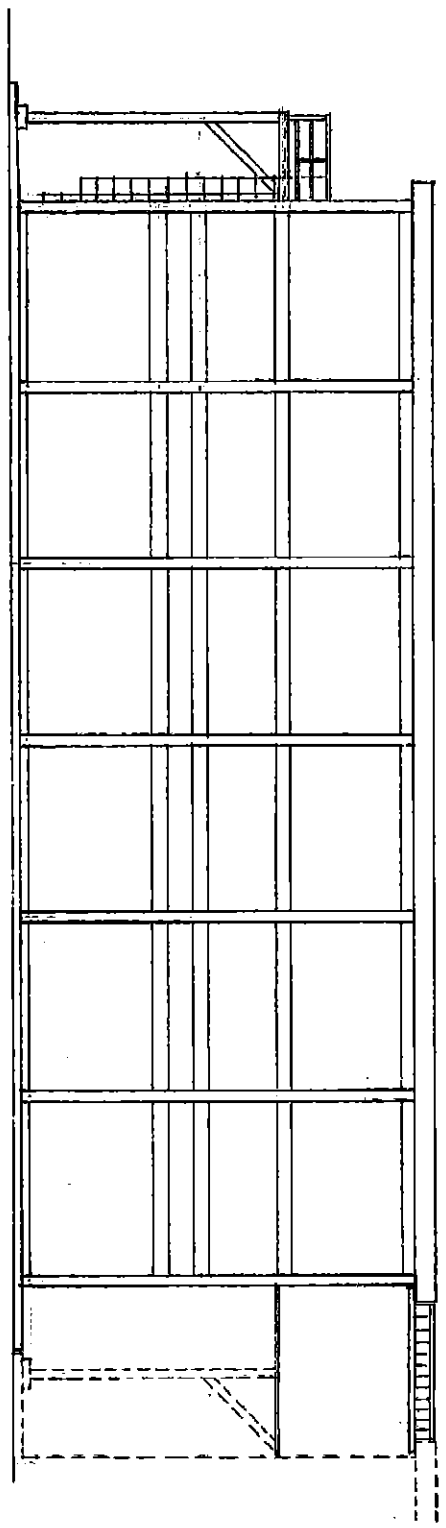
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NORTHSIDE ELEVATION 1/200



SECTION B-B 1/200



WEST SIDE ELEVATION 1/200

PK12 SWITCHGEAR BUILDING

D-5

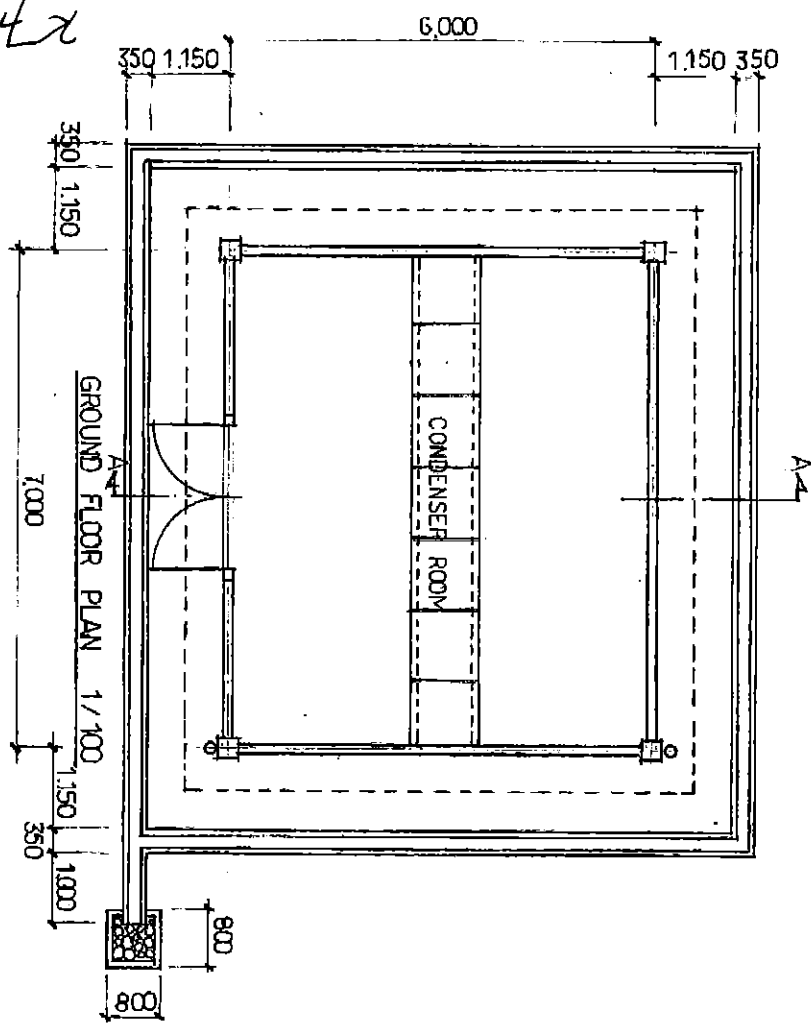
PK12 CONDENSER BUILDING PROFILE

1. STRUCTURE AND NUMBER OF STORY : REINFORCED CONCRETE STRUCTURE 1 STORY
2. FOUNDATION TYPE : SPREAD FOUNDATION
3. ALLOWABLE BEARING CAPACITY : 75 KN/m²
4. BUILDING FACILITY :
 - ELECTRIC SERVICE : LIGHTING FIXTURE
 - MECHANICAL SERVICE : ROOF DRAIN, DRAIGE DITCH

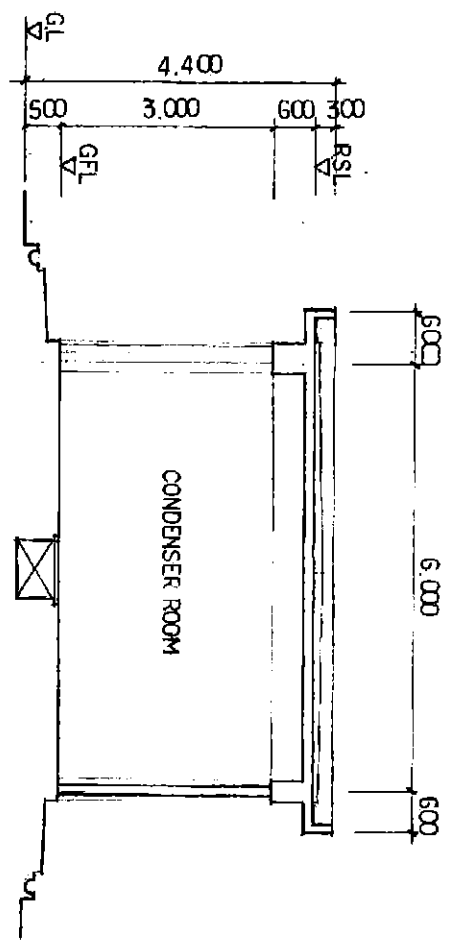
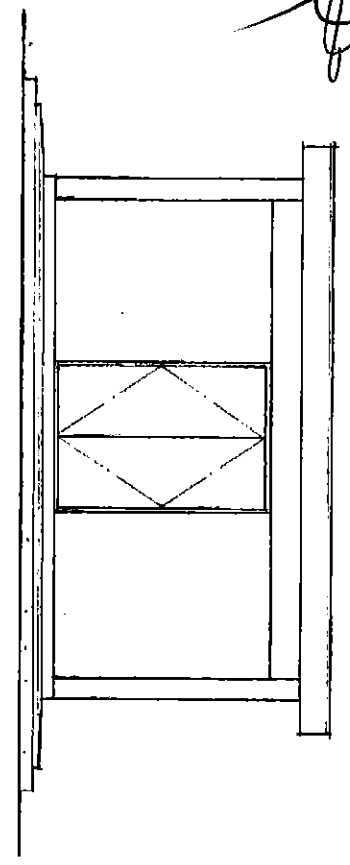
1. GENERAL	
BILDING AREA	42.00 m ²
TOTAL FLOOR AREA	42.00 m ²
FOUNDATION STRUCTURE	REINFORCED CONCRETE CONSTRUCTION
UPPER GROUND STRUCTURE	REINFORCED CONCRETE CONSTRUCTION
2. EXTERIOR FINISHING	
TOP ROOF	CONCRETE SLAB WATER-PROOF COATING
EXTERIOR WALL	CONCRETE BLOCK t-150 MORTAR TROWEL PAINTUNG FINISH (EP FOR EXTERNAL)
3. INTERIOR FINISHING	
ITEM	FINISHING / SPECIFICATION
FLOOR	CEMENT TROWELLING
WALL	EP PAINTING FINISH ON MORTAR
CEILING	EP PAINTING FINISH

7<7

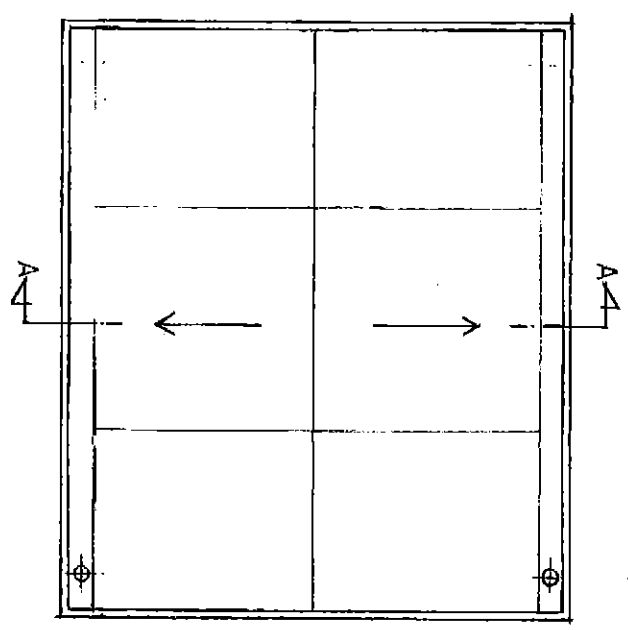
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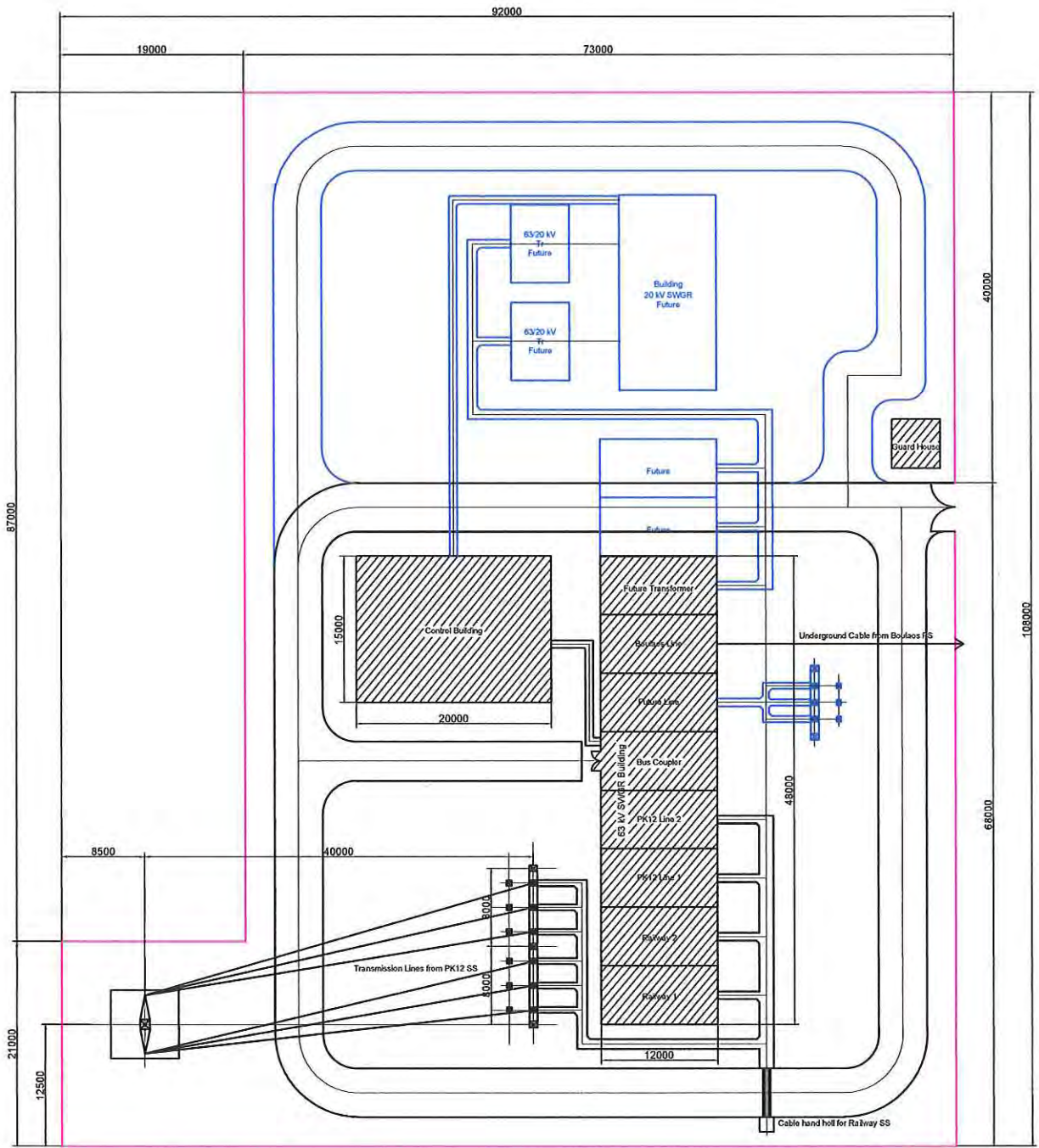
SOUTHSIDE ELEVATION 1/100



ROOF PLAN 1/100



PIK12 CONDENSER BUILDING



Nagad Switching Station Site Plan

27
 DWG. No. D-08

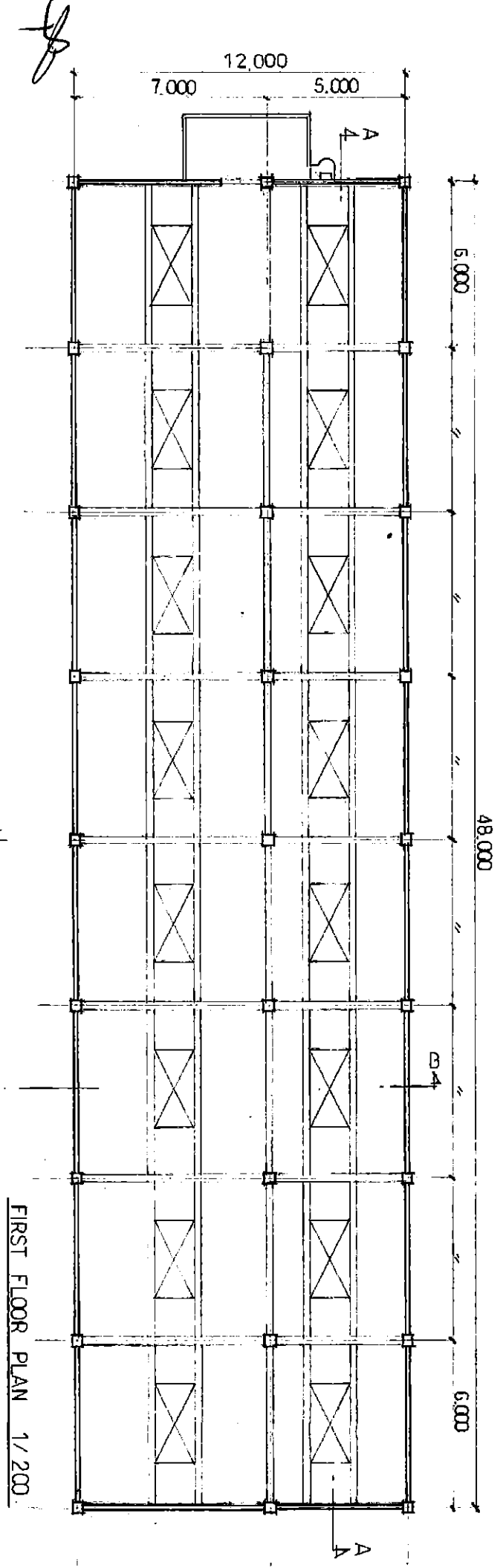
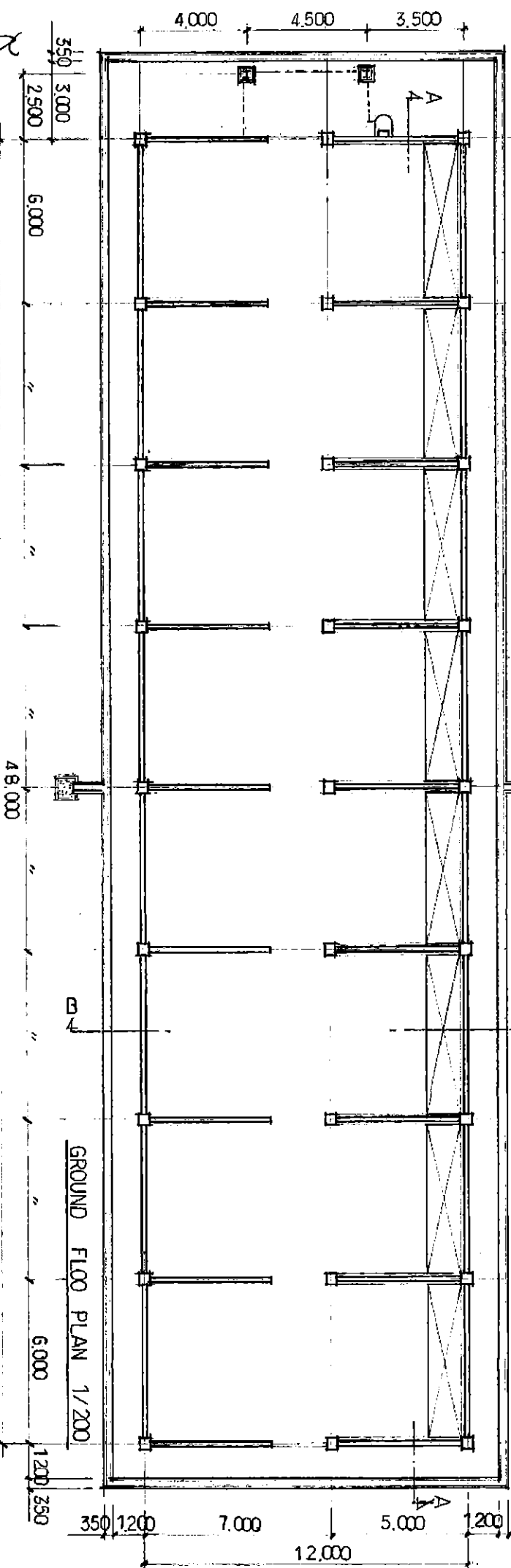
NAGAD SWITCHGEAR BUILDING PROFILE

1. STRUCTURE AND NUMBER OF STORY : REINFORCED CONCRETE STRUCTURE 2 STORY
2. FOUNDATION TYPE : SPREAD FOUNDATION
3. ALLOWABLE BEARING CAPACITY : 75 KN/m²
4. BUILDING FACILITY :
 - ELECTRIC SERVICE : LIGHTING FIXTURE
 - MECHANICAL SERVICE : ROOF DRAIN, DRAIGE DITCH

1. GENERAL	
BILDING AREA	576.00 m ²
TOTAL FLOOR AREA	1,152.00 m ²
FOUNDATION STRUCTURE	REINFORCED CONCRETE CONSTRUCTION
UPPER GROUND STRUCTURE	REINFORCED CONCRETE CONSTRUCTION
2. EXTERIOR FINISHING	
TOP ROOF	CONCRETE SLAB WATER-PROOF COATING
EXTERIOR WALL	CONCRETE BLOCK 1-150 MORTAR TROWEL PAINTUNG FINISH (EP FOR EXTERNAL)
3. INTERIOR FINISHING	
ITEM (G. AND 1 ST . FLOOR)	FINISHING / SPECIFICATION
FLOOR	CEMENT TROWELLING
WALL	EP PAINTING FINISH ON MORTAR
CEILING	EP PAINTING FINISH

77

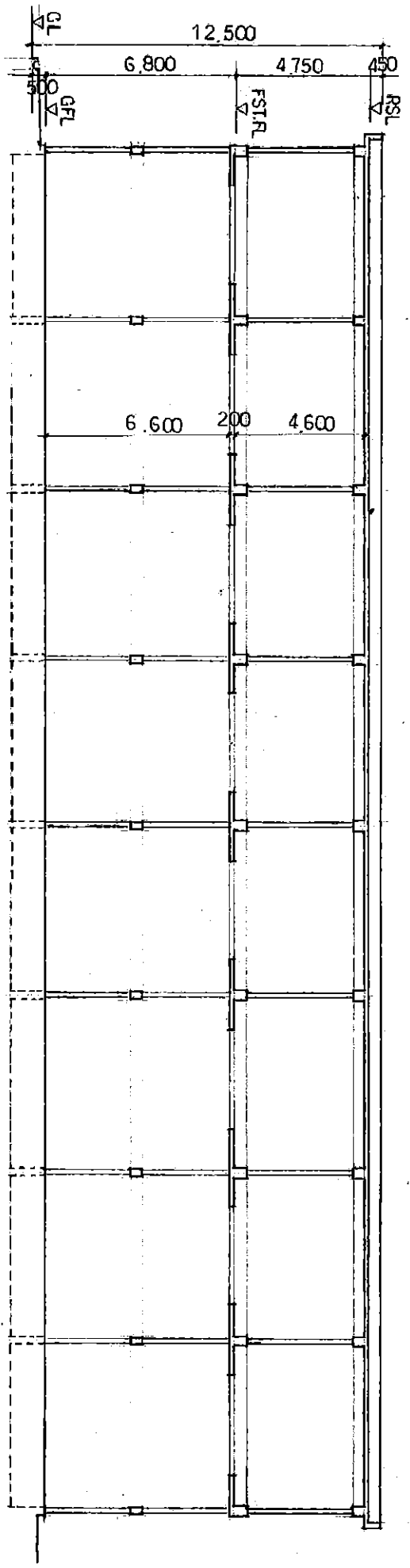
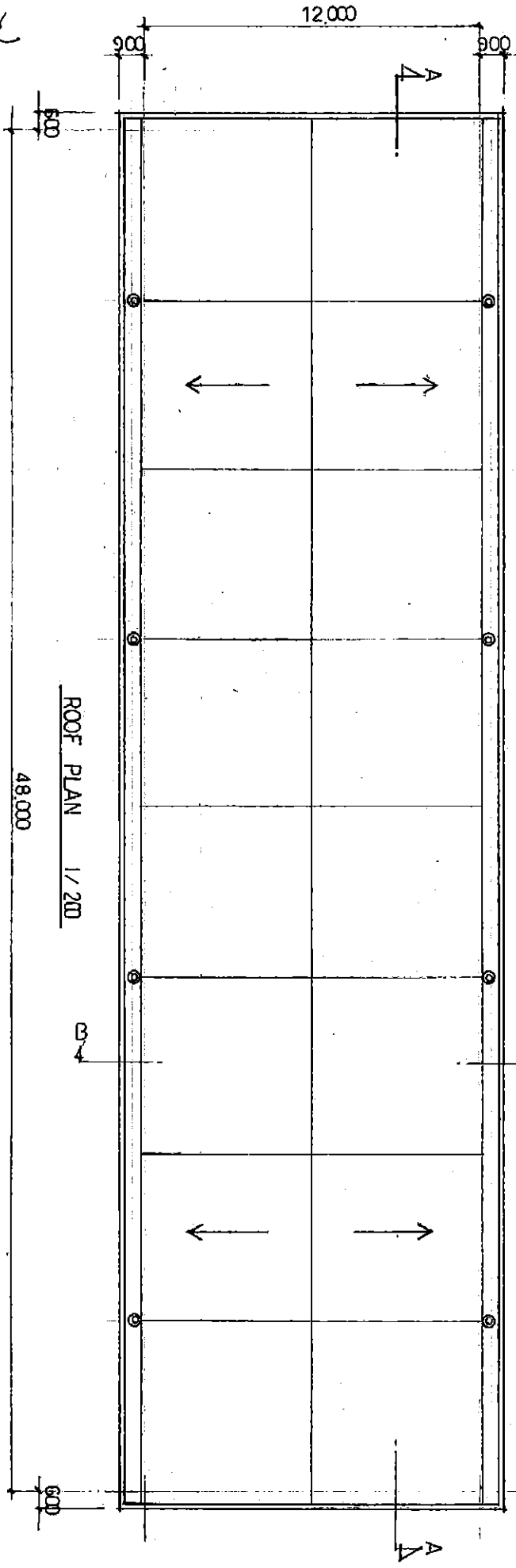
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NAGAD SWITCHGEAR BUILDING

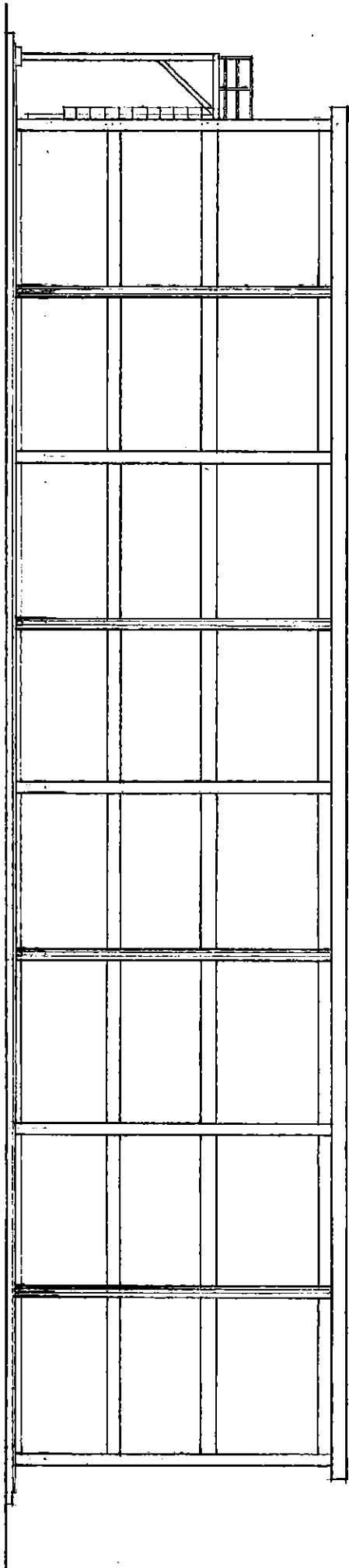
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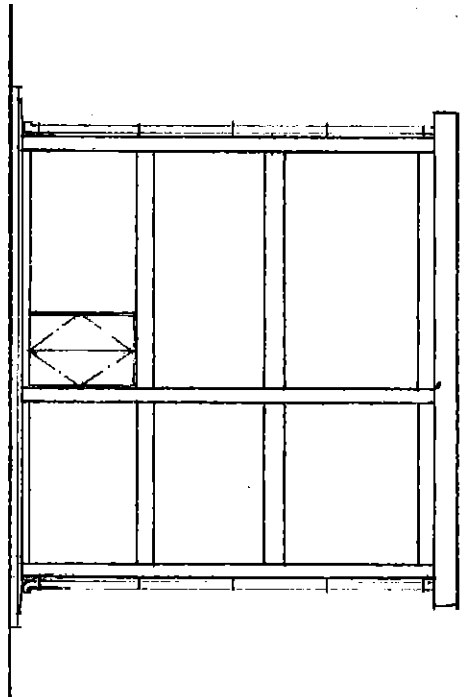


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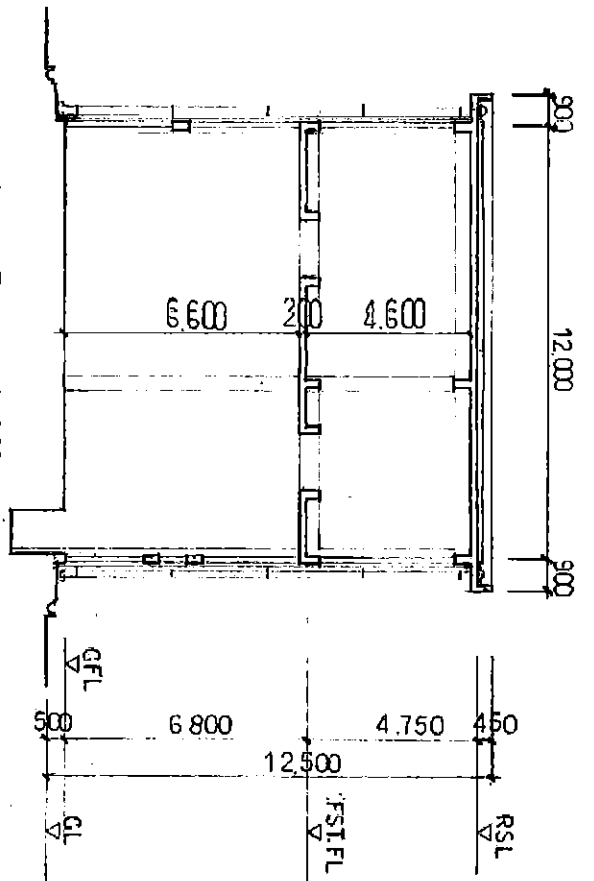
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EAST SIDE ELEVATION 1/200



SOUTHSIDE ELEVATION 1/200



B-B SECTION 1/200

NAGAD CONTROL BUILDING PROFILE

1. STRUCTURE AND NUMBER OF STORY : REINFORCED CONCRETE STRUCTURE 1 STORY
2. FOUNDATION TYPE : SPREAD FOUNDATION
3. ALLOWABLE BEARING CAPACITY : 75 KN/m²
4. BUILDING FACILITY :
 ELECTRIC SERVICE : LIGHTING FIXTURE
 MECHANICAL SERVICE : ROOF DRAIN, DRAINAGE DITCH, PLUMBING, VENTILATION AND AIRCONDITIONING SYSTEM

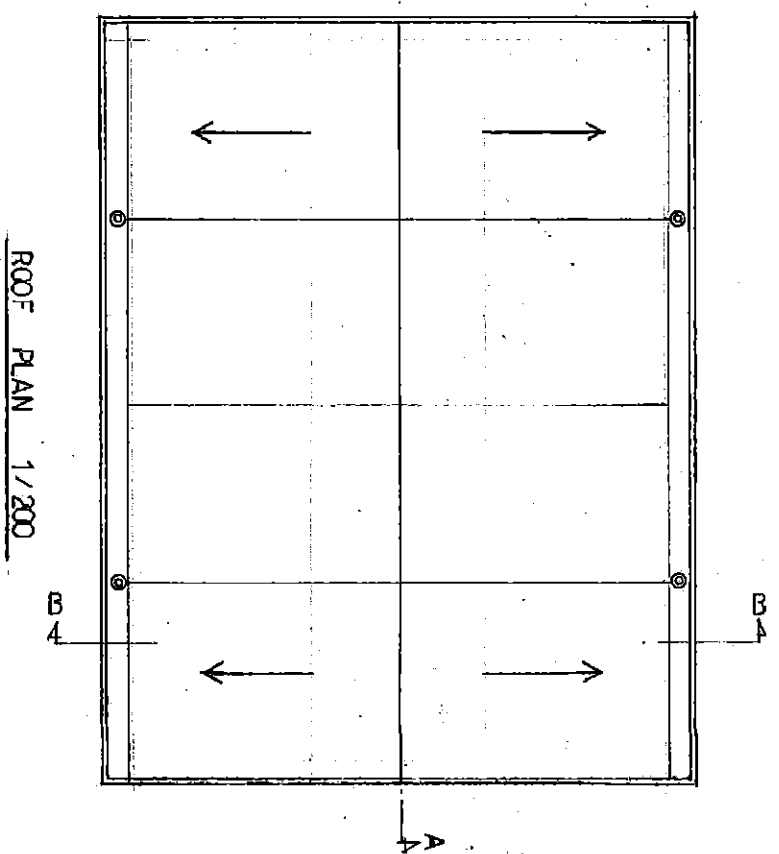
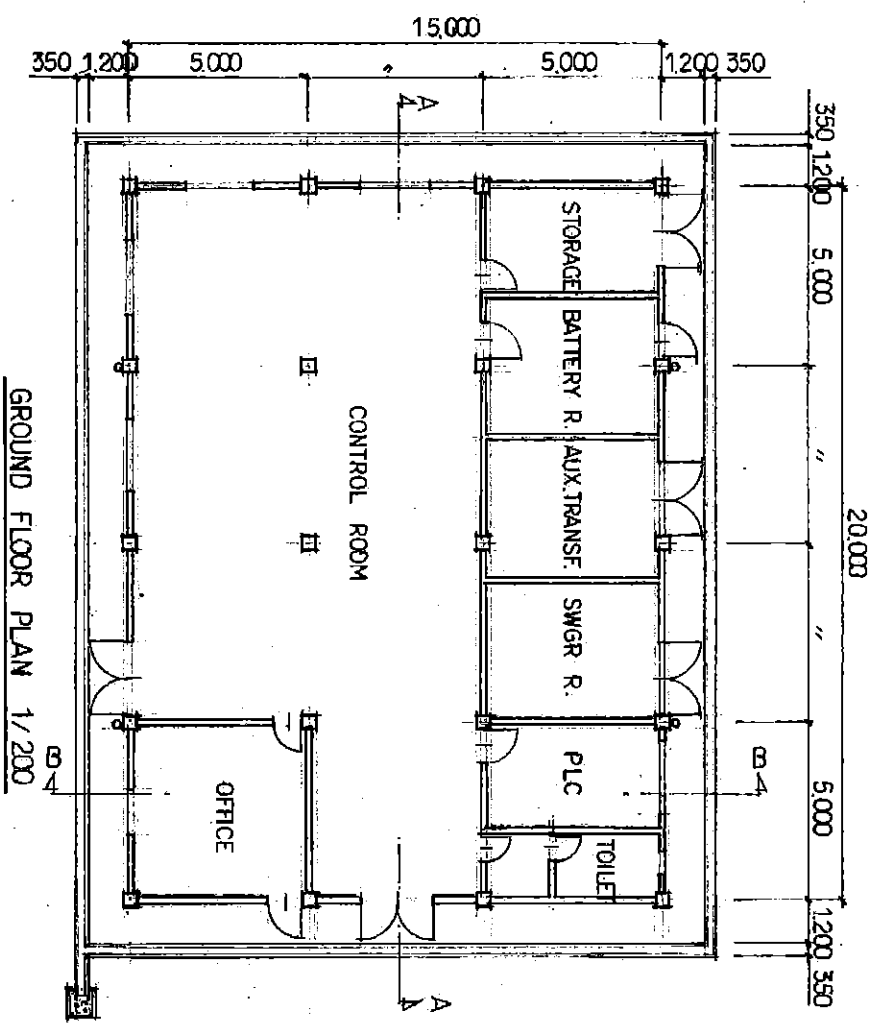
1. GENERAL	
BILDING AREA	300.00 m ²
TOTAL FLOOR AREA	300.00 m ²
FOUNDATION STRUCTURE	REINFORCED CONCRETE CONSTRUCTION
UPPER GROUND STRUCTURE	REINFORCED CONCRETE CONSTRUCTION
2. EXTERIOR FINISHING	
TOP ROOF	CONCRETE SLAB WATER-PROOF COATING
EXTERIOR WALL	CONCRETE BLOCK t-150 MORTAR TROWEL PAINTUNG FINISH (EP FOR EXTERNAL)
3. INTERIOR FINISHING	
ITEM	FINISHING / SPECIFICATION
FLOOR	CEMENT TROWELLING, TERRAZZO TILE (TOILET)
WALL	EP PAINTING FINISH ON MORTAR, CERAMIC TILE (TOILET)
CEILING	EP PAINTING FINISH



27

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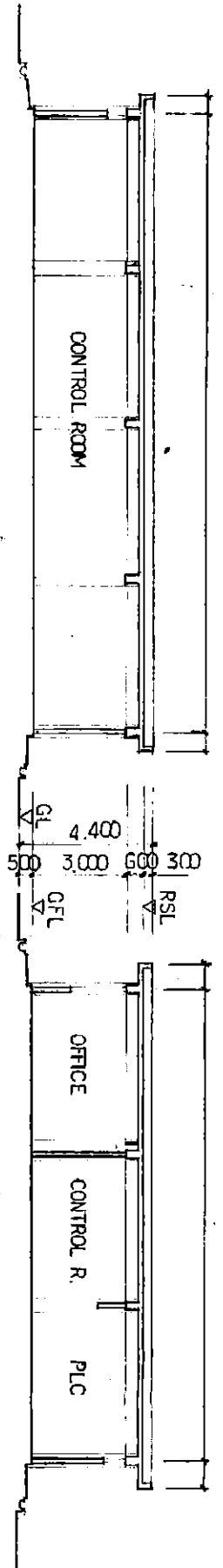
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NAGAD CONTROL BUILDING

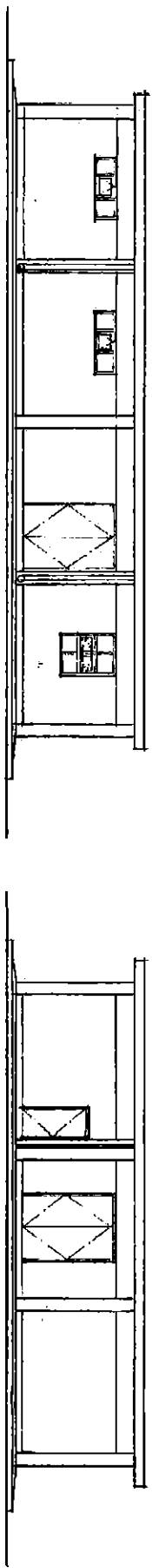
D-14

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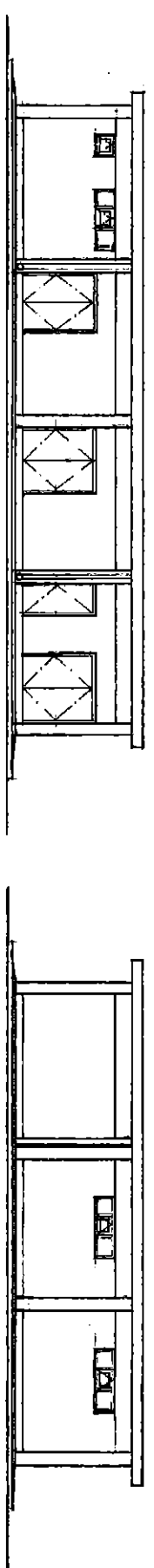
SECTION A-A 1/200

SECTION B-B 1/200



SOUTH SIDE ELEVATION 1/200

EAST SIDE ELEVATION 1/200



NORTH SIDE ELEVATION 1/200

WEST SIDE ELEVATION 1/200

4x

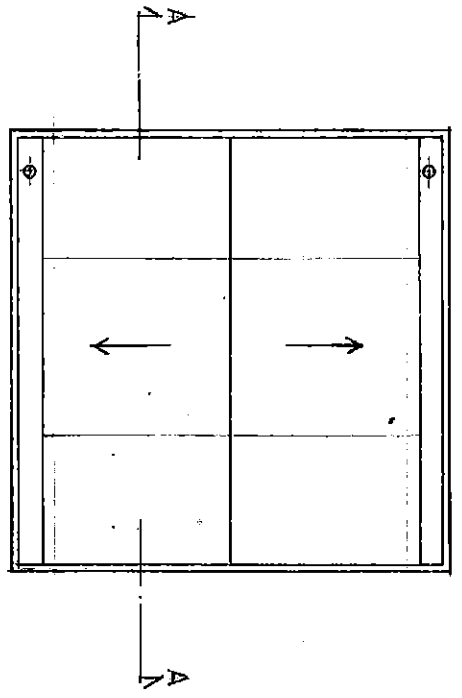
NAGAD GUARD HOUSE PROFILE

1. STRUCTURE AND NUMBER OF STORY : REINFORCED CONCRETE STRUCTURE 1 STORY
2. FOUNDATION TYPE : SPREAD FOUNDATION
3. ALLOWABLE BEARING CAPACITY : 75 KN/m²
4. BUILDING FACILITY :
 ELECTRIC SERVICE : LIGHTING FIXTURE
 MECHANICAL SERVICE : ROOF DRAIN, DRAIGE DITCH, PLUMBING, VENTILATION AND AIRCONDITIONING SYSTEM

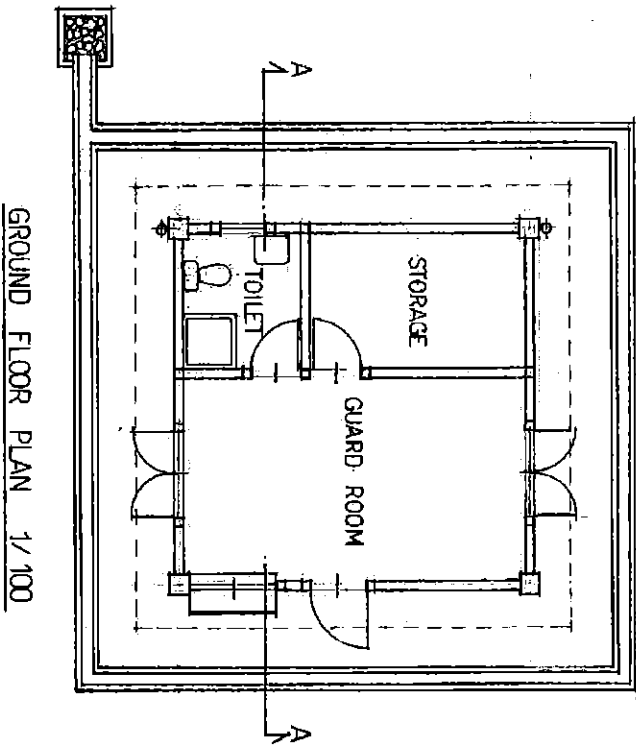
1. GENERAL	
BILDING AREA	25.00 m ²
TOTAL FLOOR AREA	25.00 m ²
FOUNDATION STRUCTURE	REINFORCED CONCRETE CONSTRUCTION
UPPER GROUND STRUCTURE	REINFORCED CONCRETE CONSTRUCTION
2. EXTERIOR FINISHING	
TOP ROOF	CONCRETE SLAB WATER-PROOF COATING
EXTERIOR WALL	CONCRETE BLOCK t-150 MORTAR TROWEL PAINTUNG FINISH (EP FOR EXTERNAL)
3. INTERIOR FINISHING	
ITEM (G AND 1 ST . FLOOR)	FINISHING / SPECIFICATION
FLOOR	CEMENT TROWELLING, TERRAZZO TILE (TOILET)
WALL	EP PAINTING FINISH ON MORTAR, CERAMIC TILE (TOILET)
CEILING	EP PAINTING FINISH

27

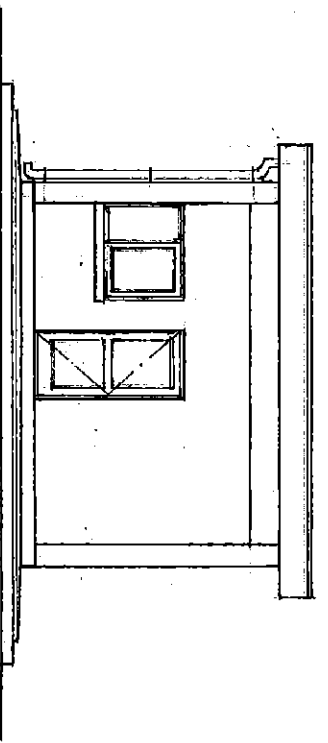
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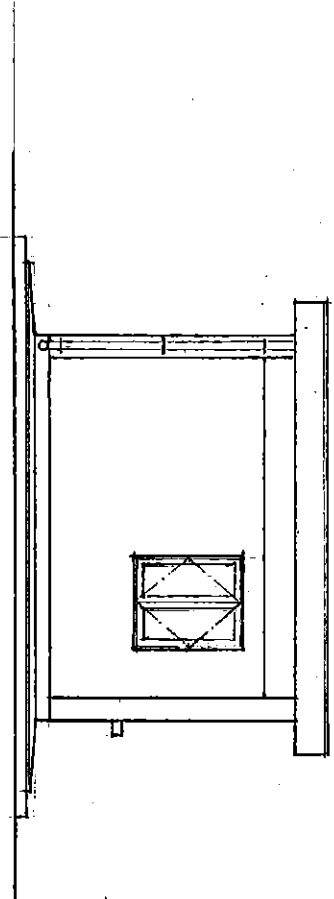
ROOF PLAN 1/100



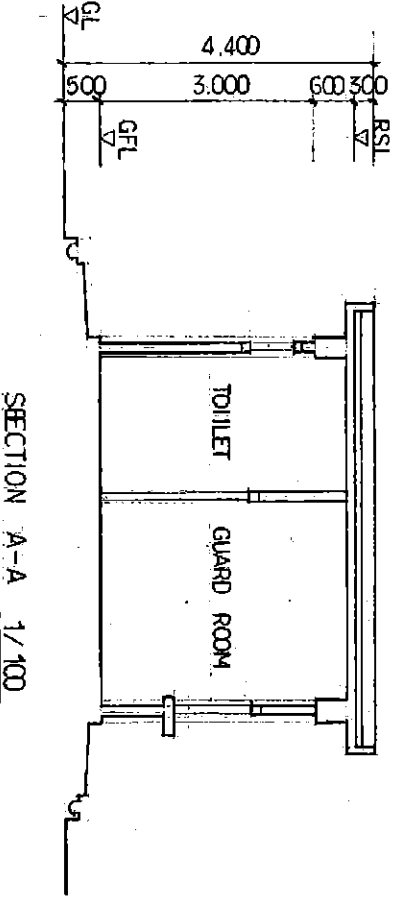
GROUND FLOOR PLAN 1/100



EAST SIDE ELEVATION 1/100



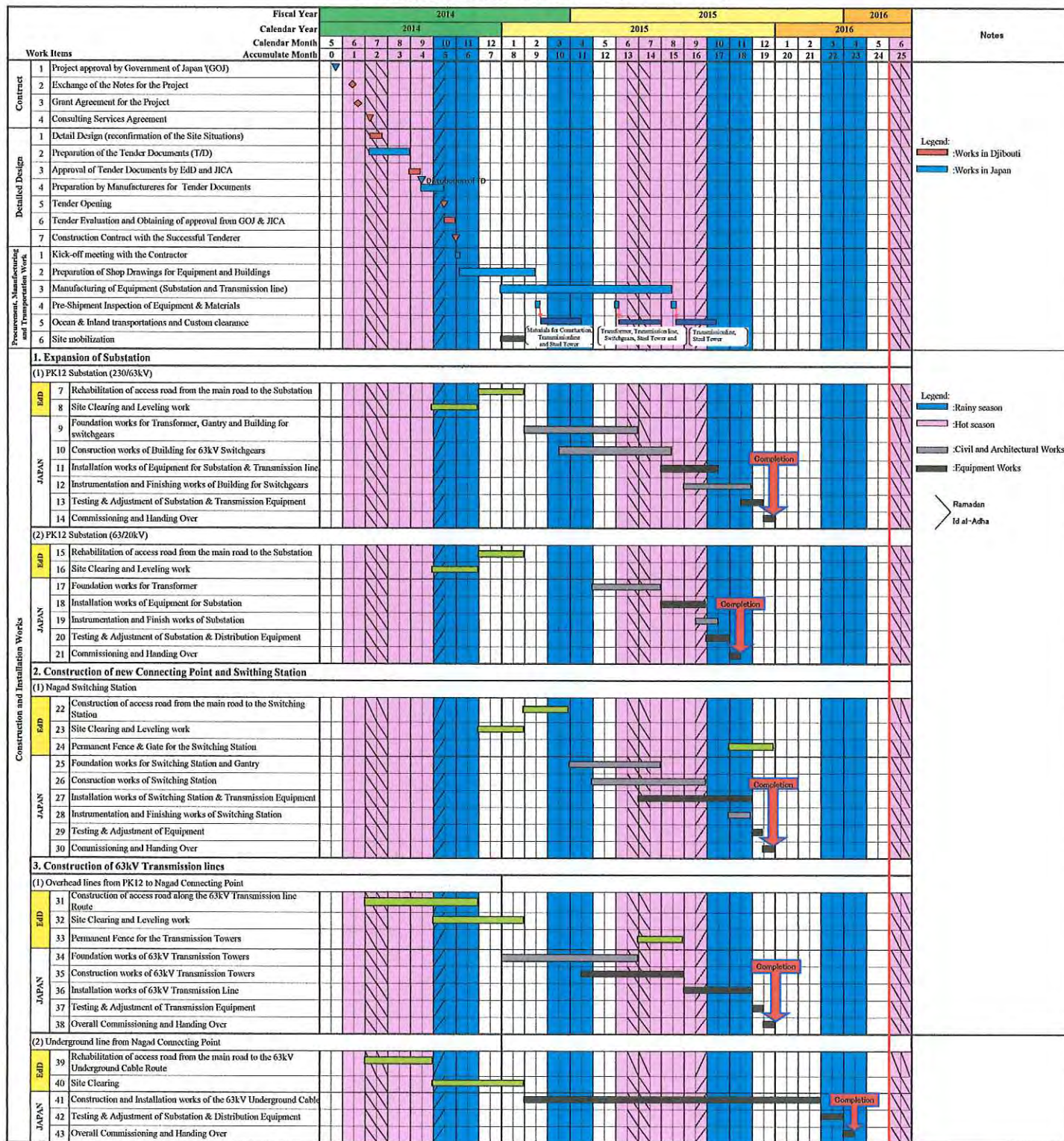
SOUTH SIDE ELEVATION 1/100



SECTION A-A 1/100

4x

Implementation Schedule (Tentative)



Legend:
█ :Works in Djibouti
█ :Works in Japan

Legend:
█ :Rainy season
█ :Hot season
█ :Civil and Architectural Works
█ :Equipment Works
 :Ramadan
 :Id al-Adha

277

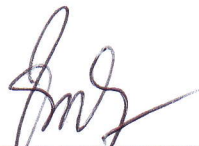
**TECHNICAL MEMORANDUM
FOR
THE 3rd PREPARATORY SURVEY
ON
THE PROJECT FOR IMPROVEMENT OF POWER SUPPLY
IN
THE REPUBLIC OF DJIBOUTI**

**AGREED UPON BETWEEN
ELECTRICITE DE DJIBOUTI (EdD)
AND
JICA PREPARATORY SURVEY TEAM**

Djibouti, 3rd April 2014



Mr. Kyoji FUJII
Chief Consultant
JICA Preparatory Survey Team
Yachiyo Engineering Co., Ltd.



Mr. Ismael DIALLO
Director of Interconnection Project
Electricite de Djibouti



Electricite du Djibouti (hereinafter referred to as "EdD") and JICA Preparatory Survey Team for the Project for Improvement of Power Supply in the Republic of Djibouti (hereinafter referred to as "the Team") had series of technical discussion to form a mutual understanding on the scope of the Project, priority order and technical specifications of project components and items to be undertaken by each party. Both parties agreed to record the following points as a conclusion of the discussions.

1. Final priority order for Components of the Project

The Team explained to EdD that some components must be dropped from the scope of the project due to the limitation of the budget allocated from the government of Japan. Firstly, both sides agreed to drop 63/20kV transformer and 20kV capacitor banks at Jaban As substation in accordance with the priority order agreed on the 2nd Technical Memorandum. Still, the project cost largely overruns the budget. Then EdD offered to drop Nagad switching station because railway project requires 132kV power supply and 63kV is not necessary for it. Finally, both sides agreed on the final priority order for components of the Project as described in Table 1.

EdD strongly requested the Team to include components 1.(1) ①②③, 1.(2) and 2.(1) in the Project. EdD mentioned that if the final cost of the project components overruns the ceiling of the budget, EdD will bear the balance to supplement the project cost.

Table 1 Final priority order for components of the Project

Item	Candidate Components agreed on 2 nd Technical Memorandum (5 th November 2013)	Final priority order for components agreed on 3 rd Technical Memorandum (3 rd April 2014)
1. 63kV transmission line between Jaban As and Boulaos via Nagad	(1) 63kV Overhead Transmission Line from Jaban As substation to – Nagad switching station ● Length: 11.3km, double circuits	[Priority 1] (1) 63kV Overhead Transmission Line (Total length: 15km) ① From Jaban As substation to Nagad substation site ● Length: 11.1km, double circuits ② From Nagad substation site to Nagad connection point ● Length: 3.9km, single circuit ③ Nagad connection point
	(2) 63kV Underground Transmission Line from Nagad switching station to Boulaos substation ● Length: 7.5km, single circuit	[Priority 1] (2) 63kV Underground Transmission Line from Nagad connection point to Boulaos substation ● Length: 7.8km, single circuit
2. Expansion of Jaban As (PK12) substation	(1) Expansion of Jaban As substation (230/63kV side) ● 230/63kV, 63MVAx1unit	[Priority 2] Same as left

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Item	Candidate Components agreed on 2 nd Technical Memorandum (5 th November 2013)	Final priority order for components agreed on 3 rd Technical Memorandum (3 rd April 2014)
	(2) Expansion of Jaban As substation (63/20kV side) ● 63/20kV, 40MVAx1unit	Dropped
	(3) 20kV Capacitor banks	Dropped
3. Nagad Switching Station	(1) 63kV switchgears, 20kV distribution panels, etc.	Dropped

2. Final transmission line route

Final transmission line route which was approved by Direction de l'Habitat et de l'Urbanisme and Direction des Domaines et de la Conservation Foncière is shown in Attachment-1. Details of overhead transmission line route near Jaban As area is shown in Attachment-2.

3. Modification of technical specifications from the 2nd Technical Memorandum

(1) Number of circuits for 63kV overhead transmission line

Number of circuits for 63kV overhead transmission line is modified as shown in Table 2. One circuit which ends at Nagad substation site will be terminated on a transmission tower and another single circuit will continue up to Nagad connection point.

EdD explained that new development projects around Nagad area, such as new airport (Aéroport de Chebeleh), Domestic animal exporting port (Port Betail) and metal factories in Damerdjog will require 63kV power supply from Nagad. This is the reason why double circuits are necessary from Jaban As to Nagad even though the 63kV overhead transmission line from Jaban As to Nagad does not supply power for railway. EdD will provide estimated power demand for those projects to the Team.

Table 2 Modification of number of circuits for overhead transmission line

Item	2 nd Technical Memorandum (5 th November 2013)	3 rd Technical Memorandum (3 rd April 2014)
63kV overhead transmission line between Jaban As and Nagad	Double circuits: from Jaban As substation to – Nagad switching station	(1) Double circuits: from Jaban As substation to Nagad substation site (2) Single circuit: from Nagad substation site to Nagad connection point

(2) Crossing point of existing 230kV, 63kV and new 63kV transmission lines

As shown in Attachment-II, new 63kV transmission line will go over or under the existing 230kV and 63kV transmission lines. The Team will study and propose the least cost method of line crossing.

A handwritten signature in blue ink, followed by the initials 'K7' written in blue ink.

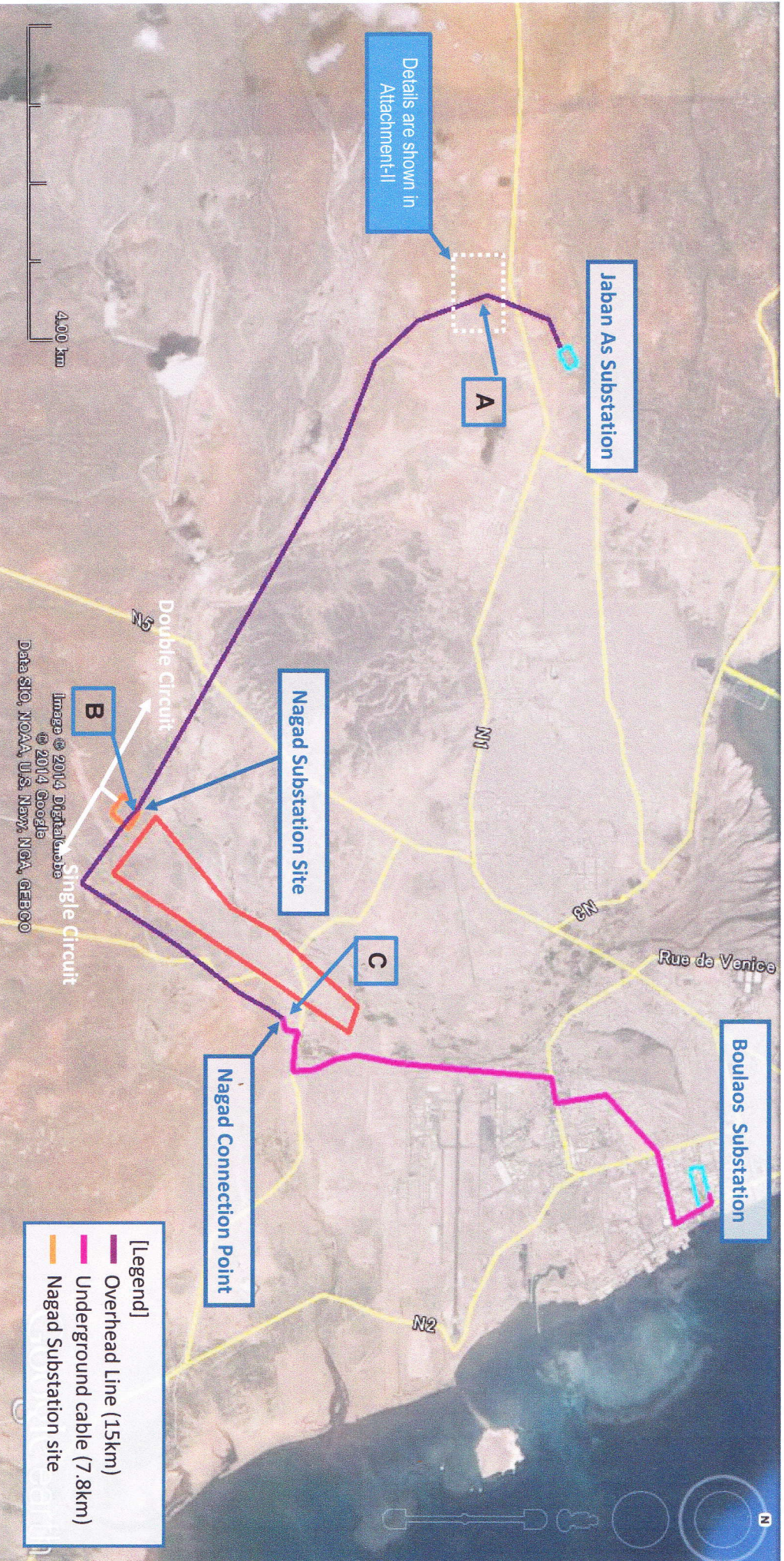
4. Land Acquisition for Transmission Corridor

Since Direction des Domaines et de la Conservation Fonçlère agreed to provide necessary transmission line corridor to EdD and it assures that no private land is existing along the transmission line corridor, no land acquisition is required for the Project. Direction des Domaines et de la Conservation Fonçlère approved to allocate 100m width from point A to B and 24m width from B to C for exclusive transmission corridor to EdD. The points A, B and C are shown in Attachment-I and II.

End

K7

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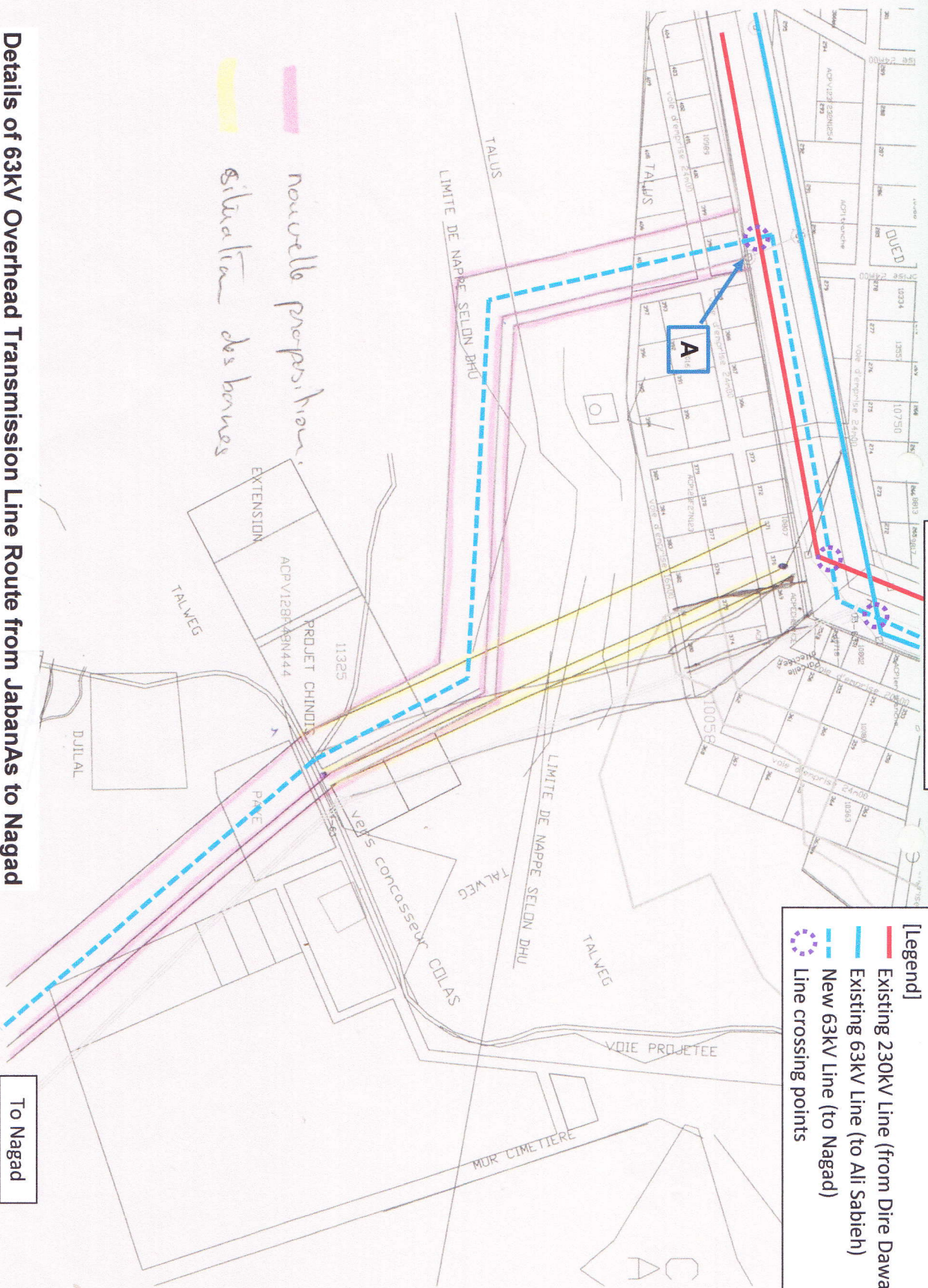
Final Transmission Line Route

4x



From Jaban As substation

- [Legend]
- Existing 230KV Line (from Dire Dawa)
 - Existing 63KV Line (to Ali Sabieh)
 - - - New 63KV Line (to Nagad)
 - Line crossing points



Details of 63KV Overhead Transmission Line Route from JabanAs to Nagad

To Nagad

4x

AA

Signature

A-6 電力潮流解析

電力潮流解析

I. 電力システムモデルの主要入力データ

表 1 発電機

発電機	場所	メーカー	運開年	定格				通常運用			インピーダンス (% MVA ベース)		燃料	燃料消費率 ²⁾ (g/kWh)
				(MW)	(KV)	(MVA)	PF (%)	(MW)	(h)	需要対応	Xd ^r	Xd		
G21	Boulaos	G.M.T FINCANTIERI B550/18	1984	15.2	5.5	19.00	80	10.0	115025	休止	25.0 ¹⁾	99 ¹⁾	重油	221
G22B	Boulaos	Wartsila GMT 18V46	2007	17.0	15.0	21.35	80	14.0	21108	ベース	22.2	205	重油	
G25	Boulaos	Wartsila 18V46	2000	14.4	5.5	18.00	80	13.4	59551	ベース	19.6	175	重油	
G1	Boulaos	Alstom Pielstick 18PC2-2	1976	6.0	5.5	7.60	80	4.0	124435	ピーク	25.0 ¹⁾	99 ¹⁾	重油	
G12	Boulaos	Caterpillar	2004	7.25	5.5	9.06	80	6.5	38296	ベース	10.5	140	重油	
G13	Boulaos	Wartsila GMT 16VA32	2001	6.0	5.5	7.50	80	4.5	43535	ベース	22.3	206	重油	
G14	Boulaos	Wartsila GMT 16VA32	2001	6.0	5.5	7.50	80	4.5	25957	ベース	22.3	206	重油	
G15	Boulaos	Wartsila GMT 16VA32	2001	6.0	5.5	7.50	80	4.5	24387	ベース	22.3	206	重油	
G16	Boulaos	Wartsila GMT 16VA32	2001	6.0	5.5	7.50	80	4.5	33559	ベース	22.3	206	重油	
G17	Boulaos	Caterpillar	2003	7.25	5.5	9.06	80	6.5	35041	休止	10.5	140	重油	
G18	Boulaos	Caterpillar	2004	7.25	5.5	9.06	80	6.5	33405	ベース	10.5	140	重油	
G23B	Boulaos	MAN 9L52/55A	2011	8.5	5.5	10.64	80	6.5	4474	ベース	23.9	214	重油	
G24	Boulaos	MAN 9L52/55A	1988	5.5	10.5	6.88	80	4.5	106745	ベース	25.0 ¹⁾	99 ¹⁾	重油	
G32	Boulaos	SEMT PIELSTICK PA6	2010	4.5	10.5	5.50	80	4.0	2593	ピーク	25.0 ¹⁾	99 ¹⁾	軽油	254
G31	Boulaos	SEMT PIELSTICK PA6	2010	4.5	10.5	5.50	80	4.0	1443	ピーク	25.0 ¹⁾	99 ¹⁾	軽油	
M6	Marabout	Wartsila GMT 16V25	1999	3.0	15.0	3.75	80	2.4	23305	ピーク	15.2	147	軽油	
M4	Marabout	Wartsila GMT 16V25	1999	3.0	15.0	3.75	80	2.4	26872	ピーク	15.2	147	軽油	
M2	Marabout	Wartsila GMT 16V25	1999	3.0	15.0	3.75	80	2.4	33593	ピーク	15.2	147	軽油	
M5	Marabout	Wartsila GMT 16V25	1999	3.0	15.0	3.75	80	2.4	30812	ピーク	15.2	147	軽油	
M3	Marabout	Wartsila GMT 16V25	1999	3.0	15.0	3.75	80	2.4	30085	ピーク	15.2	147	軽油	
M1	Marabout	Wartsila GMT 16V25	1999	3.0	15.0	3.75	80	2.4	24079	ピーク	15.2	147	軽油	

注: 1) 想定値, 2) 2012年の実績値

表 2 変圧器

変圧器	場所			メーカー	定格値			インピーダンス (%MVA ベース)	負荷時タップ切替装置 (LTC)			
					電圧 (kV)		電力 (MVA)		Min. (%)	Max. (%)	Step (%)	タップ数
	From	To	1次		2次	定格						
No1 PK/H	Jaban As	Jaban As_230kV	Jaban As_63kV	GETRA	230	63	63	13.56	-10	10	1.25	17
NO2 PK/H	Jaban As	Jaban As_230kV	Jaban As_63kV	GETRA	230	63	63	13.46	-10	10	1.25	17
No1 PK/L	Jaban As	Jaban As_230kV	Jaban As_40kV	GETRA	63	20	40	11.96	-12.5	12.5	1.25	21
No1 A/L	Ali Sabieh	Ali Sadieh_63kV	Ali Sadieh_20kV	GETRA	63	20	12	9.91	-12.5	12.5	1.25	21
No1 B/L	Boulaos	Boulaos_63kV	Boulaos_20kV	CEM	63	21	36	17.1	-12	12	1.500	17
No2 B/L	Boulaos	Boulaos_63kV	Boulaos_20kV	CEM	63	21	36	17	-12	12	1.500	17
No1 M/L	Marabout	Marabout_63kV	Marabout_20kV	CEM	63	21	36	17	-12	12	1.500	17
No1 M/G	Marabout	Marabout_20kV	Marabout_15kV	AREVA	21	15	12	7.97	-5	5	2.500	5
No2 M/G	Marabout	Marabout_20kV	Marabout_15kV	AREVA	21	15	12	9.85	-5	5	2.500	5
T21	Boulaos	Boulaos_63kV	G21	CEM	66	5.5	19	8.21	-7.5	7.5	3.75	5
T22B	Boulaos	Boulaos_63kV	G22B	AREVA	66	15	18	10.05	-7.5	7.5	3.75	5
T25	Boulaos	Boulaos_63kV	G25	IEC	66	5.5	18	11.48	-7.5	7.5	3.75	5
T32	Boulaos	Boulaos_20kV	G32	AREVA	21	10.5	6.7	6.07	-7.5	7.5	3.75	5
T31	Boulaos	Boulaos_20kV	G31	AREVA	21	10.5	6.7	6.7	-7.5	7.5	3.75	5
T11	Boulaos	Boulaos_20kV	G11	Metz	21	5.5	7.7	9.1 ¹⁾	-7.5	7.5	3.75	5
T12	Boulaos	Boulaos_20kV	G12	ALSTOM	21	5.5	9.1	8.21	-5	5	2.5	5
T13	Boulaos	Boulaos_20kV	G13	Usine de METZ	21	5.5	7.55	9.42	-5	5	5	3
T14	Boulaos	Boulaos_20kV	G14	Usine de METZ	21	5.5	7.55	9.42 ²⁾	-5	5	5	3
T15	Boulaos	Boulaos_20kV	G15	Usine de METZ	21	5.5	7.55	9.42 ²⁾	-5	5	5	3
T16	Boulaos	Boulaos_20kV	G16	Usine de METZ	21	5.5	7.55	9.42 ²⁾	-5	5	5	3
T17	Boulaos	Boulaos_20kV	G17	ALSTOM	21	5.5	9.1	8.12	-5	5	2.5	5
T18	Boulaos	Boulaos_20kV	G18	ALSTOM	21	5.5	9.1	8.21	-5	5	2.5	5
T23B	Boulaos	Boulaos_20kV	G23B	AREVA	21	5.5	11	8.19	-5	5	2.5	5
T24	Boulaos	Boulaos_20kV	G24	ALSTOM	21	10.5	6.7	8.36	-7.5	7.5	3.75	5

注: 1) PB POWERの検討値, 2) 想定値

II. ロードフロー図

表1 電力潮流解析シナリオ一覧（1／2）

ケース	Base	Case1	Case2	Case3	Case4	Case5	Case6	Case7	Case8	Case9	Case10	Case11	Case12	Case13	Case14	Case15	Case16
西暦	2012	2016		2017	2018	2018	2019	2020	2020	2021	2021	2021	2022	2023	2024	2024	2024
運用年数	-4	-1		1	2	3	4	5	6	7	8						
イベント（●：運用）																	
電力需要																	
最大需要	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
最低需要					●					●				●			
プロジェクト																	
No3 230/63kV 変圧器 (ジャバナス)				●	●						●	●	●	●	●	●	●
63kV 送電線 (ジャバナス-ブラウス間)				●	●			●	●	●	●	●	●	●	●	●	●
他ドナーによるプロジェクト																	
Semera 国際連系線			●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
パルムレ変電所化		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
ジャバナス発電所		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
「J」国マスタープラン																	
No2 63/20kV 変圧器 (ジャバナス)													●	●	●	●	●
No2 and No3 63/20kV Tr (マラブ)																	
No3 63/20kV 変圧器 (ブラウス)																	
キャパシタ (ジャバナス、ブラウス、マラブ)																	
提言事項																	
No.4 230/63kV Trの検討 (ジャバナス)																	
電力需要（変電所別）																	
力率	0.94	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
マラブ	MW 27.0	23.9	24.4	24.4	7.1	24.9	25.5	25.5	26.2	7.7	26.9	26.9	26.9	7.9	27.7	29.1	30.7
MVar	9.8	11.6	11.8	11.8	3.5	12.0	12.4	12.4	12.7	3.7	13.0	13.0	13.0	3.8	13.4	14.1	14.9
MVA	28.7	26.6	27.1	27.1	7.9	27.6	28.3	28.3	29.1	8.5	29.9	29.9	29.9	8.7	30.8	32.3	34.1
ブラウス	MW 45.5	51.3	58.6	47.6	13.9	62.1	65.7	50.1	51.1	14.9	52.3	52.3	52.3	15.3	53.5	54.7	56.1
MVar	16.5	24.8	28.4	23.1	6.7	30.1	31.8	24.3	24.7	7.2	25.3	25.3	25.3	7.4	25.9	26.5	27.2
MVA	48.4	57.0	65.1	52.9	15.4	69.0	73.0	55.7	56.8	16.6	58.1	58.1	58.1	17.0	59.4	60.8	62.3
ジャバナス	MW 2.5	27.3	28.6	28.6	8.4	30.0	31.4	31.4	32.8	9.6	37.7	37.7	37.7	11.0	43.2	48.8	51.6
MVar	0.9	13.2	13.9	13.9	4.0	14.5	15.2	15.2	15.9	4.6	18.3	18.3	18.3	5.3	20.9	23.6	25.0
MVA	2.7	30.3	31.8	31.8	9.3	33.3	34.9	36.4	10.6	41.9	41.9	41.9	41.9	12.2	48.0	54.2	57.3
ナガド	MW 0.0	0.0	0.0	11.0	3.2	0.0	0.0	15.6	17.9	5.2	20.2	20.2	20.2	5.9	22.5	22.5	22.5
MVar	0.0	0.0	0.0	5.3	1.6	0.0	0.0	7.6	8.7	2.5	9.8	9.8	9.8	2.9	10.9	10.9	10.9
MVA	0.0	0.0	0.0	12.2	3.6	0.0	0.0	17.3	19.9	5.8	22.4	22.4	22.4	6.6	25.0	25.0	25.0
パルムレ	MW 0.0	15.1	15.4	15.4	4.5	15.8	16.1	16.1	16.6	4.8	17.0	17.0	17.0	5.0	17.5	18.0	18.5
MVar	0.0	7.3	7.5	7.5	2.2	7.7	7.8	7.8	8.0	2.3	8.2	8.2	8.2	2.4	8.5	8.7	9.0
MVA	0.0	16.8	17.1	17.1	5.0	17.6	17.9	17.9	18.4	5.4	18.9	18.9	18.9	5.5	19.4	20.0	20.6
アリザビエ	MW 1.9	4.7	4.7	4.7	1.4	4.7	4.7	4.7	4.8	1.4	4.8	4.8	4.8	1.4	4.8	4.9	4.9
MVar	0.7	2.3	2.3	2.3	0.7	2.3	2.3	2.3	2.3	0.7	2.3	2.3	2.3	0.7	2.3	2.4	2.4
MVA	2.0	5.2	5.2	5.2	1.5	5.2	5.3	5.3	5.3	1.5	5.3	5.3	5.3	1.5	5.4	5.4	5.4
合計	MW 76.9	122.3	131.7	131.7	38.5	137.5	143.4	143.4	149.4	43.6	158.9	158.9	158.9	46.4	169.2	178.0	184.3
MVar	27.2	57.0	61.5	61.5	18.0	64.3	67.2	67.2	70.0	20.4	74.6	74.6	74.6	21.8	79.6	83.8	86.9
MVA	81.8	135.9	146.3	146.3	42.7	152.7	159.4	159.4	166.0	48.5	176.5	176.5	176.5	51.5	188.0	197.8	204.8
輸入・発電電力																	
輸入	MW 57.7	91.7	98.8	98.8	28.8	103.1	107.6	107.6	112.0	32.7	119.2	119.2	119.2	34.8	126.9	133.5	138.2
%	79	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75
国内	MW 15.0	30.6	32.9	32.9	9.6	34.4	35.9	35.9	37.3	10.9	39.7	39.7	39.7	11.6	42.3	44.5	46.1
%	21	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
合計	MW 72.7	122.3	131.7	131.7	38.4	137.5	143.5	143.5	149.3	43.6	158.9	158.9	158.9	46.4	169.2	178.0	184.3
送電損失																	
損失	MW 1.12	2.62	3.05	1.83	0.18	3.38	3.73	2.13	2.33	0.21	2.56	2.48	2.39	0.22	2.61	2.83	3.01
(ジャバナス-20kV Bus間)	% 1.54	2.14	2.32	1.39	0.47	2.46	2.60	1.48	1.56	0.48	1.61	1.56	1.50	0.47	1.54	1.59	1.63

表1 電力潮流解析シナリオ一覧 (2/2)

ケース	Case17	Case18	Case19	Case20	Case21	Case22	Case23	Case24	Case25	Case26	Case27	Case28	Case29	Case30	Case31	Case32	
西暦	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035						
運用年数	9	10	11	12	13	14	15	15	16	17	18	19					
イベント (●:運用)																	
電力需要																	
最大需要	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	
最低需要			●														
プロジェクト																	
No3 230/63kV 変圧器 (ジャバナス)	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
63kV 送電線 (ジャバナス-ブラウス間)	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
他ドナーによるプロジェクト																	
Semera 国際連系線	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
パルムレ変電所化	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
ジャバナス発電所	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
「J」国マスタープラン																	
No2 63/20kV 変圧器 (ジャバナス)	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
No2 and No3 63/20kV Tr (マラブ)		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
No3 63/20kV 変圧器 (ブラウス)									●	●	●	●	●	●	●	●	
キャパシタ (ジャバナス、ブラウス、マラブ)														●	●	●	
提言事項																	
No.4 230/63kV Trの検討 (ジャバナス)											●	●	●	●	●	●	
電力需要 (変電所別)																	
力率	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	
マラブ	MW 32.1	32.1	9.4	33.7	35.4	36.4	37.5	38.6	39.8	39.8	41.0	42.3	42.3	43.7	45.2	45.2	
MVar	15.5	15.5	4.5	16.3	17.1	17.6	18.2	18.7	19.3	19.3	19.9	19.9	20.5	20.5	21.2	21.9	
MVA	35.7	35.7	10.4	37.4	39.3	40.4	41.7	42.9	44.2	44.2	45.6	45.6	47.0	47.0	48.6	50.2	
ブラウス	MW 57.2	57.2	16.7	58.7	60.3	61.9	63.6	65.4	67.3	67.3	69.2	69.2	71.3	71.3	73.5	75.8	
MVar	27.7	27.7	8.1	28.4	29.2	30.0	30.8	31.7	32.6	32.6	33.5	33.5	34.5	34.5	35.6	36.7	
MVA	63.6	63.6	18.6	65.2	67.0	68.8	70.7	72.7	74.8	74.8	76.9	76.9	79.2	79.2	81.7	84.2	
ジャバナス	MW 54.3	54.3	15.9	55.7	57.2	58.7	60.2	61.7	61.8	61.8	62.0	62.0	62.1	62.1	62.3	62.5	
MVar	26.3	26.3	7.7	27.0	27.7	28.4	29.2	29.9	29.9	29.9	30.0	30.0	30.1	30.1	30.2	30.3	
MVA	60.3	60.3	17.6	61.9	63.6	65.2	66.9	68.6	68.7	68.7	68.9	68.9	69.0	69.0	69.2	69.5	
ナガド	MW 22.5	22.5	6.6	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	
MVar	10.9	10.9	3.2	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	
MVA	25.0	25.0	7.3	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	
パルムレ	MW 19.0	19.0	5.6	19.6	20.2	20.8	21.5	22.2	23.0	23.0	23.8	23.8	24.6	24.6	25.5	26.4	
MVar	9.2	9.2	2.7	9.5	9.8	10.1	10.4	10.8	11.1	11.1	11.5	11.5	11.9	11.9	12.4	12.8	
MVA	21.2	21.2	6.2	21.8	22.4	23.1	23.9	24.7	25.6	25.6	26.4	26.4	27.3	27.3	28.3	29.3	
アリザビエ	MW 4.9	4.9	1.4	5.0	5.0	5.1	5.1	5.2	5.2	5.2	5.3	5.3	5.4	5.4	5.4	5.5	
MVar	2.4	2.4	0.7	2.4	2.4	2.5	2.5	2.5	2.5	2.5	2.6	2.6	2.6	2.6	2.6	2.7	
MVA	5.4	5.4	1.6	5.6	5.6	5.7	5.7	5.8	5.8	5.8	5.9	5.9	6.0	6.0	6.0	6.1	
合計	MW 190.0	190.0	55.5	195.2	200.6	205.4	210.4	215.6	219.6	219.6	223.8	223.8	228.2	228.2	232.9	237.9	
MVar	89.7	89.7	26.2	92.1	94.7	97.0	99.4	101.9	103.8	103.8	105.8	105.8	107.9	107.9	110.2	112.6	
MVA	211.2	211.2	61.7	216.9	222.9	228.2	233.8	239.6	244.0	244.0	248.7	248.7	253.6	253.6	258.8	264.3	
輸入・発電電力																	
輸入	MW 142.5	142.5	41.6	146.4	150.5	154.1	157.8	161.7	164.7	164.7	167.9	167.9	171.2	171.2	174.7	178.4	
%	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	
国内	MW 47.5	47.5	13.9	48.8	50.2	51.4	52.6	53.9	54.9	54.9	56.0	56.0	57.1	57.1	58.2	59.5	
%	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	
合計	MW 190.0	190.0	55.5	195.2	200.7	205.5	210.4	215.6	219.6	219.6	223.9	223.9	228.3	228.3	232.9	237.9	
送電損失																	
損失	MW 3.26	3.06	0.24	3.32	3.23	3.37	3.66	3.83	4.07	3.86	4.11	3.95	4.11	3.86	4.04	4.30	
(ジャバナス-20kV Bus間)	% 1.72	1.61	0.43	1.70	1.61	1.64	1.74	1.78	1.85	1.76	1.84	1.76	1.80	1.69	1.73	1.81	

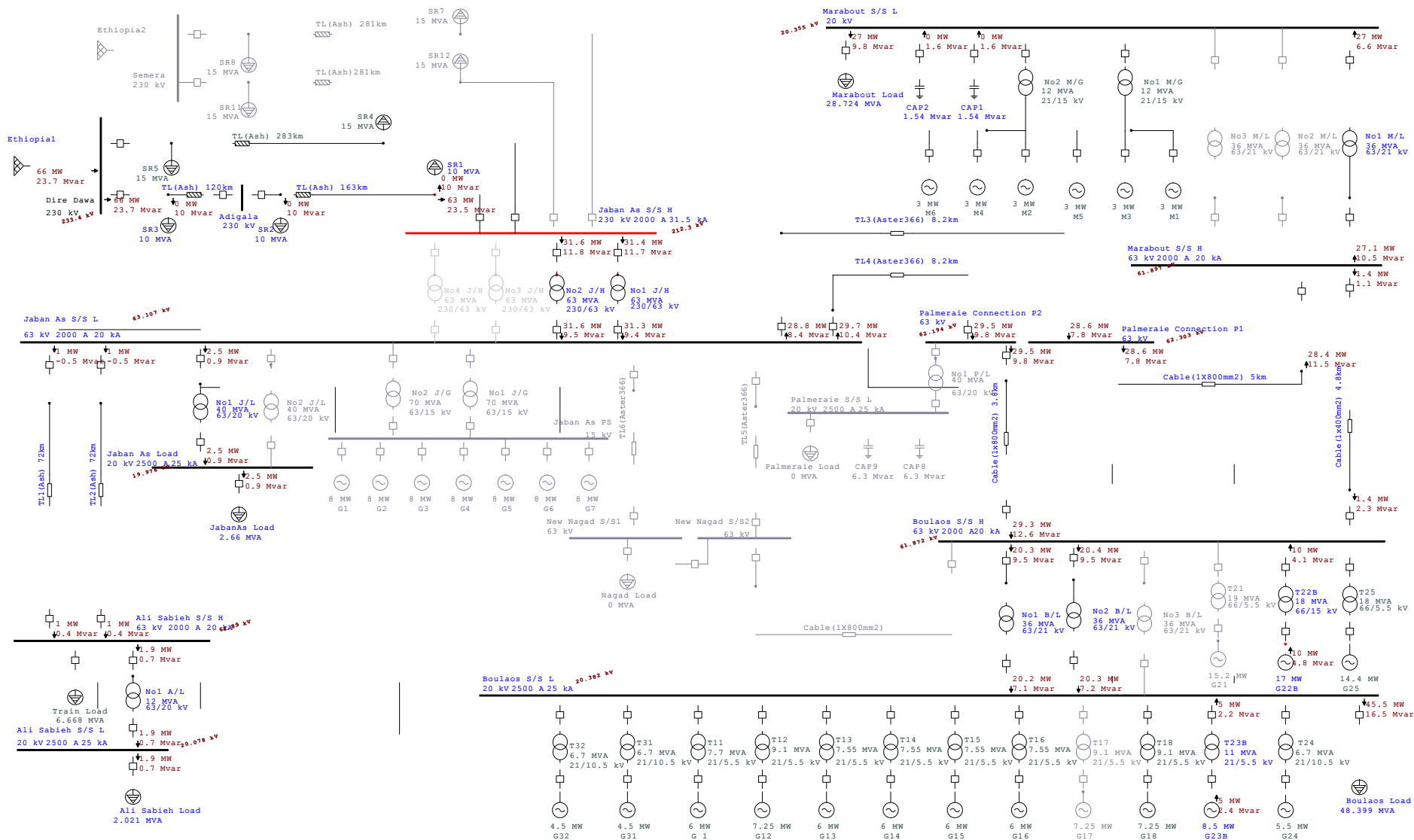


図1 ロードフロー図 2012年 (Base)

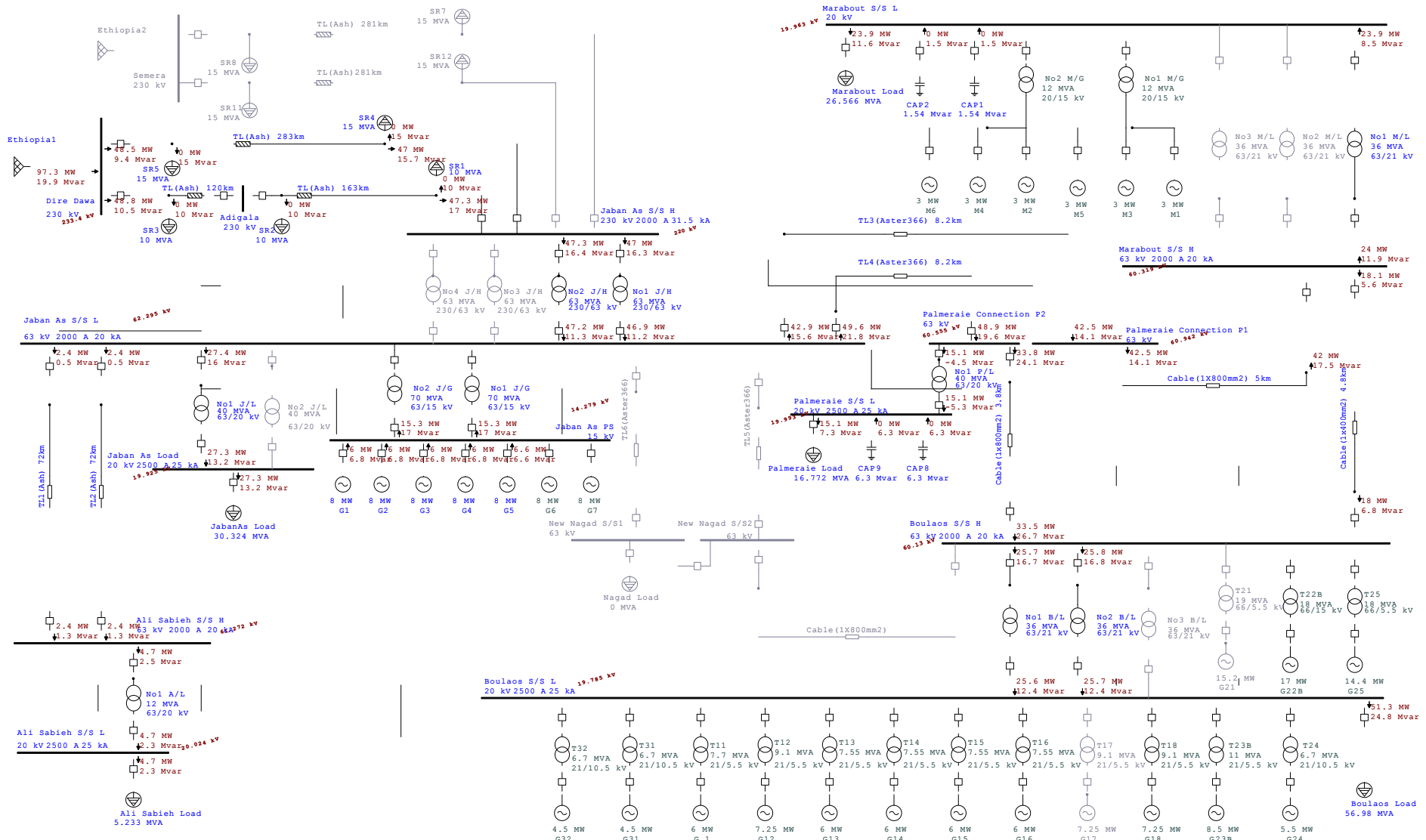


図2 ロードフロー図 2016年 (Case1)

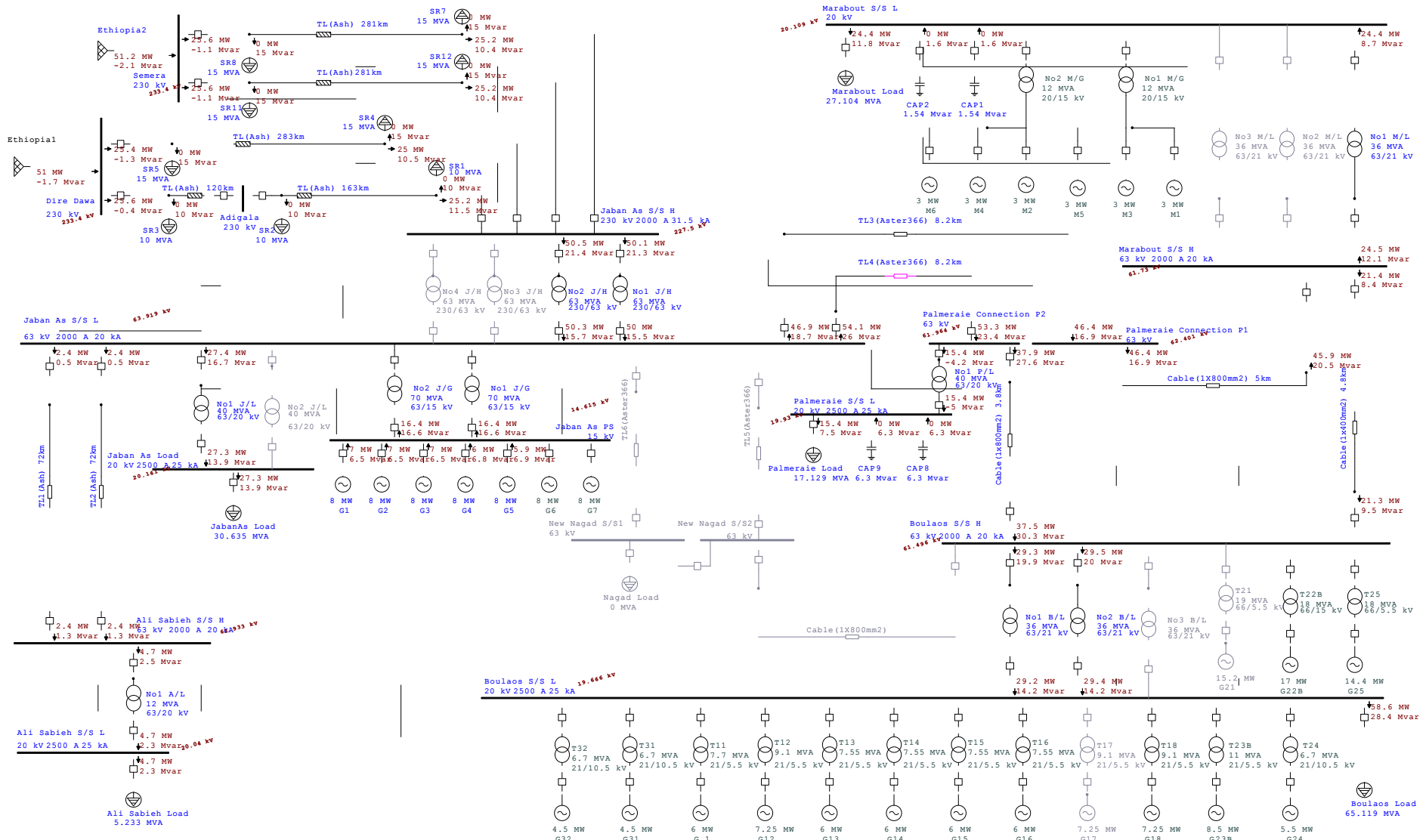


図3 ロードフロー図 2017年 (Case2)

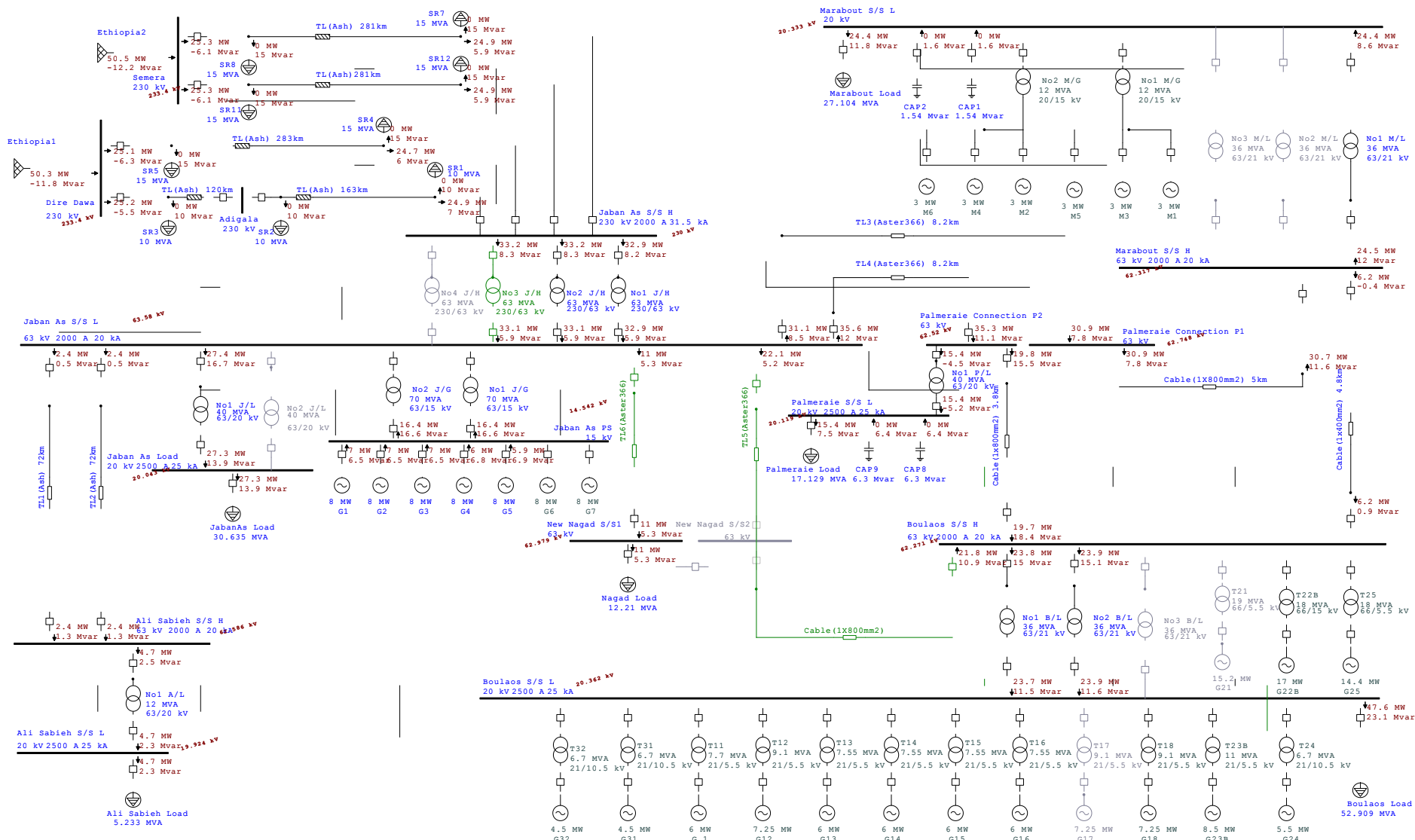


図4 ロードフロー図 2017年 (Case3)

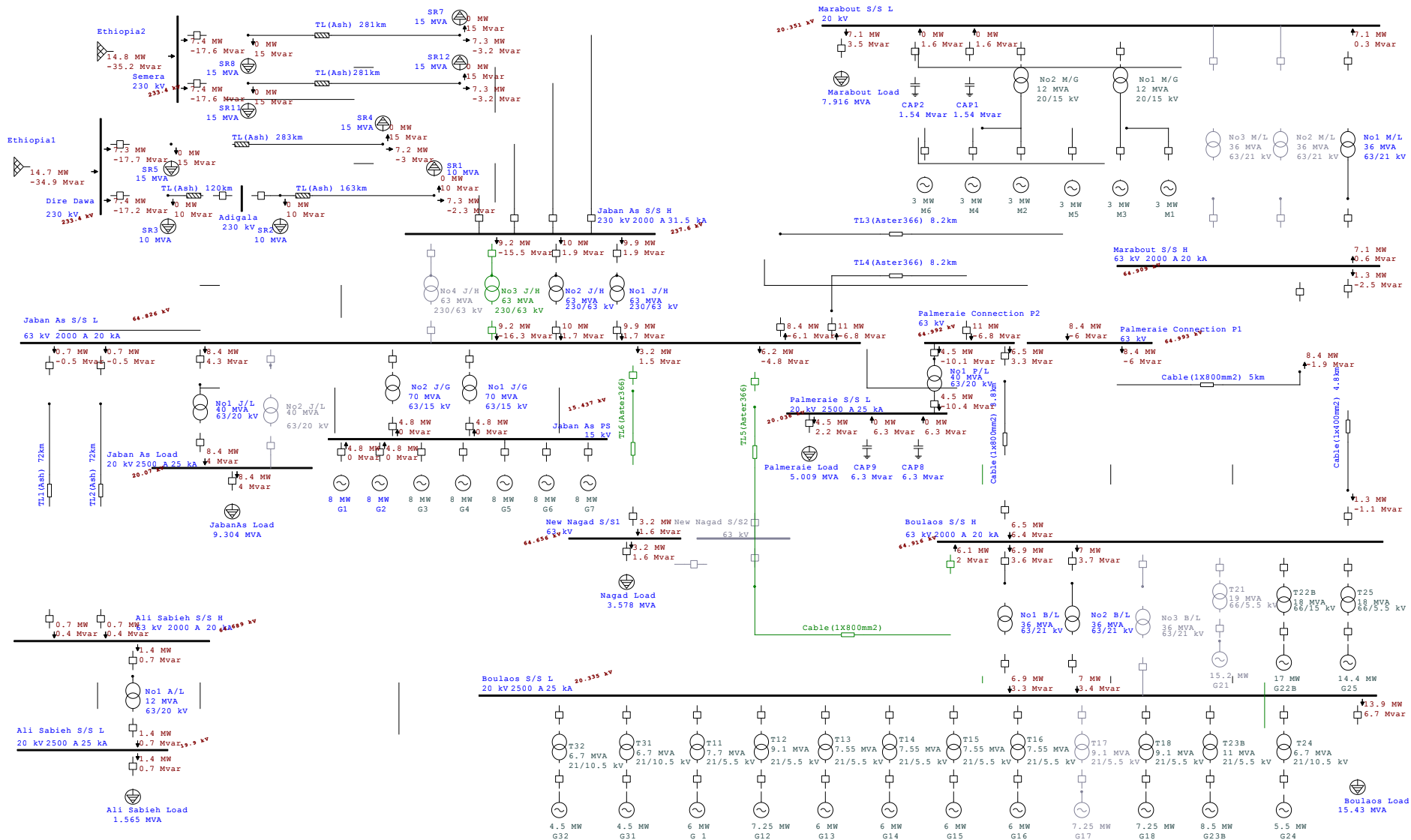


図5 ロードフロー図 2017年 (Case4)

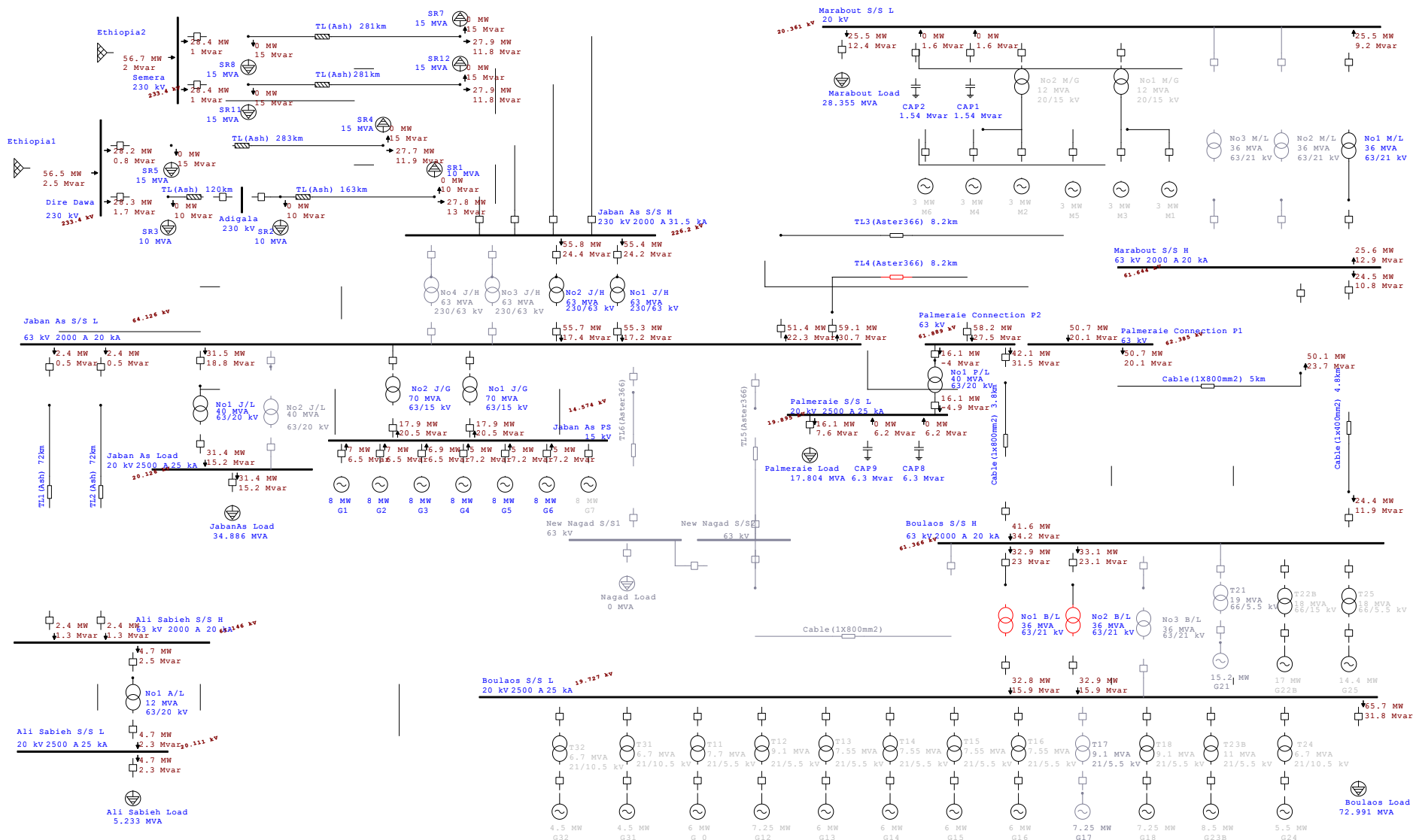


図7 ロードフロー図 2019年 (Case6)

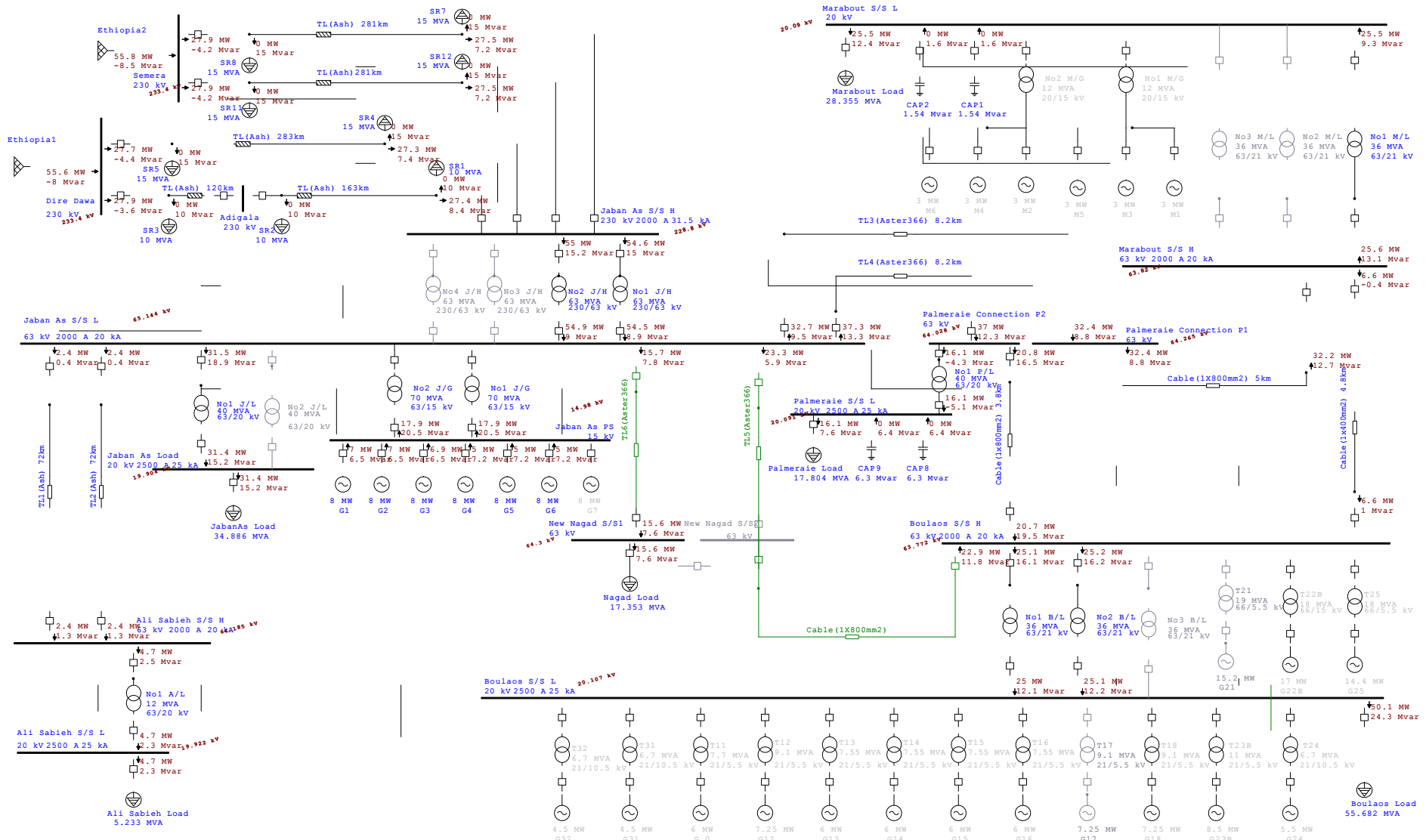


図8 ロードフロー図 2020年 (Case7)

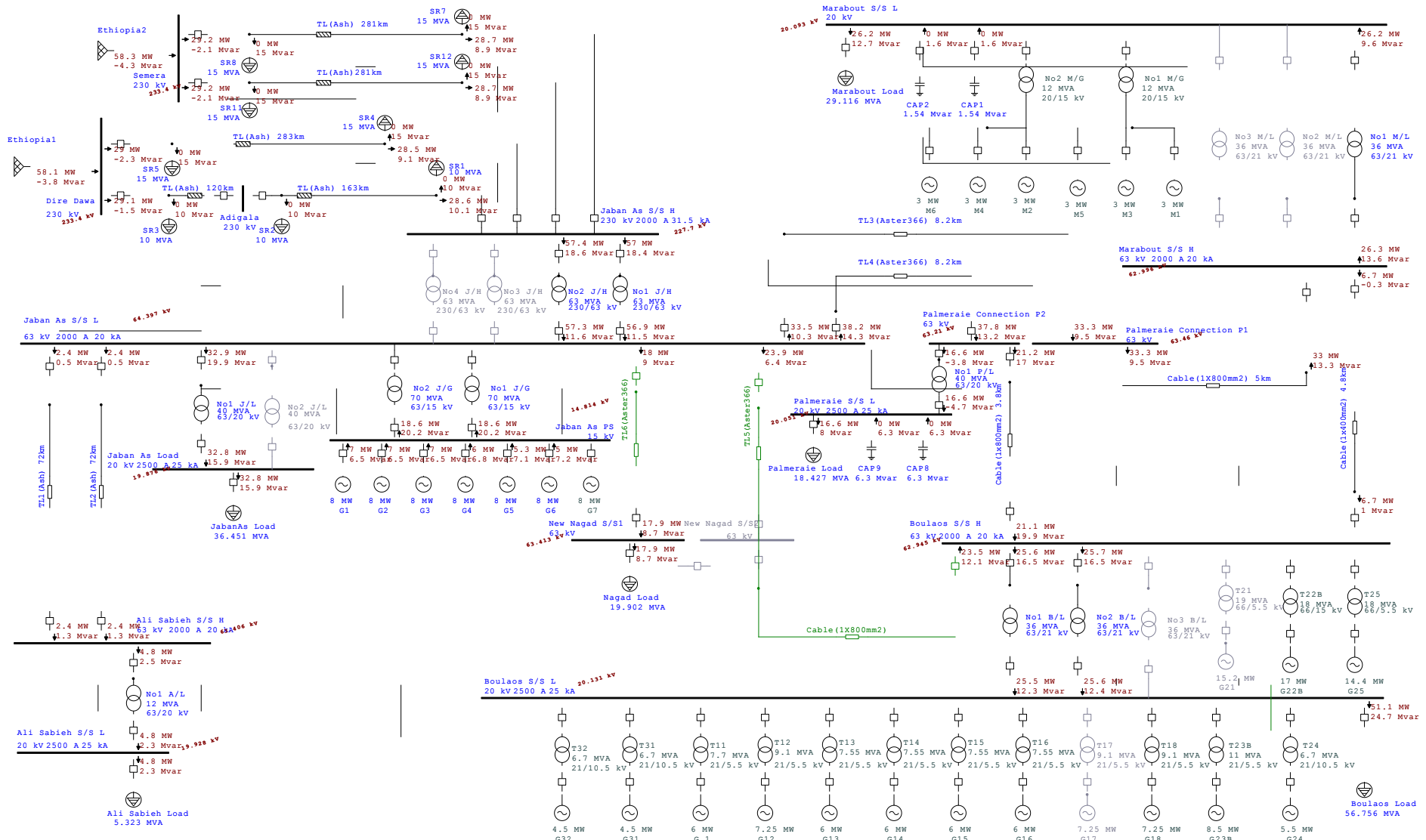


図9 ロードフロー図 2020年 (Case8)

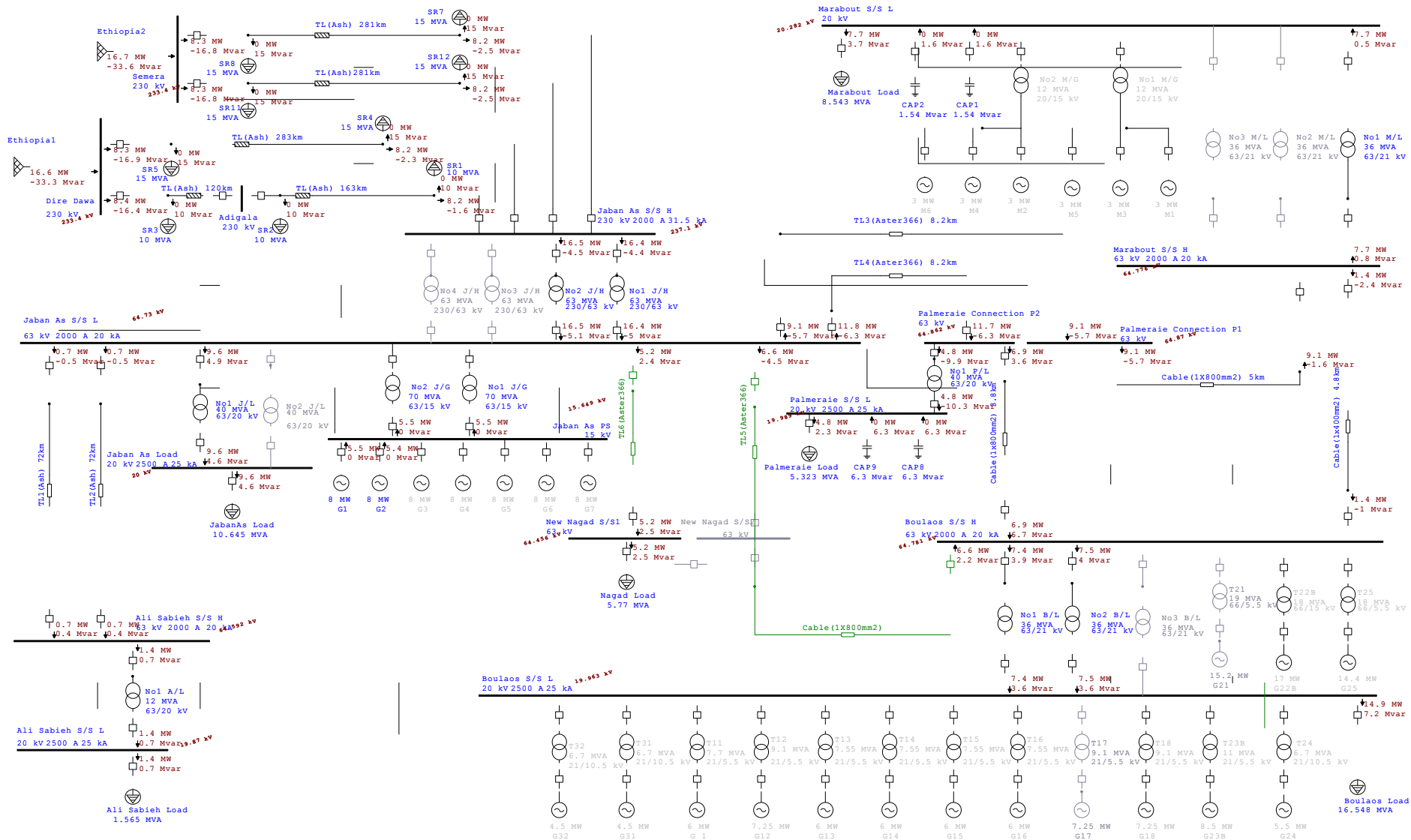


図 10 ロードフロー図 2020 年 (Case9)

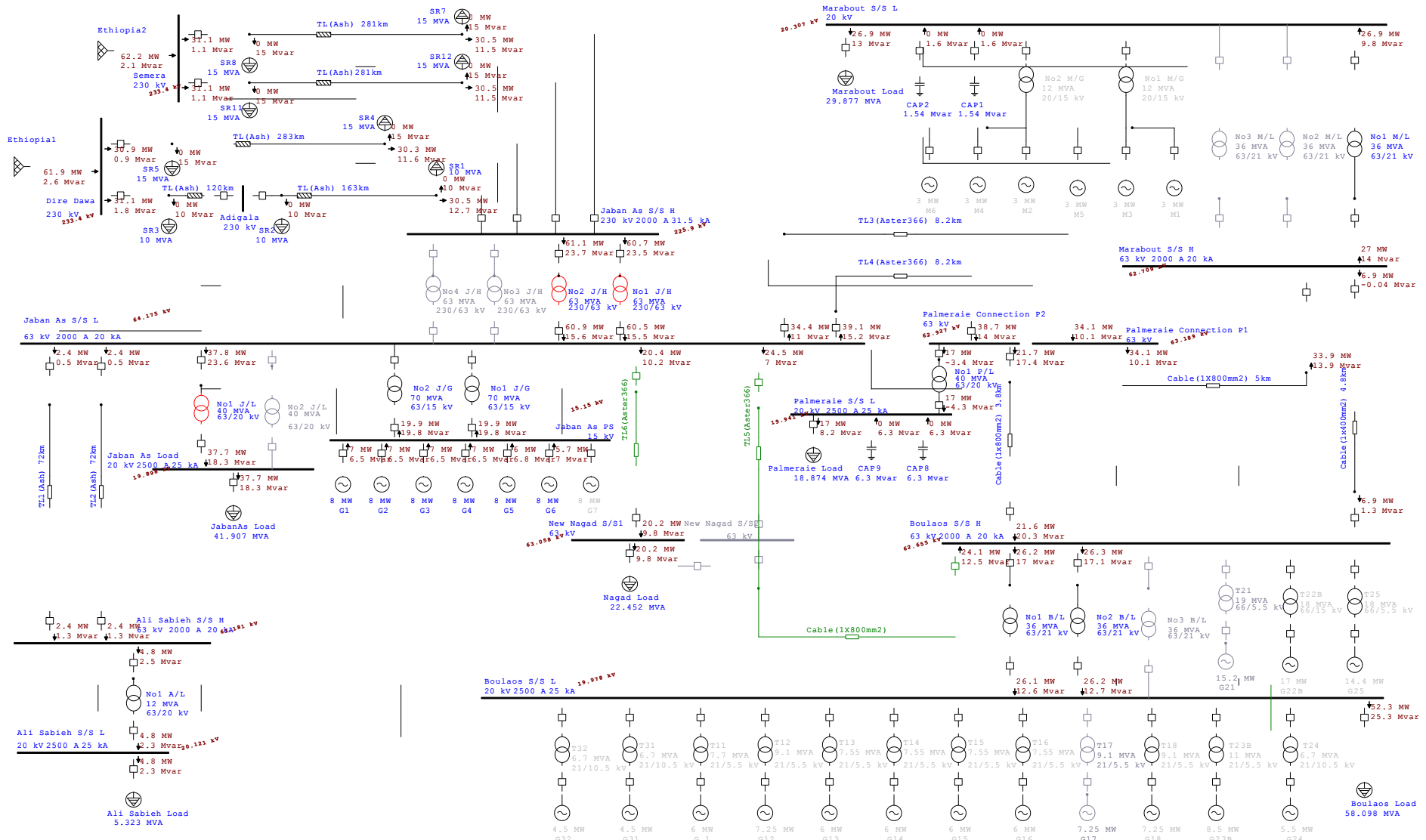


図 11 ロードフロー図 2021年 (Case10)

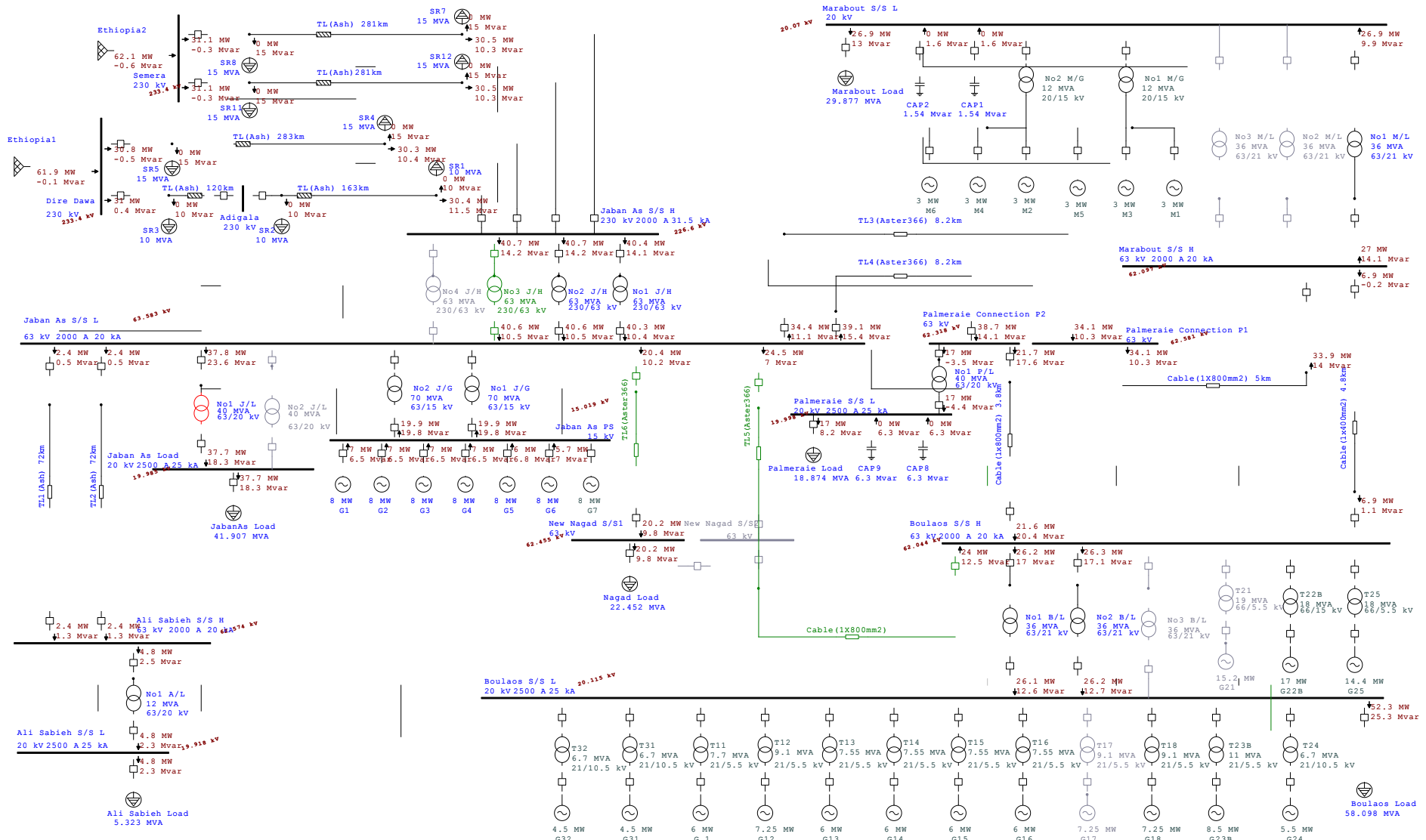


図 12 ロードフロー図 2021年 (Case11)

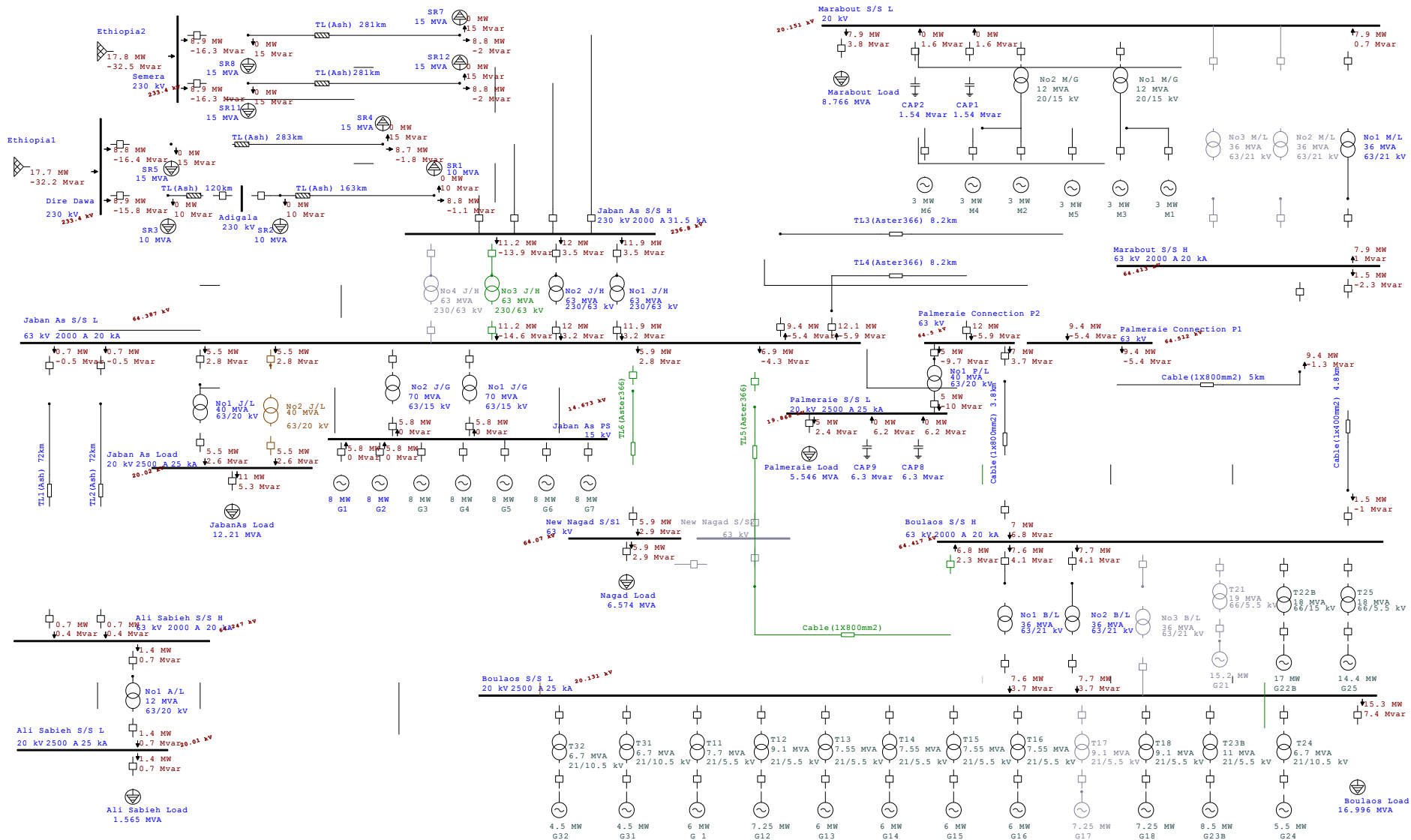


図 14 ロードフロー図 2021 年 (Case13)

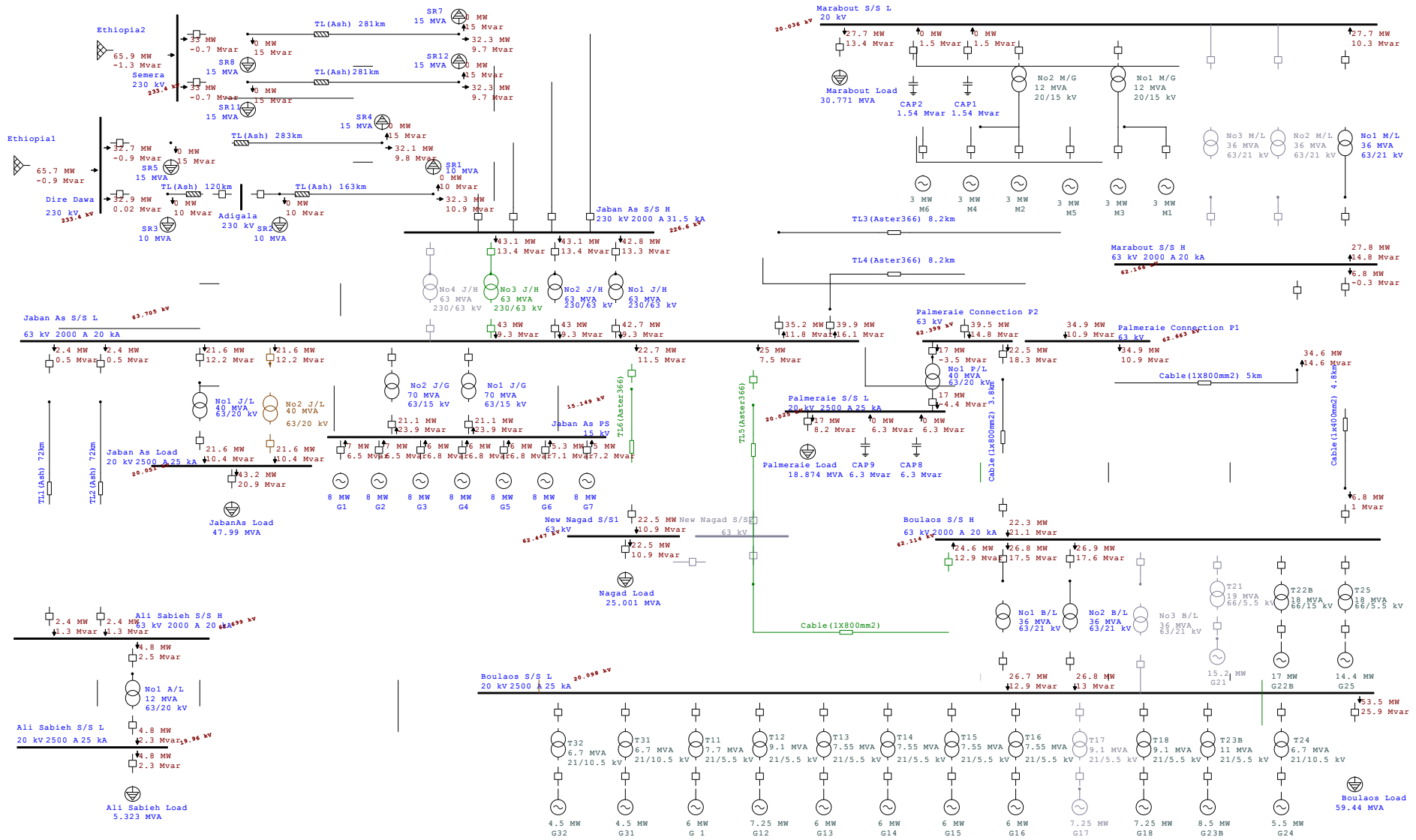


図 15 ロードフロー図 2022 年 (Case14)

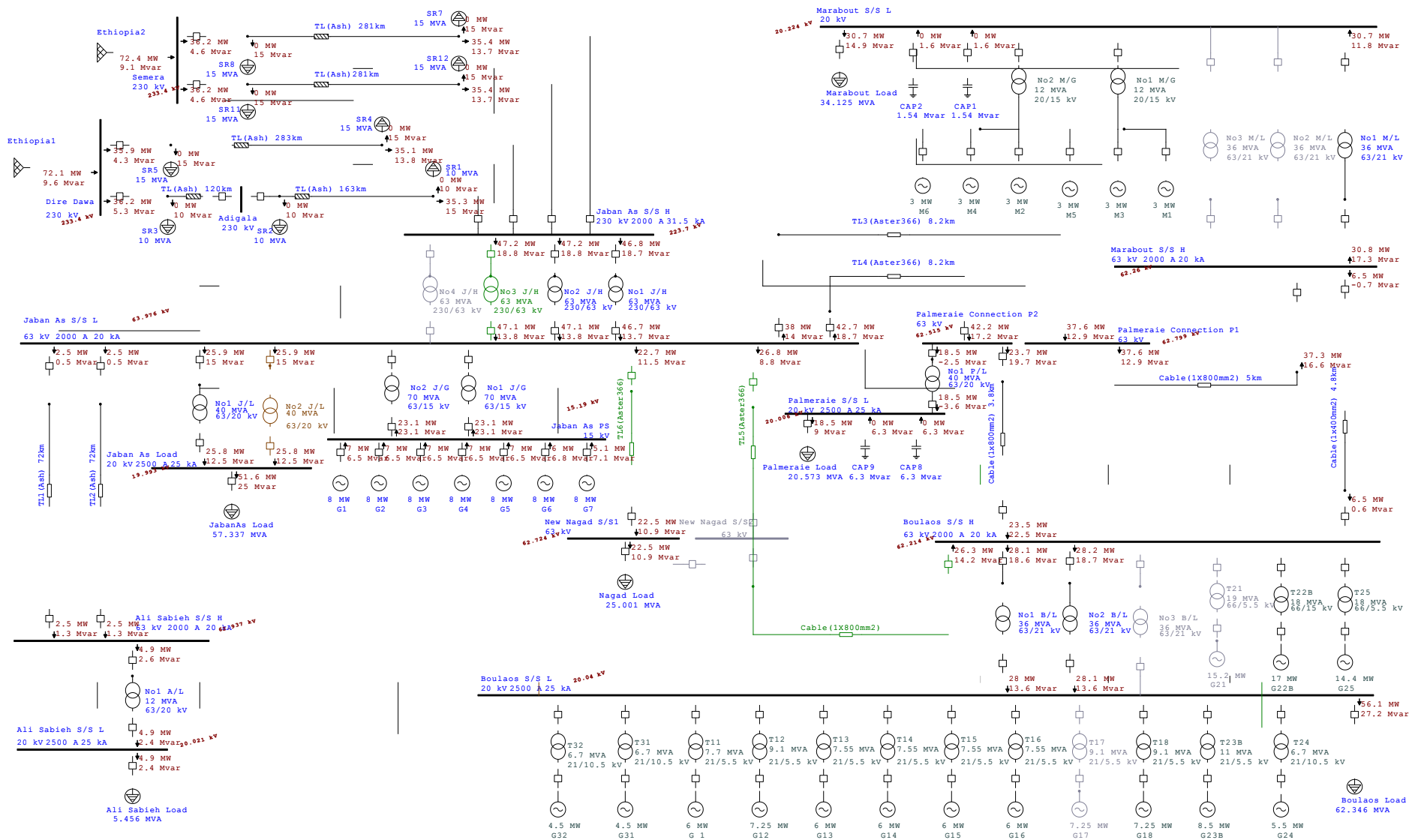


図 17 ロードフロー図 2024年 (Case16)

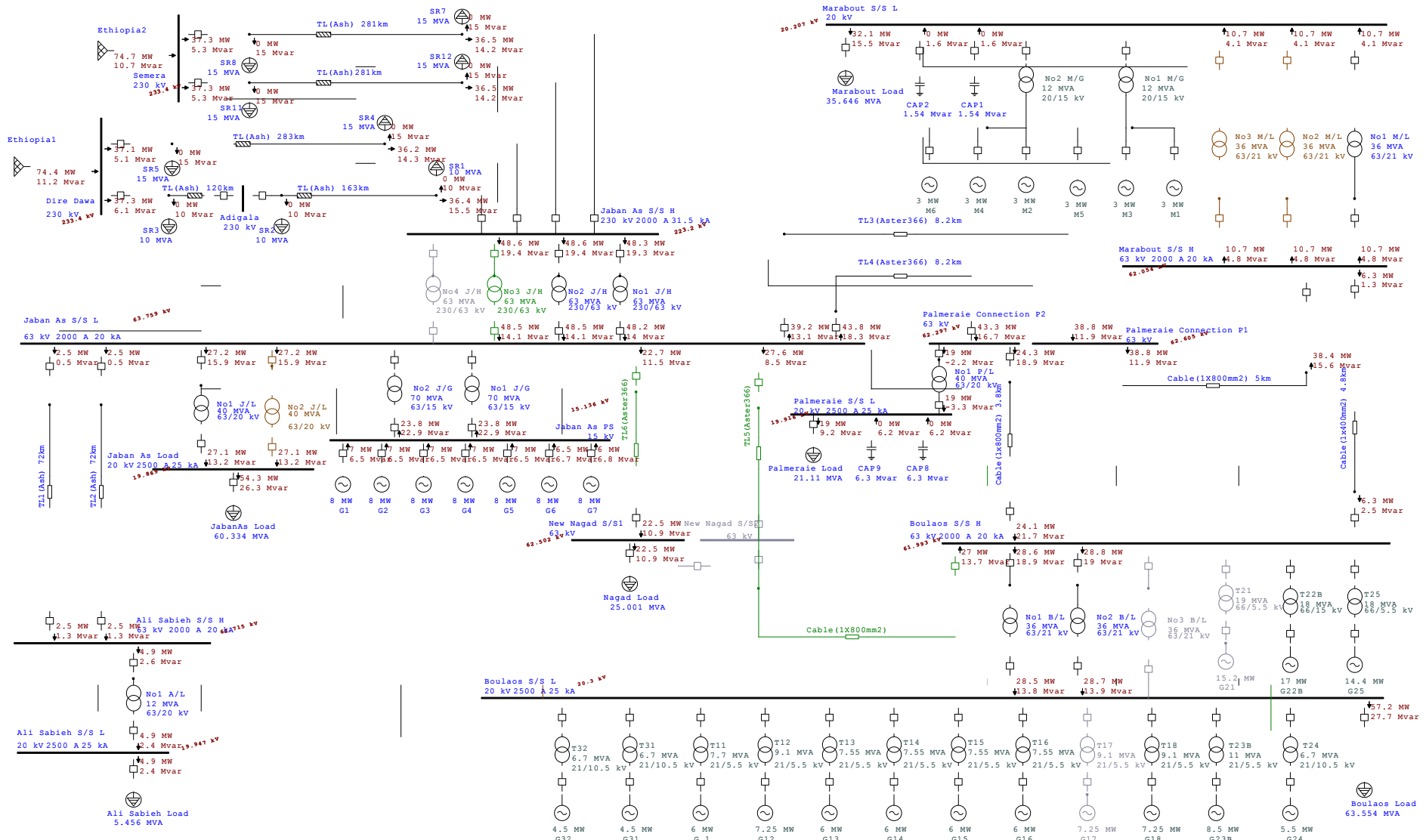


図 19 ロードフロー図 2025 年 (Case18)

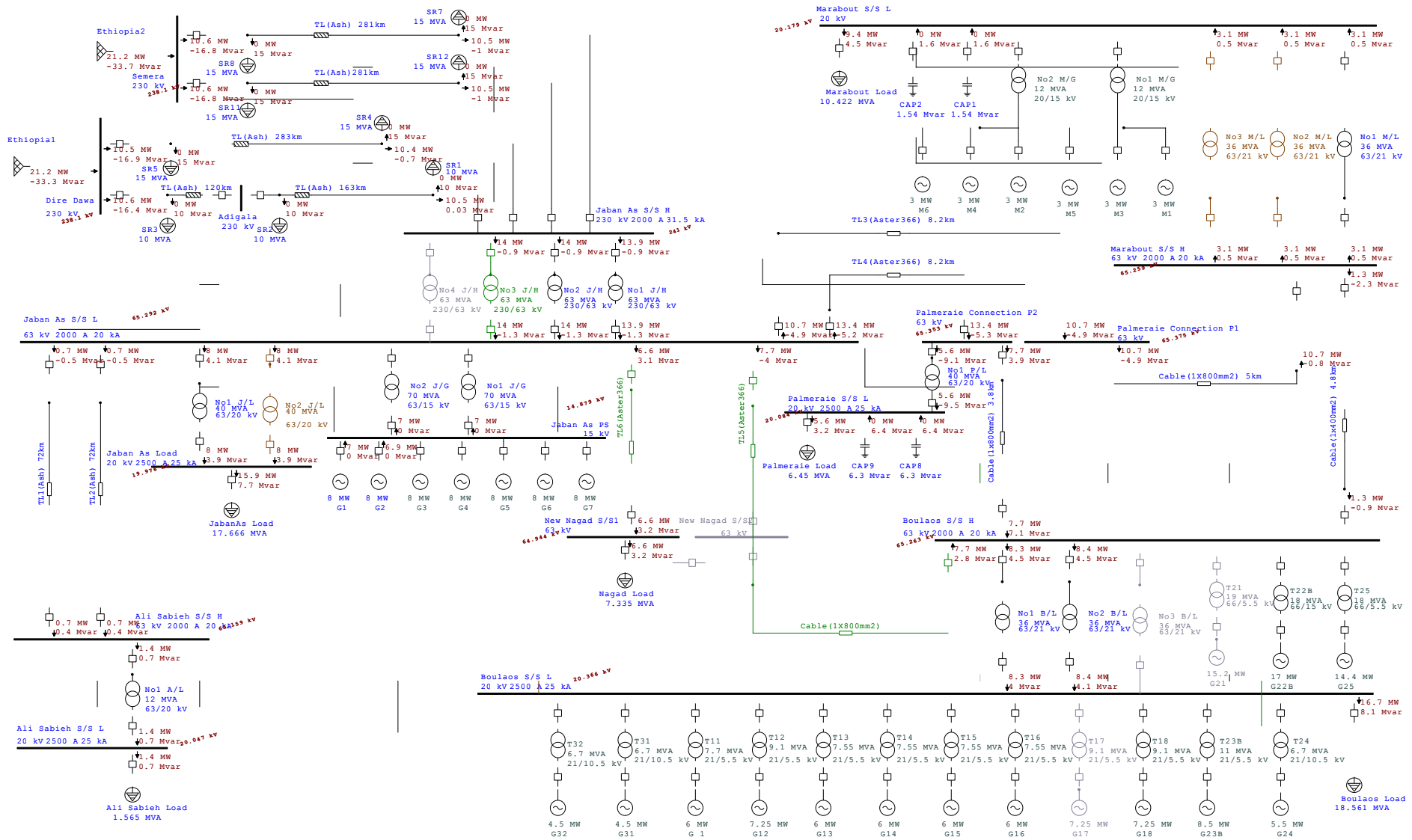


図 20 ロードフロー図 2025 年 (Case19)

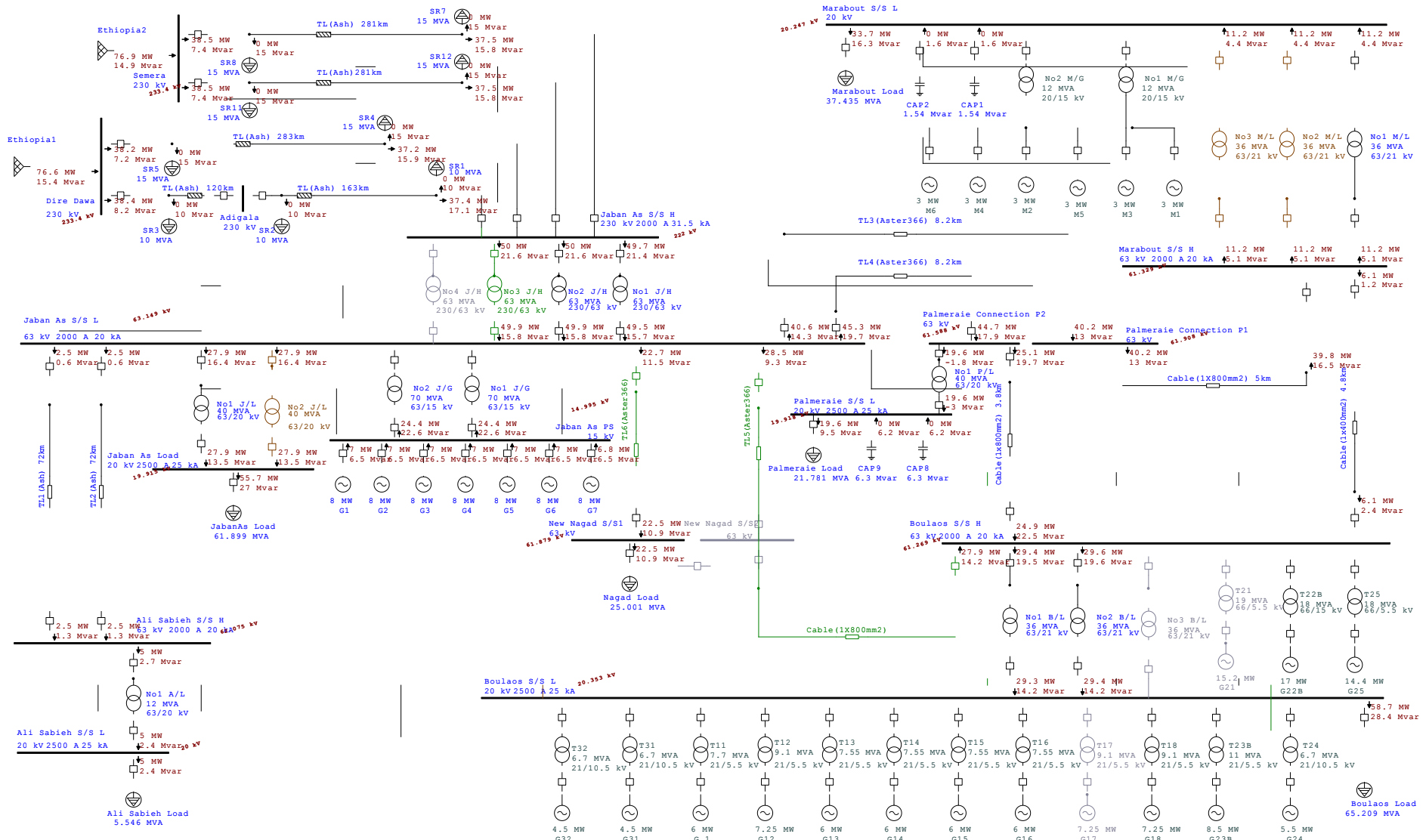


図 21 ロードフロー図 2026年 (Case20)

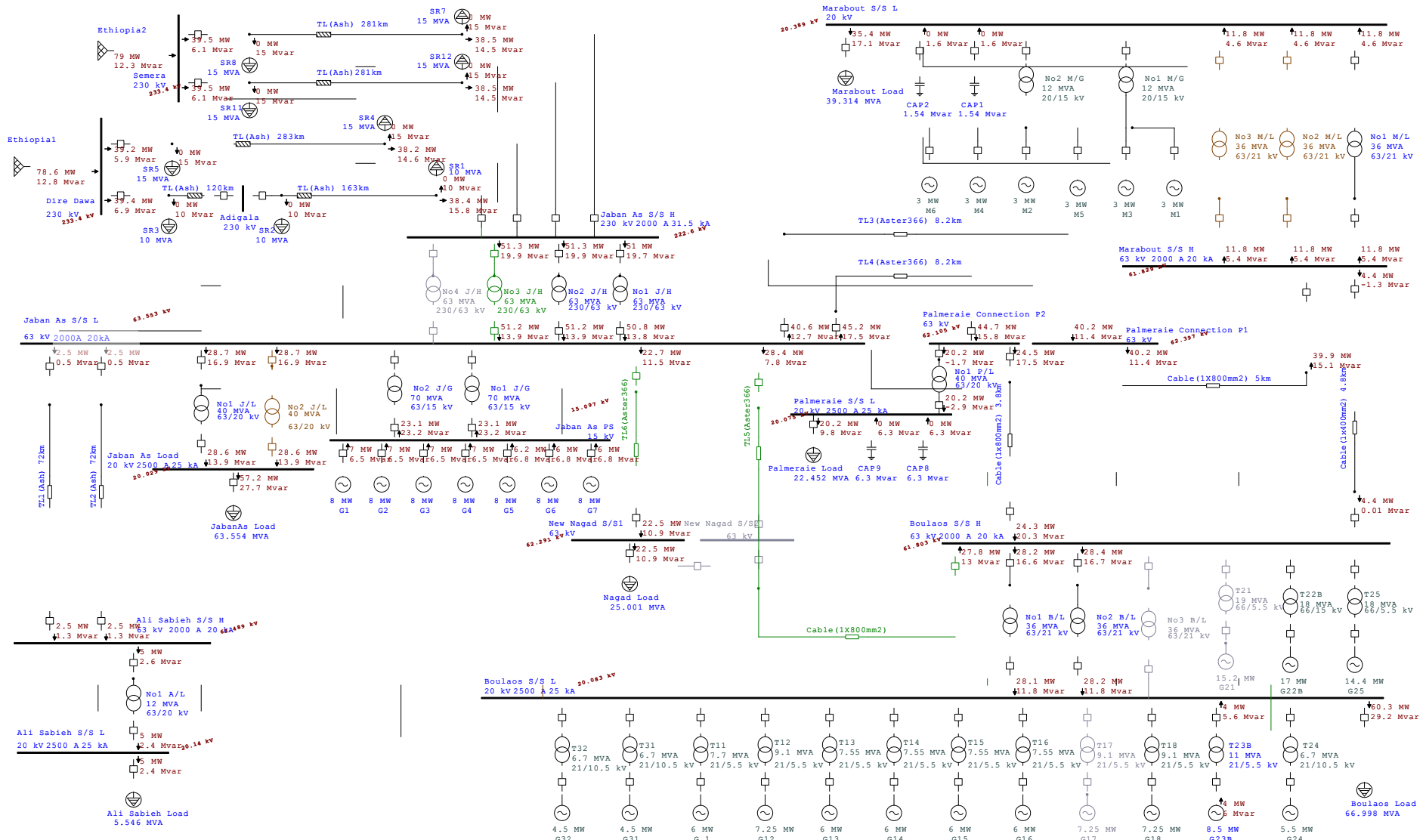


図 22 ロードフロー図 2027 年 (Case21)

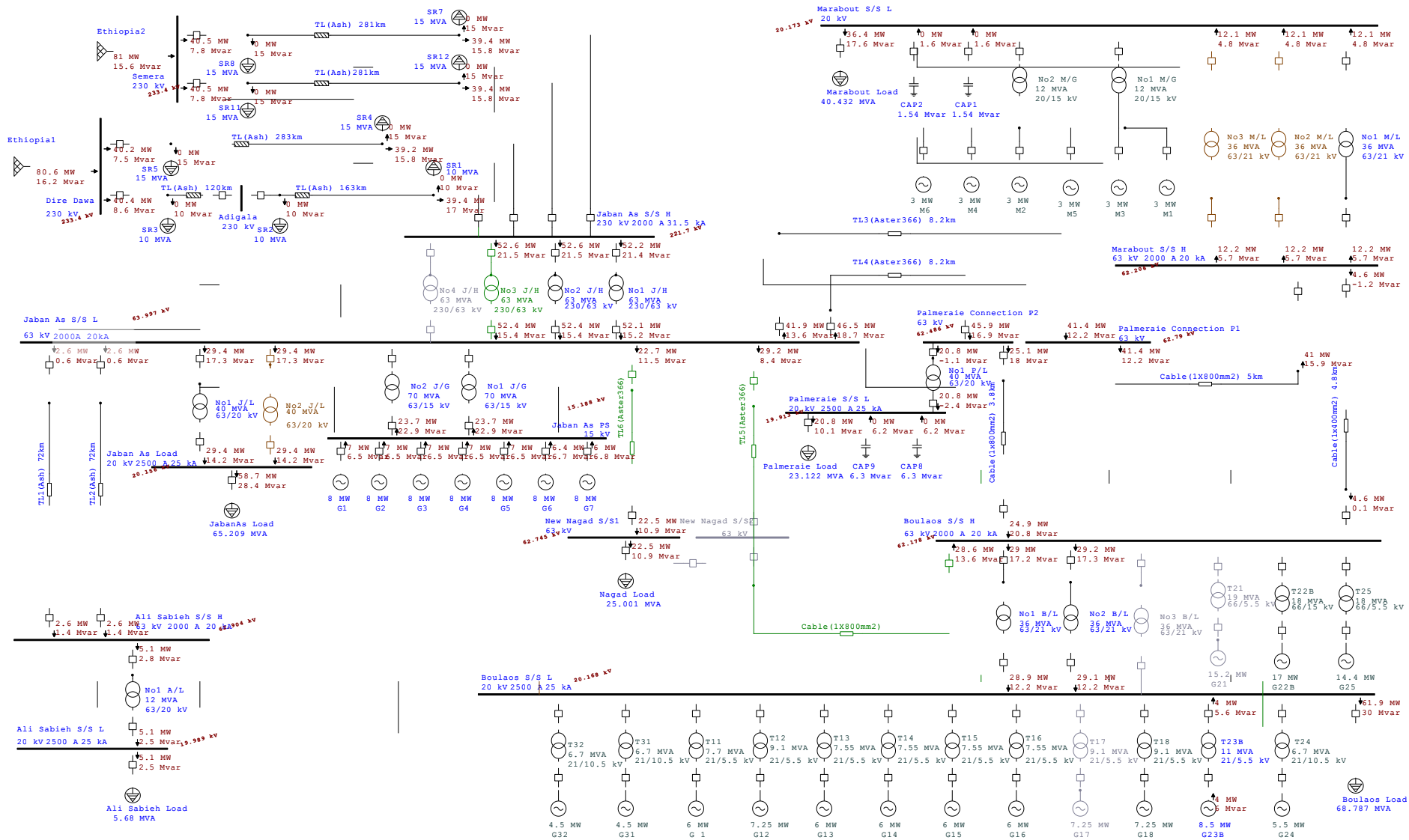


図 23 ロードフロー図 2028 年 (Case22)

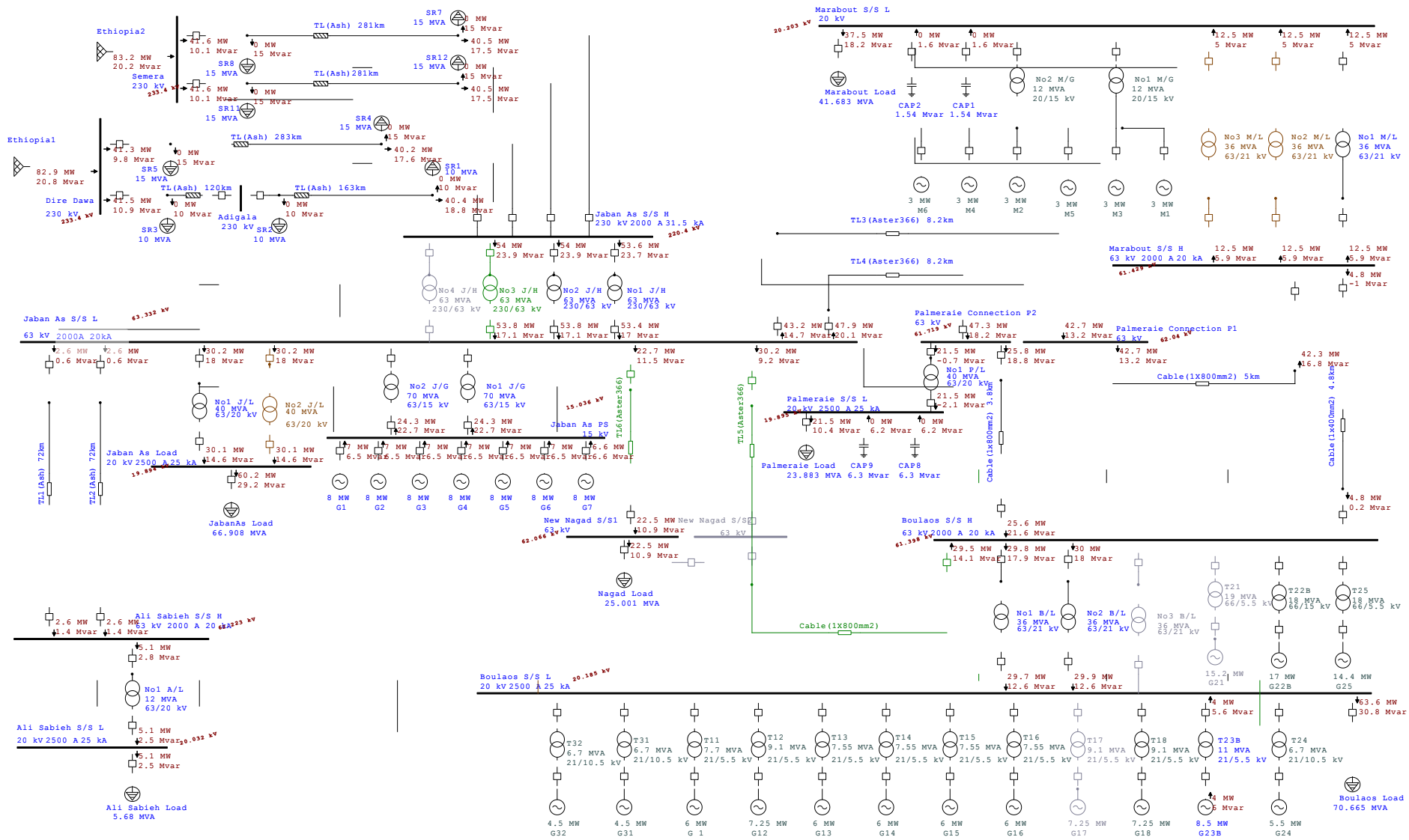


図 24 ロードフロー図 2029 年 (Case23)

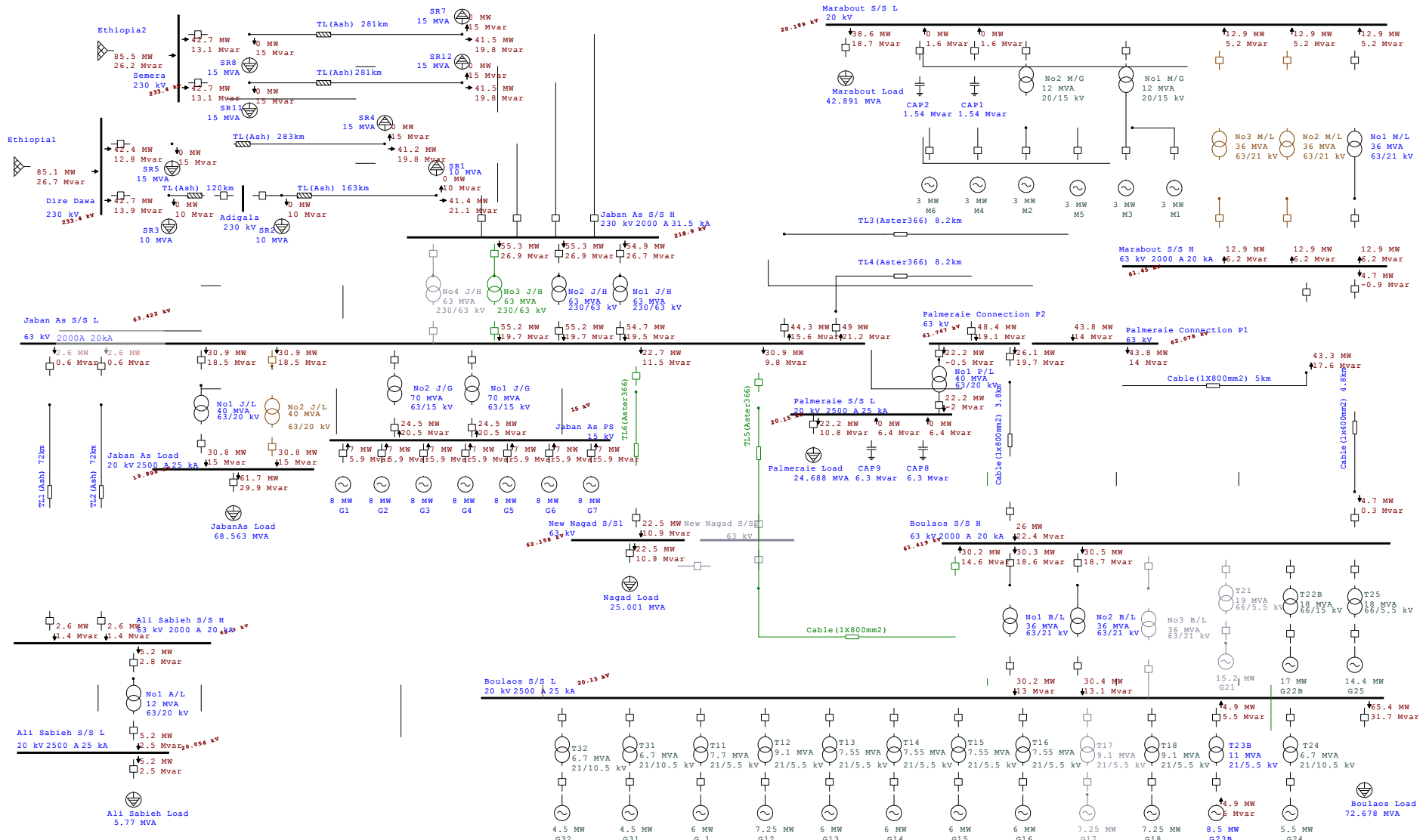


図 25 ロードフロー図 2030 年 (Case24)

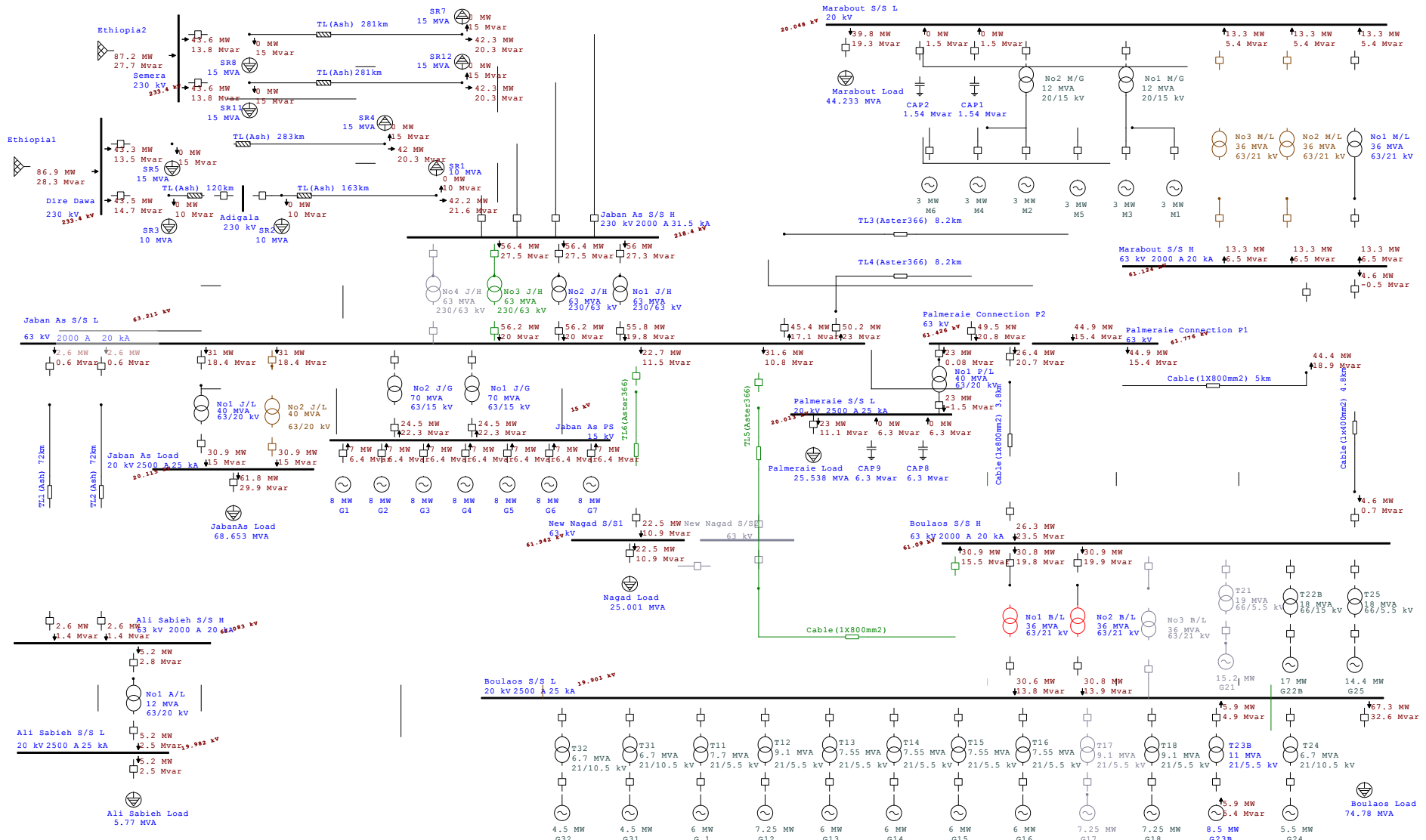


図 26 ロードフロー図 2031 年 (Case25)

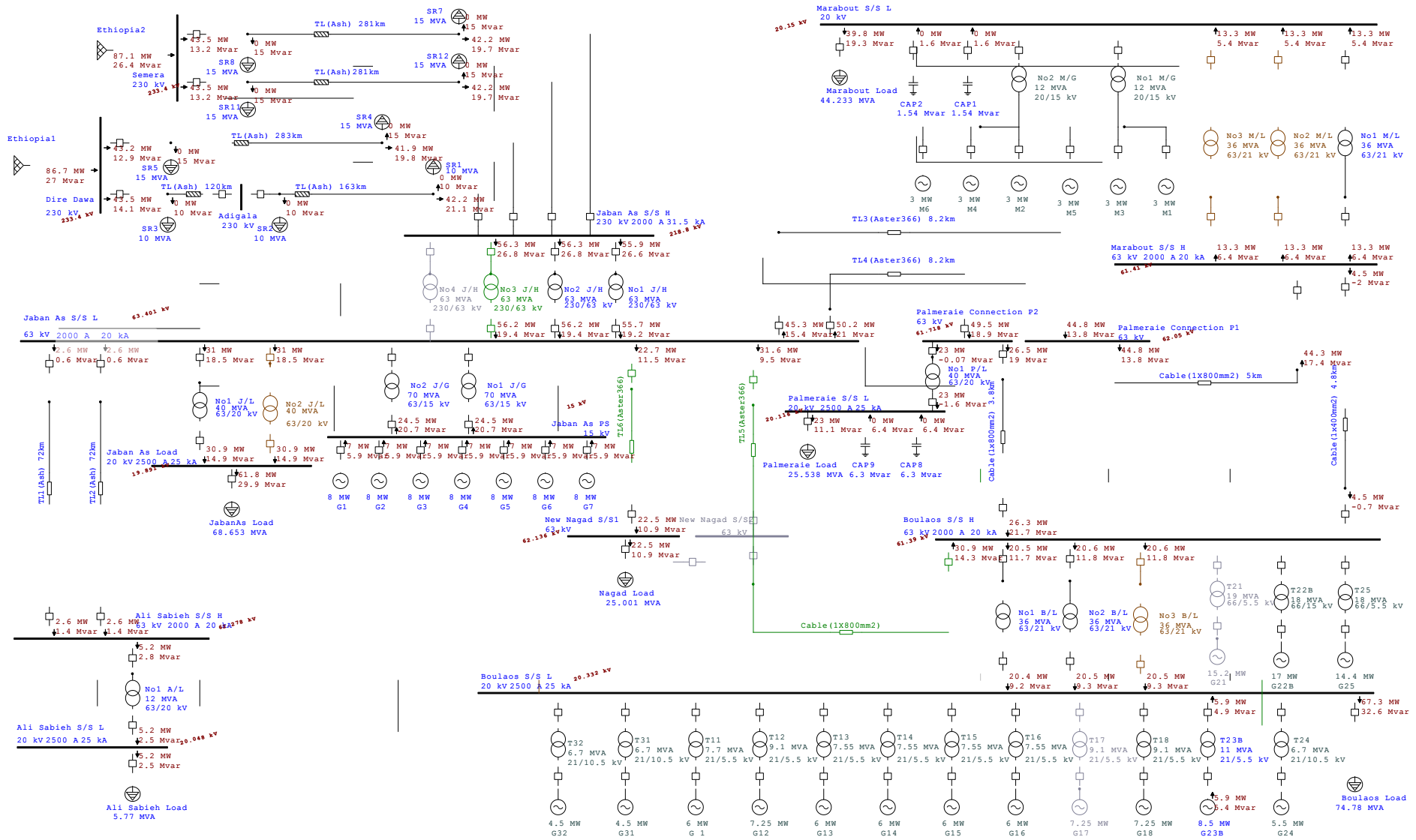


図 27 ロードフロー図 2031 年 (Case26)

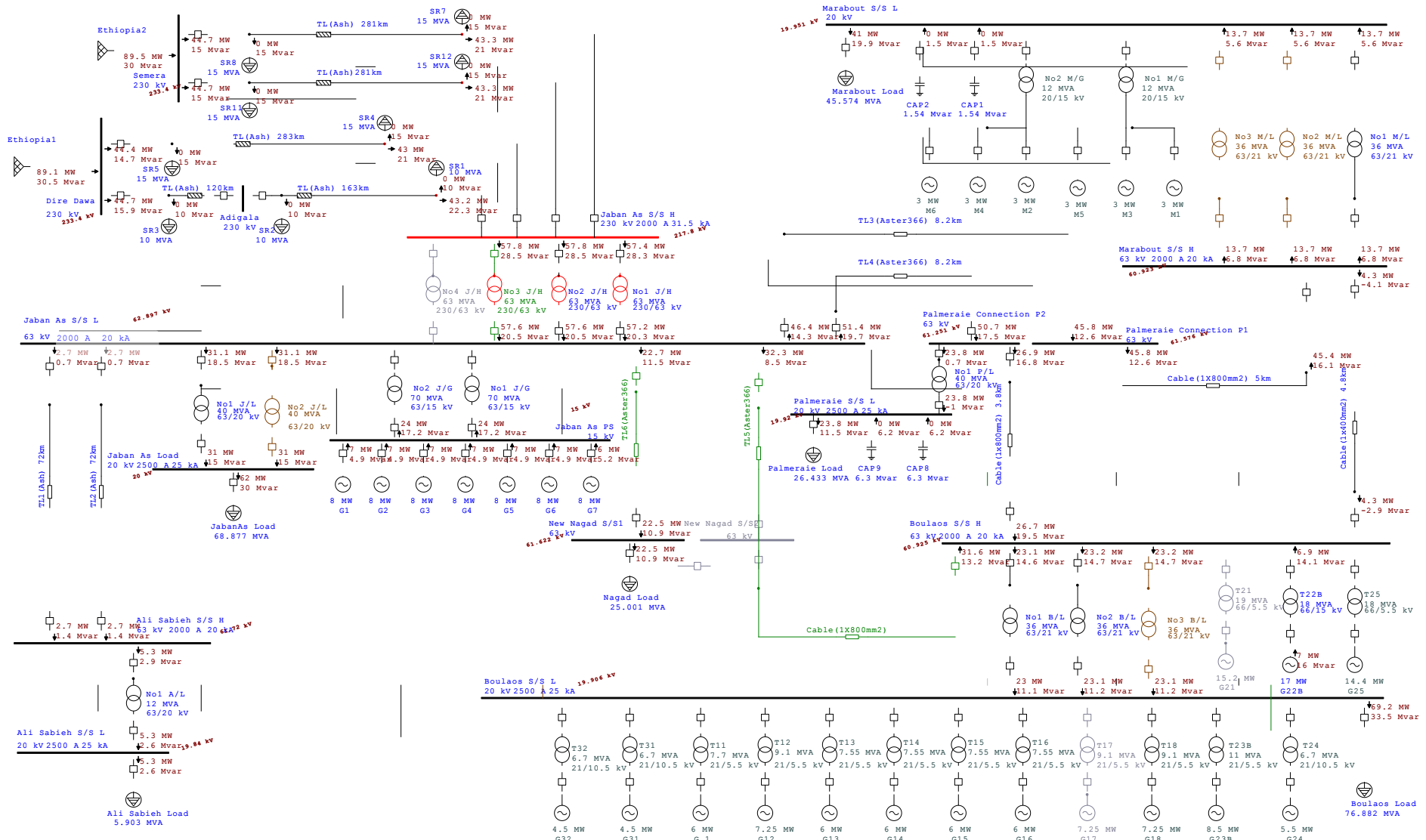


図 28 ロードフロー図 2032 年 (Case27)

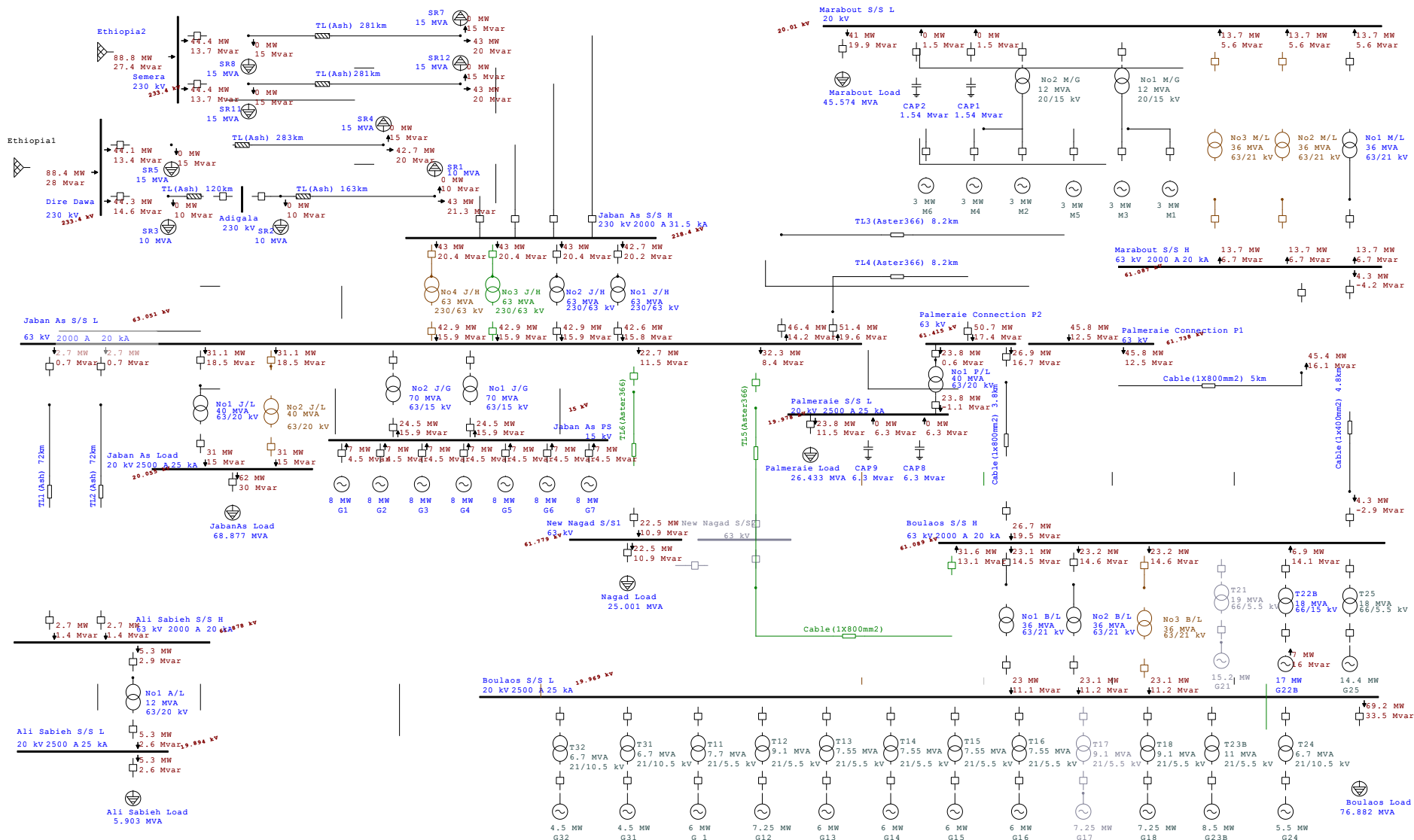


図 29 ロードフロー図 2032 年 (Case28)

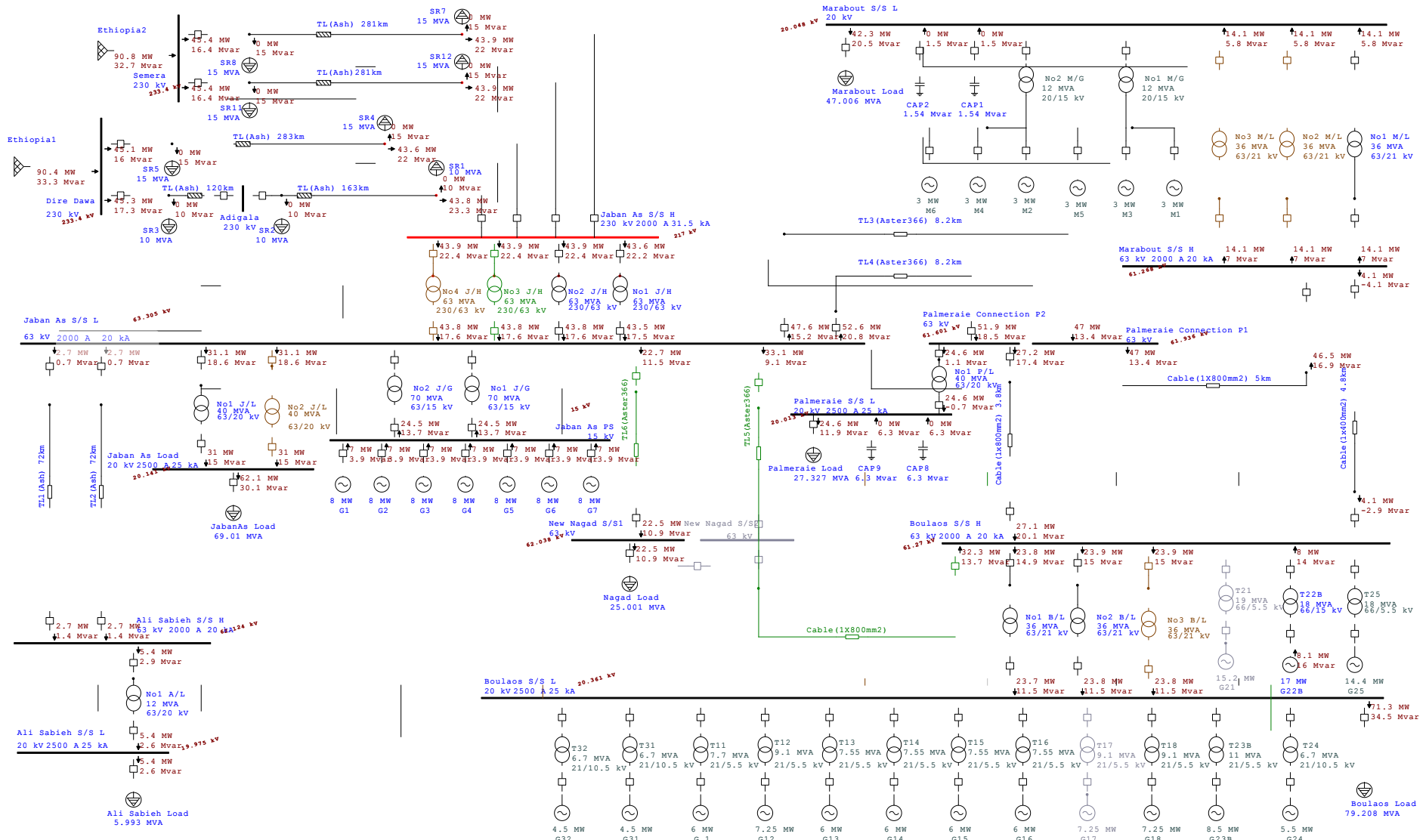


図 30 ロードフロー図 2033 年 (Case29)

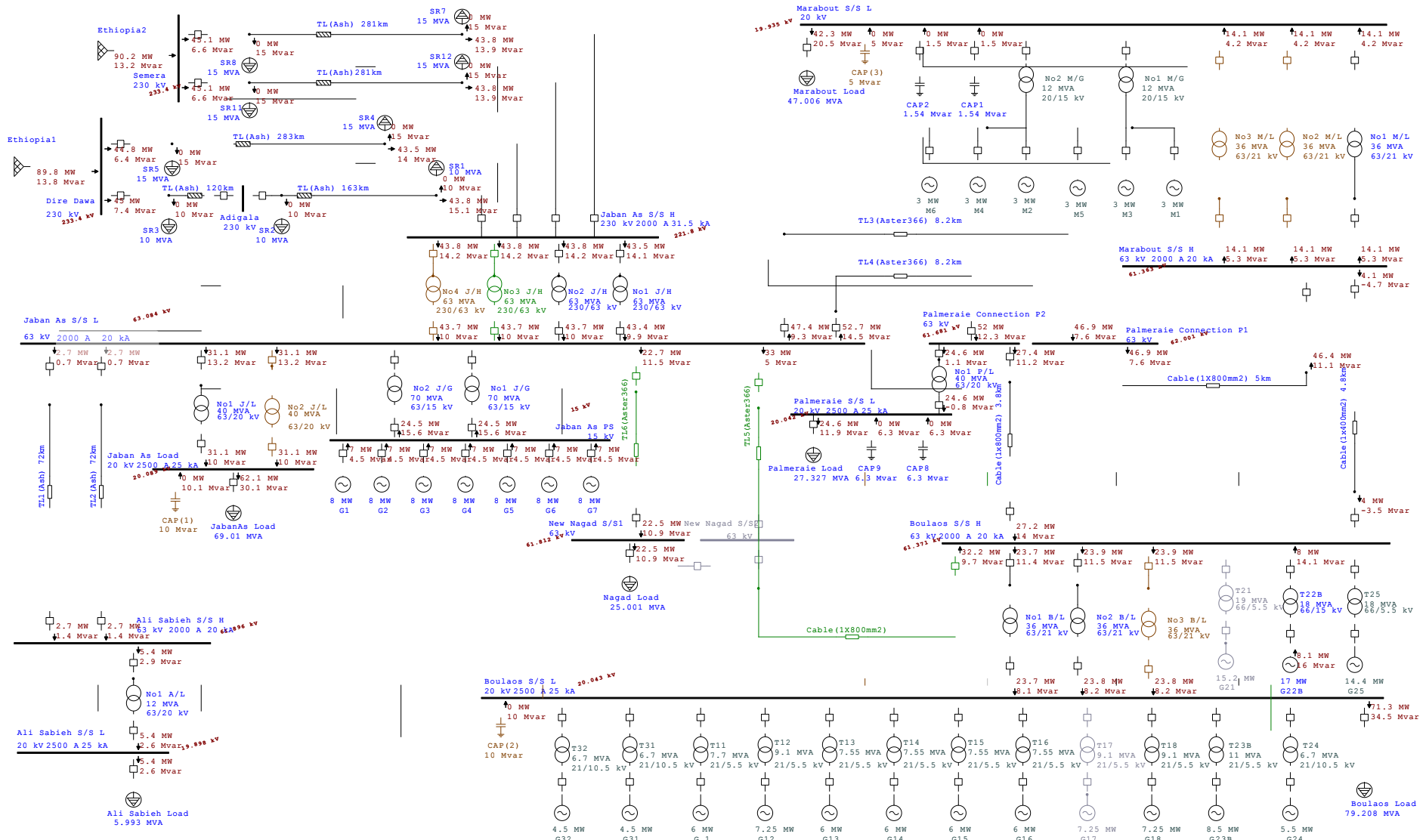


図 31 ロードフロー図 2033 年 (Case30)

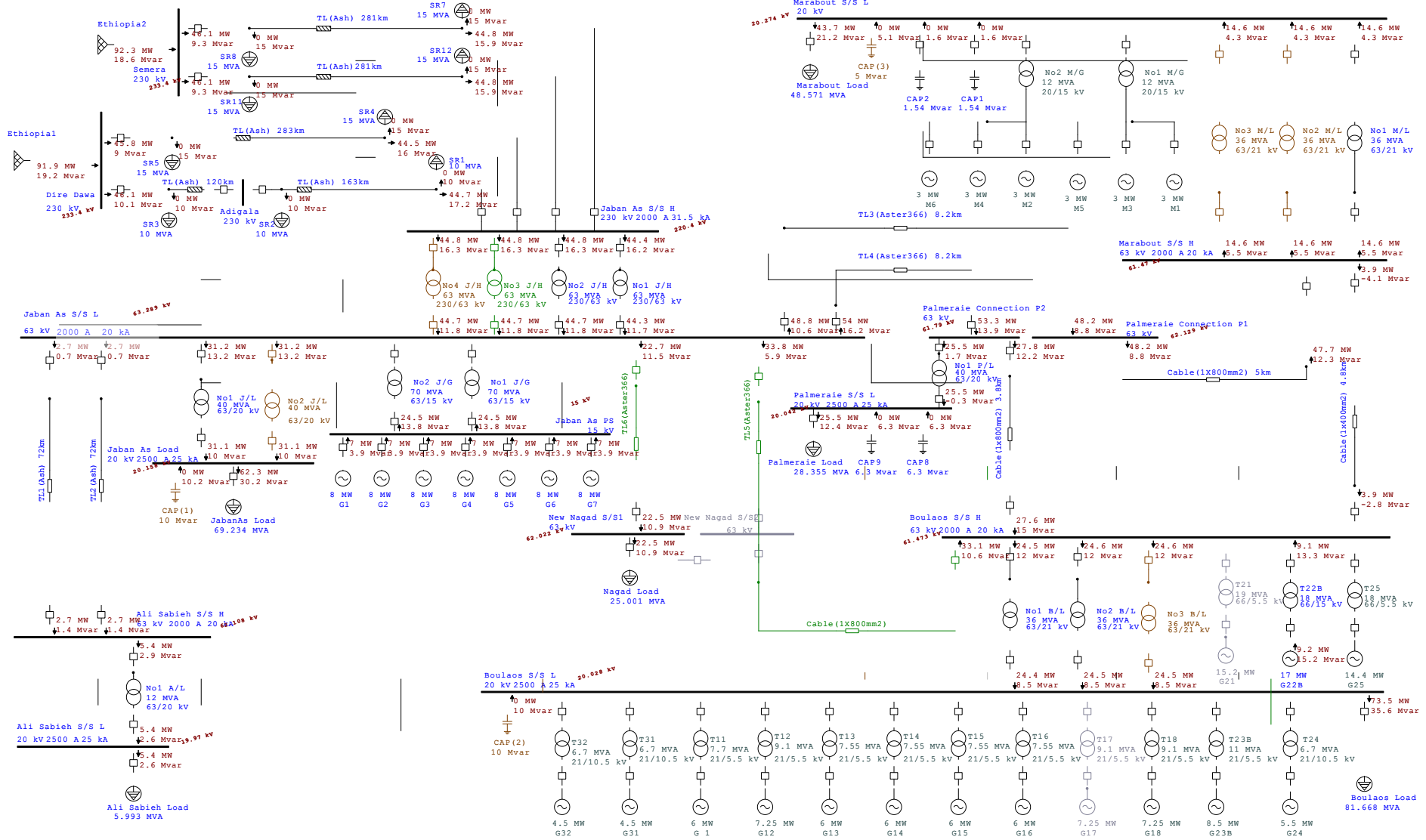


図 32 ロードフロー図 2034 年 (Case31)

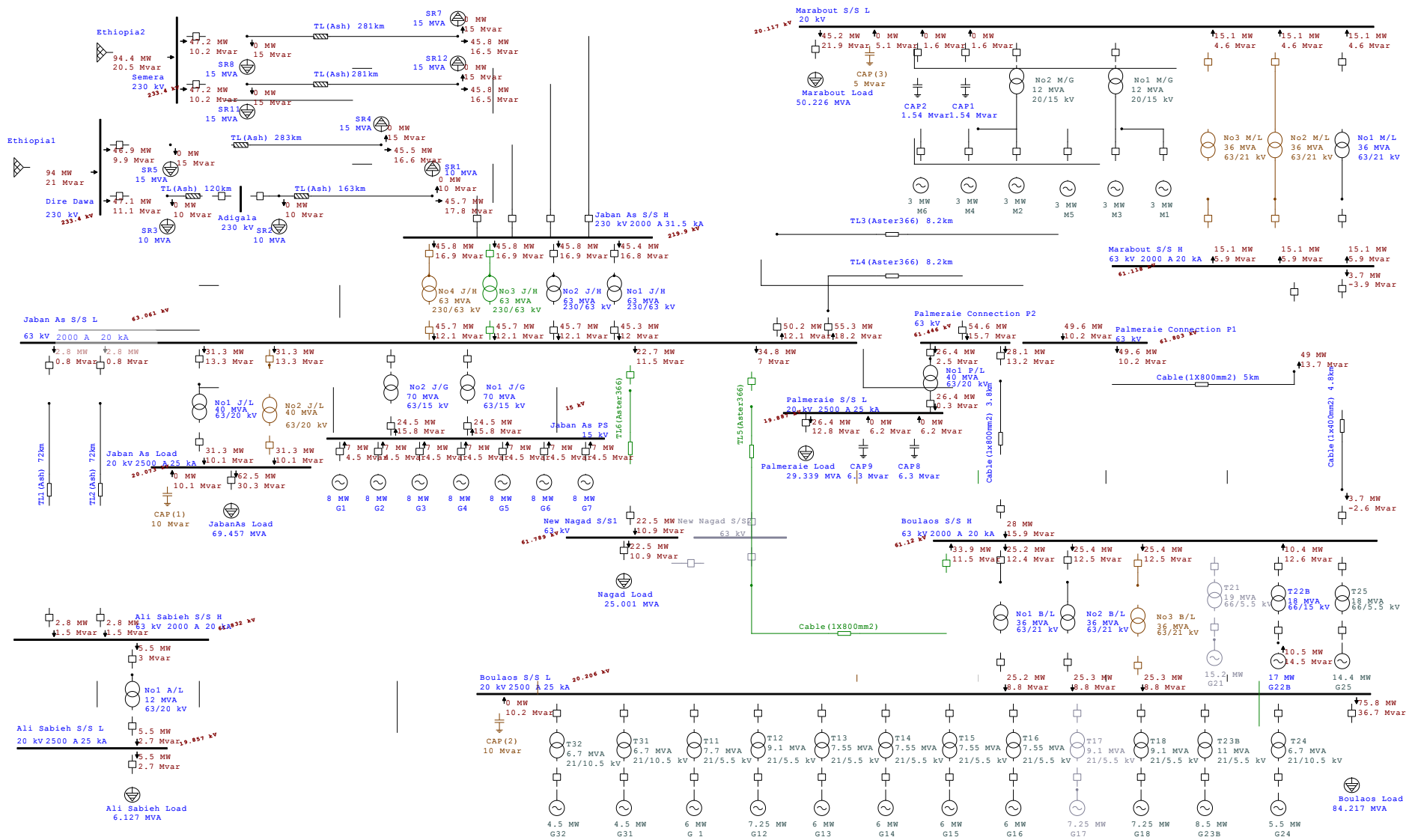


図 33 ロードフロー図 2035 年 (Case32)

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