OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as "developed", "industrialized" and "developing" are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by UNIDO.

FAIR USE POLICY

Any part of this publication may be quoted and referenced for educational and research purposes without additional permission from UNIDO. However, those who make use of quoting and referencing this publication are requested to follow the Fair Use Policy of giving due credit to UNIDO.

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

BANKABLE FEASIBILITY STUDY FOR THE ERECTION OF A SECOND GENERATION INTEGRATED STEEL MILL IN WEST OR EAST JAVA

UNIDO CONTRACT Nº 92/096
PROJECT Nº: US/INS/91/183
ACTIVITY CODE: J 14101

SUPPLEMENTARY SERVICES FOR
ENGINEERING AND TECHNOLOGY DESIGN
FINAL REPORT

prepared by

CONSORTIUM
ÖSTERREICHISCHE PLANUNGSGES.M.B.H.
AUSTROPLAN
AUSTRIAN ENGINEERING COMPANY LIMITED
VAI

JANUARY 1994

BANKABLE FEASIBILITY STUDY FOR THE ERECTION OF A SECOND GENERATION INTEGRATED STEEL MILL IN WEST OR EAST JAVA

UNIDO CONTRACT Nº 92/096
PROJECT Nº: US/INS/91/183
ACTIVITY CODE: J 14101

SUPPLEMENTARY SERVICES FOR
ENGINEERING AND TECHNOLOGY DESIGN
FINAL REPORT

prepared by

CONSORTIUM
ÖSTERREICHISCHE PLANUNGSGES. M. B. H.
AUSTROPLAN
AUSTRIAN ENGINEERING COMPANY LIMITED
VAI

JANUARY 1994

INDEX

1. BLAST FURNACE - BASIC OXYGEN FURNACE 1

1.1 GENERAL ROUTE DESCRIPTION 1

1.1.1 SIMPLIFIED PROCESS FLOW 1

1.1.2 BASIC MATERIALS FOR IRON AND STEELMAKING 2

1.1.3 COKING PLANT 2

1.1.4 BENEFICIATING IRON ORES 3

1.1.5 PRODUCTION OF PIG IRON / BLAST FURNACE (BF) 3

1.1.6 STEELMAKING PROCESS 4

1.2 COKING PLANT 4

1.2.1 ENVIRONMENTAL ASPECTS 5

1.2.2 MAIN MACHINERY AND EQUIPMENT 6

1.2.3 EQUIPMENT LIST OF COKING PLANT 14

1.2.4 PRODUCT BALANCE 17

1.2.5 CONSUMPTION FIGURES 18

1.2.6 IMPORT REQUIREMENTS - EXPORT FIGURES:
ENERGY AND UTILITIES 19

1.3 SINTER PLANT 21

1.3.1 EQUIPMENT LIST OF SINTER PLANT 21

1.3.2 PLANT BALANCE 22

1.3.3 COMSUMPTION 23

1.4 BLAST FURNACE 23

E:\projekte\pits-bo\phase-2\annex-3\corex-25.wp5

1.4.1 MAIN EQUIPMENT AND MACHINERY 23

1.4.2 EQUIPMENT LIST OF BLAST FURNACE 31

1.4.3 PRODUCT BALANCE 34

1.4.4 CONSUMPTION FIGURES 35

1.5 STEEL MELT SHOP 41

1.5.1 EQUIPMENT LIST OF LD-PLANT 41

1.5.2 PERFORMANCE CALCULATION 44

1.5.3 PLANT BALANCE 45

1.5.4 ANNUAL OUTPUT APPROX 2.42 MN T/A CRUDE STEEL 45

1.6 THIN SLAB CASTING AND ROLLING PLANT 47

1.6.1 CONTINUOUS CASTING PLANT 47

1.6.1.1 EQUIPMENT LIST (CONTINUOUS CASTING PLANT - THIN SLAB) 47

1.6.1.2 BASIC TECHNICAL DATA 48

1.6.2 HOT ROLLING MILL FOR THIN SLABS 49

1.6.2.1 EQUIPMENT LIST (THIN SLAB ROLLING MILL) 49

1.6.2.2 BASIC TECHNICAL DATA 51

1.7 AUXILIARY PLANTS 52

1.7.1 LIME PLANT 52

1.7.1.1 EQUIPMENT LIST OF LIME PLANT 52

1.7.1.2 BASIC DATA 54

1.7.1.3 CONSUMPTION 55

1.7.2 PRE-PRODUCTION FACILITIES 56

E:\projekte\pts-bolphase-2\annex-3\corex-25.wp5

1.7.2.1 IH 12 RAW MATERIAL STORAGE YARD 56

1.7.2.2 IH 14 SCRAP HANDLING AND TREATMENT 56

1.7.3 PERIPHERAL FACILITIES 56

1.7.3.1 IH 46 AIR SEPARATION PLANT 56

1.7.3.2 IH 48 SLAG HANDLING AND TREATMENT 58

1.7.3.3 IH 49 SCALE HANDLING AND TREATMENT 58

1.7.4 MAINTENANCE AND STORES 59

1.7.4.1 IH 51 CENTRAL MECHANICAL WORKSHOP 59

1.7.4.2 IH 52 CENTRAL ELECTRICAL/ELECTRONIC WORKSHOP 59

1.7.4.3 IH 53 CENTRAL MECHANICAL WORKSHOP 59

1.7.4.4 IH 54 STORE FOR SPAREPARTS AND CONSUMABLES 59

1.7.4.5 IH 57 CENTRAL REFRACTORY STORE 59

1.7.4.6 IH 58 CENTRAL OPERATING PARTS STORE 59

1.7.5 INFORMATION 59

1.7.5.1 IH 61 PLANNING SYSTEM / MANGEMENT INFO 59

1.7.5.2 IH 63 GENERAL INFORMATION 59

1.7.5.3 IH 64 BASIC AUTOMATION 59

1.7.5.4 IH 67 CENTRAL LABORATORY 59

1.7.6 INFRASTRUCTURE AND AUXILIARY EQUIPMENT 59

1.7.6.1 IH 71 ADMINISTRATION BUILDING 59

1.7.6.2 IH 73 LOCKER BUILDING AND CANTEEN 59

1.7.6.3 IH 74 FIRST AID AND SECURITY FACILITIES 59

1.7.6.4 IH 75 FIRE ALARM AND FIRE FIGHTING SYSTEM 59

1.7.6.5 IH 77 ROAD TRANSPORT 59

1.7.6.6 IH 78 RAIL TRANSPORT 60

1.7.7 UTILITY SUPPLY/TREATMENT 61

1.7.7.1 IH 81 WATER SUPPLY/TREATMENT 61

1.7.7.2 IH 82 WATER CIRCUITS AND COOLING SYSTEMS 62

1.7.7.3 IH 83 INCOMBUSTIBLE GASES AND COMPRESSED AIR 62

1.7.7.4 IH 84 COMBUSTIBLE GASES 63

1.7.7.5 IH 86 STEAM / HOT WATER 64

1.7.8 ELECTRICAL EQUIPMENT 70

1.7.8.1 IH 91 HIGH VOLTAGE FACILITIES 70

1.7.8.2 IH 92 LOW VOLTAGE FACILITIES 70

1.7.8.3 IH 93 ELECTRICAL EQUIPMENT 70

1.7.8.4 IH 97 LIGHTING AND PLUG SOCKET SYSTEM 70

1.7.8.5 IH 98 LIGHTING AND EARTHING SYSTEM 70

1.7.8.6 IH 99 OTHER ELECTRICAL EQUIPMENT 71

1.8 HUMAN RESOURCES 74

1.8.1 ADMINISTRATION MANNING TABLES 74

1.9 MATERIAL BALANCE 75

1.10 TOTAL INVESTMENT COSTS 91

1.11 PROJECT IMPLEMENTATION SCHEDULE AND BUDGETING 92

E:\projekte\prks\bolphase-2\annex-3\corex-25.wp5

2. **COREX® BASIC OXYGEN FURNACE** ... 95

2.1 GENERAL ROUTE DESCRIPTION ... 95

2.1.1 BASIC MATERIALS FOR IRON AND STEELMAKING ... 96

2.1.2 COREX® PLANT ... 96

2.1.3 STEELMAKING PROCESS ... 97

2.1.4 THIN SLAB CASTING ... 98

2.1.5 HOT STRIP ROLLING 56" ... 98

2.2 COREX® PLANT ... 98

2.2.1 EQUIPMENT LIST OF COREX® PLANT ... 99

2.2.2 PERFORMANCE CALCULATION ... 101

2.2.2.1 YEARLY PRODUCTION TIME ... 101

2.2.2.2 AVAILABILITY ... 101

2.2.3 PLANT BALANCE ... 102

2.2.4 CONSUMPTION ... 102

2.3 STEEL MELT SHOP ... 103

2.3.1 EQUIPMENT LIST OF LD-PLANT ... 103

2.3.2 PERFORMANCE CALCULATION ... 108

2.3.2.1 YEARLY PRODUCTION TIME as per 2.2.2.1 ... 108

2.3.2.2 AVAILABILITY as per 2.2.2.2 ... 108

2.3.3 PLANT BALANCE ... 108

2.3.4 ANNUAL OUTPUT APPROX 2.42 MN T/A CRUDE STEEL ... 109

2.4 THIN SLAB CASTING AND ROLLING PLANT ... 110

2.4.1 CONTINUOUS CASTING PLANT (for 3 x 150 t LD (3/2)) 111

2.4.1.1 EQUIPMENT LIST (CONTINUOUS CASTING PLANT - THIN SLAB) 111

2.4.1.2 BASIC TECHNICAL DATA 112

2.4.2 HOT ROLLING MILL FOR THIN SLABS 113

2.4.2.1 EQUIPMENT LIST (THIN SLAB ROLLING MILL) 113

2.4.2.2 BASIC TECHNICAL DATA 115

2.5 AUXILIARY PLANTS 115

2.5.1 LIME PLANT 115

2.5.1.1 EQUIPMENT LIST OF LIME PLANT 116

2.5.1.2 BASIC DATA 118

2.5.1.3 CONSUMPTION 119

2.5.2 PRE-PRODUCTION FACILITIES 119

2.5.2.1 IH 12 RAW MATERIAL STORAGE YARD 119

2.5.2.2 IH 14 SCRAP HANDLING AND TREATMENT 120

2.5.3 PERIPHERAL FACILITIES 120

2.5.3.1 IH 46 AIR SEPARATION PLANT 120

2.5.3.2 IH 48 SLAG HANDLING AND TREATMENT 123

2.5.3.3 IH 49 SCALE HANDLING AND TREATMENT 123

2.5.4 MAINTENANCE AND STORES 123

2.5.4.1 IH 51 CENTRAL MECHANICAL WORKSHOP 123

2.5.4.2 IH 52 CENTRAL ELECTRICAL/ELECTRONIC WORKSHOP 123

2.5.4.3 IH 53 CENTRAL MECHANICAL WORKSHOP 123

2.5.4.4 IH 54 STORE FOR SPARE PARTS AMD CONSUMABLES 123

2.5.4.5 IH 57 CENTRAL REFRACTORY STORE 123

2.5.4.6 IH 58 CENTRAL OPERATING PARTS STORE 123

2.5.5 INFORMATION 123

2.5.5.1 IH 61 PLANNING SYSTEM/MANAGEMENT INFO 123

2.5.5.2 IH 63 GENERAL INFORMATION 123

2.5.5.3 IH 64 BASIC AUTOMATION 123

2.5.5.4 IH 67 CENTRAL LABORATORY 123

2.5.6 INFRASTRUCTURE AND AUXILIARY EQUIPMENT 123

2.5.6.1 IH 71 ADMINISTRATION BUIDLING 123

2.5.6.2 IH 73 LOCKER BUILDING AND CANTEEN 123

2.5.6.3 IH 74 FIRST AID AND SECURITY FACILITIES 123

2.5.6.4 IH 75 FIRE ALARM AND FIRE FIGHTING SYSTEM 123

2.5.6.5 IH 77 ROAD TRANSPORT 124

2.5.7 UTILITY SUPPLY/TREATMENT 125

2.5.7.1 IH 81 WATER SUPPLY/TREATMENT 125

2.5.7.2 IH 82 WATER CIRCUITS AND COOLING SYSTEMS 126

2.5.7.3 IH 83 INCOMBUSTIBLE GASES AND COMPRESSED AIR 126

2.5.7.4 IH 84 COMBUSTIBLE GASES 127

2.5.7.5 IH 86 STEAM / HOT WATER 128

2.5.8 ELECTRICAL EQUIPMENT 133

2.5.8.1 IH 91 HIGH VOLTAGE FACILITIES 133

2.5.8.2 IH 92 LOW VOLTAGE FACILITIES 133

2.5.8.3 IH 93 ELECTRICAL EQUIPMENT 133

2.5.8.4 IH 97 LIGHTING AND PLUG SOCKET SYSTEM 133

2.5.8.5 IH 98 LIGHTING AND EARTHING SYSTEM 133

2.5.8.6 IH 99 OTHER ELECTRICAL EQUIPMENT 133

2.6 HUMAN RESOURCES 137

2.7 MATERIAL BALANCE 138

2.8 TOTAL INVESTMENT COSTS 150

2.9 PROJECT IMPLEMENTATION SCHEDULE AND BUDGETING 151

3. **SEA PORT** 154

3.1 INTRODUCTION 154

3.2 BASIC DATA 155

3.2.1 MATERIALS TO BE LOADED/UNLOADED 155

3.2.1.1 MATERIALS 155

3.2.1.2 SUPPLY CONDITIONS OF MATERIALS 155

3.2.1.3 STORAGE CAPACITY 156

3.2.2 WORKING TIME AND TIME BALANCE 157

3.3 GENERAL CONCEPT 159

3.4 GENERAL DESCRIPTION OF THE NEW HARBOUR 160

3.5 MANPOWER 161

3.6 COST ESTIMATE 161

4.3.1.1 NATURAL GAS - COREX® GAS 163

4.3.1.2 ELECTRIC ENERGY SUPPLY 164

4.4 SCENARIOS OF COMBINATION BETWEEN PTKS AND THE SGSM 167

4.4.1 BASIS 167

4.4.2 POSSIBLE TECHNOLOGICAL VARIANTS 169

4.5 CONCLUSION 176

Tables

Table 1: Contaminants in Waste Water ... 6
Table 2: Equipment List of Coking Plant ... 14
Table 3: Product Balance ... 17
Table 4: Consumption Figures ... 18
Table 5: Requirements of Energy and Utilities ... 19
Table 6: Equipment List of Sinter Plant ... 21
Table 7: Plant Balance ... 22
Table 8: Consumption Figures ... 23
Table 9: Caloric Energy ... 28
Table 10: Electric Energy Requirements ... 29
Table 11: Equipment List of Blast Furnace ... 31
Table 12: Product Balance ... 34
Table 13: Consumption Figures ... 35
Table 14: Equipment List of LD-Plant ... 41
Table 15: Plant Balance ... 45
Table 16: Annual Output approx. 2.42 mn t/a Crude Steel ... 45
Table 17: Equipment List (Continuous Casting Plant - Thin Slab) ... 47
Table 18: Equipment List (Thin Slab Rolling Mill) ... 49
Table 19: Equipment List of Lime Plant ... 52
Table 20: Consumption Figures ... 55
Table 21: Gas Productions ... 56
Table 22: Gas requirements ... 58
Table 23: Electrical Energy ... 58
Table 24: List of Vehicles ... 59
Table 26: Water Requirements ... 61
Table 27: Cooling Systems / Heat Transfers ... 62
Table 28: Incombustible Gas Requirements ... 62
Table 29: Plant Balance of Combustible Gases ... 63
Table 30: Steam Balance ... 64
Table 31: Equipment List for Auxiliaries ... 70
Table 32: Electric Energy Consumption ... 71
Table 33: Equipment List of Integration Facilities ... 71
Table 35: Administrative Personnel Requirements ... 74
Table 36: Projection of quantities and cost of raw materials and supplies ... 90
Table 37: Total Investment Costs (in 1,000 US$) ... 91
Table 38: Implementation Budgeting ... 94
Table 39: Equipment List of COREX®-Plant (2 + 1 Module) ... 99
Table 40: Yearly Production Time ... 101
Table 41: Availability ... 101
Table 42: Plant Balance ... 102

Table 43: Consumption 103
Table 44: Equipment List of LD-Plant 103
Table 45: Plant Balance 108
Table 46: Annual Output approx 2.42 mn t/a Crude Steel 109
Table 47: Equipment List (Continuous Casting Plant - Thin Slab) 111
Table 48: Equipment List (Thin Slab Rolling Mill) 113
Table 49: Equipment List of Lime Plant 116
Table 50: Consumption 119
Table 51: Gas Productions 120
Table 52: Gas Requirements 121
Table 53: Electrical Energy 121
Table 54: List of Vehicles 124
Table 55: Water Consumption 125
Table 56: Cooling Systems / Heat Transfers 126
Table 57: Gas and air flows in Qn = m^3/h (Average values) 126
Table 58: Plant Balance of Combustible Gases 127
Table 59: Steam Balance 128
Table 60: Equipment List for Auxiliaries 133
Table 61: Electric Energy Consumption 134
Table 62: Equipment List of Integration Facilities 134
Table 63: Manning Schedule Operational Personnel including Provisions for Vacation and Sick Leave 137
Table 64: Administrative Personnel Requirements 137
Table 65: Projection of quantities and cost of raw materials and supplies 149
Table 66: Total Investment Costs (in 1,000 US$) 150
Table 67: Implementation Budgeting 153
Table 68: Graded Matrix 169

Figures

Fig. 1: Simplified Process Flow 1
Fig. 2: Simplified Scheme of Coke Making 20
Fig. 3: Cross-section of a blast furnace and hot-blast stove 36
Fig. 4: Reaction Zones in a Blast Furnace 37
Fig. 5: Internal Situation of a Blast Furnace 38
Fig. 6: Top Gas Cleaning System 39
Fig. 7: Coal Injection System 40
Fig. 8: Air Separation Plant / Process Flow 57
Fig. 9: Steam Plant Balance 65
Fig. 10: Proposed Disposition of Burners in Existing Boiler 66
Fig. 11: Section through Burner for 120 MW_{therm} 67
Fig. 12: IH84 Combustible Gases / Plant Balance 68
Fig. 13: IH84 Combustible Gas / Process Flow 69
Fig. 14: Specific Consumption Figures - Lime Plant (per tonne product) 75
Fig. 15: Annual Consumption Figures - Lime Plant 76
Fig. 16: Specific Consumption Figures - Coking Plant (per tonne product) 77
Fig. 17: Annual Consumption Figures - Coking Plant 78
Fig. 18: Specific Consumption Figures - Sinter Plant (per tonne product) 79
Fig. 19: Annual Consumption Figures - Sinter Plant 80
Fig. 20: Specific Consumption Figures - Blast Furnace (per tonne product) 81
Fig. 21: Annual Consumption Figures - Blast Furnace 82
Fig. 22: Specific Consumption Figures - LD-Plant (per tonne product) 83
Fig. 23: Annual Consumption Figures - LD-Plant 84
Fig. 24: Specific Consumption Figures - Thin Slab Caster (per tonne product) 85
Fig. 25: Annual Consumption Figures - Thin Slab Caster 86
Fig. 26: Specific Consumption Figures - Thin Slab Mill (per tonne product) 87
Fig. 27: Annual Consumption Figures - Thin Slab Mill 88
Fig. 28: Material Flow Sheet 89
Fig. 29: Project Implementation 93
Fig. 30: Simplified process flow 95
Fig. 31: Air Separation Plant 122
Fig. 32: Steam Plant Balance 129
Fig. 33: Proposed Disposition of Burners in Existing Boiler 130
Fig. 34: Section through Burner for 120 MW_{therm} 131
Fig. 35: IH 84 Combustible Gas / Plant Balance 132
Fig. 36: Specific Consumption Figures - Lime Kiln (per tonne product) 138
Fig. 37: Annual Consumption Figures - Lime Kiln 139
Fig. 38: Specific Consumption Figures - COREX® Plant (per tonne product) 140
Fig. 39: Annual Consumption Figures - COREX® Plant 141
Fig. 40: Specific Consumption Figures - LD-Plant (per tonne product) 142

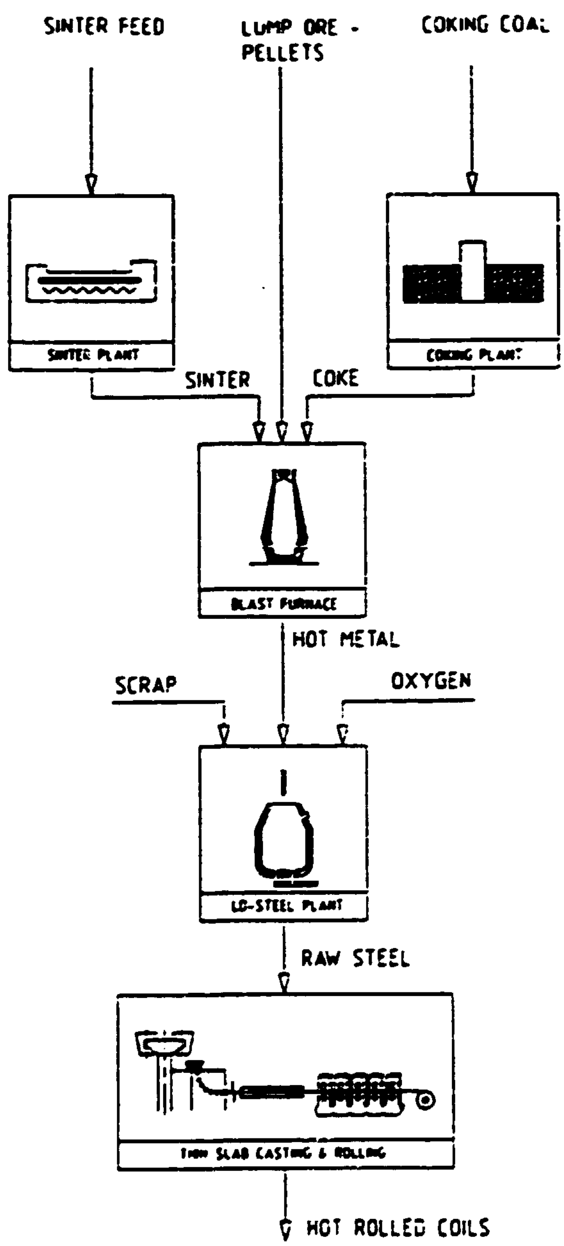
Fig. 41: Annual Consumption Figures - LD-Plant 143
Fig. 42: Specific Consumption Figures - Thin Slab Caster (per tonne product) 144
Fig. 43: Annual Consumption Figures - Thin Slab Caster 145
Fig. 44: Specific Consumption Figures - Thin Slab Mill (per tonne product) 146
Fig. 45: Annual Consumption Figures - Thin Slab Mill 147
Fig. 46: Material Flow Sheet 148
Fig. 47: Project Implementation 152
Fig. 48: Production Figures of PTKS (after ongoing expansion projects) 170
Fig. 49: Integration SGSM (COREX 1.55 mnt/a HRC) with existing PTKS 172
Fig. 50: Integration SGSM (COREX 1.55 mnt/a HRC) with PTKS 173
Fig. 51: Integration SGSM (COREX 1.55 mnt/a HRC) with PTKS 174
Fig. 52: Integration SGSM (2.5 mnt/a Crude Steel) with existing PTKS 175

1. BLAST FURNACE - BASIC OXYGEN FURNACE

1.1 GENERAL ROUTE DESCRIPTION

1.1.1 SIMPLIFIED PROCESS FLOW

Fig. 1 : Simplified Process Flow



1.1.2 BASIC MATERIALS FOR IRON AND STEELMAKING

- Iron ore for sinterfeed
  Assumption: 62 % Fe (dry basis), 4 % moisture
  Origin: Australia, Brazil, India, (Vietnam)
  Requirement: ~ 2,660,000 t/a

- Lump ore (as coolant directly into BF)
  Assumption: 62 % Fe (dry basis)
  Origin: Australia
  Requirement: ~ 940,000 t/a

- Coal:
  Assumption and
  Origin: Blend of Australian coking coal
  Indonesian (Ombilin) steam coal
  Requirement: ~ 535,000 t/a ex Australia, dry basis
  ~ 770,000 t/a ex Indonesia, dry basis

- Other Basic Materials
  - Limestone ~ 925,000 t/a
  - Dolomite ~ 220,000 t/a
  - Coke Fines ~ 130,000 t/a
  - Manganese Ore ~ 75,000 t/a
  - Anthracite ~ 403,000 t/a
  - Scrap ~ 176,000 t/a
  - Ferro Alloys ~ 30,000 t/a

  The majority of above materials are of indigenous origin.

1.1.3 COKING PLANT

Coking coal normally blended from various sources is transformed by destructive distillation at about 1.250°C into metallurgical coke, which is cellular, porous and lumpy. This distillation process takes place in the coke oven, which consists of

- the coking chambers
- the heating chambers
- the regenerative chambers.

Coking coal is the main energy input into the blast furnace.

1.1.4 BENEFICIATING IRON ORES

Aim: Improvement of chemical and physical properties of the iron ore as charge into the blast furnace.

Methods:
- crushing
- screening
- blending
- concentrating
- agglomeration (sintering)

Sintering is a process which turns ore fines, flue dust, limestone and other additives into porous lumps of desire size for blast furnace feed. The mixture blended with coke fines as fuel is ignited on a travelling grate to form sinter between 20 to 50 mm grain size as blast furnace charge. Larger grains will be crushed, smaller grains will be reentered into the sintering process.

1.1.5 PRODUCTION OF PIG IRON / BLAST FURNACE (BF)

Aim:
- Reduction of the iron oxides
- Liquifying of the iron and impurities
- Separating the iron (pig iron) and impurities (slag) by specific weight.

Burden:
- Iron ore in the form of sinter and lump ore
- Coke as energy input and reductant of the iron oxides
- Flux as slag forming agent to bind coke ash and gangue (ore impurities)

Blast: Hot air together with pulverized coal as additive fuel as combusting agent of the burden to reach temperatures of 1,600 to 1,700°C required for reduction and smelting of the burden.

Process: Burden charged on the top of the BF slowly sinks to the bottom, the blast counter currently travelling from the bottom, where the combustion takes place, to the top.

Furnace Auxiliaries:

- Burden fines: storage of the various inputs of the burden
- Hot blast stoves: heating of the air up to 1,400°C in heat exchangers which alternatively are being reheated by combusting BF gas (top gas).
- Gas cleaning plant: BF gas is being cleaned of dust and other matters by various processes and filters.
- Pig iron disposal: the hot metal is being tapped in mixer type hot metal cars (torpedo cars)

  Slag disposal: Slag is disposed of by cinder ladles which are transported to a special plant for further processing.

1.1.6 STEELMAKING PROCESS

Aim: Pig iron contains between 3 to 4 % carbon. The aim of a steel plant is to oxidise the excessive carbon to reduce its content down to the required level (normally 0.05 to 0.3 % C for flat products), together with scrap and alloying elements according to the required steel specification.

LD Process: The hot metal is first homogenized in mixers and then transferred into the LD vessel. No further heat is required as the necessary temperature is achieved in the process of oxidation of the various chemical elements in the hot metal, foremost carbon. The necessary O_2 is supplied by blowing in technical oxygen with a pressure of 800 to 1,200 kPa at a distance from 1 to 1 ½ m above the hot metal surface with a water cooled lance resulting in a bath temperature of 1,600°C. Cooling scrap, approx. 20 % of the charge, is added as well as alloying (ferro metals) and slag forming elements (burnt lime and other fluxes). Tap to tap time is approx. 40 min., the blowing process varies from 12 to 18 min. depending on the grade of steel. Tapping is effected into ladles for possible further processing (further removal of undesirable elements).

1.2 COKING PLANT

For the general process description refer to Annex 2, Chapter 1.2 of the UNIDO Report for Description of Technological Alternatives (1992)

1.2.1 ENVIRONMENTAL ASPECTS

The main sources of environmental pollution of a coking plant are:

- coal handling and preparation (grinding, screening and conveying)
- loading the coke ovens chambers and pushing the red hot coke to the coke lorry
- quenching the hot oven gases and volatiles vapours and washing the gases
- coke quenching
- crushing, grinding and screening the coke

Air pollution/Dust-emission

The amount of dust emitted by the coke oven plant is difficult to estimate. On the one hand it depends highly on the specification of the coals and the properties of the produced coke, and on the other hand on the standard of pollution control and environmental protection investment.

Assuming European standard of equipment of dust-control one can estimate the air-pollution by dust as follows:

- by preparation/handling of coals and coke respectively (incl. loading the coke oven chambers), approx. 100-150 g/t coke produced
- pushing the hot red coke to the coke lorry approx. 20-50 g/t coke
- coke quenching: in the case of wet quenching the main source of dust in the coking plant. The pollution by dust is reduced to a few g/t if dry quenching - especially the »Combi-Coke« System is used, which is envisaged for this project.

Therefore the total pollution can be estimated at approx. 120-170 g/t coke produced, corresponding to an average of 127-130 t/a dust for the given capacity.

Air Pollution/Gases and Volatiles Components

The sources of air pollution by gases and vapours of volatiles compounds in a coking plant are:

- flue gas from the coke-oven firing; assuming the ratio blast-furnace top-gas to coke ovengas to be 9:1 the amount of flue gas can be estimated to be approx. 1,750 m^3 (std.)/t coke, produce correspondingly an average 1,472 x $10^6 m^3$ (std.)/a fluegas for the given capacity.

It contains:

SO_2 345 mg/m³
NO_x 250-270 mg/m³

The flue gases need to be cleaned by desulphurization and denox-processes.

Waste Water

Assuming 292 m³ (std.) coke-oven gas produced/t of coal (dry and ashfree) corresponding to 408 m³ (std.)/t of coke to be cleaned, the amount of waste-water can be estimated to 0.35 m³/t of coke - as investigated by previous studies - corresponding to average 322,67 x 10^3 m³/a for the given capacity.

Table 1 : **Contaminants in Waste Water**

Contaminants	mg/l	t/a
Amonia	900 - 1,100	275 - 320
Sulfide	4,000 - 4,500	1,160 - 1,305
Phenol	1,100 - 1,200	320 - 350
Cyanide	3,750 - 4,200	1,040 - 1,220

This highly contaminated waste-water must be treated before it is fed to a biological sewage purification plant by various processes as follows:

- elimination of the phenol down to a content of 10 to max. 15 mg/l by multiple step countercurrent extraction using benzene or di-isopropylether as solvents

- elimination of the remaining contents of NH_3, HCN and H_2S by oxidation e.g. by H_2O_2.

1.2.2 MAIN MACHINERY AND EQUIPMENT

The coking plant consists of the following plant facilities:

Coke Oven Section

- coal blending
  Coal preparation is the most important step in the coke-making proces in terms of quality and uniformity

- (chamber) coke-ovens
  Considering the increased production capacity of the Combi- Coke process, it is estimated that the required coke tonnages can be produced in 1 coke battery of 44 coking chambers, each with a dimension of:
  7m high, 0.5m wide, 17 m long

- coke dry cooling/coal preheating

- coke transport and screening

Coke Gas Treatment section

- gas cooling

- tar precipitators and electrostatic gas cleaning

- gas exhausters (turboblowers)

- gas cleaning, H_2S/NH_3 washing

- gas distribution, gas holder, bleeder stack

- process water treatment

- sulfuric acid production or production of elemental sulfur

- water supply cooling water system

1. Coal-Preparation/Blending

Today usually a mixture of good coking coal with various non-coking coals is used as feedstock for the coking plant, even if coking coal is available in sufficient quantities. The coking coal will be blended with some different non-coking coals - sometime up to 10 to 15 components - in order to obtain the desired average properties of the coking plant feedstock.

The different coals are ground and screened off separately and then blended according to an elaborated formula. Some of the coke breeze is added to increase the cohesion of the resulting coke. By the addition of a small quantity of oil the bulk density will be increased, which is very advantageous to obtain a coke homogeneous with regard to its mechanical properties.

The modern coking technology employs preheating of the coal-mixture, which increases the throughput, reduces the costs and diminishes the required quantities of firing gases. More about this process see »Combi-Coke« process indicated in paragraph 3/Coke-cooling.

2. Cokeoven-Section

The modern coke oven design has been developed since the 1940s. The oven-chambers are approx. 14-18 m long, 4-8 m high and 0.5 m wide, equipped with doors on both sides. A coke oven battery consists of up to 60-80 chambers. The air supply as well - if necessary - the used blast-furnace top gas are preheated by the hot exit gases in regenerative heat-exchanger chambers. The recovery of the waste heat allows for higher operating temperatures and thusly to increase coking rates.

Each oven-chamber in the battery holds up 30-50 t of coal and operates on a 15/20-h cycle. Preheating the coal will markedly shorten the cycle time. The oven chambers are loaded from a mobile hopper car located on the top of the battery. Coking takes place in completely sealed chambers. Each chamber is connected by a vertical tube to the collecting pipe on the top of the battery. The by-product vapours and gases are collected and sent to recovery and processing units.

The carbonization finished, the door of the chamber is opened and a ram-machine pushes the red-hot coke into a quenching car. The coke is then transported to the quenching/cooling-unit.

The Fig. 1 shows a simplified scheme of the coke-making process. Not shown in this picture is the collecting pipe, which is located sideways on the top. In the process described in the present report the cooling tower (h) is a dry quenching unit.

3. Coke-cooling

For the coke cooling the use of the dry quenching process will be foreseen instead of the traditional wet quenching process for reasons of energy recovery and environmental protection.

From the various dry quenching processes the so-called "Combi-Coke" - process is very advantageous and economically feasible. This process utilises the heat of the dry quenching gas medium for pre-drying and pre-heating the coal before charging into the coke ovens.

Blast furnace gas from the works' network is passed into the cooling chamber of the coke dry quenching unit and heated up to approx. 750°C by hot coke. Thereby the coke is cooled from about 1,000°C to 150°C. The heated blast furnace gas is then cooled to about 550°C by adding fresh gas and used for drying and heating of the coal input up to 200°C.

Blast furnace gas is thus used only as a heat transfer media and is not consumed. After cleaning (dust removing) it will be recycled into the works' network.

The advantages of the Combi-Coke process in comparison with conventional coking plants may be summarized as follows:

- increase of coal throughput as well as coke output capacity - approx. 40 % in comparison with conventional coking process

- reduction of operating costs (approx. 10%)

- smaller coking plant size in consideration of the increased coal throughput at a given capacity

- possibility to use higher percentages of weak coking coal

- increased flexibility in coke oven plant operation

- charging of preheated coal enables shorter turnover cycles in the coking ovens and reduced energy consumption

- environmental pollution will be drastically reduced as pollutants will no longer be released into the atmosphere as in the case of the wet quenching process.

4. Coke-Gas Treatment/By-product Recovery

Using a coal mixture of approx. 20/21 % volatile matter and 80/81 % C the resulting coke oven gas amounts to appr. 292 m^3 (std.)/t coal (dry and ash-free), corresponding to 3.43 x 10^8 m^3/a at the given capacity.

Based on a coke oven production time of 8,500 working hours/y, deducting only 10 days for general repair and maintenance, the amount of gas produced will be about 40,387 m^3/h.

In addition to coke the following by-products will be recovered:

- coke oven gas (incl. approx. 30 g benzene/m^3 (std.)	... 40.387 m^3/h	3.43 x $10^8 m^3/a$
- crude tar approx.	... 5.7 t/h	48.45 x $10^3 t/a$
- elementar sulfur approx.	... 395 kg/h	3.05 x $10^3 t/a$

Steam will also be produced by the claus process which is to be utilized in the gas treatment plant.

The hot gas and volatiles matter leaving the chambers at 750/800°C is quenched in the collecting pipe by injection of ammonia liquor. Thereby about 60-70 % of the crude tar will be condensed and is fed to the tar precipitator.

The crude gases are then treated and cleaned in a number of downstream facilities, all of which are designed to cope with the above indicated hourly gas volume. The foreseen individual treatment steps, shown in the respective diagrams, are outlined below.

5. Primary Cooler

The crude gas leaving the coke oven unit at about 80°C is steam saturated and contains gaseous, liquid and solid components.

The gas is cooled by indirect cooling and washed out by injection of additional ammonia-water. Steam and tar condense and the gas is cleaned of soot and dust. The gas leaves the cooler at about 28°C.

The condensed tar and water is fed to the tar precipitator.

6. Tar Removal

Condensed tar and water from the collecting pipe and the primary cooler are fed into the tar precipitator, where the tar separates from ammonia-bearing water (ammonia liquor). The tar separates in a light fraction, which will be sold as crude tar and in a heavy portion at the bottom of the precipitator. This portion is later mixed with charging coals.

The ammonia liquor is reused for cooling purposes. Excess water is cleaned by means of gravel filters and fed into NH_3/H_2S scrubbers.

7. Electrostatic Gas Cleaning

This section consists of 2 units, which clean the gas of dust and fine tar-particles. Each unit operates at 50 % of the total capacity.

8. Gas Exhausters (Turboblowers)

The exhausters remove the gas from the coke ovens and maintain a minimum pressure of about 800 to 1,000 Pa necessary to force the gas through the downstream facilities and to the various consumers.

9. Secondary Cooler/Naphthalene Scrubber

Gases passing through the exhausters enter a combined cooler/naphthalene ($C_{10}H_8$) scrubber, where the temperature is reduced from 45°C to 30°C. Naphthalene absorbed by the tar wash oil, solidified by cooling in the upper part of the column, is washed out by the tar wash oil. Cooling of the gas takes place mainly in the lower part. The tar wash oil used is fed into the wash oil regeneration unit and reused. Regeneration of the wash oil requires steam. The steam charged with the naphthalene - volatile with steam - is recycled into the gas stream before being send to the primary coolers.

Naphthalene is recovered from the wash oil by crystallization.

10. H_2S/NH_3 Scrubbers

The gas flows through two NH_3 scrubbers and one H_2S scrubber. The scrubbing H_2S using ammonia-liquor is only possible if NH_3 is recycled into the washing process as ammonia liquor, and not recovered for sale's purposes. The recycled ammonia liquor should be free of acid components (e.g. H_2S)

The ammonia liquor flows countercurrently to the gasflow, first through the NH_3 scrubber No. 2, then through the NH_3- scrubber No.1 and finally still without H_2S through the H_2S scrubber. After the H_2S scrubber the aqueous solution, containing NH_3/H_2S is pumped to the deacidifier unit.

By washing the gas with ammonia-liquor, the remaining cyanides will also be absorbed by the wash liquor.

The washed gas, containing max. 1.5 g H_2S/m^3 (std.) - preferably <0.9 g/H_2S/m^3 (std.) - is distributed to the works' internal consumers.
The gas holder compensates for short drops in volume and pressure. Excess gas is burned off at the bleeder stack.

11. Ammonia Deacidifier

$NH_3/H_2S/HCN/CO_2$ are removed in the unit by means of steam and are burnt later at the sulfuric acid plant or to the CLAUS unit (production of elemental sulfur) to SO_2, CO_2, H_2O and N_2 and converted in the catalytic reactors to sulfuric acid.

If there is a market for ammonia (e.g. fertilizer) and concentrated ammonia-liquor, the design of the scrubber-units must be adjusted accordingly to this purpose.

12. Production of Sulfuric Acid

Based on the assumption that the demand for sulfuric acid in the local industries exceeds by far the quantity of sulfuric acid produced in the coke oven plant, the production of sulfuric acid from H_2S which is recovered from the coke oven gas is proposed in a respective facility outside of plant boundary.

Production of elemental sulfur (alternative to sulfuric acid)

As alternative to the production of sulfuric acid elemental sulfur can be produced using the CLAUS-process, actually the most used process to produce sulfur from H_2S:

The gas mixture from the deacidifier unit will be burnt with addition of fuel gas using air in an underproportional ratio to a mixture H_2S - SO_2. The hot gases will be cooled down appr. 350°C in waste heat boiler producing steam of about 15/20 bar. The gases will be than converted by means of catalysts in two consecutive reactors to elemental sulfur according to the equation $2H_2S + SO_2 = 3S + 2H_2O$ to sulfur, which will be condensed in the consecutive coolers to liquid sulfur. The liquid sulfur can be directly processed to different products or solidified to sublimated sulfur.

13. Water Supply/Cooling Water System

- raw water intake
- softening unit: lime saturator, softening reactor, gravel filter } in general facilities
- soft water basin } in general facilities
- cooling tower
- water basins: hot water basing and cold water basin

14. Waste Water Treatment

- puffer tank
- steam stripping unit
- extraction unit: multi stage countercurrent extractor, solvent storage tank, solvent regeneration unit
- unit for oxidative treatment

15. Auxiliary Plants

Cooling Water System for Coking Plant (AC 82)

- Cooling water for the indirect cooling is applied in an open circuit, recooled in open Cooling Towers (evaporative cooling) and recycled, thus minimizing the requirement of make-up water to replace the evaporation losses in the cooling towers and the bleed-off water. The recycled cooling water will be partially cleaned by means of gravel filters and need addition of biocide compounds to avoid growing of algae in the cooling tower. The requirement of make up water off the general facilities water treatment plant are 4.02 m^3/t coke or 3.7 x 10^6 m^3/a.
  0.35 m^3/t coke is waste water, which has to be treated prior to discharging, the rest is evaporation loss and deslurrying at the cooling tower (see 1.2.4 Product Balance)

1.2.3 EQUIPMENT LIST OF COKING PLANT

Table 2 : Equipment List of Coking Plant

Item/Code	Designation	Number of Equipment	Main Technical Data
RAW MATERIAL HANDLING + PREPARATION			
AC 11	Coal Storage Yard - Stacker - Reclaimer	 2 sets 2 sets	General facilities plant 3,000 t/h 400 t/h
AC 12	Coal Handling - Coal conveyor	 1 set	 300 t/h
AC 14	Coal Grinding + Mixing - Rolling crusher - Hammer mill - Screening	 2 sets 2 sets 2 set	 400 t/h 400 t/h 400 t/h
AC 15	Coal Bins	12 sets	400 t/bin
AC 16	Coal Service Tower	1 set	
AC 19	Dedusting System	1 set	Bag Filter 500 m^3 (std.)/min.
COKE OVEN			
AC 21	Charging System	1 set	Charging hopper car
AC 22	Coal Preheating System	1 set	With hot gas from dry quenching
AC 23	Coke Oven Battery		44 chambers 7 x 0.5 x 17 m Compound type: COG + BFG heated
AC 24	Coke Discharge System	1 set	Pusher machine
AC 25	Coke Quenching Plant	1 set	Coke guide car, electric locomotive, quenching tower, 135 t/h (boiler capacity 65 t/h)
AC 29	Emission Control System Dedusting for coal hopper car Dedusting for coke car	1 set 1 set 1 set	 Bag filters 900 m^3/min. Bag filter 4,000 m^3/min.
COKE TREATMENT + HANDLING			
AC 32	Crushing + Screening - Screen for coke cutter - Screen for BF coke	1 set 1 set 1 set	 200 t/h, bar screen 200 t/h
AC 38	Coke Store + Despatch	1 set	150 t/h conveyors
AC 39	Dedusting System	1 set	350 m^3/min. bag filter
BY PRODUCTS TREATMENT			
AC 41	Gas Coolers, Tar, Condensation - Primary Gas Cooler - Secondary Gas Cooler	 5 sets 2 sets	 Capacity 20,000 m^3/h Capacity 30,000 m^3/h
AC 42	Gas Exhauster Plant	2 sets	Capacity 55,000 m^3/h

Item/Code	Designation	Number of Equipment	Main Technical Data
AC 43	Gas Scrubber and Cleaning Electrostatic Filter NH_3 Scrubber	 2 sets 2 sets	 Capacity 55.000 m^3/h Capacity 50.000 m^3/h
AC 44	H_2S/NH_3 Treatment - Ammonia deacidifier	 2 sets	
AC 45	Claus plant	2 set	Capacity 0.3 t/h
AC 48	Tar Removal Plant	1 set	Capacity 4 m^3/h tar
AC 53	Maintenance Post		
AC 54	Spare Parts Depot		
AC 56	Additive Store		
AC 57	Refractory Store		
AC 58	Operating Parts Store		
INFORMATION SYSTEM			
AC 61	Planning System/Management Info		
AC 62	Prod. + Progress Control System		
AC 63	General Instrumentation		
AC 64	Basic Automation		
AC 65	Sampling/Material Testing		
AC 67	Laboratory		
AC 69	Communication System		
INFRASTRUCTURAL + AUXILIARY EQUIPMENT			
AC 71	Plant Office		
AC 73	Locker Building		
AC 75	Fire Alarm + Fighting System		
AC 77	Road Transport		
AC 78	Rail Transport		
UTILITY SUPPLY/TREATMENT			
AC 81	Water Supply/Treatment		Make up water requirement: 3.96 m^3/h from general facilities
AC 82	Water Circuits + Cooling System		
AC 83	Incombustible Gases + Compr. Air		
AC 84	Combustible Gases		
AC 85	Combustible Liquids + Fuel		
AC 86	Steam/Hot Water/Heat Recovery		

Item/Code	Designation	Number of Equipment	Main Technical Data
AC 89	Hydraulic + Lubrication System		
AC 91	High Voltage Facilities		
AC 92	Low Voltage Facilities		
AC 93	Electrical Equipment		
AC 97	Lighting + Plug Socket System		
AC 98	Lighting + Earthing System		
AC 99	Other Electrical Equipment		

1.2.4 PRODUCT BALANCE

Table 3 : Product Balance

Process	INPUT		OUTPUT	
	Designation	Quantity per t coke	Designation	Quantity per t coke
Coal preparation	Coals	1,396 kg	Coals + fines	1,396 kg
Coal preheating	Coals	1,396 kg	Heated Coals (to 200°)	1,396 kg
	Blast furnace gas (550°C)	2,000 m^3 (std.) i.e. 1,200 m^3 (std.) (750°C) + 800 m^3 (std.) (30°C) fresh gas	Exit BF gas (200°C)	1,430 m^3 (std.)
Coke battery: heating system	Coke oven gas	61.2 m^3 (std.)	Flue gas	1,750 m^3 (std.)
	Blast furnace gas	570 m^3 (std.)		
	Compr. air	773 m^3 (std.)		
Coke battery: oven chambers	coal mixture	1,396 kg	Coke	1,000 kg
			Crude gas	408 m3
Coke cooling Dry quenching	Hot coke (appr. 1 000°C)	1,000 kg	Cooled coke (appr. 150°C)	1,000 kg
	Fresh blast furnace gas	1,200 m^3 (std.) 30°C	Hot gas (to coal preheating)	1,200 m^3 (std.) 750°C
Gas cleaning system (incl. tar removal - NH_3/H_2O stripping)	Crude gas process	408 m^3 (std.)	Cleaned gas	404 m^3 (std.)
	Steam (from integr. facilities)	0.27 t	Crude tar	51.89 kg
			NH_3/H_2S *) (to sulfuric acid plant)	7.9 kg
	Cooling water (15°C)	95 m^3	Cooling water (35°C)	95 m^3
Cooling water system (evapor. cooling)	Treated water (make up water)	3.96 m^3 (0.28 m^3 ton gas cleaning)	Evaporation losses	1.2 m^3
			Blow down	0.5 m^3
			Waste water	0.35 m^3
			Process losses	1.91 m^3

*) rendering 3.6 kg/t coke elemental sulphur

1.2.5 CONSUMPTION FIGURES

Capacity: 933,750 t/a coke
Working hours: 8,500 h/y
Shut down for repair/maintenance: 10 days/year

Table 4 : **Consumption Figures**

Item	Per t Coke	Per Year
Coal (dry basis)	1,396 t/t	1,304.1 x 10^3 t/a
Coal (wet basis)	1,494 t/t	1,395.27 x 10^3 t/a
Make up water (incl. cooling losses and process-water without sulf. acid)	3.96 m^3/t	3,704 x 10^3 m^3/a
Water treatment chemicals 1/ appr.	0.17 $/t	158.7 x 10^3 $/a
Waste water treatment chemicals 2/	0.75 $/t	700 x 10^3 $/a
Electr. energy	67.6 kWh/t	63.12 GWh/y
Caloric energy	2.7 GJ/t	2,291 x 10^3 GJ/a
Steam (NH_3 stripping)	0.27 t/t	252 x 10^3 t/a
Maintenance (incl. spare parts)	4-5.5 % of machinery/equipment investment	

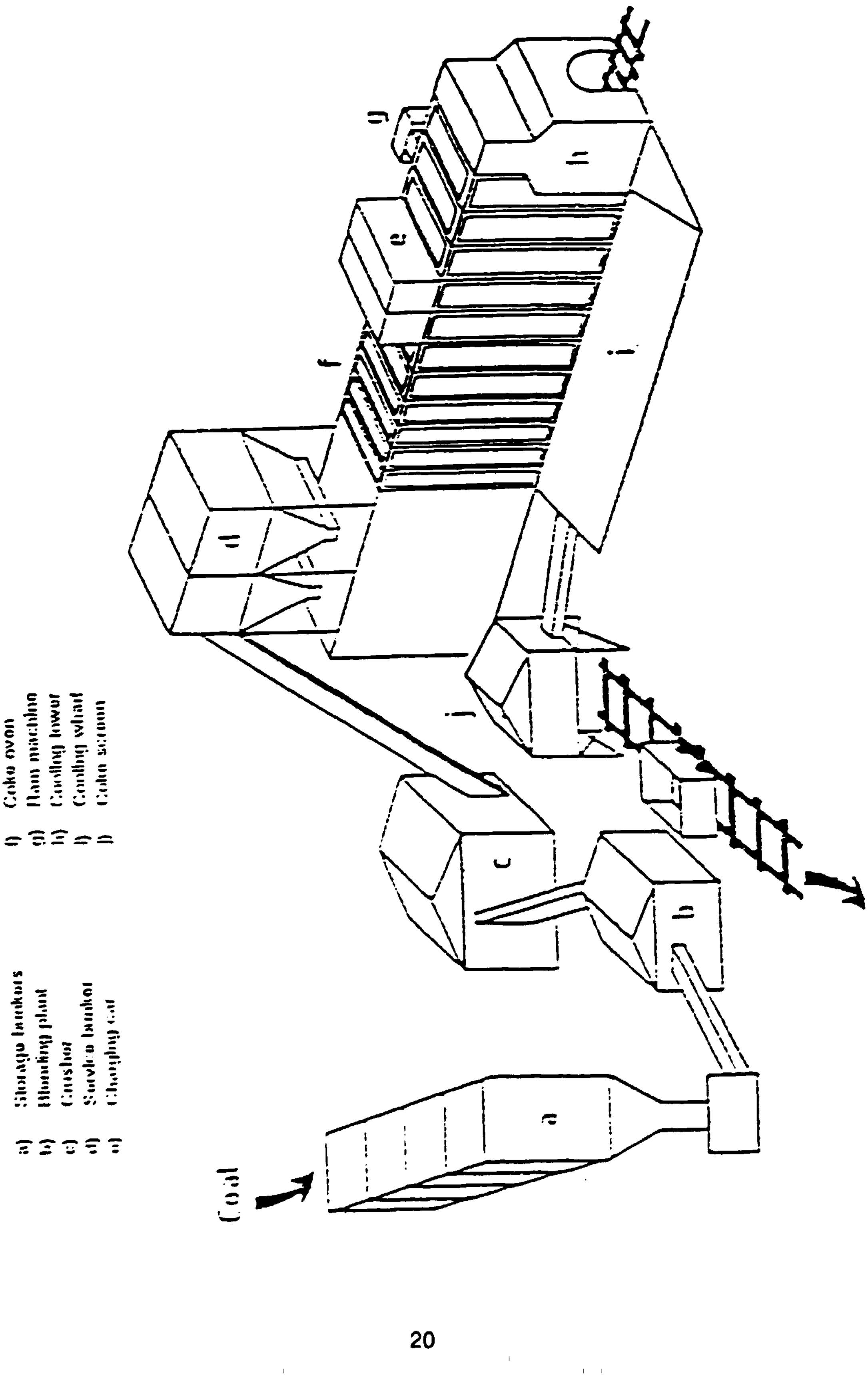
1/ depending on local water quality, value not for seawater
2/ accordingly to FRG-regulation

1.2.6 IMPORT REQUIREMENTS - EXPORT FIGURES: ENERGY AND UTILITIES

Table 5 : Requirements of Energy and Utilities

Item	Import		Export	
	per t/coke	per year	per t/coke	per year
Electric energy	67.6 kWh	63.12 GWh		
Make up water	3.96 m^3	3,704 x 10^3 m^3		
Steam (500 kPa)	0.27 t	252 x 10^3 t		
Blast furnace gas (3,250 kJ/m^3 (std.))	569.6 m^3 (std.) (30°C)	531.86 x 10^6 m^3 (std.) (30°C)		
Coke oven gas (17,600 kJ/m^3 (std.))	61.2 m^3 (std.)	57.24 x 10^6 m^3 (std.)	342.8 m^3 (std.) 6.03 GJ/t	320.08 x 10^6 m^3 (std.) 5.63 x 10^6 GJ (std.)

Fig. 2 : Simplified Scheme of Coke Making



1.3 SINTER PLANT

For the general process description, handling of effluents, gaseous emissions and wastes as well as description of main equipment and machinery refer to Annex 2, Chapter 1.3 of the UNIDO Report for Description of Technological Alternatives (1992).

1.3.1 EQUIPMENT LIST OF SINTER PLANT

Table 6 : **Equipment List of Sinter Plant**

Unit Code	Designation	Number of Equipment	Main Technical Data (Design)
AS-14	Coke Grinding Plant	1 set	35 t/h
	Roller mill (coarse/fine)	2	
	Screens	2	
AS-15	Ore Crushing and Screening - Jaw Crusher - Ball Mill - Multi Level Vibratory Screens	 2 sets 2 sets	 300 t/h
AS-16	Mixing Beds	3 piles	capacity min. 50 000 t each
AS-17	Mixing & Proportioning bin plant (for ore, fuel and additives) - Weighing equipment - Mixing drum - Rolling drum	 1 set 1 set 2 sets 2 sets	 6 ore bins (approx. 300 m^3 each) 9 additive bins (approx. 175 m^3 each) 3.5 m x 12 m long 4.0 m x 20 m long
AS-21	Hearth layer system	1 set	150 t/h
	Mixed material feeding system	1 set	750 t/h
AS-23	Sinter machine	1 set	380 m^2 sintering area, bed height 600 mm
AS-24	- Ignition furnace	1 set	for mixed gas (8.3 MJ/m^3)
AS-28	- Sinter discharge/hot breaker		
	- Star crushers area	1	

Unit Code	Designation	Number of Equipment	Main Technical Data (design)
AS-29	Waste gas system - Waste gas fan - Dust collecting system/Electro-static precipitator	1 set 1 set 1 set 1 set	 ca. 600 m^3/sec (std.) emission 50 mg/m^3
AS-33	Cooler/Heat recovery for ignition air	1	425 m^2 area
	- Cooling fan/Combustion fan	3	approx. 16 m^3/s (std.) each
	- Dust Multicyclone	1 set	
	- Cooler discharge	1 set	700 t/h
AS-34	Sinter sizing equipment	1 set	
	- Screen	2	
	- Roll crusher	1	
	- Combustion air fan	1	ca. 3.3 m^3/sec (std.)
AS-64	Plant computer and automation system	1 set	
AS-65	Sampling station	1 set	

1.3.2 PLANT BALANCE

Table 7 : Plant Balance

Process	INPUT		OUTPUT	
	Designation	Quantity/ t Sinter	Designation	Quantity/t Sinter
Raw material handling	Iron ore Mn ore Sinter fines Coke fines Limestone Burnt lime Dolomite Scale Dust	857.0 kg 24.2 kg 47.8 kg 58.7 kg 178.5 kg 9.0 kg 75.0 kg 12.9 kg 11.5 kg	Dust Sinter Fines Sinter Material	8.7 kg 47.6 kg 1218.3 kg
Sintering	Mixed gas Combustion air Sinter material	12 m^3 (std.) 450 m^3 (std.) 1,259 kg	Flue gas sinter Sinter fines	485 m^3 (std.) 1,000 kg 47.6 kg
Cooling	Cooling air	450 m^3 (std.) 30°C	Combustion air	450 m^3 (std.) 250°C
Dedusting	Flue gas	485 m^3 (std.)	Cleaned gas	485 m^3 (std.)

1.3.3 COMSUMPTION

Capacity: 3,085,028 t/a sinter
Annual working hours: 7,200 h/a
Bed size: 380 m^2, 4.75 x 80 m
Max. output: 380 t/h

Table 8 : **Consumption Figures**

Item	Per t Sinter	Per Year
Sinter material	1218.3 kg	3.758 x 10^6 t
Electric energy	51.73 kWh	160 GWh

1.4 BLAST FURNACE

For the general process description, handling of effluents, gaseous emissions and wastes as well as description of main equipment and machinery refer to Annex 2, Chapter 1.4 of the UNIDO Report for Description of Technological Alternatives (1992)

1.4.1 MAIN EQUIPMENT AND MACHINERY

1. Burden - Preparation (RB, Series 1)

To ensure a smooth operation of a shaft furnace proper gas permeability of the burden is essential. The permeability, which can be characterised by the gas pressure drop in the shaft, depends mainly on the grain size and grain size distribution of the burden. The larger the grain size the better the permeability, but too large grain sizes will reduce the reaction rate and slow down the heat transfer. Therefore the burden, consisting of ironbearing materials (lump ore, ore fines, collected dust of the plant and scale), and additives (as slag forming agents), have to be prepared according to the required grain size - respectively grain size distribution - which depends on the properties of the ironbearing materials, the type and the dimensions of the furnace, the back-pressure at the top of the furnace and still other parameters. For ironbearing feedstock of good reducibility two fractions of 50/20 mm and 20/6 mm can be recommended. The feed for the sinter plant will be ground to >6 mm.

The burden preparation consists of:

- crushing/grinding of the burden components
- screening of the crushed/ground materials
- agglomeration of the fine materials (see chapter »sintering« plant) and preparation of the resulting sinter

Primary crushing takes place in gyratory crushers or jaw crushers. For second and third stages of crushing cone crushers are mostly used.

For screening vibration screens with elliptical or linear oscillation are widely used. Multilevel screens will be recommended.

2. Blast Furnace (RB 21 and 23)

Large blast furnaces have a working volume up to 5 000 m^3 and are 100-130 m high, including the exhaust pipe for the top gas.
The hearth diameter varies from 8-14 m.

The furnaces are entirely encased in a steel shell (mantle plate) and are equipped with a refractory lining inside the mantle plate cooling boxes and stave coolers are provided to cool the lining and the shell. The blast furnace envisaged for the projected plant has a working volume of 3,250 m^3 and a hearth-diameter of 13.0 m for a production of 6,900 t/d.

The blast furnace is equipped with a steel support structure which supports the various platforms and the furnace top. The charging system has two functions: the burden distribution and gas sealing. Appropriate burden distribution with respect to both ore: coke ratio and particle diameter over the cross section of the stack at the top of the burden bed is important for better gas permeability.

A bell-less furnace top is foreseen with an adjustable, rotating chute.

Tap hole drilling, clay guns, iron and slag runners are installed in the respective cast houses.

The charging system mainly consists of:

- blast furnace charging conveyor
- weighing hoppers for coke, sinter, ore and miscellaneous materials
- storage bins for coke, sinter, ore and miscellaneous materials

The following auxiliary facilities are appointed directly to the blast furnace:

- Hot blast stoves (cowper) with blower station

- Powdered coal injection

3. Hot Blast Stoves (RB 24)

Hot blast stoves work exclusively on the basis of the regeneration principle: ceramic gridwork is heated up to about 1,400/1,450°C by the fuel gas and in a second phase the cold blast is heated by hot gridwork to about 1,150/1,200°C.

The actually used stoves are of the external combustion chamber type. The standard lining consists of silica bricks in the dome, bricks with >50 wt% alumina in the combustion chamber and silica and fireclay bricks in the gridwork (checkerwork) shaft. Magnesia bricks will also be used in place of silica bricks in the upper part of gridwork shaft.

The fuel gas is a mixed gas: blast furnace top gas with coke oven gas will be used in order to achieve the required dome temperature of 1,400/1,450°C. Combustion air and fuel gas will be preheated to about 200°C and the exit gas is not to exceed 420°C.

The blast furnace is equipped with three hot blast stoves.

Blower Station:

The blower station comprising 2 blowers for each blast furnace serves the furnace providing for the capacity of the present project 2 x 250,000 m^3 (std)/h. Both blowers are driven by electricity, each having a 28 MW drive. Both blowers will operate the furnace. In case of failure of one blower, the second steam driven blower will be able to maintain a 60 % production rate of the blast furnace. The blowers are of the axial blower type and are equipped with guide blade regulations. Blowing pressure is 500 kPa. The blast will be oxygen enriched by 2%. The oxygen will be delivered in front of the suction side of the blowers.

4. Powdered Coal Injection (RB 22)

In order to reduce the specific coke requirement of the blast furnace about 170 kg of anthracite/t pig iron are injected into the blast furnace.
Coal for the injection system will be ground and stored at the coal grinding unit. Approx. 402,000 t/a of coal will be required per year for this purpose.

Coal in the size range of 0 to 20 mm will be transported via belt conveyor from the storage yard to the day-bin at the grinding station. The desired coal product size will be achieved using separating classifiers.

The ground material will be stored in a steel bunker of approx. 250 m^3 in size and will be transported to the blast furnace by a pneumatic conveying system. The carrying medium will be nitrogen. All drop points in the transportation system will be connected to a dedusting system.
The injection system consists of pressure vessels in series and transmission pipes that feed pulverized coal into the tuyeres.

5. Top Gas Cleaning (RB 25)

The blast furnace generates approx. 1,980 m^3 top gas (std.)/t pig iron. The off-gas contains 10-50 g/m^3 (std.) dust, which must be decreased to 5-15 mg/m^3 (std). At first stage of cleaning a dust catcher reduces the dust content from 10-50 g/m^3 (std) to 5-10 g/m^3 (std) and than lowered by cyclones to <5 g/m^3 (std). Further cleaning is usually performed by electric precipitators or wet scrubbing. For the present project a venturi scrubber will be provided to obtain a dust content of 5-10 mg/m^3 (std).

The pressure drop in the two cleaning stage will be about 400-500 Pa in total.

6. Gas Expansion Turbine (RB 26)

The cleaned gas enters the expansion turbine. The pressure of about 250 kPa is reduced to 110 kPa, whereby the expansion energy is used to drive a turbine of the axial type to produce energy.

7. Slag Utilization (RB 49)

The slag produced by the blast furnace can be processed to:

- Air-cooled slag: solidification in slag pots or pouring pads
- Granulated slag: spraying of the liquid slag with water
- Pumice slag: foaming with water
- Slag wool: blowing of the liquid slag with air or steam

For the present project the production of granulated slag could be possible. Granulated slag can be produced in the form of pebbles or can have a porous structure depending on the granulation process. The different structure affects the hydraulic-bonding properties, the grindability, and the strength.

Granulated slag is used as a material for making blast furnace cement by mixing it with Portland cement after pulverisation. It is also used as a fertilizer component.

Since probably no economically feasible market for granulated slag exists, the production of air-cooled slag (slag bricks) should be envisaged. Air-cooled slag can be used as land-filling material or crushed and sized as material for road construction.

Slag bricks will be produced by solidifying in slag pots or pouring pits and are then crushed.

8. Pig Iron Transport and Desulphurization (RB 31)

Torpedo cars of 250 t size will transport the pig iron to the steel plant. The torpedo cars will be relined as required at a foreseen location near the blast furnace plant.

The sulphur content of the pig iron can be lowered by injecting a mixture of lime, CaO or similar agents into the bath using submersion lances. Two treatment stands with all of the necessary facilities are foreseen, to perform desulphurization in the torpede cars.

9. Auxiliary Plants

Cooling Water System for Blast Furnace (RB 82)

a) Cooling of the Blast Furnace:
The circulating amount of cooling water will be approx. 45-50 m^3/t pig iron. The evaporation losses by cooling tower will be approx. 0.4-0.5 m^3/t pig iron (approx. 1 % of the circulating amount), the losses by the blow down water are approx. 2-3 % of the circulating, softened water, that is 1.0-1.5 m^3/t pig iron. Therefore an amount of treated water of approx. 1.8 m^3/t pig iron or 4.24×10^6 m^3/a of soft water will be required.
Water cooling is required for the following:

- furnace shell, where a stave cooling system of the pressureless evaporation type is installed,
- bottom cooling of the blast furnace, consisting of a system of horizontal cooling pipes at the bottom of the hearth,
- tuyeres; closed cooling circuits using soft water
- hot blast valves; closed cooling circuit using soft water;
  Tuyeres and hot blast valve circuits are connected to an emergency water tank
- cooling circuit for emergency stave cooling, shell spraying, iron notch stave and ledge type stave cooling
- emergency water injection at the top

b) Slag Utilization

Since probably no economically feasible market for granulated slag exists, the production of air-cooled slag (slag bricks) should be envisaged. Air-cooled slag can be used as land-filling material or crushed and sized as material for road construction.

Slag bricks will be produced by solidifying in slag pots or pouring pits and are then crushed.

c) Top Gas Cleaning

For the cleaning of top gas a Venturi scrubber with water injection is used. Filtered water off the plants own facility amounting to 2 m^3/t pig iron is applied. Elements like Zn, Pb, Cd and other heavy metals as well as coke and particles are precipitated in a settling pool of approx. 2,500 m^3, to be removed as waste.

Energy Requirement

Caloric energy

The amount of the required specific caloric energy input (GJ/t pig iron) depends on the Fe-content of the burden, the temperature and the volume of the hot blast and of the exit top gas, the energy losses due to cooling and radiation losses.

Assuming a burden having a Fe-content approx. 62% Fe, a blast temperature of 1,350°C, exit top gas temperature of 250/300°C and a hearth-diameter of appr. 13.0 m, the caloric energy balance can be shown as follows:

Table 9 : **Caloric Energy**

INPUT	GJ/t pig iron	x10^6 GJ/y
supplied by coke and coal-injection	12.65	29.84
supplied by hot blast	2.88	6.79
OUTPUT		
Heat content top gas (1 980 m^3/t pig iron)	6.457	15.23
Heat content liquid iron and slag	2.0	4.72
cooling and radiating losses	1.25	2.95

To heat the blast (1,600 m³/1,200°C) for 1 t pig iron the following fuel gas is required:

25.76 m³ (std.) coke oven gas
741.11 m³ (std.) blast furnace top gas

<u>Electric energy</u>:

Electric energy will be required for:

- blowers for the hot blast stoves
- blowers for the coal injection system (PCI)
- coal grinding/screening (PCI-system)
- crushing/grinding/screening of feedstock materials (burden preparation)
- pumps for the cooling circuit system
- pumps for the gas scrubber
- driving motors of conveying and charging systems

Using a gas expansion turbine about 30-40 kWh/t pig iron can be recovered.

Table 10 : **Electric Energy Requirements**

INPUT			OUTPUT		
Designation	kWh/t pig iron	GWh/y	Designation	kWh/t pig iron	GWh/y
Blowers/hot blast stoves	135	318.4	Energy recovering/gas expansion turbine	33.5	79.3
Blowers/coal injection system	15	35.4			
Driving motors coal grinding (PCI)	4	9.4			
Driving motors/burden preparation	15	35.4			
Driving motors/conveying-charging systems	15	35.4			
Pumps/cooling circuit system	16	37.7	Net import electric energy	180	424.6
Pumps/gas scrubber	3.5	8.3			
Dedusting	10	23.6			

e:\projekt\pts bolphase 2\annex 3tbl 2-5 wp5

Environmental Aspects

The environmental protection concerns:

- Air pollution control
- Water pollution control
- Reduction of noise
- Waste management

The main sources of environmental pollution in the blast furnace plant are:

Air pollution control (mainly dust):

- Feedstock preparation and handling, as crushing, grinding, screening and conveying. Practically all these units are equipped with mechanical and filtering dust separators
- Casthouse: casthouse dedusting is being carried out for some years now to improve working conditions. Hoods enclosing the skimmer, iron and slag runners and their points of transfer are now usually installed. The volume that has to be trapped and dedusted in the two casthouses is approx. 500,000/600,000 m^3/h each and the power consumption reaches about 600-700 kW.
- Blast furnace top gas: is loaded with 10-50 g/m^3 of dust. After reducing the dust by dust catcher and cyclones to <5 g/m^3 further cleaning is performed by wet cleaning e.g. using Venturi scrubber. The water requirement is approx. 1 m^3 per 1,000 m^3 gas.
  The resulting wash-water is highly contaminated and must be treated specially before released to the waste water facility of the integrated plant (see water pollution control) see below.

Water pollution control

The waste water of blast furnace section is mainly the wash water of the top gas scrubber. It contains fine suspended dust, fine colloidal particles of zinc and lead, as well as toxic compounds such as cyanides etc.
After addition of flocculants it is clarified in a thickener. The separated sludge is dewatered by filtration e.g. filter press or rotary disk filter.
The dewatered sludge is usually transferred to the sinter plant.

Reduction of noise

Numerous sources of noise exist in ironworks. The noise abatement measures consist of e.g. the use of low-vibration motors, the enclosing of machines or even entire parts of the plant.
Special measures are required to dampen the feeding and expansion noises at hot blast stoves. Considerable noise reduction can be achieved

here by covering the valves and the expansion line with a sound-absorbing material and by using sound absorbers or perforated disks in the blowoff line.

Waste management

Blast furnace slag is quantitatively the most important waste in the production of pig iron. Usually it will processed to saleable products, employed in road construction and in the cement industry. Blast furnace sludge can be recycled to the sinter plant or it is for the most part dumped. The reason for this is the high content of lead, zinc and alkali.

1.4.2 EQUIPMENT LIST OF BLAST FURNACE

Table 11 : **Equipment List of Blast Furnace**

Item/Code	Designation	Number of Equipment	Main Technical Data
RAW MATERIAL HANDLING + BURDEN SYSTEM			
RB 11	Storage Bins Ore and Sinter - Storage bins ore/sinter - Storage Bins for Aux. Raw Materials - Storage Bins for Coke	 15 sets 6 sets 6 sets	 260 m^3 130 m^3 700 m^3
RB 12	Screen for Sinter	14 sets	180 t/h
RB 13	Screen for Coke	4 sets	180 t/h
RB 16	Feeder for Lump Ore	10 sets	180 t/h
RB 19	Dedusting Equipment	1 set	10 000 m^3/min. bag filter
RB 21	Charging System - Conveyor for Ore - Conveyor for Coke - Charging Conveyor - for Fines	 1 set 1 set 1 set 1 set	 3 600 t/h 800 t/h 2 250 t/h 250 t/h
RB 22	Powdered Local Injection		275 t/h
RB 23	Blast Furnace - Inner Volume - Hearth Diameter - Number of Tap Holes - Number of Tuyeres - Furnace Support - Furnace Cooling - Charging	1	 3,250 m^3 13 mm 4 34 free standing stave type bell-less type with rotating chute

e:\projekte\plts.bolphase-2\annex-3\bl-2.5.wp5

Item/Code	Designation	Number of Equipment	Main Technical Data
RB 24	Hot Stoves Number and Type Fuel Dome Temperature	3	 external combustion type BFG + COG 1 450° C
RB 25	Process Gas System - Blower - Oxygen Enrichment	 2 sets 2 sets	 250 000 m^3/h each, 500 kPa on suction side of blowers (5.000 m^3/h)
RB 26	Recuperator Gas Expansion Turbine	 1	 reducing top gas from 250 kPa to 110 kPa
RB 28	Tapping Equipment	2 cast houses	4 tap holes, pool launders and runners
RB 29	Gas Cleaning and Dedusting - Dust Collector - Venturi Scrubber - Water Separator - Dust Treatment	1 set	 water circulation 3 000 m^3/h
RB 31	Pig Iron Handling		
RB 32	Pig Iron Casting	1	Emergency use, 250 t/h
RB 38	Products Dispatch		
RB 39	Dedusting Equipment - Cast house - Raw material handling	1 1 set 1 set	 20,000 m^3/min. bag filter 10,000 m^3/min. bag filter
RB 49	Slag Handling + Treatment	2 1	crushing equipment dry pit for slag disposal
RB 50	Maintenance Post		
RB 54	Spare Parts Depot		
RB 56	Additive Store		
RB 57	Refractory Store		
RB 58	Operating Parts Store		
RB 61	Planning System/Management Info		
RB 62	Prod. & Process Control System		
RB 63	General Instrumentation		
RB 64	Basic Automation		
RB 65	Sampling/Material Testing		
RB 67	Laboratory		

Item/Code	Designation	Number of Equipment	Main Technical Data
RB 69	Communication System		
RB 71	Plant Office		
RB 73	Locker Building		
RB 75	Fire Alarm & Fighting System		
RB 77	Road Transport		
RB 78	Rail Transport		
RB 81	Water Supply/Treatment		
RB 82	Water Circuits & Cooling System		
RB 83	Incombustible Gases & Compr. Air		
RB 84	Combustible Gases		
RB 85	Combustible Liquids & Fuel		
RB 86	Steam/Hot Water/Heat Recovery		
RB 89	Hydraulic & Lubrication System		
RB 91	High Voltage Facilities		
RB 92	Low Voltage Facilities (Electrical Equipment)		
RB 97	Lighting & Plug Socket System		
RB 98	Lighting & Earthing System		
RB 99	Other Electrical Equipment		

1.4.3 PRODUCT BALANCE

Table 12 : Product Balance

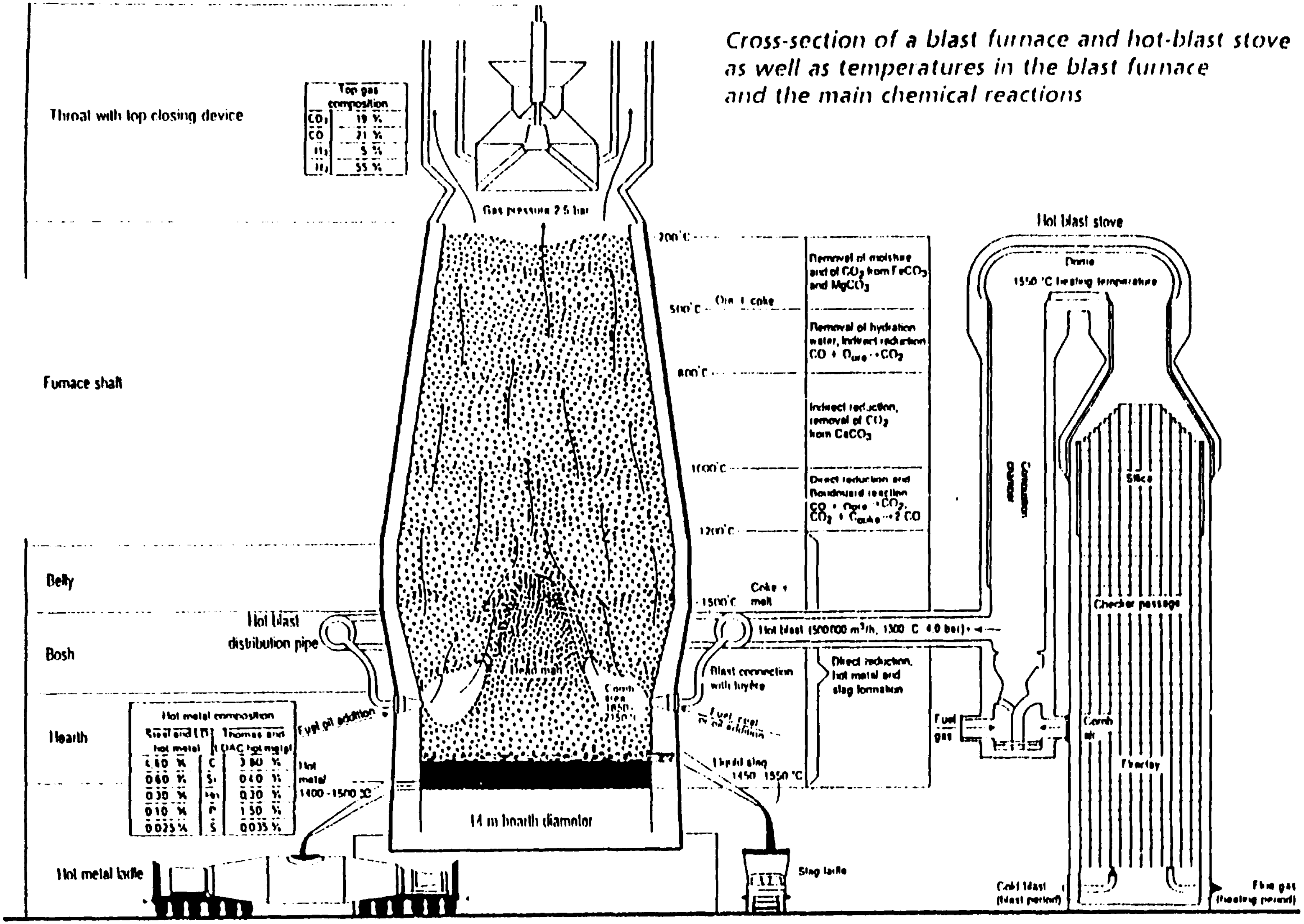
INPUT			OUTPUT		
Designation	per tonne pig iron	per year	Designation	per tonne pig iron	per year
Sinter	1,218.3 kg	3.87 x 10^6 t	Pig iron	1,000 kg	2.394 x 10^6 t
Lump ore	397 kg	9.4 x 10^5 t	Slag	336.4 kg	7.93 x 10^5 t
Anthracite	170 kg	4.02 x 10^5 t	Dust	15.04 kg	3.55 x 10^4 t
Metallurgical coke	371 kg	8.77 x 10^5 t	Scrap	9.6 kg	2.26 x 10^4 t
Blast furnace top gas	741.1 m^3 (std.)	1.75 x 10^9 m^3	Blast furnace top gas	1.985 m^3 (std.)	4.68 x 10^6 m^3 (std.)
Coke oven gas	25.7 m^3 (std.)	6.06 x 10^7 m^3 (std.)			
Make-up water (soft water cooling system)	1.8 m^3	4.25 x 10^6 m^3	Water evaporation & losses (cooling circuit	0.5 m^3	1.179x$10^6$$m^3$
			Blow down water (cooling circuit)	1.3 m^3	3.07 x $10^6$$m^3$
Hot Blast	1.580 m^3 (std.)				
Nitrogen for PCI (700 kPa)	15 m3 (std.)	35.38x10^6 m^3 (std.)			
O_2	33 m^3	77.84 x $10^6$$m^3$			
Water (clear filtered water/gas scrubber)	2 m^3 to be added	4.72 x 10^6 m^3	Waste water (gas cleaning/scrubber) recirculated from own facility	2 m^3 loss	4.72 x 10^6 m^3
Water treatment/wash-water - gas cleaning	0.1 US$	235,900 US$			
Electric energy (total with energy-recovery)	180 kWh	424.6 GWh			

1.4.4 CONSUMPTION FIGURES

Capacity	2,358,900	t/a pig iron
Working hours	8,760	h/y
Full production hours	8,208	h/y

Table 13 : **Consumption Figures**

ITEM	per tonne pig iron	per year
Sinter	1,218.3 kg	3.87 x 10^6 t
Lump ore	397 kg	9.4 x 10^5 t
Anthracite	170 kg	4.02 x 10^5 t
Metallurgical Coke	371 kg	8.77 x 10^5 t
Make-up water (soft water - cooling system)	1.8 m^3	4.25 x 10^6 m^3
Water (clear filtered water/gas scrubber)	2 m^3/t	4.72 x 106 m^3
Coke oven gas	25.7 m^3 (std.)	6.06x10^7 m^3 (std.)
Blast furnace gas (hot stoves)	741 m^3 (std.)	1.75x10^7 m^3 (std.)
Nitrogen for PCI	15 m^3 (std.)/t	35.38x10^6 m^3 (std.)
Oxygen for blast	33 m^3 (std.)	77.84 x106m3 (std.)
Water treatment/washwater - gas cleaning (chemicals)	0.1 US$	235,400 US$
Electric energy (total with energy-recovery)	180 kWh	424.6 GWh
Spare parts and maintenance	approx. 3.5 - 4.5 % of equipment/machinery investment (incl. erection)	



Cross-section of a blast furnace and hot-blast stove as well as temperatures in the blast furnace and the main chemical reactions

SUPPLEMENTARY SERIES FOR TECHNOLOGY DESIGN

Fig. 4 : Reaction Zones in a Blast Furnace

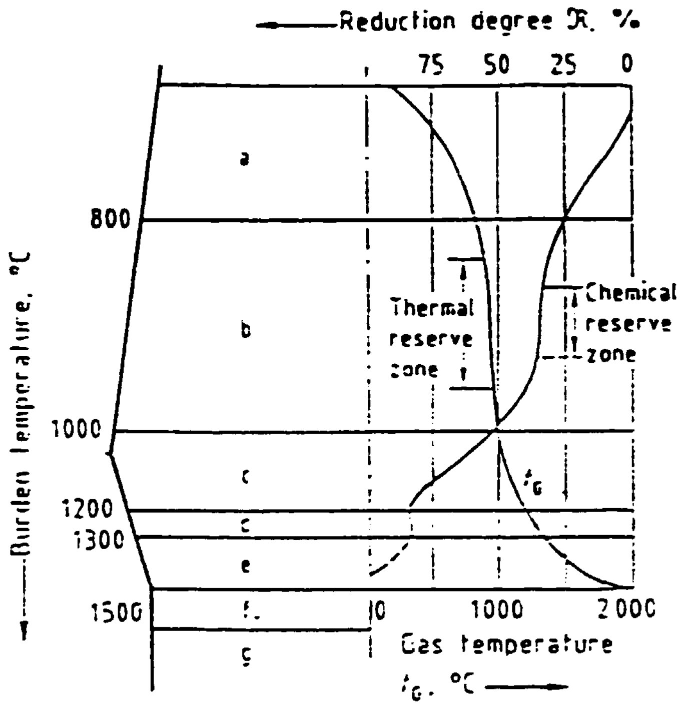


Figure Reaction zones and profiles of temperatures and reduction degree in the blast furnace [2.48]
a) Indirect reduction of Fe_2O_3 and Fe_3O_4; b) Indirect reduction of Fe_xO; c) Direct reduction of wustite and Boudouard reaction; d) Melting of iron and slag; e) Reduction of metalloid and FeO in the slag; f) Combustion in the front of the tuyeres; g) Hearth

Fig. 5 : **Internal Situation of a Blast Furnace**

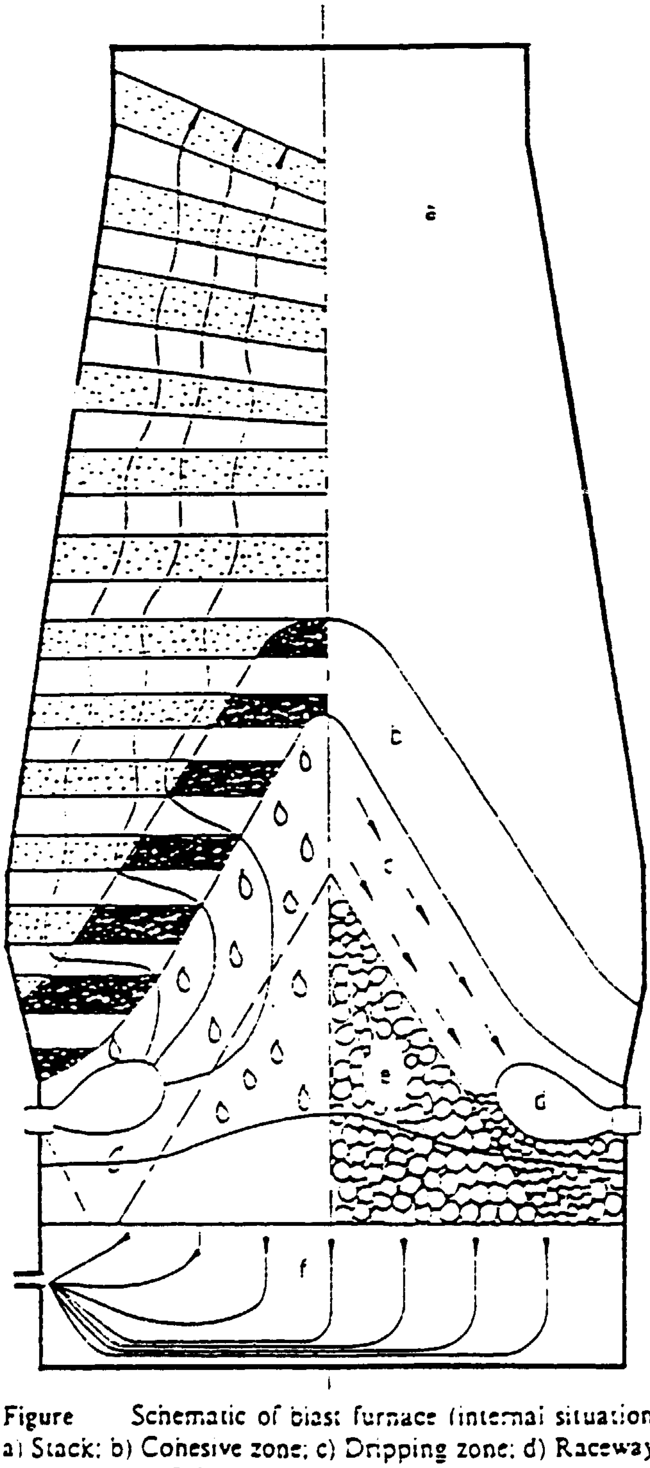


Figure Schematic of blast furnace (internal situation)
a) Stack; b) Cohesive zone; c) Dripping zone; d) Raceway;
e) Dead man; f) Hearth

Fig. 6 : Top Gas Cleaning System

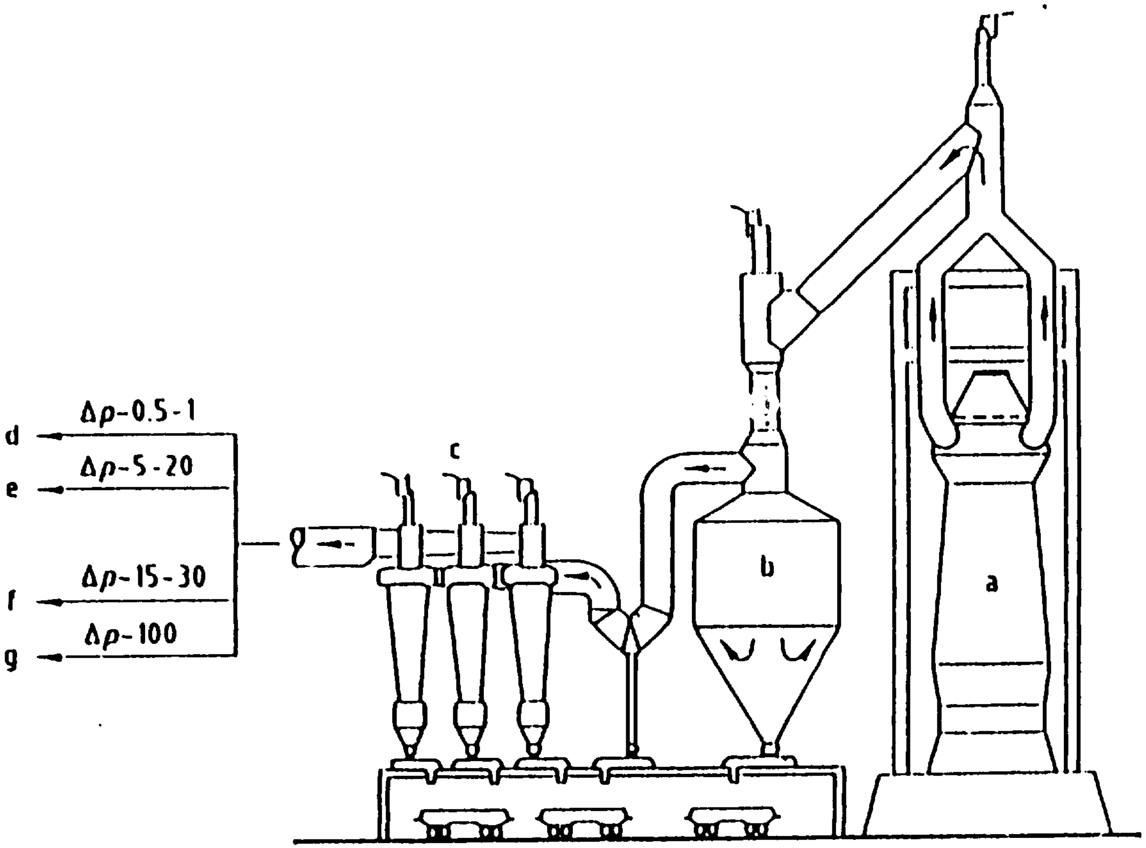
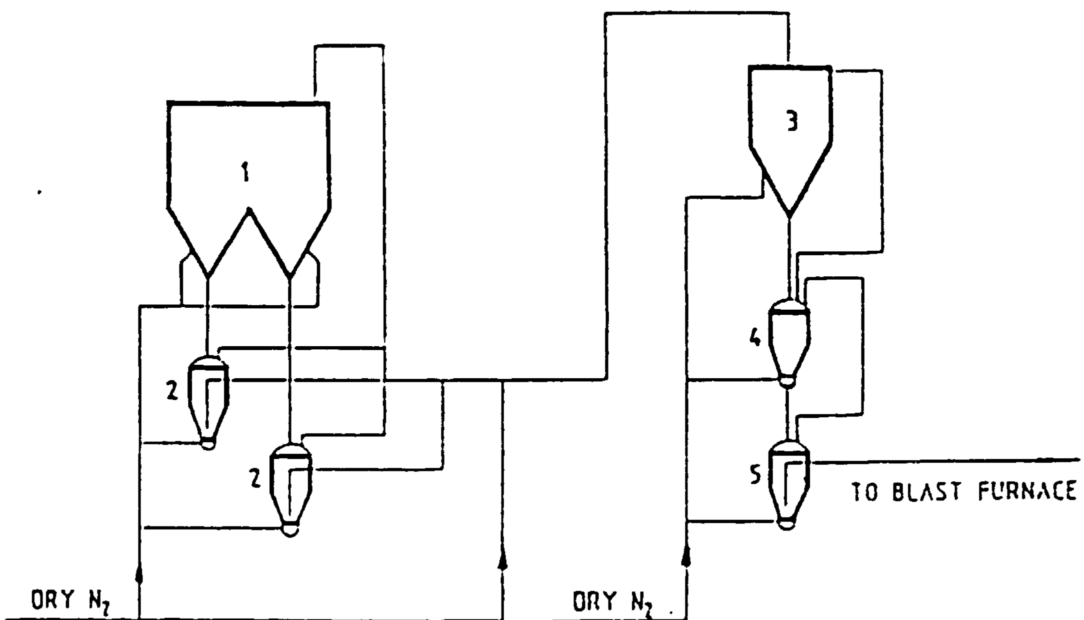


Figure 63. Top gas cleaning system [2.49]
a) Blast furnace; b) Dust catcher; c) Cyclone; d) To electric precipitator; e) To hurdle scrubber; f) To bag filter; g) To venturi scrubber

Fig. 7 : **Coal Injection System**



1 SILO

2 BLOW TANK

3 SILO

4 UPPER PRESSURE VESSEL

5 LOWER PRESSURE VESSEL

1.5 STEEL MELT SHOP

For the general process description, handling of effluents, gaseous emissions and wastes as well as description of main equipment and machinery refer to Annex 2, Chapter 1.5 of the UNIDO Report for Description of Technological Alternatives (1992).

1.5.1 EQUIPMENT LIST OF LD-PLANT

Table 14 : **Equipment List of LD-Plant**

Item/Code	Designation	Number of Equipment	Main Technical Data
SL 1	Raw and charging material treatment		
SL 11	Scrap handling - Charging crane - Chutes	1 set	 volume approx. 40 m^3
SL 12	Alloy handling system - vibrating feeder - combi gate - belt conveyor with weighing equipment - tipper car - emergency discharge chute for belt conveyor - grating for receiving bin - grating for ground level storage bin	1 set	
SL 13	Additive handling - unloading station - inclined belt conveyor - reversible belt conveyor	1 set	
SL 15	Hot metal treatment - hot metal charging crane - hot metal reladling pit - hot metal transfer car - hot metal charging ladle - ladle tilting stand - deslagging machine - ladle bubbling equipment - measuring/sampling lance system - ladle heater	1 set	
SL 16	Hot metal treatment - Desulphurizin stand	1 set	
SL 18	Ladle handling	1 set	

Item/Code	Designation	Number of Equipment	Main Technical Data
SL 19	Dedusting system for hot metal treatment - pipe line - damper - bag house - dust container - discharge device - ID fan - clean gas stack	1 set	
SL 2	Blowing operation		
SL 21	Converter charging system - high level bin - combi gate - vibrating feeder - weighing bin - reversible belt conveyor - charge bins - dosing gate - y-chute - addition chute - seal gate - compensator - emergency chute	1 set	
SL 22	Converter - converter shell - converter suspension - trunnion ring - supporting bearing and housing - converter tilting drive - converter pedestal - bottom stirring equipment on converter	1 set	2 x 230 t
SL 23	Lance blowing device - oxygen lance - oxygen flexible hose - water flexible hose - lance guide car - movable lance carrier - fixed guide - maintenance platform	2 sets	850 m^3 (std)/min. (top and bottom blowing) 1,300 m^3 (std)/min.
SL 24	Auxiliary equipment - slag stopper - dog house - temperature measurement and sampling equipment - valve station bottom stirring - valve station top blowing - media supply system for slag stopper	2 sets	

Item/Code	Designation	Number of Equipment	Main Technical Data
SL 25	Waste gas cooling and cleaning - secondary dedusting - gas holder	2 sets	 Flow rate 1,500,000 m^3/h Volume 100,000 m^3
SL 26	Ladle alloy/additive system - high level bins - vibrating feeder - belt conveyor	2 sets	
SL 27	Liquid steel handling - teeming crane - teeming ladle - emergency ladle - ladle transfer car - sliding gate with hydraulic units - equipment for sliding gate maintenance - maintenance platform - ladle support - teeming ladles and addition device - ladle heater	1 set	
SL 29	Dedusting system for ladle alloy system	1 set	
SL 3	Secondary metallurgy		
SL 31	Alloying secondary metallurgy facilities	1 set	
SL 32	Ladle stirring/bubbling injection	2 sets	
SL 33	Ladle furnace	1 set	Rated voltage max. 36 kV Furnace transformer 50 MVA Secondary current 45 kA
SL 39	Dedusting system for ladle furnace	1 set	
SL 4	Slag treatment and recycling facilities		
SL 45	Waste gas recycling	1 set	Flow rate 130,000 m^3 (std)/h
SL 46	Dust recovery	1 set	75 m^3 (std)/t
SL 49	Slag handling - slag pot - slag pot transfer car	1 set	Volume approx. 15 m^3
SL 5	Maintenance and store		
SL 51	Lance repair shop	1 set	
SL 6	Information system		
SL 62	Production and process control system	1 set	
SL 63	General instrumentation	1 set	
SL 64	Basic automation	1 set	
SL 69	Communication System	1 set	
SL 7	Infrastructure and auxiliary equipment		
SL 75	Fire alarm and fighting system	1 set	

Item/Code	Designation	Number of Equipment	Main Technical Data
SL 8	Utility supply and treatment		
SL 81	Water supply treatment	1 set	
SL 82	Water circuits and cooling system	1 set	
SL 83	Incombustible gases and compressed air	1 set	
SL 84	Combustible gases	1 set	
SL 86	Steam/hot water/heat recovery	1 set	
SL 9	Electric energy supply		
SL 91	High voltage facilities	1 set	
SL 92	Low voltage facilities	1 set	
SL 93	Electrical equipment	1 set	
SL 97	Lightning and plug socket system	1 set	
SL 98	Lightning and earthing system	1 set	

1.5.2 PERFORMANCE CALCULATION

Basic Data

HM analysis:
- C = 4.2 %
- Si = 0.6 %
- Mn = 0.24 %
- P = 0.05 %
- S = 0.05 %
- (before De-S)

HM temperature:
- at BF-tap: 1,485° C (average)
- at charging: 1,400° C

Coolants:
- Return scrap
- Purchased scrap
- Dust briquettes

Steel at tap:
- Analysis: C = 0,05 % - 0,07 %
  S ≤ 0,01 %
- Temperature: 1,650° C

1.5.3 PLANT BALANCE

Table 15 : **Plant Balance**

Process	Input		Output	
	Designation	Quantity/t CS	Designation	Quantity/t CS
Converter Charge	Hot metal	857.95 kg	Crude Steel	1,000 kg
	Pig iron	115.79 kg	Dust	14.5 kg
	Scrap	118.10 kg	Slag	100 kg
	Iron ore	5 kg	DS-Slag	15 kg
	Burnt Lime	58 kg	Loss	25 kg
	Dolomite	2 kg	Scrap	13 kg
	dust Briquettes	12.9 kg	Converter Gas	75 m^3 (std.)
	Oxygen	53 m^3 (std.)	Steam	60 kg
	DS-Agent	15 kg		
Ladle Metallurgy	Ferro Alloys	12,15 kg		
	Crude Steel	1,000 kg		
	Nitrogen	32 m^3 (std.)		
	Argon	1.5 m^3 (std.)		
	Electrodes	0.5 kg	Crude Steel	1,000 kg
Ladle Handling	Refractories (incl. LD-Vessel)	11 kg		
Energy + Electricity + Power Utilities	Electric Power	72 kWh		
	Mixed Gas	10 m^3 (std.)		
	Nat Gas	0.05 m^3 (std.)		
	Steam	7 kg		
	Compr. Air	9 m^3 (std.)		

1.5.4 ANNUAL OUTPUT APPROX 2.42 MN T/A CRUDE STEEL

2/1 operation (ie. 2 installed, thereof 1 in operation)

Table 16 : **Annual Output approx. 2.42 mn t/a Crude Steel**

Net production time BF (av.)	342 d = 8,208 h/a
Net production time LD plant	301.3 d = 7,232 h/a
Liquid metal output (av)	287.4 t/h ~ 6,900 t/d
Tap to tap time at 1/2 operation	41.14 min (av)

Charges/d at 2/1 operation	35
Converter relining	every 1.500 chgs
Duration of relining	6 d
Sulphur content liquid/solid	0.01 / 0.045 %
Days per converter trip Days for relining Total	$\frac{1{,}500}{35}$ = 42.857 d 6 d 48.857 d
2/1 operation chg/a	301.3 x 35 = 10,545 chg/a
Production of pig iron	
Annual downtime in downstream facilities	976 h
Hot metal production during downtime of downstream facilities	976 x 287.4 = 280,502 t/a
Total pig iron production	280,502 t/a
To be charged during 2/1 operation	$\frac{280{,}502}{10{,}545}$ = 26.6 t/chg
Material balance for 2/1 operation per t crude steel	
Liquid metal	856.94 kg
Iron ore*	5 kg
Pig iron	115.65 kg 49.5 %
Scrap	117.98 kg 50.5 %
Control of converter size	$\frac{287.4}{0.85694} \times \frac{41.14}{60}$ = 230 t
During 2/1 operation ferrous inputs	
Liquid metal	10,545 x 0.85694 x 230 = 2,078,398 t/a
Pig iron	10,545 x 0.11565 x 230 = 280,502 t/a
Iron ore	10,545 x 0.005 x 230 = 12,150 t/a
Scrap	10,545 x 0.11798 x 230 = 286,135 t/a
Control of BF output	
2/1 operation 2/2 operation Pig iron Total	2,078,398 t/a 0 280,502 t/a 2,358,900 t/a
Capacity of steel plant (Crude Steel)	10,545 x 230 = 2,425,350 t/a
* Balance after sublance control	

1.6 THIN SLAB CASTING AND ROLLING PLANT

For the general process description, handling of effluents, gaseous emissions and wastes as well as description of main equipment and machinery refer to Annex 2, Chapter 6.2 of the UNIDO Report for Description of Technological Alternatives (1992).

1.6.1 CONTINUOUS CASTING PLANT

1.6.1.1 EQUIPMENT LIST (CONTINUOUS CASTING PLANT - THIN SLAB)

Table 17 : **Equipment List (Continuous Casting Plant - Thin Slab)**

Item/Code	Designation	Number of Equipment	Main Technical Data
CD 2	Process Equipment		Format 700-1300x70 mm 1 x 1 Strand machine
CD 21	Ladle equipment & emerg. casting equipment	2 sets	Ladle turret: butterfly type
CD 22	Tundish equipment	2 sets	
CD 23	Additional equipment	2 sets	
CD 24	Supporting structure & cooling chamber	2 sets	
CD 25	Mold and oscillating facilities	3 sets	4-eccenter oscillator
CD 26	Strand guide	3 sets	r = 3 m, h met = 7.3 m
CD 27	Dummy bar & cutting facilities	3 sets	D/B bottom feeding system, hydraulic shear
CD 28	Runout facilities	3 sets	
CD 5	Maintenance & Stores		
CD 51	Machine maintenance	1 set	
CD 52	Tundish relining	1 set	
CD 54	Spare parts depot	1	
CD 57	Refractory store	1 set	
CD 58	Operating parts store	1 set	incl. operational spares
CD 59	Measuring & auxiliary equipment	1 set	
CD 6	Information system		
CD 62	Production and process control system	1 set	
CD 63	General instrumentation	1 set	
CD 64	Basic automation	1 set	
CD 69	Communication system	1 set	

Item/Code	Designation	Number of Equipment	Main Technical Data
CD 7	Infrastructure & Auxiliary Equipment		
CD 75	Fire alarm & fighting system	1 set	
CD 8	Utility supply & Treatment		
CD 81	Water Treatment		
CD 82	Water circuits & cooling system		
CD 83	Incombustible gases & compressed air	1 set	
CD 84	Combustible gases	1 set	
CD 86	Steam, hot water, heat recovery	1 set	
CD 89	Hydraulic & lubrication system	1 set	
CD 9	Electric energy supply		
CD 92	Low voltage facilities	1 set	
CD 93	Electrical equipment	1 set	
CD 97	Lighting & plug socket system	1 set	
CD 98	Lighting & earthing system	1 set	
CD 99	Other electrical equipment	1 set	

1.6.1.2 BASIC TECHNICAL DATA

Production	approx. 2 400 000 t thin slabs/year
Design of thin slab caster	bow-type caster with straight mold, vertical upper segment, strand containment, segments and continuous, bending and straightening of strand according to the state of the art proprietary bending and straightening process

Mold	straight parallel mold
Length	1200 mm
Strand containment:	intermediately supported rollers in vertical rack, bending & bow segment
No. of machines	2
No. of strands per machine	2 respectively 1
Height of casting platform	approx. 7.5 m
Bow radius	3 m
Metallurgical length	approx. 7.3 m
Withdrawing unit	driven rollers in straightener
Strand cutting facility	flying shear
Slab dimensions:	
Thickness	70 mm (cold condition)
Width	700 - 1300 mm (cold condition)
Length for spec. coil weight	approx. 32 m
Casting capacity per machine	average 2.4 tons/min and strand
Casting speed	max. 4.0 m/min average 3.5 m/min
Max. caster speed (drives only)	6.0 m/min
Steel grades	acc. to product mix

1.6.2 HOT ROLLING MILL FOR THIN SLABS

1.6.2.1 EQUIPMENT LIST (THIN SLAB ROLLING MILL)

Table 18 : **Equipment List (Thin Slab Rolling Mill)**

Item/Code	Designation	Number of Equipment	Main Technical Data
WT 15	Reheating Furnace	3	Roller hearth furnace capacity 320 t/h
WT 24	Finishing Mill Entry Section Finishing Stands Mill Stand Main Drive Roll Changing Device	1	6 stands (F1 - F6) 7 000 kW

Item/Code	Designation	Number of Equipment	Main Technical Data
WT 27	Strip Cooling Run-out Roller Table Laminary Strip Cooling System	1	
WT 28	Down Coiler Side Guide Assembly Ahead Coiler Pinch Roll Unit Down Coiler Coil Stripper Car	2	
WT 31	Handling Facilities Coil Conveyor Coil Banding Machine Coil Transfer Car	1	
WT 32	Inspection Line	1	
WT 38	Product Store + Dispatch	1	
WT 51	Roll Shop	1	
WT 53	Maintenance Post	1	
WT 54	Spare Parts Depot	1	
WT 56	Roll Store	1	
WT 57	Refractory Store	1	
WT 58	Operating Parts Store	1	
WT 61	Planning System/Management Info	1	
WT 62	Prod. & Process Control System	1	
WT 63	General Instrumentation	1	
WT 64	Basic Automation	1	
WT 65	Sampling/Material Testing	1	
WT 67	Laboratory	1	
WT 69	Communication System	1	
WT 71	Plant Office	1	
WT 73	Locker Building	1	
WT 75	Fire Alarm & Fighting System	1	
WT 77	Road Transport	1	
WT 81	Water Supply/Treatment	1	
WT 82	Water Circuit & Cooling System	1	
WT 83	Incombustible Gases & Compr. Air	1	

Item/Code	Designation	Number of Equipment	Main Technical Data
WT 84	Combustible Gases	1	
WT 85	Combustible Liquids & Fuel	1	
WT 86	Steam/Hot Water/Heat Recovery	1	
WT 87	Hydraulic & Lubrication System	1	
WT 91	High Voltage Facilities	1	
WT 92	Low Voltage Facilities	1	
WT 93	Electrical Equipment	1	
WT 97	Lighting & Plug Socket System	1	
WT 98	Lighting & Earthing System	1	
WT 99	Other Electrical Equipment	1	

1.6.2.2 BASIC TECHNICAL DATA

Type of furnace	Roller hearth furnace (3 off)
Fuel	Gas fired
Number of finishing stands	6 (F1 to F6) 56"
Input material	Thin slabs
- thickness	70 mm
- width	700 - 1300 mm
- length	max. 32 000 mm
Output material	hot rolled strip
- thickness	1.5 to 14 mm
- width	700 to 1300 mm
- max. coil weight	31 t

Coil dimension

- inner diameter 762 mm
- outer diameter max. 2150 mm

1.7 AUXILIARY PLANTS

For the general process description, handling of effluents, gaseous emissions and wastes as well as description of main equipment and machinery refer to Annex 2, Chapter 1.6 of the UNIDO Report for Description of Technological Alternatives (1992).

1.7.1 LIME PLANT

1.7.1.1 EQUIPMENT LIST OF LIME PLANT

Table 19 : **Equipment List of Lime Plant**

Item/Code	Designation	Number of Equipment	Main Technical Data
BS 12	Limestone Handling		
	- Front end loader	1	
	- Belt conveyor system	1 set	
BS 13	Limestone screening		
	- Screens	1 set	
	- Storage bin	2	300 m³ grain size 30 - 80 mm
	- Storage bin	1	150 m³ grain size 0 - 30 mm
	- Belt conveyor	2 sets	
	- Vibrating feeders	2	
BS 19	Dedusting system		
	- for Belt conveyor (BS 12)	1 set	
	- for screening station (BS 13)	1 set	
BS 21	Kiln charging system		
	- Belt conveyor	1 set	
	- Skip	1 set	
	- Skip hydraulic	1 set	
BS 23	Shaft kiln complete	1	
BS 28	Kiln charging system		
	- Vibrating feeder	1	
	- Belt conveyor	1 set	
BS 29	Dedusting System	1 set	
BS 31	Product Handling		
	- Bucket elevator	1	

Item/Code	Designation	Number of Equipment	Main Technical Data
BS 32	Crushing and screening		
	- Bucket elevator	1	
	- Screen	1	for fraction 0 - 60 mm
	- Screen	1	for fraction 60 - 80 mm
	- Jaw crusher	1	for fraction > 60 mm
	- Belt conveyor	1	
	- Bucket elevator	1	
	- Screen	1	for 0 - 10 mm
	- Screen	1	for 10 - 60 mm
	- Storage bin	1	300 m^3 for grains 0 - 10 mm
	- Two way chute	1	
	- Storage bins	2	450 m^3
	- Belt conveyor	1	
	- Jaw crusher	1	grain size 20 mm
	- Two way chute	1	
	- Screens	1	for 0 - 10 mm
	- Screens	1	for 10 - 20 mm
	- Belt conveyor	1	for 0 - 10 mm
	- Belt conveyor	1	for 10 - 20 mm
	- Storage Bin	1	150 m^3 for 10 - 20 mm
	- Belt conveyor to steel plant	1 set	
BS 33	Grinding Station		
	- Screen	1	0 - 30 mm
	- Magnetic separator	1	
	- Rotor hammer mill	1	
	- Belt conveyor	1 set	
	- Bucket elevator	1	
	- Cyclone with star feeder	1	
	- Bin aeration system	1 set	
	- Starfeeder	1	
	- Two way chute	1	
BS 39	Dedusting system		
	- for Crushing and Screening	1 set	
	- for Grinding plant	1 set	
BS 64	Basic automation		
	- Control process unit	1 set	
	- I/O Cards		
	- Power supply		
	- Programming unit		
	- Software		
	- Local control boxes		
	- Speed monitors		
	- Pull rope switches		
	- Belt trucking switches		
BS 92	Low voltage Facilities		
BS 93	Electrical Equipment		

1.7.1.2 BASIC DATA

Limestone:

- Incoming limestone:
  Grain size 0-80 mm
  Undersize 5 % max. 0-30 mm
  Oversize 5 % max. 120 mm in one direction

Chemical and physical properties of limestone:
The limestone has to be free of contaminations such as clay minerals, SiO_2, iron, metal pieces, wood etc.
Limestone should have no crystalline physical properties thus avoiding decrepitation during preheating and calcination.

Grain size:

Limestone kiln feed	30 to 80 mm

Moisture content:

Grain size 30 - 80 mm	max. 1 % H_2O in daily average
Bulk weight	approx. 1.4 t/m^3

Operation Time

Shaft kiln Production	600 tons of burnt lime per 24 hours continuous operation
Over all plant availability	330 days per year
Burnt lime quality	Rest CO_2-content 2 % (average)
Limestone handling and storage (14 shifts per week)	2 shifts per day
Calcining plant including burnt lime crushing and storage section (21 shifts per week)	3 shift per day

Manpower

1 Engineer
1 Secretary
1 Foreman per shift
3 Workers per shift
1 Driver for front end loader per shift

For maintenance and major repair specialists for

- Mechanic
- Electric and instrumentation
- Hydraulic

can be called upon from case to case from the main maintenance shop.

1.7.1.3 CONSUMPTION

Capacity: 201,500 t/a
Annual working hours: 7,920 h/a
Max. output: 25 t/h

Table 20 : **Consumption Figures**

Item	Per t Burnt Lime	Per Year
Limestone	1759.5 kg	354,378 t
Electric Power	59 kWh	11.88 GWh
Mixed Gas	450 m^3 (std.)	90.63 x 10^6 m^3 (std.)
Nitrogen	4.5 m^3 (std.)	9.06 x (0^5 m^3/std.)

1.7.2 PRE-PRODUCTION FACILITIES

1.7.2.1 IH 12 RAW MATERIAL STORAGE YARD

	storage area approx. for 1.5 month	storage capacity approx. for 1.5 month
- Iron ore	approx. 21,500 m^2	approx. 400,000 t
- Limestone	approx. 6,500 m^2	approx. 61,200 t
- Dolomite	approx. 2,100 m^2	approx. 24,000 t
- Coal	approx. 25,000 m^2	approx. 155,000 t
- Scrap	approx. 10,000 m^2	approx. 45,000 t

Beside the foreseen storage areas the raw materials will be handled with two stacker reclaimers. A belt conveyor system transports the raw materials to the ore screening station, the coal drying plant and the burden building by means of the yard conveyors. The technical specifications are generally the same as the dock conveyor, also running in one direction only.

3 stockpiles 650 m long and approx. 60/30 m wide each, are foreseen providing an area of 78,000 m^2. Drainage trenches on either side of the stockpiles provide dewatering after rainfalls. The water is collected in a settling pond, which overflow is ducted into the creek. The storage areas are paved and slanted 1% towards the trenches.

1.7.2.2 IH 14 SCRAP HANDLING AND TREATMENT

1.7.3 PERIPHERAL FACILITIES

1.7.3.1 IH 46 AIR SEPARATION PLANT

Table 21 : **Gas Productions**

Item/Code	Designation Equipment	Number of	Main Technical Data
		(average values)	
AIR SEPARATION PLANT IH 46	- O_2-generation (99.5% purity)	1 set	Qn = 17,750 m^3/h
	- N_2-generation	1 set	Qn = 15,350 m^3/h
	- Ar-generation	1 set	Qn = 525 m^3/h

Fig. 8 : Air Separation Plant / Process Flow

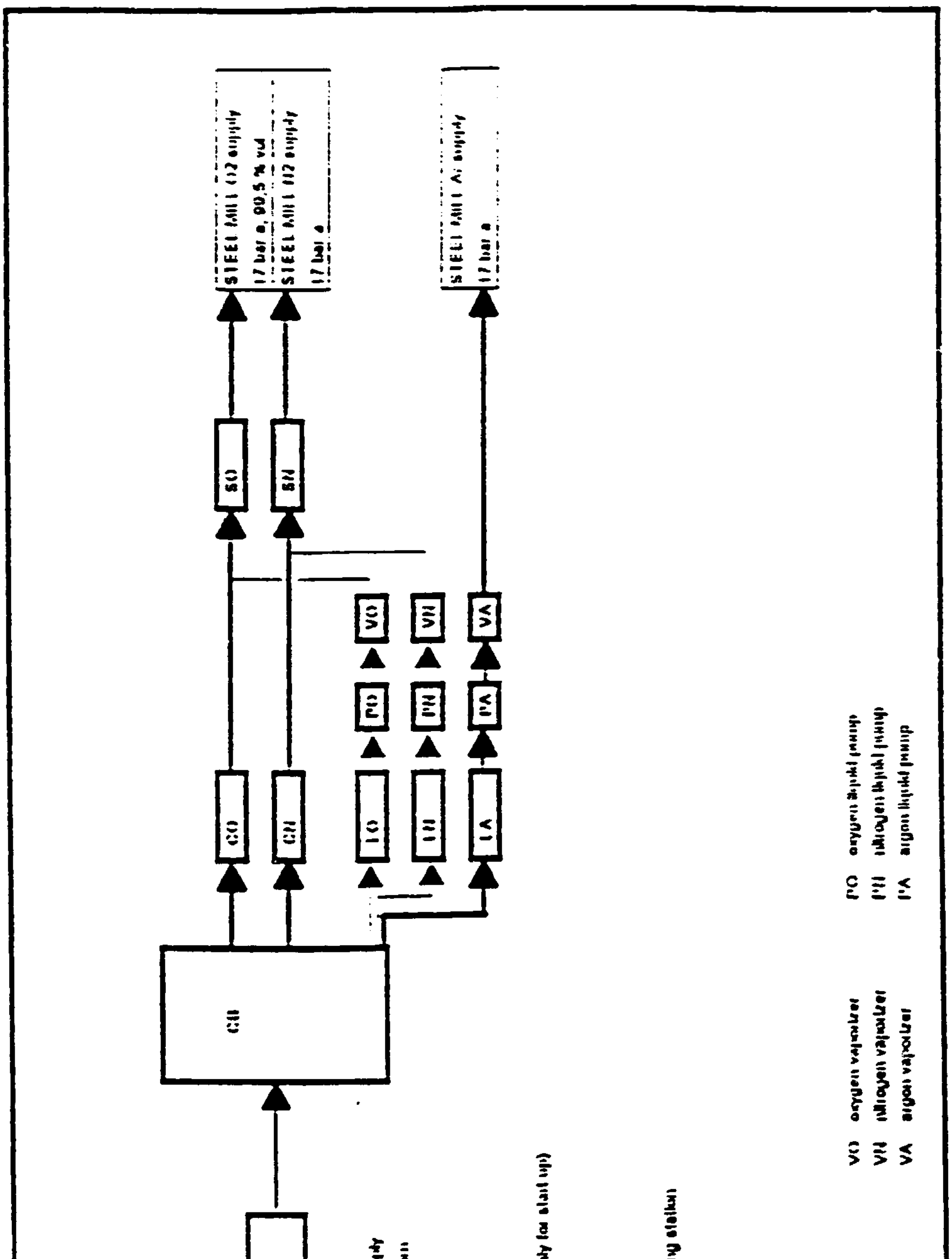


Table 22 : **Gas requirements**

	O_2 required Nm³/h av. / max.		N_2 required Nm³/h av. / max.		Ar required Nm³/h av. / max.	
Lime plant	0	0	120	180	0	0
Blast furnace (O_2-95% purity)	9,500	12,000	4,350	6,000	0	0
LD-plant (O_2-99.5% purity)	17,750	50.000	10,720	14,000	505	520
CC slabs	25	50	30	40	30	50
Integrated facilities	0	0	115	1,000	0	0

Utility requirements

Table 23 : **Electrical Energy**

Air compressor	AC	10,800 kW
Air booster	BO	-
Oxygen compr.	CO	5,000 kW
Nitrogen compr.	CN	1,300 kW
Others	-	500 kW
TOTAL		17,600 kW

Cooling water:
(total requirement based on 10 degrees temperature difference between supply and return.)
Q = 1,520 m³/h

Steam:
for regeneration of the molecular sieve dryers
Q = 0.71 t/h (saturated steam)

1.7.3.2 IH 48 SLAG HANDLING AND TREATMENT

1.7.3.3 IH 49 SCALE HANDLING AND TREATMENT

1.7.4 MAINTENANCE AND STORES

1.7.4.1 IH 51 CENTRAL MECHANICAL WORKSHOP

1.7.4.2 IH 52 CENTRAL ELECTRICAL/ELECTRONIC WORKSHOP

1.7.4.3 IH 53 CENTRAL MECHANICAL WORKSHOP

1.7.4.4 IH 54 STORE FOR SPAREPARTS AND CONSUMABLES

1.7.4.5 IH 57 CENTRAL REFRACTORY STORE

1.7.4.6 IH 58 CENTRAL OPERATING PARTS STORE

1.7.5 INFORMATION

1.7.5.1 IH 61 PLANNING SYSTEM / MANGEMENT INFO

1.7.5.2 IH 63 GENERAL INFORMATION

1.7.5.3 IH 64 BASIC AUTOMATION

1.7.5.4 IH 67 CENTRAL LABORATORY

1.7.6 INFRASTRUCTURE AND AUXILIARY EQUIPMENT

1.7.6.1 IH 71 ADMINISTRATION BUILDING

1.7.6.2 IH 73 LOCKER BUILDING AND CANTEEN

1.7.6.3 IH 74 FIRST AID AND SECURITY FACILITIES

1.7.6.4 IH 75 FIRE ALARM AND FIRE FIGHTING SYSTEM

1.7.6.5 IH 77 ROAD TRANSPORT

Table 24 : **List of Vehicles**

	Pcs	Name	Price US$
RC	7	Filterplant-container	15.167
SL	1	Alloy handling-wheel loader	195.000
SL	4	Filter plant container	[illegible]

SL	1	Alloy handling-wheel loader	195,000
SL	1	Dewatering unit-container	21,667
SL	5	Road vehicles fork lift truck	325,000
CD	4	Crop end handling container	136,500
CD	4	Crop/skull bucket	84,500
WT	1	Scale removal system wheel loader	216,667
WT	4	Handling facilities fork lift truck	1,733,333
WT	2	Handling facilities trailer	216,667
WT	2	Handling facilities tractor	433,333
WT	4	Scrap transfer trailer	390,000
IH	4	Scrap transfer container	390,000
IH	2	Scrap transfer tractor	325,000
IH	1	Mobile crane with magnet for cleaning up scrap yard	228,583
IH	28	Slag transportation slag pot	4,478,500
IH	4	Slag transportation for carrier	2,946,667
IH	3	Depot/store-lift truck	117,000
IH	18	Road vehicles container	320,125
IH	2	Road vehicles fork lift truck	75,833
IH	1	Road vehicles wheel loader	182,000
IH	1	Road vehicles elevating carrier	500,500
IH	6	Road vehicles truck	681,417
IH	10	Automobiles	238,333
IH	6	Passenger cab buses	379,167
IH	10	Cab pickup trucks	216,667
IH	1	Pumper fire truck	465,833
Sum			15,595,125

1.7.6.6 IH 78 RAIL TRANSPORT

Table 25 : **List of Rail Vehicles**

	Pcs.	Designation	Price in 1,000 US$
	3	Diesel locomotive 75 t	4,500
	9	Torpedo car 250 t	9,000
	12	Misc. cars	1,400
	4 km	Railway track and switches	1,800
	2	Weighbridge 300 t	1,000
		Total	17,300

1.7.7 UTILITY SUPPLY/TREATMENT

1.7.7.1 IH 81 WATER SUPPLY/TREATMENT

Total industrial water requirement ~ 1,470 m^3/h
Pressure 0,3 MPa at battery limit
Temperature ~ 28 °C
Unit: m^3/h average values

Table 26: **Water Requirements**

Plant	Make-up water	Service water	Fire fighting water	Potable water
Lime plant	-	1.5	0-200	1.5
Sinter plant	215		0-200	1.5
Coking plant	430	1.5	0-200	1.5
BF plant	514	2.5	0-200	in make-up incl.
LD-plant	204	3	0-200	8.5
CC thin slabs	133	1.5	0-200	4.5
Thin slab mill	194	3	0-200	4.5
Integration facilities	238	12	0-200	3
TOTAL	1,450	25	0-400	25

Waste Water

- Industrial waste water
  The industrial waste water, mainly bleed-off water from the open cooling circuits, is collected in the central water treatment plant.

  The treated waste water which is to comply with national standards and/or regulations for discharging will be pumped to the take over point (T.O.P.) at the battery limit of the iron and steel works.

  Average water flow for discharge:
  $Q_{approx} = 700\ m^3/h$

- Sanitary waste water
  The sanitary waste water is collected in a sewer system. The sewer system will be discharged at the take over point at the battery limit of the iron and steel works.

  Average water flow for discharge:
  $Q_{approx} = 21\ m^3/h$

- Rain water

  Run-off rain water from buildings, roads, etc. is drained to the battery limits of the works.

1.7.7.2 IH 82 WATER CIRCUITS AND COOLING SYSTEMS

Table 27: **Cooling Systems / Heat Transfers**

Plant/Production Unit	Total flows/circulating water m^3/h	Heat load GJ/h
Blast Furnace plant	1)	-
LD-plant	1,040	67.8
CC thin slabs	3,550	80.0
Thin slab mill	12,500	365.0
Integration facilities	1,600	66.5
1) Within utility systems of production plant (Plant code AC + RB + AS)		

1.7.7.3 IH 83 INCOMBUSTIBLE GASES AND COMPRESSED AIR

Total flows (peak values)

Compressed air: Qn = 11,000 m^3/h pe= 0.7 MPa
Instrument air: Qn = 750 m^3/h pe= 0.7 MPa
Air mist air: Qn = 15,500 m^3/h pe= 0.3 MPa

Table 28: **Incombustible Gas Requirements**

Gas and air flows in Qn = m^3/h (Average values)

CA compressed air
IA instrument air

	O_2	N_2	Ar	CA	IA	Air mist
Lime plant	-	120	-	1035	75	-
BF plant	9,500	4,350	-	1,440	-	-
LD-plant	17,750	10,720	450	3,020	75	-
CC thin slabs	25	30	20	300	75	*) - 15,500
Thin slab mill	-	-	-	1,500	225	-
Integration facilities	-	250	-	1,500	150	-
Sinter Plant	-	-	-	90	10	-
Coking Plant	-	-	-	10	-	-
*) peak value (process air)						

1.7.7.4 IH 84 COMBUSTIBLE GASES

Table 29: **Plant Balance of Combustible Gases**

		Calorific value (kJ/Nm³)	BFG Nm³/h	COG Nm³/h	LDG Nm³/h
Generated	Blast furnace	3,250	570,259		
	Coke oven	17,600		44,380	
	LD-Shop	8,350			25,123
Consumed	Blast furnace	-	212,988	6,723	
	Coke oven	-	62,572		
Balance to Gas Mixing Station		-	294,700	37,657	25,123
Mixed Gas		8,350			
Consumers	Lime plant	8,350	11,444		
	Sinter plant	8,350	5,097		
	LD plant	8,350	3,350		
	CC-thin slabs	8,350	410		
	Thin slab mill	8,350	9,657		
	Others	8,350	10,042		
	TOTAL	8,350	40,000		

The consumers will be fed with gas from the LD Shop (25.13 Nm³/h). The balance to the amount required (40,000 Nm³/h) will be composed of 5287 Nm³/h COG + 9590 Nm³/h BFG.

Total production for export

BF	285,110 Nm³/h x	3,25 MJ/Nm³ =	926,608 MJ/h
COG	32,370 Nm³/h x	17,6 MJ/Nm³ =	569,712 MJ/h
Total	317,480 Nm³/h x	4,71 MJ/Nm³ =	1,496,320 MJ/h (= (MWs/h)

Total annual heat export: 1,496.32 GJ/h x 8,208 h/a = 12,281,795 GJ/a

The calorific value of 4,71 MJ/Nm³ indicates that the gas mixture is very weak. It is therefore proposed to raise the heat value by adding it natural gas to such an extent as to be comparable to a COREX® gas (8.35 MJ/Nm³) and may safely be fired in the PTKS power station.

Heat content export gas 1496320 MJ/h (MWs/h) at 4,71 MJ/Nm^3
Natural gas addition 41759 Nm^3/h at 36 MJ/Nm^3

Total heat input/h 2999646 MJ/h (MWs/h) at 8,35 MJ/Nm^3

$$\frac{299646}{3600} = 833{,}24\ MW_{therm}$$

Power plant efficiency rate assumed o,35
Electrical output 0,35 x 833,24 = 291.6 MW_{electr}

Existing Power Plant of PTKS:

The existing steam power station of PTKS consists of 5 modules of 80 MW of power generation each, 4 of them in operation, 1 for stand-by (see Figure 8)

It is intended to feed the BF-export-gas to the steam boilers of the power station by means of

- exchange of the existing burners of the steam boilers by tripropellant burners for mixed gas, natural gas and fuel oil (see Figure 9)
- connection of the power plant and the BF plant by a feeding pipe line (dia 1 800 mm).

1.7.7.5 IH 86 STEAM / HOT WATER

Steam Balance

average values (design flows)
unit: t/h

Table 30: **Steam Balance**

Consumed	Coke Oven	35.0
	LD-plant (dedusting)	2.35
	Air separation plant	0.71
Generated	LD-plant (heat recovery)	20.0
	Steam boiler plant	20 - 35.0

Design data

Pressure:	1.0 MPa
Temperature:	185°C
Condition:	saturated steam

Fig. 9: Steam Plant Balance

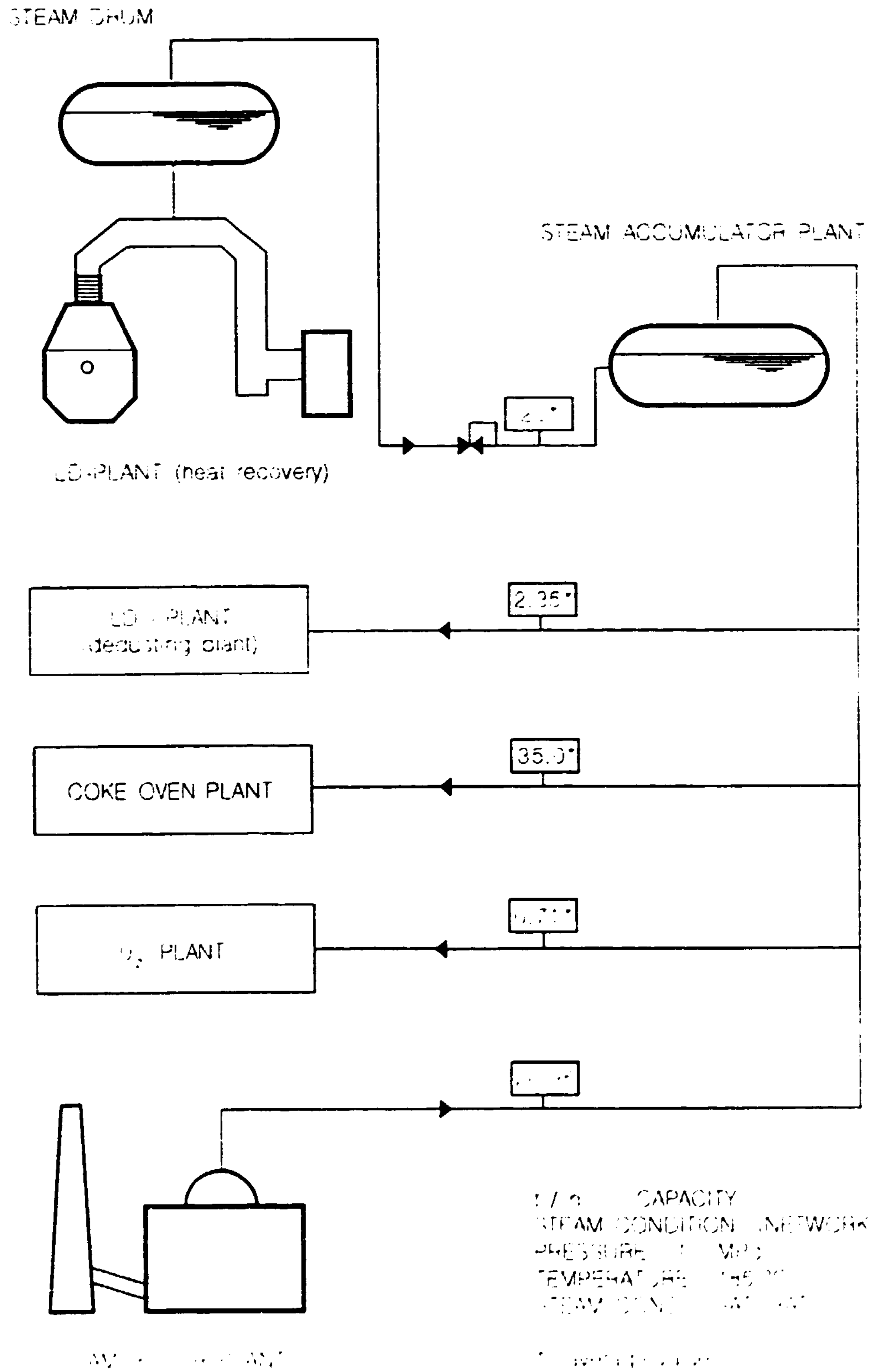


Fig. 10: **Proposed Disposition of Burners in Existing Boiler**

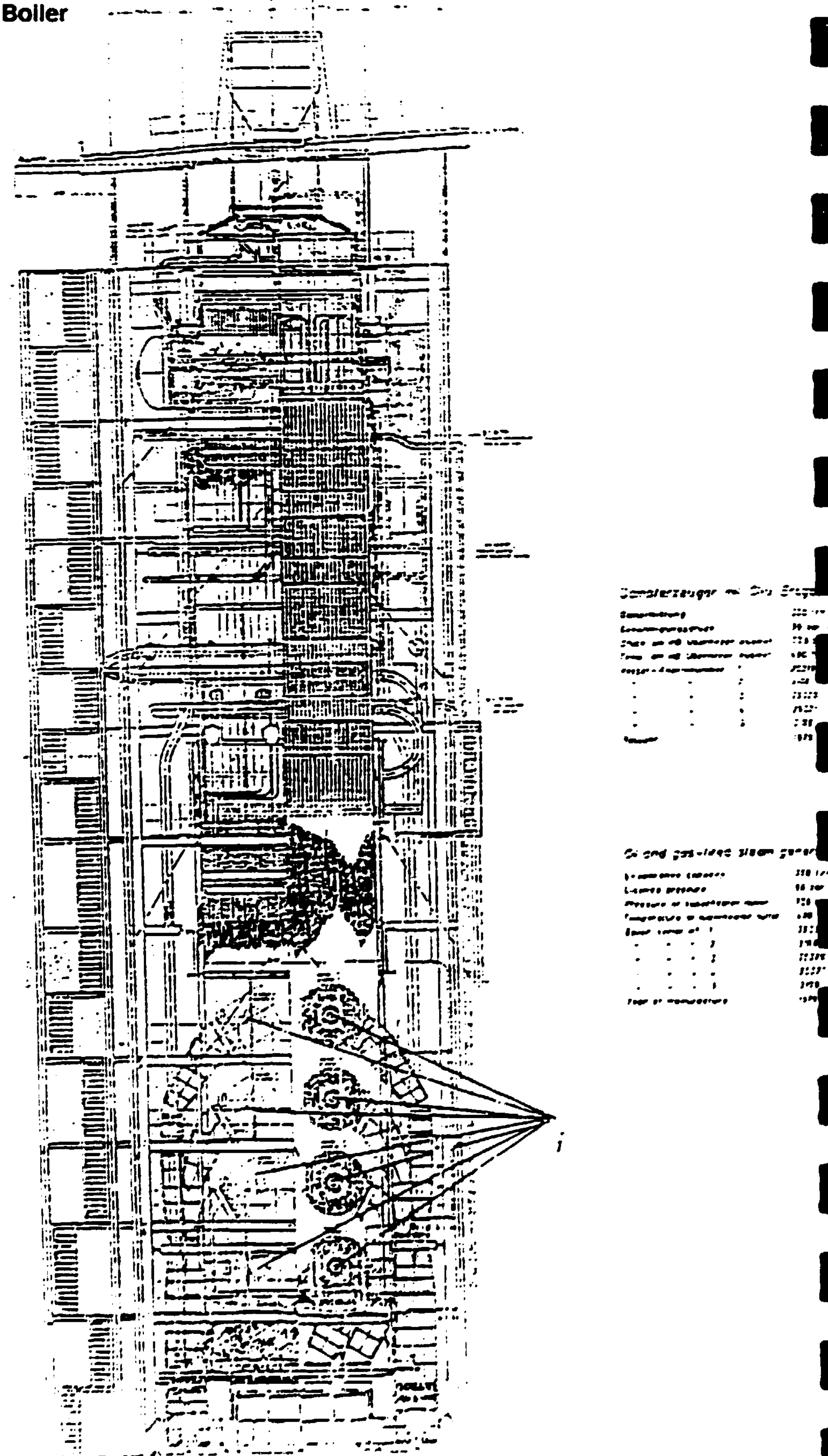


Fig. 11: **Section through Burner for 120 MW_{therm}**

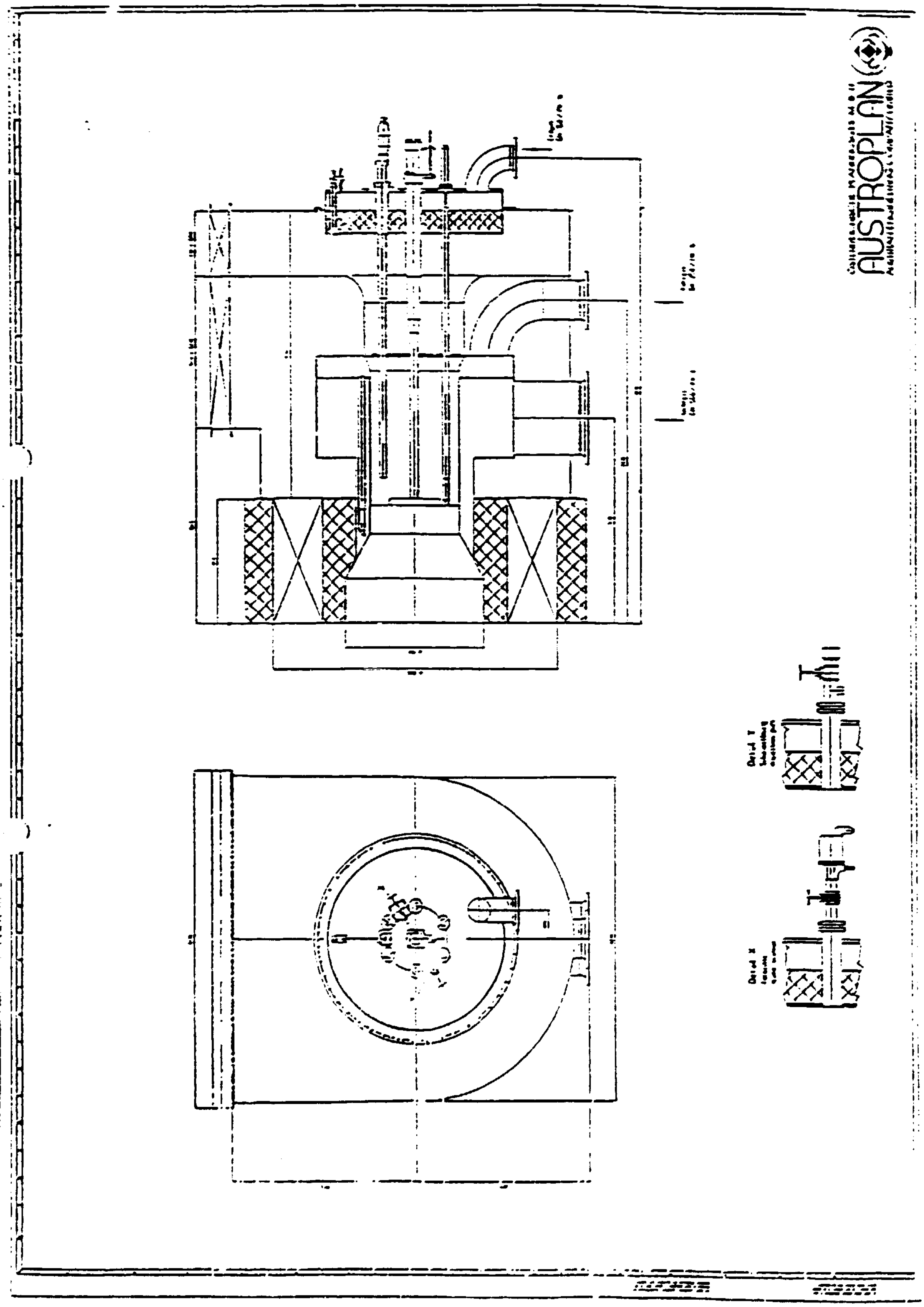


Fig. 12: **IH84 Combustible Gases / Plant Balance**

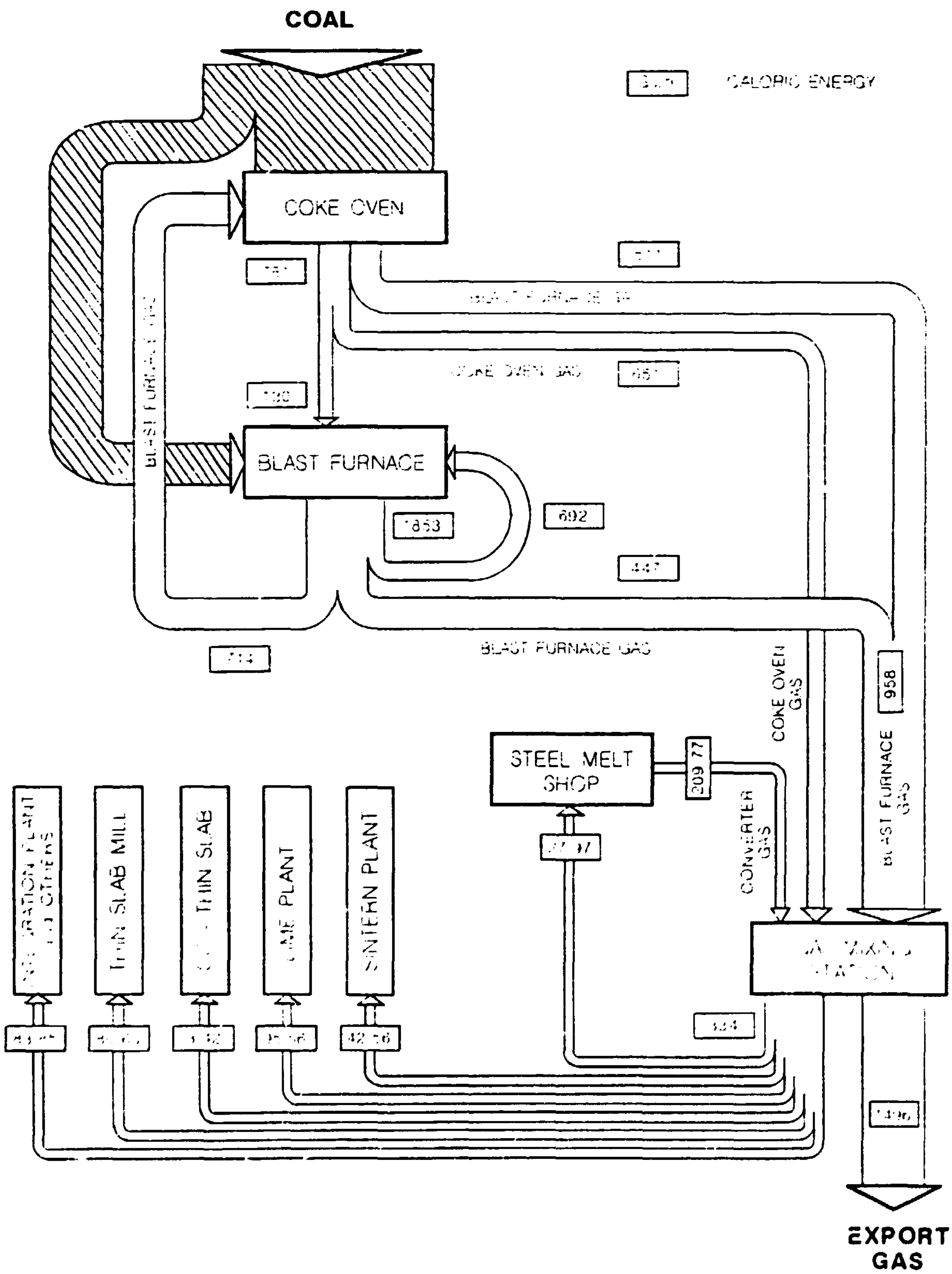


Fig. 13: **IH84 Combustible Gas / Process Flow**

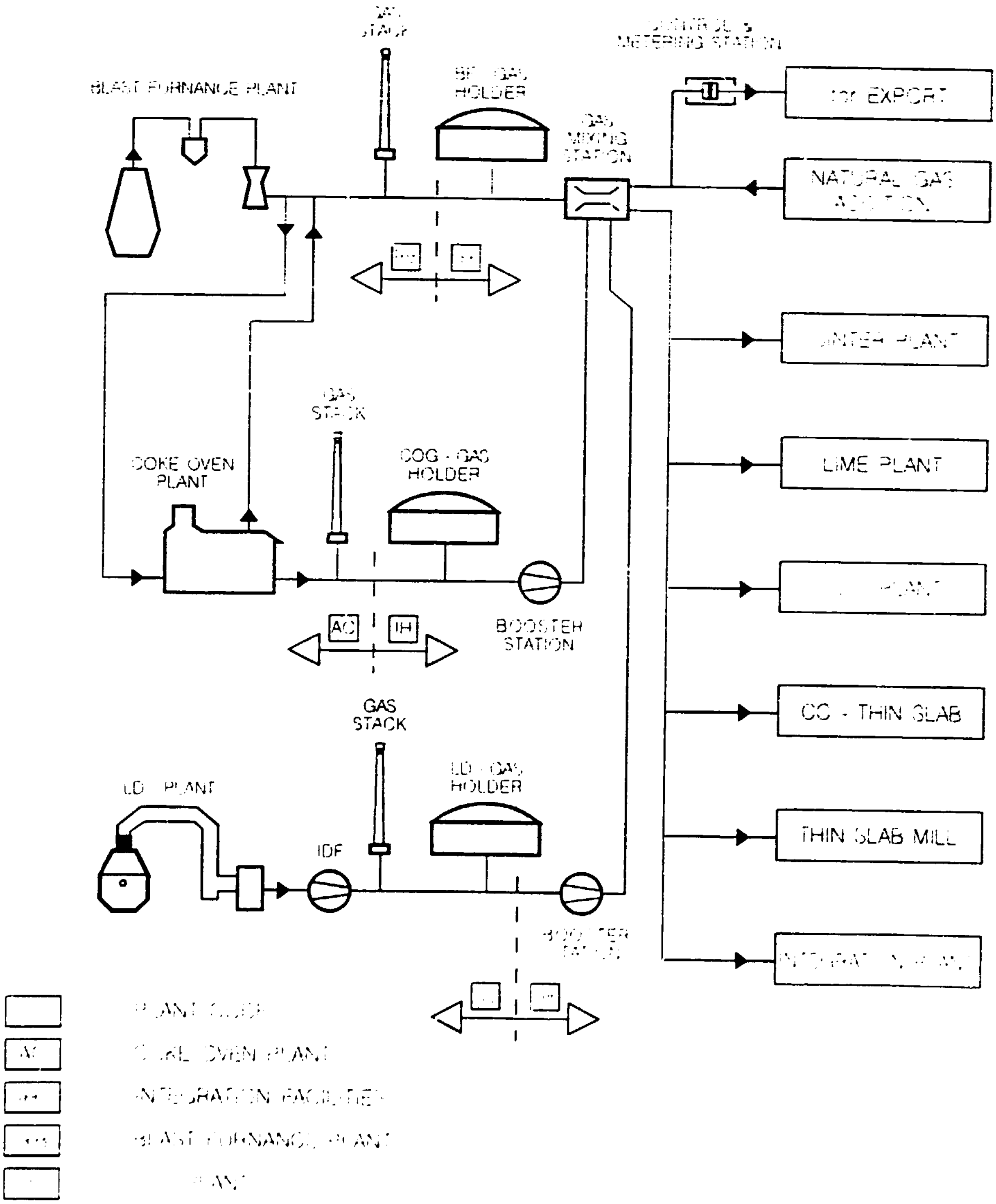


Table 31: **Equipment List for Auxiliaries**

Item/Code	Designation	Number of Equipment	Main Technical Data
UTILITY SUPPLY/TREATMENT			
IH 81	Water Supply/Treatment	1 set *)	Q = 1,600/1,470 m^3/h
	i) Make up water system	1 set	Q = 1,450 m^3/h
	ii) Service water system	1 set *)	Q = 60/25 m^3/h
	iii) Fire fighting water system	1 set	Q = 0-400 m^3/h
	iv) Potable water system	1 set *)	Q = 60/25 m^3/h
	v) Industrial waste water system	1 set	Q = 700 m^3/h
	vi) Sanitary waste water system	1 set *)	Q = 50/21 m^3/h
	vii) Rain water system	1 set	
IH 82	Water Circuits + Cooling	1 set	
	viii) LD-Plant cooling	1 set	67.8 GJ/h
	ix) CC thin slab cooling	1 set	80.0 GJ/h
	x) Thin slab mill	1 set	365 GJ/h
	xi) Auxiliary plant cooling	1 set	66.5 GJ/h
IH 83	Incombustible Gases and Air	1 set	
	xii) Oxygen distribution system	1 set *)	Qn = 62,000/27,275 m^3/h
	xiii) Nitrogen distribution system	1 set *)	Qn = 22,000/15,350 m^3/h
	xiv) Argon distribution system	1 set	Qn = 525 m^3/h
	xv) Compressed air system	1 set	Qn = 12,000/8,900 m^3/h
	xvi) Instrument air system	1 set	Qn = 750/600 m^3/h
	xvii) Air mist system	1 set *)	Qn = 15,500 m^3/h (peak)
IH 84	Combustible Gases	1 set	
	xviii) BF gas system	1 set	Qn = 600,000/570,000 m^3/h
	COG gas system		Qn = 50,000/45,000 m^3/h
	xix) LD-converter gas system	1 set	Qn = 25,100 m^3/h
	xx) Mixed gas export system	1 set	Qn = 350,000/317,500 m^3/h
	xxi) Natural gas system	1 set	Qn = 45,000/42,000 m^3/h
IH 86	Steam/Hot Water	1 set	Qn = 27.5 t/h

*) Indicated values are peak/average system flows

1.7.8 ELECTRICAL EQUIPMENT

1.7.8.1 IH 91 HIGH VOLTAGE FACILITIES

1.7.8.2 IH 92 LOW VOLTAGE FACILITIES

1.7.8.3 IH 93 ELECTRICAL EQUIPMENT

1.7.8.4 IH 97 LIGHTING AND PLUG SOCKET SYSTEM

1.7.8.5 IH 98 LIGHTING AND EARTHING SYSTEM

1.7.8.6 IH 99 OTHER ELECTRICAL EQUIPMENT

Table 32: **Electric Energy Consumption**

Item	MWh/a
Process Facilities:	
Coking Plant	63,120
Sinter Plant	159,590
Blast Furnace	424,600
LD Plant	174,420
Thin Slab Casting	8,190
Thin Slab Mill	162,960
Lime Plant	11,880
Sub Total	1,004,760
Integration Facilities:	
Oxygen Plant	194,395
Compressed Air Plant	18,164
Various	32,681
Sub Total	245,240
Grand Total	1,250,000
Consumption MW/h	153.3

Table 33: **Equipment List of Integration Facilities**

Item/Code	Designation	Number of Equipment	Main Technical Data
IH 12	Raw material storage yard - Stacker reclaimer - Belt conveyor system	 2 pieces 1 set	
IH 14	Scrap handling and treatment - bridge crane with crab and magnet - weighing bridge - hand gas cutting torches	 1 piece 1 piece 1 set	
IH 46	Air separation plant - O_2-generation (95 % purity) - O_2-generation (99.5 % purity) - N_2-generation - Ar-generation	 1 set 1 set 1 set 1 set	 Qn = 9,500 m^3/h Qn = 17,750 m^3/h Qn = 15,350 m^3/h Qn = 525 m^3/h

Item/Code	Designation	Number of Equipment	Main Technical Data
IH 48	Slag handling and treatment - hopper - wheel loader - vibration grades - impact crusher - vibrating feeder - screening machine - belt conveyor	 1 set 1 piece 1 set 1 piece 1 set 1 piece 1 set	
IH 49	Scale handling and treatment		
IH 51	Central mechanical workshops - bay crane - various tools and machines	 2 pieces 1 set	
IH 52	Central electrical/electronic workshop - bay crane - various tools and machines	 1 piece 1 set	
IH 53	Maintenance railway/vehicles - bay crane - various tools & machines	 2 pieces 1 set	
IH 54	Store for spare parts and consumables - bay crane - fork lift - pallets - various stackers	 1 piece 1 piece	
IH 57	Central refractory store - bay crane - fork lift - pallets	 1 piece 1 piece	
IH 58	Central operating parts store - bay crane - fork lift - pallets - various stacker	 1 piece	
IH 61	Planning system/management info		
IH 63	General instrumentation		
IH 64	Basic automation		
IH 67	Central laboratory		
IH 73	Administrative building		
IH 74	First aid & security device		
IH 75	Fire alarm & fighting system		
IH 77	Road transport		

Item/Code	Designation	Number of Equipment	Main Technical Data
IH 81	Water supply/treatment	1 set *)	Q = 1,600/1,470 m^3/h *)
	- make up water system	1 set	Q = 1,450 m^3/h
	- service water system	1 set *)	Q = 60/25 m^3/h *)
	- fire fighting water system	1 set	Q = 0-400 m^3/h
	- potable water system	1 set *)	Q = 60/25 m^3/h *)
	- industrial waste water system	1 set	Q = 700 m^3/h
	- sanitary waste water system	1 set *)	Q = 50/21 m^3/h *)
	- rain water system	1 set	
IH 82	Water circuits + cooling	1 set	
	- LD-plant cooling	1 set	67.8 GJ/h
	- CC thin slab cooling	1 set	80.0 GJ/h
	- Thin slab mill cooling	1 set	365.0 GJ/h
	- auxiliary plant cooling	1 set	66.5 GJ/h
IH 83	Incombustible gases and air	1 set	
	- oxygen distribution system	1 set *)	Qn = 62,000/27,275 m^3/h *)
	- nitrogen distribution system	1 set *)	Qn = 22,000/15,350 m3/h *)
	- argon distribution system	1 set	Qn = 525 m^3/h
	- compressed air system	1 set *)	Qn = 12,000/8,900 m^3/h
	- instrument air system	1 set	Qn = 750/600 m^3/h
	- air mist system	1 set *)	Qn = 15,500 m^3/h *)
IH 84	Combustible gases	1 set	
	- B-F gas system	1 set *)	Qn = 600,000/567,000 m^3/h
	COG gas system	1 set	Qn = 50,000/45,000 m^3/h
	- LD-converter gas system	1 set	Qn = 25,100 m^3/h
	- Mixed gas export system	1 set	Qn = 350,000/317,500 m^3/h
	- natural gas system	1 set	Qn = 45,000/42,000 m^3/h
IH 86	Steam/hot water	1 set	Qn = 27.5 t/h
IH 91	High voltage facilities		
IH 92	Low voltage facilities		
IH 93	Electrical equipment		
IH 97	Lighting & plug socket system		
IH 98	Lightning & earthing system		
IH 99	Other electrical equipment		

1.8 HUMAN RESOURCES

For the description of personnel requirements as their recruitment and training please refer to the Final Report of the Bankable Feasibility Study for the Erection of a Second Generation Integrated Steel Mill in East or West Java prepared by UNIDO 1993, Chapter 8.
For the production of 2.33 mn tpa HRC the following personnel is required:

Table 34: **Manning Schedule Operational Personnel Including Provisions for Vacation and Sick Leave**

	Cat. 1	Cat. 2	Cat. 3	Cat. 4	Total
Raw Material Handling, Lime Plant	2	14	23	30	69
Sinter Plant	3	28	35	49	115
Coking Plant	3	92	169	221	485
Blast Furnace	3	26	210	68	307
Steel Plant incl. Thin Slab Casting	3	113	531	378	1,025
Thin Slab Mill	2	26	114	92	234
Auxiliary Plant and Energy	3	102	168	201	474
Central Maintenance + Warehouse	10	26	63	29	128
Harbour and Transport	3	18	70	172	263
Grand Total	32	445	1,383	1,240	3,100
Thereof running maintenance personnel in production departments approx. 20-30 % included					

1.8.1 ADMINISTRATION MANNING TABLES

The manning for the various administrative and head office personnel is detailed in the following Table.

Table 35: **Administrative Personnel Requirements**

	Cat. 1 Supervisory	Cat. 2 Technical + Commercial Mngr.	Cat. 3 Administrative + Skilled	Cat. 4 Unskilled	Total
Administration	40	73	265	72	450

1.9 MATERIAL BALANCE

Fig. 14: **Specific Consumption Figures - Lime Plant (per tonne product)**

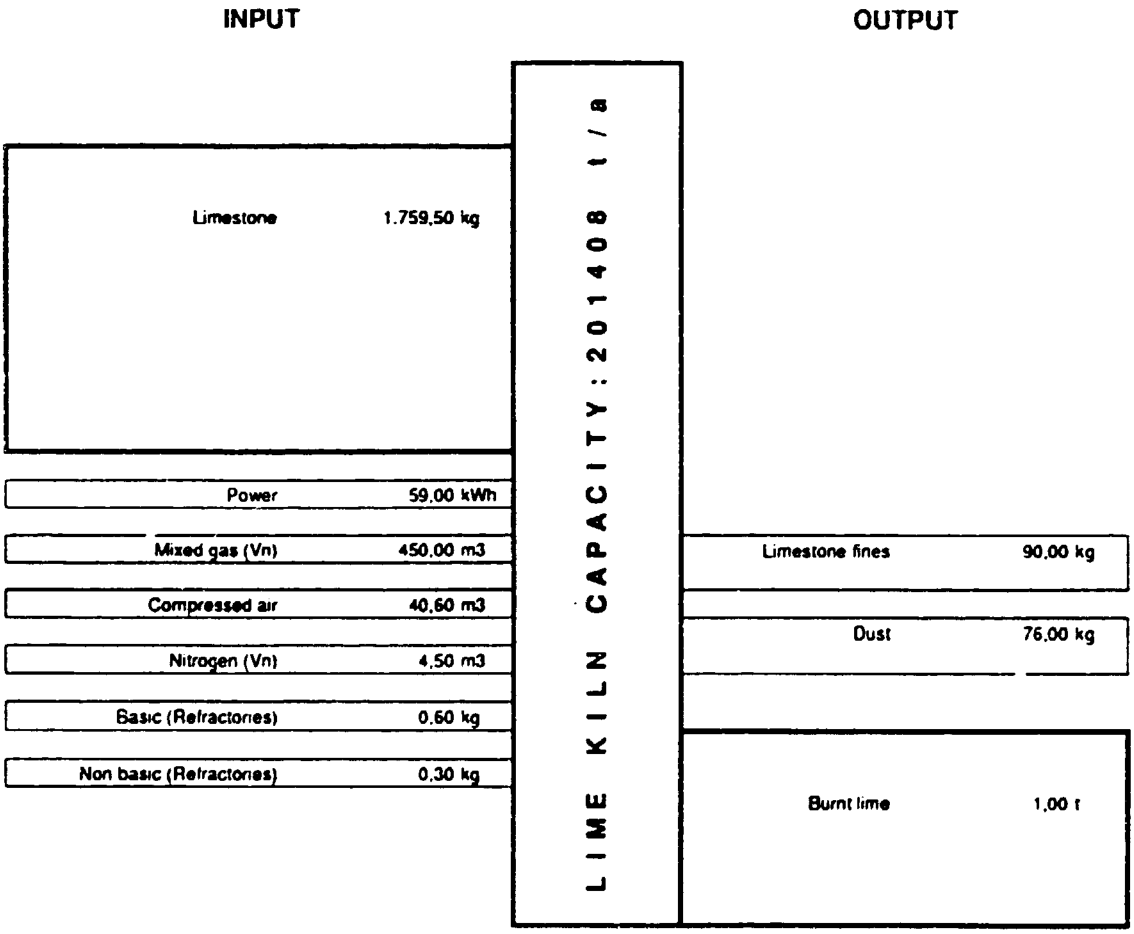


Fig. 15: **Annual Consumption Figures - Lime Plant**

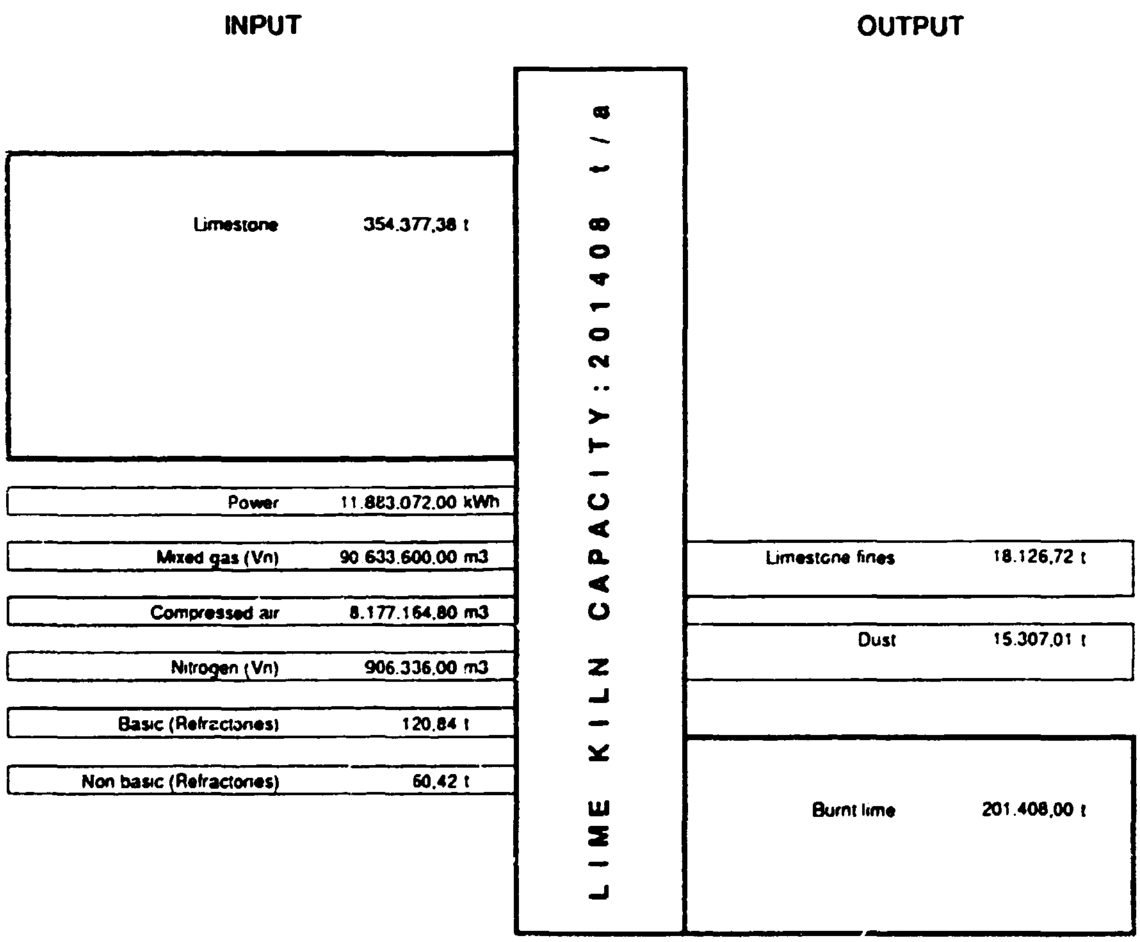


Fig. 16: **Specific Consumption Figures - Coking Plant (per tonne product)**

COKING PLANT CAP.: 933750 t/a

INPUT

Coal (dry basis)	1.396,00 kg
Electrical energy	67,60 kWh
BF-Gas (3.25 MJ/m3)	570,00 m3
Make-up water	3,96 m3
Steam (NH3 stripping)	270,00 kg
Water treatm. chemicals (appr.)	0,17 US$
Waste water treatm. chemicals	0,75 US$
Compressed air (Vn)	0,06 m3
Combustion air (Vn)	773,00 m3

OUTPUT

Waste gas	1.750,00 m3
Coke fines	51,90 kg
Coke oven gas (17.6 MJ/m3)	342,80 m3
Crude tar	51,90 kg
H2S	4,25 kg
Ammonia	3,66 kg
Sewage	0,35 m3
Light Oil	14,40 kg
Metallurgical Coke	1,00 t

Fig. 17: **Annual Consumption Figures - Coking Plant**

COKING PLANT CAP.: 933750 t/a

INPUT

Coal (dry basis)	1.303.515,00	t
Electrical energy	63.121.500,00	kWh
BF-Gas (3 25 MJ/m3)	532.237.500,00	m3
Make-up water	3.697.650,00	m3
Steam (NH3 stripping)	252.112,50	t
Water treatm. chemicals (appr.)	158.737,50	US$
Waste water treatm. chemicals	700.312,50	US$
Compressed air (Vn)	56.025,00	m3
Combustion air (Vn)	721 788 750 00	m3

OUTPUT

Waste gas	1.634 062 500,00	m3
Coke fines	48.461,63	t
Coke oven gas (17.6 MJ/m3)	320.089.500,00	m3
Crude tar	48.461,63	t
H2S	3.968,44	t
Ammonia	3.417,53	t
Sewage	326.812,50	m3
Light Oil	13.446,00	t
Metallurgical Coke	933.750,00	t

Fig. 18: **Specific Consumption Figures - Sinter Plant (per tonne product)**

SINTERPLANT CAPACITY: 3085028 t/a

INPUT

Iron ore	857,00 kg
	(531,34) kg
Mn-Ore	24,17 kg
	(1,45) kg
Sinter-Return-Fines	47,80 kg
	(27,23) kg
BF-Dust	11,50 kg
	(2,50) kg
Scale	12,93 kg
	(9,09) kg
Coke fines	58,50 kg
Limestone	178,50 kg
Dolomite	75,00 kg
Burnt lime	9,00 kg
Mixed gas (8.35 MJ/m3)	12,00 Nm3
Electric power	51,73 kWh
Combustion air (Vn)	450,00 m3
Compressed air (Vn)	0,20 m3
Industrial water	0,50 m3
Refractories	1,00 kg
Consumables (Oil,Grease)	1,00 kg

OUTPUT

Dust	8,70 kg
	(1,90) kg
Sinter fines	47,60 kg
	(27,23) kg
Waste gas (Vn)	505,00 m3
Effluents (process)	0,02 m3
Losses	11,60 kg
thereof (Mat handl. + proc. dust)	6,20 kg
Sinter	1,00 t
	(542,48) kg

(metallic content in brackets)

Fig. 19: **Annual Consumption Figures - Sinter Plant**

SINTERPLANT CAPACITY: 3085028 t/a

INPUT

Iron ore	2.643.869,00 t
	(1.639.198,78) t
Mn-Ore	74.565,13 t
	(4.473,29) t
Sinter-Return-Fines	147.464,34 t
	(84.005,31) t
BF-Dust	35.477,82 t
	(7.712,57) t
Scale	39.889,41 t
	(28.042,90) t
Coke fines	180.474,14 t
Limestone	550.677,50 t
Dolomite	231.377,10 t
Burnt lime	27.765,25 t
Mixed gas (8.35 MJ/m3)	37.020.336,00 Nm3
Electric power	159.588.498,44 kWh
Combustion air (Vn)	1.388.262.600,00 m3
Compressed air (Vn)	617.005,60 m3
industrial water	1.542.514,00 m3
Refractories	3.085,03 t
Consumables (Oil,Grease)	3.085,03 t

OUTPUT

Dust	26.839,74 t
	(5.861,55) t
Sinter fines	146.847,33 t
	(84.005,31) t
Waste gas (Vn)	1.557.939.140,00 m3
Effluents (process)	61.700,56 m3
Losses	35.786,32 t
thereof (Mat handl. + proc. dust)	19.127,17 t
Sinter	3.085.028,00 t
	(1.673.565,99) t

(metallic content in brackets)

Fig. 20: **Specific Consumption Figures - Blast Furnace (per tonne product)**

BLAST FURNACE CAPACITY: 2358900 t/a

INPUT

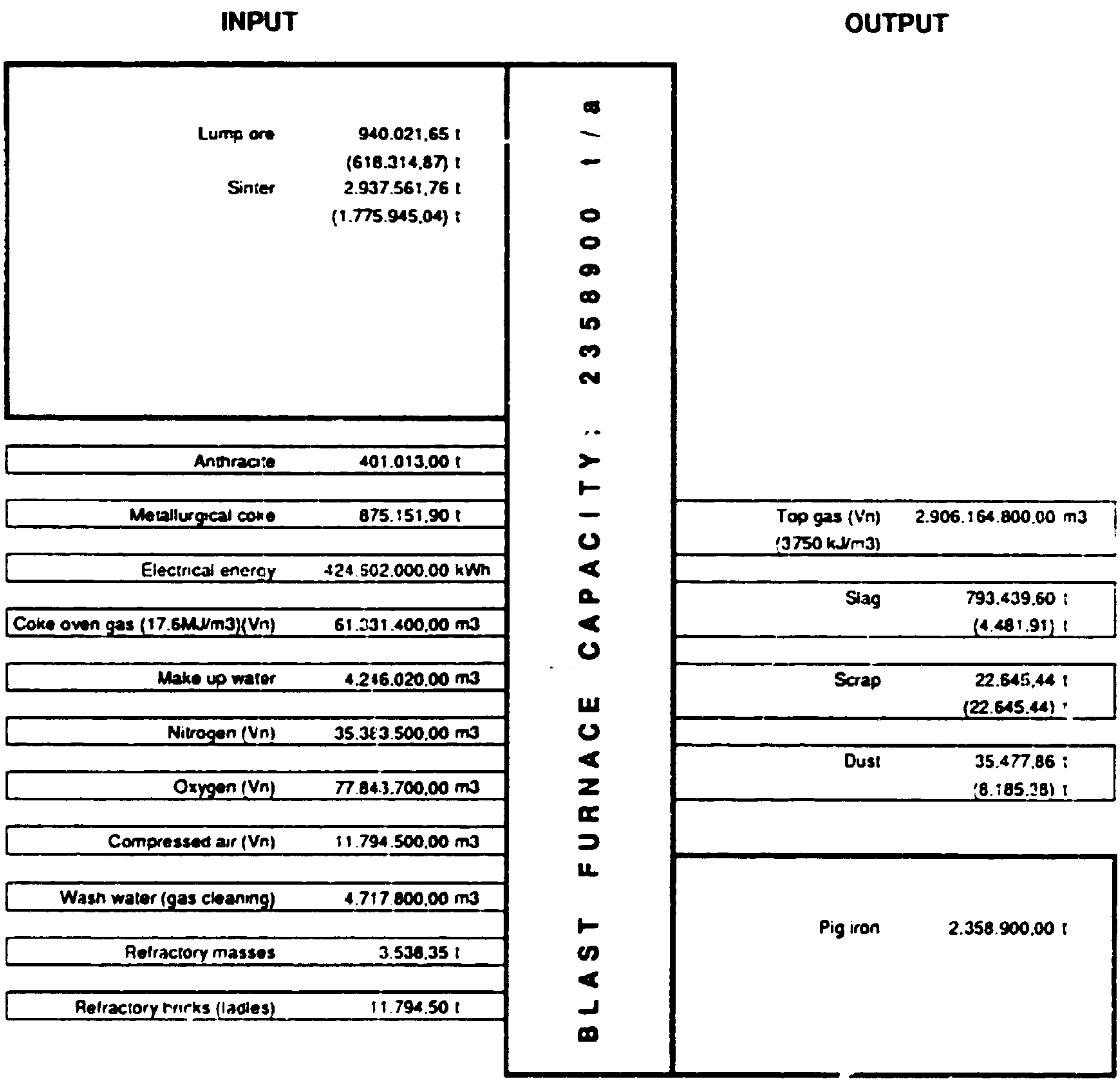
Lump ore	398.50 kg
	(262.12) kg
Sinter	1.245.31 kg
	(752.87) kg
Anthracite	170.00 kg
Metallurgical coke	371.00 kg
Electrical energy	180.00 kWh
Coke oven gas (17.6MJ/m3)(Vn)	26.00 m3
Make up water	1.80 m3
Nitrogen (Vn)	15.00 m3
Oxygen (Vn)	33.00 m3
Compressed air (Vn)	5.00 m3
Wash water (gas cleaning)	2.00 m3
Refractory masses	1.50 kg
Refractory bricks (ladles)	5.00 kg

OUTPUT

Top gas (Vn) (3750 kJ/m3)	1.232.00 m3
Slag	336.36 kg
	(1.90) kg
Scrap	9.60 kg
	(9.60) kg
Dust	15.04 kg
	(3.47) kg
Pig iron	1.00 t

(metallic content in brackets)

Fig. 21: Annual Consumption Figures - Blast Furnace



(metallic content in brackets)

Fig. 22: **Specific Consumption Figures - LD-Plant (per tonne product)**

LD - PLANT CAPACITY: 2422500 t/a

INPUT

Pig iron	115,79 kg
	(109,13) kg
Hot metal	857,95 kg
	(808,62) kg
Scrap	118,10 kg
	(118,10) kg
Alloys	12,14 kg
	(12,14) kg
Dust	12,90 kg
	(9,20) kg
Lump ore	5,00 kg
	(3,10) kg
Burnt lime	58,00 kg
Dolomite	2,00 kg
Industrial water	0,60 m3
Mixed gas (8.35MJ/m3) (Vn)	10,00 m3
Nat. gas (36.12 MJ/m3) (Vn)	0,05 m3
Steam	7,00 kg
Oxygen (Vn)	53,00 m3
Nitrogen (Vn)	32,00 m3
Argon (Vn)	1,50 m3
Compressed air (Vn)	9,00 m3
Electric power	72,00 kWh
Refractories	11,10 kg
Electrodes	0,50 kg
DS-agent	15,00 kg

OUTPUT

Converter gas (Vn) (8.4 MJ/m3)	75,00 m3
Steam	60,00 kg
Dust	14,60 kg
	(10,36) kg
DS-slag	15,00 kg
Slag	100,00 kg
	(19.50) kg
Scrap	13,00 kg
	(13,00) kg
Losses	25,00 kg
	(17,40) kg
Liquid steel	1,00 t

(metallic content in brackets)

Fig. 23: **Annual Consumption Figures - LD-Plant**

LD - PLANT CAPACITY : 2422500 t/a

INPUT

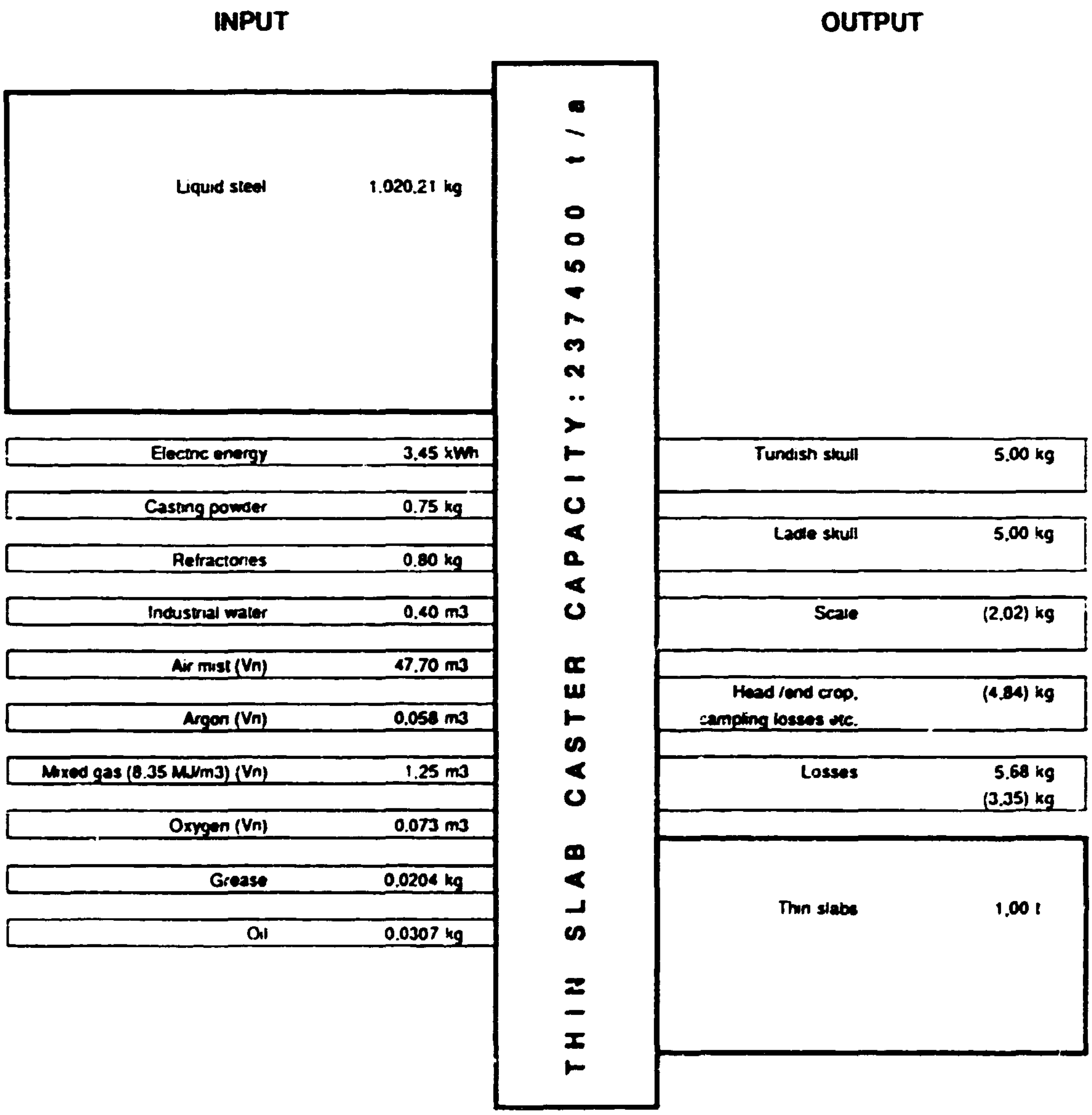
Pig Iron	280.501,28 t
	(264.367,43) t
Hot metal	2.078.383,88 t
	(1.958.881,95) t
Scrap	286.097,25 t
	(286.097,25) t
Alloys	29.409,15 t
	(29.409,15) t
Dust	31.250,25 t
	(22.287,00) t
Lump ore	12.112,50 t
	(7.509,75) t
Burnt lime	140.505,00 t
Dolomite	4.845,00 t
Industrial water	1.453.500,00 m3
Mixed gas (8.35MJ/m3) (Vn)	24 225 000,00 m3
Nat. gas (36.12 MJ/m3) (Vn)	121.125,00 m3
Steam	16.957,50 t
Oxygen (Vn)	128 392 500,00 m3
Nitrogen (Vn)	77.520 000,00 m3
Argon (Vn)	3.633.750,00 m3
Compressed air (Vn)	21 802 500,00 m3
Electric power	174 420 000,00 kWh
Refractories	26 809 75 t
Electrodes	1 211 25 t
DS-agent	36.337 50 t

OUTPUT

Converter gas (Vn) (8,4 MJ/m3)	181.687 500.00 m3
Steam	145.350,00 t
Dust	35.368,50 t
	(25.097,10) t
DS-slag	36.337,50 t
Slag	242.250,00 t
	(47.238,75) t
Scrap	31 492,50 t
	(31.492,50) t
Losses	60.562,50 t
	(42.151,50) t
Liquid steel	2.422.500,00 t

(metallic content in brackets)

Fig. 24: **Specific Consumption Figures - Thin Slab Caster (per tonne product)**



(metallic content in brackets)

Fig. 25: **Annual Consumption Figures - Thin Slab Caster**

THIN SLAB CASTER CAPACITY : 2374500 t/a

INPUT

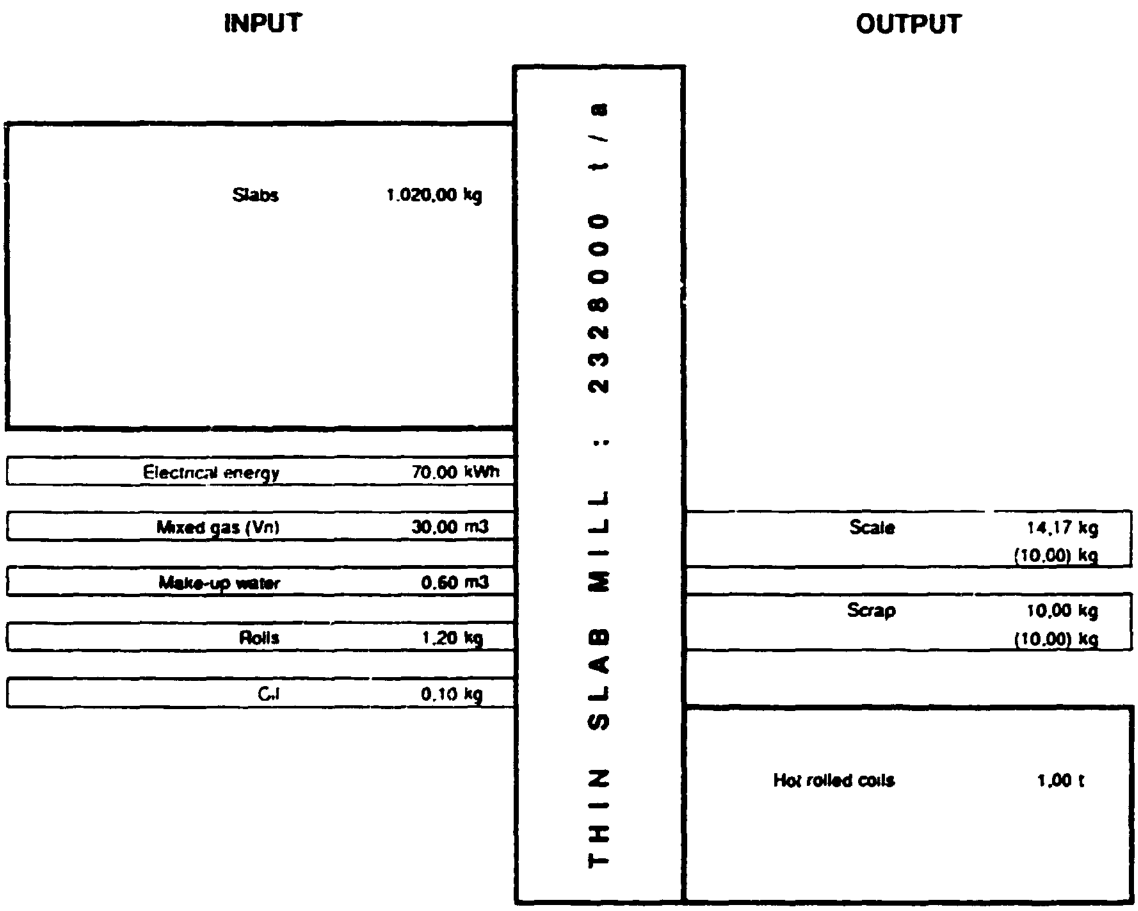
Liquid steel	2.422.488,65 t
Electric energy	8.192.025,00 kWh
Casting powder	1.780,88 t
Refractories	1.899,60 t
Industrial water	949.800,00 m3
Air mist (Vn)	113.263.650,00 m3
Argon (Vn)	137.721,00 m3
Mixed gas (8.35 MJ/m3) (Vn)	2.968.125,00 m3
Oxygen (Vn)	173.338,50 m3
Grease	48,44 t
Oil	72,90 t

OUTPUT

Tundish skull	11.872,50 t
Ladle skull	11.872,50 t
Scale	(4.796,49) t
Head /end crop, sampling losses etc.	(11.492,58) t
Losses	13.487,16 t (7.954,58) t
Thin slabs	2.374.500,00 t

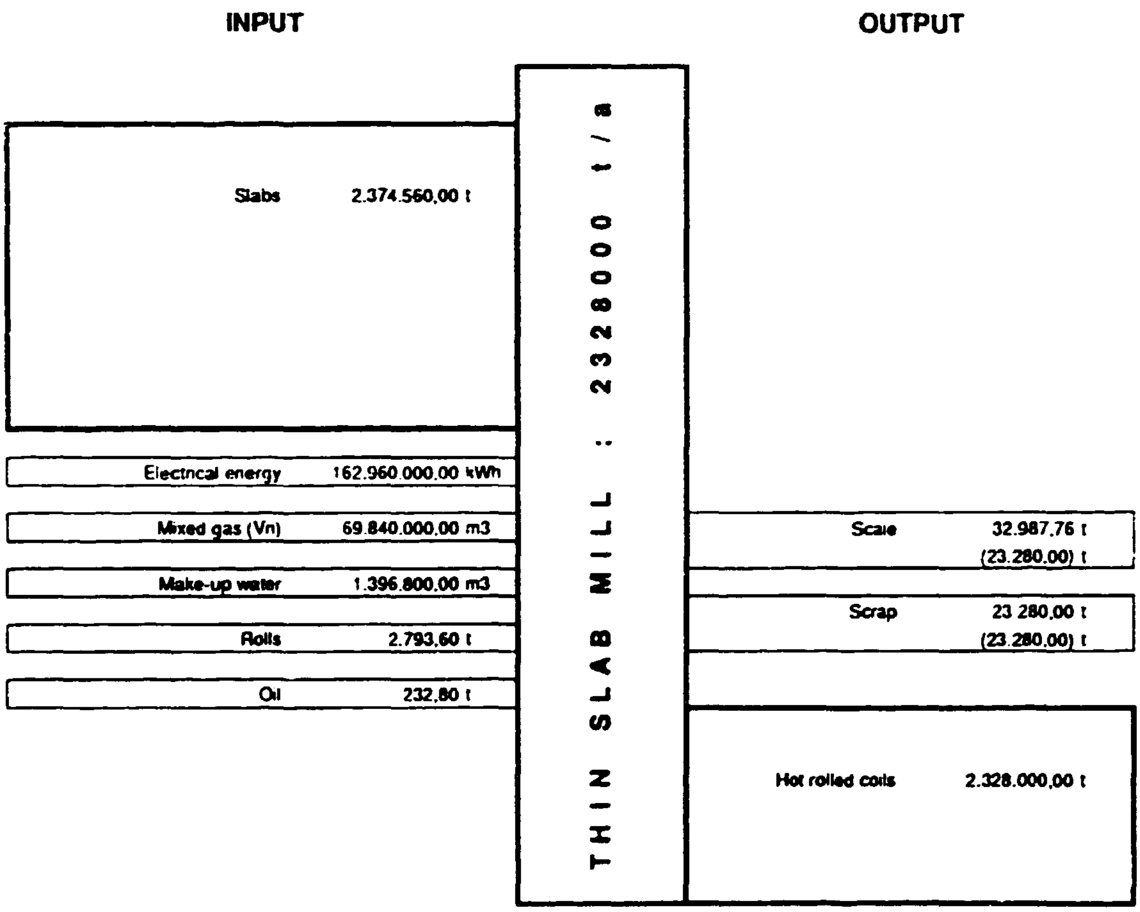
(metallic content in brackets)

Fig. 26: **Specific Consumption Figures - Thin Slab Mill (per tonne product)**



(metallic content in brackets)

Fig. 27: **Annual Consumption Figures - Thin Slab Mill**



(metallic content in brackets)

Fig. 28: **Material Flow Sheet**

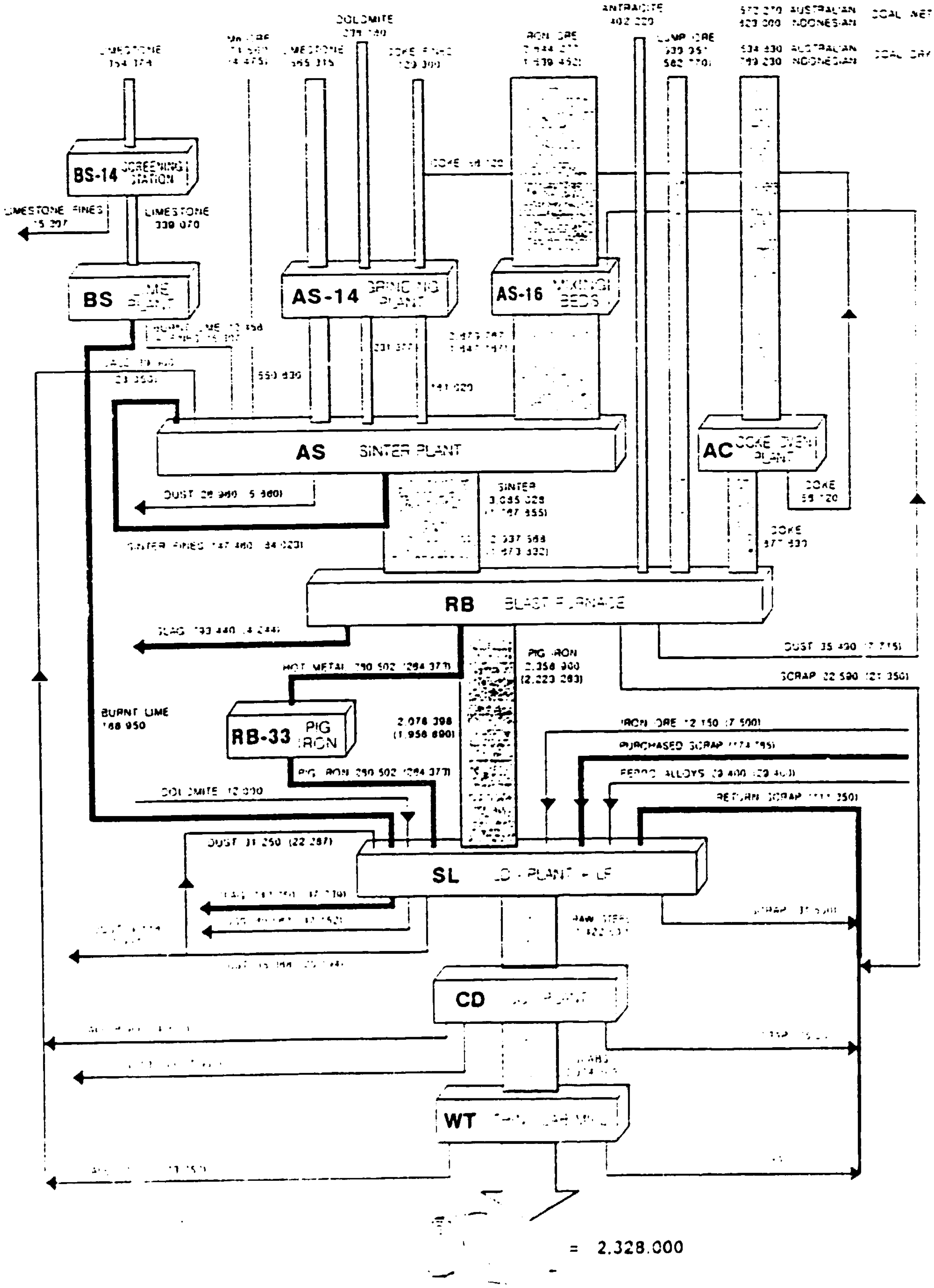


Table 36: **Projection of quantities and cost of raw materials and supplies**

Description	Price per unit		unit	Annual	Annual
INPUTS:	local *)	CIF		consumption	costs
RAW MATERIALS:				(000 units)	(000 US$)
Limestone	10		t	920.0	9,200.0
Iron ore (sinter feed)		26.58	t	2,657.0	70,623.06
Iron ore (lump)		31.16	t	340.0	29,290.4
Dolomite	40		t	250.2	10,008.0
Scrap **)		137.5	t	174.8	24,035.0
Alloys		700	t	29.4	21,580.0
Mn Ore		190	t	74.6	14,174.0
ENERGY:					
Electric energy	60		MWh	1,0437.44	62,246.46
Coal (wet) for coke I		62	t	572.3	35,482.6
Coal (wet) for coke II	36		t	823.0	29,628.0
Coke fines		80	t	129.3	10,344.0
Anthracite	26		t	402.2	10,457.2
CONSUMABLES:					
Refractory bricks I	1,200		t	11.65	13,980.0
Refractory bricks II		2,300	t	2.38	5,474.0
Refractory masses	650		t	30.87	20,065.5
Oxygen	0.036		m³	206,410.0	7,430.74
Nitrogen	0.036		m³	113,810.0	4,097.15
Argon	0.036		m³	3,371.0	135.77
Compressed air	0.007		m³	155,704.3	1,089.93
Water	0.02		m³	11,600.0	232.0
Steam ***)			t	147.75	0
Electrodes		2,000	t	1.21	2,422.0
DS-agent		396	t	36.34	14,389.65
Casting powder		4,500	t	1.78	8,013.94
Grease	400		t	0.15	20.0
Oil, Gas oil, Gasoline	400		t	10.0	4,000.0
Rolls		3,500	t	2.79	9,777.6
Nozzles, other Refr.		2,100	t	1.9	3,990.0
TOTAL					422,187.0

*) Conversion rate 1 US$ = 2070 Rupiahs
**) Plus in-plant scrap
***) Own production

1.10 TOTAL INVESTMENT COSTS

Table 37: **Total Investment Costs** (in 1,000 US$)

Items	Investment Costs
Land (145 ha)	43,500
MAIN PLANT COMPONENTS	
Sinter plant + raw material handling facilities	223,100
Coking plant	266,500
B-F-plant	386,100
LD-plant	351,000
Continuous casting thin slabs	95,000
Thin slab mill	274,000
Sub-Total of main plant components	**1,595,700**
OTHERS	
Lime plant	31,900
Oxygen plant	41,000
Integration facilities	242,000
Sub-total plant	**1,954,100**
Harbour and power plant	232,000
Initial spare parts	27,360
Insurance and freight	18,500
Pre-production expenditures	53,100 *)
Initial net working capital	33,110
TOTAL INITIAL INVESTMENT	**2,318,170 *)**

*) Excluding capitalized interest

1.11 PROJECT IMPLEMENTATION SCHEDULE AND BUDGETING

The detailed implementation programme proposed for the realization of the project is shown in Fig. 29.

Also attached in Table 38 is the capital expenditures during implementation. Please note that considerable savings may be achieved timewise, if the project is contracted out as turnkey implementation. The current proposal is based on process key contracting with global sourcing.

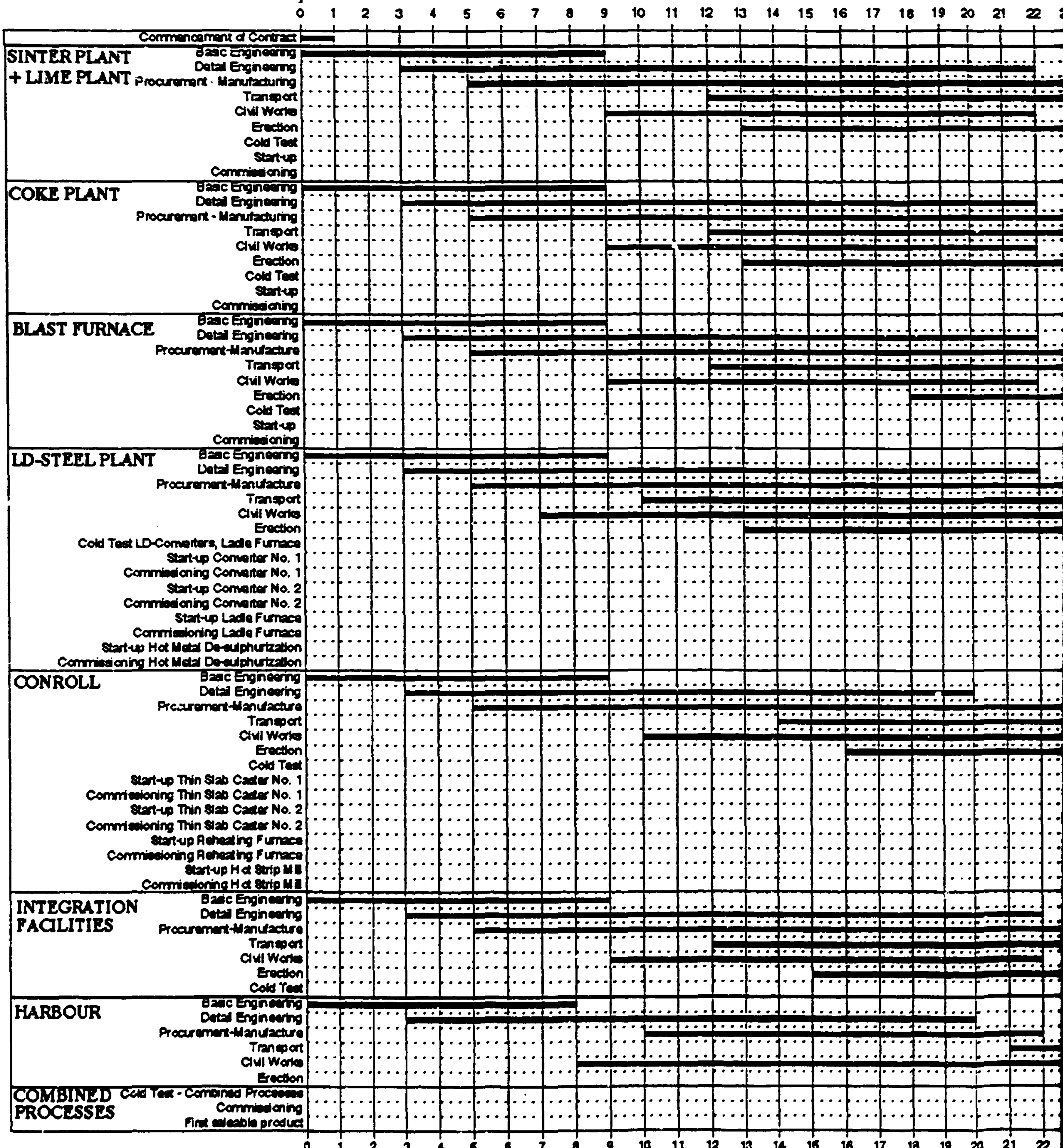
Some of the main assumptions made in drawing up the programme are that:

(a) Key personnel and resources would be available to start work
(b) All enquiries would be issued within the anticipated dates and the number of contracts would be kept to a minimum
(c) Enquiry documents would ensure that information received in offers would enable foundation and building drawing arrangements to be commenced without delay.
(d) Design would be staged so that construction could commence before final design is completed.

According to the programme, various executive activities, such as purchase of machinery and equipment, construction, buildings and other civil works, personnel recruitment and personnel training, delivery of machinery and equipment, and erection of machinery and equipment are planned to be undertaken according to a phased programme in order to achieve the best economic way of realizing the project.

To a considerable degree, delivery-schedules will depend on the location and identity of the manufacturers and other suppliers from which the machinery and equipment will be procured, based on global sourcing.

SECTION 1


0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
Commencement of Contract
SINTER PLANT + LIME PLANT
Basic Engineering
Detail Engineering
Procurement - Manufacturing
Transport
Civil Works
Erection
Cold Test
Start-up
Commissioning
COKE PLANT
Basic Engineering
Detail Engineering
Procurement - Manufacturing
Transport
Civil Works
Erection
Cold Test
Start-up
Commissioning
BLAST FURNACE
Basic Engineering
Detail Engineering
Procurement-Manufacture
Transport
Civil Works
Erection
Cold Test
Start-up
Commissioning
LD-STEEL PLANT
Basic Engineering
Detail Engineering
Procurement-Manufacture
Transport
Civil Works
Erection
Cold Test LD-Converters, Ladle Furnace
Start-up Converter No. 1
Commissioning Converter No. 1
Start-up Converter No. 2
Commissioning Converter No. 2
Start-up Ladle Furnace
Commissioning Ladle Furnace
Start-up Hot Metal De-sulphurization
Commissioning Hot Metal De-sulphurization
CONROLL
Basic Engineering
Detail Engineering
Procurement-Manufacture
Transport
Civil Works
Erection
Cold Test
Start-up Thin Slab Caster No. 1
Commissioning Thin Slab Caster No. 1
Start-up Thin Slab Caster No. 2
Commissioning Thin Slab Caster No. 2
Start-up Reheating Furnace
Commissioning Reheating Furnace
Start-up Hot Strip Mill
Commissioning Hot Strip Mill
INTEGRATION FACILITIES
Basic Engineering
Detail Engineering
Procurement-Manufacture
Transport
Civil Works
Erection
Cold Test
HARBOUR
Basic Engineering
Detail Engineering
Procurement-Manufacture
Transport
Civil Works
Erection
COMBINED PROCESSES
Cold Test - Combined Processes
Commissioning
First saleable product
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22

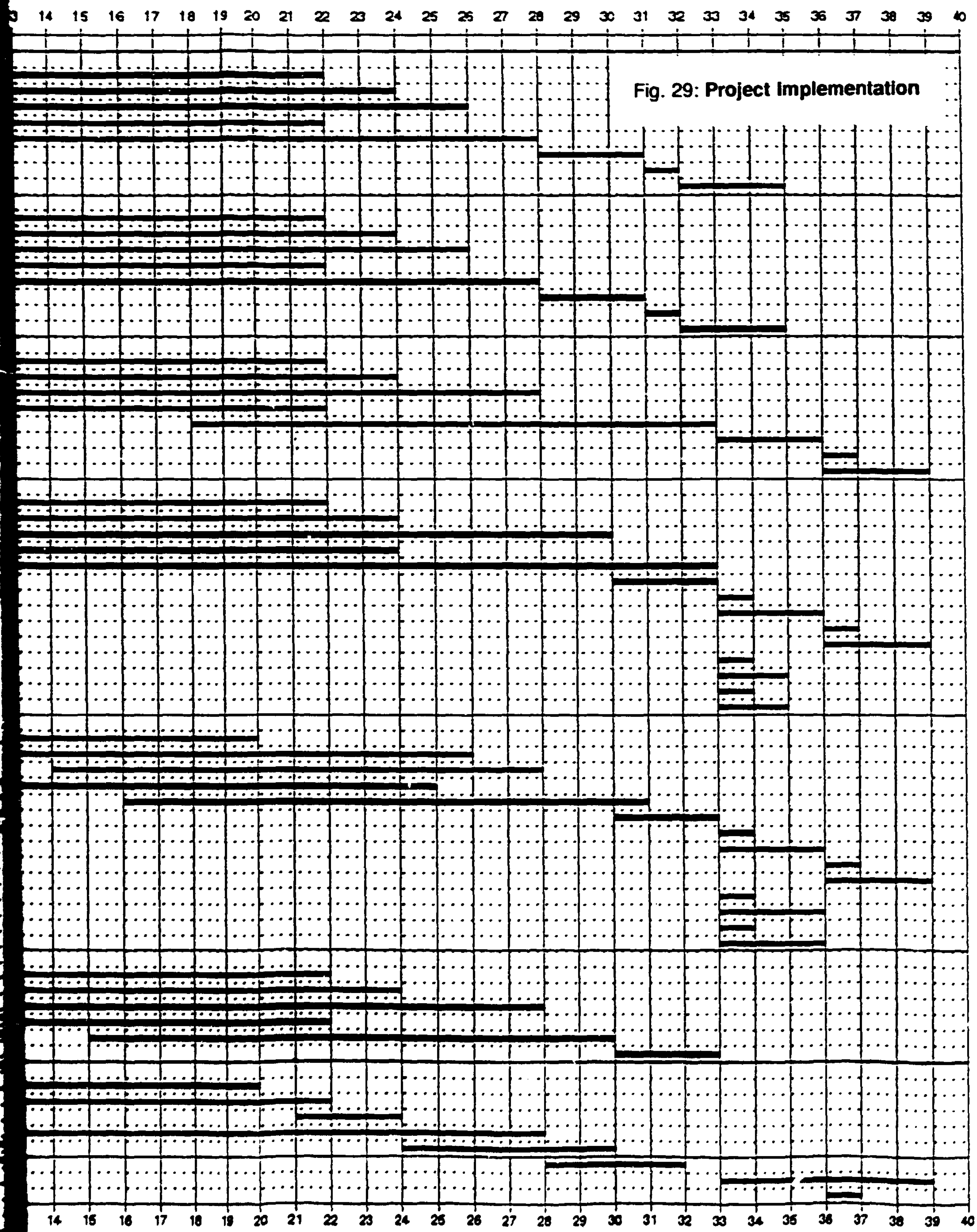


Fig. 29: **Project Implementation**

SECTION 2

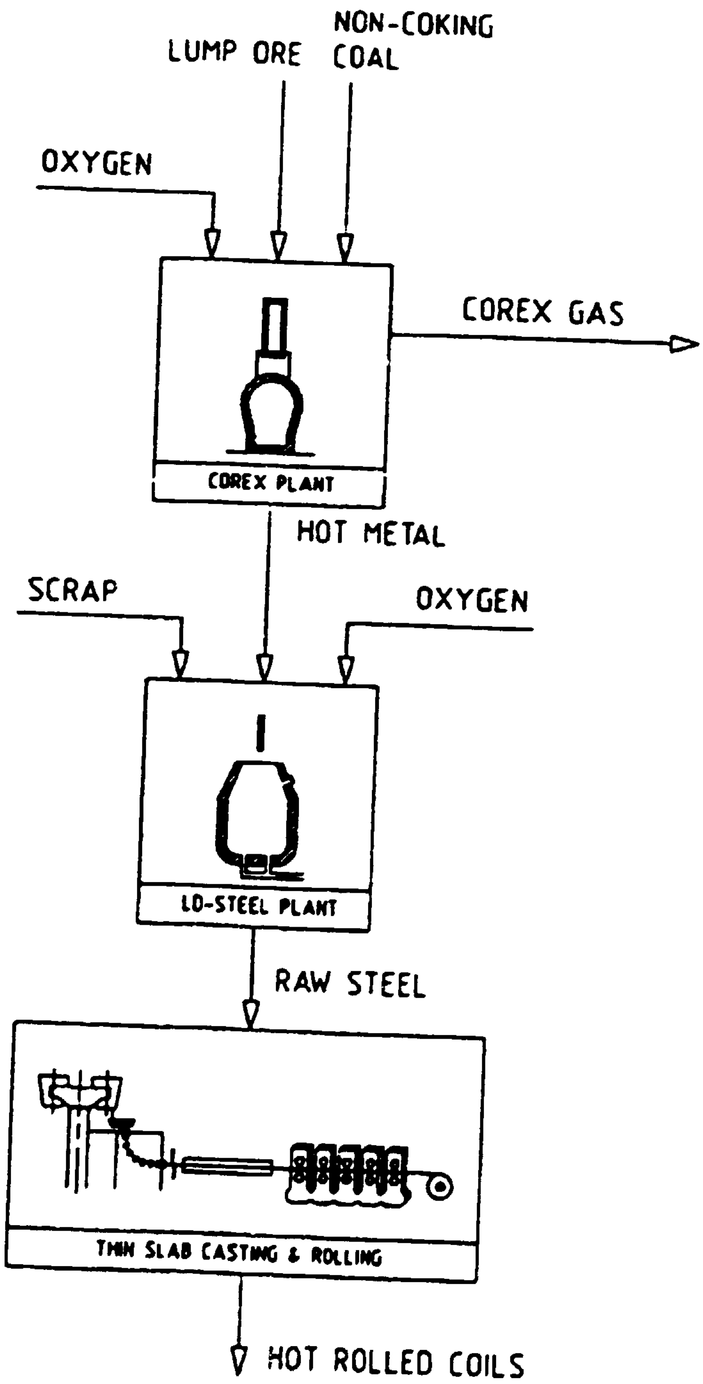
Table 38: **Implementation Budgeting in Mio US$, excluding capitalized interest**

Input Table (in million US$)	Half Years							Total
	1	2	3	4	5	6	7	
Foreign	1.215	69.182	266.707	328.403	283.810	174.184	164.948	1,288.449
Local	22.193	73.796	282.944	301.776	153.157	90.649	105.206	1,029.721
Total	23.408	142.978	549.651	630.179	436.967	264.833	270.154	2,318.170

2. COREX® BASIC OXYGEN FURNACE

2.1 GENERAL ROUTE DESCRIPTION

Fig. 30: **Simplified process flow**



2.1.1 BASIC MATERIALS FOR IRON AND STEELMAKING

- Iron ore lump [1/]
  Mt. Newman ore, 2.5 % moisture, Fe 63-64% (dry basis)
  Origin: Australia
  Requirement: 3,340,000

- Coal [1/]
  Ombilin: medium volatile (19 to 28 %), steam coal, 7 % moisture
  Lumut B: medium volatile (19 to 28 %), steam coal, 7 % moisture
  Origin: Indonesia
  Requirement: 2,290,000 t/a

- Other basic materials

• Limestone	784,200 t/a
• Dolomite	137,900 t/a
• Quartzite	63,800 t/a
• Scrap (purchased)	284,000 t/a
• Ferro alloys	29,400 t/a

Above materials are of indigenous origin except scrap in part.

2.1.2 COREX® PLANT

Aim: Reduction of the iron oxides and melting of the iron ore, pellets and lump ores into hot metal (pig iron) to be used as feed stock in the successive steel plant.

Burden:
- iron ore and pellets
- coal as energy input and reductant of the iron oxides
- fluxes as slag forming agent to bind ashes and gangue (ore impurities)

Process: The COREX® System distributes the process into two sequences

a) The production of reduction gas and melting of sponge iron in the melter-gasifier located below

b) The shaft furnace, where the reduction of the iron burden takes place.

1/ It is assumed that these raw materials will be screened at the mines prior to transport to limit the amount of fines.

The process operates up to 500 kPa but contrary to the blast furnace the coal is charged into a separate vessel from where it is transported via screw conveyors into the melter-gasifier. At the top of the gasifier the coal comes into contact with the gas at temperatures of approx. 1 100°C. The coal is dried and completely degasified, the coal pieces being transformed into coke. This coke is gasified by oxygen which is injected via nozzles located approx. in one third of the height of the vessel. In front of the nozzles the oxygen burns to CO_2 which turns into CO with the coke. On leaving the gasifier the hot crude gas is cooled by means of cooling gas, cleaned and ducted to the reduction furnace. The reduction furnace is being charged with the ore to be reduced via a lock system. Screw conveyors transport the reduced ore now transformed into sponge iron from the bottom of the reduction furnace to the top of the melter-gasifier to be melted.

Slag and liquid iron are tapped off intermittently.

Gas treatment: the reduction gas emitted from the gasifier contains up to 95 % CO which is cooled via cooling gas (same origin) ducted in a closed circuit and cleaned by cyclones. From this closed circuit a branch runs off to the reduction furnace for gas supply. Below the charging locks of the furnace the gas having participated in the reduction of the iron ore is emitted as top gas, which after cleansing may be used as export gas serving other consumers and in part is mixed with the cooling gas also.

Pig iron tapping and slag disposal is performed analogously as in the BF process via pool launders and runners into the respective vessels.

2.1.3 STEELMAKING PROCESS

Aim: Pig iron contains between 3 to 4 % carbon. The aim of a steel plant is to oxidise the excessive carbon to reduce its content down to the required level (normally 0.1 to 0.3 % C for flat products), together with scrap and alloying elements according to the required steel specification.

LD Process: The hot metal is first desulphurized (if required) and then transferred into the LD vessel. No further heat is required as the necessary temperature is achieved in the process of oxidation of the various chemical elements in the hot metal, foremost carbon. The necessary O_2 is supplied by blowing in technical oxygen with a pressure of 800 to 1 200 kPa at a distance from 1 to 1 ½ m above the hot metal surface with a water cooled lance resulting in a bath temperature of 1 600°C. Cooling scrap is added approx.

20 % of the charge as well as alloying (ferro metals) and slag forming elements (burnt lime and other fluxes). Tap to tap time is generally approx. 40 min., the blowing process varies from 12 to 18 min. depending on the grade of steel. Tapping is effected into ladles for possible further processing (further removal of undesirable elements).

2.1.4 THIN SLAB CASTING

Killed crude steel at about 1 600°C is cast into a water cooled copper mould or rather sleeve. The cross section identifies the cross section of the slab, whereby the width is adjustable conforming approximately to the strip width to be rolled. »Thin Slab Casting« generally refers to slab heights of well less than 100 mm, 50 to 70 mm having become the most common.

The process and the main equipment is principally the same as with conventional continuous casting, the cooled thin slab also being guided in a 90° arc from the vertical into the horizontal plane, except that this slab is cut much longer due to its thinness to comply with the weight of a conventionally cast slab (i.e. 3 to 3.5 times longer).

After being cut this slab now slowly travels in line through a soaking furnace of more than 120 m length to equalize the temperature differences between the core and the surface of the thin slab.

2.1.5 HOT STRIP ROLLING 56"

After exiting the furnace the thin slab is being descaled, cropped, and enters in line into the 4 high finishing mill (6 stands) to be dressed down to its designated strip thickness. This mill again is similar to the finishing mill of the conventional type, as are all the other downstream facilities like laminar flow cooling, coiling and possibly slitting, edge trimming, etc.

2.2 COREX® PLANT

For the general process description, handling of effluents, gaseous emissions and wastes as well as description of main equipment and machinery refer to Annex 1 »Engineering and Technology Design«, Chapter 2.2, of the Final Report of the Feasibility Study »Second Generation Integrated Steel Mill, Indonesia« (1993).

2.2.1 EQUIPMENT LIST OF COREX® PLANT

Table 39: **Equipment List of COREX®-Plant (2 + 1 Module)**

Item/Code	Designation Equipment	Number of Equipment	Main Technical Data
RC 13	Coal Drying Plant - receiving bins - dosing belt conveyor - hot gas generator - coal drier - dedusting equipment - transport equipment - steel structure	2 + 1 sets	max. heating value = 3 x 12 MW = appr. 36 MW
RC 16	Burden System - bunkers - weighing equipment - feeders - transport equipment - screens - steel structure	2 sets	max. storage capacity for raw materials = 12 h
RC 19	Dedusting System - complete bag filter system for ore and coal including fan ductwork and hoods	2+1 sets	
RC 21	Furnace Charging System for ore and coal - bucket belt conveyors - charging bins, hoppers - coal screw conveyors - steel structure	2+1 sets	
RC 22	Reduction Shaft - burden distribution system - reduction shaft shell - refractories - screw conveyors ore - down pipes	2+1 sets	
RC 23	Melter Gasifier and Facilities - melter gasifier shell - refractories - stave cooling - tuyers - dust recycling system with dust burners - gas off takes - steel structure	2+1 sets	9 t/h = 270 t/h hot metal production

Item/Code	Designation Equipment	Number of Equipment	Main Technical Data
RC 25	Process Gas System - ductwork - refractories - gas cooling and cleaning system - cooling gas compressors - steel structure	2+1 sets	
RC 26	Tapping Equipment - tap hole drilling machine - tap hole clay gun - hydraulic unit	4+2 sets	
RC 29	Gas Cleaning and Dedusting system - ductwork - refractories - top gas cooling and cleaning system - steel structure	2+1 sets	
RC 31	Hot Metal Handling - Pool launder - iron runner - tilting runner - refractories - steel structure - crane	2+1 sets	
RC 32	Pig Iron Casting Machine	2 sets	2 x 150 t/h = 300 t/h pig iron
RC 39	Dedusting System - dedusting hoods - ductwork - filterhouse with dust discharge system - damper assembly - drought fan - clean air stack	2+1 sets	Raw gas capacity V_n = (2+1) x 800.000 = 2.400.000 m^3/h
RC 45	Sludge Recycling - Sludge dewatering unit - granulating mixer - storage and charging equipment for burnt lime, coal fines - conveying equipment - steel structure	1 set	appr. 8 t/h (dry basis)
RC 46	Dust Recovery	3 sets	
RC 49	Slag Handling and Treatment - slag runners - refractories - slag pit - steel structure	6 sets	
RC 53	Maintenance Post	1 set	
RC 62	Production and Process Control System	3 sets	
RC 63	General Instrumentation	3 sets	

Item/Code	Designation Equipment	Number of Equipment	Main Technical Data
RC 64	Basic Automation	2 sets	
RC 69	Communication System	3 sets	
RC 71	Plant Office	1 set	
RC 75	Fire Alarm and Fighting System	3 sets	
RC 81	Water Supply/Treatment	2+1 sets	
RC 82	Water Circuits and Cooling systems	2+1 sets	
RC 83	Incombustible Gases and Compressed Air	2+1 sets	
RC 84	Combustible Gases	2+1 sets	
RC 86	Steam/Hot Water/Heat Recovery	2+1 sets	
RC 91	High Voltage Facilities	2+1 sets	
RC 92	Low Voltage Facilities	2+1 sets	
RC 93	Electric Equipment	2+1 sets	
RC 97	Lighting and Plug Socket System	2+1 sets	
RC 98	Lightning and Earthing System	2+1 sets	

2.2.2 PERFORMANCE CALCULATION

2.2.2.1 YEARLY PRODUCTION TIME

Table 40: **Yearly Production Time**

	D/Y	H/Y
Calendar time	365	8 760
General repair	7	168
Scheduled maintenance	8.5	204
Theoretical production time	349.5	8 388

2.2.2.2 AVAILABILITY

Table 41: **Availability**

	Downtime H/Y	Availability	H/Y
COREX® *	100	97.2 %	8 150
BOF	240	97.1 %	8 148

Thin Slab Caster	340	96.0 %	8 048
Rolling Mill	690	91.8 %	7 698
Rolling Mill **	404	95.2 %	7 984
8 388 x 0.972 x 0.971 x 0.959 x 0.952 =			7 232
Effective production time		301.3 d/y 7 232 h/y	

* Due to the storage capacity for hot metal only production stops exceeding 4 hours will be taken into consideration

** Due to the storage capacity of the reheating furnace of max. 25 min. (in correlation with casting speed) the availability of the rolling mill will increase from 91.8 to 95.2 %

2.2.3 PLANT BALANCE

Table 42: **Plant Balance**

Process	INPUT		OUTPUT	
	Designation	Quantitiy / t HM	Designation	Quantity / t HM
	Lump ore	1512 kg	- C	42.8 kg
	Coal (Ombilin)	788 kg	- Fe	947.8 kg
	Coal Lumut B	252 kg		
	Quartzite	29 kg	- Si	6 kg
	Limestone	196 kg	- Mn - P	2.4 kg 0.5 kg
	Dolomite	57 kg	- S	0.5 kg
	Burnt lime	15 kg	Total HM	1,000 kg
	Oxygen	643 m^3	Export gas	1,774 m^3
	Nitrogen	85 m^3	Off gas	22 m^3
	Compr. air	11 m^3	Slag	318 kg
	Steam	45 kg	Effluents	1 m^3
	Electric power	65 kWh	Scrap	10.5 kg

2.2.4 CONSUMPTION

Capacity:

7,232 h at 3 x ~ 90 t/h =1,952,640t HM
918 h at 3 x 90 t/h * = 247,860t solid P.I.
2,200,500t/a

Table 43: **Consumption**

Item	per t Hot Metal	per Year
Raw materials, energy and fluxes	2,849 kg	6,269,225 t
Oxygen	643 m^3	1,415 x 10^9 m^3
Nitrogen	85 m^3	187 x 10^6 m^3
Steam	45 kg	99,023 t
Industr. water	2 m^3	4,401 x 10^6 m^3
Electric power	65 kWh	143 x 10^3 GWh

2.3 STEEL MELT SHOP

For the general process description, handling of effluents, gaseous emissions and wastes as well as description of main equipment and machinery refer to Annex 1 »Engineering and Technology Design«, Chapter 2.3, of the Final Report of the Feasibility Study »Second Generation Integrated Steel Mill, Indonesia« (1993).

In order to produce the required amount of 2,422 mn t of crude steel the operation mode in the LD plant will be changed. The former operation mode 2/1 (i.e. two converters installed, one thereof in operation) will be changed to a 3/2 operation mode. This means of the three installed converters two will be in operation one as standby save those times, when relining is required. Since the two converters have been installed in the initial phase, one additional converter is required.

2.3.1 EQUIPMENT LIST OF LD-PLANT

Table 44: **Equipment List of LD-Plant**

Item/Code	Designation	Number of Equipment	Main Technical Data
SL 1	Raw and charging material treatment		
SL 11	Scrap handling - Charging crane - Chutes	1 set	 volume approx. 40 m^3

Item/Code	Designation	Number of Equipment	Main Technical Data
SL 12	Alloy handling system - vibrating feeder - combi gate - belt conveyor with weighing equipment - tripper car - emergency discharge chute for belt conveyor - grating for receiving bin - grating for ground level storage bin	2+1 sets	
SL 13	Additive handling - unloading station - inclined belt conveyor - reversible belt conveyor	2+1 sets	
SL 15	Hot metal treatment - hot metal charging crane - hot metal charging ladle - ladle tilting stand - deslagging machine - ladle bubbling equipment - measuring/sampling lance system - ladle heater	2 sets	
SL 16	Hot metal treatment - Desulphurizing stand	2 sets	
SL 18	Ladle handling	2 sets	
SL 19	Dedusting system for hot metal treatment - pipe line - damper - bag house - dust container - discharge device - ID fan - clean gas stack	2 sets	
SL 2	Blowing operation		

Item/Code	Designation	Number of Equipment	Main Technical Data
SL 21	Converter charging system - high level bin - combi gate - vibrating feeder - weighing bin - reversible belt conveyor - charge bins - dosing gate - y-chute - addition chute - seal gate - compensator - emergency chute	2+1 sets	
SL 22	Converter - converter shell - converter suspension - trunnion ring - supporting bearing and housing - converter tilting drive - converter pedestal - bottom stirring equipment on converter	2+1 sets	150 m^3 3 x 150 t
SL 23	Lance blowing device - oxygen lance - oxygen flexible hose - water flexible hose - lance guide car - movable lance carrier - fixed guide - maintenance platform	2+1 sets	550 m^3 (std)/min./converter top and bottom blowing 850 m^3 (std)/min./converter
SL 24	Auxiliary equipment - slag stopper - dog house - temperature measurement and sampling equipment - valve station bottom stirring - valve station top blowing - media supply system for slag stopper	2+1 sets	
SL 25	Waste gas cooling and cleaning - secondary dedusting - gas holder	2+1 sets	Combustion rate 0.1 Flow rate 1 000 000 m^3/h Volume 70.000 m^3
SL 26	Ladle alloy/additive system - high level bins - vibrating feeder - belt conveyor	1 set	

Item/Code	Designation	Number of Equipment	Main Technical Data
SL 27	Liquid steel handling - teeming crane - teeming ladle - emergency ladle - ladle transfer car - sliding gate with hydraulic units - equipment for sliding gate maintenance - maintenance platform - ladle support - teeming ladles and addition device - ladle heater	2+1 sets	
SL 29	Dedusting system for ladle alloy system	1 set	
SL 3	Secondary metallurgy		
SL 31	Alloying secondary metallurgy facilities	1 set	
SL 32	Ladle stirring/bubbling injection	1 set	
SL 33	Ladle furnace	1 set	Rated voltage max. 36 kV Furnace transformer 20 MVA Secondary current 45 kA
SL 39	Dedusting system for ladle furnace	1 set	
SL 4	Slag treatment and recycling facilities		
SL 45	Waste gas recycling	1 set	Flow rate 85.000 m^3 (std)/h/converter
SL 46	Dust recovery	1 set	75 m^3 (std)/t
SL 49	Slag handling - slag pot - slag pot transfer car	1 set	Volume approx. 15 m^3
SL 5	Maintenance and store		
SL 51	Lance repair shop	1 set	
SL 6	Information system		
SL 62	Production and process control system	1 set	
SL 63	General instrumentation	1 set	
SL 64	Basic automation	1 set	
SL 69	Communication System	1 set	
SL 7	Infrastructure and auxiliary equipment		
SL 75	Fire alarm and fighting system	1 set	

Item/Code	Designation	Number of Equipment	Main Technical Data
SL 8	Utility supply and treatment		
SL 81	Water supply treatment	1 set	
SL 82	Water circuits and cooling system	1 set	
SL 83	Incombustible gases and compressed air	1 set	
SL 84	Combustible gases	1 set	
SL 86	Steam/hot water/heat recovery	1 set	
SL 9	Electric energy supply		
SL 91	High voltage facilities	1 set	
SL 92	Low voltage facilities	1 set	
SL 93	Electrical equipment	1 set	
SL 97	Lightning and plug socket system	1 set	
SL 98	Lightning and earthing system	1 set	

2.3.2 PERFORMANCE CALCULATION

2.3.2.1 YEARLY PRODUCTION TIME as per 2.2.2.1

2.3.2.2 AVAILABILITY as per 2.2.2.2

2.3.3 PLANT BALANCE

Table 45: **Plant Balance**

Process	Input		Output	
	Designation	Quantity/t CS	Designation	Quantity/t CS
Converter charge	Hot metal	806,0 kg	Crude steel	1,000 kg
	Pig iron	102,3 kg	Dust	18,2 kg
	Scrap	179,4 kg	Slag	100,0 kg
	Scale	16,5 kg	DS-Slag	15,0 kg
	Dust briquettes	12,9 kg	Converter gas	80,5 m^3 (std.)
	Burnt lime	78,0 kg	Steam	60,0 kg
	Dolomite	5,0 kg	Scrap	18,6 kg
	Oxygen	55,4 m^3 (std.)	Loss	25,0 kg
	DS-agent	15 kg		
Ladle metallurgy	Ferro alloys	12,2 kg		
	Crude steel	1,000 kg		
	Nitrogen	32,0 m^3 (std.)		
	Argon	1.5 m^3 (std.)		
	Electrodes	0.5 kg		
Ladle handling	Refractories (incl. LD vessel)	11.0 kg		
Energy + electric power, utilities	Electric power Mixed gas Nat. gas Steam Compr. air	72,0 kWh 10,00 m^3 (std.) 0,05 m^3 (std.) 7,0 kg 9 m^3 (std.)		

2.3.4 ANNUAL OUTPUT APPROX 2.42 MN T/A CRUDE STEEL

Table 46: **Annual Output approx 2.42 mn t/a Crude Steel**

3/2 operation (i.e. 3 installed, thereof 2 in operation)

Net production time COREX® (av.)	8,150 h = 339.6 d
Net production time LD plant	7,232 h = 301.3 d
Liquid metal output (av)	270 t/h = 6,480 t/d
Tap to tap time at 3/2 operation **	53.7 min
Charges/d at 3/2 operation	26.8/d conv, 53.6/d total
Converter relining	every 1,500 chgs
Duration of relining	5 d
Sulphur content liquid/solid	0.01 / 0.045 %
Days per converter trip Days for relining Total	$\frac{1,500}{26.8}$ = 56 d 5 d 61 d
2/3 operation chg/a	53.6 x 301.3 = 16,150 chg/a
Production of pig iron	
Annual downtime in downstream facilities	918 h
Hot metal production during downtime of downstream facilities	918 x 270 = 247,860 t/a
Total pig iron production	247,860 t/a
To be charged during 2/3 operation	$\frac{247,860}{16,150}$ = 15,347 t/chg
Material balance for 2/3 operation per t crude steel	
Liquid metal	806.04 kg
Iron ore*	5 kg
Pig iron	102.32 kg 38.5 %
Scrap	163.33 kg 61.5 %
Control of converter size	$\frac{270}{0.80604} \times \frac{53.7}{60 \times 2}$ = 150 t
During 2/3 operation	

Ferrous inputs	
Liquid metal	16,150 x 0.80604 x 150 = 1,952,632 t/a
Pig iron	16,150 x 0.10232 x 150 = 247,860 t/a
Iron ore	16,150 x 0.005 x 150 = 12,112 t/a
Scrap	16,150 x 0.16333 x 150 = 395,667 t/a
Control of COREX* output	
2/3 operation Pig iron Total	1,952,640 t/a 247,860 t/a 2,200,500 t/a
Capacity of steel plant (Crude Steel) **	16,150 x 150 = 2,422,500 t/a
* Balance after sublance control	
** Available surplus capacity	(36 chg/d max. - 35 ch/d) x 2 x 150 x 301.3 d = 90,390 t/a

This design assumes an increase in production to 2,422,500 t/a crude steel to be implemented in 2 stages.

1st stage: 2 COREX® C-2000 + BOF with two 150 t converters, thereof 1 in operation
Production of crude steel: 1,640,000 t/a

2nd stage: Addition of 1 COREX® C-2000 + one 150 t converter in the BOF. Operation with 2 converters of three installed
Production of crude steel: 2,422,500 t/a

This design renders a surplus capacity of approx. 900,000 t/a, which may be consumed - should the requirement for additional production advise - by feeding more hot metal into the BOF. Additional hot metal accrues by substituting the feed stock into the COREX® modules from iron ore to pellets. For the production of just 2,422,500 t/a crude steel without stagewise implementation a BOF with 2 converters of 230 t each (1 thereof in operation) would be more suitable (identical to chapter 1.5.4, BF route).

2.4 THIN SLAB CASTING AND ROLLING PLANT

For the general process description, handling of effluents, gaseous emissions and wastes as well as description of main equipment and machinery refer to Annex 1 »Engineering and Technology Design«, Chapter 2.4, of the Final Report of the Feasibility Study »Second Generation Integrated Steel Mill, Indonesia« (1993).

2.4.1 CONTINUOUS CASTING PLANT (for 3 x 150 t LD (3/2))

2.4.1.1 EQUIPMENT LIST (CONTINUOUS CASTING PLANT - THIN SLAB)

Table 47: Equipment List (Continuous Casting Plant - Thin Slab)

Item/Code	Designation	Number of Equipment	Main Technical Data
CD 2	Process Equipment		Format 700-1300x70 mm 1 x 1 Strand machine
CD 21	Ladle equipment & emerg. casting equipment	3 sets	Ladle turret: butterfly type
CD 22	Tundish equipment	3 sets	
CD 23	Additional equipment	3 sets	
CD 24	Supporting structure & cooling chamber	3	
CD 25	Mold and oscillating facilities	3 sets	4-eccenter oscillator
CD 26	Strand guide	3 sets	r = 3 m, h met = 7.3 m
CD 27	Dummy bar & cutting facilities	3 sets	D/B bottom feeding system, hydraulic shear
CD 28	Run-out facilities	3	
CD 5	Maintenance & Stores		
CD 51	Machine maintenance	1 set	
CD 52	Tundish relining	1 set	
CD 54	Spare parts depot	1	
CD 57	Refractory store	1 set	
CD 58	Operating parts store	1 set	incl. operational spares
CD 59	Measuring & auxiliary equipment	1 set	
CD 6	Information system		
CD 62	Production and process control system	1 set	
CD 63	General instrumentation	1 set	
CD 64	Basic automation	1 set	
CD 69	Communication system	1 set	
CD 7	Infrastructure & Auxiliary Equipment		
CD 75	Fire alarm & fighting system	1 set	
CD 8	Utility supply & Treatment		

Item/Code	Designation	Number of Equipment	Main Technical Data
CD 81	Water Treatment		
CD 82	Water circuits & cooling system		
CD 83	Incombustible gases & compressed air	1 set	
CD 84	Combustible gases	1 set	
CD 86	Steam, hot water, heat recovery	1 set	
CD 89	Hydraulic & lubrication system	1 set	
CD 9	Electric energy supply		
CD 92	Low voltage facilities	1 set	
CD 93	Electrical equipment	1 set	
CD 97	Lighting & plug socket system	1 set	
CD 98	Lighting & earthing system	1 set	
CD 99	Other electrical equipment	1 set	

2.4.1.2 BASIC TECHNICAL DATA

Production	approx. 2,300,000 t thin slabs/year
Design of thin slab caster	bow-type caster with straight mold, vertical upper segment, strand containment, segments and continuous, bending and straightening of strand according to the state of the art proprietary bending and straightening process
Mold	straight parallel mold
Length	1,200 mm
Strand containment:	intermediately supported rollers in vertical rack, bending & bow segment
No. of machines	3
No. of strands per machine	1
Height of casting platform	approx. 7.5 m
Bow radius	3 m
Metallurgical length	approx. 7.3 m
Withdrawing unit	driven rollers in straightener
Strand cutting facility	flying shear

Slab dimensions:	
Thickness	70 mm (cold condition)
Width	700 - 1300 mm (cold condition)
Length for spec. coil weight	approx. 32 m
Casting capacity per machine	average 2.4 tons/min and strand
Casting speed	max. 4.0 m/min average 3.5 m/min
Max. caster speed (drives only)	6.0 m/min
Steel grades	acc. to product mix

2.4.2 HOT ROLLING MILL FOR THIN SLABS

2.4.2.1 EQUIPMENT LIST (THIN SLAB ROLLING MILL)

Table 48: **Equipment List (Thin Slab Rolling Mill)**

Item/Code	Designation	Number of Equipment	Main Technical Data
WT 15	Reheating Furnace	3	Roller hearth furnace capacity 320 t/h
WT 24	Finishing Mill Entry Section Finishing Stands Mill Stand Main Drive Roll Changing Device	1	6 stands (F1 - F6) 7 000 kW
WT 27	Strip Cooling Run-out Roller Table Laminary Strip Cooling System	1	
WT 28	Down Coiler Side Guide Assembly Ahead Coiler Pinch Roll Unit Down Coiler Coil Stripper Car	2	
WT 31	Handling Facilities Coil Conveyor Coil Banding Machine Coil Transfer Car	1	
WT 32	Inspection Line	1	
WT 38	Product Store + Dispatch	1	
WT 51	Roll Shop	1	

Item/Code	Designation	Number of Equipment	Main Technical Data
WT 53	Maintenance Post	1	
WT 54	Spare Parts Depot	1	
WT 56	Roll Store	1	
WT 57	Refractory Store	1	
WT 58	Operating Parts Store	1	
WT 61	Planning System/Management Info	1	
WT 62	Prod. & Process Control System	1	
WT 63	General Instrumentation	1	
WT 64	Basic Automation	1	
WT 65	Sampling/Material Testing	1	
WT 67	Laboratory	1	
WT 69	Communication System	1	
WT 71	Plant Office	1	
WT 73	Locker Building	1	
WT 75	Fire Alarm & Fighting System	1	
WT 77	Road Transport	1	
WT 81	Water Supply/Treatment	1	
WT 82	Water Circuit & Cooling System	1	
WT 83	Incombustible Gases & Compr. Air	1	
WT 84	Combustible Gases	1	
WT 85	Combustible Liquids & Fuel	1	
WT 86	Steam/Hot Water/Heat Recovery	1	
WT 87	Hydraulic & Lubrication System	1	
WT 91	High Voltage Facilities	1	
WT 92	Low Voltage Facilities	1	
WT 93	Electrical Equipment	1	
WT 97	Lighting & Plug Socket System	1	
WT 98	Lighting & Earthing System	1	
WT 99	Other Electrical Equipment	1	

2.4.2.2 BASIC TECHNICAL DATA

Type of furnace	Roller hearth furnace (3 off)
Fuel	Gas fired
Number of finishing stands	6 (F1 to F6) 56"
Input material	Thin slabs
- thickness	70 mm
- width	700 - 1300 mm
- length	max.32 000 mm
Output material	hot rolled strip
- thickness	1.5 to 14 mm
- width	700 to 1300 mm
- max. coil weight	31 t
Coil dimension	
- inner diameter	762 mm
- outer diameter	max. 2150 mm

2.5 AUXILIARY PLANTS

For the general process description, handling of effluents, gaseous emissions and wastes as well as description of main equipment and machinery refer to Annex 2, Chapter 1.6 of the UNIDO Report for Description of Technological Alternatives (1992).

2.5.1 LIME PLANT

For the general process description, handling of effluents, gaseous emissions and wastes as well as description of main equipment and machinery refer to Annex 1 »Engineering and Technology Design«, Chapter 2.5, of the Final Report of the Feasibility Study »Second Generation Integrated Steel Mill, Indonesia« (1993).

The additional requirement of burnt lime for the LD plant when changing the operation mode to a 3/2 generation is 68,650 t/a.

For the initial LD operation (2/1) a Lime Kiln with a capacity of 450 t/d is foreseen. With the increase in production and the change over to a 3/2 operation an additional Lime Kiln with a capacity of 200 t/d is required (stagewise implementation).
If the increased production is anticipated from the beginning, then one Lime Kiln with a production of 600 t/d identical to the BF route chapter 1.7.1 has to be foreseen.

2.5.1.1 EQUIPMENT LIST OF LIME PLANT

Table 49: **Equipment List of Lime Plant**

Item/Code	Designation	Number of Equipment	Main Technical Data
BS 12	Limestone Handling		
	- Front end loader	1	
	- Belt conveyor system	1 set	
BS 13	Limestone screening		
	- Screens	1 set	
	- Storage bin	2	300 m^3 grain size 30 - 80 mm
	- Storage bin	1	150 m^3 grain size 0 - 30 mm
	- Belt conveyor	2 sets	
	- Vibrating feeders	2	
BS 19	Dedusting system		
	- for Belt conveyor (BS 12)	1 set	
	- for screening station (BS 13)	1 set	
BS 21	Kiln charging system		
	- Belt conveyor	1 set	
	- Skip	1+1 set	
	- Skip hydraulic	1+1 set	
BS 23	Shaft kiln complete	1+1	425 t/d + 200 t/d
BS 28	Kiln charging system		
	- Vibrating feeder	1+1	
	- Belt conveyor	1+1 set	
BS 29	Dedusting System	1+1 set	
BS 31	Product Handling		
	- Bucket elevator	1	

Item/Code	Designation	Number of Equipment	Main Technical Data
BS 32	Crushing and screening		
	- Bucket elevator	1	
	- Screen	1	for fraction 0 - 60 mm
	- Screen	1	for fraction 60 - 80 mm
	- Jaw crusher	1	for fraction > 60 mm
	- Belt conveyor	1	
	- Bucket elevator	1	
	- Screen	1	for 0 - 10 mm
	- Screen	1	for 10 - 60 mm
	- Storage bin	1	300 m^3 for grains 0 - 10 mm
	- Two way chute	1	
	- Storage bins	2	450 m^3
	- Belt conveyor	1	
	- Jaw crusher	1	grain size 20 mm
	- Two way chute	1	
	- Screens	1	for 0 - 10 mm
	- Screens	1	for 10 - 20 mm
	- Belt conveyor	1	for 0 - 10 mm
	- Belt conveyor	1	for 10 - 20 mm
	- Storage Bin	1	150 m^3 for 10 - 20 mm
	- Belt conveyor to steel plant	1 set	
BS 33	Grinding Station		
	- Screen	1	0 - 30 mm
	- Magnetic separator	1	
	- Rotor hammer mill	1	
	- Belt conveyor	1 set	
	- Bucket elevator	1	
	- Cyclone with star feeder	1	
	- Bin aeration system	1 set	
	- Starfeeder	1	
	- Two way chute	1	
BS 39	Dedusting system		
	- for Crushing and Screening	1 set	
	- for Grinding plant	1 set	
BS 64	Basic automation		
	- Control process unit	1 set	
	- I/O Cards		
	- Power supply		
	- Programming unit		
	- Software		
	- Local control boxes		
	- Speed monitors		
	- Pull rope switches		
	- Belt trucking switches		
BS 92	Low voltage Facilities		
BS 93	Electrical Equipment		

2.5.1.2 BASIC DATA

Limestone:

- Incoming limestone:
  Grain size 0-80 mm
  Undersize 5 % max. 0-30 mm
  Oversize 5 % max. 120 mm in one direction

Chemical and physical properties of limestone:
The limestone has to be free of contaminations such as clay minerals, SiO_2, iron, metal pieces, wood etc.
Limestone should have no crystalline physical properties thus avoiding decrepitation during preheating and calcination.

Grain size:

Limestone kiln feed	30 to 80 mm

Moisture content:

Grain size 30 - 80 mm	max. 1 % H_2O in daily average
Bulk weight	approx. 1.4 t/m^3

<u>Operation Time</u>

Shaft kiln Production	450+150 tons of burnt lime per 24 hours continuous operation
Over all plant availability	330 days per year
Burnt lime quality	Rest CO_2-content 2 % (average)
Limestone handling and storage (14 shifts per week)	2 shifts per day
Calcining plant including burnt lime crushing and storage section (21 shifts per week)	3 shifts per day

Manpower

1 Engineer
1 Secretary
1 Foreman per shift
5 Workers per shift
1 Driver for front end loader per shift

For maintenance and major repair specialists for

- Mechanic
- Electric and instrumentation
- Hydraulic

can be called upon from case to case from the main maintenance shop.

2.5.1.3 CONSUMPTION

Capacity:	215,350 t/a
Annual working hours:	8,000 h/a
Max. output:	18.75 + 8.33 t/h

Table 50: **Consumption**

Item	Per t Burnt Lime	Per Year
Limestone	1773.5 kg*	381,933 t
Electric Power	46 kWh	9.9 GWh
Mixed Gas	450 m^3 (std.)	96.9 x 10^6 m^3
Compressed Air	40.6 m^3 (std.)	8.74 x 10^6 m^3

*) excluding limestone fines

2.5.2 PRE-PRODUCTION FACILITIES

2.5.2.1 IH 12 RAW MATERIAL STORAGE YARD

	storage area approx. for 1.5 month	storage capacity approx. for 1.5 month
- Lump ore	approx. 21,500 m^2	approx. 400,000 t
- Limestone	approx. 6,500 m^2	approx. 61,200 t

- Dolomite approx. 6,500 m^2 approx. 61,200 t
- Coal approx. 43,000 m^2 approx. 300,000 t
- Scrap approx. 10,000 m^2 approx. 45,000 t

Beside the foreseen storage areas the raw materials will be handled with two stacker reclaimers. A belt conveyor system transports the raw materials to the ore screening station, the coal drying plant and the burden building by means of the yard conveyors. The technical specifications are generally the same as the dock conveyor, also running in one direction only.

3 stockpiles 650 m long and approx. 60/30 m wide each, are foreseen providing an area of 78,000 m^2. Drainage trenches on either side of the stockpiles provide dewatering after rainfalls. The water is collected in a settling pond, which overflow is ducted into the sea. The storage areas are paved and slanted 1% towards the trenches.

2.5.2.2 IH 14 SCRAP HANDLING AND TREATMENT

2.5.3 PERIPHERAL FACILITIES

2.5.3.1 IH 46 AIR SEPARATION PLANT

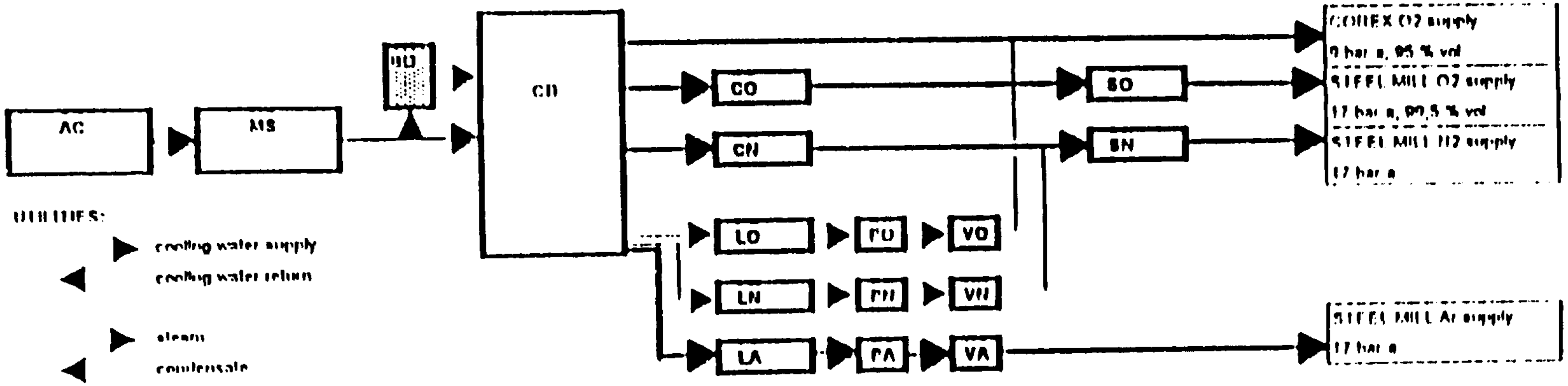
Table 51: **Gas Productions**

Item/Code	Designation Equipment	Number of	Main Technical Data
		(average values)	
AIR SEPARATION PLANT IH 46	- O_2-generation (95% purity) - O_2-generation (99,5% purity) - N_2-generation - Ar-generation	1 set 1 set 1 set	Qn = 175,000 m^3/h Qn = 18,600 m^3/h Qn = 37,870 m^3/h Qn = 520 m^3/h

Fig. 31 : Air Separation Plant

III-46

AIR SEPARATION PLANT / PROCESS FLOW



UTILITIES:

- cooling water supply
- cooling water return
- steam
- condensate
- instrument air (only for start up)

Legend:

AC air compressor station
MS molecular sieve air drying station
BO air booster (only for COREX O2 - internal O2 compression)
CB cold box
CO oxygen compressor
CN nitrogen compressor
SO oxygen storage vessel
SN nitrogen storage vessel
LO liquid oxygen tank
LN liquid nitrogen tank
LA liquid argon tank
VO oxygen vaporizer
VN nitrogen vaporizer
VA argon vaporizer
PO oxygen liquid pump
PN nitrogen liquid pump
PA argon liquid pump

2.5.3.2 IH 48 SLAG HANDLING AND TREATMENT

2.5.3.3 IH 49 SCALE HANDLING AND TREATMENT

2.5.4 MAINTENANCE AND STORES

2.5.4.1 IH 51 CENTRAL MECHANICAL WORKSHOP

2.5.4.2 IH 52 CENTRAL ELECTRICAL/ELECTRONIC WORKSHOP

2.5.4.3 IH 53 CENTRAL MECHANICAL WORKSHOP

2.5.4.4 IH 54 STORE FOR SPARE PARTS AMD CONSUMABLES

2.5.4.5 IH 57 CENTRAL REFRACTORY STORE

2.5.4.6 IH 58 CENTRAL OPERATING PARTS STORE

2.5.5 INFORMATION

2.5.5.1 IH 61 PLANNING SYSTEM/MANAGEMENT INFO

2.5.5.2 IH 63 GENERAL INFORMATION

2.5.5.3 IH 64 BASIC AUTOMATION

2.5.5.4 IH 67 CENTRAL LABORATORY

2.5.6 INFRASTRUCTURE AND AUXILIARY EQUIPMENT

2.5.6.1 IH 71 ADMINISTRATION BUIDLING

2.5.6.2 IH 73 LOCKER BUILDING AND CANTEEN

2.5.6.3 IH 74 FIRST AID AND SECURITY FACILITIES

2.5.6.4 IH 75 FIRE ALARM AND FIRE FIGHTING SYSTEM

2.5.6.5 IH 77 ROAD TRANSPORT

Table 54: List of Vehicles

	Pcs	Name	Price US$
RC	7	Filterplant-container	15,167
RC	3	Hot metal transportation-ladle carrier	2,730,000
SL	3	Alloy handling-wheel loader	195,000
SL	4	Filter plant container	86,667
SL	1	Alloy handling-wheel loader	195,000
SL	1	Dewatering unit-container	21,667
SL	5	Road vehicles fork lift truck	325,000
CD	4	Crop end handling container	136,500
CD	4	Crop/skull bucket	84,500
WT	1	Scale removal system wheel loader	216,667
WT	4	Handling facilities fork lift truck	1,733,333
WT	2	Handling facilities trailer	216,667
WT	2	Handling facilities tractor	433,333
WT	4	Scrap transfer trailer	390,000
IH	4	Scrap transfer container	390,000
IH	2	Scrap transfer tractor	325,000
IH	1	Mobile crane with magnet for cleaning up scrap yard	228,583
IH	28	Slag transportation slag pot	4,478,500
IH	4	Slag transportation for carrier	2,946,667
IH	3	Depot/store-lift truck	117,000
IH	18	Road vehicles container	320,125
IH	2	Road vehicles fork lift truck	75,833
IH	1	Road vehicles wheel loader	182,000
IH	1	Road vehicles elevating carrier	500,500
IH	6	Road vehicles truck	681,417
IH	10	Automobiles	238,333
IH	6	Passenger cab buses	379,167
IH	10	Cab pickup trucks	216,667
IH	1	Pumper fire truck	465,833
Sum			18,325,125

2.5.7 UTILITY SUPPLY/TREATMENT

2.5.7.1 IH 81 WATER SUPPLY/TREATMENT

Total industrial water requirement ~ 1,450 m^3/h
Pressure 0,3 MPa at battery limit
Temperature ~ 28 °C

Table 55: **Water Consumption**

Unit: m^3/h average values

Plant	Make-up water	Service water	Fire fighting water	Potable water
Lime plant	-	1.5	0-200	1.5
COREX-plant	540	2.5	0-200	in make-up incl.
LD-plant	204	3	0-200	8.5
CC thin slabs	133	1.5	0-200	4.5
Thin slab mill	194	3	0-200	4.5
Integration facilities	329	13.5	0-200	6
TOTAL	1,400	25	0-400	25

Waste Water

- Industrial waste water
  The industrial waste water, mainly bleed-off water from the open cooling circuits, is collected in the central water treatment plant.

  The treated waste water which is to comply with national standards and/or regulations for discharging will be pumped to the take over point (T.O.P.) at the battery limit of the iron and steel works.

  Average water flow for discharge:
  $Q_{approx} = 525\ m^3/h$

- Sanitary waste water
  The sanitary waste water is collected in a sewer system. The sewer system will be discharged at the take over point at the battery limit of the iron and steel works.

Average water flow for discharge:
$Q_{approx} = 25\ m^3/h$

- Rain water

Run-off rain water from buildings, roads, etc. is drained to the battery limits of the works.

2.5.7.2 IH 82 WATER CIRCUITS AND COOLING SYSTEMS

Table 56: **Cooling Systems / Heat Transfers**

Plant/Production Unit	Total flows/circulating water m^3/h	Heat load GJ/h
COREX® plant	1)	-
LD-plant	1,040	67.8
CC thin slabs	3,550	80.0
Thin slab mill	12,500	365.0
Integration facilities	6,750	282.0
1) Within utility systems of production plant (Plant code AC + RB + AS)		

2.5.7.3 IH 83 INCOMBUSTIBLE GASES AND COMPRESSED AIR

Total flows (peak values)

Compressed air: Qn = 12,000 m^3/h pe = 0.7 MPa
Instrument air: Qn = 700 m^3/h pe = 0.7 MPa
Air mist air: Qn = 17,500 m^3/h pe = 0.3 MPa

Table 57: **Gas and air flows in Qn = m^3/h (Average values)**

CA compressed air
IA instrument air

	O_2	N_2	Ar	CA	IA	Air mist
Lime plant	-	120	-	1,100	75	-
COREX-plant	175,000	23,000	-	2,970	-	-
LD-plant	18,600	10,720	500	3,000	75	-
CC thin slabs	25	30	20	300	75	* 17,500
Thin slab mill	-	-	-	1,500	225	-
Integration facilities	-	115	-	1,500	150	-
*) peak value (process air)						

2.5.7.4 IH 84 COMBUSTIBLE GASES

Table 58: **Plant Balance of Combustible Gases**

		Calorific value (kJ/Nm³)	COREX Nm³/h	LDG Nm³/h
Generated	COREX® plant LD-Shop	8,431 8,431	478,980	 28,078
Balance to Gas Mixing Station		-	478,980	28,078
Mixed Gas		8,431		
Consumers	Lime plant	8,431	12,120	
	LD plant	8,431	3,350	
	CC-thin slabs	8,431	410	
	Thin slab mill	8,431	9,660	
	Others	8,431	3,428	
	TOTAL	8,431	28,968	
FOR EXPORT		8,431	478,000	

Total production for export:

478,000 Nm³/h x 8,431 MJ/Nm³ = 4,030,018 MJ/h (= (MWs/h)

Total annual heat export: 4,030.018 GJ/h x 8,150 h/a = 32,844,647 GJ/a

Total heat input:

$$\frac{4,030,018 \text{ MWs}}{3,600 \text{ s}} = 1119.45 \text{ MW}_{therm}$$

Power plant efficiency rate assumed 0,35

Electrical output:

$$0,35 \times 1119.45 = 391,8 \text{ MW}_{elektr}$$

Existing Power Plant of PTKS:

The existing steam power station of PTKS consists of 5 modules of 80 MW of power generation each, 4 of them in operation, 1 for stand-by (see Figure 4)

It is intended to feed the COREX®-gas to the steam boilers of the power station by means of

- exchange of the existing burners of the steam boilers by tripropellant burners for BF gas, natural gas and fuel oil (see Figure 9)
- connection of the power plant and the BF plant by a feeding pipe line (dia 1 800 mm).

2.5.7.5 IH 86 STEAM / HOT WATER

Steam Balance

average values (design flows)
unit: t/h

Table 59: **Steam Balance**

Consumed	COREX® plant	12.15
	LD-plant (dedusting)	2.35
	Air separation plant	4.23
Generated	LD-plant (heat recovery)	20.00
	Steam boiler plant	0 - 15.00

Design data

Pressure: 1.0 MPa
Temperature: 185°C
Condition: saturated steam

E:\projekte\ptks-bolphase-2\annex-3\corex-25.wp5

Fig. 32: Steam Plant Balance

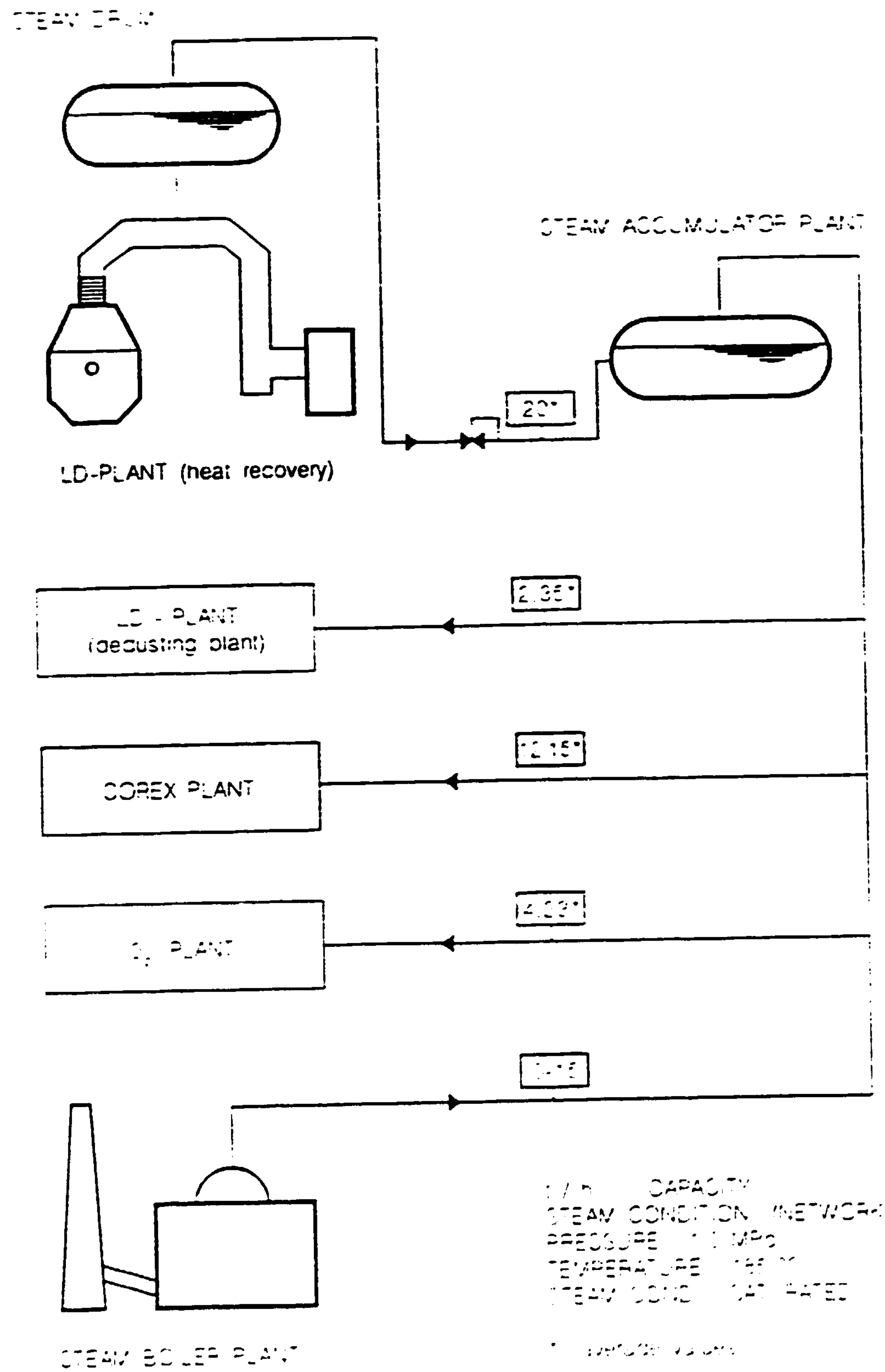


Fig. 33:
Proposed Disposition of Burners in Existing Boiler

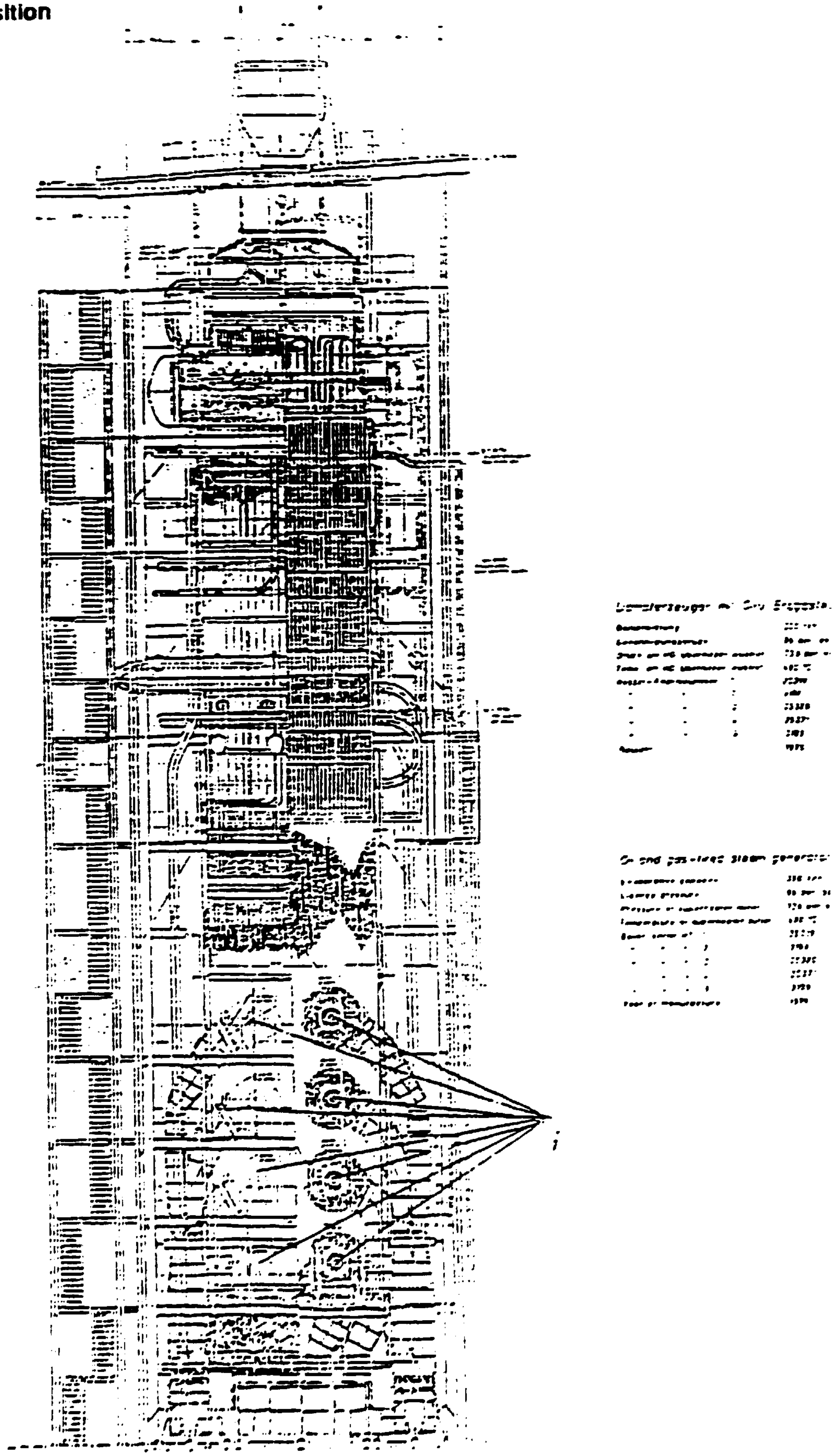


Fig. 34: Section through Burner for 120 MW_{therm}

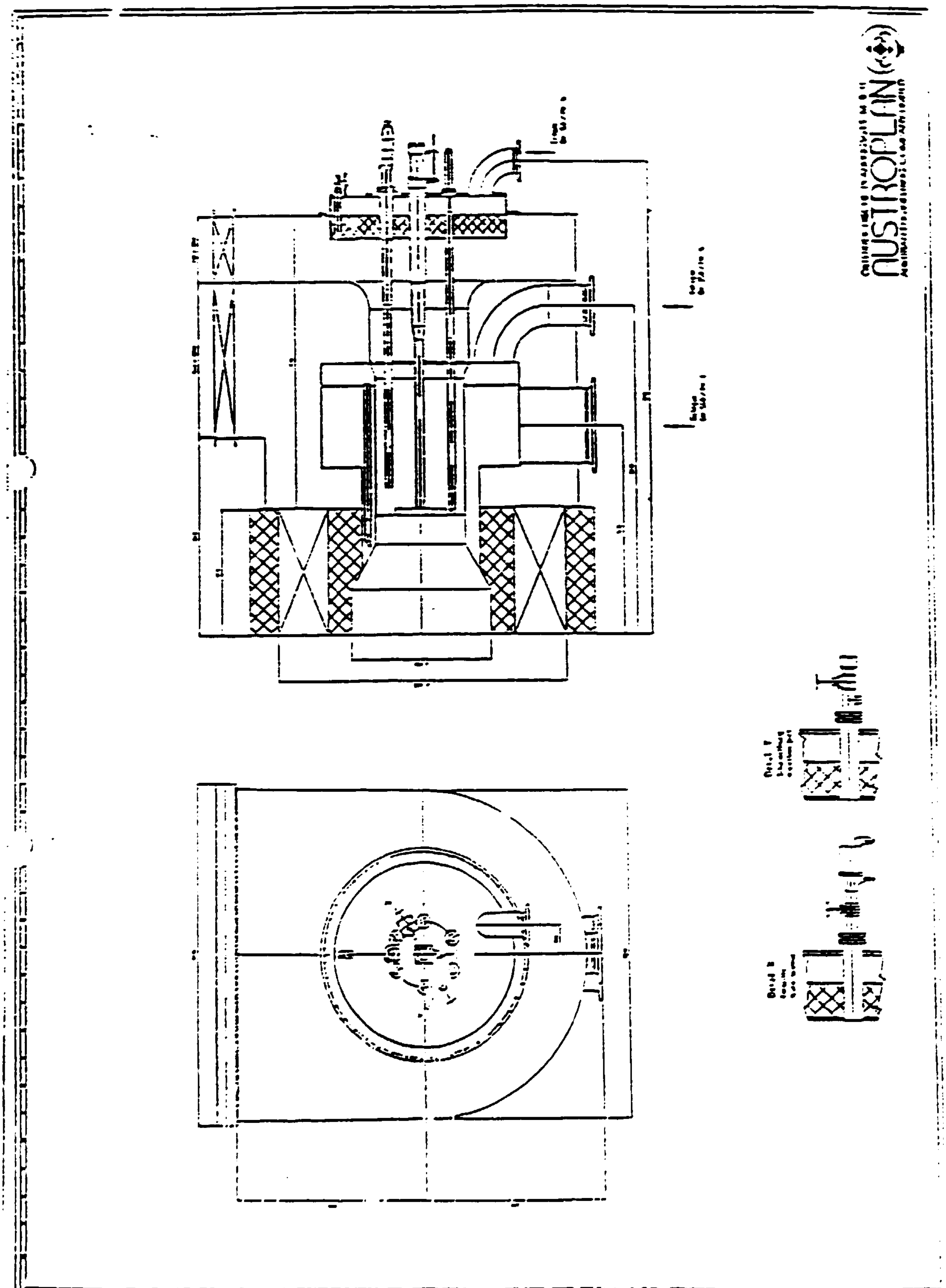


Fig. 35: **IH 84 Combustible Gas / Plant Balance**

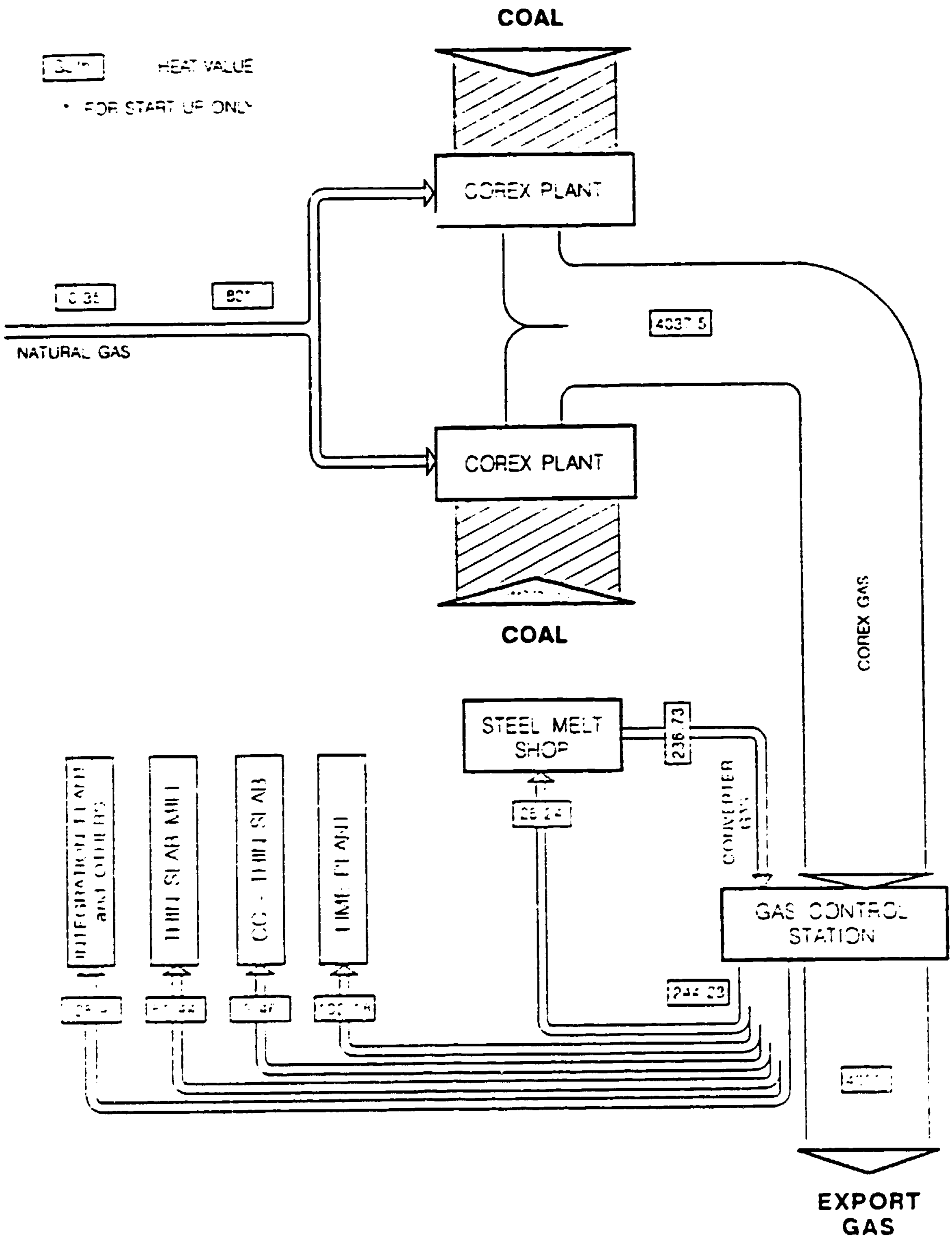


Table 60: **Equipment List for Auxiliaries**

Item/Code	Designation	Number of Equipment	Main Technical Data
UTILITY SUPPLY/TREATMENT			
IH 81	Water Supply/Treatment	1 set *)	Q = 1,600/1,450 m³/h
	i) Make up water system	1 set	Q = 1,400 m³/h
	ii) Service water system	1 set *)	Q = 60/25 m³/h
	iii) Fire fighting water system	1 set	Q = 0-400 m³/h
	iv) Potable water system	1 set *)	Q = 60/25 m³/h
	v) Industrial waste water system	1 set	Q = 525 m³/h
	vi) Sanitary waste water system	1 set *)	Q = 50/25 m³/h
	vii) Rain water system	1 set	
IH 82	Water Circuits + Cooling	1 set	
	viii) LD-Plant cooling	1 set	67.8 GJ/h
	ix) CC thin slab cooling	1 set	80.0 GJ/h
	x) Thin slab mill	1 set	365.0 GJ/h
	xi) Auxiliary plant cooling	1 set	282.0 GJ/h
IH 83	Incombustible Gases and Air	1 set	
	xii) Oxygen distribution system	1 set *)	Qn = 240,000/193,625 m³/h
	xiii) Nitrogen distribution system	1 set *)	Qn = 40,000/24,000 m³/h
	xiv) Argon distribution system	1 set	Qn = 550 m³/h
	xv) Compressed air system	1 set	Qn = 12,000/10,400 m³/h
	xvi) Instrument air system	1 set	Qn = 700/600 m³/h
	xvii) Air mist system	1 set *)	Qn = 17,500 m³/h (peak)
IH 84	Combustible Gases	1 set	
	xviii) Corex gas system	1 set	Qn = 600,000/480,000 m³/h
	xix) LD-converter gas system	1 set	Qn = 28,500 m³/h
	xx) COREX® Export system	1 set	Qn = 550,000/478,000 m³/h
	xxi) Natural gas system	1 set	Qn = 2,500/10 m³/h
IH 86	Steam/Hot Water	1 set	Qn = 15 t/h

*) indicated values are peak/average system flows

2.5.8 ELECTRICAL EQUIPMENT

2.5.8.1 IH 91 HIGH VOLTAGE FACILITIES

2.5.8.2 IH 92 LOW VOLTAGE FACILITIES

2.5.8.3 IH 93 ELECTRICAL EQUIPMENT

2.5.8.4 IH 97 LIGHTING AND PLUG SOCKET SYSTEM

2.5.8.5 IH 98 LIGHTING AND EARTHING SYSTEM

2.5.8.6 IH 99 OTHER ELECTRICAL EQUIPMENT

Table 61: **Electric Energy Consumption**

Item	MWh/a
Process Facilities:	
COREX® Plant	143,030
LD Plant	174,420
Thin Slab Casting	8,190
Thin Slab Mill	162,960
Lime Plant	9,910
Sub Total	498,510
Integration Facilities:	
Oxygen Plant	1,088,400
Compressed Air Plant	19,600
Various	33,490
Sub Total	1,141,490
Grand Total	1,640,000
Consumption/h	201 MW

Table 62: **Equipment List of Integration Facilities**

Item/Code	Designation	Number of Equipment	Main Technical Data
IH 12	Raw material storage yard - Stacker reclaimer - Belt conveyor system	 2 pieces 1 set	
IH 14	Scrap handling and treatment - bridge crane with crab and magnet - weighing bridge - hand gas cutting torches	 1 piece 1 piece 1 set	
IH 46	Air separation plant - O_2-generation (95 % purity) - O_2-generation (99.5 % purity) - N_2-generation - Ar-generation	 1 set 1 set 1 set 1 set	 Qn = 175,000 m^3/h Qn = 18,600 m^3/h Qn = 37,870 m^3/h Qn = 520 m^3/h
IH 48	Slag handling and treatment - hopper - wheel loader - vibration grades - impact crusher - vibrating feeder - screening machine - belt conveyor	 1 set 1 piece 1 set 1 piece 1 set 1 piece 1 set	
IH 49	Scale handling and treatment		

Item/Code	Designation	Number of Equipment	Main Technical Data
IH 51	Central mechanical workshops - bay crane - various tools and machines	 2 pieces 1 set	
IH 52	Central electrical/electronic workshop - bay crane - various tools and machines	 1 piece 1 set	
IH 53	Maintenance railway/vehicles - bay crane - various tools & machines	 2 pieces 1 set	
IH 54	Store for spare parts and consumables - bay crane - fork lift - pallets - various stackers	 1 piece 1 piece	
IH 57	Central refractory store - bay crane - fork lift - pallets	 1 piece 1 piece	
IH 58	Central operating parts store - bay crane - fork lift - pallets - various stacker	 1 piece	
IH 61	Planning system/management info		
IH 63	General instrumentation		
IH 64	Basic automation		
IH 67	Central laboratory		
IH 73	Administrative building		
IH 74	First aid & security device		
IH 75	Fire alarm & fighting system		
IH 77	Road transport		
IH 81	Water supply/treatment - make up water system - service water system - fire fighting water system - potable water system - industrial waste water system - sanitary waste water system - rain water system	1 set *) 1 set 1 set *) 1 set 1 set *) 1 set 1 set *) 1 set	Q = 1,600/1,450 m^3/h *) Q = 1,400 m^3/h Q = 60/25 m^3/h 1) *) Q = 0-400 m^3/h Q = 60/25 m^3/h 1) *) Q = 525 m3/h Q = 50/25 m^3/h 1) *)

Item/Code	Designation	Number of Equipment	Main Technical Data
IH 82	Water circuits + cooling	1 set	
	- LD-plant cooling	1 set	67.8 GJ/h
	- CC thin slab cooling	1 set	80.0 GJ/h
	- Thin slab mill cooling	1 set	365.0 GJ/h
	- auxiliary plant cooling	1 set	282.0 GJ/h
IH 83	Incombustible gases and air	1 set	
	- oxygen distribution system	1 set *)	Qn = 240,000/193,625 m^3/h *)
	- nitrogen distribution system	1 set *)	Qn = 40,000/24,000 m3/h *)
	- argon distribution system	1 set	Qn = 550 m^3/h
	- compressed air system	1 set *)	Qn = 12,000/10,400 m^3/h
	- instrument air system	1 set	Qn = 700/600 m^3/h
	- air mist system	1 set *)	Qn = 17,500 m^3/h *)
IH 84	Combustible gases	1 set	
	- B-F gas system	1 set *)	Qn = 600,000/480,000 m^3/h
	- LD-converter gas system	1 set	Qn = 28,500 m^3/h
	- Mixed gas export system	1 set	Qn = 550,000/478,000 m^3/h
	- natural gas system	1 set	Qn = 2 500/10 m^3/h
IH 86	Steam/hot water	1 set	Qn = 15 t/h
IH 91	High voltage facilities		
IH 92	Low voltage facilities		
IH 93	Electrical equipment		
IH 97	Lighting & plug socket system		
IH 98	Lightning & earthing system		
IH 99	Other electrical equipment		

2.6 HUMAN RESOURCES

For the description of personnel requirements and their recruitment and training please refer to the Final Report of the Bankable Feasibility Study for the Erection of a Second Generation Integrated Steel Mill in East or West Java prepared by UNIDO 1993, Chapter 8.
For the production of 2.33 mn t/a HRC the following personnel is required:

Table 63: **Manning Schedule Operational Personnel including Provisions for Vacation and Sick Leave**

	Cat. 1	Cat. 2	Cat. 3	Cat. 4	Total
Raw Material Handling, Lime Plant	3	22	34	46	105
COREX® Plant	4	3[illegible]	305	111	457
Steel Plant incl. Thin Slab Casting	6	140	650	569	1,365
Thin Slab Mill	4	34	124	102	264
Auxiliary Plant and Energy	4	111	180	219	514
Central Maintenance + Warehouse	10	26	83	39	158
Harbour and Transport	4	27	80	192	303
Grand Total	35	397	1,456	1,278	3,166
Thereof running maintenance personnel in production departments approx. 20-30 % included					

Table 64: **Administrative Personnel Requirements**

	Cat. 1 Supervisory	Cat. 2 Technical + Commercial Mngr.	Cat. 3 Administrative + Skilled	Cat. 4 Unskilled	Total
Administration	40	73	265	72	450

2.7 MATERIAL BALANCE

Fig. 36: Specific Consumption Figures - Lime Kiln (per tonne product)

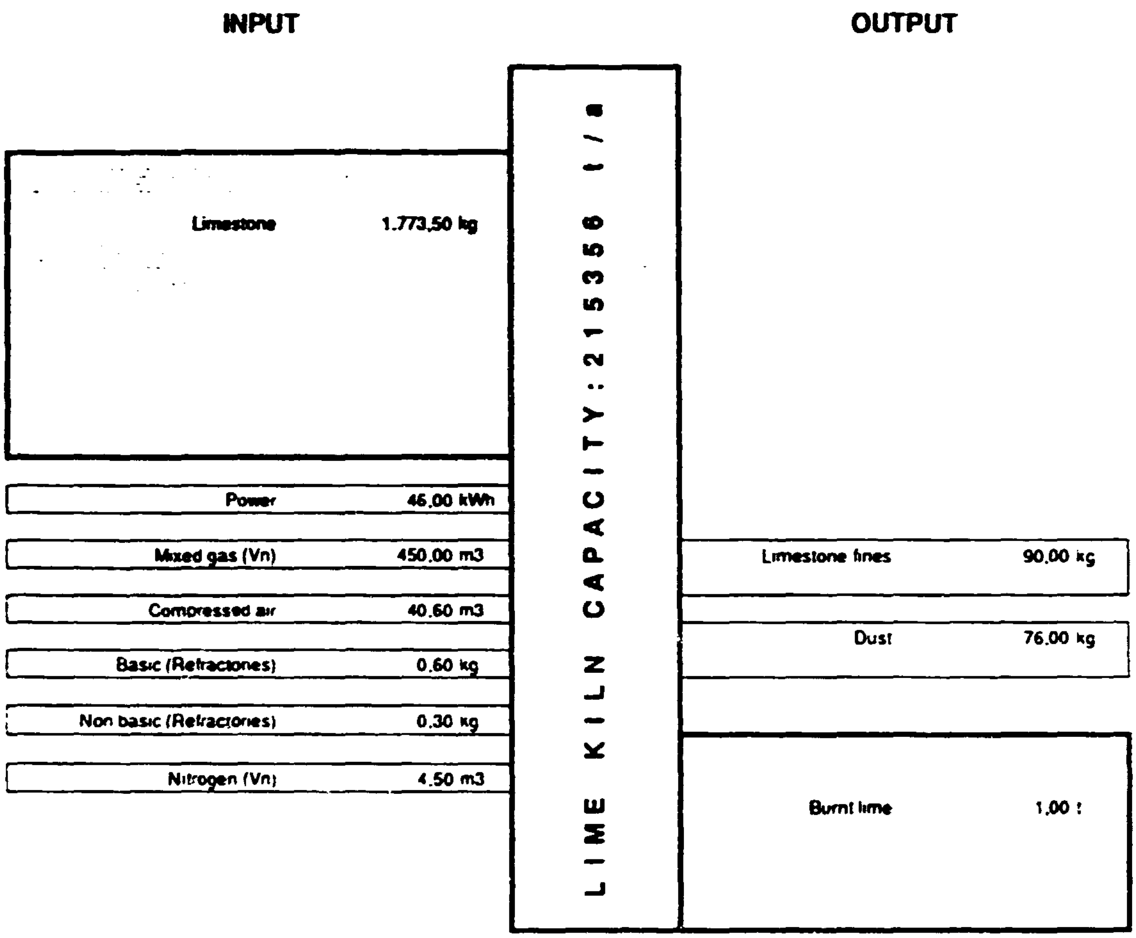


Fig. 37: Annual Consumption Figures - Lime Kiln

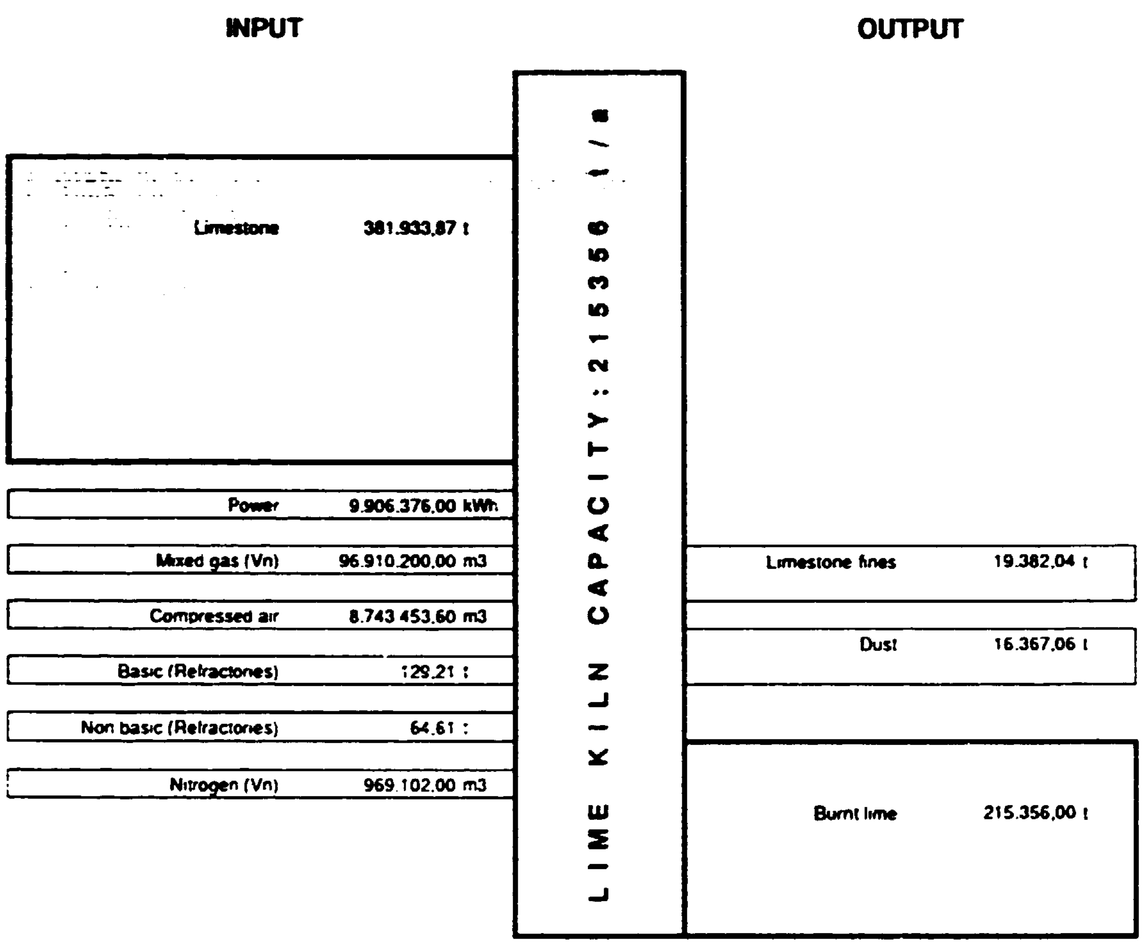


Fig. 38: Specific Consumption Figures - COREX® Plant (per tonne product)

INPUT

Lump ore Mt newman	1.511,93 kg (958,00) kg
Coal Ombilin	788,00 kg (1,86) kg
Coal Lumut B	252,33 kg (0,62) kg
Quartz	29,00 kg
Limestone	196,00 kg
Dolomite	57,00 kg
Burnt lime	15,00 kg
El. Power	65,00 kWh
Natural gas (Vn)	0,06 m3
Oxygen (95%)	643,00 m3
Nitrogen (Vn)	85,00 m3
Compressed air (Vn)	11,00 m3
Industrial water	2,00 m3
Refractory masses	1,50 kg
Refractory bricks	5,00 kg
Steam	45,00 kg

3 x COREX PLANT : 2200500 t/a

C 2000

OUTPUT

Export gas (Vn) (8,43 MJ/m3)	1.774,00 m3
Excessgas	22,00 m3
Effluents (process)	1,00 m3
Effluents (sanitary)	0,03 m3
Sludge (dry basis)	4,03 kg (1,55) kg
Slag	318,03 kg (1,27) kg
Scrap	10,47 kg (9,90) kg
Hot metal	1,00 t 947,80 kg

E:\projekte\pt\ks-bo\phase-2\annex-3\corex-25.wp5

Fig. 39: Annual Consumption Figures - COREX® Plant

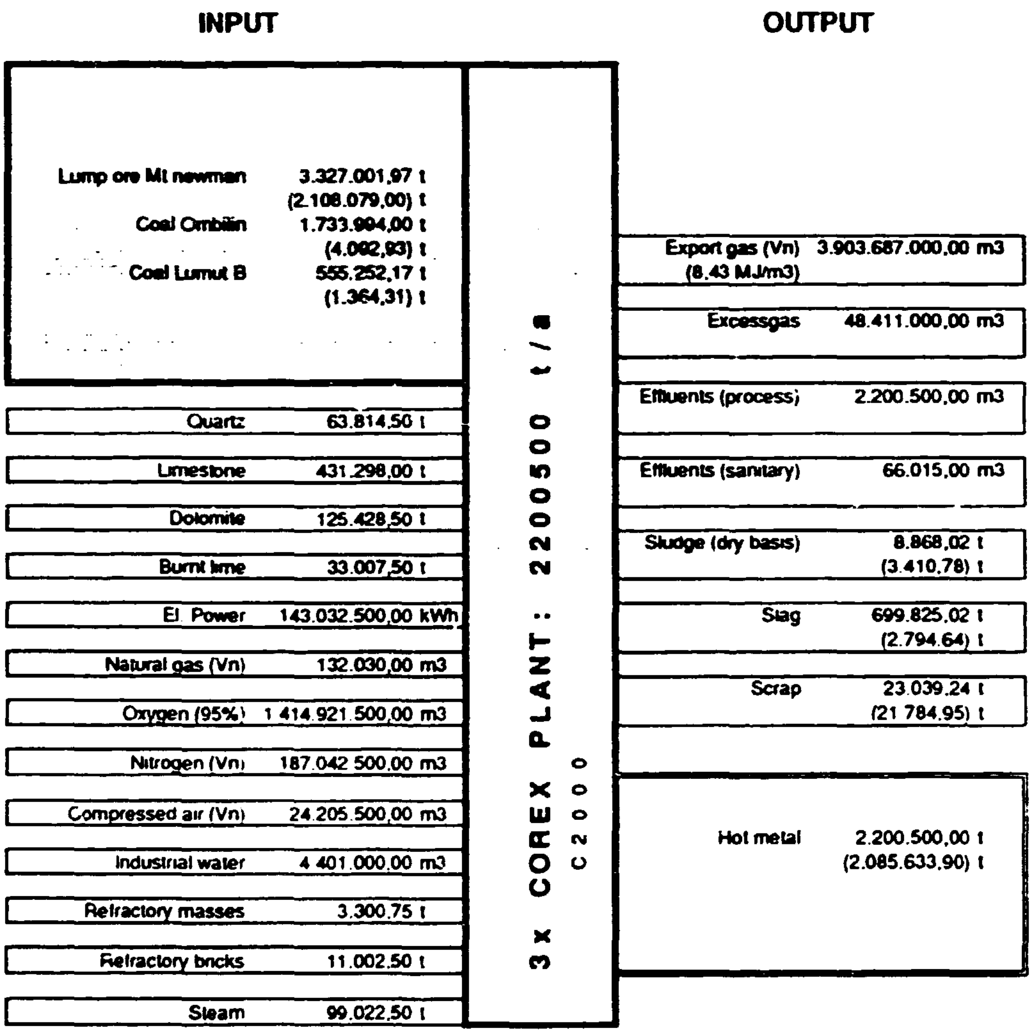


Fig. 40: **Specific Consumption Figures - LD-Plant (per tonne product)**

LD - PLANT CAPACITY: 2422500 t/a

INPUT

Hot metal	806,04 kg
	(763,96) kg
Pig iron	102,32 kg
	(96,98) kg
Lump ore	5,00 kg
	(3,10) kg
Scrap	179,40 kg
	(163,33) kg
Alloys	12,14 kg
	(12,14) kg
Dust	12,88 kg
	(9,23) kg
Scale	16,47 kg
	(11,58) kg
Burnt lime	78,00 kg
Dolomit	5,00 kg
Industrial water	0,60 m3
Mixed gas (8.35 MJ/m3) (Vn)	10,00 m3
Nat. gas (35.0 MJ/m3) (Vn)	0,05 m3
Steam	7,00 kg
Oxygen (Vn)	55,40 m3
Nitrogen (Vn)	32,00 m3
Argon (Vn)	1,50 m3
Compressed air (Vn)	9,00 m3
Electric power	72,00 kWh
Refractories	11,00 kg
Electrodes	0,50 kg
DS-agent	15,00 kg

OUTPUT

Converter gas (Vn) (8.4 MJ/m3)	80,50 m3
Steam	60,00 kg
Dust	18,20 kg
	(12,76) kg
DS-slag	15,00 kg
Slag	100,00 kg
	19,50 kg
Scrap	18,57 kg
	13,00 kg
Losses	25,00 kg
	17,40 kg
Liquid steel	1,00 t

(metallic content in brackets)

Fig. 41: Annual Consumption Figures - LD-Plant

LD - PLANT CAPACITY: 2422500 t/a

INPUT

Hot metal	1.952.631,90 t (1.850.693,10) t
Pig iron	247.870,20 t (234.934,05) t
Lump ore	12.112,50 t (7.509,75) t
Scrap	434.596,50 t (395.666,93) t
Alloys	29.409,15 t (29.409,15) t
Dust	31.201,80 t (22.359,68) t
Scale	39.898,58 t (28.052,55) t
Burnt lime	188.955,00 t
Dolomit	12.112,50 t
Industrial water	1.453.500,00 m3
Mixed gas (8.35 MJ/m3) (Vn)	24.225.000,00 m3
Nat. gas (35.0 MJ/m3) (Vn)	121.125,00 m3
Steam	16.957,50 t
Oxygen (Vn)	134.206.500,00 m3
Nitrogen (Vn)	77.520.000,00 m3
Argon (Vn)	3.633.750,00 m3
Compressed air (Vn)	21.802.500,00 m3
Electric power	174.420.000,00 kWh
Refractories	26.647,50 t
Electrodes	1.211,25 t
DS-agent	36.337,50 t

OUTPUT

Converter gas (Vn) (8.4 MJ/m3)	195.011.250,00 m3
Steam	145.350,00 t
Dust	44.089,50 t (30.911,10) t
DS-slag	36.337,50 t
Slag	242.250,00 t (47.238,75) t
Scrap	44.985,83 t (31.492,50) t
Losses	60.562,50 t (42.151,50) t
Liquid steel	2.422.500,00 t

(metallic content in brackets)

Fig. 42: Specific Consumption Figures - Thin Slab Caster (per tonne product)

THIN SLAB CASTER CAPACITY: 2374500 t/a

INPUT

Liquid steel	1.020,21 kg
Electric energy	3.45 kWh
Casting powder	0,75 kg
Refractories	0.80 kg
Industrial water	0.40 m3
Air mist (Vn)	47.70 m3
Argon (Vn)	0,058 m3
Mixed gas (8.35 MJ/m3) (Vn)	1.25 m3
Oxygen (Vn)	0.073 m3
Grease	0.0204 kg
Oil	0.0307 kg

OUTPUT

Tundish skull	5,00 kg
Ladle skull	5,00 kg
Scale	(2,02) kg
Head /end crop, sampling losses etc.	(4,84) kg
Losses	5.68 kg (3.35) kg
Thin slabs	1,00 t

(metallic content in brackets)

E:\projekte\piks-bolphase-2\annex-3\corex-25.wp5

Fig. 43: Annual Consumption Figures - Thin Slab Caster

THIN SLAB CASTER CAPACITY: 2374500 t/a

INPUT

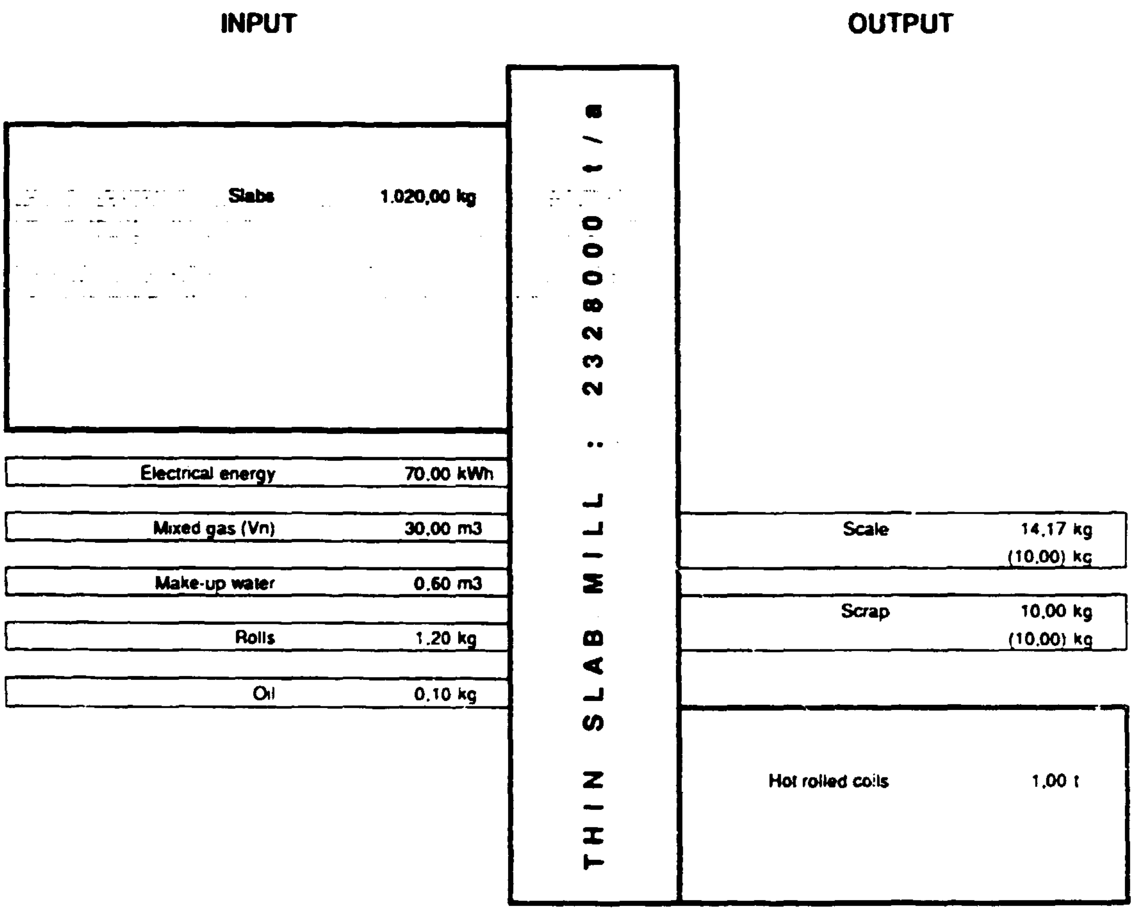
Liquid steel	2.422.488,65 t
Electric energy	8.192.025,00 kWh
Casting powder	1.780,88 t
Refractories	1.899,60 t
Industrial water	949.800,00 m3
Air mist (Vn)	113.263.650,00 m3
Argon (Vn)	137.721,00 m3
Mixed gas (8.35 MJ/m3) (Vn)	2.968.125,00 m3
Oxygen (Vn)	173.338,50 m3
Grease	48,44 t
Oil	72,90 t

OUTPUT

Tundish skull	11.872,50 t
Ladle skull	11.872,50 t
Scale	(4.796,49) t
Head /end crop, sampling losses etc.	(11.492,58) t
Losses	13.487,16 t (7.954,58) t
Thin slabs	2.374.500,00 t

(metallic content in brackets)

Fig. 44: Specific Consumption Figures - Thin Slab Mill (per tonne product)



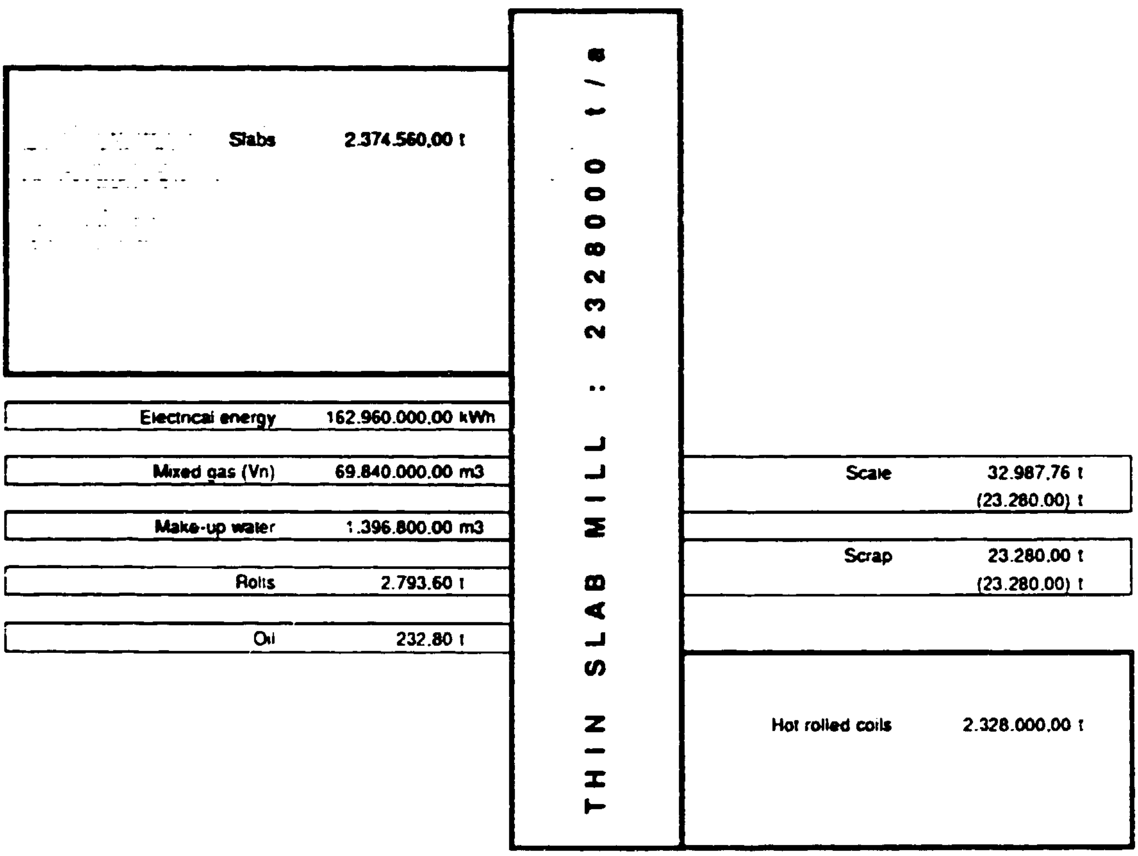
(metallic content in brackets)

E:\projekte\pks-bo\phase-2\annex-3\corex-25.wp5

Fig. 45: Annual Consumption Figures - Thin Slab Mill

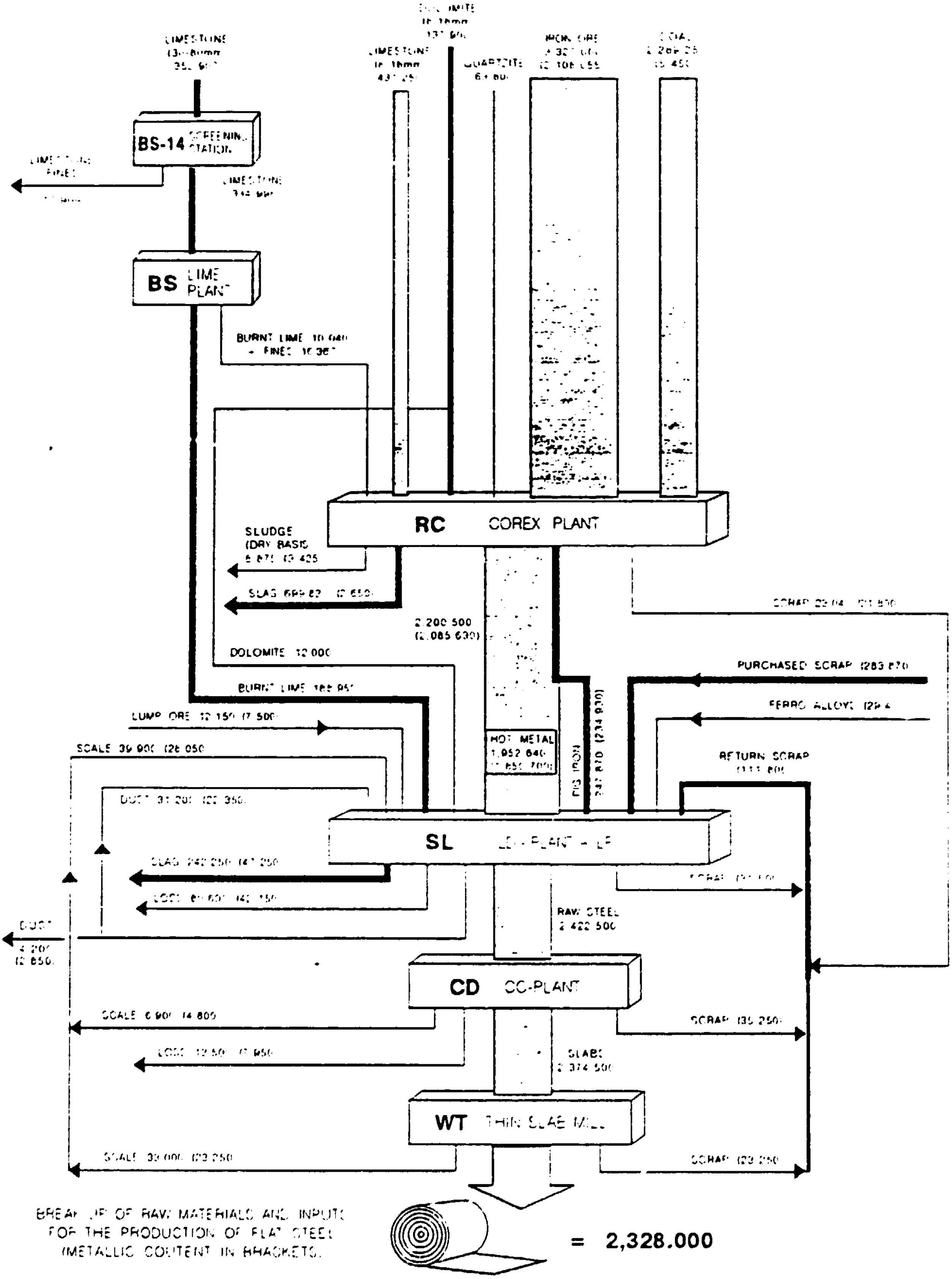
INPUT

OUTPUT



(metallic content in brackets)

Fig. 46: **Material Flow Sheet**



BREAK UP OF RAW MATERIALS AND INPUTS FOR THE PRODUCTION OF FLAT STEEL (METALLIC CONTENT IN BRACKETS)

Table 65: **Projection of quantities and cost of raw materials and supplies**

Description	Price per unit		unit	Annual	Annual
INPUTS:	local *)	CIF		consumption	costs
RAW MATERIALS:				(000 units)	(000 US$)
Limestone	10		t	784.2	7841.6
Iron ore		26.58	t	3,339.2	88,755.9
Dolomite	40		t	137.9	5,516.0
Scrap **)		137.5	t	283.9	39,032.1
Alloys		700	t	29.4	20,580.0
ENERGY:					
Electric energy	60		MWh	532.0	31,920.0
Coal (wet)	36		t	2,289.3	82,413.0
Natural Gas	0.088		m^3	248.3	21.8
CONSUMABLES:					
Refractory bricks I	1,200		t	11.6	13,950.0
Refractory bricks II		2,300	t	2.4	5,451.0
Refractory masses	650		t	30.8	20,021.6
Oxygen	0.036		m^3	1,549,301.0	55,774.8
Nitrogen	0.036		m^3	265,531.6	9,559.1
Argon	0.036		m^3	3,771.5	135.8
Compressed air	0.007		m^3	167,171.3	1,170.2
Water	0.02		m^3	11,600.0	232.0
Steam ***)			t	80.6	0.0
Electrodes		2,000	t	1.2	2,422.5
DS-agent		396	t	36.3	14,389.7
Casting powder		4,500	t	1.8	8,013.9
Grease	400		t	0.15	20.0
Oil, Gas oil, Gasoline	400		t	10.0	4,000.0
Rolls		3,500	t	2.8	9,777.6
Nozzles, other Refr.		2,100	t	1.9	3,990.0
TOTAL					424,988.6

*) Conversion rate 1 US$ = 2070 Rupiahs
**) Plus in-plant crap
***) Own production

2.8 TOTAL INVESTMENT COSTS

Table 66: **Total Investment Costs** (in 1,000 US$)

Items				
	2 COREX®	1 COREX®	Total	
Land	(80 ha) 24,000	(35 ha) 10,500	(115 ha) 34,500	
MAIN PLANT COMPONENTS				
COREX® plant	391,820	215,000	606,820	
LD-plant	265,570	106,228	371,800	
Continuous casting thin slabs	65,150	31,850	97,000	
Thin slab mill	263,230	11,770	275,000	
Sub-Total of main plant components	985,770	364,848	1,350,620	
OTHERS				
Lime plant	24,540	15,460	40,000	
Oxygen plant	81,570	37,430	119,000	
Integration facilities	192,320	41,680	234,000	
Sub-total plant	1,308,200	469,918	1,778,120	
Harbour and power plant	192,000	40,000	232,000	
Initial spare parts	16,660	5,067	21,727	
Insurance and freight	12,500	6,000	18,500	
Pre-production expenditures	121,070	49,560	170,630	
Initial net working capital	21,200	10,600	31,800	
TOTAL INITIAL INVESTMENT	1,671,630	581,145	2,252,775	

2.9 PROJECT IMPLEMENTATION SCHEDULE AND BUDGETING

The detailed implementation programme proposed for the realization of the project is shown in Fig. 47.

Also attached in Table 67 is the capital expenditures during implementation. Please note that considerable savings may be achieved timewise, if the project is contracted out as turnkey implementation. The current proposal is based on process key contracting with global sourcing.

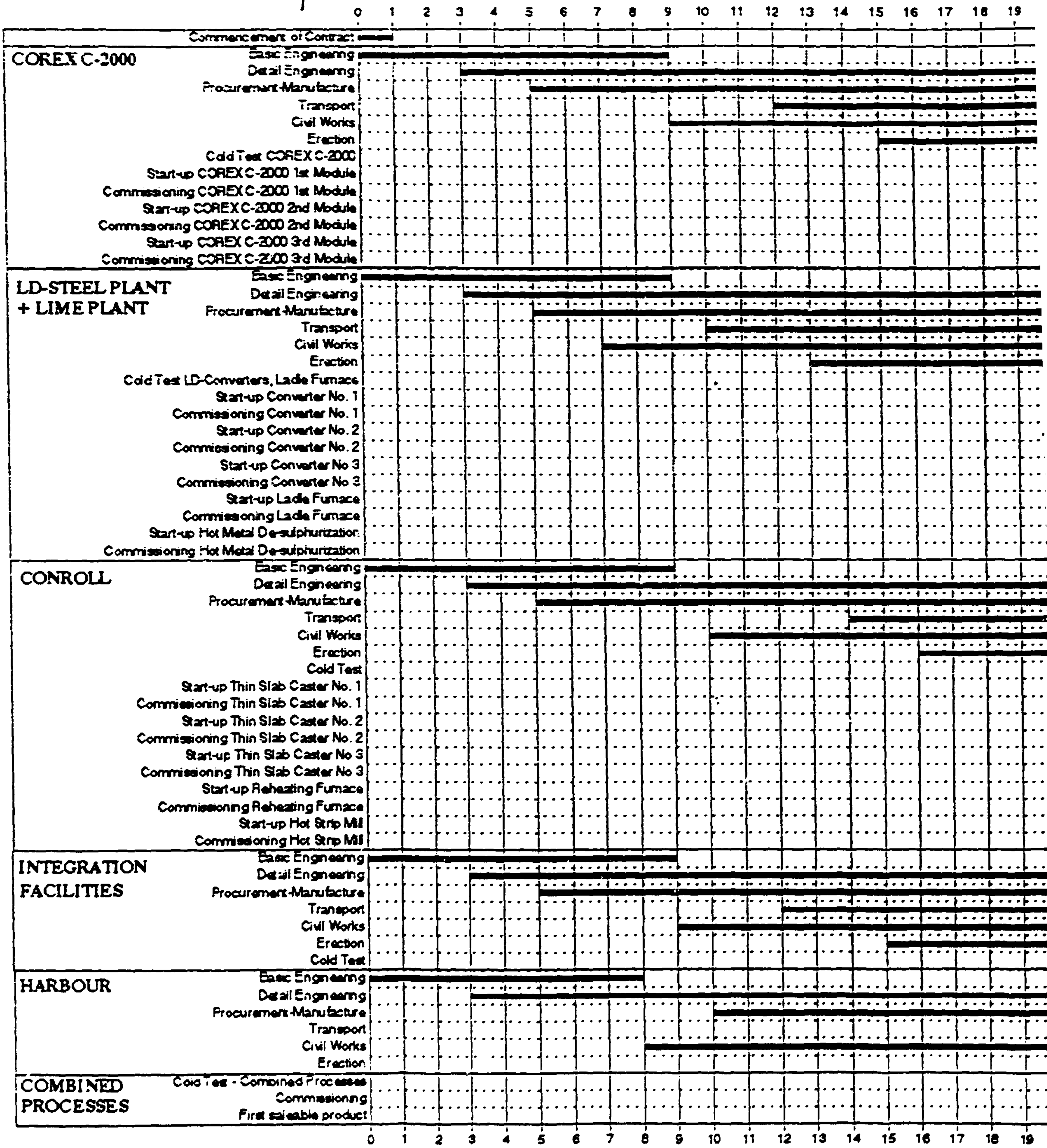
Some of the main assumptions made in drawing up the programme are that:

(a) Key personnel and resources would be available to start work
(b) All enquiries would be issued within the anticipated dates and the number of contracts would be kept to a minimum
(c) Enquiry documents would ensure that information received in offers would enable foundation and building drawing arrangements to be commenced without delay.
(d) Design would be staged so that construction could commence before final design is completed.

According to the programme, various executive activities, such as purchase of machinery and equipment, construction, buildings and other civil works, personnel recruitment and personnel training, delivery of machinery and equipment, and erection of machinery and equipment are planned to be undertaken according to a phased programme in order to achieve the best economic way of realizing the project.

To a considerable degree, delivery-schedules will depend on the location and identity of the manufacturers and other suppliers from which the machinery and equipment will be procured, based on global sourcing.

SECTION 1


0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
Commencement of Contract
COREX C-2000
Basic Engineering
Detail Engineering
Procurement-Manufacture
Transport
Civil Works
Erection
Cold Test COREX C-2000
Start-up COREX C-2000 1st Module
Commissioning COREX C-2000 1st Module
Start-up COREX C-2000 2nd Module
Commissioning COREX C-2000 2nd Module
Start-up COREX C-2000 3rd Module
Commissioning COREX C-2000 3rd Module
LD-STEEL PLANT + LIME PLANT
Basic Engineering
Detail Engineering
Procurement-Manufacture
Transport
Civil Works
Erection
Cold Test LD-Converters, Ladle Furnace
Start-up Converter No. 1
Commissioning Converter No. 1
Start-up Converter No. 2
Commissioning Converter No. 2
Start-up Converter No 3
Commissioning Converter No 3
Start-up Ladle Furnace
Commissioning Ladle Furnace
Start-up Hot Metal De-sulphurization
Commissioning Hot Metal De-sulphurization
CONROLL
Basic Engineering
Detail Engineering
Procurement-Manufacture
Transport
Civil Works
Erection
Cold Test
Start-up Thin Slab Caster No. 1
Commissioning Thin Slab Caster No. 1
Start-up Thin Slab Caster No. 2
Commissioning Thin Slab Caster No. 2
Start-up Thin Slab Caster No 3
Commissioning Thin Slab Caster No 3
Start-up Reheating Furnace
Commissioning Reheating Furnace
Start-up Hot Strip Mill
Commissioning Hot Strip Mill
INTEGRATION FACILITIES
Basic Engineering
Detail Engineering
Procurement-Manufacture
Transport
Civil Works
Erection
Cold Test
HARBOUR
Basic Engineering
Detail Engineering
Procurement-Manufacture
Transport
Civil Works
Erection
COMBINED PROCESSES
Cold Test - Combined Processes
Commissioning
First saleable product
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

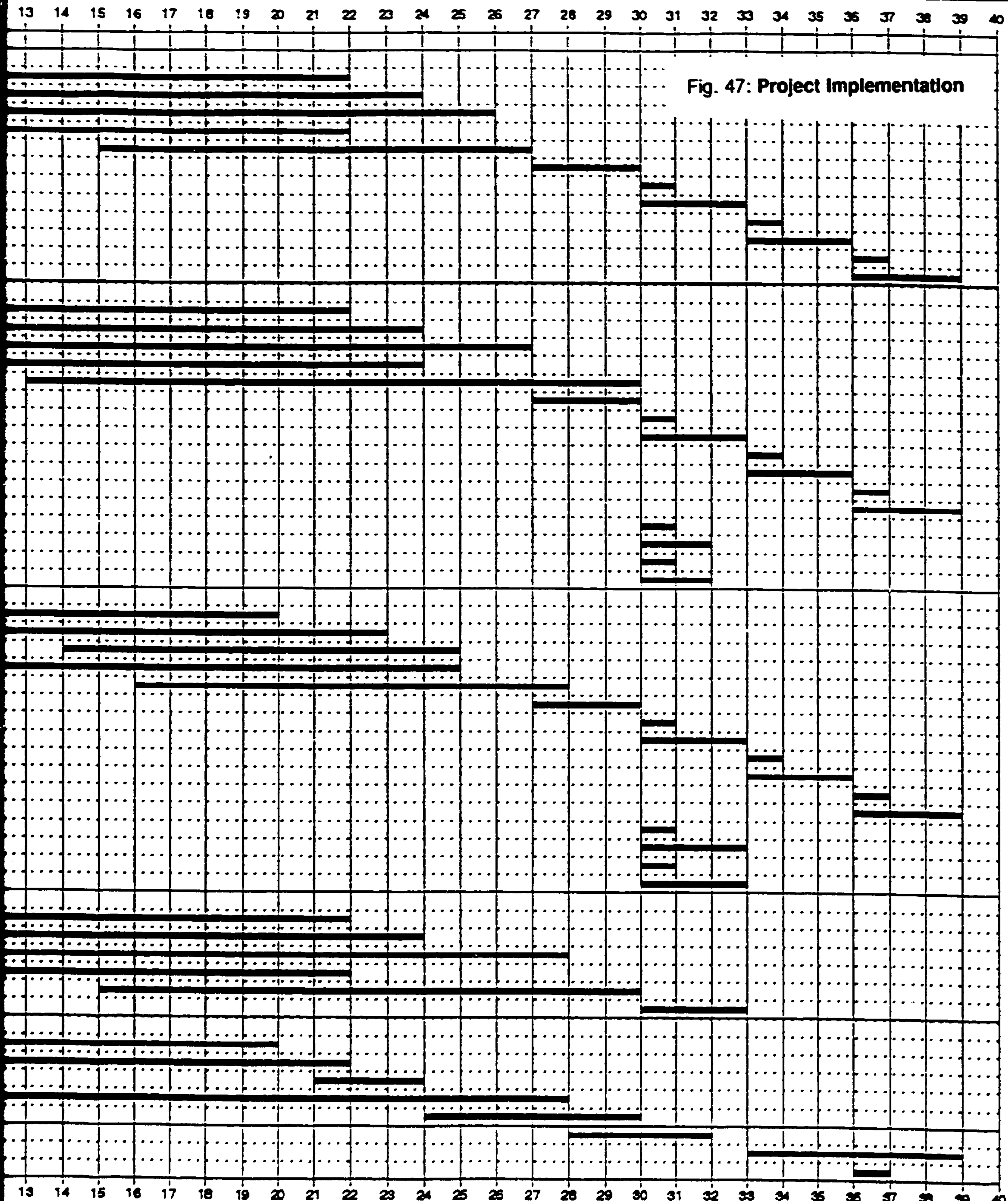


Fig. 47: **Project Implementation**

Table 67: **Implementation Budgeting in Mio US$**

Input Table (in million US$)	Half Years							Total
	1	2	3	4	5	6	7	
Foreign	1.304	63.986	246.677	303.740	293.295	191.809	183.271	1,284.082
Local	20.526	68.254	261.694	279.112	141.655	83.841	113.611	968.693
Total	21.830	132.240	508.371	582.852	434.950	275.650	269.882	2,252.775

3. SEA PORT

3.1 INTRODUCTION

P.T. Krakatau Steel operates harbour facilities consisting of:
1 Off Shore jetty (3 berths), water depth 14 m, equipped with:

- 4 Unloading bridges a 750 t/h unloading capacity (free digging rate)
- 2 berths (No.2 & 3) are used for bulk unloading (pellets and coal)
- berth No.1 was planned for dispatch of DRI
- Conveying System for bulk material, which only can serve berths No. 2 & 3 (2 lines of conveyors each having 1500 t/h capacity; conveyor width: 1.0 m, belt speed > 3 m/s. Berth No.2 only can transfer the bulk material onto one conveyor line)
- Max. vessel size 70 000 DWt

An increase of vessel size would be highly welcomed, but is limited due to following facts:

- further dredging (deeper than 14 m) is not possible, because of jetty structure.
- free height of unloading bridges is to low for larger vessel sizes.

To avoid any limitation on raw material supply (capacities and vessel sizes) it seems to be necessary to install new port facilities for the Second Generation Steel Mill.

In the following one of the possible solutions is indicated, however, before realization all necessary investigations and elaborations have to be carried out by experienced harbour builders to consider all local conditions and circumstances and also to define the best and most economic port location.

3.2 BASIC DATA

3.2.1 MATERIALS TO BE LOADED/UNLOADED

3.2.1.1 MATERIALS

- Bulk materials
  - Iron ore 3 600 000 t/a
  - Coal 1 840 000 t/a
  - Scrap 180 000 t/a (at the existing berth Cigading)
- Cargo at existing CIGADING site
  - Ferro alloys 30 000 t/a
  - Operating materials and consumables (like electrodes, refractories, carbon, alumina, etc.)
  - Spare parts
  - Product dispatch (if any)

3.2.1.2 SUPPLY CONDITIONS OF MATERIALS

- iron, ore
  supply: bulk, by vessels up to 150 000 dwt
  unloading: by bridge unloader

- coal
  supply:bulk, by vessels up to 150 000 dwt (possible, but average approx. 20 000 dwt-coastal shipment)
  unloading: by bridge unloader

- Scrap
  supply: bulk, by vessels up to 30 000 DWT
  unloading: level luffing crane

- Ferro alloys
  supply: in drums on pallets, by vessel
  unloading: level luffing crane

- All other materials
  supply: cargo condition
  unloading: level luffing crane

3.2.1.3 STORAGE CAPACITY

The storage capacity shall be designed as follows: To keep the working capital as low as possible the storage capacity should not be more than 1 month. On the other hand any arriving vessel has to be unloaded. Considering this, a minimum storing capacity of 2.5 vessels should be made available (except scrap).

- Ore yard

  Recalculation:
  monthly ore consumption:
  = 3 600 000 t/a : 12 months = 300 000 t/month
  2.5 vessels:
  = 150 000 t x 2.5 = 375 000 t

  selected storage capacity:
  considering two (2) ore origins a storing capacity of 400 000 t is recommended.

- Coal

  Recalculation:
  monthly coal consumption:
  = 1 840 000 t/a : 12 months = 153 000 t/month
  8 vessels:
  = 20 000 t x 8 = 160 000 t

  selected storage capacity:
  considering two (2) or more coal origins a storing capacity of 155 000 t is recommended.

- Scrap

  Recalculation:
  monthly scrap consumption:
  = 180 000 t/a : 12 months = 15 000 t/month
  1 vessel:
  = 30 000 t x 1 = 30 000 t

  selected storage capacity:
  a storing capacity of 45 000 t is recommended.

- Cargo
  storing areas already existing at Cigading site.

3.2.2 WORKING TIME AND TIME BALANCE

General down times (holidays) cannot be considered, because of the very expensive costs in case an ocean vessel have just to wait for unloading.

Bulk Unloading

For the Second Generation Steel Mill - 2.3 mn t/a HRC it is proposed to install a new bulk unloading harbour for the first step with one berthing facility for bulk carriers up to 150 000 dwt. succeeded by one berth for unloading scrap and general cargo with a capacity of 20 000 - 30 000 dwt. Two level luffing cranes cater to the unloading activities, a scrap yard is located at the head end of the harbour. Unloading itself shall be done by two (2) bridge unloaders having an average capacity of 1000 t/h each (= approx. 1400 t/h free digging rate). A corresponding conveying system leads the raw materials to the individual storage piles/sections.

The layout considers further extension, which allows installations of a further berth, bridge unloaders and corresponding storage area.

- Unloading bridges:
  - Ore: 3 585 000 t/a
  - Average vessel size (assumed) =120 000 dwt
  - No of vessels / a :
    = 3 585 000 t/a : 120 000 t/vess.= 29.87 V
  - Average berthing time (turnround time):
    = 120 000 t : 2000 t/h + 10 h = 70h
  - Berth occupation:
    = 70 h x 29.87 = 2 090 h

  - Coal: 1 927 000 t/a
  - Average vessel size (assumed) = 20 000 dwt
  - No of vessels / a :
    = 1 927 000 t/a : 20 000 t/vess.= 96.34 V
  - Average berthing time (turnround time):
    = 20 000 t : 2000 t/h + 10 h = 20h
  - Berth occupation:
    = 20 h x 96.34 = 1 926.84 h

  - Utilization of unloading bridges:
    = 4016.8 h : 330 d : 24 h/d = 50.7 %

Cargo Unloading

- Level luffing crane

• Scrap	180 000 t/a
• Average vessel size (assumed) =	10 000 dwt
• No.of vessels /a :	
= 180 000 t/a : 10 000 t/V. =	18 V.
• Average berthing time (turnround time) :	
= 10 000 t : 50 t/h * 2 pc + 10 h =	110 h
• Berth occupation :	
= 110 x 18 =	1 980 h
• General Cargo (assumed)	60 000 t/a
• Average vessel size (assumed) =	5 000 dwt
• No.of vessels /a :	
= 60 000 t/a : 5 000 t/V. =	12 V.
• Average berthing time (turnround time) :	
= 5 000 t : 20 t/h * 2 pc + 10 h =	135 h
• Berth occupation :	
= 135 x 12 =	1 620 h
• Utilization of level luffing cranes:	
= (1620+1980) h : 330 d : 24 h/d =	45 %

3.3 GENERAL CONCEPT

- Ore

Ore supplied by ocean vessels will be unloaded by bridge unloaders, which transfer the ore onto the pier conveyor.

Via further conveyors and the stacker/reclaimer units the bulk materials are stored onto the ore storage yard.
From there the ore is removed by the same stacker/reclaimer units and will be transported by conveyors to the individual consumers.
Another possibility is to transport the ore partly directly from the ocean vessel to the consumers.

- Coal

Coal supplied by ocean vessels/coastal ships will be unloaded by bridge unloaders, which transfer the coal onto the pier conveyor.

Via further conveyors and the stacker/reclaimer units the bulk materials are stored onto the coal storage yard.
From there the coal is removed by the stacker/reclaimer units and will be transported by conveyors to the consumers.
An other possibility is to transport the coal partly directly from the unloading bridge to the consumers.

- Scrap

Scrap delivered by ocean vessel or barges will be unloaded by means of the level luffing cranes and stored at the scrap yard of the harbour area. The transport to the scrap yard SGSM takes place by means of trucks.
A direct transloading from vessels/barges onto trucks by the level luffing cranes is also possible.

- Ferro alloys (as cargo)

Ferro alloys will be unloaded by means of the level luffing cranes and placed at an intermediate storage area. From there it will be transported by means of fork lift trucks/trucks to the storing positions.

- General cargo

General cargo is unloaded by level luffing cranes and directly transported to the individual warehouse.

- Auxiliary facilities

  To allow a smooth operation the sea port shall be provided with:
  * Tug boat facilities
  * Repair posts
  * Fuel and lubricant store
  * Spot laboratory
  * Office and locker building
  * Water supply distribution
  * Energy supply and distribution

3.4 GENERAL DESCRIPTION OF THE NEW HARBOUR

The new harbour shall have the following main facilities:
- 2 Tug boat facilities
- 4 Unloading facilities (unloading bridges and luffing cranes)
- 1 Raw material storage yard
- 1 Sample taking
- 1 Laboratory facilities
- 1 Repair posts
  * mechanical department
  * electrical department
  * vehicle repair
  * spare part store
- 1 Lubricant store
- 1 Automation and communication system
- 1 Administration/locker building
- 1 Fire alarm system
- 7 Road transportation trucks for scrap transport
- 1 Fuel station
- 1 Utility supply and distribution
- 1 Energy supply & distribution

As indicated in the list above equipment for sample taking is provided.
This automatic sampler can be adjusted to a sample schedule. For evaluating the samples a spot laboratory is located at the transformer station, where the following tests for the raw material can be carried out:

- humidity
- grain size
- compressive strength

In case further physical or chemical analyses are required, the samples will be pretreated to carry out the necessary analyses at the plant site's central laboratory.

3.5 MANPOWER

For the operation of the harbour the following personnel is required (including running maintenance, vacation and sick leave:

Category 1:	4 persons
Category 2:	12 persons
Category 3:	65 persons
Category 4:	28 persons

3.6 COST ESTIMATE

Civil works	US$	165 mn
Unloading equipment, transport, vehicles, laboratory equipment, tugboats	US$	59 mn
Total harbour	US$	224 mn

Not included in above are costs for offshore dredging.

4. ANALYSIS AND ASSESSMENT OF THE OPTIMIZATION POTENTIAL BETWEEN THE EXISTING FACILITIES OF P.T. KRAKATAU STEEL AND THE PROPOSED FACILITIES OF THE SECOND GENERATION STEEL MILL WITH A PRODUCTION VOLUME OF 1.5 mn t/a HRC

4.1 INTRODUCTION

P.T. Krakatau Steel has currently embarked on modernization and expansion programme to increase its production to a level of approx. 2.3 mn t/a of hot rolled coil. It is expected that this programme will be finished within the first half of 1994.

Within the scope of the expansion programme two additional facilities are to be highlighted viz

- Installation of a double shaft direct reduction facility (HYL III) with a capacity of 1.30 mn t/a DRI
- Installation of a second slab steel plant (SSP II) with a capacity of 800 kt/a slabs.

Furthermore modifications of several facilities with the aim to increase capacity and improve quality are under progress.

All of the above has to be accompanied by an improvement of the infra-structural facilities.

Most notable are

- Increase of electric power supply. With the installation of an additional transmission line of 220 MVA capacity from the PLN power grid, PTKS will dispose of 380 MVA electric power from the public grid in addition to the approx. max. 500 MVA of its own power plant

- Extension of Cigading harbour facilities. With the extension of the pier by approx. 220 m with relevant unloading facilities, PTKS expects to double the capacity of the harbour from current 3 mn t/a to 6 mn t/a.

Within this environment the Second Generation Integrated Steel Mill is being planned to complement the then enlarged PT Krakatau Steel Plant with a capacity of then up to 3.8 mn t/a of HRC with an additional 1.55 mn t/a HRC. It is to be noted that capacitywise the Indonesian market will only require hot rolled coils of this quantity in the long term.

Sheer capacity considerations therefore cannot be the basis to justify the implementation of the SGSM, but rather two outside factors, viz.

- Price of natural gas: All current expansion and modification programmes of PTKS are based on the continuation of the DRI - EAF process route, which is heavily dependent on the supply of N.G. and electric energy at competitive prices. There is strong evidence that the price for natural gas may be doubled or even tripled once the current supply contract expires. It is also to be expected that the price for electric energy will also suffer from an increase analogously. The current modification programmes aiming also at energy conservation will certainly bring about a significant decrease of specific consumption, but certainly not enough to compensate for the price increase.

- Market assessment: The market assessment contained within the UNIDO report shows a demand of narrow to medium wide primarily cold rolled strip, therefore requiring relatively thin gauge HRC. It is questionable, whether this product may be produced economically on the current 88" wide hot strip mill even facilitating the envisaged modifications and expansions as compared to a modern 56" wide hot strip mill primarily designed for the purpose to produce HRC to be cold rolled thereafter.

It is under these aspects that the successive considerations have been established.

4.2 OBJECTIVES

It is the objective of this report to point out possible linkages between the existing PTKS Plant and the envisaged Second Generation Steel Mill with the aim of utmost utilization of existing facilities and possible interaction between the two plants with the aim to streamline costs for
- energy
- utilities
- infrastructural facilities
- manpower
- administration

4.3 OPTIMIZATION

4.3.1 ENERGY

4.3.1.1 NATURAL GAS - COREX® GAS

In general there are two approaches to save costs for external energy by utilizing the accruing COREX® gas from the SGSM within PTKS.

- Substitution of natural gas in the direct reduction units and there especially for heating purposes such as the steam reformers and heating of the washed reduction gases

- Utilization of the COREX® gas for heating the boilers in the PTKS captive power plant:
  1.5 billion Nm^3/a COREX gas with a

heat content of	21,105,200.0 GJ/a	
or	2,546.5 GJ/h (GWs/h)	
equal to	$\frac{2,546.5\ (GWs/h)}{3,600.0\ (s/h)}$	$= 0.7\ GW_{therm}$

Assuming an efficiency rate of 35 % in the power plant:
Production of electric energy: 0.35 x 700 = 247.5 $MW_{electr.}$
Thereof used in the SGSM: approx. 147.5 MW
Available for PTKS: 100 MW
Depending on the price policies of the external energy suppliers either of the two options may be utilized for cost saving in the SGSM or at PTKS. Yet another aspect needs to be considered: If the expansion programme is realized to the end, i.e. a production of 3.25 mn t/a DRI rendering 4 mn t/a crude steel, there will be no more natural gas available to power the electric power plants due to limited supply (137 mm scf/d).

4.3.1.2 ELECTRIC ENERGY SUPPLY

As has been indicated, by the installation of a second transmission line the available capacity will be 380 MVA from external sources and 500 MVA from the captive power plant. Assuming that this supply amount will be completely consumed by the enlarged and modified facilities of PTKS, yet another transmission line will have to be installed to feed the SGSM, or better yet, considerations need to be made to install a combined cycle power plant (CCPP) 2 x 125 MVA as captive power plant for the supply of the SGSM and in part of PTKS. The input for this CCPP could then be COREX® gas and in part natural gas.

4.3.2 UTILITIES

4.3.2.1 WATER

The plant operational availability of water at Krenceng amounts to 7,200 m^3/h. With the ongoing expansion and modernization programme coming on stream, the expected water demand from current 3,000 m^3/h will rise to approx. 5,500 m^3/h. The SGSM's water consumption has been assessed with approx.

1,000 m^3/h. The water facilities at Cidanau and Krenceng therefore will be sufficient to also supply the SGSM.

4.3.2.2 STEAM

During production the SGSM is self sufficient regarding steam supply through the heat recovery in the LD Plant. However, during start up procedures in the SGSM, steam has to be supplied from a captive steam boiler with approx. 12 t/h output. Since far larger facilities are in operation at PTKS, it is proposed to eliminate this boiler plant at the SGSM in lieu of a supply line from the PTKS plant to deliver steam during the start up phases of the SGSM.

4.3.2.3 INCOMBUSTIBLE GASES

No interface between the two plants justifiable

4.3.2.4 COMPRESSED AIR

No interface between the two plants justifiable

4.3.3 INFRASTRUCTURAL FACILITIES

4.3.3.1 HARBOUR

As has been indicated in chapter 3 a new harbour next to Cigading is required to handle the raw materials' supply for the SGSM. The existing harbour including the extension programme under way to safeguard the unloading and loading of raw materials and supplies within the scope of the current modernization and expansion programme, however, is not in a position to fulfil the relevant requirements of the SGSM with one exception:

The scrap requirements of the SGSM with a capacity of 2.55 mn t/a amount to 237.6 kt/a. According to a utilization assessment of the expanded harbour facilities, it appears feasible to further utilize these facilities for unloading the scrap required for the SGSM and also handle it through the common scrap yard.

4.3.4 MANPOWER

At present approx. 9,300 persons are employed by PT Krakatau Steel. This figure is very high by any standards in relation to production and is explained that PTKS also indulges in numerous other activities having little or nothing to do with steel production (see also the following chapter). However, one major item favouring the decision to implement the SGSM next to the existing facilities had been the availability and ready exchange of trained personnel between the two plants. The personnel requirement for the SGSM amounts to 2500 persons in operational activities and 375 persons for administration. The latter numbe, - no doubt - may be drawn from personnel currently engaged in the pursuit of not steel related activities but familiar with administrative work. The production departments of PTKS currently employ approx. 6000 persons. It is to be assumed that a detailed job assessment also will find experienced personnel available for the SGSM.

The employment rate of PTKS relieved from extracurricular activities and the SGSM may therefore be expected not to rise considerably above the current figures.

4.3.5 ADMINISTRATION AND OVERHEADS

Without question numerous administrative activities may jointly be executed for both plants or within separate departments contained in one operational unit to reduce administrative costs and overheads. Such activities may be related to

- Head Office and General Management
- Planning Division
- Production Division
- Personnel Directorate
- Financial Division
- Marketing Division
- Technology Division
- Logistic Directorate

The purpose of such an approach is not only to reduce costs in the operation of the business units as such, but far more important to adjust the activities of either plants for optimal synergetic results.

PTKS has already embarked on an organizational restructuring programme to comply with the requirements of the ongoing modernization and enlargement activities of the plant. Attention should be paid already now to organizational structures which will then - once the SGSM will be implemented - also comply with the requirements of management of both plants.

The present restructuring programme includes:

- Corporate restructuring
  - Reduction of unrelated or low leverage activities to focus on the scarce resources on core business activities (outsourcing of activities non steel related).
  - Streamline processes to improve management efficiency

- Operations restructuring
  - Improvement of production unit efficiency
  - Enhance production system (process flow)

- Organization restructuring
  - Improvement of management effectiveness (relinquishment of bureaucratic procedures)
  - Reduction of organizational costs

4.4 SCENARIOS OF COMBINATION BETWEEN PTKS AND THE SGSM

4.4.1 BASIS

In a growing competitive market with increasing import pressure the project has to aim at quality and price leadership in the sector of high quality flat products mainly for domestic markets (it has to satisfy Indonesia's domestic flat steel demand after the year 2000) and possibilities for export.

For the year 2000 a flat steel demand of 3.634 million tonnes is expected. For the year 2005 a demand of 4.562 mnt/a and for the year 2010 a demand of 5.488 mnt/a flat products is forecast.

The requirements which have to be fulfilled by the SGSM can be simplified as follows:

- Satisfy market demand of flat products in Indonesia in the decade after 2000 (quantity and quality wise)

- Make optimal use of existing facilities of PTKS.

- Total production quantity HRC required in the year 2000 is 3.634 mnt/a, in 2005 it will be 4.562 mnt/a and in 2010 5.488 mnt/a. Consequently combined HRC capacity of the existing PTKS and the SGSM should be 3.5 mnt/a for the year 2000 (taking into consideration also the installed capacities of the re-rollers producing plate).

- From 1998 onwards production of sponge iron by the Hyl I process will be uneconomic, due to the threefold increase of the price of natural gas.

- Scarcity in supply of natural gas and electric power will continue.

- Phasing of investment if possible.

In the following table various factors influencing the technological combination of the SGSM with the existing PTKS are defined and their importance for the project is classified into high - medium - low:

Table 68: **Graded Matrix**

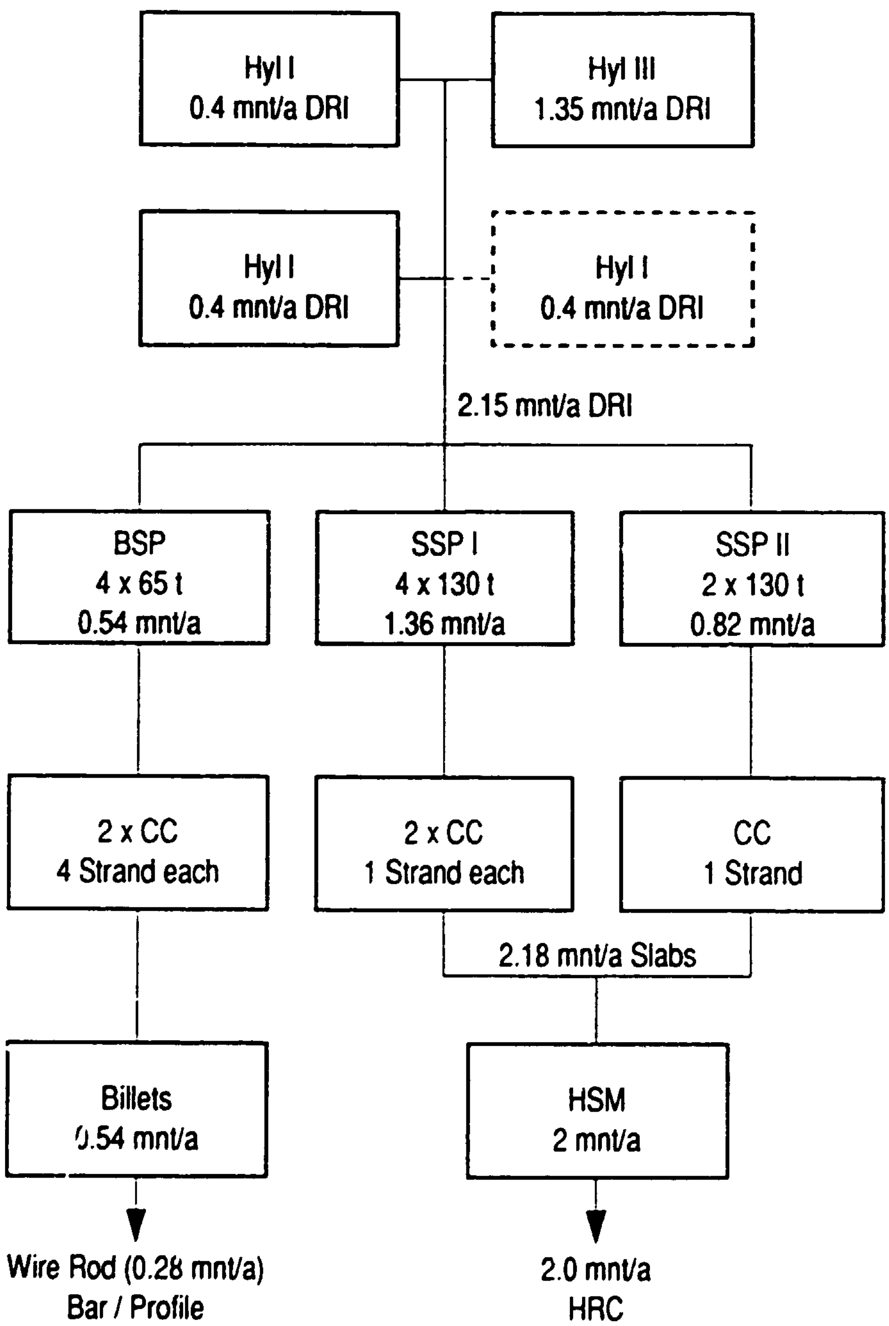
Factor	Importance for the SGSM		
	High	**Medium**	**Low**
Integration PTKS-SGSM	x		
Satisfy Market Demand regarding			
- Capacity	x		
- Quality	x		
- Flexibility	x		
Optimum Capacity Utilisation of existing			
- Gas Supply		x	
- Steel Slab Plant I (SSP I)		x	
- Steel Slab Plant II (SSP II)		x	
- Hot Strip Mill (HSM)	x		
- Billet Steel Plant (BSP)		x	
Extension of existing			
- Steel Slab Plant I			x
- Steel Slab Plant II			x
- Hot Strip Mill		x	
- Billet Steel Plant			x
New Hot Strip Mill (conventional)		x	
Thin Slab Casting/Rolling	x		
Use of Indigenous Raw Materials	x		
Low Impact on Power Grid	x		
Possibility of Extension with market demand	x		

4.4.2 POSSIBLE TECHNOLOGICAL VARIANTS

As can be seen from the above, highest priority was put on fulfilment of market requirements (capacity, quality, flexibility and possible extension with market demand) and the use of indigenous raw materials, on a low impact on the power grid and on the introduction of the energy saving technology thin slab casting and rolling.

The production capacities which are available at the existing plants of PTKS, after the present expansion projects are concluded, are presented in the following block-diagram.

Fig. 48: **Production Figures of PTKS (after ongoing expansion projects)** (as stated by PTKS)



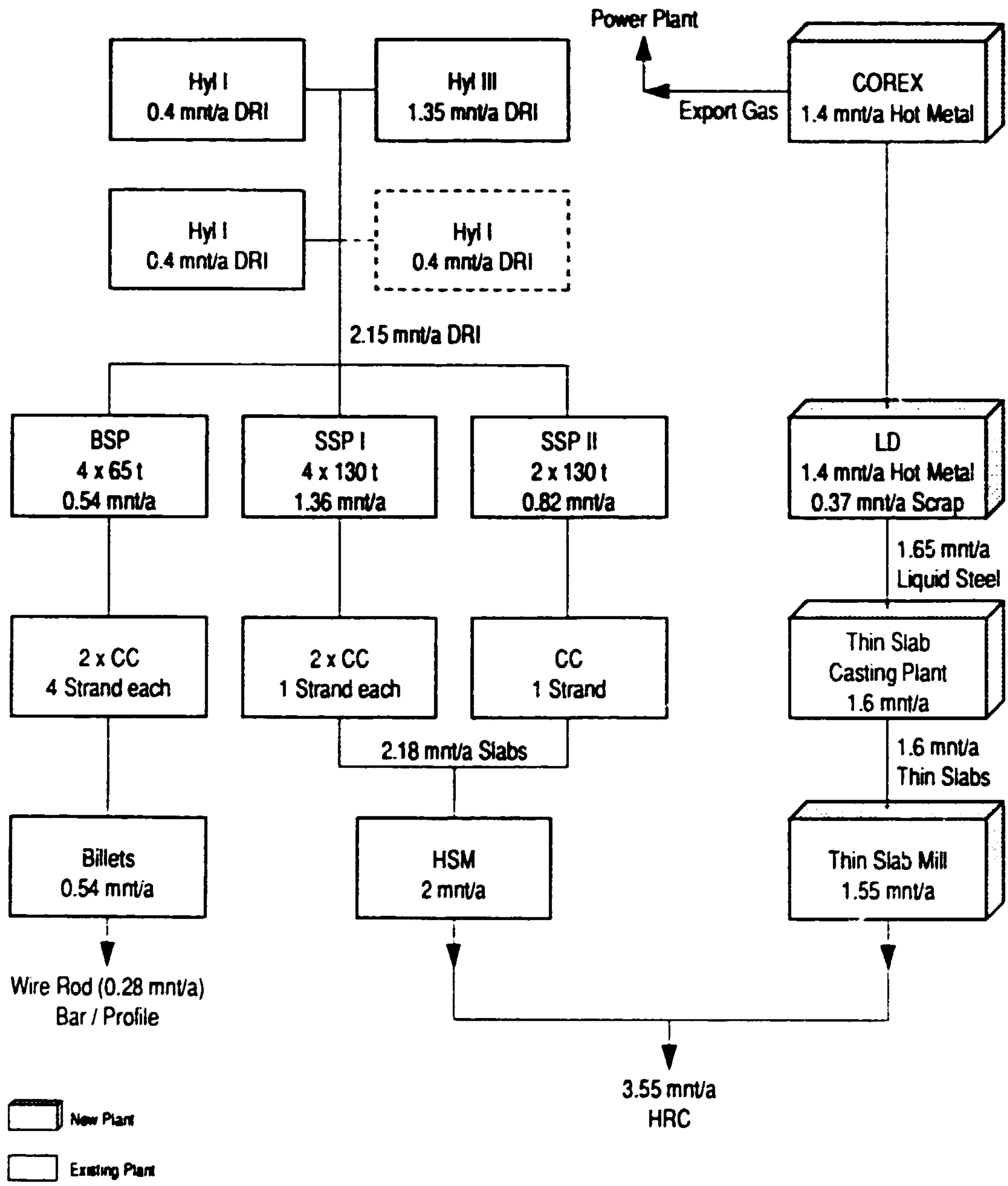
Principally, the main areas of integration of the existing PTKS plant and the SGSM are on the one hand the infrastructure (harbour, utility supply etc.) and on the other hand the production programme of the rolling mill.

The present Hot Strip Mill (HSM) of PTKS is designed to roll coils (HRC) up to a maximum width of 2 200 mm (rated 88 inch), the present production structure shows that more than 50 % of production is in the width-range of 820 to 1 320-mm (thickness-range of 1.8 to 6.0 mm) due to imminent requirements of the downstream processing industry.

Herein, production peaks are given between 1 020 mm to 1 320 mm width and 1.8 to 2.0 mm thickness. Compared to the rated capacity (for larger reference width and thickness) productivity of the mill drops significantly at this low-end of the product range. The maximum width rolling capacity installed (i.e. 88 inch equivalent approx. 2 200 mm) is only being utilized for a minor volume of production - though a higher »latent demand« for these wide strip products at a thickness > 6.0 mm is certainly manifest and will grow in the future.

With regard to the above the new rolling mill of the SGSM is suggested for a maximum production width of 56 inch (equiv. 1 420 mm) and to concentrate the product mix on cold rolling feed stock (50 % < 2 mm to 2.55 mm thickness). By this measure the existing (No. 1) Cilegon HSM will become available for an increased share of wide strip production > 1 400 mm width and > 3.8 mm thickness thus increasing productivity output and sales revenues and decreasing allocated fixed costs.

Fig. 49: Integration SGSM (COREX 1.55 mnt/a HRC) with existing PTKS (with existing Hyl I and Hyl III)



Taking into consideration the termination of the present gas supply contract of PTKS in 1998 and the expected increase of the gas price (approx. 3 times the present value), the possibilities to replace the uneconomic Direct Reduction Modules Hyl I by other technical means is proposed. This replacement increases the production of sponge iron. Since the capacity of the flat side is already fully utilized this additional sponge iron can be used for an increase of the production of long products.

Fig. 50: **Integration SGSM (COREX 1.55 mnt/a HRC) with PTKS**
(Replacement Hyl I Modules by Hyl III)

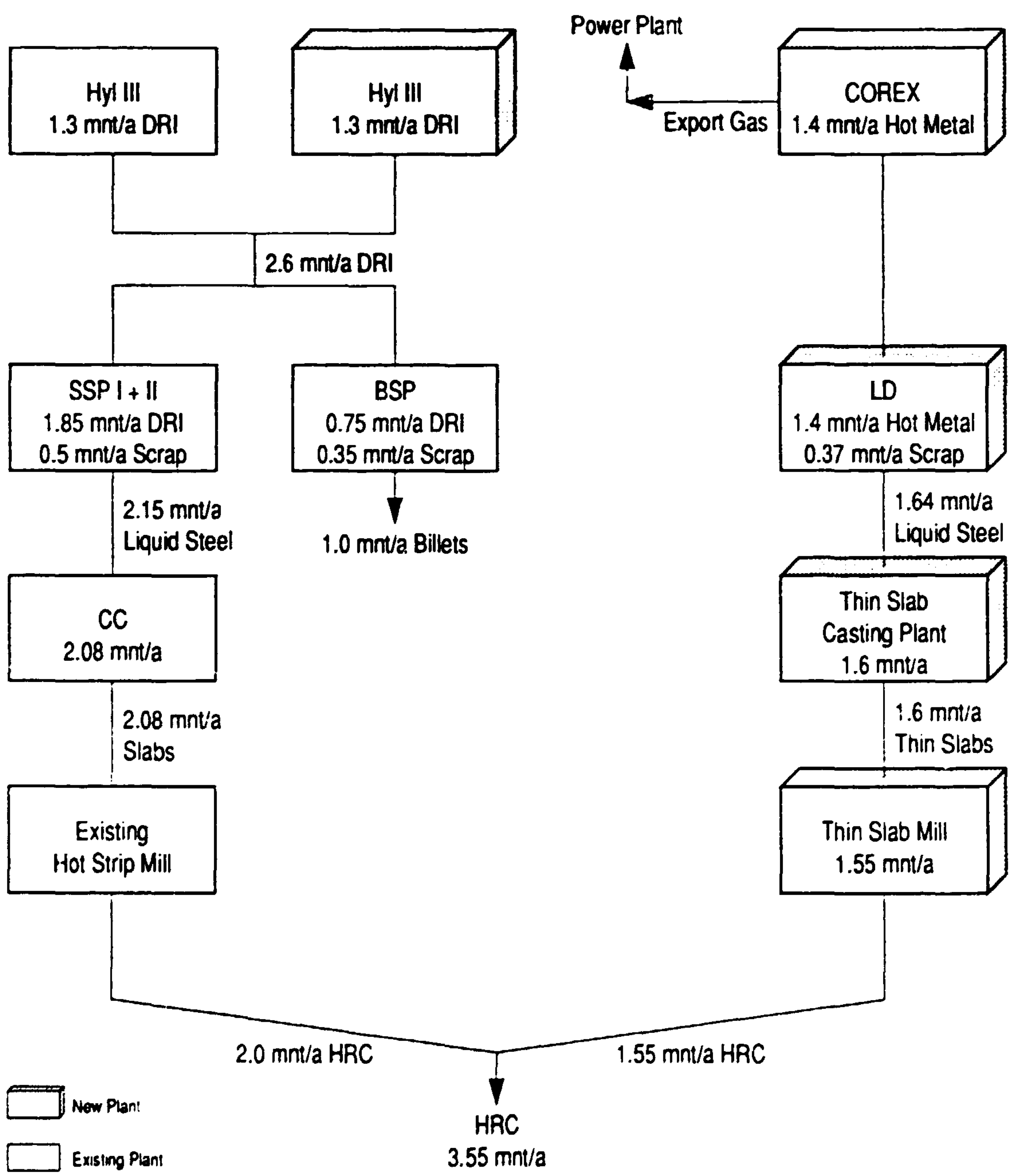
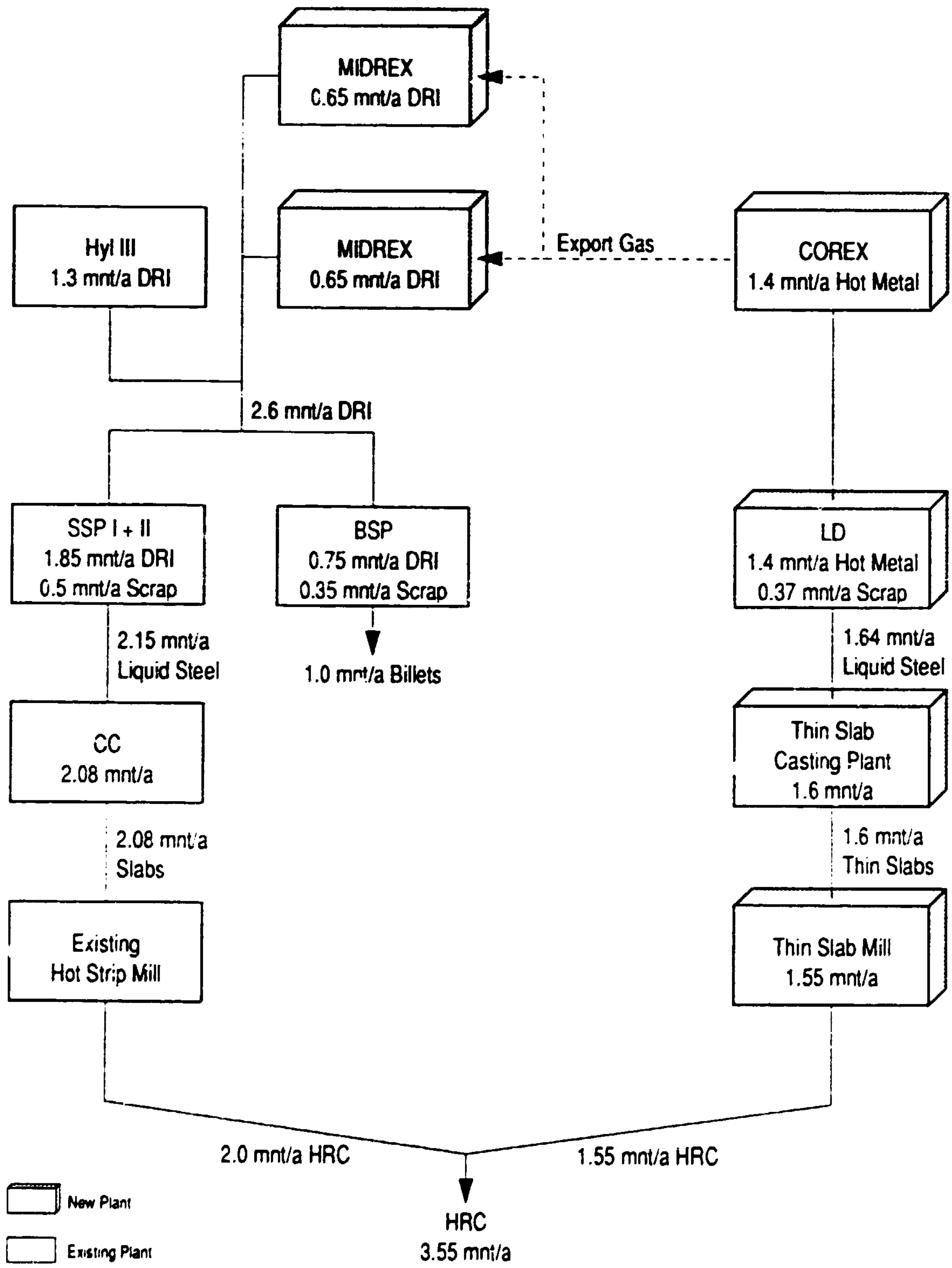


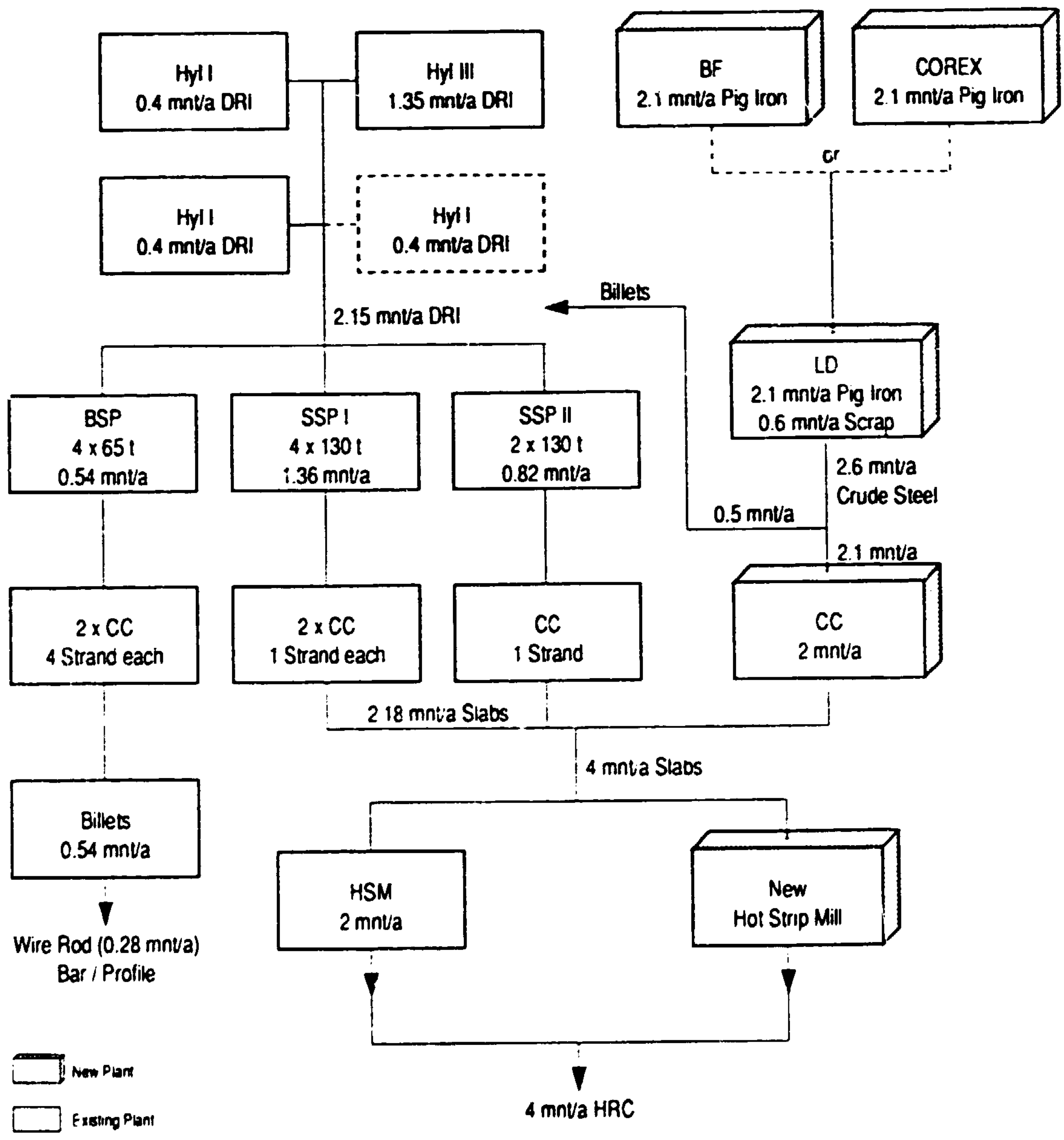
Fig. 51: Integration SGSM (COREX 1.55 mnt/a HRC) with PTKS (Replacement Hyl I Modules by MIDREX)



E:\projekte\ptks bo\phase 2\annex 3\corex-25.wp5

In two techno-economic elaborations the case of the production of 2.5 mn t/a crude steel by the Blast Furnace and the Direct Smelting Route have been described (chapter 1 and 2). The relevant production figures, the use of the crude steel production for long and flat products and the revenues for the products to be expected were proposed by the National Steering Committee.

Fig. 52: **Integration SGSM (2.5 mnt/a Crude Steel) with existing PTKS**
(as advised by NSC)



4.5 CONCLUSION

In depth investigations are currently under way executed by outside Consultants to optimize and adjust the present performance of FTKS to the requirements and needs of the ongoing modernization and expansion project. It is the aim of this chapter to point out in a descriptive form the additional requirements and needs of organization and operation should the SGSM be implemented neighbouring to the facilities of PT Krakatau Steel.

PLANT LAYOUTS

BANKABLE FEASIBILITY STUDY FOR THE ERECTION OF A SECOND GENERATION INTEGRATED STEEL MILL IN WEST OR EAST JAVA

UNIDO CONTRACT Nº 92/096
PROJECT Nº: US/INS/91/183
ACTIVITY CODE: J 14101

ENGINEERING AND TECHNOLOGY DESIGN FINAL REPORT FOR OUTPUT 2

prepared by

CONSORTIUM
AUSTROPLAN
VAI

September 1993

BANKABLE FEASIBILITY STUDY FOR THE ERECTION OF A SECOND GENERATION INTEGRATED STEEL MILL IN WEST OR EAST JAVA

UNIDO CONTRACT Nº 92/096
PROJECT Nº: US/INS/91/183
ACTIVITY CODE: J 14101

ENGINEERING AND TECHNOLOGY DESIGN FINAL REPORT FOR OUTPUT 2

prepared by

CONSORTIUM
ÖSTERREICHISCHE PLANUNGSGES. M. B. H.
AUSTROPLAN
AUSTRIAN ENGINEERING COMPANY LIMITED
VAI

September 1993

INDEX

1.	**GENERAL ROUTE DESCRIPTION**	1
1.1	BASIC MATERIALS FOR IRON AND STEELMAKING	2
1.2	COREX® PLANT	2
1.3	STEELMAKING PROCESS	3
1.4	THIN SLAB CASTING	4
1.5	HOT STRIP ROLLING 56"	4
2.	**GENERAL TECHNICAL DATA AND PROCESS DESCRIPTION**	5
2.1	COAL DRYING	5
2.2	COREX® PLANT	6
2.2.1	PROCESS DESCRIPTION	6
2.2.2	ENVIRONMENTAL ASPECTS	12
2.2.3	COREX® BASIC FLOW SHEET	14
2.2.4	PERFORMANCE CALCULATION	15
2.2.4.1	YEARLY PRODUCTION TIME	15
2.2.4.2	AVAILABILITY	15
2.3	STEEL MELT SHOP	41
2.3.1	PROCESS DESCRIPTION	41
2.3.2	PERFORMANCE CALCULATION	46
2.3.2.1	YEARLY PRODUCTION TIME (see item 2.2.4)	46
2.3.2.2	BASIC DATA	46
2.3.2.3	ANNUAL OUTPUT	47
2.3.3	MAIN EQUIPMENT AND MACHINERY	48
2.3.4	EQUIPMENT LIST OF LD-PLANT	56
2.4	THIN SLAB CASTING - DIRECT ROLLING	60
2.4.1	GENERAL ROUTE DESCRIPTION	60

E:\projekte\ptis-bo\phase-2\tech-desc\5-8.wp5

2.4.1.1 CONTINUOUS CASTING 60
2.4.1.1.1 Hot Strip Rolling 56" 60
2.4.2 THIN SLAB CASTING AND ROLLING PLANT 62
2.4.2.1 CONTINUOUS CASTING PLANT 62
2.4.2.1.1 Basic Technical Data 62
2.4.2.1.2 Main Machinery and Equipment 63
2.4.2.2 HOT ROLLING MILL FOR THIN SLABS 68
2.4.2.2.1 Basic Technical Data 68
2.4.2.2.2 Description of Proposed Equipment 69
2.5 LIME PLANT 85
2.5.1 PROCESS DESCRIPTION 85
2.5.2 BASIC DATA 87
2.5.3 MAIN MACHINERY AND EQUIPMENT 90
2.5.4 EQUIPMENT LIST (LIME PLANT) 97
2.6 INTEGRATION FACILITIES 99
2.6.1 PRE-PRODUCTION FACILITIES 99
2.6.1.1 IH 12 Raw material storage yard 99
2.6.1.2 IH 14 Scrap handling and treatment 99
2.6.2 PERIPHERAL FACILITIES 100
2.6.2.1 IH 46 Air separation plant for 2 corex® modules 100
2.6.2.2 IH 48 Slag handling and treatment 105
2.6.2.3 IH 49 Scale Handling and Treatment 106
2.6.3 MAINTENANCE AND STORES 106
2.6.3.1 IH 51 Central Mechanical Workshop 106
2.6.3.2 IH 52 Central Electrical/Electronic Workshop 107
2.6.3.3 IH 53 Central Mechanical Workshop 108
2.6.3.4 IH 54 Store for Spare Parts and Consumables 108
2.6.3.5 IH 57 Central Refractory Store 109
2.6.3.6 IH 58 Central operating parts store 109

2.6.4 INFORMATION 109
2.6.4.1 IH 61 Planning System/Management Info 109
2.6.4.2 IH 63 General Instrumentation 109
2.6.4.3 IH 64 Basic Automation 109
2.6.4.4 IH 67 Central Laboratory 110
2.6.5 INFRASTRUCTURE AND AUXILIARY EQUIPMENT 110
2.6.5.1 IH 71 Administration Building 110
2.6.5.2 IH 73 Locker Building & Canteen 110
2.6.5.3 IH 74 First Aid & Security Device 110
2.6.5.4 !H 75 Fire Alarm & Fighting System 110
2.6.5.5 IH 77 Road Transport 111
2.6.6 IH 77 Road Transport 113
2.6.7 IH 8 UTILITY SUPPLY / TREATMENT 114
2.6.7.1 IH 81 Water Supply / Treatment 114
2.6.7.2 IH 82 Water Circuits & Cooling Systems 117
2.6.7.3 IH 83 Incombustible Gases and Compressed Air 118
2.6.7.4 IH 86 Steam / Hot Water 126
2.6.7.5 ELECTRIC ENERGY 129
2.6.7.5.1 IH 91 High Voltage Facilities 132
2.6.7.5.2 IH 92 Low Voltage Facilities 132
2.6.7.5.3 IH 93 Electrical Equipment 132
2.6.7.5.4 IH 97 Lighting & Plug Socket System 132
2.6.7.5.5 IH 98 Lightning & Earthing System 132
2.6.7.5.6 IH 99 Other Electrical Equipment 132

3. **SEA PORT** 136
3.1 INTRODUCTION 136
3.2 BASIC DATA 137
3.2.1 MATERIALS TO BE LOADED/UNLOADED 137
3.2.1.1 MATERIALS 137

E:\projekte\pks-bolphase-2\tech-desc\5-8.wp5

3.2.1.2 SUPPLY CONDITIONS OF MATERIALS 137
3.2.1.3 STORAGE CAPACITY 138
3.2.2 WORKING TIME AND TIME BALANCE 139
3.3 GENERAL CONCEPT 141
3.4 GENERAL DESCRIPTION OF THE NEW HARBOUR 142
3.5 MANPOWER 143
3.6 COST ESTIMATE 143

4. **PLANT BALANCE** 144

5. **ORGANIZATION AND OVERHEAD COSTS** 156
5.1 GENERAL REMARKS 156
5.1.1 FOREWORD 156
5.1.2 ORGANIZATIONAL STRUCTURE AND STRATEGY 156
5.1.3 REASONS FOR DEVELOPING AN ORGANIZATION STRUCTURE 157
5.2 PROPOSED ORGANIZATIONAL STRUCTURE 157
5.2.1 CHOICE OF THE STRUCTURE 157
5.2.2 ORGANIZATION SCHEME 158
5.3 OVERHEAD COSTS 161
5.3.1 GENERAL 161

6. **MANPOWER** 162
6.1 GENERAL 162
6.2 PERSONNEL REQUIREMENTS 162
6.2.1 PLANT DEPARTMENTS 162
6.2.2 PERSONNEL CATEGORIES 163
6.2.3 OPERATION CYCLES 164
6.2.4 ADMINISTRATION MANNING TABLES 165
6.3 RECRUITMENT AND TRAINING 165
6.3.1 GENERAL REMARKS 165
6.3.2 TRAINING PROGRAMME 166

6.3.2.1 TRAINING PLAN 166

6.3.2.2 TRAINING ABROAD 167

6.3.2.3 ON SITE TRAINING DURING ERECTION, COMMISSIONING AND PRODUCTION BUILD-UP PERIOD 167

6.3.2.4 PERSONNEL TO BE TRAINED ABROAD 168

6.3.2.5 TRAINING COSTS 169

6.3.3 RECRUITMENT 170

7. **INITIAL FIXED INVESTMENT** 171

7.1 TOTAL INITIAL FIXED INVESTMENT 171

7.2 PRE-OPERATIONAL EXPENDITURES 171

7.3 WORKING CAPITAL REQUIREMENTS 172

7.3.1 INVESTMENT DURING PRODUCTION 173

8. **PROJECT IMPLEMENTATION SCHEDULE AND BUDGETING** 174

9. **PLANT STRUCTURE** 177

10. **PLANT LAYOUT** 179

E:\projekte\piks-bolphase-2\tech-desc\5-8.wp5

Tables

Table 1: Yearly Production Time ... 15
Table 2: Availability ... 15
Table 3: Equipment List of COREX®-Plant ... 38
Table 4: Equipment List of LD-Plant ... 56
Table 5: Equipment List (Continuous Casting Plant - Thin Slab) ... 67
Table 6: Reference Production Programme (Product Mix) in kt/a ... 82
Table 7: Equipment List (Thin Slab Rolling Mill) ... 83
Table 8: Equipment List (Lime Plant) ... 97
Table 9: Gas Productions ... 100
Table 10: Gas requirements ... 102
Table 11: Electrical Energy ... 102
Table 12: List of Vehicles ... 113
Table 13: Water Consumption ... 116
Table 14: Cooling Systems / Heat Transfers ... 118
Table 15: Gas Consumption ... 119
Table 16: Plant Balance of Combustible Gases ... 123
Table 17: Steam Balance ... 126
Table 18: Equipment List for Auxiliaries ... 128
Table 19: Electric Energy Consumption ... 132
Table 20: Equipment List of Integration Facilities ... 133
Table 21: Projection of Quantities and Cost of Raw Materials and Supplies ... 155
Table 22: Overhead Costs ... 161
Table 23: Qualification of Personnel ... 163
Table 24: Manning Schedule Operational Personnel including Provisions for Vacation and Sick Leave ... 164
Table 25: Administrative Personnel Requirements ... 165
Table 26: Description of Training Code ... 166
Table 27: Split according to plants ... 168
Table 28: Training schedule ... 169
Table 29: Recruitment during Implementation ... 170
Table 30: Implementation Budgeting ... 171
Table 31: Total Initial Fixed Investment ... 172
Table 32: Pre-Production Capital Exenditures (in mn US$) ... 176
Table 33: Plant Structure ... 177

E:\projekte\pits-bo\phase-2\tech-desc\5-8.wps

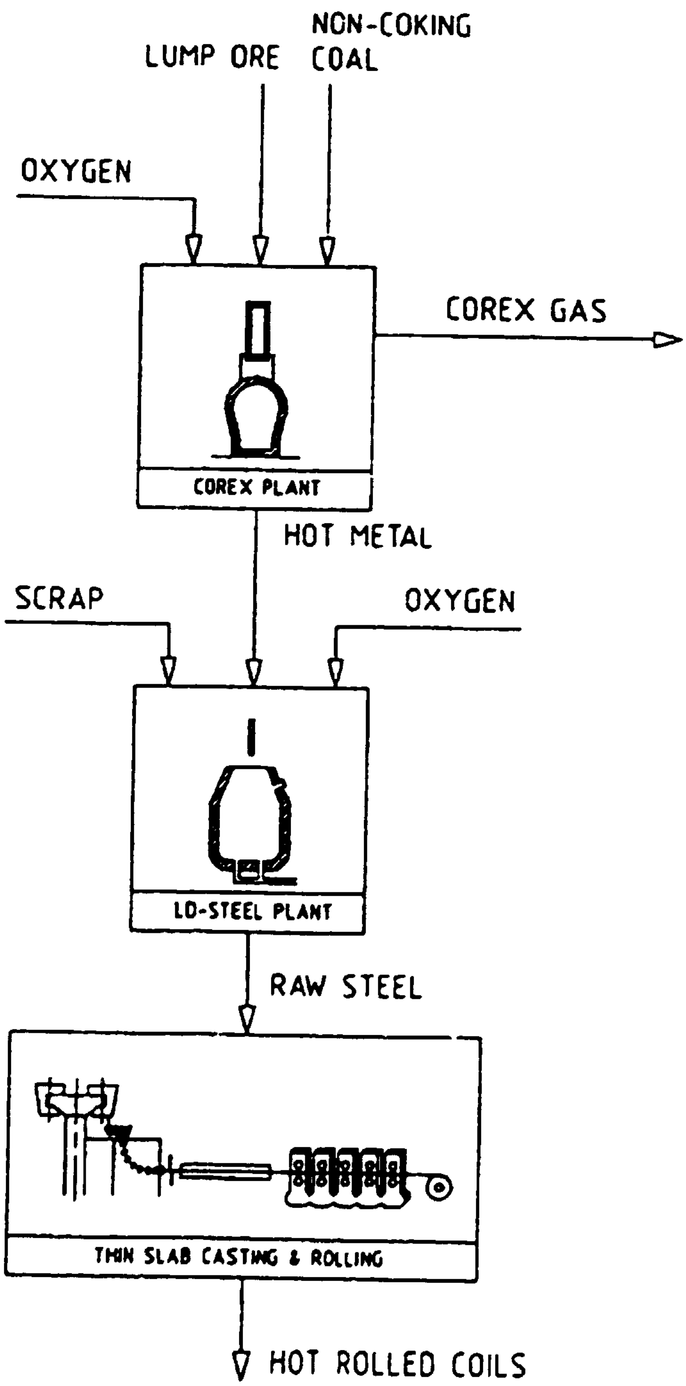
Figures

Fig. 1: Simplified process flow 1
Fig. 2: COREX® basic flow sheet 14
Fig. 3: Cross Section through LD Plant 42
Fig. 4: Longitudinal Section Thin Slab Caster 61
Fig. 5: Longitudinal Section of Thin Slab Mill 70
Fig. 6: Process Description of Lime Kiln 89
Fig. 7: Air Separation Plant, Process Flow 104
Fig. 8: IH 84 Combustible Gas / Plant Balance 121
Fig. 9: Process Flow 122
Fig. 10: Proposed Disposition of Burners in Existing Boiler 124
Fig. 11: Section through Burner for 120 MW_{therm} 125
Fig. 12: Steam Plant Balance 127
Fig. 13: Single Line Power Diagram 131
Fig. 14: Specific Consumption Figures - Lime Kiln (per tonne product) 144
Fig. 15: Specific Consumption Figures - Lime Kiln (per year) 145
Fig. 16: Specific Consumption Figures - COREX Plant (per tonne product) 146
Fig. 17: Specific Consumption Figures - COREX Plant (per year) 147
Fig. 18: Specific Consumption Figures - LD - Plant (per tonne product) 148
Fig. 19: Specific Consumption Figures - LD - Plant (per year) 149
Fig. 20: Specific Consumption Figures - Thin Slab Caster (per tonne product) 150
Fig. 21: Specific Consumption Figures - Thin Slab Caster (per year) 151
Fig. 22: Specific Consumption Figures - Thin Slab Mill (per tonne product) 152
Fig. 23: Specific Consumption Figures - Thin Slab Mill (per year) 153
Fig. 24: Material Flow Sheet 154
Fig. 25: SGSM Table of Organization 160
Fig. 26: Implementation Schedule 175

1. GENERAL ROUTE DESCRIPTION

For more comprehensive information refer to the relevant chapters.

Fig. 1: Simplified process flow



E:\projekte\pks-bo\phase-2\tech-descl1-4.wp5

1.1 BASIC MATERIALS FOR IRON AND STEELMAKING

- Iron ore [1/]
  Mt. Newman ore, 2.5 % moisture
  Origin: Australia
  Requirement: 2.13 mn t/a
- Coal [1/]
  Ombilin: medium volatile (19 to 28 %), steam coal, 7 % moisture
  Origin: Indonesia
  Requirement: 1 472 mn t/a
- Other basic materials
  For the requirements refer to Material Flow Sheet

  - Limestone
  - Dolomite
  - Quartzite
  - Scrap

  Above materials are of indigenous origin except scrap in part.

1.2 COREX® PLANT

Aim: Reduction of the iron oxides and melting of the iron ore, pellets and lump ores into hot metal (pig iron) to be used as feed stock in the successive steel plant.

Burden:
- iron ore and pellets
- coal as energy input and reductant of the iron oxides
- fluxes as slag forming agent to bind ashes and gangue (ore impurities)

Process: The COREX® System distributes the process into two sequences

a) The production of reduction gas and melting of sponge iron in the melter-gasifier located below

b) The shaft furnace, where the reduction of the iron burden takes place.

1/ It is assumed that these raw materials will be screened at the mines prior to transport to limit the amount of fines.

The process operates up to 500 kPa but contrary to the blast furnace the coal is charged into a separate vessel from where it is transported via screw conveyors into the melter-gasifier. At the top of the gasifier the coal comes into contact with the gas at temperatures of approx. 1 100°C. The coal is dried and completely degasified, the coal pieces being transformed into coke. This coke is gasified by oxygen which is injected via nozzles located approx. in one third of the height of the vessel. In front of the nozzles the oxygen burns to CO_2 which turns into CO with the col e. On leaving the gasifier the hot crude gas is cooled by means of cooling gas, cleaned and ducted to the reduction furnace. The reduction furnace is being charged with the ore to be reduced via a lock system. Screw conveyors transport the reduced ore now transformed into sponge iron from the bottom of the reduction furnace to the top of the melter-gasifier to be melted.

Slag and liquid iron are tapped off intermittently.

Gas treatment: the reduction gas emitted from the gasifier contains up to 95 % CO which is cooled via cooling gas (same origin) ducted in a closed circuit and cleaned by cyclones. From this closed circuit a branch runs off to the reduction furnace for gas supply. Below the charging locks of the furnace the gas having participated in the reduction of the iron ore is emitted as top gas, which after cleansing may be used as export gas serving other consumers and in part is mixed with the cooling gas also.

Pig iron tapping and slag disposal is performed analogously as in the BF process via pool launders and runners into the respective vessels.

1.3 STEELMAKING PROCESS

Aim: Pig iron contains between 3 to 4 % carbon. The aim of a steel plant is to oxidise the excessive carbon to reduce its content down to the required level (normally 0.1 to 0.3 % C for flat products), together with scrap and alloying elements according to the required steel specification.

LD Process: The hot metal is first desulphurized (if required) and then transferred into the LD vessel. No further heat is required as the necessary temperature is achieved in the process of oxidation of the various chemical elements in the hot metal, foremost carbon. The necessary O_2 is supplied by blowing in technical oxygen with a pressure of 800 to 1 200 kPa at a distance from 1 to 1 ½ m above the hot metal surface with a water cooled lance resulting in a bath temperature of 1 600°C. Cooling scrap is added approx.

20 % of the charge as well as alloying (ferro metals) and slag forming elements (burnt lime and other fluxes). Tap to tap time is generally approx. 40 min., the blowing process varies from 12 to 18 min. depending on the grade of steel. Tapping is effected into ladles for possible further processing (further removal of undesirable elements).

1.4 THIN SLAB CASTING

Killed crude steel at about 1 600°C is cast into a water cooled copper mould or rather sleeve. The cross section identifies the cross section of the slab, whereby the width is adjustable conforming approximately to the strip width to be rolled. »Thin Slab Casting« generally refers to slab heights of well less than 100 mm, 50 to 70 mm having become the most common.

The process and the main equipment is principally the same as with conventional continuous casting, the cooled thin slab also being guided in a 90° arc from the vertical into the horizontal plane, except that this slab is cut much longer due to its thinness to comply with the weight of a conventionally cast slab (i.e. 3 to 3.5 times longer).

After being cut this slab now slowly travels in line through a soaking furnace of more than 120 m length to equalize the temperature differences between the core and the surface of the thin slab.

1.5 HOT STRIP ROLLING 56"

After exiting the furnace the thin slab is being descaled, cropped, and enters in line into the 4 high finishing mill (6 stands) to be dressed down to its designated strip thickness. This mill again is similar to the finishing mill of the conventional type, as are all the other downstream facilities like laminar flow cooling, coiling and possibly slitting, edge trimming, etc.

2. GENERAL TECHNICAL DATA AND PROCESS DESCRIPTION

2.1 COAL DRYING

Basis:
In the COREX® process a wide variety of coals can be used. Certain aspects while selecting coals must be taken into consideration. Some of these aspects are also valid for considering the process of coal drying.

1. Total moisture content of coal
2. Inherent moisture content of coal
3. Disintegration of coarse coal during drying
4. Self ignition behaviour of coal after drying
5. Briquetting possibility of dried coal fines
6. Generation of C-organics during drying
7. Cooling of dried coal.

ad 1) ad 2)

Total moisture content of raw coal for the COREX® process is normally between 3 to 10 %. The inherent moisture is between 1 and 3%. The COREX® process itself requires a coal blend with a total moisture in the coal in the range of about 5 % (± 1%) as a general rule. In the case given, Ombilin coals will be employed with 7 % moisture.

The moisture content of the incoming raw coal determines the necessary number of coal driers and associate equipment such as hot gas generator, combustion and dilution gas fan as well ad dedusting equipment a.s.o.

<u>Description of the drying process</u>:

The fume gas of combusted COREX® gas is cooled to a defined temperature by adding air. Afterwards this gas flows through a vibrating feeder drying the coal which passes the feeder. For a detailed description see also item 2.2.5, RC 13.

2.2 COREX® PLANT

2.2.1 PROCESS DESCRIPTION

(refer to enclosed basic flow sheet)

The production of hot metal via the traditional route sinter plant, coke oven plant and blast furnace can be substituted by one single unit, the COREX® process. In the COREX® process a wide variety of coals (non coking coals) as well as iron oxides, such as lump ores, pellets and sinter are used in a continuous process. A medium calorific gas is generated as a by-product of the hot metal production.

The main feature of the COREX® process as compared with blast furnace is the splitting of the process into two reactors. Consequently reaching independence from coke or coking coal:

- Generation of reducing gas and melting of the sponge iron in the melter gasifier
- Reduction of iron ore/pellets in the shaft furnace

In the upper part (dome) of the melter gasifier, the coal is dried and degassed prior to gasification under partial oxidation in a fluidized bed in the lower part of the melter gasifier.

The reducing gas generated in the melter gasifier, after having passed a dust separation cyclone, is transferred into the reduction shaft arranged above the melter gasifier.

The reduction shaft operates according to the counter-flow principle, the reduction temperature being approx. 850 °C. The hot sponge iron resulting from this process procedure is directly conveyed by means of speed controllable screw conveyors into the melter gasifier, where it is melted down by the energy generated using the partial oxidation of the coal. Hot metal and slag are tapped periodically from the hearth of the furnace.

Reactions in the dome of the melter gasifier

In the dome of the melter gasifier the temperature is approximately 1 050°C. The coal is charged into the melter gasifier by screw conveyors. It is dried and degassed abruptly at the temperature as indicated above.

In the dome of the gasifier, the coal particles are heated up and smaller coal sizes are directly transformed into char. Larger coal grains are degassed in the fluidized bed at higher temperatures.

During degassing, higher hydrocarbons, methane, CO_2, H_2 and CO are liberated. The hydrocarbons are transformed into CO and H_2 by endothermic reactions by means of CO_2 or H_2O.

In addition, the following reactions are also taking place in the upper zone of the gasifier:

$CO_2 + C$	$= 2\ CO$	Boudouard reaction
$H_20 + C$	$= CO + H_2$	Water gas reaction
$CO + H_2O$	$= CO_2 + H_2$	Shift reaction

Gasification in the fluidized bed

The degassed coal is gasified by oxygen which is blown in through a number of tuyeres. During this procedure, the following reactions take place:

$$C + 1/2\ 0_2 = C0$$
$$C0 + 1/2\ 0_2 = C0_2$$
$$C + C0_2 = 2\ C0$$

The coal is transferred into a fluidized condition by the ascending gas generated. The average fluidized bed temperature amounts to 1.600-1.700 °C. Because of the lateral oxygen injection and the wide grain size range, no classical fluidized bed characterized by a uniform grain size distribution is formed in the melter gasifier. The temperature gradient and the flow conditions in the fluidized bed can be influenced by selection of coal grain size, coal composition, height of the fluidized bed, system pressure and oxygen velocity. All these parameters also have an influence on the melting behaviour of the sponge iron and the composition of the hot metal.

Melting metallurgy

It is a characteristic feature of the COREX® process that the energy released during coal gasification is used for melting of the sponge iron.

The hot sponge iron is continuously charged from the shaft furnace into the melter gasifier. Determining for the sponge iron quantity charged is the melting potential available in the fluidized bed.

The sponge iron charging points are situated at the top of the gasifier. By means of gravity, the hot sponge iron falls through the dome zone above the fluidized bed, is slowed down, heated up and finally melted down. The liquid hot metal and the slag are collected at the furnace hearth. The separation is effected by the different densities similar to blast furnace practice.

The sulphur distribution between slag and hot metal is a function of the basicity of the slag. The reference value is a slag basicity B_2 (CaO/SiO_2) of approx. 1.2. The basicity is adjusted by the addition of limestone, dolomite, quartz or the use of a self fluxing burden as for instance sinter.

Charging of limestone and/or dolomite can either be effected with the coal or the iron oxides via the shaft. The sulphur content in the hot metal is additionally influenced by the sulphur content of the coal as well as by the specific coal consumption.

An essential influence on the metallurgical work in the melter gasifier is the metallization degree as well as the C-content of the sponge iron. The sponge iron analysis, however, depends on the specific reduction gas volume as well as on the reducing potential $[(CO+H_2) / (CO_2+CO+H_2O+H_2)]$.

Reduction of the Iron Ore/pellets

After dust separation in the hot cyclones, the reducing gas is introduced into the reduction shaft at a temperature of approx. 850 °C. Since the reduction of iron ore/pellets by means of carbon monoxide is an exothermic reaction plus an exothermic reaction of carbon monoxide decomposition occurs in parallel ($2\ CO = CO_2 + C$), the temperature inside the shaft furnace will be higher than the reducing gas entry temperature in the area of the bustle. The metallization degree of the sponge iron ranges between 90 and 95 %. The carbon dust not having been separated in the hot cyclones, is mostly filtered in the reduction shaft by the burden and returned with the hot sponge iron as adherent carbon to the melter gasifier.

Following typical reactions are taking place in the COREX® shaft furnace:

$3\ Fe_2O_3 + CO = 2\ Fe_3O_4 + CO_2$ $3\ Fe_2O_3 + H_2 = 2\ Fe_3O_4 + H_2O$	hematite is transformed to magnetite
$Fe_3O_4 + CO = 3\ FeO + CO_2$ $Fe_3O_4 + H_2 = 3\ FeO + H_2O$	magnetite is transformed to wustite
$FeO + CO = Fe + CO_2$ $FeO + H_2 = Fe + H_2O$	wustite is transformed to metallized iron

$3\ Fe + 2\ CO$	$= Fe_3C + CO_2$	carburization
$2\ CO$	$= C + CO_2$	formation of carbon
$CaCO_3$	$= CaO + CO_2$	calcining of limestone
$CaMg(CO_3)_2$	$= CaO \times MgO + 2\ CO_2$	calcining of dolomite

In order to achieve both a good degree of metallization and a good carburization of the sponge iron, the CO_2- and H_2O-content in the reducing gas must be as low as possible. The used reducing gas, the top gas, leaves the reduction shaft almost desulphurized.

Gas treatment

The gas generated in the melter gasifier when using coal, is characterized by an analysis of approx. 70 % CO and approx. 20 % H_2, the remainder is composed of CO_2, N_2, H_2O and CH_4. The CO_2 and H_20 content depends essentially on the humidity of the coal as well as on the dome temperature in the gasifier. The generator gas leaving the melter gasifier is loaded with dust. Most of this dust is separated from the gasifier gas by means of hot cyclones and recycled via dust-burners into the gasifier. Since the gas temperature at the outlet of the melter gasifier is higher than the required reducing gas temperature, the gas temperature is adjusted by addition of cooling gas in order to reduce the gas temperature to approx. 850 °C. The cooled and cleaned gasifier gas is introduced into the reduction shaft via a bustle and passes through the shaft furnace in a counterflow direction to the iron ore.

The quenched and cleaned top gas has a calorific value of between 2 500 to 3 500 kcal/m^3 (std) and can be used as a fuel for heating purposes or as a fuel for power generating plants. The export gas is very clean and has a dust content of less than 10 mg/m^3 (std) and a H_2S-content of less than 80 ppm. This makes the gas also suitable for use in gas turbines.

Influence of raw materials

The COREX® process is characterized by a great flexibility regarding the raw materials.

Coal and additives

An essential influencing factor for the COREX® process is the volatile content of the coal. When using high volatile coal, more reducing gas is produced with regard to the possible melting capacity. Through blending with lowvolatile coals, an optimum melting capacity and the required reducing gas amount can be achieved. Coals with volatile matters of 20 to 30 percent are perfectly suited for the COREX® process. A volatile content above 30 percent creates a certain amount of surplus gas (export gas).

Besides the content of volatiles, the exact mixture essentially depends on the humidity of the coals.

A further factor for the energy balance of the melter gasifier is the fines content of the coal.

The fines of the incoming coal create a load for the dust recycling system and can only be gasified after injection via the dust burners. In order to minimize the dust problem, it is advised to limit the undersize portion below 2 mm to max. 5 %. The optimum grain size range is coal-specific.

The required amount and type of the additives depend on the ash composition of the coals as well as on the gangue composition of the iron ores/pellets.

Coals, which are characterized by high ash content are very acid in most cases. The sulphur present in the coal can influence the sulphur content in the hot metal and should be kept below 1 percent. Consequently, a certain amount of limestone and/or dolomite must be added to achieve the desired basicity. Limestone and dolomite can be charged with the ore/pellets, and they are calcined in the shaft.
For the appr. 3 months start up period about 20 % of the coal input shall be compensated by coke to ease start up procedures.

Iron Oxides

In order to evaluate the oxides physical properties, reduction properties and chemical composition have to be taken into consideration.

The grain size of the iron carriers should be

- lump ore 8 - 20 mm
- pellets 8 - 16 mm
- sinter 10 - 30 mm

with total fine contents not exceeding 5 %. The lump ores should be suitable for shaft operations with good reducibility and low grain decrepitation.

A considerable fragmentation or abrasion of feed materials during reduction inhibits the gas flow within the burden and influences productivity, coal consumption, and product quality. Most of the disintegration occurs during the reduction stage from hematite to magnetite. The behaviour of the iron oxides are tested in static and dynamic test apparatus.

With regard to the chemical analysis of the iron oxides the following must be taken into consideration.

- The iron content should be higher than 60 percent, otherwise the slag amount will increase and consequently coal and oxygen consumption will increase.

- The TiO_2-content is limited as in the blast furnace operation, due to it's influence on the slag viscosity.

- A high SiO_2-content results in high slag volume and a high limestone/-dolomite consumption.

- A high Al_2O_3-content must be compensated by adding of additives which reduces the Al_2O_3-content in the slag below 15 %.

- 90 % of the phosphorous content in the raw materials is found in the hot metal.

- 70 percent of Manganese is found in the hot metal.

- Ores with a high alkaline content do not prove to have a negative influence in the COREX® process as experienced in the blast furnace process.
  The alkali is bound and removed in the slag on the one hand and on the other hand removed in the cooling gas scrubber.

Separation of the molten slag and the liquid pig iron takes place in the bottom of the hearth, where, on account of the specific weight differences, the slag will float on the liquid metal to run off the slag taps into the mobile slag pot transporters.

The pig iron runs into the so-called submarine ladle via the poul launders to be transported via trackless ladle fork lift transporters into the steel plant.

During downtimes of the downstream facilities the liquid metal will be cast into the continuous P.I. casting machine.

2.2.2 ENVIRONMENTAL ASPECTS

The emissions of the coke oven/blast furnace route compared to the COREX® route play an important role today. In the conventional route the dust and gaseous emissions are considerably higher than in the COREX® route. Due to the fact, that all organic compounds from the coal are decomposed into CO and H_2 in the dome of the COREX® gasifier, the soluble matters in the waste water are negligible compared to values from the coke oven / blast furnace route.

Gaseous emissions and dust

In the COREX® process reducing conditions are maintained so that the formation of sulphur dioxide is not expected, not even in the stack.

However, H_2S formed in the melter gasifier is absorbed into the reduction shaft by the sponge iron or the lime and dolomite with the result that the sulphur content in the off-gas is very low (approx. 80 ppm). Indication of ammonia compounds and cyanides are practically avoided due to the use of common pure oxygen (appr. 95 %), compared to the blast furnace, where air is used for the hot blast.

Measurements executed by TÜV Rheinland/Germany on COREX® Plant Iscor/S.A. have shown that the emissions from the COREX® plant amount to only a small fraction of that of an integrated plant with Coke Ovens, Sinterplant and Blast Furnace.
During the period of this investigation the plant was operating under normal conditions.

The raw materials used were Tabazimbi ore (100 %) and a mixture of the coal qualities Delmas 2 (60 %) and Wolwekrans (40 %).

Sampling, analyses and required chemical and physical measurements were carried out on the basis of VDE and DIN regulations (Germany) as well as in accordance with the regulations of German Standard Procedures for water analysis.

On the base of the investigations and referred to one ton Hot Metal the following specific emissions data can be concluded:

Gaseous Emissions:

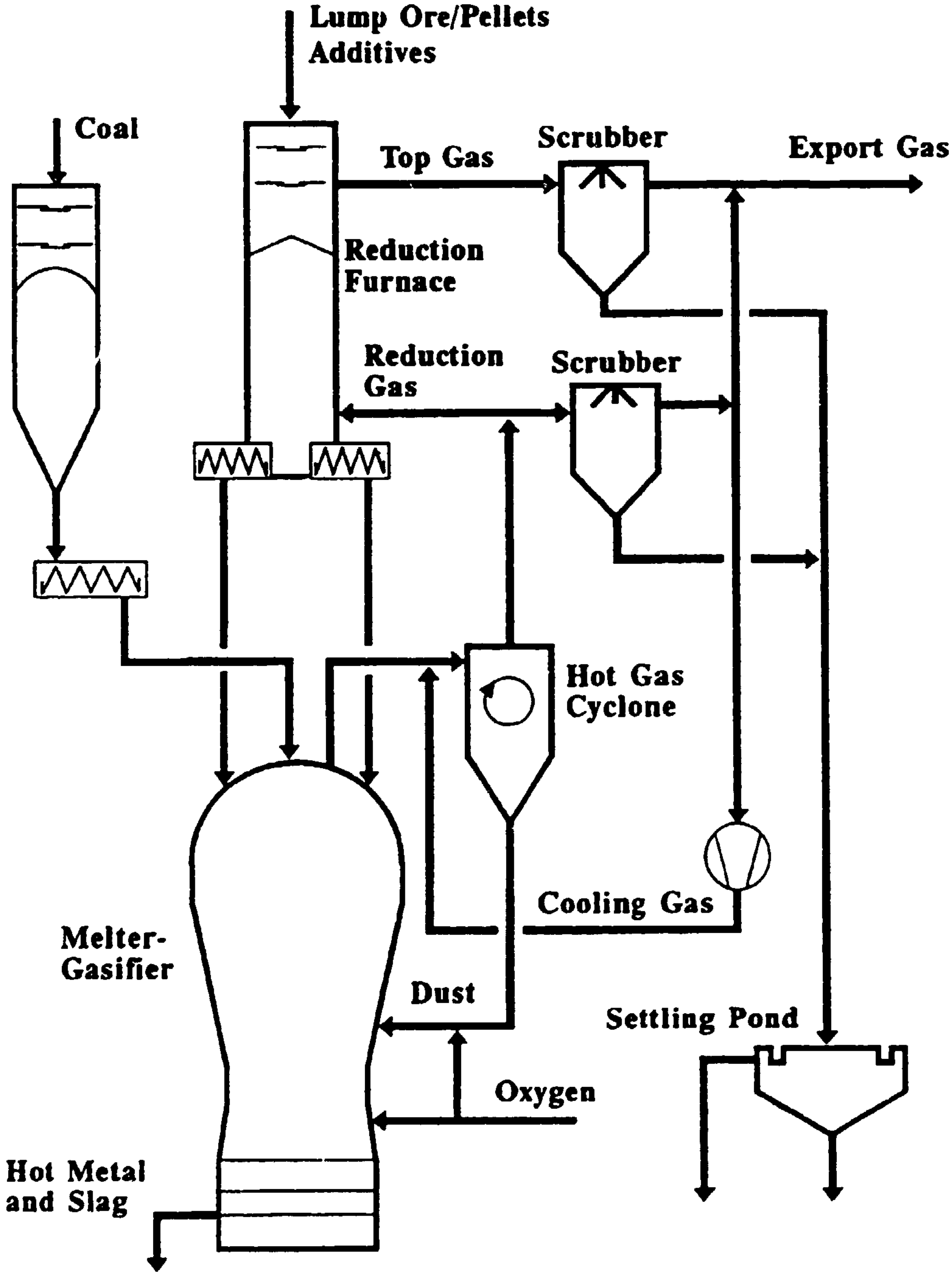
- Sulphur dioxide	53 g/t HM
- Nitrogen dioxide	114 g/t HM
- Dust	130 g/t HM

Aqueous Emissions:

- Phenol	0.04 g/t HM
- Sulfide	0.01 g/t HM
- Cyanides	1 g/t HM
- Ammonia	60 g/t HM

2.2.3 COREX® BASIC FLOW SHEET

Fig. 2: **COREX® basic flow sheet**



2.2.4 PERFORMANCE CALCULATION

2.2.4.1 YEARLY PRODUCTION TIME

Table 1: **Yearly Production Time**

	D/Y	H/Y
Calendar time	365	8 760
General repair	7	168
Scheduled maintenance	8.5	204
Theoretical production time	349.5	8 388

2.2.4.2 AVAILABILITY

Table 2: **Availability**

	Downtime H/Y	Availability	H/Y
COREX *	100	98.8 %	8 288
BOF	240	97.1 %	8 148
Thin Slab Caster	470	94.4 %	7 918
Rolling Mill	690	91.8 %	7 698
Rolling Mill **	404	95.2 %	7 984
8 388 x 0.988 x 0.971 x 0.944 x 0.952 =			7 232
Effective production time	301.3 d/y	7 232 h/y	

* Due to the storage capacity for hot metal only production stops exceeding 4 hours will be taken into consideration

** Due to the storage capacity of the reheating furnace of max. 25 min. (in correlation with casting speed) the availability of the rolling mill will increase from 91.8 to 95.2 %

E:\projekte\pits-bo\phase-2\tech-desc\1-4.wp5

2.2.4.3 BASIC DATA

COREX® Production capacity

- 2 COREX® C-2000, at 90 t/h module ~ 180 t/h

Input in kg/t liquid metal

Iron ore	1512 (958 kg Fe)
Coal	1040 (2,5 kg Fe)
Quartzite	29 kg
Limestone	196 kg
Dolomite	57 kg
Burnt Lime	15 kg

Output (Composition of liquid metal) in kg/t

C	=	42,0 kg
Si	=	6,0 kg
Mn	=	2,4 kg
P	=	0,5 kg
S	=	0,5 kg

Liquid metal temperature at COREX tap: 1 485 °C av.

2.2.4.4 ANNUAL OUTPUT

-

	t/year	
7 232 h at 2 x 90 t/h	1 295 900	liquid P.I.
1 048 h at 2 x 56 t/h *	117 500	solid P.I.
8 280 h	1 413 400	

* at reduced capacity to adapt the production to the required pig iron demand in down-times of downstream facilities

2.2.5 MAIN MACHINERY AND EQUIPMENT

RC 1 Raw material handling & burden system

The proposed raw material handling begins once raw material has been deposited in storage bins.

All equipment required for raw material handling prior to the storage bins, e.g. Unloading, storage yards, screening, crushing, conveying a.s.o.) are covered under item 6.3.1.

RC 12 Oxide Handling

Due to segregation and decrepitation of the ore during the handling from the mine to the mill, screening of the ore is necessary , to maintain a uniform level of grain size distribution and to separate the fines (- 6 mm).

Due to build up of fines in the burden building a screening plant should be located after the ore storage bins but before the weighing bins feeding the bucket belt.

Depending on quantities and qualities of the separated fines, the fines may be returned to the ore under controllable conditions.

The proposed screening plant will consist of a screening machine, a dedusting plant and the necessary conveying equipment.

The additives to the ore (dolomite, limestone) may also be screened, but only if the provided materials have a fines content (- 6 mm) of more than 10 percent.

RC 13 Coal Handling

Coal screening and crushing plant

Depending on the quality and grain size distribution of the coal provided for the COREX® plant screening and maybe crushing of the coal is necessary in order to maintain a fairly uniform grain size distribution and to remove large foreign obstacles.

The screening and crushing of the coal and the required coal transporting equipment is covered under item 6.3.1.

A dedusting plant can be incorporated to extract the dust at the various material transfer points, as well as from the screening machine and from the crushing machine and is covered under item 6.3.1.

Coal drying plant

As the provided coal has a variable moisture content a coal drying plant is necessary.

The coal drying plant shall not only reduce the moisture content, but should also control, adjust and maintain the moisture in the coal at a stable level.

In the coal drying plant the granulated sludge shall also be dried together with the coal.

The coal dust from the coal drying plant, which is extracted and accumulated by the dedusting plants, is utilized as a filler material for the sludge granulation.

When the fines content (- 2 mm) in the coal exceeds 5 percent the dust should be separated.

The dust may be used as additional energy carrier in power station if the calorific value and the chemical composition is suitable.

Coal drying plant consists mainly of:

- receiving bins
- dosing belt conveyor
- hot gas generators
- coal dryers
- dedusting equipment
- transport equipment
- building steel structure

RC 14 Additive Handling
see item RC 16

RC 15 Circulating Material Handling
see item RC 16

RC 16 Burden System

The burden material (ore, coal) is discharged from the storage bins by means of vibrating feeders and charged into a weighing hopper which is equipped with load cells. After being weighed the material is discharged via belt onto the bucket belt. The bucket belts (two are installed, one for ore, one for coal) transport the burden up the process tower and discharges the batch into a charging bin above the reduction shaft respectively into the coal bin.

The additives are discharged from the storage bins by means of vibrating feeders and charged into weigning hoppers which are equipped with load cells.

After weighing, the additives are discharged the same route to the reduction furnace as the iron ore/pellets.

The additives for coal are discharged from the storage bin by means of vibrating feeders and are charged into weighing hoppers, equipped with load cells.

After weighing, the additives are discharged the same route to the melter gasifier as the coal.

Ore and fluxes are charged from the charging bin into the pressurized reduction shaft via a double lock hopper system.

The coal is charged via a double lock hopper system and screw conveyors into the melter gasifier.

Burden system mainly consists of:

- bunkers
- weighing equipment
- feeders
- transport equipment
- screens
- building steel structure

RC 19 Dedusting System

Consisting mainly of:

- complete bag filter dedusting system for ore including fan, ductwork and hoods
- complete bag filter dedusting system for coal including fan, ductwork and hoods

RC 2 Reduction Shaft & Melter Gasifier

The COREX®-Tower comprises the following main facilities

- charging system for raw materials
- reduction furnace
- melter gasifier
- gas handling and treating

RC 21 Furnace Charging System

The coal is charged via the coal bucket belt to the upper part of the lock hopper system consisting of an open charging bin, which can be closed at the bottom with a sealing gate. This gate is a combination of a material holding flap and a gas-tight flap and is consequently the top lock of the intermediate hopper.

By opening this gate the material will be released into the intermediate hopper. The hopper will be pressurized with nitrogen after each charging cycle. The batch from the intermediate hopper is discharged at the bottom into a feeding hopper through a similar sealing gate as described above. All gates are driven hydraulically.

Discharging from the feeding hopper is done by screw conveyors with adjustable speed for a controlled flow of coal into the melter gasifier.

The top closing system above the reduction shaft is similar to the coal charging system.

Charging of the reduction shaft is directly carried out from the feeding hopper through the distribution pipes into the shaft. Additives are mainly added to the iron ore/pellet charge, but can be added for quick and specific metallurgical balance to the coal also.

Furnace Charging system consists mainly of:

- bucket belts for ore and coal
- charging bins, hoppers
- coal screw conveyors
- steel structure

RC 22 Reduction Shaft

The reduction shaft is supported by a steel structure above the melter gasifier.

The burden is transferred via the afore mentioned lock hopper system with a downstream distributing system into the reduction shaft. The reducing gas generated in the melter gasifier enters into the reduction shaft via a bustle and reduces the iron ore/pellets to direct reduced iron (DRI).

In the lower part of the reduction shaft, six water-cooled screw conveyors are installed. The drives of the screw conveyors are effected hydraulically. The screw conveyors feed the material into six downpipes feeding the melter gasifier.

The reduction shaft temperature is monitored by thermo-couples and the walls are provided with a wear-resistant refractory lining.

Reduction shaft consists mainly of:

- burden distribution system
- reduction shaft shell, refractories
- screw conveyors ore
- down pipes
- steel structure

RC 23 Melter Gasifier & Facilities

In the melter gasifier the coal is gasified. The DRI and the additives are melted down to hot metal and slag.

Coal, DRI and additives are charged with the charging systems into the top of the melter gasifier. Oxygen is blown into the gasifier through tuyeres in the lower part of the melter gasifier.

The generator gas produced in the melter gasifier leaves through four refractory lined ducts.

The dust, separated by four hot cyclones, is recycled via dust burners into the melter gasifier just above the upper level of the fluidized bed. The gasifier shell is cooled by a stave cooling system. The top of the vessel is cooled by external air only, but a spray water system for emergency cases is provided.

The gasifier is equipped with two tapholes for hot metal and slag discharge.

The shell is refractory lined in accordance with the requirements of the different gasifier zones.

The melter gasifier is equipped with the necessary control devices required for the metallurgical operation, such as thermocouples and level indicators.

Melter gasifier consists mainly of:

- melter gasifier shell, refractories
- stave cooling
- tuyers
- dust recycling system with dust burners
- gas off-takes
- steel structure

RC 25 Process Gas System

The gasifier gas generated in the melter gasifier is discharged through four refractory lined ducts and cooled down to reducing gas temperature by addition of cooling gas. Before the reducing gas enters the reduction shaft the coarse dust is removed by four hot cyclones.

For cooling gas production, a partial flow of the dedusted gasifier gas is further cleaned and cooled in a scrubber system. The cooling gas is pressurized by compressors and fed back for temperature adjustment of the generator gas.

The hot gas ducts are refractory lined.

Process Gas System consists mainly of:

- ductwork, refractories
- gas cooling and cleaning systems
- cooling gas compressors
- steel structure

RC 28 Tapping Equipment

Consisting of

- tap hole drilling machine
- tap hole clay gun
- hydraulic unit

RC 29 Gas cleaning & dedusting system

The top gas leaving the reduction shaft is cleaned and cooled in a similar scrubber system like the cooling gas.

The hot gas ducts are refractory lined.

The gas system consists mainly of:

- ductwork refractories
- topgas cooling and cleaning system
- steel structure

RC 3 Hot Metal Handling

RC 31 Hot Metal Handling

The basic design of the casthouse is in accordance with the state of the art for Blast Furnaces.

The tapping of hot metal and slag will take place approximately 8 to 9 times per day with an average tapping weight of 220 to 250 tons of hot metal.

The tap hole is opened with a special tap hole drilling machine. The closing of the tap hole is by means of a clay gun. The tap hole drilling and closing machine is operated from a control room on the casthouse platform.

It is proposed that the hot metal tapping is done from one casthouse, while the other casthouse launder and runner system is under repair or on stand by.

The hot metal and the slag flows from the tap hole into a pool launder. In the pool launder the slag is separated from the hot metal by means of a skimmer. The pool launder shell is air cooled by a fan.

The hot metal flows from the pool launder via a runner into the tilting runner from where it is directed into the appropriate ladles located under the casthouse platform.

The hot slag separated in the pool launder is guided via runners into a slag pit.

Hot Metal handling consists mainly of:

- Pool launders
- iron runner
- tilting runner
- refractories
- steel structure

The pool launder and the runners are lined with refractory materials.

The casthouses are of steel structure with fireproof casting floors and each casthouse is equipped with a crane for maintenance and cleaning.

RC 32 Pig Iron Casting Machine

The pig iron casting machine consists of 2 conveying lines equipped with moulds, in which the liquid hot metal will be poured. The moulds are cooled by spraying water; after solidification and cooling down of the cast iron pigs (→ pig iron) the castings will be dumped at the conveyor discharge end of the caster.

From there they can be stored and fed to the steel melting process.

The Twin Strand Pig Casting Machine mainly consists of:

- moulds with mould chain
- structural framework with drives and knock out system
- twin water spray systems with recirculating facilities
- teeing ladle lefting device for hot metal pouring

The capacity at nominal production will be 2x90 tonnes/hour.

RC 39 Dedusting System

The casthouse is equipped with a dedusting system to extract fumes and dust from tap holes, launders and runners.

Consisting mainly of:

- dedusting hoods for tap holes, iron and slag runners, iron tilting runners
- ductwork from extraction points to filterhouse
- filterhouse with dust discharge device
- damper assembly
- draught fan
- clean air stack

RC 4 Slag Handling & Recycling

RC 45 Sludge Recycling

It is proposed to granulate the sludge from the clarifiers and feed the granulates with the coal to the melter gasifier.

The amount of granulates which can be fed to the process depends on the quality of the raw materials. Approx. 90 percent of the sludge can be recycled and returned to the process, avoiding too high enrichment of the trace elements (alcalines, zinc, etc).

The sludge from the clarifier is pumped to the dewatering unit, from where the dewatered sludge is conveyed into the granulating mixer. Burnt lime and coal fines are added. The produced green granulates are discharged and stored to cure before added to the coal.

The granulation plant mainly consists of:

- sludge dewatering unit
- granulating mixer
- storage and charging equipment for burnt lime, coal fines
- conveying equipment
- steel structure

RC 46 Dust Recovery

The dust collected in the filter house will be discharged, handled and removed with the sludge from the clarifiers.

RC 49 Slag Handling & Treatment

At each tap 40 to 65 tons of slag (25 to 30 tons/hour), depending on the quality of the used raw materials are discharged from the melter gasifier.

The hot slag (approx. 1500 °C) is separated from the hot metal in the pool launder and is directed via a slag runner into the slag pit from where it has to be removed and dumped.

Slag handling and Treatment mainly consists:

- slag runners
- refractories
- slag pit
- steel structure

RC 5 Maintenance & Store

RC 53 Maintenance Post

A maintenance post is foreseen to allow smaller maintenance and repair work.

RC 6 Information System

General Control Philosophy

The process part of the plant and the corresponding auxiliary plant is fully operated from the central control room.

The control desk accommodates the video monitors with keyboards and printer for data logger.

The control panel accommodates the overview mimic with status indication of drives and on/off valves, and the alarm windows for interlock-alarming.

RC 62 Production & Process Control System

RC 63 General Instrumentation

Field Devices and Instruments

General

The equipment may be slightly changed during detail design depending on sub-supplier's standards and on process requirements.

Control Valves, Control Flaps

Control valves and control flaps for remote control have pneumatic actuators.

Shut-off valves

Remote controlled valves have globe or butterfly valves, including the pneumatic actuator with pilot solenoids and limit position switches, where required.

Measuring Transmitters

All significant and important physical and mechanical measurements which are to be processed will be transduced into a DC signal of 4-20 mA.

Thermocouples, Resistance Thermometers

Resistance thermometers are used for temperatures not exceeding a maximum of 500°C. Thermocouples are used for temperatures beyond 500°C.

Local Temperature Measuring Devices

This would be of bi-metal type. Casing diameter will be selected individually and will be either 100 mm or 160 mm.

Measuring Paths with Reactance Appliances

For flow metering, measuring orifices or Venturi nozzles are preferably used. Inductive flow meters, Ultra Sonic and pressure nozzle metering will be used for special purposes.

Local Flow Metering (Monitors, Counters)

For locally indicated flow rates with minor signalization, flow monitors (with flaps, pressure plates or suspended matter) of solid metal design, will be used.

Pressure, Differential Pressure Measuring Devices

Transmitters of various types according to process requirements will be used. Manometers with limit switches will be used for Local indication with inter-lockings.

Level Meterings

For important level metering of liquids in pressure tanks, preferably differential pressure transducers or ultrasonic transducers with container for lateral attachment on tanks with strongly fluctuating media, are to be used.

For important open pressureless containers, pressure transducers with membrane for direct flanging or pressure transducers operating according to the percolator method are to be used.

For other level measurement capacitive, conductive or vibrating systems are to be used.

For level metering of solid material in containers and bins, radioactive systems, echo-probe systems or weighing systems with load cells, corresponding to the nature of the material and mode of installation are used.

Weighing Equipment

General

Following weighing system is envisaged:

- Static weighing system
  for hopper scales (fix)

All electronic weighers are equipped with load cells (strain gauges or pressductors).

For botching, display and communication with other systems micro-processors are used.

Details of performance of equipment and standard documentation may vary according to manufacturer's standards.

Weighing Cabinets

The weighing cabinets contain the following devices corresponding to the functional demands:

- power supply
- electronic weighing equipment
- micro-computer and interface for digital display, DCS and PLC-systems, where necessary.

Gas Analyzer System

The gas analyzing system consists of a gas sampling station, a gas treatment station, analyzers, and of calibration equipment with calibrating gases.

Depending on the gas to be analyzed the gas tapping system as well as the impulse pipes have to be assembled accordingly (cooling, heating, stainless, etc.).

The gas analyzing system is designed and installed to allow shortest possible down times of the complete system (short gas paths, gas speed, gas volume, down time of analyzers).

The analyzers, which are preferred, will work on a physical basis, such as:
gas analyzers on thermal conductivity basis,
thermo-magnetic basis, or infrared basis.

The analyzers will be calibrated with suitable calibration gases.

CO, CO_2, CH_4:	INFRARED
O_2:	MAGNETIC
H_2:	THERMAL CONDUCTIVITY

The gas sampling system and the gas pumps are envisaged as twin system. Switch-over between the two systems is carried out manually via push buttons.

RC 64 Basic Automation

Digital Control System (DCS)

Digital control systems (DCS) are programmable memory-based systems for observation and operational purposes of the technological process as well as for performing of measurements and open/closed loop control functions.

The digital control system mainly consists of the following components depending on the requirements and precision in the specification of the scope of supply:

- Central processing unit (CPU)
- Memory
- Input/Output modules for connection of peripheral signals
- Interface modules
- Operating consoles (monitor and keyboard)
- Communication systems within the DCS (bus systems) or to other automation systems (serial links)
- Programming devices
- Power supply unit
- Printer

The CPU, memory, input/output modules and power supply units are installed in cubicles, ready for installation in an air-conditioned equipment room.

The cubicles are wired to terminal blocks.

Programmable Logic Controller (PLC)

PLC's are programmable memory based systems for interlocking and sequencing.

The PLC's are envisaged as stand alone systems with parallel or serial link connection to DCS-systems.

Generally the PLC-system consists of the following components, installed in ready wired cubicles:

- Power supply module
- Processor module (CPU)
- Program memory module
- In- and output modules (24 V DC or 48 V DC control voltage preferably and depending on the manufacturer)
- Communication systems (bus systems) to DCS-systems (e.g. serial links or bus systems)
- Interface modules

Battery back-up is to be provided if RAM-memories are used for maintaining memory contents in case of voltage loss.

RC 65 Sampling / Material Testing

Sampling/Material testing shall be done by Central Laboratory.

RC 69 Communication System

Comprising of call stations (office and external type) and automatic intercom centre with:

- Joining and connection modules
- Fault indication modules
- Checking and testing equipment
- Power pack for charging and floating lead battery

RC 7 Infrastructure & Auxiliary Equipment

RC 71 Plant Office

A plant office is foreseen to accommodate main control room, MCC, HV-switch gear, Transformers, UPS and central intercom system station. Further more rooms for air condition and ventilation system for the office area are incorporated.

RC 75 Fire Alarm & Fighting System

Fire alarm system

including

- automatic fire detectors
- manual alarm boxes
- release and control unit for automatic CO_2 and halon extinguishing system
- audible and visual alerting facilities

Fire fighting systems

including

- carbon dioxide extinguishing system
- halon extinguishing system
- water spray system
- portable fire extinguisher

RC 8 Utility Supply / Treatment

RC 81 Water Supply / Treatment

Industrial water will be at disposal at plant battery limit. From there it will be conducted by means of a pipe system to the consumption points required within the COREX®-Plant.

Adding make-up water compensates for all water losses within the water systems described above. The make-up water is available in two varieties:

- softened water
- industrial cooling water.

Softened water is only used for the closed machine cooling water system. As there is no evaporation and blow down in such a closed circuit, water losses will occur due to leakages only.

Water losses in the open cooling water circuits are caused by evaporation, blow down and leakages.

The total water losses are compensated for by addition of industrial cooling water.

RC 82 Water Circuits & Cooling System

Description:

The cooling water supply to the COREX®-plant is split up into 2 cooling water systems, depending on the kind of equipment to be cooled and the required water quality respectively, as well as the kind of contamination caused by the consumers.

These systems are:

a) Machine cooling water systems
including staves cooling for gasifier
b) Gas scrubber water system (process water)

Machine Cooling Water System

The machine cooling water system serves for cooling of the oxygen-tuyeres, nuclear level probes, dust burners, inliners, screw conveyors for DRI, cooling staves etc.

The heat transfer at the consumers takes place in closed units at a high temperature level on the heat transfer surface. Thus high water quality is required, i.e. softened water.

The closed circuit is cooled by indirect cooling.

An overhead tank connected to the system serves as buffer tank for pressure control on the suction lines of the closed system circulating pumps and as intermediate water storage for an emergency purpose to ensure a continuous water supply, particularly for the oxygen tuyeres, for a certain time.

With this method a minimum flow rate can be maintained in case of failures of water supply pumps.

Gas Scrubber Water System

This water system treats the water used for cleaning and cooling the gas in the top gas and cooling gas scrubbers, where it has been heated up and contaminated with suspended solids, mainly of fine coal and ash particles as well as iron and iron oxides residuals.

Thus, clarification and re-cooling of the circuit water is required, which is effectuated in an open water circuit comprising a preseparation clarifier and an evaporative cooling tower.

The water discharge out of both scrubbers is treated by the following common clarification procedure:

In order to remove occasionally apparent coarse particles the bottom drains of both scrubbers pass a decanter before entering the clarifier while the rest of the effluents are led directly into the flotation tank.

Prior to the clarifier inlet, the scum is removed by a skimmer system.

In the first clarifier the suspended solid are separated by gravity. After passing the cooling tower a second clarifier is installed to remove precipitated carbonates.

The clarified water is then pumped back to the scrubber system.

The accumulated sludge is discharged and pumped to a sludge dump.

RC 83 Incombustible Gases & Compressed Air

The utility supply will comprise the following systems:

- Nitrogen supply and Instrument Nitrogen
- Compressed air supply
- Oxygen supply

Nitrogen system

Nitrogen is used for inertisation and purging as well as for control purposes and for pressurizing of lock hoppers for raw material loading and dust discharging. Furthermore it serves also for control, valve actuators. Thus, two pipe networks are foreseen, one for plant nitrogen and one for instrument nitrogen.

The required quantity and quality of nitrogen is required in gaseous state with 10 bar abs. at plant battery limit and conducted to the consumers by means of an appropriate pipe network.

Compressed air system

Compressed air will be taken over and conducted to the various consumers by means of an appropriate pipe net-work.

A compressed air system having a pressure of min. 600 Kpa gauge.
Compressed air is required for the tap hole drilling machine and for general connection points.

Oxygen system

The required quality and quantity of oxygen will be supplied at plant battery limit with a pressure of 8 bar abs. From there it will be conducted by means of an appropriate pipe system to the tuyeres, dust burners and consuming points in the casthouse.

RC 84 Combustible Gases

Natural Gas System

The required quantity and quality of Natural Gas will be taken over at plant battery limit. From there it will be conducted to the pilot burner for the flare stack and the tapping launder by means of an appropriate pipe network. This Natural Gas will also be used for dryout of refractory and during start up of coal drying when COREX®-gas is not available.

RC 86 Steam/Hot Water/Heat Recovery

The required quantity of steam will be taken over at plant battery limit at 1200 Kpa and 430°C. Steam is used to influence the gas composition in the melter gasifier.

RC 9 Electric Energy Supply

General description

The electric power for the whole COREX®-Plant will be supplied from the plant 6 Kv-switchgear via two 6 Kv-cablelines connected to the two incoming feeders of the 6 kV-switchgear of the COREX®-Plant.

Each cableline, and later also the low voltage transformers are to supply the full power in case of failure of the corresponding device.

From the 6 kV switchgear with longitudinal bus-coupling and metering cubicles on both sides of the coupling, the following low voltage transformers and motors will be supplied:

transformers 6/0.4 kV 1.6 MVA
for charging, process and water treatment
transformers 6/0.4 kV 1.0 MVA

To improve the power factor each HV-motor will have a capacitor in parallel connection.

RC 91 High Voltage Facilities

6 kV-Switchgear

Consisting of

- incoming feeders 800 A
- metering cubicles
- coupling cubicle 800 A
- motor feeders 800 A with power factor connection
- transformer feeders 800 A

Transformers

- Distribution transformers 1.6 MVA
  6/0.4 kV $\pm$ 5 % Uk = 7 % Dyn 5 ONAN/ONAF

- Distribution transformers 1.0 MVA
  6/0.4 kV $\pm$ 5 % Uk = 7 % Dyn 5 ONAN/ONAF

RC 92 Low Voltage Facilities

Low Voltage Distribution Boards (MCC)

Consisting of

- motor control center for charging and process
- LV-distribution board
- motor control center for water treatment
- UPS-system for the basic automation and instrumentation system

RC 93 Electric Equipment

The following types are required:

- Incoming feeders
- Coupling cubicles

- Metering cubicles
- Transformer feeders
- Motor feeders

Transformers

For feeding of the low voltage switchgear resp. MCC's three-phase oil transformers are envisaged.

Motors

According to the present conditions regarding working load, method of operation, duty cycle, speed control, system conditions and coolant temperature, three-phase induction motors with squirrel-cage rotor, suitable for continuous and intermitted operation, are required.

- Three-phase Motors for High Voltage 6 kV
- Three-phase Motors for Low Voltage

Low Voltage Distribution Boards
(Motor control center)

Low Voltage Distribution Boards consist of feeding and coupling panel with withdrawable circuit breakers and several attached panels with plug-in unit compartments of superimposed arrangement. Feeders for supply of package units, magnetic valves, starting alarms and so on will be mounted in the panels (not in-plug-in units). A cable compartment for accommodating the power and control cables is installed in the right part of the panel. The panels are completely enclosed and can be installed in operating rooms at the wall or back-to-back.

Uninterrupted Power Supply (UPS)

For the power supply of the digital control system, the PLC-system, the alarm printer and the recorder a UPS is required.

The UPS is designed for short voltage fluctuations as well as for periods of main power failure of the incoming feeder.

RC 97 Lighting & Plug Socket System

Lighting and socket system (for process tower, casthouse, stock house, coal drying facility and sludge granulation).

Consisting of

- light-distributors max. 400/250 A
- light-sub-distributors and small-distributors max. 80/100 A
- luminaries with tubular lamps
- floodlight fittings
- lighting poles with slip filter luminaries
- luminaries in explosion-protection design
- socket panels
- individual sockets 380/32 A and 220 V/16 A

RC 98 Lightning & Earthing System

Lightning protection and earthing system has to be provided where required.

RC 99 Other Electrical Equipment

Depending on the safety of the overall emergency power supply it may become necessary to install an independent diesel power generator.

Table 3: Equipment List of COREX®-Plant

Item/Code	Designation Equipment	Number of Equipment	Main Technical Data
RC 13	Coal Drying Plant - receiving bins - dosing belt conveyor - hot gas generator - coal drier - dedusting equipment - transport equipment - steel structure	2 sets	max. heating value = 2 x 12 MW = appr. 24 MW
RC 16	Burden System - bunkers - weighing equipment - feeders - transport equipment - screens - steel structure	1 set	max. storage capacity for raw materials = 12 h
RC 19	Dedusting System - complete bag filter system for ore and coal including fan ductwork and hoods	2 sets	
RC 21	Furnace Charging System for ore and coal - bucket belt conveyors - charging bins, hoppers - coal screw conveyors - steel structure	2 sets	
RC 22	Reduction Shaft - burden distribution system - reduction shaft shell - refractories - screw conveyors ore - down pipes	2 sets	
RC 23	Melter Gasifier and Facilities - melter gasifier shell - refractories - stave cooling - tuyers - dust recycling system with dust burners - gas off takes - steel structure	2 sets	90 t/h = 180 t/h hot metal production
RC 25	Process Gas System - ductwork - refractories - gas cooling and cleaning system - cooling gas compressors - steel structure	2 sets	

Item/Code	Designation Equipment	Number of Equipment	Main Technical Data
RC 28	Tapping Equipment - tap hole drilling machine - tap hole clay gun - hydraulic unit	4 sets	
RC 29	Gas Cleaning and Dedusting system - ductwork - refractories - top gas cooling and cleaning system - steel structure	2 sets	
RC 31	Hot Metal Handling - Pool launder - iron runner - tilting runner - refractories - steel structure - crane	4 sets	
RC 32	Pig Iron Casting Machine	2 sets	90 t/h = 180 t/h pig iron
RC 39	Dedusting System - dedusting hoods - ductwork - filterhouse with dust discharge system - damper assembly - drought fan - clean air stack	2 sets	Raw gas capacity V_n = 2 x 800.000 = 1.600.000 m^3/h
RC 45	Sludge Recycling - Sludge dewatering unit - granulating mixer - storage and charging equipment for burn lime, cola fines - conveying equipment - steel structure	1 set	appr. 8 t/h (dry basis)
RC 46	Dust Recovery	2 sets	
RC 49	Slag Handling and Treatment - slag runners - refractories - slag pit - steel structure	4 sets	
RC 53	Maintenance Post	1 set	
RC 62	Production and Process Control System	2 sets	
RC 63	General Instrumentation	2 sets	
RC 64	Basic Automation	1 set	
RC 69	Communication System	2 sets	
RC 71	Plant Office	1 set	
RC 75	Fire Alarm and Fighting System	2 sets	

Item/Code	Designation Equipment	Number of Equipment	Main Technical Data
RC 81	Water Supply/Treatment	2 sets	
RC 82	Water Circuits and Cooling systems	2 sets	
RC 83	Incombustible Gases and Compressed Air	2 sets	
RC 84	Combustible Gases	2 sets	
RC 86	Steam/Hot Water/Heat Recovery	2 sets	
RC 91	High Voltage Facilities	2 sets	
RC 92	Low Voltage Facilities	2 sets	
RC 93	Electric Equipment	2 sets	
RC 97	Lighting and Plug Socket System	2 sets	
RC 98	Lightning and Earthing System	2 sets	

2.3 STEEL MELT SHOP

2.3.1 PROCESS DESCRIPTION

Basically, the steel plant consists of three aisles:

- charging aisle
- converter aisle
- ladle aisle

Material flow is designed such that the input materials are transported in longitudinal aisle direction, the primary and secondary products in transverse direction.

The hot metal is filled into the charging ladle and weighed and then supplied to the steel plant by means of a ladle fork lift. There, the charging crane conveys the ladle to the hot metal desulphurization station.

Hot metal desulphurization

This process is not part of the LD process but will be used to produce low sulphur steel grades.

The hot metal is delivered by rubber type ladle carrier in charging ladles from the COREX® plant to the steelmaking plant.

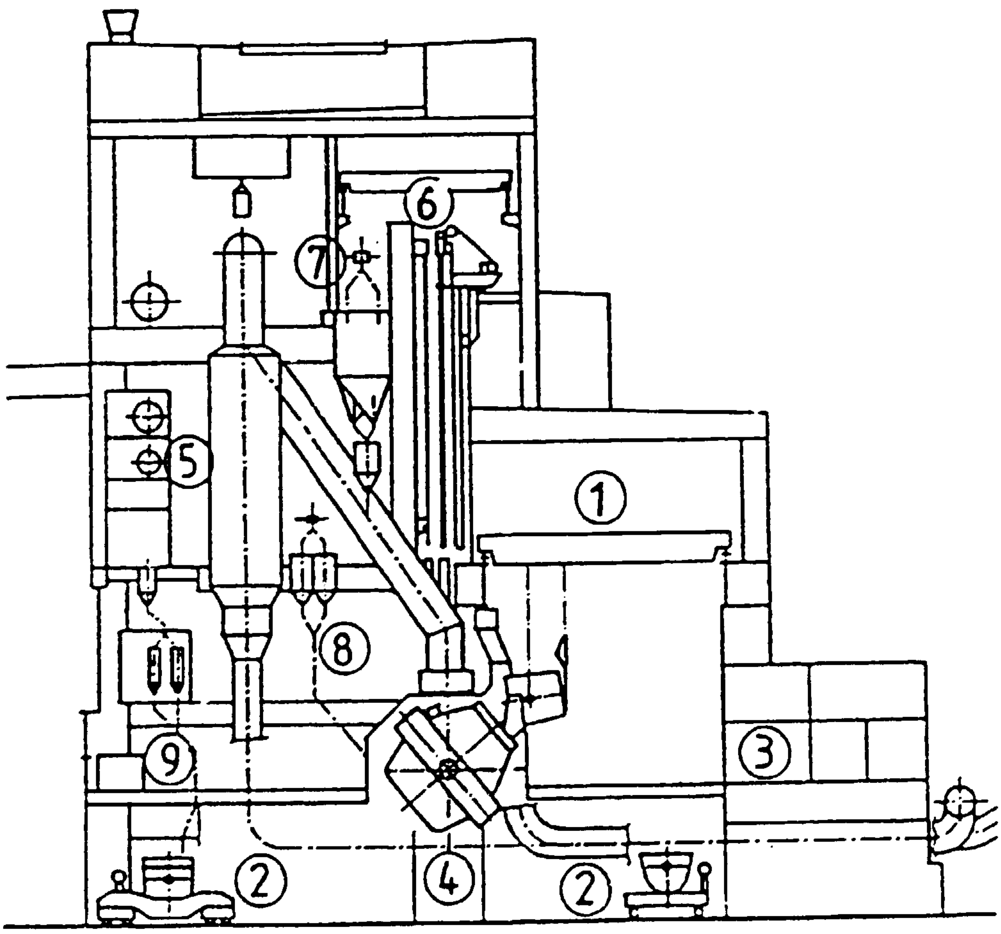
Prior to pouring into the converter the hot metal is desulphurized whereby desulphurization reagent is injected into the hot metal.

Desulphurization is carried out in the charging ladle.

The slag produced from the hot metal desulphurization is relatively high in sulphur and is removed into a slag pot by a skimming machine.

Fig. 3: **Cross Section through LD Plant**

1 Charging Crane
2 Mill vehicles (Slag pot car, Ladle car)
3 Central control room
4 Converter
5 Waste gas cooling-, and cleaning system
6 Oxygen-, sublance equipment
7 Flux addition system
8 Alloy addition system
9 Ladle trimming stand



Converter Charging

The scrap is delivered in prepared weights, loaded in charging chutes from the scrap yard to the steelmaking plant, where it is charged directly into the converter held by a charging crane.

The hot metal is spout-poured into the converter from a charging ladle held by a charging crane.

For hot metal pouring and scrap charging the converter is brought into charging position by means of its tilting drive.

Refining in LD converter

After the scrap and hot metal are charged the water-cooled oxygen lance is lowered into the converter and oxygen is turned on. The LD process uses pure oxygen to refine the hot metal into steel. Oxygen is blown with super sonic speed onto the hot metal.

Once ignition is obtained, fluxes are added according to requirements of slag chemistry immediately or batchwise to produce sufficient basic slag at the early part of the blow to protect the converter lining and to reduce impurities such as S and P to final acceptable levels.

The main thermochemical reaction which take place during the blow is exothermic oxidation of carbon, silicon, manganese, iron and are as follows:

$[C] + \{1/2\ 0_2\} = \{CO\}$
$[Si] + \{0_2\} = (Si0_2)$
$[Mn] + \{1/2\ 0_2\} = (MnO)$
$[Fe] + \{1/2\ 0_2\} = (FeO)$

The combination of these elements with oxygen and the sensible heat of the hot metal generate sufficient heat to raise the temperature of the metal to the required level and to allow the use of scrap, cold pig iron, iron ore, in the charge to balance the excess heat available.

Some elements are discharged in gaseous form from the converter or combine with the fluxes to form slag i.e.

Si: $(SiO_2) + 2(FeO) = (2\ FeO\ .\ SiO_2)$
$(2\ FeO\ .\ SiO_2) + 2(CaO) = (2CaO\ .\ SiO_2) + 2(FeO)$

P: $2[P] + 5(FeO) + 4(CaO) = (4CaO\ .\ P_2O_5) + [5Fe]$

S: [S] + (CaO) + (CaS) + [1/2 O_2]

C: [C] + {1/2 0_2} = {CO}

A small portion of CO is post-combusted to CO_2.

{CO} + {1/2 0_2} = {CO_2}

Note: [ ] dissolved in steel
( ) in slag
{ } gaseous

Reaction between the oxygen and the metal intensifies with the increasing evolution of CO gas.

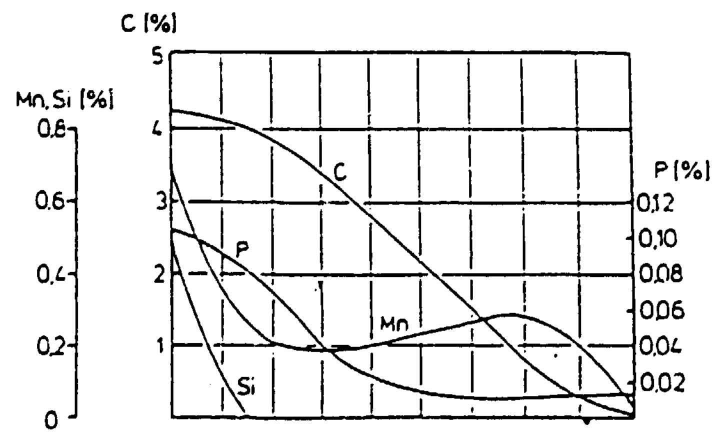
The agitation and circulation of the bath cause intimate mixing of slag and metal. This reaction is further supported by the injection of inert gas (N_2, Ar) through the converter bottom especially at the end of decarburization when Co gas evolution decreases.

The characteristic of oxygen blowing can be described as hard or soft. In a hard blow a greater penetration of the oxygen jet into the bath is used by lowering the oxygen lance closer to the bath. A soft blow means less oxygen jet penetration.

Typical results of the two types of blow are as follows:

	Hard	Soft
FeO in Slag	decrease	increase
Residual bath P	increase	decrease
Residual bath Mn	increase	decrease
Slopping	decrease	increase
Refractory wear	decrease	increase

A typical pattern of the change of bath chemistry during a blowing cycle is shown below:



Some time before end of blow the heat is tested for carbon and temperature to predict the blow end conditions by use of a sublance with dynamic process model. If the predicted conditions deviate from the desired turn-down conditions immediate corrective measures are applied (coolant or heating agent additions, additional amount of oxygen, etc.).

At end of blow the heat is again tested for carbon, temperature and analysis.

Converter Tapping and Alloying

Once the temperature and analysis are adjusted, the teeming ladle is brought into position underneath the converter and the converter is turned down for tapping. During tapping ferro alloys, deoxidants and top slag are added, according to requirements, into the teeming ladle.

Ladle argon stirring during and some time after tapping is used to assist dissolution of ferro alloys and homogenization of steel.

Excessive slag carry-over from the converter into the teeming ladle is hindered by the use of a slag stopper device which closes the taphole at the end of tapping.

Converter Deslagging

After tapping is completed, the converter is brought into deslagging position and is drained from liquid slag. The slag is collected in a slag pot brought into position underneath the converter.

Ladle Furnace Treatment

Before the heat is handed over to the continuous caster the liquid steel is finally treated to meet the requirement for the casting process.

A ladle furnace is used as secondary metallurgy unit providing the following functions:

- Temperature adjustment (heating or cooling)
- Final analysis adjustment
- Homogenization by inert gas stirring
- Fine deoxidation
- Modification of non-metallic inclusions
- Steel desulphurization

Furthermore, the ladle furnace operates as a buffer between converter and continuous caster enabling to hand over the heat just on time for sequence casting.

The slag accumulating in the steel plant is transported in slag buckets from the place of accumulation in the charging aisle and/or the ladle aisle to the slag preparation. Transport is by vehicles on the road.

The charging and/or teeming ladles required for operation are relined in a central ladle lining aisle in extension of the ladle aisle. They are then transported on the road to the charging aisle or for hot metal transfer. Two slide-gate changing stations with horizontal driers are installed in the ladle aisle also.

2.3.2 PERFORMANCE CALCULATION

2.3.2.1 YEARLY PRODUCTION TIME (see item 2.2.4)

2.3.2.2 BASIC DATA

HM analysis:	C = 4.2 %
	Si = 0.6 %
	Mn = 0.24 %
	P = 0.05 %
	S = 0.05 %
	(before De-S)
HM temperature:	
at COREX®-tap:	1 485° C (average)
at charging:	1 400° C
Coolants:	Pig iron
	Return scrap
	Purchased scrap
	Dust briquettes
	Lump ore
Steel at tap:	
- Analysis:	C = 0.05 % - 0.07 %
	S $\leq$ 0.01 %
- Temperature:	1 650° C

Converter Charge

HM	802 kg/t
Scrap + pig iron	278 kg/t
Briquettes	13 kg/t
Alloys	12 kg/t

2.3.2.3 ANNUAL OUTPUT

Tap to tap time	37 min.
Periodical maintenance time	3.5 min.
Unscheduled down time	1.5 min. 1/
Total tap/tap time	42 min.

Required amount of liquid steel for CC: 1 615 000 t/a

Charges/d: $\frac{24 \times 60}{40.5} = 35.55$

Charges/y: 301.3 x 35.55 = 10 713

Required converter capacity: $\frac{1\,615\,000 \text{ t/a} \times 40.5}{7\,232 \text{ h} \times 60} = 150$ t/heat

Design capacity: 150 t/heats

Periodical maintenance during operation

- Taphole repair (every 80 heats, 50 min.)
- Converter mouth maintenance (breaking skulls)
- Gunning

Unscheduled down time (240 h)

- Delay in material supply
- Waiting time for tapping
- Equipment failure

1/ included in 240^h unscheduled downtime as per 2.2.5

2.3.3 MAIN EQUIPMENT AND MACHINERY

SL 11 Scrap Handling

The scrap is delivered from the scrap yard in prepared weights, loaded in scrap chutes by means of a by road transportation from the scrap yard to the steel-making plant.

The scrap chute is equipped with rollers and pulled by a tractor.

Charging of scrap into the converter is carried out by a scrap charging crane.

SL 12 Alloy Handling

Alloys are delivered by dump trucks to the alloy store building for intermediate storage. According to requirements, the alloys are dumped into a ground bin, discharged by a vibrating feeder onto a belt conveyor and conveyed to the steelmaking plant.

SL 13 Additive Handling

All fluxes, except burnt lime, are delivered by dump trucks to ground hoppers, located outside of the steelmaking plant, for intermediate storage. The fluxes are discharged by vibrating feeders onto a belt conveyor and conveyed to the steelmaking plant.

The burnt lime is directly conveyed from the calcining plant to the high level storage bins above the converter.

SL 15 Hot Metal Handling

The hot metal is delivered in capped charging ladles by ladle fork lifts from the COREX® plant to the steelmaking plant.

Ladle tilting stands are provided at the hot metal treatment stations in which the charging ladle is deposited vertical for desulphurisation and tilted as required for deslagging by a skimming machine.

The charging ladles are designed with a pouring spout and are lined with refractories.

The hot metal is poured into the converter by a hot metal charging crane.

Drying and heating of charging ladles is carried out by vertical ladle heaters.

SL 16 Hot Metal Treatment

Injection facilities including storage bins and pressure vessel are assumed to desulphurize the hot metal.

For hot metal treatment the charging ladle is deposited on a ladle tilting stand located in a treatment box.

A temperature measuring and sampling device with slag breaker is also required.

SL 18 Ladle Handling

The ladle handling facilities comprise equipment required for the cooling, wrecking, relining, drying/heating and transportation of ladles which are taken out of the production cycle.

The equipment comprises:

- Ladle handling crane
- Vertical ladle dryers
- Ladle relining stand
- Wrecking machine
- Ladle tilting stand
- Ladle cooling blower
- Relining tools (mortar mixer, brick cutter, etc.)

SL 21 Converter Charging System

The fluxes are conveyed via a conveyor belt system from the ground hoppers and calcining plant to the steelmaking plant where they are stored in high level bins above the converters. The bins hold a capacity of at least 12 hours operation. The fluxes are discharged from these bins by vibrating feeders or dosing gates, weighed and added via chutes into the converter.

SL 22 Converter Plant

One (for stage 1) or two (for stage 2) converters are incorporated in the steelmaking plant. The operating mode is 1 out of 1 converter (one converter in operation) respectively 2 out of 2 for stage 2.

The converter shell is equipped with removable lipring segments and with a taphole for steel discharge.

The converter shell is lined with refractory bricks.

Each converter shell is suspended in a trunnion ring via a suspension system. The trunnion ring is supported by its two pins via bearings on two pedestals. A tilting drive allows free rotation of the converter to either sides. Tilting speed is stepless controlled.

Tilting of converter is carried out at auxiliary control stands on charging and tapping side.

Each converter is enclosed by a doghouse to capture fumes and sparkings. The doghouse is equipped with two sliding doors in front side and two slewing doors at back side.

SL 23 Lance Blowing Device

For each converter a lance blowing device is required.

Each lance blowing device consists of two lances both connected to oxygen and cooling water hoses, ready for operation. The lances are automatically exchanged in their position (operation or stand-by) by a horizontal moveable lance carrier.

The water cooled lance is fixed on a separate lance car which is vertically moved into the stationary lance guide.

Lifting and lowering of the lance is carried out by a hoisting device.

SL 24 Auxiliary Equipment

Slag stopper and slag detection system

Each converter is equipped with a pneumatic slag stopper and a slag detection system which are arranged at the taphole.

The slag stopper is actuated pneumatically and injects compressed air or nitrogen through the taphole to prevent slag carry-over into the teeming ladle at the end of tapping. To ensure immediate response of the slag stopper a buffer tank (4 m^3) is required next to the converter.

The slag detection system utilizes electromagnetic principles and produces an alarm when slag flow starts.

Upon alarm the slag stopper closes automatically. In addition, an optical or acoustic signal indicates end of tapping.

The two sensor coils are installed inside of the taphole.

Bottom stirring system

Each converter is equipped with a bottom stirring system.

Inert gas (Ar, N_2) is injected through the converter bottom via stirring elements to improve metal to slag reactions.

Each stirring element is individually flow controlled.

A rotary joint provides for introduction of the piping into the trunnion pin from where the piping is routed to the converter bottom.

The rotary joint allows unrestricted rotation of the converter through 360°

For the injection of inert gas approximately 10 stirring elements are envisaged.
A valve station incorporates all equipment and instruments required for the control of pressure and flow rate of the inert gas (Ar, N_2)

Sublance system

The sublance system serves for measuring the carbon content, the steel bath temperature, oxygen activity, as well as for sampling of steel without tilting the converter during and after completion of oxygen blowing by using various types of sensors.
The bath level (hot metal) is measured with a special type of sensor before charging of scrap.

The sensors are automatically discharged from the sensor storage and handled by a manipulator which attaches/detaches the sensor to/from the contact rod of the sublance.

The water-cooled sublance is lowered by means of the sublance car through a sealed sublance socket into the converter to a predetermined bath depth.
The retention time in the steel bath is controlled according to requirements.

During lifting of the sublance out of the converter, slag scrapers are actuated to clean the sublance from slag deposits. As soon as the highest position is reached, the sublance socket is closed automatically by a sublance gate. The sensor is removed from the sublance by a manipulator and dropped through a recovery chute to the working platform for manual probe dispatch to the laboratory.

Converter relining

The converter relining facilities comprises equipment which is required for the cooling, relining, gunning and preheating of the converter as well as for repair of the taphole.

The equipment comprises:

- Service crane
- Gunning machine
- Relining device
- Taphole repair machine
- Preheating burner
- Cooling blower
- Relining tools (mortar mixer, brick cutter, etc.)

Temperature measuring and sampling device

The device is used for temperature measurement and sampling of steel in the teeming ladle, after tapping at the ladle bubbling stand.

The measuring lance is fixed to a lance car which is vertically moved in a guide. Lifting and lowering is carried out by a hoisting device. The sensor is attached/detached manually to/from the measuring lance.

SL 25 Waste Gas Cooling and Cleaning

The waste gas exiting the converter at high temperature is drawn into the cooling stack where it is partly combusted according to the air quantity drawn in.

From the water-cooled cooling stack the waste gas is ducted into the wet-type filter plant, in which, the cleaning of the waste gas is achieved in two stages.

In the precleaning stage, by the injection of water, the waste gas is further cooled and at the same time the coarse and medium sized dust particles are separated.

The precleaning stage consists of a vertical saturator which is connected to the cooling stack.

The connection to the cooling stack is equipped with a water sealed valve.

From the precleaning stage the injected water together with the absorbed dust particles is directed into an intermediate tank , from which the sludge water is directed via a trough to the water treatment and sludge handling plant.

The precleaned waste gas then enters the second cleaning stage where precision cleaning is performed.

The scrubbing water injected at high speed is carried along by the gas and mixed intensively.

During the process, the dust contained in the waste gas is washed out by the water droplets.

In the scrubbing water separator arranged downstream, the water with the dust is separated from the waste gas. This water then flows back into the first cleaning stage via pumps. This circuit returns the scrubbing water for reuse.

The cleaned waste gas flows to the I.D.fan via a duct line and then into the clean gas stack. Prior to entering into the atmosphere, the waste gas is flared off at the top of the clean gas stack.

The waste gas containing sufficient CO-gas is directed via a switch over station into the gas holder.

SL 26 Ladle Alloying System

The alloys are conveyed via a belt conveyor system from the ground hopper to the steelmaking plant, where they are stored in bins above the converters and ladle furnace. The alloys are discharged from these bins by vibrating feeders, weighed and added via a chute into the teeming ladle during tapping and ladle treatment respectively.

SL 27 Liquid Steel Handling

The facilities for liquid steel handling comprise of equipment required for the heating, repair (slide gate) and transportation of teeming ladles which are in the production cycle.

The equipment comprises:

- Teeming crane
- Teeming ladles with slide gates and refractory linings

- Ladle transfer cars
- Ladle stands (for horizontal deposit)
- Ladle heater (horizontal type)
- Ladle heaters (vertical type)
- Slide gate repair tools

SL 29 Secondary Dedusting System

The function of the secondary dedusting plant is to extract the fumes generated during the following operations:

- Charging of converter
- Tapping of converter
- Hot metal treatment

For this purpose hoods are arranged at the extraction points.

The gas duct lines of the individual hoods are connected to a common main gas duct which feeds the bag house. The cleaned gas is directed into the atmosphere. The separated dust is conveyed via mechanical conveyors into a dust hopper. At the outlet of the dust hopper a moisturizing equipment provides for dust treatment before transportation.

SL 31 Alloying Secondary Metallurgy

Refer to SL 12 and SL 26.

SL 32 Ladle Bubbling Stand

During and after tapping the steel is stirred by injection of inert gas (Ar) through a stirring brick. A valve station is provided to control the required pressure and flow rate of intergas (Ar)

SL 33 Ladle Furnace

The ladle furnace mainly consists of:

- Electrode lifting and supporting unit
- Furnace roof with suspension
- High current system: Transformer house and high current cables
- Hydraulic system with cylinders and piping
- Cooling water piping
- Lubrication system

The furnace roof is of water cooled tube-to-tube design with holes for the electrodes and openings for alloying, sampling, temperature measurement and wire injection.
Lifting of electrodes and furnace roof is done hydraulically by cylinders. The hydraulic system is operated with a water-glycol mixture.
The high current cables are designed as water cooled multiple cables.

A transfer car transports the teeming ladle into and out of the treatment position.

SL 34 Auxiliary Equipment for Ladle Furnace

Comprising:

- Wire feeding machines for solid and filled wire
- Top lance facilities with valve station
- Temperature measuring and sampling device
- Valve station for ladle bubbling
- Electrode nipple stand

SL 45 Waste Gas Recovery
Refer to SL 25.

SL 49 Slag Handling

The slag generated at the hot metal treatment station, converters and residual ladle slag is collected in slag pots. The slag pot is made of castings.
For deslagging of the converter, the slag pot is placed on a slag pot car which transports the slag pot outside of the steelmaking plant.

The slag pot is transported by an automotive carrier to the slag yard for further processing.

2.3.4 EQUIPMENT LIST OF LD-PLANT

Table 4: Equipment List of LD-Plant

Item/Code	Designation	Number of Equipment	Main Technical Data
SL 1	Raw and charging material treatment		
SL 11	Scrap handling - Charging crane - Chutes	1 set	 volume approx. 40 m^3
SL 12	Alloy handling system - vibrating feeder - combi gate - belt conveyor with weighing equipment - tripper car - emergency discharge chute for belt conveyor - grating for receiving bin - grating for ground level storage bin	2 sets	
SL 13	Additive handling - unloading station - inclined belt conveyor - reversible belt conveyor	2 sets	
SL 15	Hot metal treatment - hot metal charging crane - hot metal charging ladle - ladle tilting stand - deslagging machine - ladle bubbling equipment - measuring/sampling lance system - ladle heater	1 set	
SL 16	Hot metal treatment - Desulphurizing stand	1 set	
SL 18	Ladle handling	1 set	
SL 19	Dedusting system for hot metal treatment - pipe line - damper - bag house - dust container - discharge device - ID fan - clean gas stack	1 set	
SL 2	Blowing operation		

Item/Code	Designation	Number of Equipment	Main Technical Data
SL 21	Converter charging system - high level bin - combi gate - vibrating feeder - weighing bin - reversible belt conveyor - charge bins - dosing gate - y-chute - addition chute - seal gate - compensator - emergency chute	2 sets (1 set)	
SL 22	Converter - converter shell - converter suspension - trunnion ring - supporting bearing and housing - converter tilting drive - converter pedestal - bottom stirring equipment on converter	2 sets	150 m^3 2 x 150 t
SL 23	Lance blowing device - oxygen lance - oxygen flexible hose - water flexible hose - lance guide car - movable lance carrier - fixed guide - maintenance platform	2 sets	550 m^3 (std)/min./converter top and bottom blowing 850 m^3 (std)/min./converter
SL 24	Auxiliary equipment - slag stopper - dog house - temperature measurement and sampling equipment - valve station bottom stirring - valve station top blowing - media supply system for slag stopper	2 sets	
SL 25	Waste gas cooling and cleaning - secondary dedusting - gas holder	2 sets	Combustion rate 0.1 Flow rate 1 000 000 m^3/h Volume 70.000 m^3
SL 26	Ladle alloy/additive system - high level bins - vibrating feeder - belt conveyor	2 sets (1 set)	

Item/Code	Designation	Number of Equipment	Main Technical Data
SL 27	Liquid steel handling - teeming crane - teeming ladle - emergency ladle - ladle transfer car - sliding gate with hydraulic units - equipment for sliding gate maintenance - maintenance platform - ladle support - teeming ladle sand addition device - ladle heater	1 set	
SL 29	Dedusting system for ladle alloy system	1 set	
SL 3	Secondary metallurgy		
SL 31	Alloying secondary metallurgy facilities	1 set	
SL 32	Ladle stirring/bubbling injection	2 sets	
SL 33	Ladle furnace	1 set	Rated voltage max. 36 kV Furnace transformer 20 MVA Secondary current 45 kA
SL 39	Dedusting system for ladle furnace	1 set	
SL 4	Slag treatment and recycling facilities		
SL 45	Waste gas recycling	1 set	Flow rate 85.000 m^3 (std)/h/converter
SL 46	Dust recovery	1 set	75 m^3 (std)/t
SL 49	Slag handling - slag pot - slag pot transfer car	1 set	Volume approx. 15 m^3
SL 5	Maintenance and store		
SL 51	Lance repair shop	1 set	
SL 6	Information system		
SL 62	Production and process control system	1 set	
SL 63	General instrumentation	1 set	
SL 64	Basic automation	1 set	
SL 69	Communication System	1 set	
SL 7	Infrastructure and auxiliary equipment		

Item/Code	Designation	Number of Equipment	Main Technical Data
SL 75	Fire alarm and fighting system	1 set	
SL 8	Utility supply and treatment		
SL 81	Water supply treatment	1 set	
SL 82	Water circuits and cooling system	1 set	
SL 83	Incombustible gases and compressed air	1 set	
SL 84	Combustible gases	1 set	
SL 86	Steam/hot water/heat recovery	1 set	
SL 9	Electric energy supply		
SL 91	High voltage facilities	1 set	
SL 92	Low voltage facilities	1 set	
SL 93	Electrical equipment	1 set	
SL 97	Lightning and plug socket system	1 set	
SL 98	Lightning and earthing system	1 set	

2.4 THIN SLAB CASTING - DIRECT ROLLING

2.4.1 GENERAL ROUTE DESCRIPTION

2.4.1.1 CONTINUOUS CASTING

Killed crude steel at about 1 600°C is cast into a water cooled copper mould or rather sleeve. The cross section identifies the cross section of the slab, whereby the width is adjustable conforming approximately to the strip width to be rolled. »Thin Slab Casting« generally refers to slab heights of well less than 100 mm, 50 to 70 mm having become the most common.

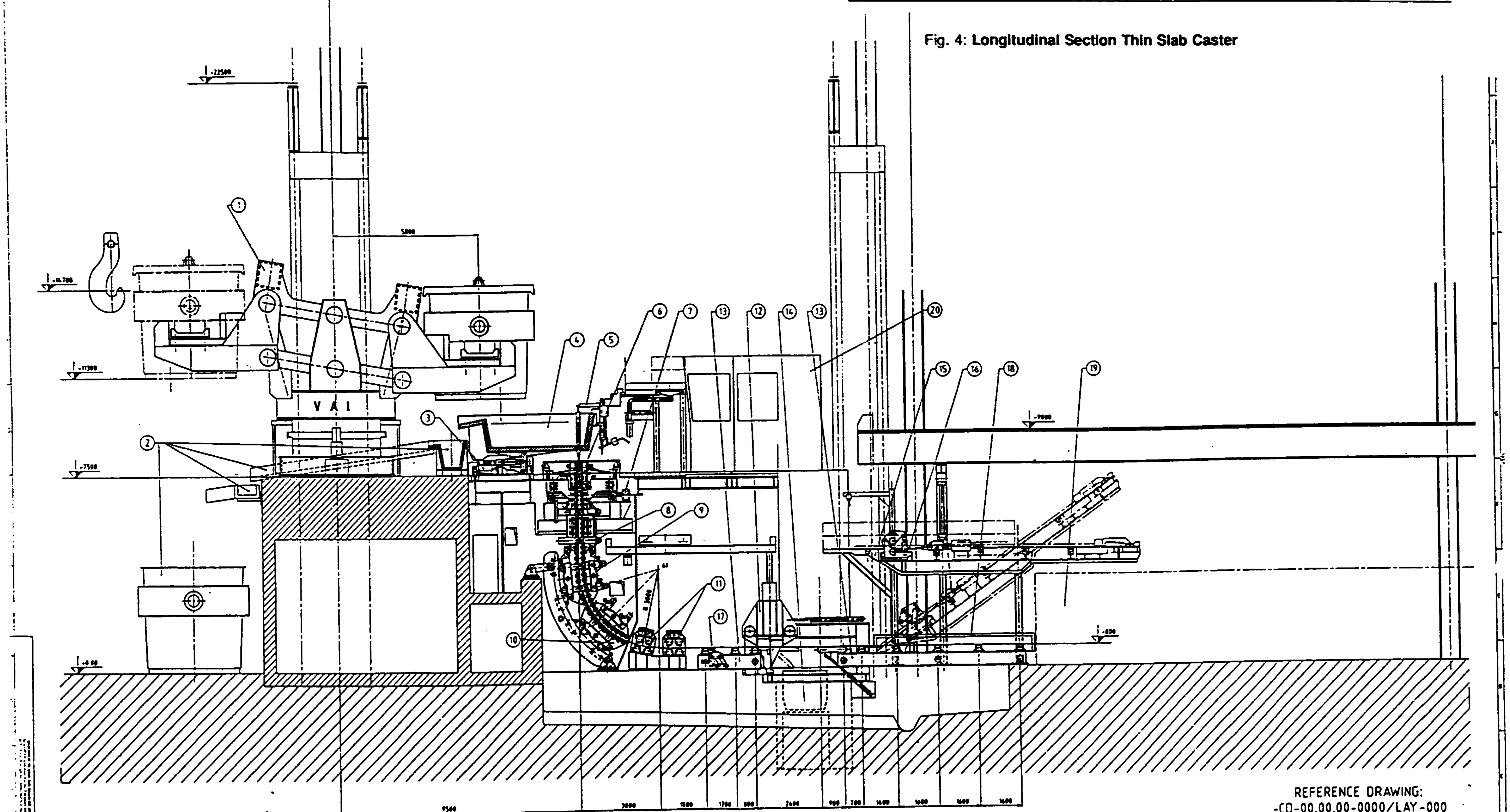
The process and the main equipment is principally the same as with conventional continuous casting, the cooled thin slab also being guided in a 90° arc from the vertical into the horizontal plane, except that this slab is cut much longer due to its thinness to comply with the weight of a conventionally cast slab (i.e. 3 to 3.5 times longer).

After being cut this slab now slowly travels in line through a soaking furnace of more than 120 m length to equalize the temperature differences between the core and the surface of the thin slab.

2.4.1.1.1 Hot Strip Rolling 56"

After exiting the furnace the thin slab is being descaled, cropped, and enters in line into the 4 high finishing mill (6 stands) to be dressed down to its designated strip thickness. This mill again is similar to the finishing mill of the conventional type, as are all the other downstream facilities like laminar flow cooling, coiling and possibly slitting, edge trimming, etc.

Fig. 4: **Longitudinal Section Thin Slab Caster**



REFERENCE DRAWING:
-CD-00.00.00-0000/LAY-000

PROJECT DRAWING ONLY

LEGEND

1 LADLE TURRET BUTTERFLY TYPE
2 EMERGENCY CASTING SYSTEM
3 TUNDISH CAR
4 TUNDISH
5 STOPPER ROD CONTROL
6 AUTOMATIC WIDTH ADJUSTABLE MOULD
7 4-EXCENTER OSCILLATOR WITH QUICK CHANGE FRAME
8 VERTICAL RACK
9 BENDER SEGMENT
10 BOW SEGMENT
11 WITHDRAWAL STAND WITH DRIVES
12 HYDRAULIC SHEAR
13 ROLLER TABLES
14 CROP END CHUTE AND BUCKET
15 DUMMY BAR RAMP
16 DUMMY BAR
17 DUMMY BAR DISCONNECTING DEVICE
18 ROLLER TABLE INSULATION
19 REHEATING FURNACE
20 MAIN CONTROL ROOM

TECHNICAL DATA

HEAT SIZE:
CASTING WIDTH:
CASTING THICKNESS:
CASTING SPEED:
METALLURGICAL LENGTH:
MACHINE RADIUS:
TUNDISH CONTENT:

CC-PLANT CONROLL®
LONGITUDINAL SECTION
1 STRAND THIN SLAB CASTER
-CD-00.00.00-0001/LAY-000

2.4.2 THIN SLAB CASTING AND ROLLING PLANT

2.4.2.1 CONTINUOUS CASTING PLANT

2.4.2.1.1 Basic Technical Data

Production	approx. 1 600 000 t thin slabs/year
Design of thin slab caster	bow-type caster with straight mold, vertical upper segment, strand containment, segments and continuous, bending and straightening of strand according to the state of the art proprietary bending and straightening process
Mold	straight parallel mold
Length	1200 mm
Strand containment:	intermediately supported rollers in vertical rack, bending & bow segment
No. of machines	1
No. of strands per machine	2
Height of casting platform	approx. 7.5 m
Bow radius	3 m
Metallurgical length	approx. 7.3 m
Withdrawing unit	driven rollers in straightener
Strand cutting facility	flying shear
Slab dimensions:	
Thickness	70 mm (cold condition)
Width	700 - 1300 mm (cold condition)
Length for spec. coil weight	approx. 32 m
Casting capacity per machine	average 2.4 tons/min and strand
Casting speed	max. 4.0 m/min average 3.5 m/min
Max. caster speed (drives only)	6.0 m/min
Steel grades	acc. to product mix

E:\projekte\ptks-bo\phase-2\tech-desc\1-4.wp5

2.4.2.1.2 Main Machinery and Equipment

CD 21 Ladle Turret

The thin slab caster is provided with a ladle turret which enables easy sequence casting with ladle exchange on fly. The ladles are independently lifted and commonly rotated in either direction.

CD 22 Tundish equipment

Two tundish cars are running perpendicular to the casting direction on the casting platform. The tundish car is fully hydraulically driven. The tundish is of through type, is approximately 4 m long and 0.85 m wide (inner dimension) and has a capacity of 22 t at its overflow level (1000 mm). It is provided with an automatic hydraulic stopper control which is connected to the mold level control system.

A tundish preheater is provided at each tundish car parking position at the end of the runway. The submerged entry nozzle, which is specially designed for thin slab casting, is preheated before start of casting.

CD 23 Ladle shroud manipulator

A ladle shroud manipulator is mounted on the casting platform. The shroud is manually swung, rotated lifted, lowered and moved back and forth.

CD 24 Steam exhaust system

The entire strand guide is enclosed by the cooling chamber. The steam generated during casting is sucked into the steam duct from the cooling chamber and exhausted into the atmosphere by the exhaust fan through the stuck.

Water cooling system

The caster is equipped with the mold cooling system, spray cooling system and machine cooling system.

The mold cooling water which is of soft water is running in a closed circuit and cooled by a heat exchanger. The loss of soft water takes place only when the mold is exchanged.The cooling water flow for all four mold Cu-plates are independently monitored and controlled.

The air - water spray is used for the secondary cooling system. The cooling water flow is dynamically controlled according to the strand age in the strand guide.The spray cooling piping after the main strainer is made of stainless steel.

The cooling systems are connected to the emergency cooling systems to protect the machine.

CD 25 Mold

The mold is provided with straight and parallel Cu-plates which does not give unnecessary deformation on the very thin strand shell in the mold. The optimized cooling slot geometry serves for high and uniform heat flux. The mold is provided with width change device for the width change between casting sequences (during restranding). The mold is quick changeable and fixed to the lifting table of the oscillator. The water connections are automatically after mounting the mold.

One pair of foot rollers with 2 intermediate supports and 100 mm diameter is provided below the wide face Cu-plates. The foot rollers are stainless steel overlay welded. The strand is cooled via spray nozzles at the exit of the mold.

Quick change stand

The mold, lifting table, lifting table guides, the oscillator and the vertical rack are mounted on a quick change stand. A 4-eccentric type oscillator oscillates the mold in a sinusoidal way. The frequency is adjusted by changing the AC-motor speed automatically according to the casting speed and the stroke is adjusted manually by changing the eccentricity of the drive shafts. The mold lifting table is guided by wearfree rod type guide units. The mold and vertical rack can be exchanged independently upward through the opening of the lifting table or handled together with the quick change stand. The water/air connections are automatically after mounting the quick change stand.

CD 26 Vertical rack

The vertical rack supports the strand after leaving the mold. It consists of intermediate supported rollers of 150 mm diameter. They are stainless steel overlay welded for long service life.

Cooling of the strand is via air-mist nozzles. The vertical rack can be quickly exchanged.

Bender Segment

The bender segment is of frame type and supports the strand after leaving the vertical rack. It bends the strand into a constant radius of 3 m continuously according to the VAI-bending curve. The rollers are intermediate supported, 175 mm in diameter and stainless steel overlay welded for long service life.

Cooling of the strand is via air-mist nozzles.

Bow Segment

The bow segment is designed similar to the bending segment. There the final solidification takes place.

CD 27 Withdrawal Unit

The withdrawal unit serves for dummy bar and slab transportation. Furthermore the solidified slab is straightened to the horizontal position. The rollers are of solid type, individually driven via DC-motors and adjusted via hydraulic cylinders.

The roller diameter is 300 mm and the surface is stainless steel overlay welded.

Slab shear

After the withdrawal unit a flying hydraulic shear is provided to cut the strand into the desired length. For crop chopping a crop end removal system is provided below the shear.

Dummy bar system

The dummy bar ramp is located after the shear. Prior to the start of casting the dummy bar is driven into the strand guide by the withdrawal unit. The dummy bar is disconnected by a disconnection device located in front of the shear from the hot strand when the dummy bar head comes out of the strand guide after start of casting. Then the dummy bar is driven up to the ramp by the pinch rolls on the ramp. The dummy bar ramp is then lifted to the waiting position by hydraulic cylinders and a heat insulation cover is closed to protect the slab from heat losses.

CD 28 Roller table

After the withdrawal unit a roller table is provided to transfer the strand to the roller hearth furnace. Parts of the roller table are covered with heat insulating hoods.

CD 51 Machine maintenance area

The machine maintenance area is located in the furnace bay to carry out the alignment, function test and assembly and disassembly work at the molds, quick change stand and segments. A cross transfer serves for transportation between the bays. A 3.5 t wall crane serves for assistance during work.

CD 52 Tundish maintenance area

The tundish maintenance area is located in the casting bay to cool down, deskull, reline and dry the tundish lining. Castable refractory is used.

CD 89 Hydraulic system

The description of the mill refers to the following main equipment units consisting of:

The hydraulic system consists of

- main hydraulic unit
- shear hydraulic unit
- ladle slide gate hydraulic unit
- tundish stopper hydraulic unit
- maintenance area hydraulic unit

Water clycol is used. All units are provided with necessary pumps, tank, valve stands, gauges, filters, accumulators, etc. The piping in the cooling chamber is made of stainless steel.

Lubrication system

The lubrication system consists of

- lubrication unit for the ladle turret and
- lubrication unit for the caster

All units are equipped with necessary pumps, gauges, pressure switches, distributors, flexible hoses, etc. The piping material in the cooling chamber is made of copper.

Table 5: **Equipment List (Continuous Casting Plant - Thin Slab)**

Item/Code	Designation	Number of Equipment	Main Technical Data
CD 2	Process Equipment		Format 700-1300x70 mm 1 x 2 Strand machine
CD 21	Ladle equipment & emerg. casting equipment	1 set	Ladle turret: butterfly type
CD 22	Tundish equipment	1 set	
CD 23	Additional equipment	1 set	
CD 24	Supporting structure & cooling chamber	1	
CD 25	Mold and oscillating facilities	2 set	4-eccenter oscillator
CD 26	Strand guide	2 set	r = 3 m, h met = 7.3 m
CD 27	Dummy bar & cutting facilities	2 set	D/B bottom feeding system, hydraulic shear
CD 28	Runout facilities	2	
CD 5	Maintenance & Stores		
CD 51	Machine maintenance	1 set	
CD 52	Tundish relining	1 set	
CD 54	Spare parts depot	1	
CD 57	Refractory store	1 set	
CD 58	Operating parts store	1 set	incl. operational spares
CD 59	Measuring & auxiliary equipment	1 set	
CD 6	Information system		
CD 62	Production and process control system	1 set	
CD 63	General instrumentation	1 set	
CD 64	Basic automation	1 set	
CD 69	Communication svstem	1 set	
CD 7	Infrastructure & Auxiliary Equipment		
CD 75	Fire alarm & fighting system	1 set	
CD 8	Utility supply & Treatment		
CD 81	Water Treatment		
CD 82	Water circuits & cooling system		

Item/Code	Designation	Number of Equipment	Main Technical Data
CD 83	Incombustible gases & compressed air	1 set	
CD 84	Combustible gases	1 set	
CD 86	Steam, hot water, heat recovery	1 set	
CD 89	Hydraulic & lubrication system	1 set	
CD 9	Electric energy supply		
CD 92	Low voltage facilities	1 set	
CD 93	Electrical equipment	1 set	
CD 97	Lighting & plug socket system	1 set	
CD 98	Lighting & earthing system	1 set	
CD 99	Other electrical equipment	1 set	

2.4.2.2 HOT ROLLING MILL FOR THIN SLABS

2.4.2.2.1 Basic Technical Data

Type of furnace	Roller hearth furnace
Fuel	Gas fired
Number of finishing stands	6 (F1 to F6) 56"
Input material	Thin slabs
- thickness	70 mm
- width	700 - 1300 mm
- length	max.32 000 mm
Output material	hot rolled strip
- thickness	1.5 to 14 mm
- width	700 to 1300 mm
- max. coil weight	31 t
Coil dimension	
- inner diameter	762 mm
- outer diameter	max. 2150 mm

2.4.2.2.2 Description of Proposed Equipment

WT 15 Reheating furnace

WT 24 Finishing mill

Entry section

Entry roller table with adjustable side guides for transporting of thin slabs, located between furnace and hydraulically shear.

Side guide

Technical data

Length of side guides	appr.3500 mm
Distance between sideguides	min. 600 mm
	max. 1350 mm
Traversing speed	appr. 50 mm/s per side

The hydraulically actuated sideguide assembly serves for lateral guidance and centrically feeding of the thin slabs into the hydraulical shear, the descaler and mill stands.

Hydraulic shear

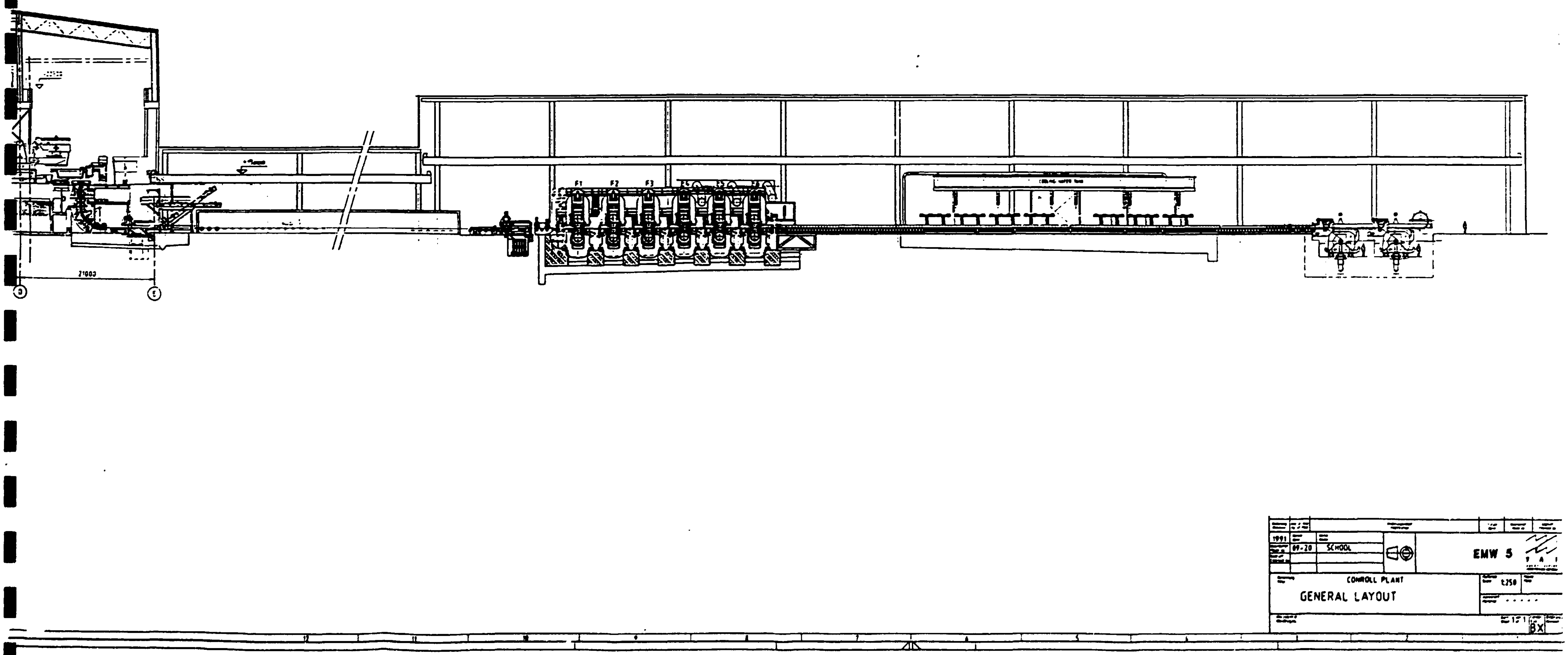
Technical data

Type	hydraulically operated undercut shear
Slab cross section	max. 70 x 1300 mm
Cutting temperature	min. 850 °C
Shear strength	max. 180 N/mm²
Cutting force	approx. 2000 t
Shear traversing	via hydraulic cylinder
Traversing length	approx. 2000 mm

The hydraulically operated shear is arranged in front of the high pressure water descaler.

The shear serves for cutting thin slabs to scrap in case of mil[illegible]own.
The knife drive and the travelling drive operate via hydraulic cylinders.

Fig. 5: **Longitudinal Section of Thin Slab Mill**



The cut scrap pieces ready for charging drop into scrap buckets via a scrap chute.
The bow-shaped cut is performed by the downcutting and upcutting knives, both knives approaching the slab very closely.
After cutting, the shear travels hydraulically into home position.
The knives are integrated into the knife bar and are kept in place by the knife holder (knife change unit). Fixation is hydro-mechanical.

Scrap handling system

The crop chute serves for transport of the cut scrap pieces from the shear to the scrap bucket underneath the shear. Two scrap buckets are arranged on a transfer car.
For changing of scrap bucket the transfer car moves out of filling position via hydraulic cylinder. The fully scrap bucket is changed by overhead crane with a handling tackle while the other bucket is in filling position underneath the shear.

Descaler

Pinch roll type descaler, consisting of solid pinch rolls on entry and delivery side, intermediate rollers and high pressure descaler.

Technical data

Number of spraying units	2
Spraying width	approx. 1350 mm
Number of spray nozzles for each unit	approx. 14
Pressure at nozzles	approx. 220 bar
Water flow volume	max. 200 m^3/h

Finishing stands F1 - F6

General

The Rolling Mill is equipped with the latest state of the art facilities as briefly described in the following [1/].

1/ To allow for rolling primarily HRC in thinner gauges than the current envisaged reference programme, it is advised to provide room for a 7[th] finishing stand, to be installed when the requirement arises.

Speed/Tension control

Loopers are installed between stands F2/F3, F3/F4, F4/F5 and between F5/F6. Electric minimum tension control system is installed between stands F1/F2. This facilities serves for controlling the speed of the main motors.

Gauge control

All mill stands are equipped with hydraulic automatic gauge control (HAGC) system which is operated by hydraulic cylinders located in the top mill housing.

The rolling forces of the mill stands are measured by load cells incorporated in the bottom housing window.
The rolling force is indicated on the display unit in the control pulpit.

Work roll change

Work roll changing is performed by means of a quick-changing device.

Work roll bending/shifting system

Hydraulic cylinders integrated in the so called "MAE-WEST-BLOCK'S" acting in upwards and respectively downwards direction operate as balancing cylinders and provide additional the necessary bending forces for the work rolls via the work roll chocks.
All mill stands are also equipped with work roll shifting devices, whereby the work rolls can be axially displaced in relation to each other via hydraulic cylinders.
Together with the bottle-shaped work rolls in the first stands a continuous variable roll gap adjustment (CVC-SYSTEM) is possible.
This CVC device together with the before mentioned work roll bending allows a very effective crown and flatness influence and control regarding the achieved strip qualities.
The cyclic shifting of the cylindrical shaped rolls in the last stands effects a decrease of roll wear and longer life time of work rolls.
In each MAE-WEST BLOCK the part which holds the bending cylinders is shiftable supported in the fixed part of the MAE-WEST BLOCK which is bolted to the mill stands. This serves for the purpose that the bending and balancing forces are fed in the work roll chocks even on the same place independent of the work roll shifting position. Due to this the bearing life time is increased.

Pass line adjustment

The passline adjustment of the bottom back-up and work rolls will be done by a stepped wedge adjusting system integrated in the lower mill housing.
The distance between hydraulic AGC-cylinders and the back-up roll chocks will be overcome by the stroke of the cylinders and by inserted spacer shims, also constructed as quick changing device via hydraulically actuated retraction mechanism.

Technical data

Work rolls F1 - F3	
Roll dia.	max. 850 / min. 780 mm
Barrel length	approx. 1 425 mm (56")
Work rolls F4 - F6	
Roll dia.	max. 760 / min. 685 mm
Barrel length	approx. 1 425 mm (56")
Back-up rolls F1 - F6	
Roll dia.	1525 / 1375 mm
Barrel length	approx. 1350 mm
Rolling force	max. 40 MN
Drive capacity F1 - F6	0-7000/7000 KW
Speed	0-150/320 rpm
Hydraulic gap setting system F1 - F6 (AGC)	
Number of cylinders	2 x 6 = 12 units
Piston dia.	approx. 1050 mm
Piston rod dia.	approx. 970 mm
Total lift	approx. 100 mm
Hydraulic pressure	
on piston side	approx. 260 bar
on piston rod side	approx. 20 / 60 bar

Baiancing and work roll bending

Hydraulic pressure	approx. 260 bar
Bending force	max. 1000 KN

Work roll shifting

Number of cylinders	4 x 6 = 24 units
Shifting stroke	approx. +/- 125 mm
Hydraulic pressure	approx. 260 bar

Descaling system

Place of installation	mill stand F1, F2 and F3
Pressure at nozzles	max. 150 bar
Water flow volume	total max. 200 m^3/h
Roll cooling system	
Water flow volume	max. 3300 m^3/h
Pressure	approx. 10 bar

Work roll shifting (F1 - F6)

Finishing stands F1 through F6 are equipped with work roll shifting system for controlling the strip crown and flatness in coaction with the integrated work roll bending system.
These devices are combined with and integrated in the Mae West Block's.
The CVC drive is effected by means of 2 hydraulic cylinders per roll which, via the shiftable part of the Mae West bloc and the chocks, enable the work rolls to be axially displaced

Axial shifting of the special ground top and bottom work rolls (bottle shaped CVC-rolls) in opposite directions will effect a desired roll crown in accordance with the shifting direction.

Through the last mill stands cylindrical work roll shifting produces an uniformity of roll wear, while strip flatness is controlled by the work roll bending system.

Hydraulic gap setting system

The hydraulic gap setting system is used for roll gap adjustment and serves as a control system for automatic gauge control (AGC), furthermore, the system allow load limitation by means of the overflow value.
The hydraulic gap setting system is characterized by exact adjustments also when running through minimum adjustment distances and in the presence of high rolling loads.
The setting operations are performed in extremely short periods of time.

Entry and exit guides

Entry and exit guides are of rugged design to suit the handling of heavy - gauge transfer bars(thin slabs).
The guides are hydraulically moved for roll changing purposes.
Exit guides comprising top and bottom part for accommodating the wipers, the cooling boxes for roll cooling and the descaling pipes for F1-F3.
Width adjustment of entry guides traversable via threaded spindles with motor drive.
The height of the entry guides is adjusted by means hydraulically actuated eccenter.
The retracing device of the entry and exit guides are operated by means of hydraulic cylinders.
A remote width indicator is fitted in the control pulpit and is included in the electrical equipment.

Wipers

Top wipers contact force is generated by means of pneumatic cylinders.
The lower stripper, on the other hand, is forced on the bottom work roll and held in contact with the barrel thereof by its dead weight.

Interstand descaling system

Technical data

Pressure (adjustable)	max. 200 bar
Flow (total #1-3)	max. 200 m^3/h

Top and bottom pressure water descaling pipes are arranged on the exit side of mill stand F1, F2 and F3.

Design

Top and bottom pressure water descaling spray beams of steel construction with nozzles and fastening material
Tips made of carbide metal
Pressure adjustable via hand valves.

<u>Mill stand main drive</u>

Gear - type spindles for stands F1 - F6

Design

Gear - type spindles with coupling wobblers with crowned external toothing and coupling sleeves with internal toothing.

Spindles can be used for CVC shifting on the mill pinion side.

Spindle shaft on mill pinion side provided with extended external toothing, shear groove for overload protection and incorporated spring mechanism for axial pre-tensioning purposes.

Roll side coupling sleeve retained in position during roll changing by means of spindle carrier.

Lubricated by oil circulation system, connected to the centralized lubrication system

Pinion stands for mill stand F1 - F6

Data

Pinion stands designed for (at 0-150/320 RPM)	N motor = 7000 KW
Ratio	1
Normal torque	
F1 - F3	max. 3300 kNM
F4 - F6	max. 1500 kNM
Type	double helical F1 - F3
	single helical F4 - F6

Design

Housing is a weldment with output side hood, horizontal split joints, inspection hole covers and breathers

Shafts supported in antifriction bearings assemblies.

Gear wheels of case-hardening steel with double helical toothing.

Antifriction bearings and toothings - oil lubricated, connected to the central lubrication system

Main drive gears for mill stand F1 - F5

Data

Type	single helical gear
Main drive gears designed for (at n= 0 - 150/320 RPM)	N motor = 7000 kW
Ratio	
Mill stand F1	5.3 one step design
Mill stand F2	5.3 one step design
Mill stand F3	4.0 one step design
Mill stand F4	2.25 one step design
Mill stand F5	1.3 one step design

Design

Housing is a weldment with horizontal split joints, inspection hole covers and breathers.

Shafts supported in antifriction bearing assemblies.

Antifriction bearings and toothings - oil lubricated, connected to the central lubrication system

Roll changing device

Work roll changing device

The device is designed as a work roll quick changing device. The two work rolls are jointly retracted from the mill stand by means of hydraulic cylinder. The

retraction cylinder is secured in a hydraulically operated swing door and is located below mill floor during rolling.
Along the operator side of finishing mill hydraulically actuated shifting tables are arranged and they allow the reground work roll sets to be shifted to a centred position in front of mill stand and to be pushed into the stand by roll changing cylinder.

Backup roll changing device

The shifting tables are lifted off and removed by crane. The changing cylinder supported on the foundation pulls the bottom back-up roll only out of the mill stand. The roll changing stool is then placed onto the bottom back-up roll by means of crane and thereupon, the lower back-up roll is moved back into the mill stand together with the changing stool. Thereafter the top back-up roll is hydraulically lowered and set onto the changing stool, the 2 rolls then are jointly retracted and individually lifted by crane and transported into the roll shop.

WT 27 Strip cooling

Run-out roller table

For transporting the hot rolled strip from the finishing mill to the coiler, lateral guides are provided for on the individual rollers.
Roller and drive motor are arranged on a common base to facilitate quick roll change. Roller surface is cooled by cooling headers arranged underneath the rollers.

Laminar strip cooling system

Technical data

Water flow volume	approx. 4000 m³/h
Water pressure	approx. 0.8 bar
Number of retractable header groups	7
Length of cooling line	approx. 45 m
Width of application	approx. 1350 mm
Number of cooling zones	
Top side	8 micro-control zones 10 normal cooling zones
Bottom side	8 micro-control zones 10 normal cooling zones
Water flow of blow-off sweeps	approx. 50 m³/h

Water pressure of blow-off sweeps approx. 10 bar

For cooling the rolled strip by cooling water being fed to the strip from the top and bottom sides in the form of a more or less laminar-flow stream.

The top cooling headers are hydraulically raise- and lowerable in the event of a cobble accruing on the run-out roller table, thus to prevent the system from damages.

The strip cooling system consists of normal cooling zones and so-called "micro-control cooling zones" which can be individually switched on and off.

Upon entry of the strip head end into the cooling line, the various cooling section are successively switched on as a function of strip travel end, subsequently, upon the strip tail end approaching they are switched off successively as a function of strip travel, too.

The maximum number of cooling sections to be switched on in each case concerned is a function of the following strip data:

- strip gauge
- temperature difference
- speed

An overhead water storage tank is installed between the pumping package and the water supply line in order to allow a constant feed pressure to be generated and maintained in the supply line.

WT 28 Down coiler

Side guide assembly ahead coiler

Technical data

Distance between sideguides	min. 600 mm max. 1350 mm
Quick adjustment	plus 100 mm at one side pneumatically operated
Traversing speed	approx. 20 mm/s per side

This sideguide assembly serves for the lateral guidance of the strip.
The drive side arranged guide is designed as long sideguide.

The guide on the opposite side is designed as short press-on guide, after strip entry into pinch roll unit, it can be adjusted by an additional amount of max. 100 mm towards the roller table centreline by means of a pneumatic quick adjusting device.

Pinch roll unit

Technical data

Lower pinch roll dia.	400 mm
barrel length	appr. 1400 mm
Upper pinch roll dia.	900 mm
barrel length	appr. 1400 mm
Opening between the pinch rolls at free strip passage	approx. 450 mm

Down coiler

Technical data

Type	3-wrapper rollers type coiler with expandable mandrel and step-control system.
Coiler mandrel	expanded - 764 mm dia collapsed - 727 mm dia
Number of wrapper rolls	3
Roll dia	380 mm
Barrel length	1350 mm
Clearance in operating side coiler housing	approx. 1800 mm

The three wrapper roller type down coiler is considered as the most favourable design regarding the range of strip gauges and regarding the demand for minimum maintenance expenditure and favourable maintenance conditions.

Each wrapper roller with guiding plate is equipped with a servo-hydraulic system (step control system) for allowing the strip surface to be handled with due care. The wrapper rollers are lifted by the servo-hydraulic system when the strip head end approaches the roller thus to reduce impact forces and to minimize the risk of strip damages.

The four segment coiler mandrel is hydraulically expanded and collapsed. The mandrel is pre-expanded when the strip approaches the coiler. Position controlled final expansion is carried out during coiling the first wraps.

This mode of operation in conjunction with the strip tension control and minimum mass moment of inertia of coiler drive allows the coil to be built up with a minimum of strip tension variations. Mandrel drive is equipped with a single stage switch gear.

For supporting the coiler mandrel during the coiling process, a coiler mandrel outboard support bearing is foreseen.

A chute roller is arranged in the down-coiler entry chute for taking up the counter forces being generated when coiling heavy gauge strips.

Coil stripper car

Coil stripper car serves for transferring the coil from the coiler to the banding station.

WT 31 Coil conveying

Coil banding machine

The fully automatic banding machine is installed between coiler and the coil conveyer. The coils are positioned on a fixed coil saddle by means of coil car with the horizontal axis in direction of flow.

Coil transfer car

Coil transfer car serves to transfer the coil from the banding station to the coil conveyer.

Table 6: Reference Production Programme (Product Mix) in kt/a

Thickness (mm)	%	Strip width (mm)						
		720	820	920	1 020	1 120	1 250	Total
1.50-2.05	25	6	113	39	151	6	18	333
2.06-2.55	25	11	11	52	109	18	185	386
2.56-3.05	20	13	17	51	31	70	105	287
3.06-5.76	30	15	19	83	39	256	132	544
Total	100	45	160	225	330	350	440	1 550

Table 7: Equipment List (Thin Slab Rolling Mill)

Item/Code	Designation	Number of Equipment	Main Technical Data
WT 15	Reheating Furnace	1	Roller hearth furnace capacity 320 t/h
WT 24	Finishing Mill Entry Section Finishing Stands Mill Stand Main Drive Roll Changing Device	1	6 stands (F1 - F6) 7 000 kW
WT 27	Strip Cooling Run-out Roller Table Laminary Strip Cooling System	1	
WT 28	Down Coiler Side Guide Assembly Ahead Coiler Pinch Roll Unit Down Coiler Coil Stripper Car	2	
WT 31	Handling Facilities Coil Conveyor Coil Banding Machine Coil Transfer Car	1	
WT 32	Inspection Line	1	
WT 38	Product Store + Dispatch	1	
WT 51	Roll Shop	1	
WT 53	Maintenance Post	1	
WT 54	Spare Parts Depot	1	
WT 56	Roll Store	1	
WT 57	Refractory Store	1	
WT 58	Operating Parts Store	1	
WT 61	Planning System/Management Info	1	
WT 62	Prod. & Process Control System	1	
WT 63	General Instrumentation	1	
WT 64	Basic Automation	1	
WT 65	Sampling/Material Testing	1	
WT 67	Laboratory	1	
WT 69	Communication System	1	

Item/Code	Designation	Number of Equipment	Main Technical Data
WT 71	Plant Office	1	
WT 73	Locker Building	1	
WT 75	Fire Alarm & Fighting System	1	
WT 77	Road Transport	1	
WT 81	Water Supply/Treatment	1	
WT 82	Water Circuit & Cooling System	1	
WT 83	Incombustible Gases & Compr. Air	1	
WT 84	Combustible Gases	1	
WT 85	Combustible Liquids & Fuel	1	
WT 86	Steam/Hot Water/Heat Recovery	1	
WT 87	Hydraulic & Lubrication System	1	
WT 91	High Voltage Facilities	1	
WT 92	Low Voltage Facilities	1	
WT 93	Electrical Equipment	1	
WT 97	Lighting & Plug Socket System	1	
WT 98	Lighting & Earthing System	1	
WT 99	Other Electrical Equipment	1	

2.5 LIME PLANT

2.5.1 PROCESS DESCRIPTION

For the desulphurisation and dephosphorisation of the steel during the melting process burnt lime has to be used as also in a smaller quantity in the COREX® process. A lime burning plant is chosen to ensure the necessary quantity and quality of burnt lime.

For the production of high quality burnt lime a double shaft kiln has been foreseen.

The plant includes
Limestone, screening and storage.
Burnt lime crushing, screening, grinding and storage equipment

Calcining Process

Fig. 6 schematically describes the calcining process. A and B are the two shafts filled with the charge and interconnected by a channel. Charging and discharging devices have been omitted from the diagram. Only one of the two shafts, e.g. shaft A, is heated by fuel, the other (shaft B) by the waste gases from shaft A. Lime is simultaneously burned in both shafts. In certain intervals (depending on the daily production) there will be a reversal.

Then shaft B is fired by fuel and the waste gases are evacuated via the connecting channel through shaft A. During reversal, the two shafts are alternately charged and burnt lime is continuously discharged from both shafts.

Combustion air is admitted into the fuelfired shaft A through the charging device and passes downwards. The air will pick up heat from the limestone which has been heated during the previous period by the waste gases. The fuel is admitted at the lower end of the preheating zone (regenerator). The waste gases leave shaft A through the connecting channel and rises in shaft B. Cooling air is simultaneously admitted from below into both shafts (A+B).

Although in the upper part of the calcining zone the gas burns with very hot air, the temperature of the charge cannot rise far above 1000°C because the limestone, at the beginning of calcination, has no insulating CaO-cover and rapidly absorbs the heat offered without a rise in temperature.

Only in the lower part of the calcining zone the waste gases which have already transmitted their useful heat to a great extent - come into contact with the largely calcined charge. There they supply, at small temperature differences, the heat necessary for releasing the remaining CO_2.

Only in the upper part of the calcining zone does the temperature of the gases rise to 1100 - 1200°C. The waste gas temperature in the connecting channel is maintained at a maximum of 1000°C thus avoiding over-burning of the lime.

While rising to the charging device, the waste gases transmit their sensible heat to the limestone in the preheating zone of shaft B.

The limestone is heated and accumulates at the same time as regenerator the quantity of heat necessary for heating the combustion air after reversal. The waste gases leave the kiln at approx. 100°C.

The quantity of cooling air is chosen so that its heat storage capacity is just sufficient to absorb the sensible heat of the lime. The burnt lime can be cooled down to approx. 80-100°C.

Charging and reversal operation

Shaft A of the kiln (see above mentioned fig.) will be admitted with fuel and combustion air. At the end of the calcining period, fuel and air supply will be stopped.

Subsequently, the opening of the limestone hopper leading into shaft A will be released and the limestone quantity weighed previously in the weighing equipment drops into shaft A.

After emptying the limestone hopper, on the top of the kiln limestone hopper opening leading to shaft A will be closed. Immediately after this, the traps of the two distributing boxes will be closed again, simultaneously the traps for combustion air and waste gas of the two shafts will be reversed.

Shaft B is now supplied with combustion air after the two shafts have been admitted again with cooling air before reversal of the traps of the distribution boxes. Then the fuel supply to shaft B will be opened.

Now, the limestone is burnt in shaft B and regeneratively heated in shaft A.

Reversal time depends on the desired production rate. At full production, reversal occurs every 10-15 minutes, at reduced production at correspondingly longer intervals. During each reversal, a certain, weighed limestone quantity is charged.

2.5.2 BASIC DATA

Limestone:

- Incoming limestone:
  Grain size 0-80 mm
  Undersize 5 % max. 0-30 mm
  Oversize 5 % max. 120 mm in one direction

Chemical and physical properties of limestone:
The limestone has to be free of contaminations such as clay minerals, SiO_2, iron, metal pieces, wood etc.
Limestone should have no crystalline physical properties thus avoiding decrepitation during preheating and calcination.

Grain size:
Limestone kiln feed — 30 to 80 mm

Moisture content:
Grain size 30 - 80 mm — max. 1 % H_2O in daily average
Bulk weight — approx. 1.4 t/m^3

Operation Time

Shaft kiln

Production	350 tons of burnt lime per 24 hours continuous operation
Over all plant availability	330 days per year
Burnt lime quality	Rest CO_2-content 2 % (average)
Limestone handling and storage (14 shifts per week)	2 shifts per day
Calcining plant including burnt lime crushing and storage section	
(21 shifts per week)	2 shift per day
Briquetting plant	1 shift per day
Hydrating plant	1 shift per day

Manpower

1 Engineer
1 Secretary
1 Foreman per shift
3 Workers per shift
1 Driver for front end loader per shift

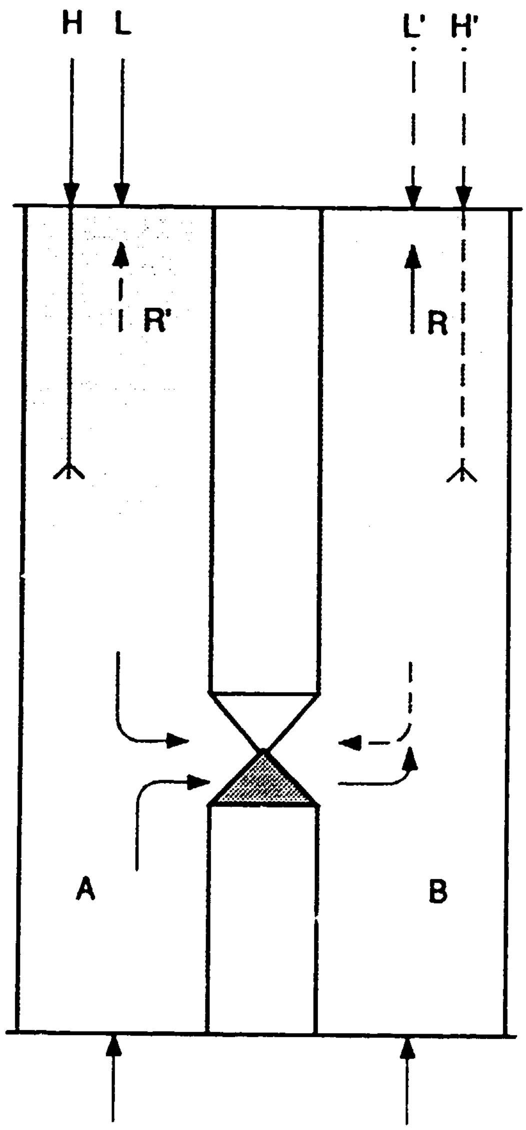
For maintenance and major repair specialists for

- Mechanic
- Electric and instrumentation
- Hydraulic

can be called upon from case to case from the main maintenance shop.

Fig. 6: **Process Description of Lime Kiln**

Fuel H and combustion air L enter shaft A
Waste gas R flows through shaft B
Fuel H' and combustion air L' enter shaft B
Waste gas R' flows through shaft A
Cooling air K flows through both shafts (A, B)



2.5.3 MAIN MACHINERY AND EQUIPMENT

BS 12 Limestone Handling

For the transport of the limestone grain size 0-80 mm from the open air storage yard to the limestone screening station following main equipment is included.

- One front end loader
- Belt conveyor system to the screening machine
- Dedusting system for conveyor system

BS 13 Limestone Screening

Limestone is screened into grain size 0-30 mm which will be disposed.
Grain size 30-80 mm is stored for burnt lime production.
Equipment includes:

- Screening machine
- Storage bin 400 m^3 for limestone grain size 30-80 mm
- Storage bin 100 m^3 for limestone grain size 0-30 mm
- 2 pcs belt conveyor
- 2 pcs vibrating feeders
- Dedusting system
- all necessary steel structure

BS 2 SHAFT KILN PLANT

BS 21 Kiln Charging System

From the dry bin the limestone is transported to the kiln inlet bin via a belt conveyor and skip.
Equipment includes:

- Belt conveyor
- Skip
- Skip hydraulic

BS 23 Shaft kiln

The kiln shell in Steel structure including anchors, platforms, stairs etc.

Firing system

The kiln shafts are fired with mixed gas through gas lances installed in the top part of the shafts.

It mainly consists of fuel lances, fuel distribution, measuring and regulating devices and reversing valves.

Hydraulic system

All movable parts in the charging system and discharging system and the fuel reversing valves will be hydraulically actuated.

Lining material

The refractory lining mainly consists of:

- the wear lining, consisting of magnesite bricks in the calcining area and of hard fireclays in the preheating and cooling zone area
- the lightweight bricks
- the insulating materials between brickwork and kiln shell
- all required processing materials, such as mortar, ramming masses, etc.

Air Supply

Combustion air and cooling air are supplied to the kiln by rotary compressors.

BS 28 Kiln Discharging System

The burnt lime from the shaft kiln is discharged via a vibrating feeder and transported via belt conveyor to the burnt lime handling station.

Equipment includes:

- Vibrating feeder
- Belt conveyor

BS 29 Dedusting System

Dedusting the waste gas of the kiln
Dust content in waste gas after filter less than 50 mg/Nm^3

BS 3 BURNT LIME HANDLING

- Burnt lime in grain size 0-80 mm is transported via belt conveyor from the kiln discharge to the crushing and screening station.
- Burnt lime in grain size 0-80 mm is screened into fractions 0-10 mm and 10-80 mm. The fraction 10-80 mm is crushed down to 0-60 mm. The two fractions are transported via a belt conveyor and bucket elevator to a screening machine. The screened material 10-60 mm is transported via a two way chute either to a second crushing and screening plant or to two storage bins with 300 m^3 capacity each. From the storage bins the burnt lime is transported via belt conveyor to the LD-shop. The fraction 0-10 mm, screened at the above mentioned machine, is stored in bin of 200 m^3 capacity from where the material is supplied to the crushing station.

The burnt lime 10-60 mm coming from the above mentioned two-way chute is crushed down to 0-20 mm in a jaw crusher and conveyed via another two-way chute either via a belt conveyor to the crushing station, or to a screen. The screened material (10-20 mm) is conveyed via a belt conveyor to a bin with 100 m^3 capacity, from which the burnt lime can be transported to the ladle furnace shop via belt conveyor. The grain size 0-10 mm from the above screening machine is transported via belt conveyor to the crushing station.

Equipment includes:

- Bucket elevator
- Screening machine for fraction 0-60 mm and 60-80 mm
- Jaw crusher for fraction under 60 mm
- Belt conveyor
- Bucket elevator
- Screening machine for fractions 0-10 mm and 10-60 mm
- Bin capacity 200 m^3 in steel structure for burnt lime grain size 0-10 mm
- Two-way chute , hydraulically actuated
- Reversible belt conveyor
- Two bins with 300 m^3 capacity each in steel structure
- Belt conveyor
- Jaw crusher, crushing burnt lime to 20 mm
- Two-way chute hydraulically actuated
- Screening machine for fraction 0-10 mm and 10-20 mm
- Belt conveyor for grain size 0-10 mm
- Belt conveyor for grain size 10-20 mm
- Bin capacity 100 m^3 for grain size 10-20 mm for ladle furnace
- Belt conveyor to the LF-shop.
- Dedusting system

Burnt Lime Grinding Station

Burnt lime in grain size 0-10 mm is discharged from a 200 m³ bin via a vibrating feeder and magnetic separator into double rotor hammer mill. The ground material is transported with the process air via a cage type separator, a cyclone and a dedusting system. The ground material collected at the cyclone and de-dusting equipment is conveyed via starfeeders into a bin with a capacity of 100 m³. The bin is equipped with an aerating system. The bin is discharged via dosing starfeeder either to a pneumatic pump, which transports the burnt lime to the COREX® plant.

Basic Data:

Production	21.000 to/a
Grain size	90 % smaller 0,09 mm

Equipment includes:

- Magnetic separator
- Hammer mill
- Cage type separator
- Cyclone
- Starfeeder
- Process dedusting system
- Star feeder
- Bin 100 m³ capacity in steel structure
- Aeration system
- Dosing star feeder
- Pneumatic transport system

Steel Structure and Housing

Housing of the burnt lime crushing, screening and storage area including the necessary steel structure, stairs and platforms.

BS 64 Basic Automation Description

Programmable logic control system

Drive control, sequencing and monitoring of the plant is effected by means for a programmable logic control system.

The system consists of

- Control process unit

- I/O cards
- Power supply
- Programming unit
- Software

Peripheral devices

For the process requirements the necessary amount of the peripherical control devices has to be foreseen.

These are as follows:

- Local control boxes
- Speed monitors
- Pull rope switches
- Belt tracking switches
- Emergency stop push buttons
- Audible starting alarms

Operator panel

For control of the lime plant a control panel with mimic diagram is proposed.

BS 92 Low Voltage Facilities

Control voltage and auxiliary voltage supplies

The necessary systems are proposed.

Cable and erection material

All cables and erection material for the lime plant is proposed.

Lighting, socket plant

- high- bay illumination
- work station illumination
- storage yards illumination
- emergency lighting
- socket plant
- cables and erection material

Communications System

- Telephone system

Earthing and lightning protection

BS 93 Electrical Equipment

Motor control center

The MCC consists of metal enclosed vertical sections with an incoming feeder and with drawable modules for motor starter units and feeders supplying the various consumers.

Rated voltage	380 V, 60 Hz
Max. asymmetrical short circuit capacity	50 kA
Enclosure	IP 40

Motors

AC motors for squirrel cage type are proposed

Type of protection	IP 55

Thyristor power supply

AC motors with VVF Panels are foreseen.

Field Instrumentation Descripıion

Temperature measurings

- PT 100, range of application 0-550°C
- Thermocouples Ni-CrNi
  range of application 550°C - 1000°C
  with transmitter 4-20 mA
- Thermocouples Pt-RhPt
  range of application over 1000°C

Flow elements

- Standard orifice plates with differential pressure transmitter 4-20 mA, Accuracy ± 0.5 % of the scale end value

Pressure measurings

- pressure gauges or transmitter 4-20 mA, Accuracy ± 0.5 %

Level measurings

- Capacitive level probes
- Radioactive level probes are foreseen for measuring kiln level

Weighing equipment

Static weigher with load cells for the kiln

2.5.4 EQUIPMENT LIST (LIME PLANT)

Table 8: **Equipment List (Lime Plant)**

Item/Code	Designation	Number of Equipment	Main Technical Data
BS 12	Limestone Handling		
	- Front end loader	1	
	- Belt conveyor system	1 set	
BS 13	Limestone screening		
	- Screens	1 set	
	- Storage bin	1	400 m³ grain size 30 - 80 mm
	- Storage bin	1	100 m³ grain size 0 - 30 mm
	- Belt conveyor	2 sets	
	- Vibrating feeders	2	
BS 19	Dedusting system		
	- for Belt conveyor (BS 12)	1 set	
	- for screening station (BS 13)	1 set	
BS 21	Kiln charging system		
	- Belt conveyor	1 set	
	- Skip	1 set	
	- Skip hydraulic	1 set	
BS 23	Shaft kiln complete	1	
BS 28	Kiln charging system		
	- Vibrating feeder	1	
	- Belt conveyor	1 set	
BS 29	Dedusting System	1 set	
BS 31	Product Handling		
	- Bucket elevator	1	

Item/Code	Designation	Number of Equipment	Main Technical Data
BS 32	Crushing and screening		
	- Bucket elevator	1	
	- Screen	1	for fraction 0 - 60 mm
	- Screen	1	for fraction 60 - 80 mm
	- Jaw crusher	1	for fraction < 60 mm
	- Belt conveyor	1	
	- Bucket elevator	1	
	- Screen	1	for 0 - 10 mm
	- Screen	1	for 10 - 60 mm
	- Storage bin	1	200 m³ for grains 0 - 10 mm
	- Two way chute	1	
	- Storage bins	2	300 m³
	- Belt conveyor	1	
	- Jaw crusher	1	grain size 20 mm
	- Two way chute	1	
	- Screens	1	for 0 - 10 mm
	- Screens	1	for 10 - 20 mm
	- Belt conveyor	1	for 0 - 10 mm
	- Belt conveyor	1	for 10 - 20 mm
	- Storage Bin	1	100 m³ for 10 - 20 mm
	- Belt conveyor to steel plant	1 set	
BS 33	Grinding Station		
	- Screen	1	0 - 30 mm
	- Magnetic separator	1	
	- Rotor hammer mill	1	
	- Belt conveyor	1 set	
	- Bucket elevator	1	
	- Cyclone with star feeder	1	
	- Bin aeration system	1 set	
	- Starfeeder	1	
	- Two way chute	1	
BS 39	Dedusting system		
	- for Crushing and Screening	1 set	
	- for Grinding plant	1 set	
BS 64	Basic automation		
	- Control process unit	1 set	
	- I/O Cards		
	- Power supply		
	- Programming unit		
	- Software		
	- Local control boxes		
	- Speed monitors		
	- Pull rope switches		
	- Belt trucking switches		
BS 92	Low voltage Facilities		
BS 93	Electrical Equipment		

2.6 INTEGRATION FACILITIES

2.6.1 PRE-PRODUCTION FACILITIES

2.6.1.1 IH 12 Raw material storage yard

Bulk material will be transported via a belt conveyor system from the harbour to the raw material storage yard and distributed to the storage areas. This yard will be situated in the southern part of the plant. The raw material storage and handling is foreseen for following materials:

	storage area for 1.5 month	storage capacity
- Iron ore	approx. 16 000 m^2	approx. 300 000 t
- Limestone	approx. 6 500 m^2	approx. 61 200 t
- Dolomite	approx. 700 m^2	approx. 8 000 t
- Coal	approx. 19 500 m^2	approx. 125 000 t
- Scrap	approx. 10 000 m^2	approx. 45 000 t

Beside the foreseen storage areas the raw materials will be handled with two stacker reclaimers. A belt conveyor system transports the raw materials to the ore screening station, the coal drying plant and the burden building by means of the yard conveyors. The technical specifications are generally the same as the dock conveyor, also running in one direction only.

4 stockpiles 500 m long and approx. 35 m wide each, are foreseen providing an area of 70.000 m^2. Drainage trenches on either side of the stockpiles provide dewatering after rainfalls. The water is collected in a settling pond, which overflow is ducted into the creek. The storage areas are paved and slanted 1% towards the trenches.

2.6.1.2 IH 14 Scrap handling and treatment

Process Description

The scrap yard serves for classification, storage and treatment of external and return scrap.

It consists of 1 aisle, the bridge crane which is equipped with magnet and crab each executing the scrap manipulation.

Scrap is transported by truck. The return scrap is unloaded at the front side by means of floor vehicles. A hand gas cutting torch is provided for scrap treatment.

The treated scrap ready for charging is loaded into scrap chutes which are placed on pallets. To obtain an optimal arrangement of the individual scrap qualities in the scrap chutes in layers, the scrap is weighed on weigh-bridges located at the individual loading yards.

The pallets with scrap chutes are transported on flat vehicles so that they can be received or deposited at any time and at any place.

Main Machinery

Bridge Crane

For loading and unloading of scrap, equipped with crab and magnet.

Weighing Bridge

Weighing of buckets and chutes leaving the scrap yard.

Hand Gas Cutting Torches

Scrap, which is too large for charging is cut with hand gas torches. The stalls for gas cutting are located at the front sides of aisles.

2.6.2 PERIPHERAL FACILITIES

2.6.2.1 IH 46 Air separation plant for 2 corex® modules

Table 9: **Gas Productions**

Item/Code	Designation Equipment	Number of	Main Technical Data (average values)
AIR SEPARATION PLANT IH 46	- O_2-generation (95% purity)	1 set	Qn = 113.000 m^3/h
	- O_2-generation (99.5% purity)	1 set	Qn = 10.600 m^3/h
	- N_2-generation	1 set	Qn = 23.600 m^3/h
	- Ar-generation	1 set	Qn = 300 m^3/h

GENERAL

The air separation plant is designed to serve the

- Lime plant
- COREX® plant
- LD-plant
- Continuous casting slabs
- Auxiliary plants of integration facilities

with necessary oxygen and/or nitrogen and/or argon in gaseous condition.

Process Description

(Additional see principal process diagram)

Production of oxygen, nitrogen and argon

Ambient air is compressed by an air compressor and afterwards purified (CO_2, H_2O) in a molecular sieve station.

The purified process air is then fed into the cold box where the process air is cooled down, partially liquified and separated into O_2, N_2 and Ar by a low temperature distillation process.

For the generation of »COREX® oxygen-95 % purity« it is possible and economical to compress liquid oxygen with a purity of 95 % vol. with a liquid pump installed inside the cold box.

The compressed liquid oxygen is then vaporized in counter flow to a partial stream of the process air (before being compressed in an air booster with a discharge pressure of approx. 15 bar).

This process design enables the supply of internal compressed »COREX® oxygen« with using external compressor stations. In the case given - where a combined cycle power plant will be installed - the most appropriate approach would be to »bleed« air off the compressor prior to the combustion chamber of the gas turbine as pressurized air input into the oxygen plant.
Additional gaseous oxygen with a purity of 99.5 % vol. and nitrogen is produced. Both gases have to be compressed and stored in vessels to achieve the requirements of the consumers.

Back-up system

In addition to the production of gaseous oxygen and nitrogen, both gases are also generated in liquid phase.
The liquid gases are stored in tanks, which are big enough to supply the required gases after a shut down of the air separation plant for the save shut down sequence of the consumers.

Argon is only generated in liquid phase.
In accordance with the requirements of the consumers, the liquid argon is compressed by a pump, vaporized and fed into the pipelines connected to the consumers.

Table 10: **Gas requirements**

	O_2 required Nm³/h av. / max.		N_2 required Nm³/h av. / max.		Ar required Nm³/h av. / max.	
Lime plant	0	0	2.000	2.500	0	0
Corex plant (O_2-95% purity)	113.000	120.000	15.000	18.000	0	0
LD-plant (O_2-99.5% purity)	10.600	50.000	6.400	7.000	300	300
CC slabs	20	40	20	35	20	40
Integrated facilities	0	0	200	1.000	0	0

Utility requirements

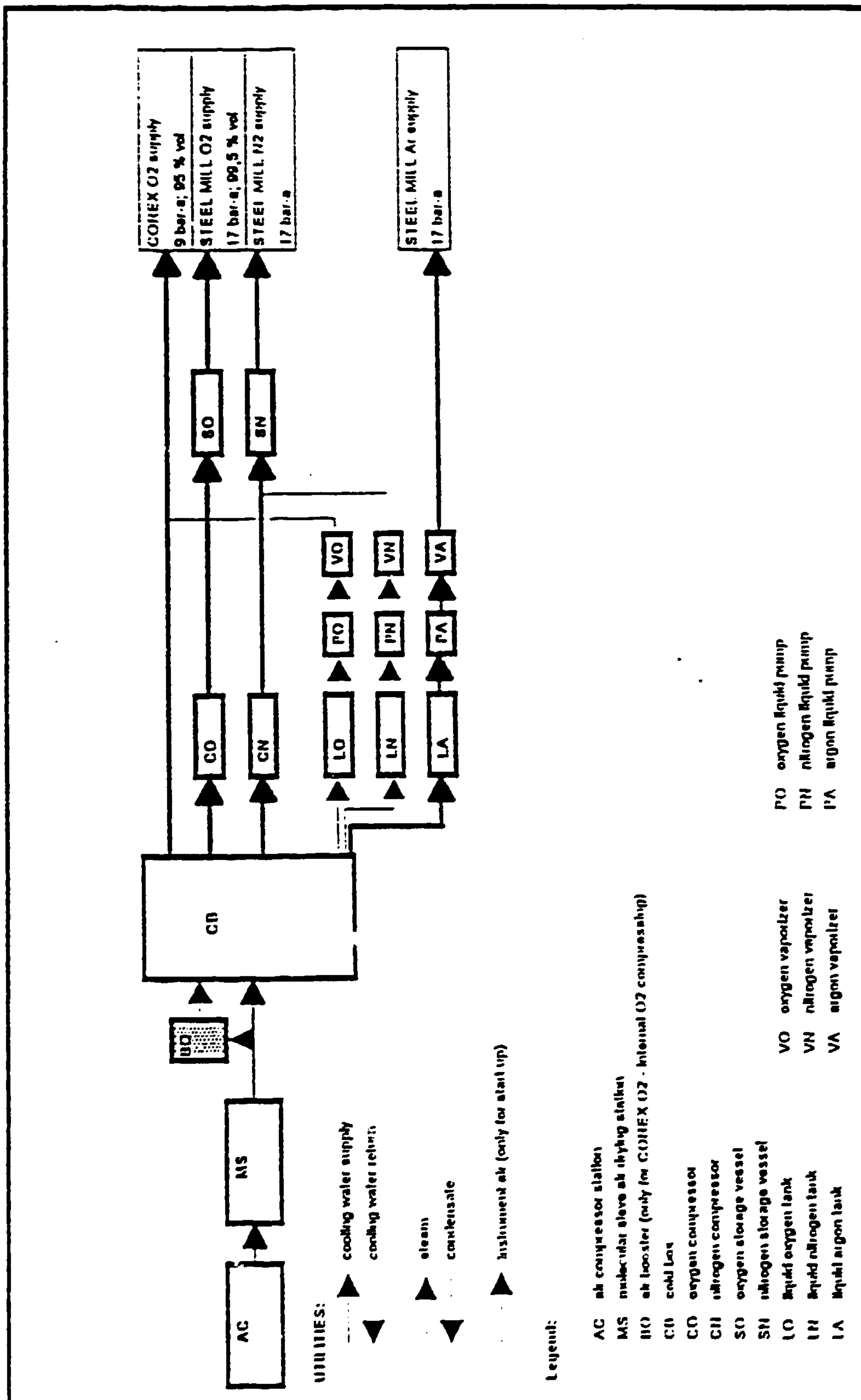
Table 11: **Electrical Energy**

Air compressor	AC	40.400 kW
Air booster	BO	5.600 kW
Oxygen compr.	CO	1.900 kW
Nitrogen compr.	CN	1.700 kW
Others	-	500 kW
TOTAL		50.100 kW

Cooling water:
(total requirement based on 10 degrees temperature difference between supply and return.)
Q = 4.300 m^3/h

Steam:
for regeneration of the molecular sieve dryers
Q = 2.70 t/h (saturated steam)

Fig. 7: **Air Separation Plant, Process Flow**



IH-46	AIR SEPARATION PLANT / PROCESS FLOW	

2.6.2.2 IH 48 Slag handling and treatment

Process Description

Slag 0 - 300 mm, with singular pieces of a max. length up to 1000 mm is charged into the charge hopper with grid by wheel loader or truck.

Sizes bigger than 300 x 300 mm have to be removed by wheel loader beside the charge hopper to be demolished by drop impact hammer and crane.

An unbalance type vibratory trough conveyor with controllable conveying capacity underneath the charge hopper assures a continuous charge to the downstream line.

The material 0 - 300 mm is transported by belt conveyor to the vibrating grate where material 0 – 40 mm will be screened. An overband magnet above the vibrating grate effects the iron separation 40 – 300 mm. The de-ironed slag is placed onto belt conveyor which will be used as sorting belt. Before charging the slag into the crusher feeding bin it is checked for electrically conductive objects. As soon as the metal detector is activated by an electrically conducting foreign object, the complete conveyor system is stopped. The foreign objects will have to be removed by hand. Other foreign objects like refractory material and wastes can also be removed by hand from belt.

The slag 0 - 40 mm from vibrating grate is placed on to screening machine where the slag will be screened into fractions 0 – 8 mm and 8 – 40 mm. Slag 0 – 8 mm will be conveyed by chute to open deposit. Slag 8 – 40 mm is delivered by chute to belt conveyor.

Crushing and sizing

The de-ironed slag 40 - 300 mm from belt conveyor will be delivered to crusher feeding bin and by vibrating feeder impact crusher.

The crusher feeding bin is equipped with a level indicator/transmitter (min, max, middle) which controls downstream conveying equipment and material flow.

In the impact crusher the fed slag 40 – 300 mm will be crushed into size 0 – 40 mm.

The crushed slag 0 - 40 mm after the crusher will be conveyed together with the slag 0 – 40 mm from pre-screening with belt conveyor to bucket elevator.

A vibrating feeder feeds the slag on to an electromagnetic drum. The extracted iron is charged through a chute into a vibrating screen that separates fractions 0 – 8 mm and 8 – 40 mm. The extracted iron is delivered through a chute to storage boxes.

The slag is supplied to screening machine which classifies into fractions 0 – 8 mm, 8 – 16 mm, 16 – 25 mm, 25 – 40 mm. This fractions are delivered through chutes into storage boxes.

2.6.2.3 IH 49 Scale Handling and Treatment

The scale out of the pit will be transported from the water treatment area to the scrap yard. After depositing and drying by air, the scale will be continuously portioned into the scrap chute.

2.6.3 MAINTENANCE AND STORES

2.6.3.1 IH 51 Central Mechanical Workshop

The cental mechanical workshop is subdivided as follows:

1. Aisle
   1 Bay crane 10 to
   - Material store
   - Material preparation
   - Cleaning area
   - Area for disassembly/assembly
   - Welding area
   - Area for fitter

2. Aisle
   1 Bay crane 7.5 to
   - Intermediate store
   - Machining section

   Both aisles are connected by a transfer car.

3. Civil building
   - Hydraulic fitter
   - Office
   - Stores

The scope of supply of the technological equipment provides for a basic equipment for repairs in the first few years of operation, which is intended to be appropriately and economically completed in the subsequent years, according to the experience made during operation. For this reason, it is advisable to emphasize the stocking of spare parts in the first few years and to focus on a controlled spare parts manufacture only in subsequent years. Thus, the areas for the central mechanical workshop and spare parts store are amply dimensioned.

2.6.3.2 IH 52 Central Electrical/Electronic Workshop

The central electrical/electronic workshop is subdivided as follows:

1. Aisle
   Bay crane 5 to
   - Assembly/Disassembly
   - Testing
   - Stores

2. Aisle
   - Isolation, winding, impregnation, drying (motors max. 100 kW)
   - Electric

3. Civil buildings
   - Instrumentation
   - Electronic
   - Stores
   - Offices

The scope of supply of the technological equipment provides for a basic equipment for repairs in the first few years of operation, which is intended to be appropriately and economically completed in the subsequent years, according to the experience made during operation.

Thus, the areas for the electr. mechanical workshop and spare parts store are amply dimensioned.

2.6.3.3 IH 53 Central Mechanical Workshop

The service shop for heavy load vehicles and for small locomotives is decided as follows:

1. Aisle
   - Bay crane 15 to
   - Pit
   - Oil/grease, tyre, brake, battery service station for heavy load vehicles, loading facilities - front loader, slag transportation - pot carrier.

2. Aisle
   - Mechanical workshop and stacker service

3. Civil building
   - Office
   - Stores
   - Battery service

2.6.3.4 IH 54 Store for Spare Parts and Consumables

The store is subdivided as follows:

1. Aisle
   - Pallet store for approx. 1300 pallets with stacker operation
   - Floor store with stacker operation

2. Aisle
   - 3-storey-small part storage accessible via stairs and platforms
   - One air conditioned store for precision parts
   - Tool cabinets
   - Long bar shelves
   - Bay crane 10 to

3. Covered, fenced outdoor storage
   - Small part storage for hazardous goods

4. Civil building
   - Offices

2.6.3.5 IH 57 Central Refractory Store

To be implemented together with existing facilities

2.6.3.6 IH 58 Central operating parts store

To be implemented together with existing facilities

2.6.4 INFORMATION

2.6.4.1 IH 61 Planning System/Management Info

(Automation System Level 3)

The automatic system for modern industrial plants distinguishes at least three different levels of a automation system.

In principle, individual machines and transportation units are controlled by PLC's and/or microcomputer systems which represent the automation system level 1.

The automation system level 2 is responsible for supervision and tracking of the production process of a certain production unit of a plant.
The automation system level 2 receives the most important actual process information from automation system level 1 and transmits preset values to this.

The automation system level 3 is responsible for the production planning. It receives the most important actual production information from automation system level 2 and transmits the production planning schedule to this.

2.6.4.2 IH 63 General Instrumentation

Measurement of process variables by field instruments, controlling is within a digital distributed control system.

2.6.4.3 IH 64 Basic Automation

Safety for human and machine is achieved by non-redundant PLC system applying hard wired back-up for critical functions. Data communication amongst the level 1 controller is achieved by serial interface.

The basic automation configuration is based on the philosophy to perform sequential and closed loop controls within one unified hardware system. Programming is by ladder diagrams and/or functional block language.

2.6.4.4 IH 67 Central Laboratory

The laboratory should comprise following sections:

- Spectrometer Laboratory with
  - o Sample Preparation
  - o Spectrometry
  - o Quick Analysis

- Continuous Casting Laboratory with
  - o Sample Preparation
  - o Testing Equipment
  - o Micro-Macro Laboratory

- Wet Chemical Laboratory with
  - o Sample Preparation
  - o Analyzing Equipment

- Water Laboratory with
  - o Water Testing Equipment

- Oil/Lubricants Laboratory

- Coal Laboratory

2.6.5 INFRASTRUCTURE AND AUXILIARY EQUIPMENT

2.6.5.1 IH 71 Administration Building

2.6.5.2 IH 73 Locker Building & Canteen

2.6.5.3 IH 74 First Aid & Security Device

2.6.5.4 IH 75 Fire Alarm & Fighting System

2.6.5.5 IH 77 Road Transport

Roads

General

Basis for the utilization of the plant area is the layout. It shows the split up of the area into traffic areas and into areas for all existing or planned building.

Layout and transport volume result in the traffic and traffic intensity expected. Correspondingly, the traffic areas are divided into main roads, by-roads and parking lots.

Routing of the roads depends on the in-plant traffic intensity, the location of buildings as well as on the elevation of buildings. A rectangular, screen-type arrangement shall be aimed for the interest of a suitable utilization.

Contrary to the public roads a calculated speed of 15 km/h shall be foreseen for the in-plant traffic.

Main Roads

Main roads, distinguished by high transport volume and traffic intensity especially with heavy load trucks shall be provided with a concrete pavement.

For planning the following parameters shall be considered:

- road width preferred: - 9 m
- Curve radius - 12 m

For the selection of the vertical curve radius at crossings, curves and turning points, the vehicle with the maximum turning radius shall be decisive. The minimum radius, however, shall be 9 m.

- max. slope
  - for special truck 6 (3) %
  - for general trucks up to 8 %
- cross fall 1 - 2 %
- loading (wheel base) 14 tons
- loading diagram Class IQ-super 20

Draining of surface water from traffic area shall be carried out either via draining chutes and road inlets into the local sewer system or via the road shoulders into open trenches.

Special heavy duty roads and areas

Special road and area construction is required to accommodate the special vehicles such as the ladle fork lifts. These vehicles will have a wheel load of approx. 50-60 t, which will require a special interlocking of the concrete road slabs and special steel reinforcement within the slabs. This applies to all roads and areas between the COREX® plant up to and within the LD plant being serviced by afore mentioned vehicles.

Similar considerations are applicable to the slab yard (hot box) in front of the HSM 2. Vehicles and trailers, designed for pick up of hot slabs being delivered by the underground roller table as well as servicing the slab charge into the rolling mills, will also have sheel loads exceeding the standard weight. Existing roads being served by these vehicles will have to be reassessed in regard to the new requirements.

By-roads

Less frequented roads shall be designed with concrete pavement or gravel.

For by-roads the following planning parameters shall be observed:

- Road width	4.5 m
- Curve radius	9 (6) m
- max. slope	up to 9 %
- Loading (axle base)	13 tons
- Loading diagram	Class IQ-20

Surface draining of by-roads shall be the same as for main roads.

Parking lots

Parking lots will be provided with an concrete pavement and shall be designed min. slope 1 %.

The max. diagonal slope between longitudinal slope and cross fall for draining water shall be 2.5 %.

Street Lighting

Street lighting shall be by whip-shaped lamp posts. Considering special vehicles the distance of the posts from the road border shall not be less than 0.75 m. The spacing to each other shall be 30 – 40 m at a light spot height of 7.5 m.

2.6.6 IH 77 Road Transport

Table 12: List of Vehicles

	Pcs	Name	Price US$
RC	7	Filterplant-container	15 167
RC	2	Hot metal transportation-ladle carrier	1 820 000
SL	1	Alloy handling-wheel loader	195 000
SL	4	Filter plant container	86 667
SL	1	Alloy handling-wheel loader	195 000
SL	1	Dewatering unit-container	21 667
SL	5	Road vehicles fork lift truck	325 000
CD	4	Crop end handling container	136 500
CD	4	Crop/skull bucket	84 500
WT	1	Scale removal system wheel loader	216 667
WT	4	Handling facilities fork lift truck	1 733 333
WT	2	Handling facilities trailer	216 667
WT	2	Handling facilities tractor	433 333
WT	4	Scrap transfer trailer	390 000
IH	4	Scrap transfer container	390 000
IH	2	Scrap transfer tractor	325 000
IH	1	Mobile crane with magnet for cleaning up scrap yard	228 583
IH	28	Slag transportation slag pot	4 478 500
IH	4	Slag transportation for carrier	2 946 667
IH	3	Depot/store-lift truck	117 000
IH	18	Road vehicles container	320 125
IH	2	Road vehicles fork lift truck	75 833
IH	1	Road vehicles wheel loader	182 000
IH	1	Road vehicles elevating carrier	500 500
IH	6	Road vehicles truck	681 417
IH	10	Automobiles	238 333
IH	6	Passenger cab buses	379 167
IH	10	Cab pickup trucks	216 667
IH	1	Pumper fire truck	465 833
Sum			17 415 125

E:\projekte\ptks-bolphase 2\tech-descl1-4.wp5

2.6.7 IH 8 UTILITY SUPPLY / TREATMENT

DESCRIPTION OF REQUIRED PLANTS

IH 80 General

This chapter covers the scope of general utility systems belonging to part »Integration Facilities«.

The utility systems are designed to serve the

- Lime plant
- COREX® plant
- LD-plant
- Continuous casting slabs
- Auxiliary plants of integration facilities

with necessary utilities.

Basically the general utility systems consist of main utility plants (like central water treatment station, compressed air generating station a.s.o.) and the adequate utility distribution piping up to the take over points (T.O.P.) of the individual production plants.

The utility systems downstream of these T.O.P.'s belong to the production plants.

The COREX® plant is equipped with separate water treatment facilities (cooling systems including clarifying and recooling) which is integrated within the COREX® plant. Only make up water is supplied to this T.O.P.

2.6.7.1 IH 81 Water Supply / Treatment

WATER SUPPLY

The industrial water is taken from the T.O.P. at the battery limit of the ISM.

The below indicated water analyses is the basis for the treatment concept. It has been assumed that the water is taken of the same lake as the industrial water which is used in the existing PTKS-Steel works in Cilegon.

Generally, the industrial water is used after treatment for following systems:

- Make up water for open cooling water circuits
- Make up water for closed cooling water circuits (soft water)
- Service water
- Fire fighting water
- Potable water.

Total industrial water requirement:

Flow (average)	= 980 m^3/h (approx.)
Pressure	= 0.3 MPa at battery limit
Temperature	= 20°C (approx.)

Typical analysis of raw water:

Suspended solids	max. 10 mg/l
El. conductivity	max. 250 mhos/cm
Dissolved solids	max. 250 mg/l
pH-value	8.3 - 8.7
Dissolved oxygen	min. 6 mg/l
Free CO_2	max. 10 mg/l
Total hardness	47.5 - 178 mg/l as $CaCO_3$
Calcium (Ca^{2+})	22.5 - 65 mg/l as $CaCO_3$
Magnesium (Mg^{2+})	14.0 - 35 mg/l as $CaCO_3$
Alkalinity/m-value	max. 100 mg/l as $CaCO_3$
Sulfate (SO42)	max. 55 mg/l
Chloride (Cl-)	max. 50 mg/l
KMnO4-Consumption	max. 10 mg/l
Silicate (SiO_2)	max. 80 mg/l
Chlorine (Cl_2)	0.1 - 0.5 mg/l
Iron (Fe^{2+}/Fe^{3+})	max. 0.5 mg/l
Manganese (Mn)	max. 0.1 mg/l
Ammonia (NH4+)	0 mg/l
Zinc (Zn2+)	max. 1.0 mg/l
Nitrite (NO2)	0 mg/l
Sulphide (S^{2-})	0 mg/l
Chromate (Cr^{6+})	0 mg/l
Parasitic microorganism	0 mg/l
Pathogenic microorganism	0 mg/l
Coliform bacteria	0 mg/l

The water supply systems are based on following water flows:

Unit: m^3/h average values

Table 13: **Water Consumption**

Plant	Make-up water	Service water	Fire fighting water	Potable water
Lime plant	-	1	0-200	1
COREX® plant	350	1	0-200	in make-up incl.
LD-plant	*)	2	0-200	6
CC thin slabs	*)	1	0-200	3
Thin slab mill	*)	2	0-200	3
Integration facilities	600	8	0-200	2
TOTAL	950	15	0-400	1
*) Make up water rate in item integration facilities included				

WASTE WATER

- Industrial waste water

  The industrial waste water, mainly bleed-off water from the open cooling circuits, is collected in the central water treatment plant.

  The treated waste water which is to comply with national standards and/or regulations for discharging will be pumped to the take over point (T.O.P.) at the battery limit of the iron and steel works.

  Average water flow for discharge:
  $Q_{approx} = 350\ m^3/h$

- Sanitary waste water

  The sanitary waste water is collected in a sewer system. The sewer system will be discharged at the take over point at the battery limit of the iron and steel works.

  Average water flow for discharge:
  $Q_{approx} = 15\ m^3/h$

- Rain water

  Run-off rain water from buildings, roads, etc. is drained to the battery limits of the works.

2.6.7.2 IH 82 Water Circuits & Cooling Systems

The cooling water systems comprise the following circuits:

- Closed circuits:
  These cooling circuits are designed as closed loops. The water quality is soft water which remains in the circuit. This type of cooling circuit is foreseen for the critical cooling devices such as lance for LD-converter, mould of CC-plant a.s.o.

  The back-cooling of these cooling circuits is foreseen by means of heat exchangers with an open cooling tower circuit on the secondary side.

- Open circuits:
  The open cooling water circuits are in contact with the open air and are cooled back by cooling towers with evaporation. The water quality of these cooling loops is determined by limited hardness and a minimum concentration of corrosion components.

  In order to prevent an excessive increase in the hardness and salt content of the circulating water, a part of the water is taken as blow down from the cooling tower reservoirs.

- Scale water circuits:

  This open circuits are foreseen for spray cooling in the continuous casting slabs and in the slab mill.

  The spray cooling water, contaminated with scale and oil leaves the consumers in pressure-free condition via a scale flume by gravity flow into a scale pit.

  The coarse scale is separated there.
  From the pit the water is pumped via longitudinal clarifiers and gravel filters to the cooling towers and back to the consumers again.

  The scale collected in the scale pit is removed by a scale bucket for discharging into vehicles.

Note:
To avoid corrosion, scaling and algae growth, a chemical treatment program according the individual needs of each system will be chosen.

Table 14: **Cooling Systems / Heat Transfers**

Plant/Production Unit	Total flows/circulating water m^3/h	Heat load GJ/h
COREX® plant	1)	-
LD-plant	700	45.9
CC thin slabs	2 364	53.8
Thin slab mill	8 350	243.-
Integration facilities	4 500	188.0
1) Within utility systems of production plant (Plant code RC)		

2.6.7.3 IH 83 Incombustible Gases and Compressed Air

Following systems are covered under this item:

- Oxygen distribution system
- Nitrogen distribution system
- Argon distribution system
- Compressed air system
- Instrument air system
- Air mist system.

Oxygen, nitrogen and argon are taken in gaseous condition at the take over point of the air separation plant (item IH 46) and are distributed by a piping system to the take over points of the various production plants.

There are two (2) oxygen distribution systems foreseen. One system serves the COREX® plant (95 % purity, 1.0 MPa pressure) the other system (99.5 % purity, 1.7 MPa pressure) serves the rest of consumers.

Compressed air and instrument air are generated in the central compressor station. The compressor station is located in the area of the water treatment plant.

The compressed air is produced by water cooled compressors. One stand-by unit is foreseen. Downstream the compressors air drying units and air receivers are foreseen.

The instrument air is generated by a separate instrument air compressor station with adequate filter and drying facilities.

The air mist generator station generate the necessary air for the air mist cooling of slab continuous casting.

Total flows (peak values)

Compressed air:	Qn = 12 000 m^3/h	pe = 0.7 MPa
Instrument air:	Qn = 500 m^3/h	pe = 0.7 MPa
Air mist air:	Qn = 13 000 m^3/h	pe = 0.3 MPa

Gas and air flows in Qn = m^3/h (Average values)

CA compressed air
IA instrument air

Table 15: **Gas Consumption**

	O_2	N_2	Ar	CA	IA	Air mist
Lime plant	-	2 000	-	500	50	-
COREX® plant	113 000	15 000	-	2 000	-	-
LD-plant	10 600	6 400	300	2 000	50	-
CC thin slabs	30	20	20	200	50	1/ 13 000
Thin slab mill	-	-	-	1 000	150	-
Integration facilities	-	200	-	1 000	100	-
2) peak value (process air)						

IH 84 Combustible Gas

Following systems are covered under this item:

- COREX® gas
- LD-converter gas
- Natural gas
- Export gas.

The cleaned exhaust gases from COREX®- and LD-plant are distributed to the gas control station.

In the gas control station these gases are mixed to get a homogeneous calorific value.

1/ peak value (process air)

A gas booster station for LD converter gas insures an adequate system pressure for a proper operation of the gas control station.

Design calorific values:	
For internal consumers:	8 431 kJ/m³ (Vn)
For export gas:	8 431 kJ/m³ (Vn)
Design flows:	
LDG booster station:	Q_n = 15 000 m³/h

Adaption of the existing Power Plant of PTKS:

The existing steam power station of PTKS consists of 5 modules of 80 MW of power generation each, 4 of them in operation, 1 for stand-by (see Figure 8)

It is intended to feed the COREX®-export-gas to the steam boilers of the power station by means of

- exchange of the existing burners of the steam boilers by tripropellant burners for COREX® gas, natural gas and fuel oil (see Figure 9)
- connection of the power plant and the COREX® plant by a feeding pipe line (dia 1 800 mm).

Fig. 8: **Proposed Disposition of Burners in Existing Boiler**

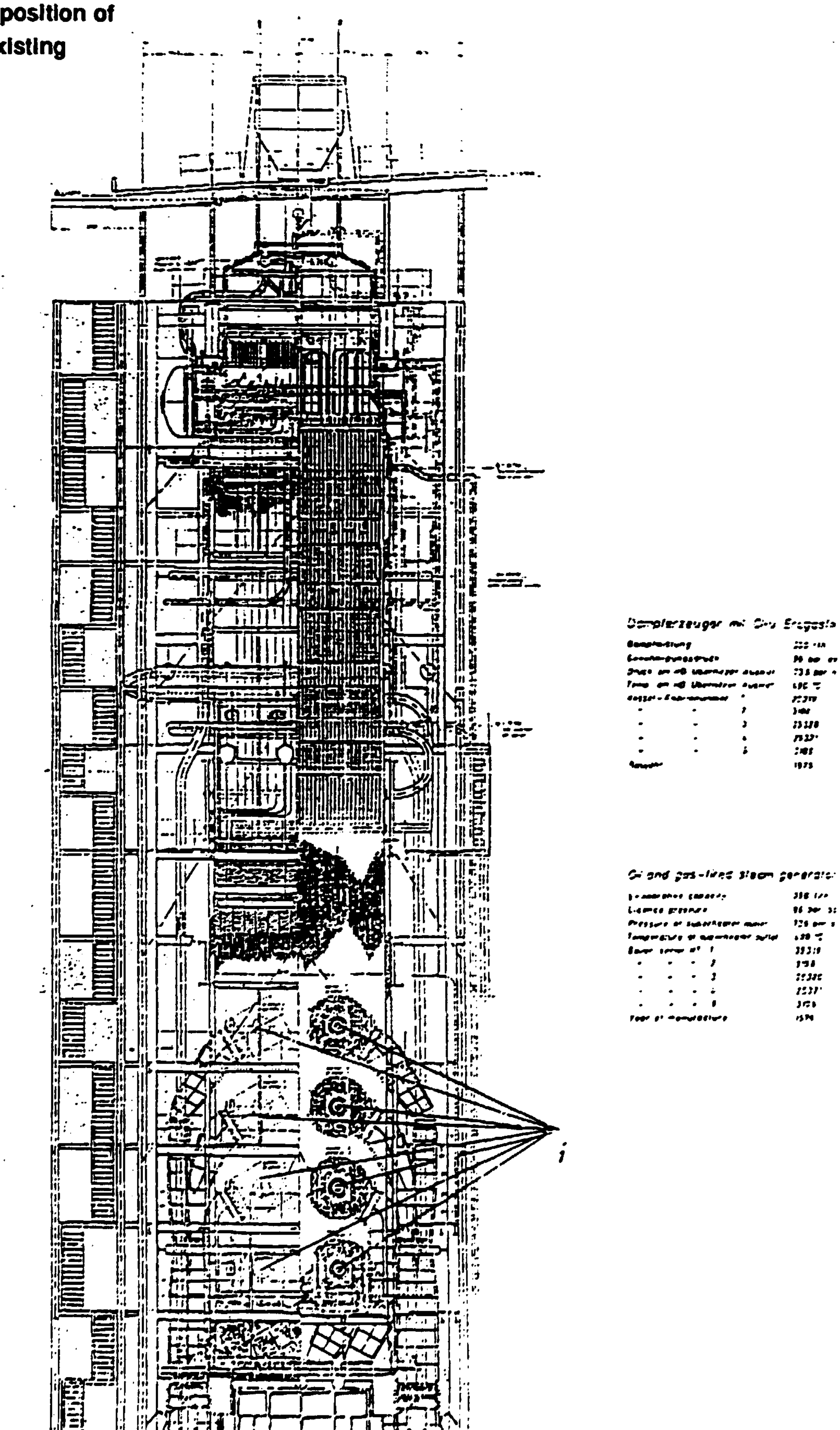


Fig. 9: **Section through Burner for 120 MW_{therm}**

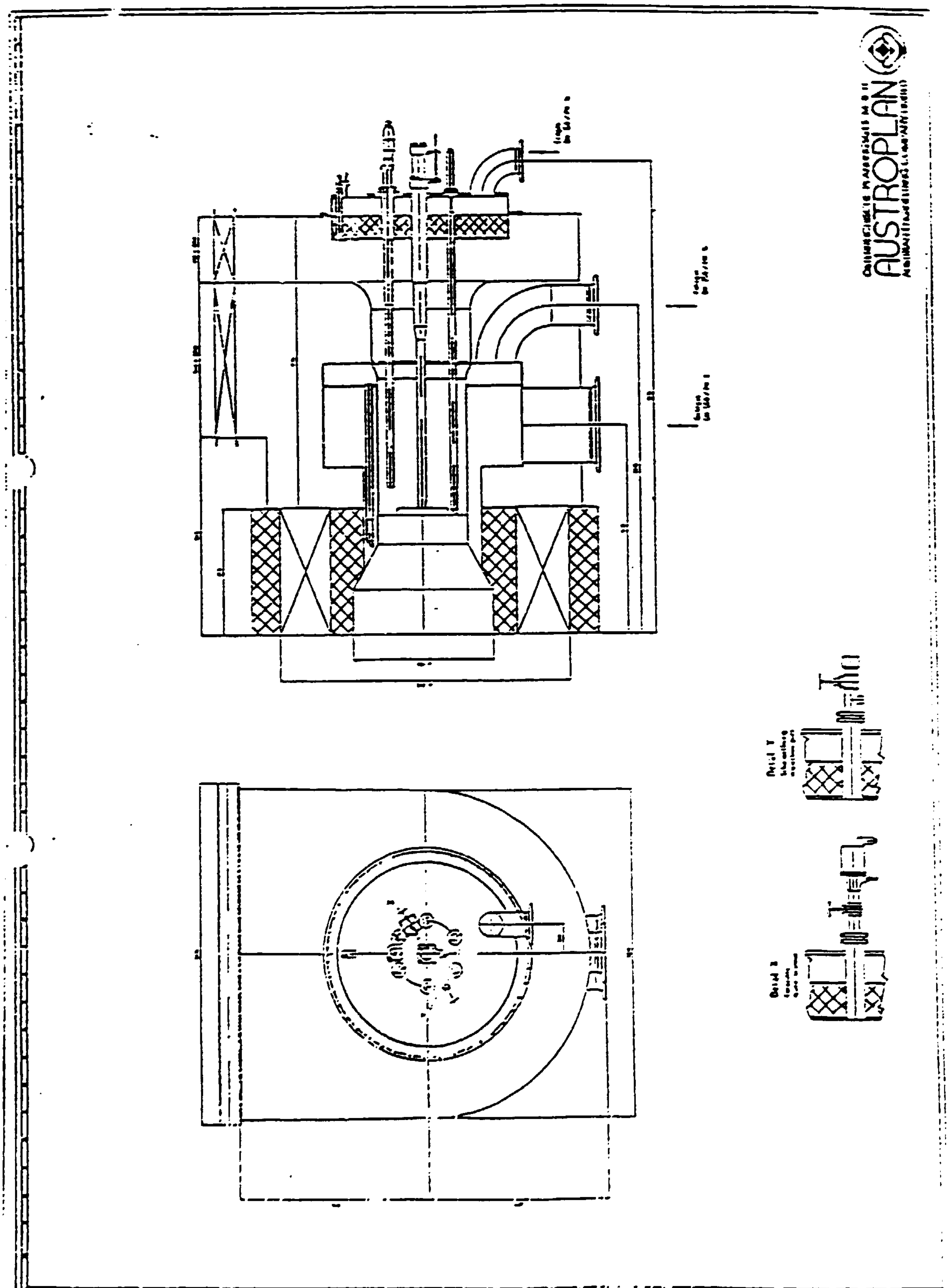


Table 16: **Plant Balance of Combustible Gases**

average values (design flows)
unit Qn = m^3/h

	Calorific value (kJ/Nm^3)	COREX® Nm^3/h	LD Gas Nm^3/h
Generated COREX® gas	8 431	317 500	
LD-Shop	8 431		15,000
Balance to Gas Control Station		317 500	
Internal use consumers	8 431		15,000
Lime plant	8 431	6 000	
Gas LD-plant	8 431	2 000	
Consumers CC thin slabs	8 431	700	
Thin slab mill	8 431	7 000	
TOTAL	8 431	15 700	
FOR EXPORT	8 431	316 800	

Total production/a:

COREX:	1 413 400 t/a x 1 774 Nm^3/t x 8 431 MJ =	21 140 000 GJ/a
BOF:	1 615 000 t/a x 75 Nm^3/t x 8.4 MJ =	1 021 200 GJ/a
Total production		22 161 200 GJ/a

Total consumption/a:

Thin slab casting:	7 500 h x 700 m^3 x 8.43 MJ =	44 300 Gt/a
Others:	8 000 h x 1 500 m^3 x 8.43 MJ =	1 011 700 Gt/a
Total consumption		1 056 000 Gt/a

Grand Total for Export to Power Plant 21 105 200 GJ/a

Fig. 10: IH 84 Combustible Gas / Plant Balance

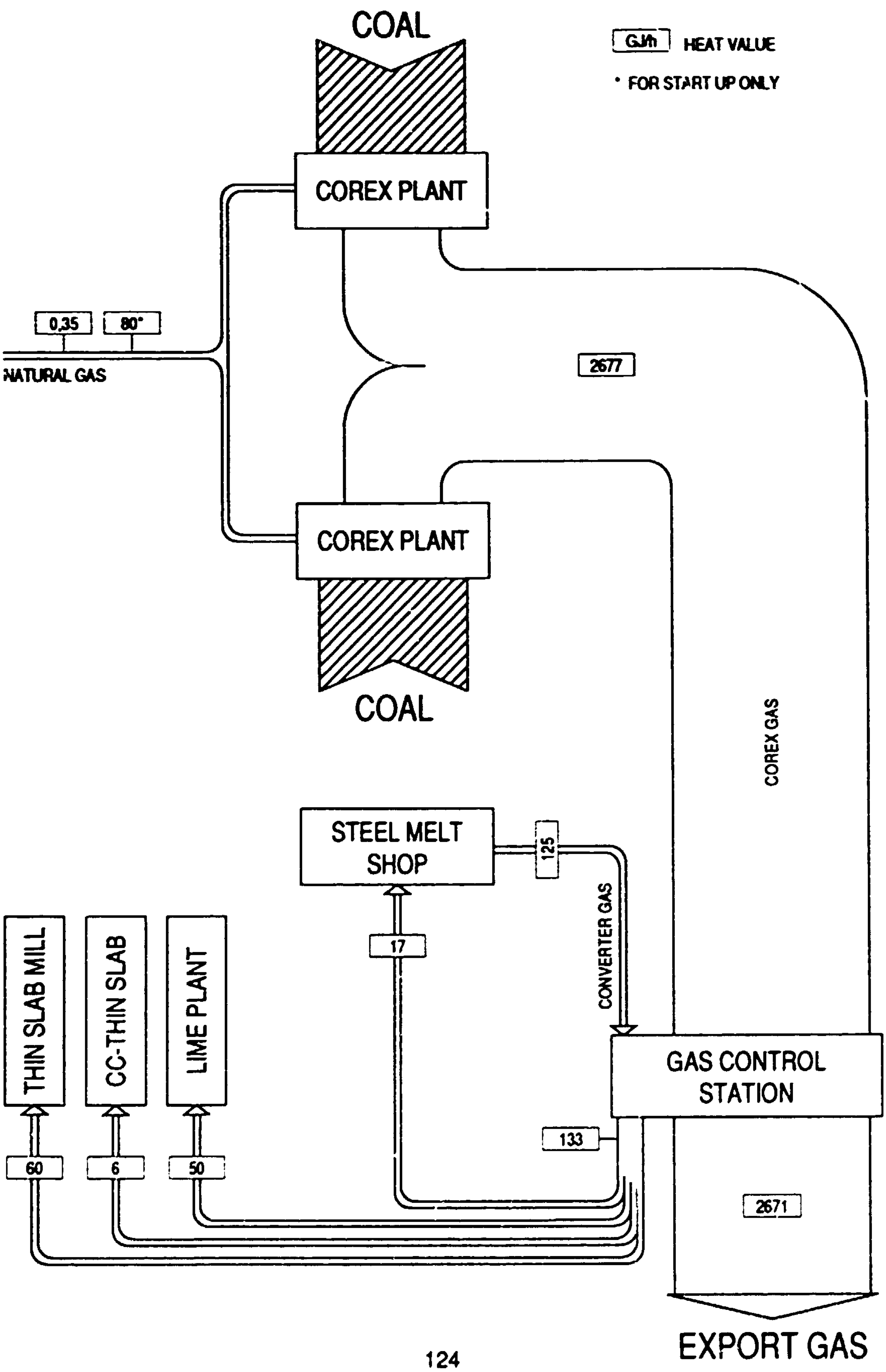
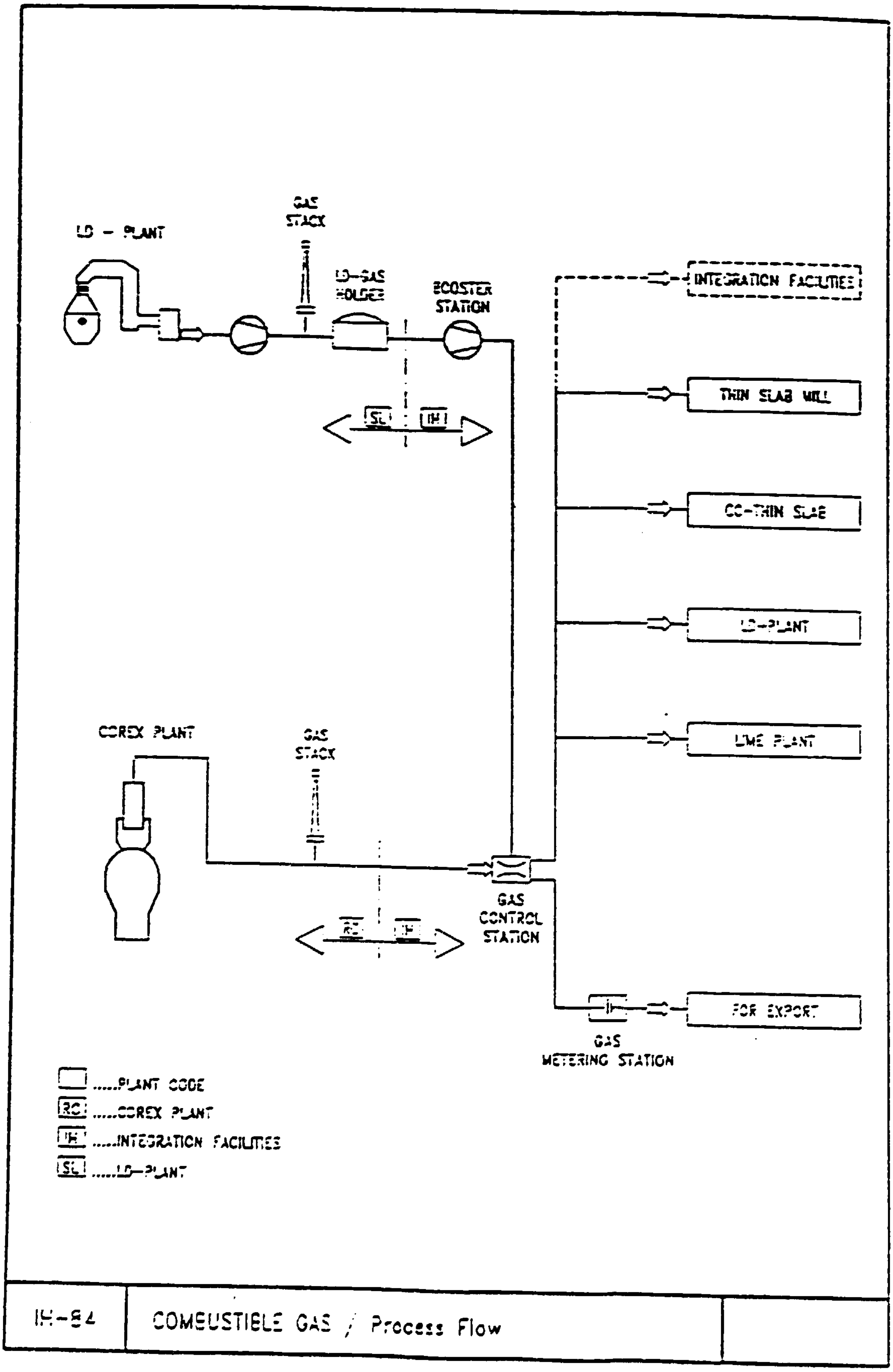


Fig. 11: Process Flow



2.6.7.4 IH 86 Steam / Hot Water

Steam is produced by the waste gas cooling plant in the steel melt shop (waste heat recovery).

The steam is fed via a steam accumulator plant (pressure and temperature controlled) into the steam network.

Steam is used in the COREX® plant, LD-dedusting, air separation plant and for various heating purposes.

The surplus steam which is not needed in the plant is for export.

In case of steam shortage (shut-down of the LD-dedusting plant) the existing steam boiler plant is able to cover the difference in steam demand. The steam boiler plant may also be fired by export COREX® gas and is equipped with an adequate boiler feed water plant.

STEAM BALANCE

average values (design flows)
unit: t/h

Table 17: **Steam Balance**

	COREX® plant	8.0
Consumed	LD-plant (dedusting)	1.4
	Air separation plant	2.6
	LD-plant (heat recovery)	13.4
Generated	Steam boiler plant	12
FOR EXPORT		0-8

Design data

Pressure: 1.0 MPa
Temperature: 185°C
Condition: saturated steam

Fig. 12: Steam Plant Balance

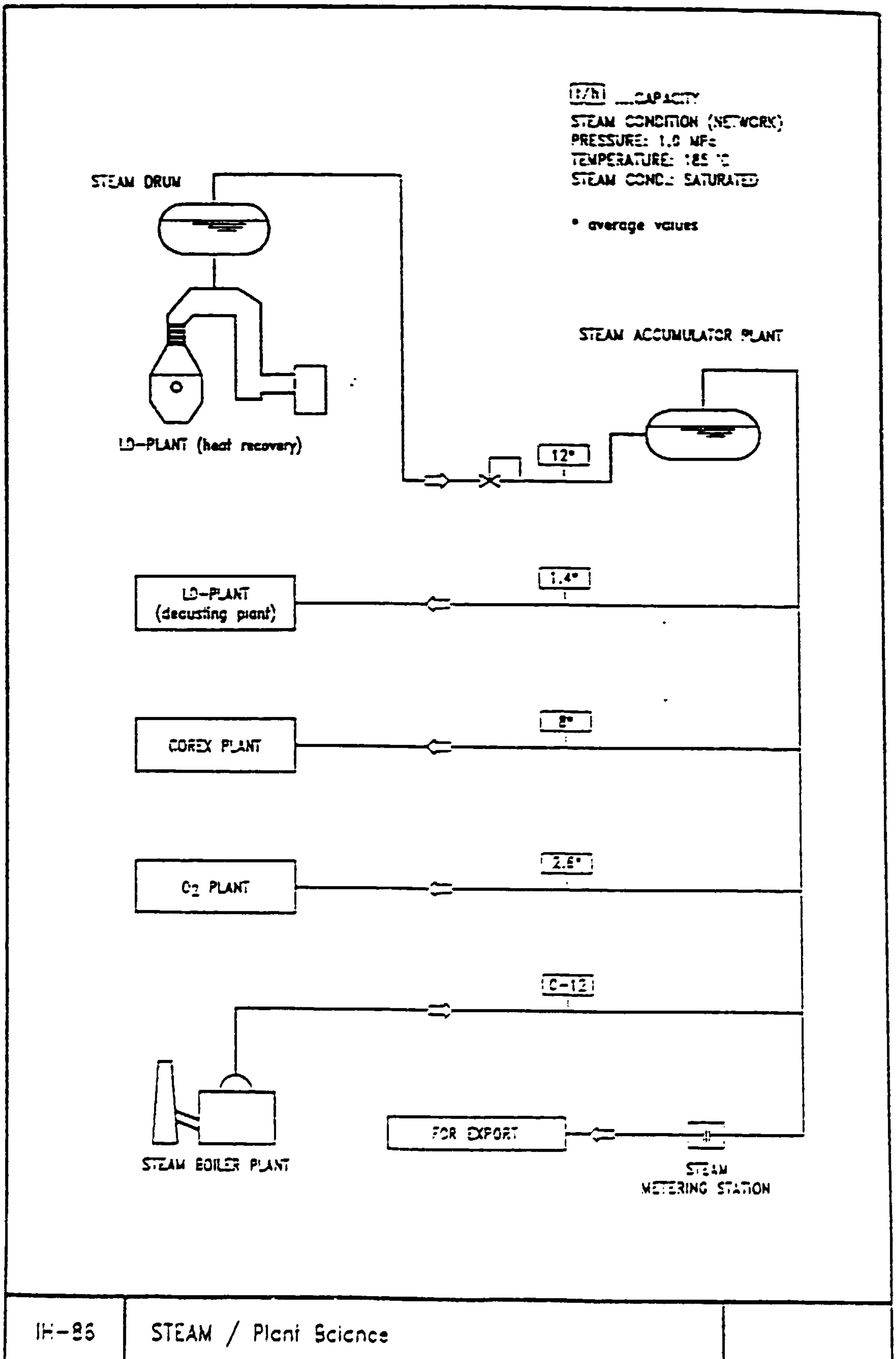


Table 18: Equipment List for Auxiliaries

Item/Code	Designation	Number of Equipment		Main Technical Data
UTILITY SUPPLY/TREATMENT				
IH 81	Water Supply/Treatment	1 set	*)	Q = 1100/980 m³/h
	i) Make up water system	1 set		Q = 950 m³/h
	ii) Service water system	1 set	*)	Q = 50/15 m³/h
	iii) Fire fighting water system	1 set		Q = 0-400 m³/h
	iv) Potable water system	1 set	*)	Q = 60/15 m³/h
	v) Industrial waste water system	1 set		Q = 350 m³/h
	vi) Sanitary waste water system	1 set	*)	Q = 40/10 m³/h
	vii) Rain water system	1 set		
IH 82	Water Circuits + Cooling	1 set		
	viii) LD-Plant cooling	1 set		45 GJ/h
	ix) CC thin slab cooling	1 set		53 GJ/h
	x) Thin slab mill	1 set		243 GJ/h
	xi) Auxiliary plant cooling	1 set		188 GJ/h
IH 83	Incombustible Gases and Air	1 set		
	xii) Oxygen distribution system	1 set	*)	Qn = 150 000/123 600 m³/h
	xiii) Nitrogen distribution system	1 set	*)	Qn = 25 000/23600 m³/h
	xiv) Argon distribution system	1 set		Qn = 300 m³/h
	xv) Compressed air system	1 set		Qn = 6 700 m³/h
	xvi) Instrument air system	1 set		Qn = 400 m³/h
	xvii) Air mist system	1 set	*)	Qn = 13 000 m³/h (peak)
IH 84	Combustible Gases	1 set		
	xviii) Corex gas system	1 set		Qn = 350 000/317 000 m³/h
	xix) LD-converter gas system	1 set		Qn = 15 000 m³/h
	xx) COREX® Export system	1 set		Qn = 350 000/317 000 m³/h
	xxi) Natural gas system	1 set		Qn = 2 500/10 m³/h
IH 86	Steam/Hot Water	1 set		Qn = 12 t/h

*) Indicated values are peak/average system flows

2.6.7.5 ELECTRIC ENERGY

(see also attached single line diagram)

The electric power for the whole plant will be supplied from the 150 kV public net by two 150 kV overhead lines. The short circuit capacity on PCC will be 50 kA.

From a 150 kV indoor SF6 switchyard, three 70 MVA transformers with on load tap changer 150 kV ± 12 x 1.5 % / 30 kV will supply power via a 30 kV switchgear equipment.

Two of these transformers with each 70 MVA, designed with on load tap changer 150 kV ± 12 x 1.5 % / 30 kV will supply power to a redundant transformer - and 6 kV distribution system for the Main Station, LD-plant, water treatment (LD + CONROLL PLANT), CONROLL®-plant, COREX®-plant, coal drying plant and a 25 MVA-filter circuit.

One of this transformers with 70 MVA, designed with on load tap changer 150 kV ± 12 x 1.5 % / 30 kV will supply power to a 22 MVA - Ladle Furnace, CONROLL®-plant, 30 MVA-filter circuit and one equipment for main drives.

The whole system is designed in a redundant system via bus bar couplings on 130 kV-, 30 kV- and 6 kV-system.

In case of failure of the main incoming power, four emergency diesel generator sets with automatic start facility, will feed the emergency consumers.

The star points of the 30 kV side of the main transformer will be resistance grounded, the type of protection will be protective earthing.

The auxiliary voltage for the switchgears will be 220 V DC, supplied by two charging rectifiers, two batteries and DC distribution board.

Protection Relays
In principle following protection will be provided:

SF-switchgear

- incoming feeders: impedance and directional protection
- transformers: impedance, short circuit, overload and differential protection
- busbar: differential protection
- coupling: short circuit protection

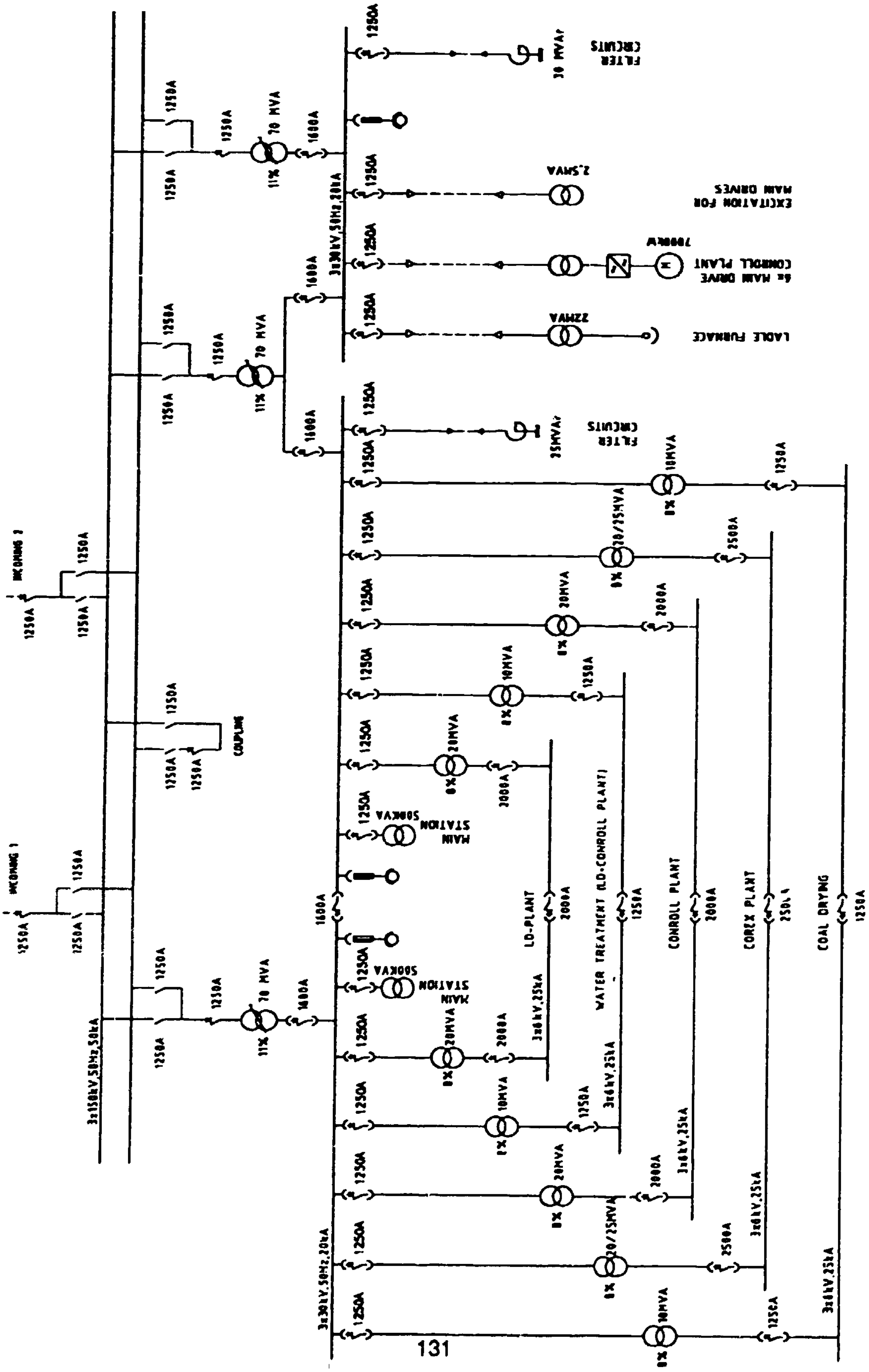
30 kV, 6 kV

- transformers: short circuit, overload and differential protection

Distribution
transformers: short circuit, overload protection

motor: undervoltage, short circuit, overload, earth fault, asymmetric protection, as well as locked motor

Fig. 13: **Single Line Power Diagram**



2.6.7.5.1 IH 91 High Voltage Facilities

2.6.7.5.2 IH 92 Low Voltage Facilities

2.6.7.5.3 IH 93 Electrical Equipment

The design of all equipment is based on the technological requirement considering ambient and environmental conditions of a plant. The equipment applied should be furthermore based on standardized component design to ensure proven technology.

2.6.7.5.4 IH 97 Lighting & Plug Socket System

Appropriate lighting for the mill area and auxiliaries by fluorescents.
For miscellaneous consumers 380 V 3-wire and 220 V 2-wire plug sockets are envisaged.

2.6.7.5.5 IH 98 Lightning & Earthing System

Machine and electrical system grounding to be connected to the general earth system. Control system grounding shall be separate.

2.6.7.5.6 IH 99 Other Electrical Equipment

All required cables and erection material for interconnection as well as grounding of the specified electrical equipment, instrumentation and automation including the required auxiliary material will be in accordance with the appropriate standards.

Table 19: **Electric Energy Consumption**

Item	MWh/a
Process Facilities:	
COREX® Plant	116 280
LD Plant	91 871
Thin Slab Casting	5 461
Thin Slab Mill	108 640
Lime Plant	6 748
Sub Total	329 000
Integration Facilities:	
Oxygen Plant	701 162
Compressed Air Plant	12 768
Various	26 070
Sub Total	740 000
Grand Total	1 069 000
Consumption/h	147 MW

Table 20: **Equipment List of Integration Facilities**

Item/Code	Designation	Number of Equipment	Main Technical Data
IH 12	Raw material storage yard - Stacker reclaimer - Belt conveyor system	 2 pieces 1 set	
IH 14	Scrap handling and treatment - bridge crane with crab and magnet - weighing bridge - hand gas cutting torches	 1 piece 1 piece 1 set	
IH 46	Air separation plant - O_2-generation (95 % purity) - O_2-generation (99.5 % purity) - N_2-generation - Ar-generation	 1 set 1 set 1 set 1 set	 Qn = 113 000 m^3/h Qn = 10 600 m^3/h Qn = 23 600 m^3/h Qn = 300 m^3/h
IH 48	Slag handling and treatment - hopper - wheel loader - vibration grades - impact crusher - vibrating feeder - screening machine - belt conveyor	 1 set 1 piece 1 set 1 piece 1 set 1 piece 1 set	
IH 49	Scale handling and treatment		
IH 51	Central mechanical workshops - bay crane - various tools and machines	 2 pieces 1 set	
IH 52	Central electrical/electronic workshop - bay crane - various tools and machines	 1 piece 1 set	
IH 53	Maintenance railway/vehicles - bay crane - various tools & machines	 2 pieces 1 set	
IH 54	Store for spare parts and consumables - bay crane - fork lift - pallets - various stackers	 1 piece 1 piece	
IH 57	Central refractory store - bay crane - fork lift - pallets	 1 piece 1 piece	

Item/Code	Designation	Number of Equipment	Main Technical Data
IH 58	Central operating parts store - bay crane - fork lift - pallets - various stacker	 1 piece	
IH 61	Planning system/management info		
IH 63	General instrumentation		
IH 64	Basic automation		
IH 67	Central laboratory		
IH 73	Administrative building		
IH 74	First aid & security device		
IH 75	Fire alarm & fighting system		
IH 77	Road transport		
IH 81	Water supply/treatment - make up water system - service water system - fire fighting water system - potable water system - industrial waste water system - sanitary waste water system - rain water system	 1 set 1 set 1 set 1 set 1 set 1 set 1 set	Q = 1 100/980 m^3/h *) Q = 950 m^3/h Q = 50/15 m^3/h 1/ *) Q = 0-400 m^3/h Q = 60/15 m^3/h 1/ *) Q = 350 m^3/h Q = 40/10 m^3/h 1/ *)
IH 82	Water circuits + cooling - LD-plant cooling - CC thin slab cooling - Thin slab mill cooling - auxiliary plant cooling	1 set 1 set 1 set 1 set 1 set	 45 GJ/h 53 GJ/h 243 GJ/h 188 GJ/h
IH 83	Incombustible gases and air - oxygen distribution system - nitrogen distribution system - argon distribution system - compressed air system - instrument air system - air mist system	1 set 1 set 1 set 1 set 1 set 1 set 1 set	 Qn = 150 000/123 000 m^3/h *) Qn = 25 000/23 600 m^3/h *) Qn = 300 m^3/h Qn = 6 700 m^3/h Qn = 400 m^3/h Qn = 13 000 m^3/h *)
IH 84	Combustible gases - COREX® excess gas system - LD-converter gas system - export gas system - natural gas system	1 set 1 set 1 set 1 set 1 set	 Qn = 350 000/325 000 m^3/h Qn = 15 000 m^3/h Qn = 350 000/325 000 m^3/h Qn = 2 500/10 m^3/h
IH 86	Steam/hot water	1 set	Qn = 12 t/h
IH 91	High voltage facilities		

Item/Code	Designation	Number of Equipment	Main Technical Data
IH 92	Low voltage facilities		
IH 93	Electrical equipment		
IH 97	Lighting & plug socket system		
IH 98	Lightning & earthing system		
IH 99	Other electrical equipment		

3. SEA PORT

3.1 INTRODUCTION

P.T. Krakatau Steel operates harbour facilities consisting of:
1 Off Shore jetty (3 berths), water depth 14 m, equipped with:

- 4 Unloading bridges a 750 t/h unloading capacity (free digging rate)
- 2 berths (No.2 & 3) are used for bulk unloading (pellets and coal)
- berth No.1 was planned for dispatch of DRI
- Conveying System for bulk material, which only can serve berths No. 2 & 3 (2 lines of conveyors each having 1500 t/h capacity; conveyor width: 1.0 m, belt speed > 3 m/s. Berth No.2 only can transfer the bulk material onto one conveyor line)
- Max. vessel size 70 000 DWt

An increase of vessel size would be highly welcomed, but is limited due to following facts:

- further dredging (deeper than 14 m) is not possible, because of jetty structure.
- free height of unloading bridges is to low for larger vessel sizes.

To avoid any limitation on raw material supply (capacities and vessel sizes) it seems to be necessary to install new port facilities for the Second Generation Steel Mill.

In the following one of the possible solutions is indicated, however, before realization all necessary investigations and elaborations have to be carried out by experienced harbour builders to consider all local conditions and circumstances and also to define the best and most economic port location.

3.2 BASIC DATA

3.2.1 MATERIALS TO BE LOADED/UNLOADED

3.2.1.1 MATERIALS

- Bulk materials
  - Iron ore 2 300 000 t/a
  - Coal 1 500 000 t/a
  - Scrap 290 000 t/a (at the existing berth Cigading)

- Cargo at existing CIGADING site
  - Ferro alloys 20 000 t/a
  - Operating materials and consumables (like electrodes, refractories, carbon, alumina, etc.)
  - Spare parts
  - Product dispatch (if any)

3.2.1.2 SUPPLY CONDITIONS OF MATERIALS

- pellets, ore
  supply: bulk, by vessels up to 150 000 dwt
  unloading: by bridge unloader

- coal
  supply:bulk, by vessels up to 150 000 dwt (possible, but average approx. 20 000 dwt-coastal shipment)
  unloading: by bridge unloader

- Scrap
  supply: bulk, by vessels up to 30 000 DWT
  unloading: level luffing crane

- Ferro alloys
  supply: in drums on pallets, by vessel
  unloading: level luffing crane

- All other materials
  supply: cargo condition
  unloading: level luffing crane

3.2.1.3 STORAGE CAPACITY

The storage capacity shall be designed as follows: To keep the working capital as low as possible the storage capacity should not be more than 1 month. On the other hand any arriving vessel has to be unloaded. Considering this, a minimum storing capacity of 1.5 vessels should be made available.

- Ore yard

  Recalculation:
  monthly ore consumption:
  = 2 300 000 t/a : 12 months = 191 700 t/month
  1.5 vessels:
  = 150 000 t x 1.5 = 225 000 t

  selected storage capacity:
  considering two (2) ore origins a storing capacity of 300 000 t is recommended.

- Coal

  Recalculation:
  monthly coal consumption:
  = 1 500 000 t/a : 12 months = 125 000 t/month
  1.5 vessels:
  = 20 000 t x 1.5 = 30 000 t

  selected storage capacity:
  considering two (2) or more coal origins a storing capacity of 125 000 t is recommended.

- Scrap

  Recalculation:
  monthly scrap consumption:
  = 290 000 t/a : 12 months = 24 000 t/month
  1.5 vessels:
  = 30 000 t x 1.5 = 45 000 t

  selected storage capacity:
  a storing capacity of 45 000 t is recommended.

- Cargo
  storing areas already existing at cigading site.

3.2.2 WORKING TIME AND TIME BALANCE

General down times (holidays) cannot be considered, because of the very expensive costs in case an ocean vessel have just to wait for unloading.

BULK UNLOADING

For the Second Generation Steel Mill it is proposed to install a new bulk unloading harbour for the first step with one berthing facility for bulk carriers up to 150 000 dwt. Unloading itself shall be done by two (2) bridge unloaders having an average capacity of 1000 t/h each (= approx. 1400 t/h free digging rate). A corresponding conveying system leads the raw materials to the individual storage piles/sections.

The layout considers further extension, which allows installations of a further berth, bridge unloaders and corresponding storage area.

- Unloading bridges:
  - Ore: 2 300 000 t/a
  - Average vessel size (assumed) =120 000 dwt
  - No of vessels / a :
    = 2 300 000 t/a : 120 000 t/vess.= 19.2 V
  - Average berthing time (turnround time):
    = 120 000 t : 2000 t/h + 10 h = 70h
  - Berth occupation:
    = 70 h x 19.2 = 1 344 h

  - Coal: 1 500 000 t/a
  - Average vessel size (assumed) = 20 000 dwt
  - No of vessels / a :
    = 1 500 000 t/a : 20 000 t/vess.= 75 V
  - Average berthing time (turnround time):
    = 20 000 t : 2000 t/h + 10 h = 20h
  - Berth occupation:
    = 20 h x 75 = 1 500 h

  - Utilization of unloading bridges:
    = 2844 h : 330 d : 24 h/d = 36 %

CARGO UNLOADING AT CIGADONG

- Level luffing crane

• Scrap	290 000 t/a
• Average vessel size (assumed) =	10 000 dwt
• No.of vessels /a :	
= 290 000 t/a : 10 000 t/V. =	29 V.
• Average berthing time (turnround time) :	
= 10 000 t : 50 t/h * 2 pc + 10 h =	110 h
• Berth occupation :	
= 110 x 29 =	3 190 h
• General Cargo (assumed)	40 000 t/a
• Average vessel size (assumed) =	5 000 dwt
• No.of vessels /a :	
= 40 000 t/a : 5 000 t/V. =	8 V.
• Average berthing time (turnround time) :	
= 5 000 t : 20 t/h * 2 pc + 10 h =	135 h
• Berth occupation :	
= 135 x 8 =	1 080 h
• Utilization of level luffing cranes:	
= 4 270 h : 330 d : 24 h/d =	54 %

E:\projekte\piks-bolphase-2\tech-desc\1-4.wp5

3.3 GENERAL CONCEPT

- Ore

Ore supplied by ocean vessels will be unloaded by bridge unloaders, which transfer the ore onto the pier conveyor.

Via further conveyors and the stacker/reclaimer units the bulk materials are stored onto the ore storage yard.
From there the ore is removed by the same stacker/reclaimer units and will be transported by conveyors to the individual consumers.
Another possibility is to transport the ore partly directly from the ocean vessel to the consumers.

- Coal

Coal supplied by ocean vessels/coastal ships will be unloaded by bridge unloaders, which transfer the coal onto the pier conveyor.

Via further conveyors and the stacker/reclaimer units the bulk materials are stored onto the coal storage yard.
From there the coal is removed by the stacker/reclaimer units and will be transported by conveyors to the consumers.
An other possibility is to transport the coal partly directly from the unloading bridge to the consumers.

- Scrap

Scrap delivered by ocean vessel or barges will be unloaded by means of the level luffing cranes and stored at the scrap yard of the harbour area. The transport to the scrap yard SGSM takes place by means of trucks.
A direct transloading from vessels/barges onto trucks by the level luffing cranes is also possible.

- Ferro alloys (as cargo)

Ferro alloys will be unloaded by means of the level luffing cranes and placed at an intermediate storage area. From there it will be transported by means of fork lift trucks/trucks to the storing positions.

- General cargo

General cargo is unloaded by level luffing cranes and directly transported to the individual warehouse.

- Auxiliary facilities

To allow a smooth operation the sea port shall be provided with:

* Tug boat facilities
* Repair posts
* Fuel and lubricant store
* Spot laboratory
* Office and locker building
* Water supply distribution
* Energy supply and distribution

3.4 GENERAL DESCRIPTION OF THE NEW HARBOUR

The new harbour shall have the following main facilities:

- 2 Tug boat facilities
- 4 Unloading facilities (unloading bridges and luffing cranes)
- 1 Raw material storage yard
- 1 Sample taking
- 1 Laboratory facilities
- 1 Repair posts
    * mechanical department
    * electrical department
    * vehicle repair
    * spare part store
- 1 Lubricant store
- 1 Automation and communication system
- 1 Administration/locker building
- 1 Fire alarm system
- 7 Road transportation trucks for scrap transport
- 1 Fuel station
- 1 Utility supply and distribution
- 1 Energy supply & distribution

As indicated in the list above equipment for sample taking is provided.
This automatic sampler can be adjusted to a sample schedule. For evaluating the samples a spot laboratory is located at the transformer station, where the following tests for the raw material can be carried out:

- humidity
- grain size
- compressive strength

In case further physical or chemical analyses are required, the samples will be pretreated to carry out the necessary analyses at the plant site's central laboratory.

3.5 MANPOWER

For the operation of the harbour the following personnel is required (including running maintenance, vacation and sick leave:

Category 1:	4 persons
Category 2:	12 persons
Category 3:	65 persons
Category 4:	28 persons

3.6 COST ESTIMATE

Civil works	US$	125 mn
Unloading equipment, transport, vehicles, laboratory equipment, tugboats	US$	59 mn
Total harbour	US$	184 mn

Not included in above are costs for offshore dredging.

4. PLANT BALANCE

Fig. 14: Specific Consumption Figures - Lime Kiln (per tonne product)

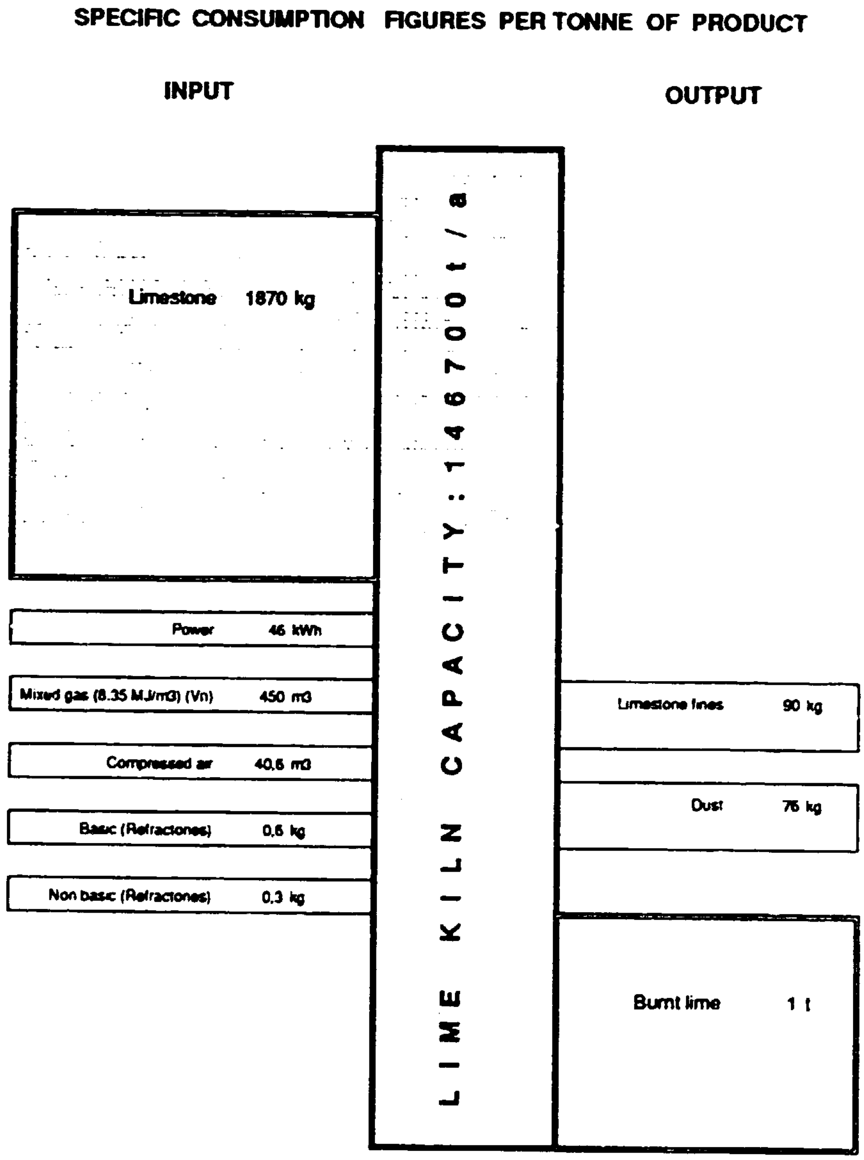


Fig. 15: **Specific Consumption Figures - Lime Kiln (per year)**

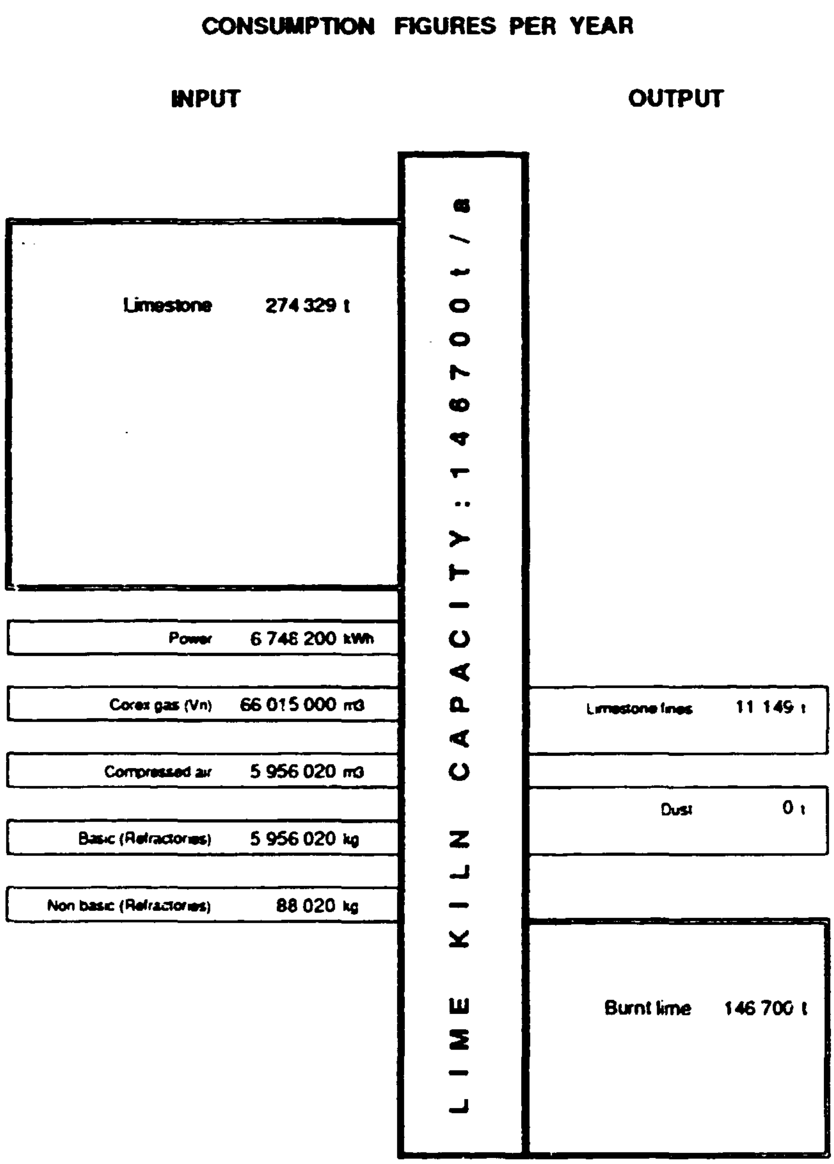
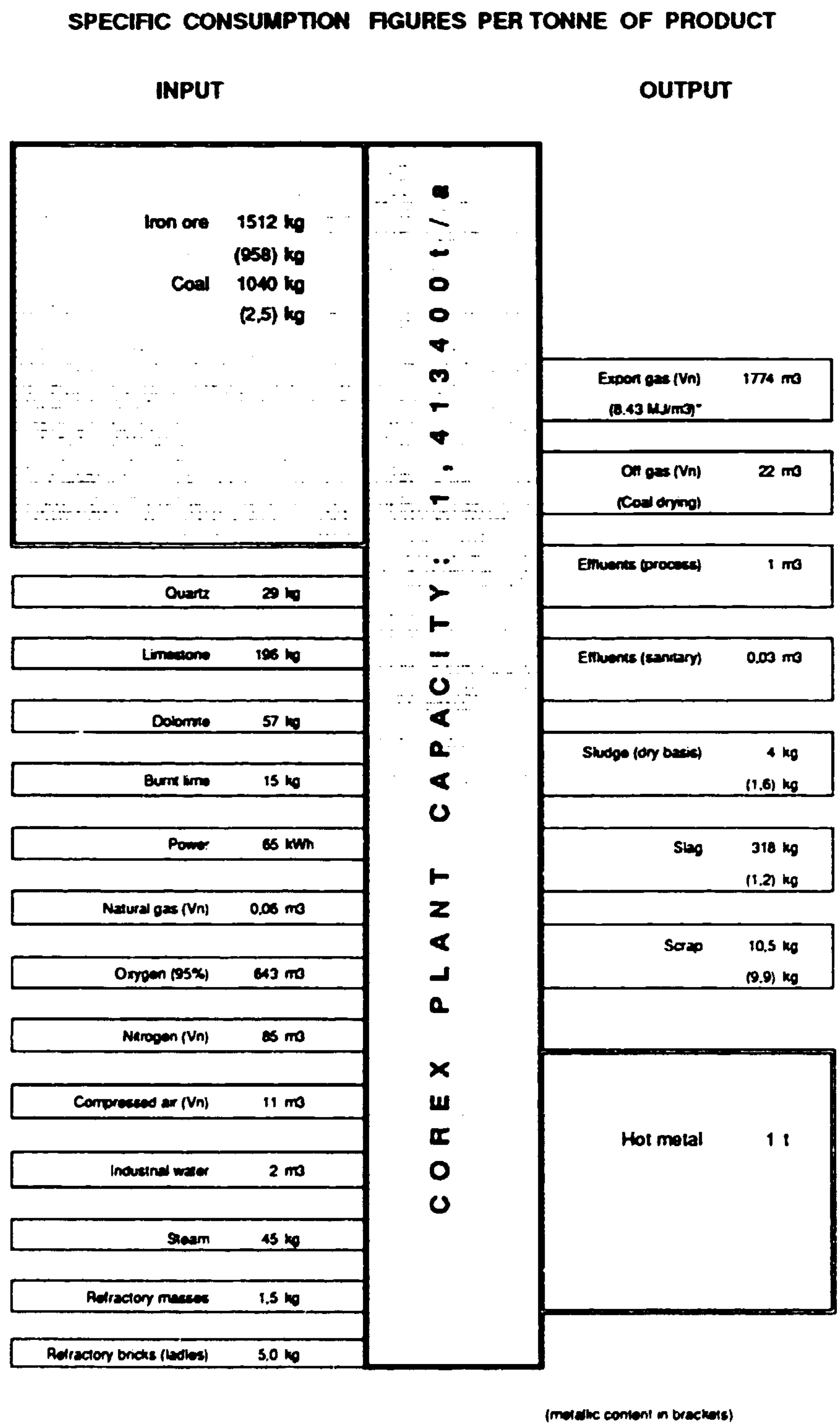


Fig. 16: Specific Consumption Figures - COREX Plant (per tonne product)



E:\projekte\pks-bo\phase-2\tech-desc\1-4.wp5

Fig. 17: **Specific Consumption Figures - COREX Plant (per year)**

CONSUMPTION FIGURES PER YEAR

COREX PLANT CAPACITY: 1,413 400 t/a
Variant 2

INPUT

Iron ore	2 137 061 t
	(1 354 037) t
Coal	1 469 936 t
	(3 534) t
Quartz	40 989 t
Limestone	277 026 t
Dolomite	80 564 t
Burnt lime	21 201 t
Power	91 871 000 kWh
Natural gas (Vn)	84 804 m3
Oxygen (95%)	908 816 200 m3
Nitrogen (Vn)	120 139 000 m3
Compressed air (Vn)	15 547 400 m3
Industrial water	2 826 800 m3
Steam	63 603 t
Refractories	2 120 t

OUTPUT

Export gas (Vn) (8.43 MJ/m3)*	2 507 371 600 m3
Off gas (Vn) (Coal drying)	31 094 800 m3
Effluents (process)	1 413 400 m3
Effluents (sanitary)	42 402 m3
Sludge (dry basis)	5 654 t
	(2 261) t
Slag	449 461 t
	(1 696) t
Scrap	14 841 t
	(13 993) t
Hot metal	1 413 400 t

(metallic content in brackets)

Fig. 18: **Specific Consumption Figures - LD - Plant (per tonne product)**

CONSUMPTION FIGURES PER YEAR

LD - PLANT CAPACITY: 1,615 000 t/a

INPUT

Hot metal	1 295 828 t
	(1 228 224) t
Pig Iron	117 524 t
	(111 387) t
Lump Ore	8 043 t
	(4 990) t
Scrap	332 480 t
	(311 534) t
Alloys	19 590 t
	(19 590) t
Dust	20 834 t
	(14 858) t
Scale	27 132 t
	(21 641) t
Burnt lime	125 486 t
Dolomite	8 043 t
Industrial water	969 000 m3
Mixed gas (8.35 MJ/m3) (Vn)	16 150 000 m3
Nat. gas (36.12 MJ/m3) (Vn)	80 750 m3
Steam	11 305 t
Oxygen (Vn)	85 595 000 m3
Nitrogen (Vn)	51 680 000 m3
Argon (Vn)	2 422 500 m3
Compressed air (Vn)	14 535 000 m3
Electric power	116 280 000 kWh
Refractories	17 765 t
Electrodes	808 t
DS-agent	24 225 t

OUTPUT

Converter gas (Vn) (8.4 MJ/m3)	121 125 000 m3
Steam	96 900 t
Dust	23 579 t
	(16 796) t
DS-slag	24 225 t
Slag	161 500 t
	(31 493) t
Scrap	32 300 t
	(20 995) t
Losses	40 375 t
	(28 101) t
Liquid steel	1 615 000 t

(metallic content in brackets)

Fig. 19: **Specific Consumption Figures - LD - Plant (per year)**

CONSUMPTION FIGURES PER YEAR

LD - PLANT CAPACITY: 1,615 000 t/a

INPUT

Hot metal	1 295 828 t
	(1 228 224) t
Pig Iron	117 524 t
	(111 387) t
Lump Ore	8 043 t
	(4 990) t
Scrap	332 480 t
	(311 534) t
Alloys	19 590 t
	(19 590) t
Dust	20 834 t
	(14 858) t
Scale	27 132 t
	(21 641) t
Burnt lime	125 486 t
Dolomite	8 043 t
Industrial water	969 000 m3
Mixed gas (8.35 MJ/m3) (Vn)	16 150 000 m3
Nat. gas (36.12 MJ/m3) (Vn)	80 750 m3
Steam	11 305 t
Oxygen (Vn)	85 595 000 m3
Nitrogen (Vn)	51 680 000 m3
Argon (Vn)	2 422 500 m3
Compressed air (Vn)	14 535 000 m3
Electric power	116 280 000 kWh
Refractories	17 765 t
Electrodes	808 t
DS-agent	24 225 t

OUTPUT

Converter gas (Vn) (8.4 MJ/m3)	121 125 000 m3
Steam	96 900 t
Dust	23 579 t
	(16 796) t
DS-slag	[illegible] t
Slag	161 500 t
	(31 493) t
Scrap	32 300 t
	(20 995) t
Losses	40 375 t
	(28 101) t
Liquid steel	1 615 000 t

(metallic content in brackets)

Fig. 20: **Specific Consumption Figures - Thin Slab Caster (per tonne product)**

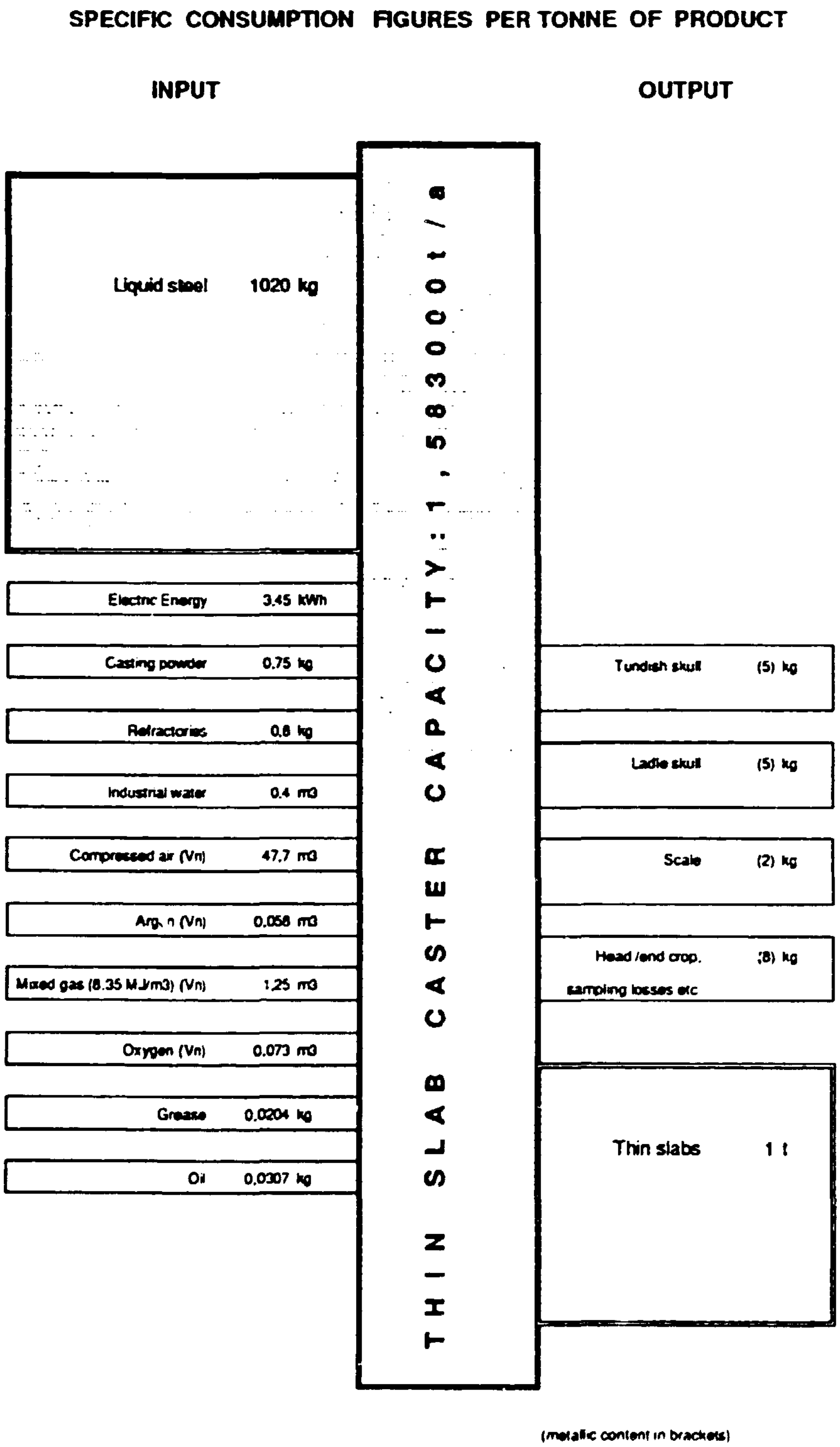
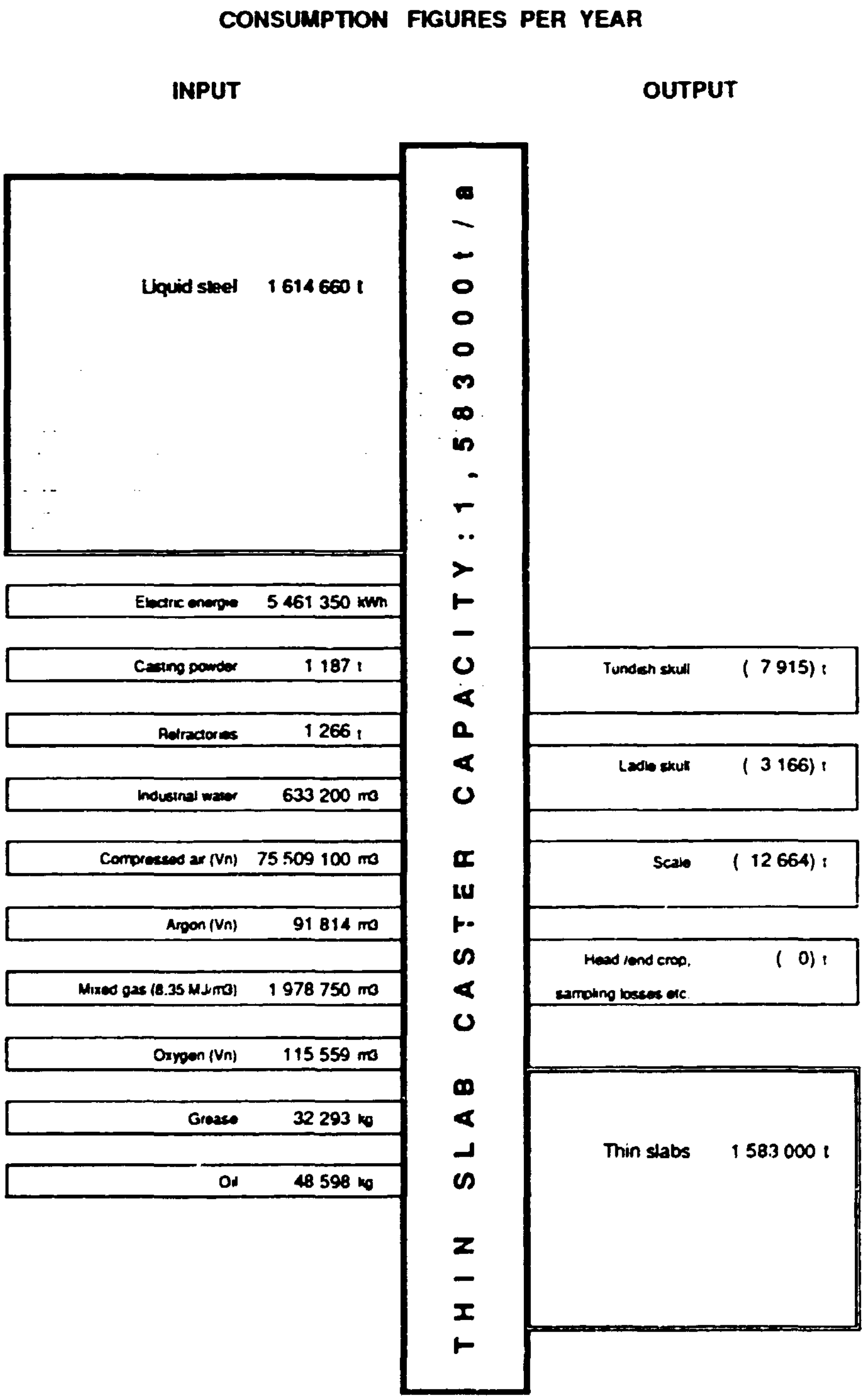


Fig. 21: Specific Consumption Figures - Thin Slab Caster (per year)



(metallic content in brackets)

Fig. 22: **Specific Consumption Figures - Thin Slab Mill (per tonne product)**

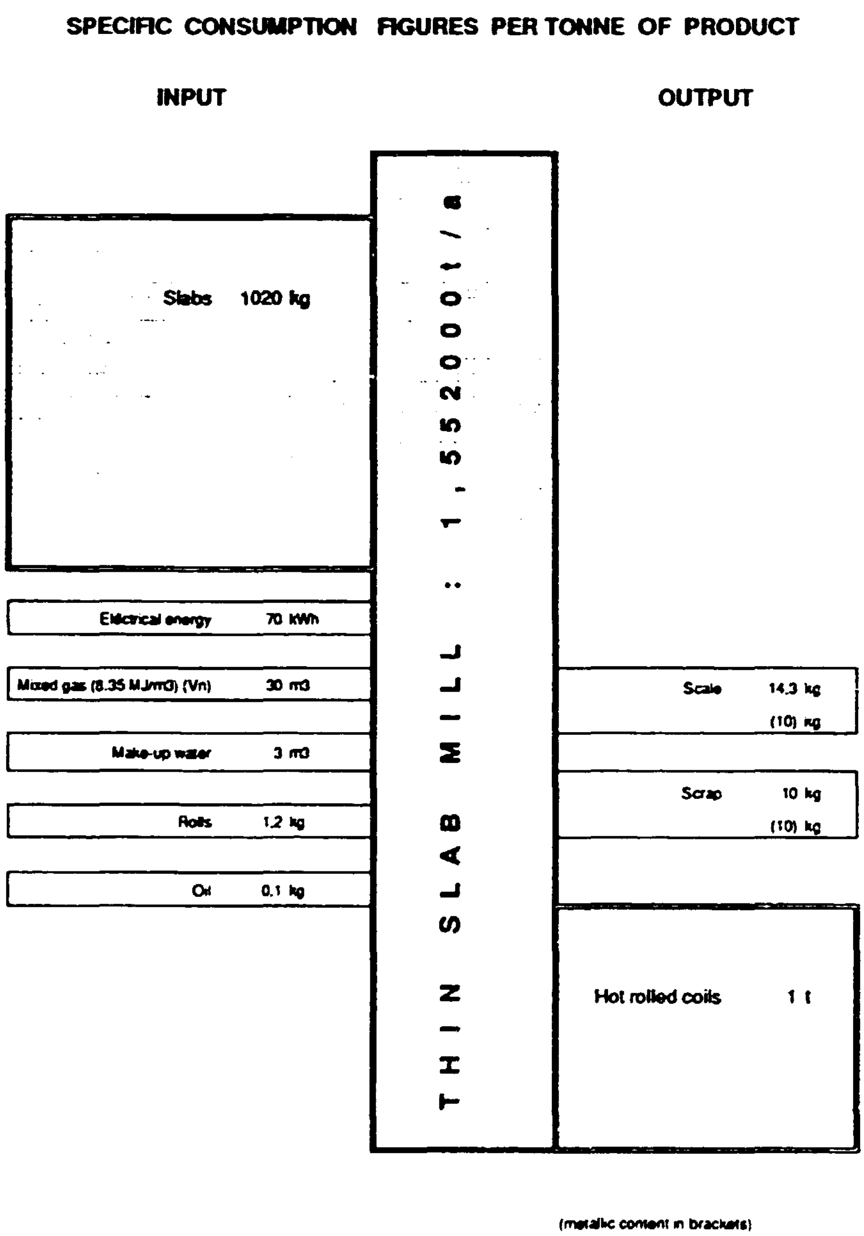
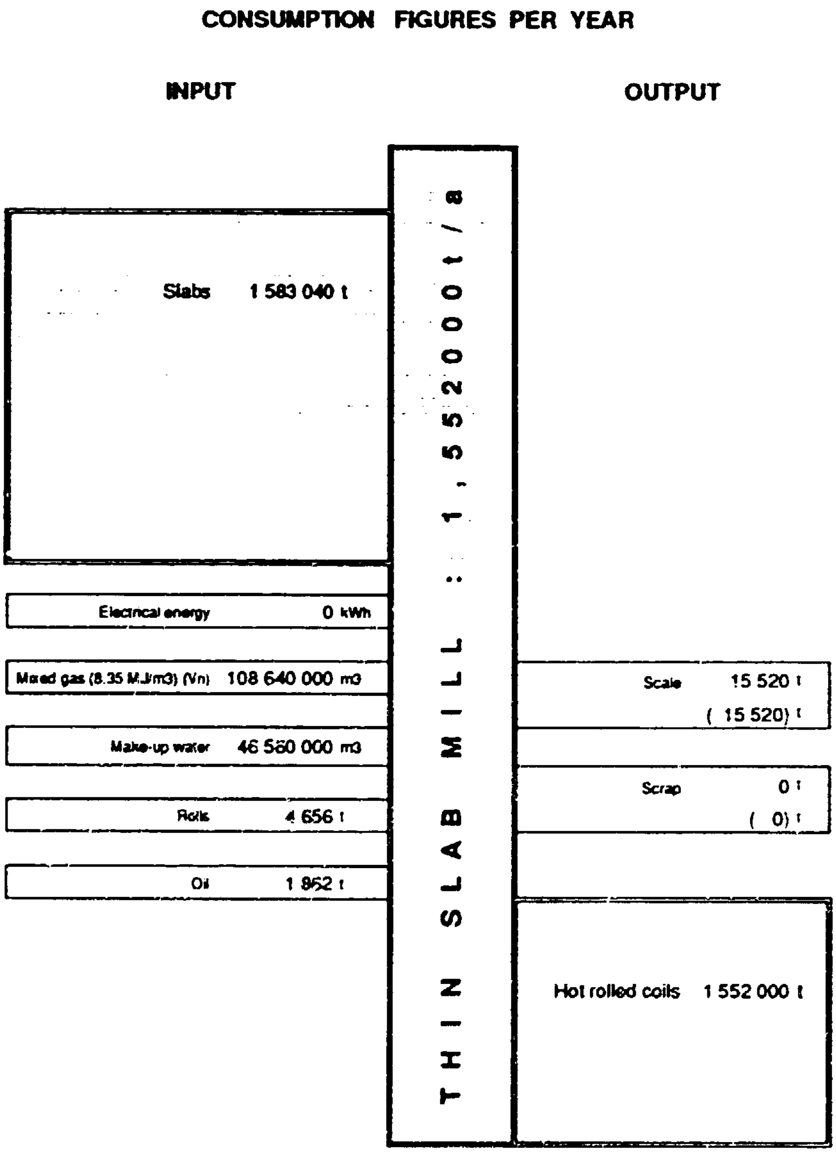


Fig. 23: **Specific Consumption Figures - Thin Slab Mill (per year)**



(metallic content in brackets)

Fig. 24: **Material Flow Sheet**

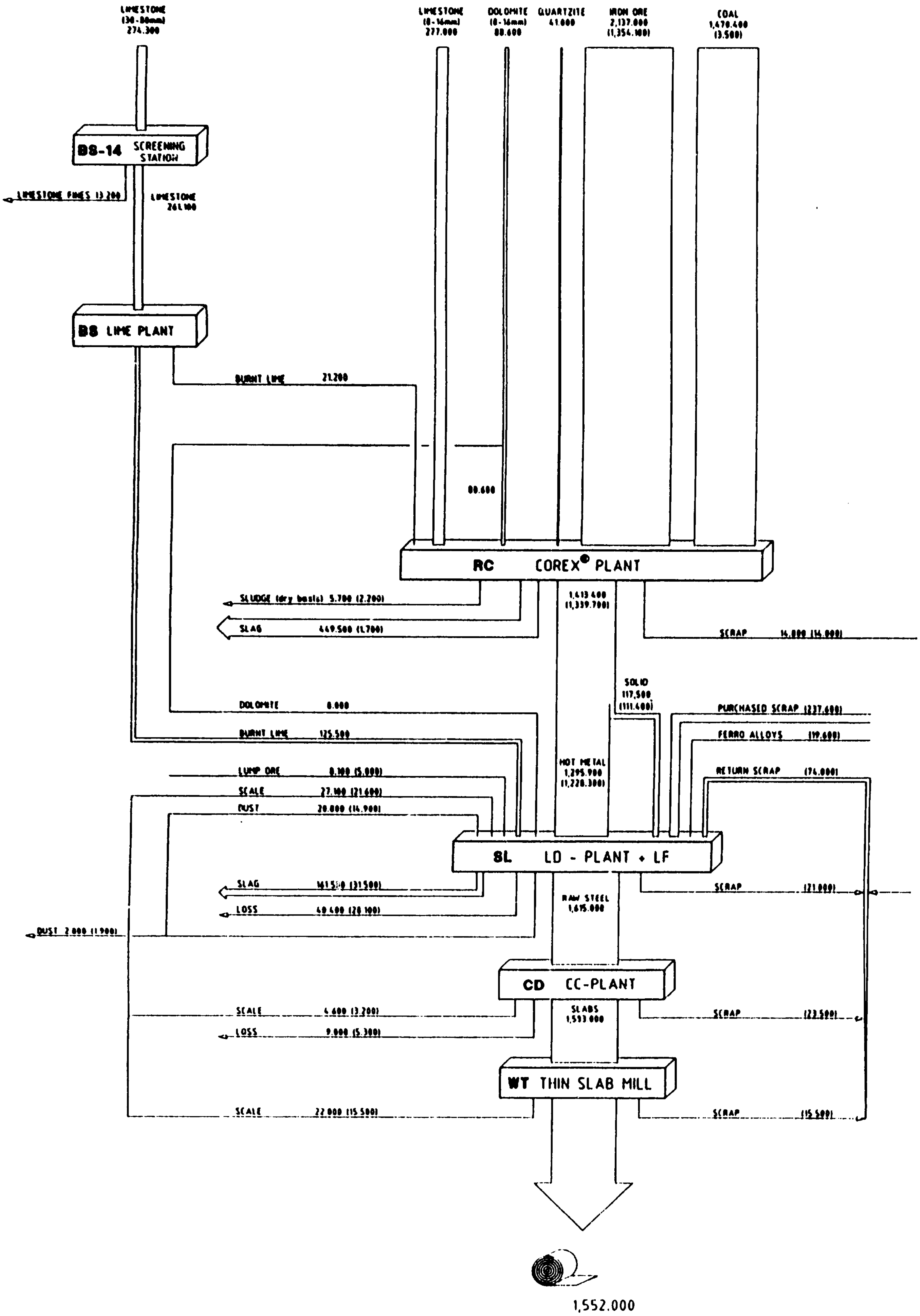


Table 21 : **Projection of quantities and cost of raw materials and supplies**

Description	Price per unit in US$		unit	Annual consumption (000 units)	Annual costs (000 US$
	local *)	CIF			
INPUTS:					
RAW MATERIALS:					
Limestone	10		t	551.3	5,513.0
Iron ore		31.16	t	2,145.1	66,841.3
Dolomite	40		t	88.6	3,544.0
Scrap **)		137.5	t	237.6	32,670.0
Alloys		700	t	19.6	13,720.0
ENERGY:					
Electric energy	60		MWh	329.0	19,740.0
Coal (wet)	36		t	1,469.9	52,917.7
Natural Gas	0.088		m^3	165.5	14.6
CONSUMABLES:					
Refractory bricks I	1,200		t	7.7	9,300.0
Refractory bricks II		2,300	t	1.6	3,634.0
Refractory masses		650	t	20.5	13,347.7
Oxygen	0.036		m^3	994,526.8	35,803.0
Nitrogen	0.036		m^3	171,819.0	6,185.5
Argon	0.036		m^3	2,514.3	90.5
Compressed air	0.007		m^3	111,447.5	780.1
Water	0.02		m^3	9,085.0	181.7
Steam ***)			t	74.9	0
Electrodes		2,000	t	0.8	1,616.0
DS-agent		396	t	24.2	9,593.1
Casting powder		4,500	t	1.2	5,341.5
Grease	400		t	0.w	13.2
Oil, Gas oil, Gasoline	400		t	0.4	163.2
Rolls	3,500		t	1.9	6,517.0
TOTAL					287 527.10

*) Conversion rate 1 US$ = 2, 070 Rupiahs
**) Plus in-plant scrap
***) Own production

5. ORGANIZATION AND OVERHEAD COSTS

5.1 GENERAL REMARKS

5.1.1 FOREWORD

Project formulating and organization planning are closely related and therefore, have been undertaken jointly in the course of the present study.

In dealing with the organization arrangements for the project concerned, attention has been paid to the planning of overhead costs related to the operations of the factory, the administration and sales and distribution services. To facilitate this task, the production process has been divided into appropriate and related functions grouped into cost centres.

The suggested organization structure, has been laid out in a manner to facilitate the smooth employment of a cost accounting system and calculation of the overheads for various cost centres in conjunction with overriding or related departments and divisions of PT Krakatau Steel.

5.1.2 ORGANIZATIONAL STRUCTURE AND STRATEGY

Much research has been conducted on the relation between organization structure and the strategy of the company. Some current studies on the above subject have developed the following general conclusions:

- Management's strategic choices shape the organization's structure.
- Strategy and structure must be properly aligned if the organization is to be successful in achieving its objectives.
- Organization structure constrains strategy.
- An organization can seldom veer substantially from its current strategy without alterations in its structure.

From all research conducted it can be concluded that a chosen strategy cannot be effectively implemented without developing a sound organizational structure.

5.1.3 REASONS FOR DEVELOPING AN ORGANIZATION STRUCTURE

One of the primary reasons for establishing an organization structure is to establish lines of authority that enable management to exercise the necessary degree of control over the organization. Authority is the right to expend resources. Establishing lines of authority creates order within an organization. The absence of authority leads to situations in which everyone is telling everyone else what to do. Lines of authority also serve to link the various organizational units and sub-units together. Once authority has been delegated, it creates an obligation to perform the assigned work. This obligation is called responsibility.

Secondly, an organizational structure enhances the likelihood of accomplishing organizational objectives because of synergism. Synergism occurs when organizational units work together to produce a whole greater than the sum of the parts. Synergism results when three people working together produce more than five people working separately. Division of labour and increased coordination, both of which are products of an effective organizational structure, lead to synergism.

Finally, an organization structure facilitates communication between the various organizational units.

The organization structure evolves from a process of a division of work and then a reunification of work. Work can be divided either vertically or horizontally. Vertical division of work creates the various levels within the organization. In addition, levels of responsibility of work and results in the creation of individual jobs.

5.2 PROPOSED ORGANIZATIONAL STRUCTURE

5.2.1 CHOICE OF THE STRUCTURE

In choosing an appropriate structure for a particular organization, the primary concern should be on how effectively the structure facilitates the accomplishment of organizational objectives and strategy.

The management structure and organization scheme, which are important aspects in all industrial organizations, should be considered early in the development of an integrated iron and steel plant project.

Unfortunately, no absolute guidelines exist for choosing the one best structure.

The research studies conducted in the industrialized countries on this subject seem to support what practising managers have been saying for years: no organizational structure is applicable for all situations. Recognition by management practitioners and scholars that there is no universal best way to organize has led to the evolvement of contingency or situational approach to organizing.

The situational approach recognizes that the most appropriate organizational structure depends primarily on organizational objectives but also is influenced by the size of the organization, the environmental conditions, faced by the organization, the technology employed by the organization, and other dynamic forces. However, it can be stated that:

The simplest organization structure that will do the job is the best one. What makes an organization structure »good« are the problems it does not create. The simpler the structure, the less that can go wrong.

5.2.2 ORGANIZATION SCHEME

As described earlier in this part of the study a very important factor in obtaining efficient and economical operation is the way in which resources of manpower, material and capital are organized so that there is proper coordination and delineation of responsibility and authority.

The structure outlines the working relationship between all levels of personnel and matches the style of the management adopted.

Fig. 26 shows a management structure for the SGSM Works after the establishment of the proposed iron and steel plant in conjunction with overriding departments and divisions to be operated jointly with P.T. Krakatau Steel.

The management structure is based on three levels of management within the organization, namely:

- 1 General
- 2 Area/Division
- 3 Works/Department

The President (at head office) of both companies would have overall responsibility for the policy operations and results also of the SGSM plant. To establish clearly defined lines of communication, authority and sources of decision, lines responsibility would predominate. The Cilegon Works Director would report directly to the President.

The following eight managers would report directly to the Works Director:

- Administration
- Quality Control
- Billet Steel Plant
- Logistics
- Integrated Steel Plant
- Integration Facilities
- Thin Slab Rolling Mill
- Harbour and Material Handling

Production management would be the responsibility of the Plant/Resident Manager who would coordinate the activities for the producing areas and would be guided by the managers of these areas.

Within the Integration Facilities' Department lies the responsibility to provide a maintenance and repair service to the works including the provision of all spares, materials and tools either through external procurement or manufacture in the workshops on site. With the production plant operating continuously, it will be essential to minimize breakdowns. To achieve this, maintenance facilities must always be available and a detailed system of planned maintenance instituted within each production department in cooperation with the general maintenance and store department.

Furthermore, this department would be responsible for supply and maintenance of all works engineering services.

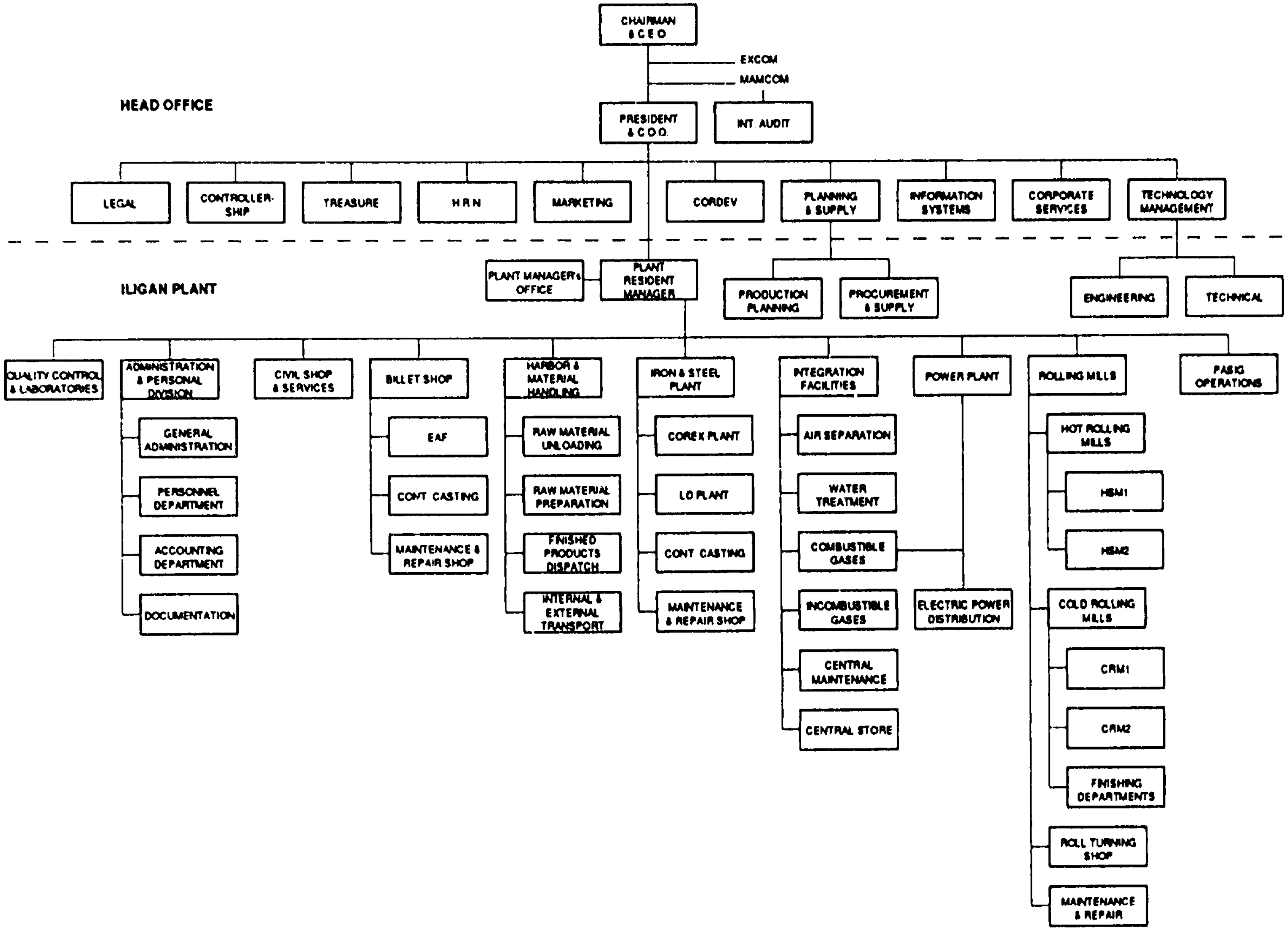


Fig. 25: **SGSM Table of Organization**

5.3 OVERHEAD COSTS

5.3.1 GENERAL

Disregarding the costs of the present existing departments for this item, the factory overhead cost, i.e. costs accruing outside of the production in production facilities and administration costs, i.e. costs accruing for the organization of production and lastly maintenance costs, i.e. costs to keep the production units operative, may be established as follows:

Table 22: **Overhead Costs**

Factory overheads/a	mn US$
Administrative costs 1/	16 800
Marketing (non labour) 2/	2 760
Maintenance 3/	7 384
Spares 3/	7 385

1/	Persons employed at plant		375
	Average cost for 1 workplace	US$	5 000.--
	Subtotal	US$	1 875 000.--
	Additional cost for social amenities (locker room, medical ward, canteen, etc.) Lump sum	US$	1 025 000.--
	Cost contribution to Head Office and local PTKS departments excluding marketing (2.5 % of sales revenues)	US$	13 900 000.--
	Total administration	US$	16 800 000.--
2/	Cost contribution to PTKS marketing division (0.5 % of sales revenues)	US$	2 780 000.--
3/	Approx. 1 % of equipment cost		

6. MANPOWER

6.1 GENERAL

This section of the study discusses the initial general personnel considerations for the establishment of the proposed Ircn and Steel Plant. The success of this project will depend to a large extent on the cooperation of many groups of people from different disciplines. To achieve the project objectives individuals should be carefully chosen and given complete assistance in developing their material and social needs.

This section provides a suggested indication of projected manpower requirements together with other factors relevant to recruitment and training which should be considered at appropriate times. Of fundamental importance would be the adoption of a formal personnel programme at an early stage in the project development, since the recruitment and training of suitable personnel will be a prerequisite for the successful operation for the plant.

6.2 PERSONNEL REQUIREMENTS

6.2.1 PLANT DEPARTMENTS

Manning tables are required for the following departments for either locations:

(a) Administrative, Management and Production Control Department

1. Head Office Jakarta
2. General affairs
3. Production planning
4. Production control

(b) Plants Department

1. Raw material handling
2. COREX® plant
3. Steel plant
4. Thin slab casting and rolling
5. Auxiliary plants and energy
6. Central maintenance shop
7. Transport + harbour

E:\projekte\pks-bo\phase-2\tech-desc\5-8.wp5

6.2.2 PERSONNEL CATEGORIES

The personnel required to operate the works need to be grouped into categories for the purpose of establishing employment costs as well as to assist in the evaluation of recruitment and training programmes. In this study the following categories have been used:

Category 1: Supervisory personnel
Category 2: Technical personnel
Category 3: Administrative and skilled workers
Category 4: Unskilled workers

The precise determination of status and skill categories must take into account established practice in the country and within the employing organization and therefore the suggested categories may be subject to change. The categories and subdivisions and the employment policies to be finally adopted will follow detailed discussions between all relevant parties. At this stage the above main categories are adequate for preliminary assessment.

Table 23: **Qualification of Personnel**

Category	Training Code	Qualification	Recommended Professional Experience
1	A	University or College Degree in metallurgical, mechanical or chemical engineering; Degree for commercial or business administration	Min. 3 years of management or operational experience in steelmaking, chemical or mining industries
2	B	Technical College Degree;	0-3 years of experience
		High School Certificate; Physical or Chemical Technician	1-5 years experience in similar plants and with associated tasks
3	C	High School Certificate	1-3 years experience
	B	Technical Training, Craftsman	3-5 years of experience with similar tasks
4	C	Basic Schooling	Some general experience (e.g. truck driver)

6.2.3 OPERATION CYCLES

For the purpose of estimation of the total requirement of personnel, the following cycles have been assumed:

- Day-shift operation; 1 shift, 8 hours operation (excluding Sundays)
- 2-shift operation; 16 hours (excluding Sundays)
- 3-shift operation: 24 hours (excluding Sundays)
- 4-shift operation: 24 hours (including Sundays).

The manning tables are established corresponding to the planned working hours and operating shifts per week.

In establishing the tables of the manning requirements, allowances have been made for 5 percent of the total working time required for vacations and 10 percent for sickleave.

Table 24: **Manning Schedule Operational Personnel Including Provisions for Vacation and Sick Leave**

	Cat. 1	Cat. 2	Cat. 3	Cat. 4	Total
Raw Material Handling, Lime Plant	2	14	23	30	69
COREX® Plant	3	26	210	68	307
Steel Plant incl. Thin Slab Casting	3	113	531	378	1.025
Thin Slab Mill	2	26	114	92	234
Auxiliary Plant and Energy	3	102	168	201	474
Central Maintenance + Warehouse	10	26	63	29	128
Harbour and Transport	3	18	70	172	263
Grand Total	26	325	1.179	970	2.500
Thereof running maintenance personnel in production departments approx. 20-30 % included					

6.2.4 ADMINISTRATION MANNING TABLES

The manning for the various administrative and head office personnel is detailed in the following Table.

Table 25: **Administrative Personnel Requirements**

	Cat. 1 Supervisory	Cat. 2 Technical + Commercial Mngr.	Cat. 3 Adminis-trative + Skilled	Cat. 4 Unskilled	Total
Administration	32	56	223	64	375

6.3 RECRUITMENT AND TRAINING

6.3.1 GENERAL REMARKS

Recruitment and training of manpower is an important task to be undertaken during the implementation and subsequent operational phases of the works.

A successful ISM operation demands that the employees are well trained, highly motivated, physically fit, and fully committed to the success of the project.

Close attention is required at the planning stage and the programme should ensure that trained personnel will be able to run and maintain the plant once it is commissioned.

The following criteria are of fundamental importance for recruitment:

- Careful timing of recruitment so that new personnel are allowed adequate training time yet are not under-utilized
- Matching qualifications and experience to specific requirements, avoiding employing over-qualified personnel
- Recruiting a workforce balanced in age, specialist disciplines and experience.

As far as practicable, a progressive build-up of trained manpower will ensure the formation of cadres, divided according to shift requirements.

6.3.2 TRAINING PROGRAMME

6.3.2.1 TRAINING PLAN

As far as practicable, a progressive build-up of trained manpower will ensure the following:

(a) Formation of cadres, divided according to shift requirements, except in special cases demanding immediate establishment of three-shifts.

(b) Build-up of manpower from top to bottom within each category. For example, of the university graduates available in the first year for training, the first person to be in position on completion of training, in a particular department, will be the superintendent, who will be followed by the manager, assistant managers, and so on.

Training of personnel will comprise the following:

(1) Training abroad
(2) On-site training during the erection and commissioning of plant and equipment.

Table 26: **Description of Training Code**

Code	Location	Steel Mill Orientation Program (SMOP)	General Department Training (GDT)	On the job training
A	abroad	abroad, 1 month	abroad, 3 months	As trainer for Code B on SMOP and Code C on GDT on site
B	abroad + on site	on site, 1 month	abroad, 3 months	abroad 3 months trainee of contractor and as trainer for Codec on GDT on site, 15 months C
C	on site	-	on site 0.5 month	on site, 12 months trainee of contractor and of Code B

Objectives of Training Activities

Steel Mill Orientation Program (SMOP)

The objective is to achieve an overall view of the technology and especially organization of an integrated steel mill complex, including all production and service facilities, production planning, maintenance, process and quality control, materials, personnel and financial management. The management training shall provide the necessary training and education courses, which guarantee a trouble free daily work and allows personnel development and improvement of management techniques. This would enable the personnel concerned to visualize the independent nature of the various units and the need for its integrated operation besides giving them an idea of the stages of each production process and other works services and their dependencies.

For the executive staff (commercial and technical) this phase of training will be given in an operational integrated steel plant. During this stage the personnel concerned will be placed in small groups in each department/functional entity by rotation for a specific time.

General Department Training (GDT)

After the steel mill orientation course, the executive staff will be subjected to the general department training to give them a detailed understanding of the layout, equipment, process, organisation and functional systems of production planning and control, quality assurance, safety, cost control, training and development, industrial engineering, inventory control, tools and techniques related to the department/plant unit, in which the concerned persons will be employed on completion of the training.

On the Job Training

During this phase, which is the concluding phase of the training, the supervisory/technical staff will be attached to their counterparts in the department and given the opportunity to learn and perform all their duties in daily routine.

6.3.2.2 TRAINING ABROAD

In accordance with SGSM's requirements, the training will be provided only for key personnel.

6.3.2.3 ON SITE TRAINING DURING ERECTION, COMMISSIONING AND PRODUCTION BUILD-UP PERIOD

The main objective of the training to be given on site will be on the transfer of know-how and skill from the contractors personnel to the SGSM personnel. The on site training shall comprise of the following phases:

- Steel plant orientation for training personnel in Code B
- General department training (cold training) in Code C

- On the job training in Codes B and C

The department training for skilled operating staff, maintenance and service staff, laboratory and technical office personnel will be provided in the general training by the Contractor's personnel. The aim is to support the trainees in developing industrial discipline in understanding their positions in the context of the department.

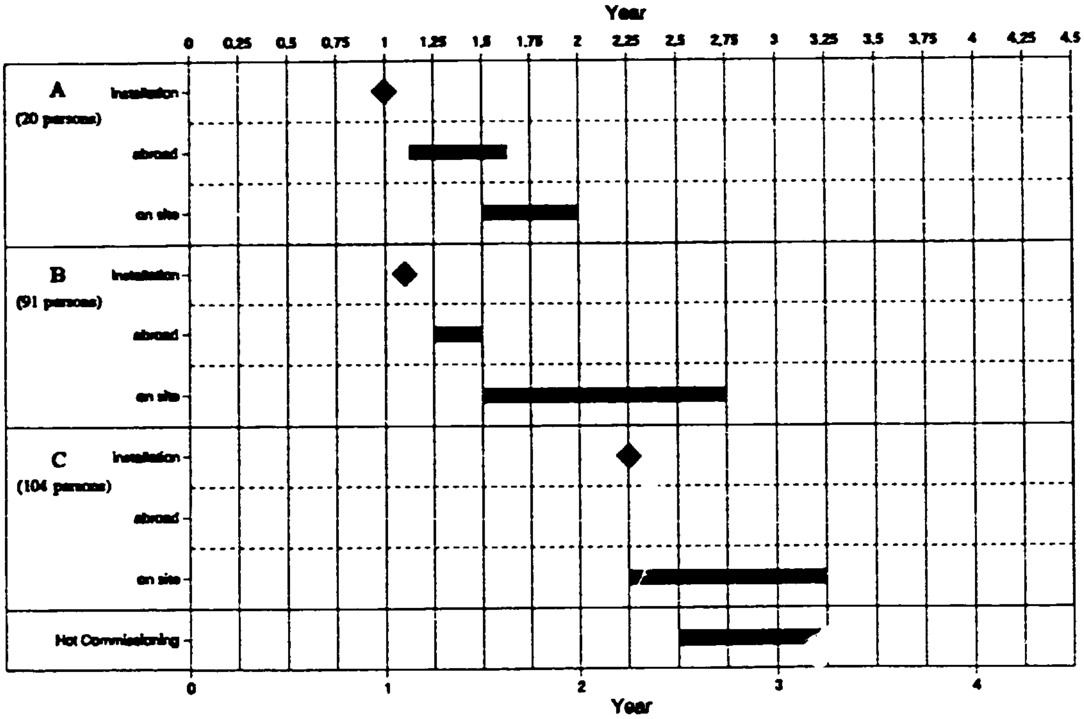
During On The Job Training Phase, which is the concluding phase of the on site training, the skilled and unskilled operating, service, laboratory and technical staff will be trained by the Contractor's personnel in the start up and production build-up period during the production.

6.3.2.4 PERSONNEL TO BE TRAINED ABROAD

Table 27: **Split according to plants**

	Cat. 1	Cat. 2	Cat. 3	Cat. 4	Total
Raw Material Handling, Lime Plant	1	2			3
COREX® Plant	2	20	20		42
Steel Plant incl. Thin Slab Casting	2	25	25		52
Thin Slab Mill	2	15	15		32
Auxiliary Plant and Energy	1	8	8		17
Central Maintenance and Warehouse	1	3	3		7
Harbour and Transport	1	3	3		7
Administration	10	15	30		55
Total abroad	20	91	104		215

Table 28: **Training schedule**



6.3.2.5 TRAINING COSTS

In average the 215 persons according to table 28 shall receive training for 6.5 months, 3 months thereof the training will be abroad.
The cost per manmonth training is estimated at

US$ 7 000.--

Total training cost 215 x 6.5 x 7 000 =	US$	9 782 500.--
Flights abroad		
1 flight/man: US$ 2 500.--		
Total flights: US$ 2 500 x 215 =	US$	537 500.--
Living expenses abroad		
1 manmonth: US$ 1 500.--		
Total living expenses: US$ 1 500 x 215 x 3 =	US$	967 500.--
Insurance: US$ 1 000.--/man	US$	215 000.--
Total	US$	11 502 500.--

The total training costs are assesed at

US$ 11.5 mn

Salaries and wages of the 215 men to be trained are included in personnel costs during pre-production.

6.3.3 RECRUITMENT

Table 29: **Recruitment during Implementation**

Installation in year	Cat. 1	Cat. 2	Cat. 3	Cat. 4	Total
1	5	50	22	20	97
2	20	150	280	50	500
3	33	181	1 000	164	1 378
4	-	-	100	800	900
Total	58	381	1 402	1 034	2 875

7. INITIAL FIXED INVESTMENT

7.1 TOTAL INITIAL FIXED INVESTMENT

Table 30: **Total Initial Fixed Investment**

Designation	mn US$
COREX® Plant	391.92
LD Plant	265.67
CC Thin Slabs	65.25
Thin Slab Mill	263.33
Lime Plant	24.67
Oxygen Plant	81.67
Integration Facilities	192.42
Harbour	184.--
Supplement to Power Plant	8.--
TOTAL	1,476.93
Cost, Insurance, Freight	12.50
Capital Spares	16.67
Land and Site Development	14.16
Pre-Production Expenditures (w.o. capital interest)	41.82
Inventory, Working Capital	21.21
TOTAL	1,583.29

7.2 PRE-OPERATIONAL EXPENDITURES

Apart from fixed investments, every industrial project incurs certain expenditures from commercial production which are due, for example, to the acquisition or generation of capital assets. These expenditures, which have to be capitalized, include a number of items that originated during the various stages of project formulation and implementation.

A break-down of the most significant preproduction capital expenditures is shown in Table 31 below:

Table 31: **Pre-Production Capital Exenditures (In mn US$)**

Item	mn US$
Capital issue expenditure	8 000
Consulting monitoring services	5 420
Personnel recruitment	16 900
Training, incl. flights + acommodation	11 500
Capitalized interest	to be assessed by UNIDO
Total w.o. capitalized interest	41 820

7 half year periods, have been assumed for project implementation.
The items which occur prior to the production period have been capitaiized as non-physical assets and will be amortized during the first six years of operation.

i) Preliminary and Capital Issue Expenditures

These include expenditures incurred during the registration and the formation of the company, the legal fees for loan applications and land purchase agreements.

ii) Project, Monitoring and Consultancy Services

The estimate of cost for Consulting and Project Monitoring Services is based on the assumption that the investor will appoint an internationally renowned Consulting Engineer during the projects' implementation schedule.

iii) Personnel Recruitment and Pre-operational Training

For a comprehensive split up see chapter.

7.3 WORKING CAPITAL REQUIREMENTS

The working capital (defined as balance of current assets minus current liabilities), indicates the financial means required to operate the project under normal circumstances. The part of Working Capital required in the last period of the construction phase for raw materials (US$ 19,839 mn) and spare parts inventory (US$ 1,385 mn) therefore amounts to

US$ 21,215 mn

to be included in the Preproduction Capital Expenditures.

7.3.1 INVESTMENT DURING PRODUCTION

(Current Investment)

The COREX® modules will require a major refurbishment after every 7 years of production.

- After 7 years
  Refurbishment of melter-gasifier for 2 COREX® modules cost US$ 25 mn

- After 14 years
  Refurbishment of melter-gasifier and reduction shaft for 2 COREX® modules cost US$ 39 mn, included is an appropriate amount for revamping of the total installation to comply with the latest state of the art in iron smelting (similar to B-F refurbishment).

8. PROJECT IMPLEMENTATION SCHEDULE AND BUDGETING

The detailed implementation programme proposed for the realization of the project is shown in Fig. 26.

Also attached in Table 32 is the capital expenditures during implementation. Please note that considerable savings may be achieved timewise, if the project is contracted out as turnkey implementation. The current proposal is based on process key contracting with global sourcing.

Some of the main assumptions made in drawing up the programme are that:

(a) Key personnel and resources would be available to start work
(b) All enquiries would be issued within the anticipated dates and the number of contracts would be kept to a minimum
(c) Enquiry documents would ensure that information received in offers would enable foundation and building drawing arrangements to be commenced without delay.
(d) Design would be staged so that construction could commence before final design is completed.

According to the programme, various executive activities, such as purchase of machinery and equipment, construction, buildings and other civil works, personnel recruitment and personnel training, delivery of machinery and equipment, and erection of machinery and equipment are planned to be undertaken according to a phased programme in order to achieve the best economic way of realizing the project.

To a considerable degree, delivery-schedules will depend on the location and identity of the manufacturers and other suppliers from which the machinery and equipment will be procured, based on global sourcing.

8. PROJECT IMPLEMENTATION SCHEDULE AND BUDGETING

The detailed implementation programme proposed for the realization of the project is shown in Fig. 26.

Also attached in Table 32 is the capital expenditures during implementation. Please note that considerable savings may be achieved timewise, if the project is contracted out as turnkey implementation. The current proposal is based on process key contracting with global sourcing.

Some of the main assumptions made in drawing up the programme are that:

(a) Key personnel and resources would be available to start work
(b) All enquiries would be issued within the anticipated dates and the number of contracts would be kept to a minimum
(c) Enquiry documents would ensure that information received in offers would enable foundation and building drawing arrangements to be commenced without delay.
(d) Design would be staged so that construction could commence before final design is completed.

According to the programme, various executive activities, such as purchase of machinery and equipment, construction, buildings and other civil works, personnel recruitment and personnel training, delivery of machinery and equipment, and erection of machinery and equipment are planned to be undertaken according to a phased programme in order to achieve the best economic way of realizing the project.

To a considerable degree, delivery-schedules will depend on the location and identity of the manufacturers and other suppliers from which the machinery and equipment will be procured, based on global sourcing.

Fig. 26: **Implementation Schedule**

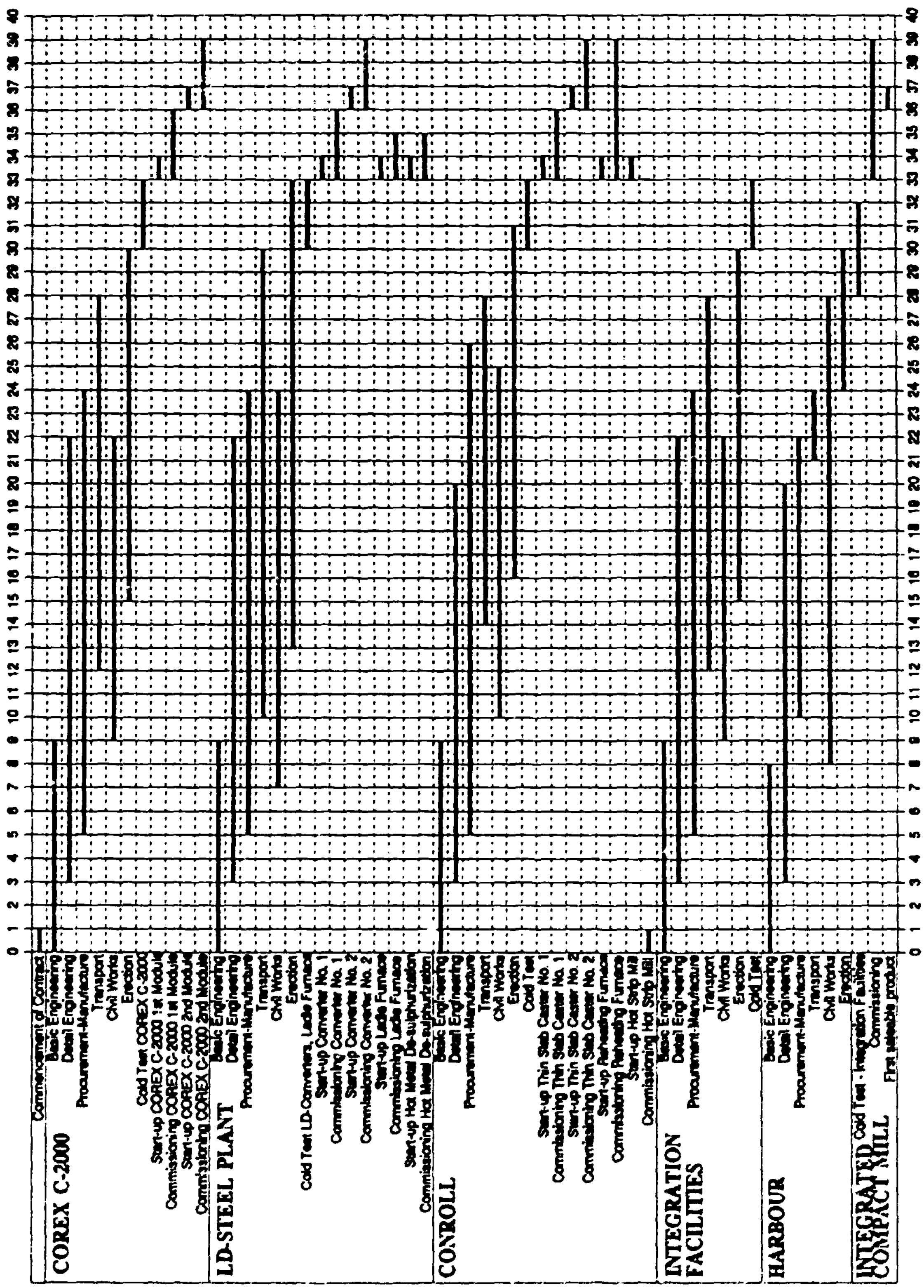


Table 32: Implementation Budgeting

	Half years							
Input Table	1	2	3	4	5	6	7	Total
Land								0
Site preparation and development								0
Structures and civil (a)		3,47	13,86	13,86	3,47			34,66
Structures and civil (b)								0
Incorporated fixed assets, constructio		2,57	7,71	10,28	12,86	12,86	5,14	51,42
Incorporated fixed assets, technology,	0,75	1,25	1,00	0,75	0,75	0,25	0,25	5
Incorporated fixed assets, other (c)		0,50	2,00	2,50	2,50	1,50	1,00	10
Plant machinery and equipment (a)		31,63	126,50	158,13	158,13	94,88	63,25	632,5
Plant machinery and equipment (b)						7,92	7,92	15,83
Auxiliary and service facilities		7,04	28,15	35,19	35,19	21,11	14,08	140,75
Pre-production expenditures	0,60	0,93	0,34	0,55	1,87	7,30	8,66	20,25
Inventory, working capital							11,21	11,21
TOTAL foreign	1,35	47,39	179,56	221,26	214,77	145,82	111,51	921,66
Land	10,00							10
Site preparation and development	4,16							4,16
Structures and civil (a)		23,58	94,33	94,33	23,58			235,83
Structures and civil (b)		12,50	50,00	50,00	12,50			125
Incorporated fixed assets, constructio		6,21	18,63	24,83	31,04	31,04	12,42	124,17
Incorporated fixed assets, technology,	0,06	0,11	0,08	0,06	0,06	0,02	0,02	0,42
Incorporated fixed assets, other (c)		0,13	0,50	0,63	0,63	0,38	0,25	2,5
Plant machinery and equipment (a)		5,93	23,70	29,63	29,63	17,78	11,85	118,5
Plant machinery and equipment (b)						0,42	0,42	0,83
Auxiliary and service facilities		0,40	1,58	1,98	1,98	1,19	0,79	7,92
Pre-production expenditures	0,60	0,93	0,34	1,87	1,87	7,30	8,66	21,57
Inventory, working capital							10,00	10,00
TOTAL local	14,82	49,79	189,16	203,33	101,29	58,13	44,41	660,93
GRAND TOTAL	16,17	97, 18	368,72	424,59	316,06	203,95	155,92	1.582,59

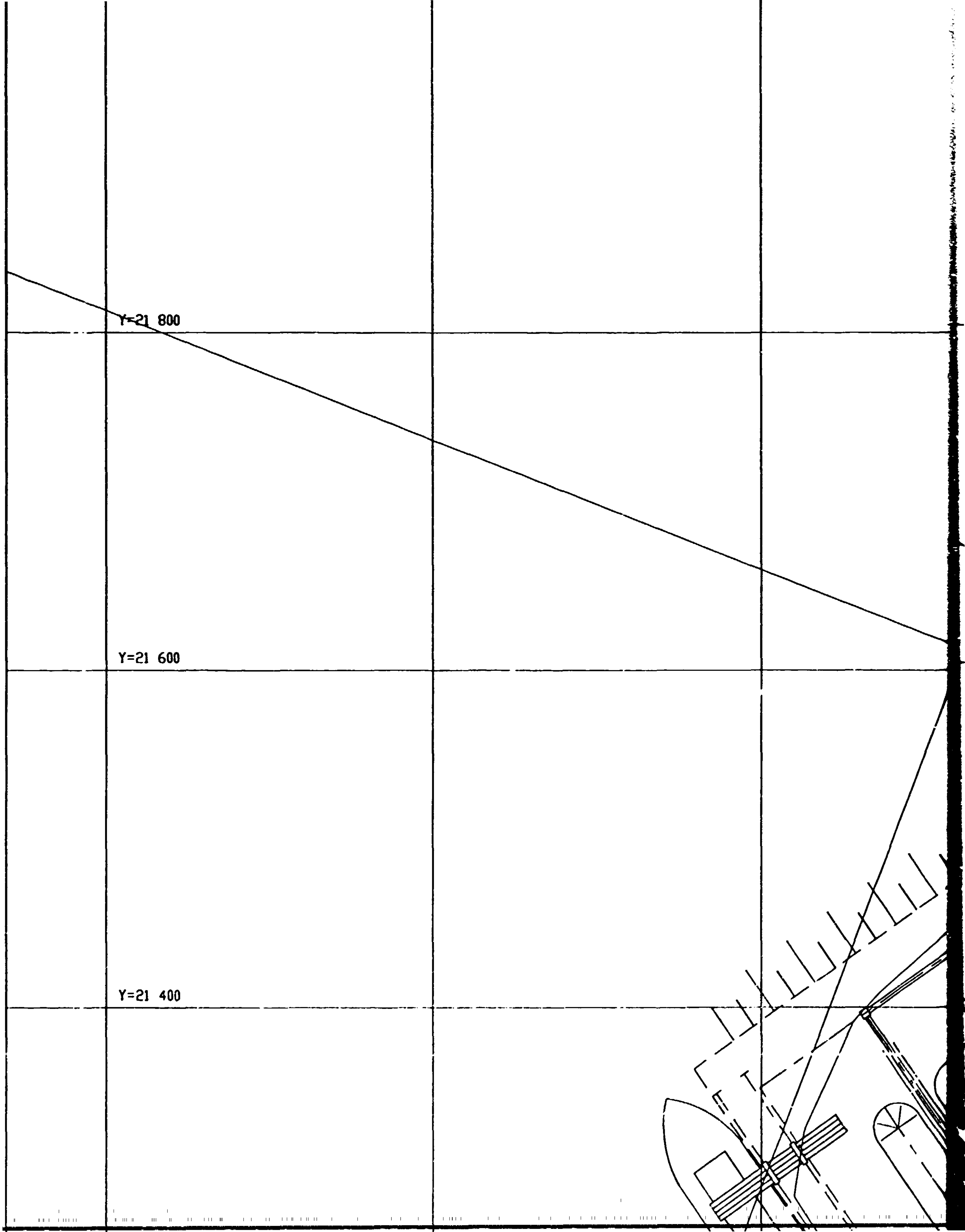
	RC COREX PLANT	SL LD - PLANT	CD CONT CASTING THIN SLABS	WT THIN SLAB MILL	IH INTEGRATION FACILITIES	SUB-SERIES
						00
						01
						02
						03
						04
						05
						06
						07
						08
						09
	RAW MAT.HANDL. & BURDEN SYST.	**RAW & CHARGING MAT. TREATMENT**		**CHARG.TREATM. & REHEATING FURN.**	**RAW MAT. HANDLING & TREATMENT**	
						10
		SCRAP HANDLING			RAW MATERIAL UNLOADING	11
	BXYD HANDLING	ALLOY HANDLING SYSTEM			RAW MATERIAL STORAGE YARD	12
	COAL HANDLING	ADDITIVE HANDLING			RAW MATERIAL HANDLING	13
	ADDITIVE HANDLING				SCRAP HANDLING & TREATMENT	14
	CIRCULATING MATERIAL HANDLING	HOT METAL HANDLING		REHEATING FURNACE		15
	BURDEN SYSTEM	HOT METAL TREATMENT				16
						17
	LADLE HANDLING	LADLE HANDLING				18
	DEDUSTING SYSTEM	DEDUSTING SYSTEM				19
	RED. SHAFT & MELTER GASIFIER	**BLOWING OPERATION**	**THIN SLAB CASTING MACHINE**	**ROLLING FACILITIES**		
				AUXILIARY EQUIPMENT		20
	FURNACE CHARGING SYSTEM	CONVERTER CHARGING SYSTEM	LADLE EQUIPM. & EMERG CASTING			21
	REDUCTION SHAFT	CONVERTER	TUNDISH FACILITIES			22
	MELTER GASIFIER & FACILITIES	LANCE BLOWING DEVICE	ADDITIONAL EQUIPMENT			23
		AUXILIARY EQUIPMENT	SUPPORTING STR. & COOLING CHAMBER	FINISHING MILL		24
	PROCESS GAS SYSTEM	WASTE GAS COOLING & CLEANING	MOLD & OSCILLATING FACILITIES			25
		LADLE ALLOY./ADDITIVE SYSTEM	STRAND GUIDE & WITHDRAWAL UNIT			26
		LIQUID STEEL HANDLING	DUMMY BAR & CUTTING FACILITIES	STRIP COOLING		27
	TAPPING EQUIPMENT		RUN-OUT FACILITIES	DOWN COILER		28
	GAS CLEANING & DEDUSTING SYST.	DEDUSTING SYSTEM		COIL CONVEYING SYSTEM		29
D	**HOT METAL HANDLING**	**SECONDARY METALLURGY**		**STRIP ADJUSTAGE & INSP.**	**SITE/TEMPORARY FACILITIES**	
						30
	HOT METAL HANDLING	ALLOYING SEC. METALLURGICAL FAC.			PLANT/SITE AREA	31
		LADLE STIRRING/BUBBLING/INJECTION		STRIP INSPECTION LINE		32
		LADLE FURNACE			CAMP/CATERING	33
		AUXILIARY EQUIPMENT			CONSTRUCTION/SITE INSTALLATION	34
						35
					CONSTRUCT.BUILDG./SITE OFFICE	36
					TEMPORARY TRANSPORT FACILITIES	37
				PRODUCT STORE & DISPATCH	CONSTRUCTION UTILITIES	38
	DEDUSTING SYSTEM	DEDUSTING SYSTEM			CONSTRUCTION POWER	39
	SLAG HANDLING & RECYCLING	**SLAG TR. & RECYCL. FACILITIES**			**PERIPHERAL FACILITIES**	
						40
						41
						42
						43
						44
	SLUDGE RECYCLING	WASTE GAS RECYCLING				45
	DUST RECOVERY	DUST RECOVERY			AIR SEPARATION PLANT	46
						47
					SLAG HANDLING & TREATMENT	48
	SLAG HANDLING & TREATMENT	SLAG HANDLING			SCALE HANDLING & TREATMENT	49
	MAINTENANCE & STORE	**MAINTENANCE & STORE**	**MAINTENANCE & STORE**	**MAINTENANCE & STORE**	**MAINTENANCE & STORE**	
						50
		LANCE REPAIR SHOP	MACHINE MAINTENANCE	ROLL SHOP	CENTRAL MAINTENANCE (MECHANIC)	51
			TUNDISH RELINING		CENTRAL MAINTENANCE (ELECTRIC)	52
	MAINTENANCE POST	MAINTENANCE POST		MAINTENANCE POST	MAINTENANCE RAILWAY/VEHICLES	53
			SPARE PARTS DEPOT	SPARE PARTS DEPOT	GENERAL SPARE PARTS DEPOT	54
					BUILDING SERVICES	55
			CONSUMABLES	ROLL STORE		56
			REFRACTORY STORE		CENTRAL REFRACTORY STORE	57
			OPERATING PARTS STORE	FIRSTFILLINGS	CENTRAL OPERATING PARTS STORE	58
			MEASURING & AUXILIARY EQUIPM.			59
	INFORMATION SYSTEM	**INFORMATION SYSTEM**	**INFORMATION SYSTEM**	**INFORMATION SYSTEM**	**INFORMATION SYSTEM**	
						60
					PLANNING SYSTEM/MANAGEMENT INFO	61
	PROD. & PROCESS CONTROL SYSTEM	PROD. & PROCESS CONTROL SYSTEM	PROD. & PROCESS CONTROL SYSTEM	PROD. & PROCESS CONTROL SYSTEM		62
	GENERAL INSTRUMENTATION	GENERAL INSTRUMENTATION	GENERAL INSTRUMENTATION	GENERAL INSTRUMENTATION	GENERAL INSTRUMENTATION	63
	BASIC AUTOMATION	BASIC AUTOMATION	BASIC AUTOMATION	BASIC AUTOMATION	BASIC AUTOMATION	64
	SAMPLING/MATERIAL TESTING					65
						66
				LABORATORY	CENTRAL LABORATORY	67
						68
	COMMUNICATION SYSTEM	COMMUNICATION SYSTEM	COMMUNICATION SYSTEM	COMMUNICATION SYSTEM	COMMUNICATION SYSTEM	69
L	**INFRASTR. & AUXILIARY EQUIPM.**	**INFRASTR. & AUXILIARY EQUIPM.**	**INFRASTR. & AUXILIARY EQUIPM.**	**INFRASTR. & AUXILIARY EQUIPM.**	**INFRASTR. & AUXILIARY EQUIPM.**	
						70
	PLANT OFFICE				ADMINISTRATION BUILDING	71
						72
					LOCKER BUILDING & CANTEEN	73
					FIRST AID & SECURITY DEVICE	74
	FIRE ALARM & FIGHTING SYSTEM	FIRE ALARM & FIGHTING SYSTEM	FIRE ALARM & FIGHTING SYSTEM	FIRE ALARM & FIGHTING SYSTEM	FIRE ALARM & FIGHTING SYSTEM	75
						76
					ROAD TRANSPORT	77
					RAIL TRANSPORT	78
						79
	UTILITY SUPPLY/TREATMENT	**UTILITY SUPPLY/TREATMENT**	**UTILITY SUPPLY/TREATMENT**	**UTILITY SUPPLY/TREATMENT**	**UTILITY SUPPLY/TREATMENT**	
						80
	WATER SUPPLY/TREATMENT	WATER SUPPLY/TREATMENT	WATER SUPPLY/TREATMENT	WATER SUPPLY/TREATMENT	WATER SUPPLY/TREATMENT	81
	WATER CIRCUITS & COOLING SYSTEM	WATER CIRCUITS & COOLING SYSTEM	WATER CIRCUITS & COOLING SYSTEM	WATER CIRCUITS & COOLING SYSTEM	WATER CIRCUITS & COOLING SYSTEM	82
AIR	INCOMBUSTIBLE GASES & COMPR. AIR	INCOMBUSTIBLE GASES & COMPR. AIR	INCOMBUSTIBLE GASES & COMPR. AIR	INCOMBUSTIBLE GASES & COMPR. AIR	INCOMBUSTIBLE GASES & COMPR. AIR	83
	COMBUSTIBLE GASES	COMBUSTIBLE GASES	COMBUSTIBLE GASES	COMBUSTIBLE GASES	COMBUSTIBLE GASES	84
						85
	STEAM/HOT WATER/HEAT RECOVERY	STEAM/HOT WATER/HEAT RECOVERY	STEAM/HOT WATER/HEAT RECOVERY	STEAM/HOT WATER/HEAT RECOVERY	STEAM/HOT WATER/HEAT RECOVERY	86
						87
						88
M			HYDRAULIC & LUBRICATION SYSTEM	HYDRAULIC & LUBRICATION SYSTEM		89
	ELECTRIC ENERGY SUPPLY	**ELECTRIC ENERGY SUPPLY**	**ELECTRIC ENERGY SUPPLY**	**ELECTRIC ENERGY SUPPLY**	**ELECTRIC ENERGY SUPPLY**	
						90
	HIGH VOLTAGE FACILITIES	HIGH VOLTAGE FACILITIES		HIGH VOLTAGE FACILITIES	HIGH VOLTAGE FACILITIES	91
	LOW VOLTAGE FACILITIES	LOW VOLTAGE FACILITIES	LOW VOLTAGE FACILITIES	LOW VOLTAGE FACILITIES	LOW VOLTAGE FACILITIES	92
	ELECTRICAL EQUIPMENT	ELECTRICAL EQUIPMENT	ELECTRICAL EQUIPMENT	ELECTRICAL EQUIPMENT	ELECTRICAL EQUIPMENT	93
						94
						95
						96

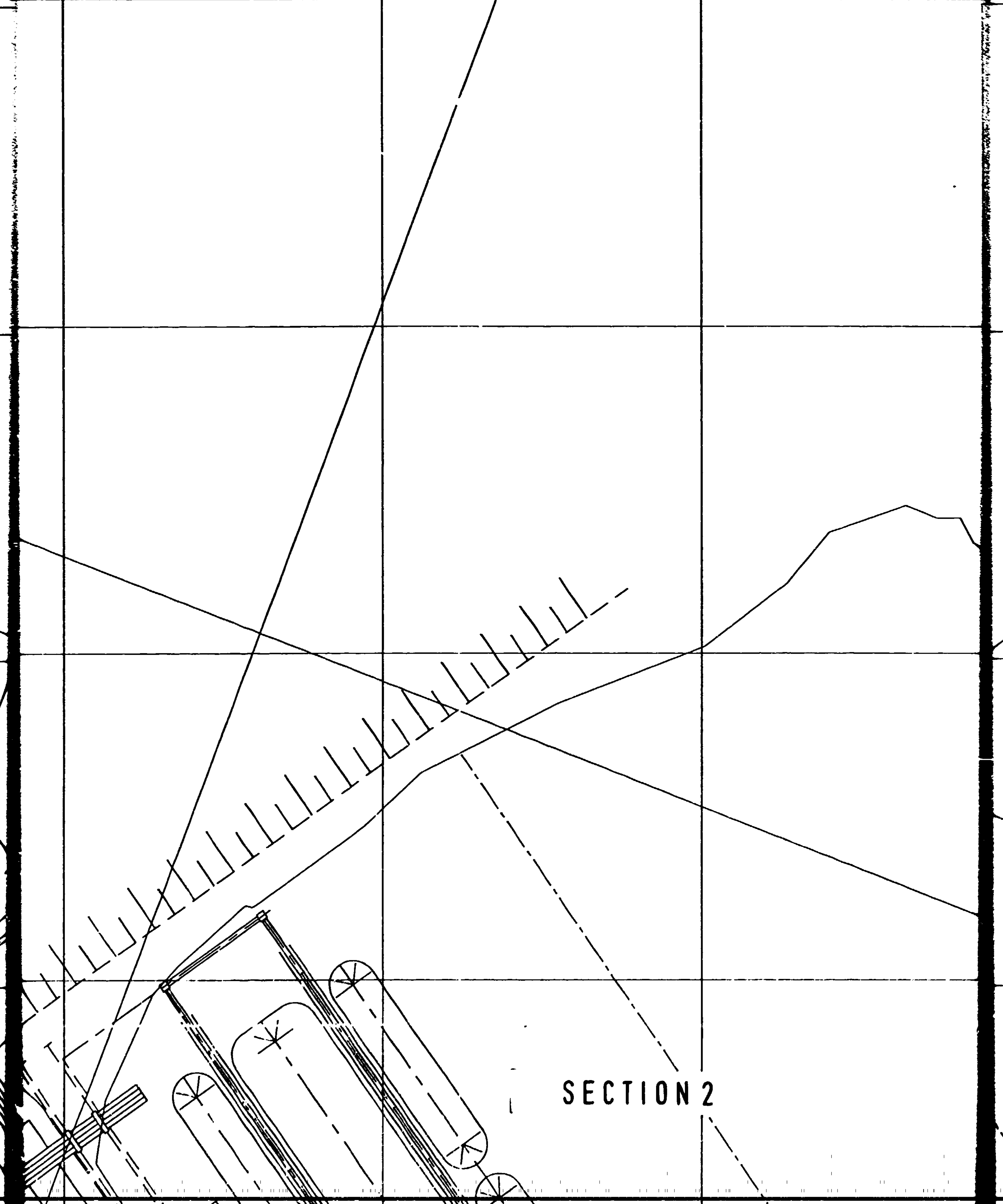
9. PLANT STRUCTURE

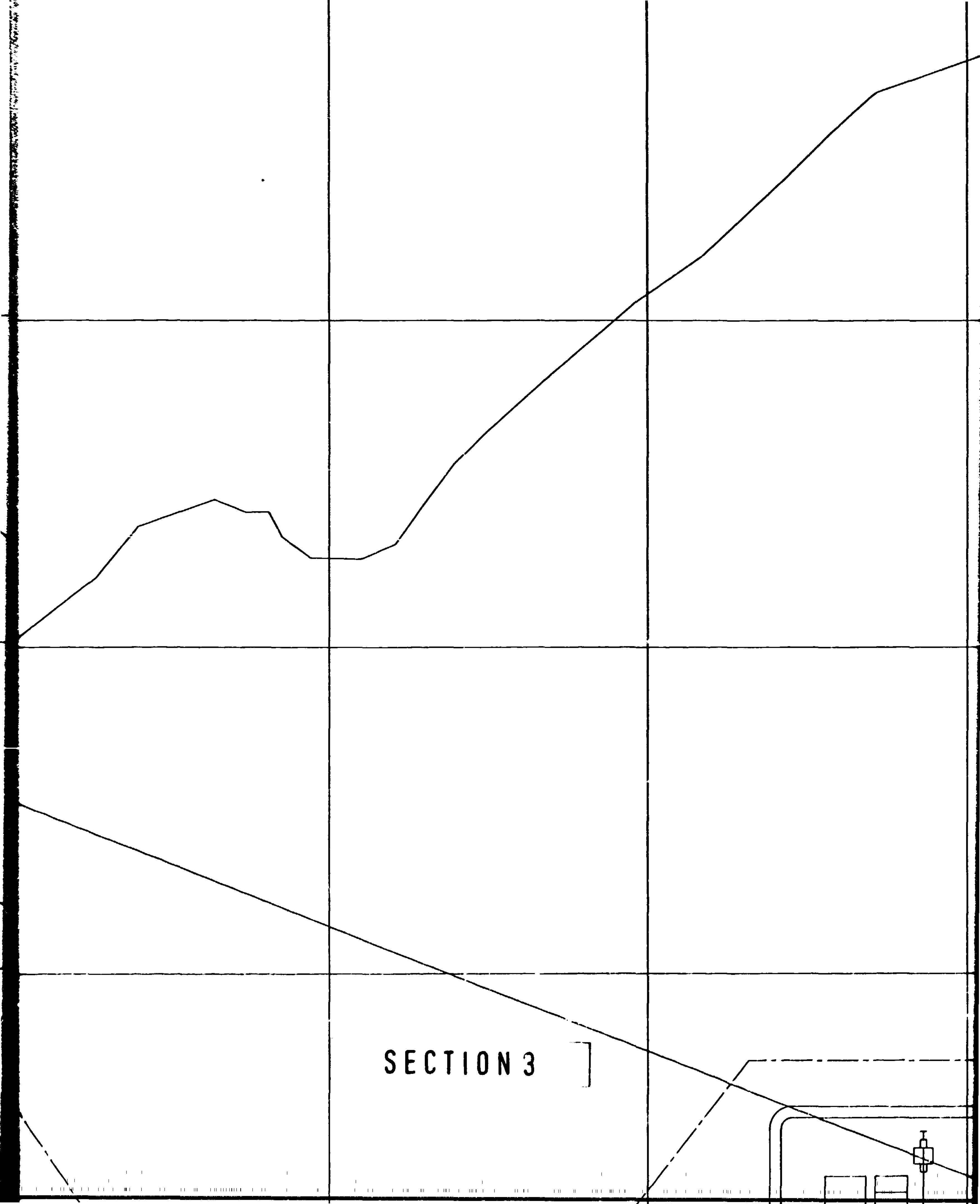
Table 33: Plant Structure

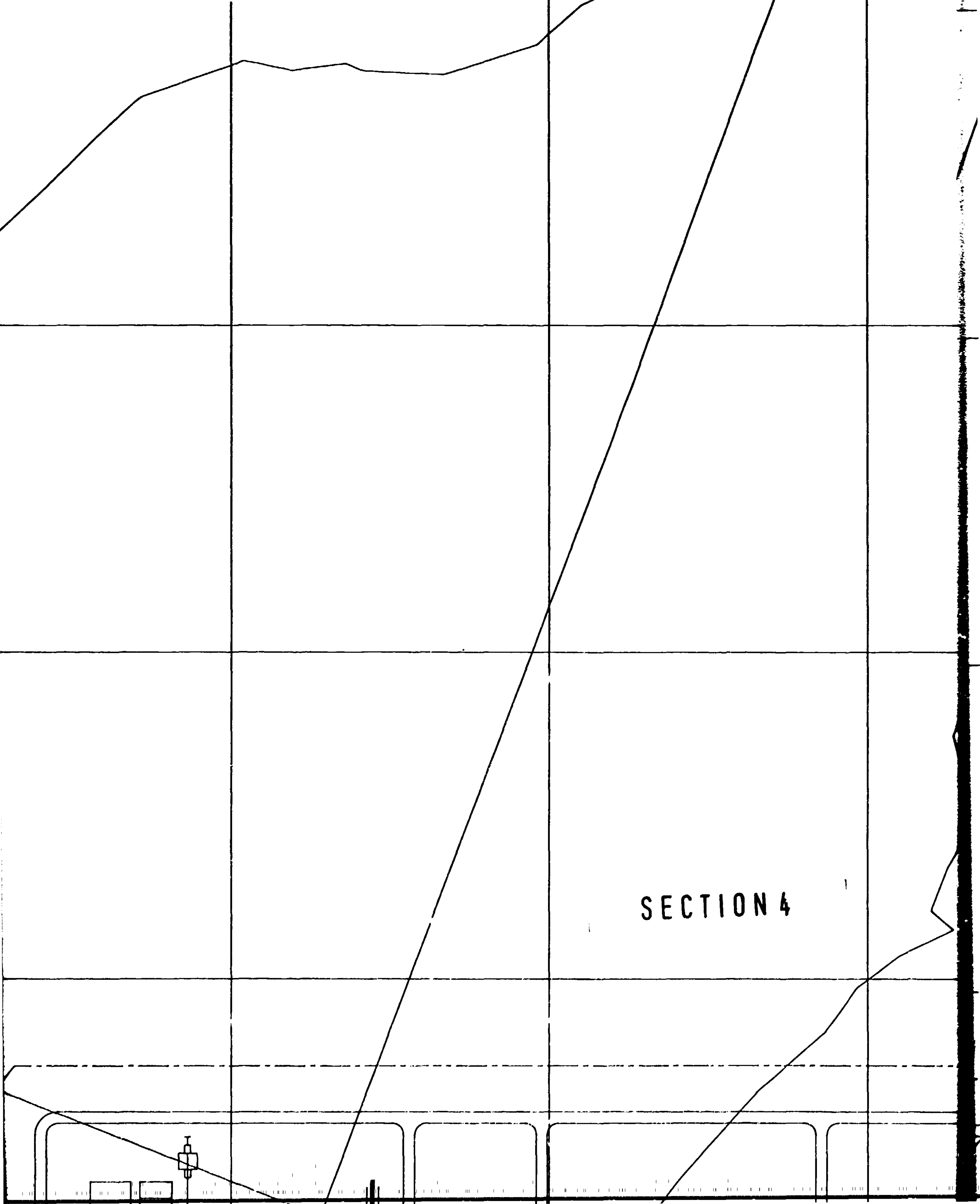
SUB-SERIE	
00 01 02 03 04 05 06 07 08 09	SERIE 0 STRUCTURE & TRANSFER ELEMENTS
10 11 12 13 14 15 16 17 18 19	SERIE 1 PRE PROCESS FACILITIES
20 21 22 23 24 25 26 27 28 29	SERIE 2 PROCESS EQUIPMENT
30 31 32 33 34 35 36 37 38 39	SERIE 3 DOWN STREAM FACILITIES
40 41 42 43 44 45 46 47 48 49	SERIE 4 PERIPHERAL FACILITIES
50 51 52 53 54 55 56 57 58 59	SERIE 5 MAINTENANCE & STORES
60 61 62 63 64 65 66 67 68 69	SERIE 6 INFORMATION
70 71 72 73 74 75 76 77 78 79	SERIE 7 INFRASTRUCTURE & AUXILIARY EQUIPMENT
80 81 82 83 84 85 86 87 88 89	SERIE 8 UTILITIES
90 91 92 93 94 95 96 97 98 99	SERIE 9 ELECTRIC ENERGY

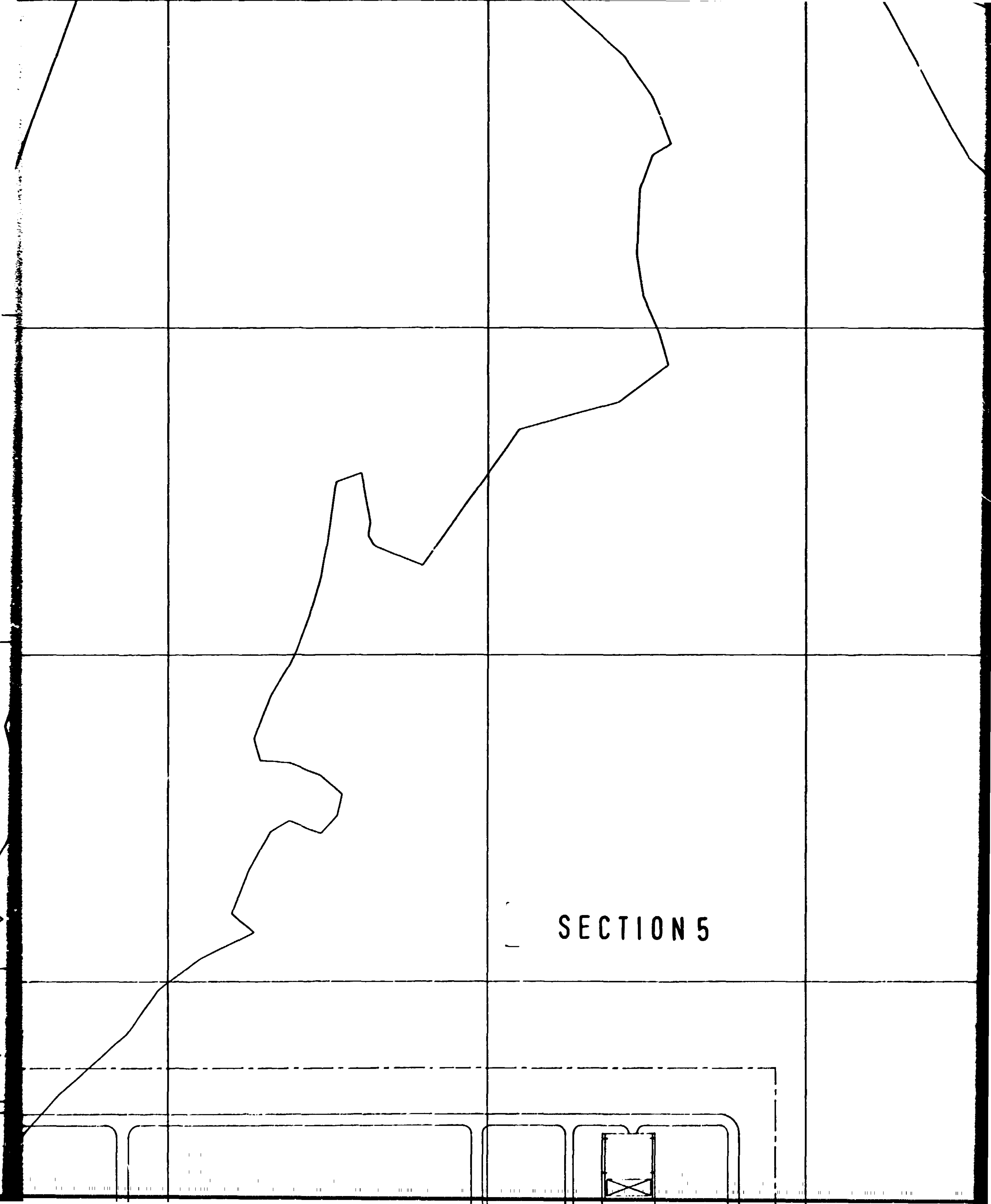
10. PLANT LAYOUT

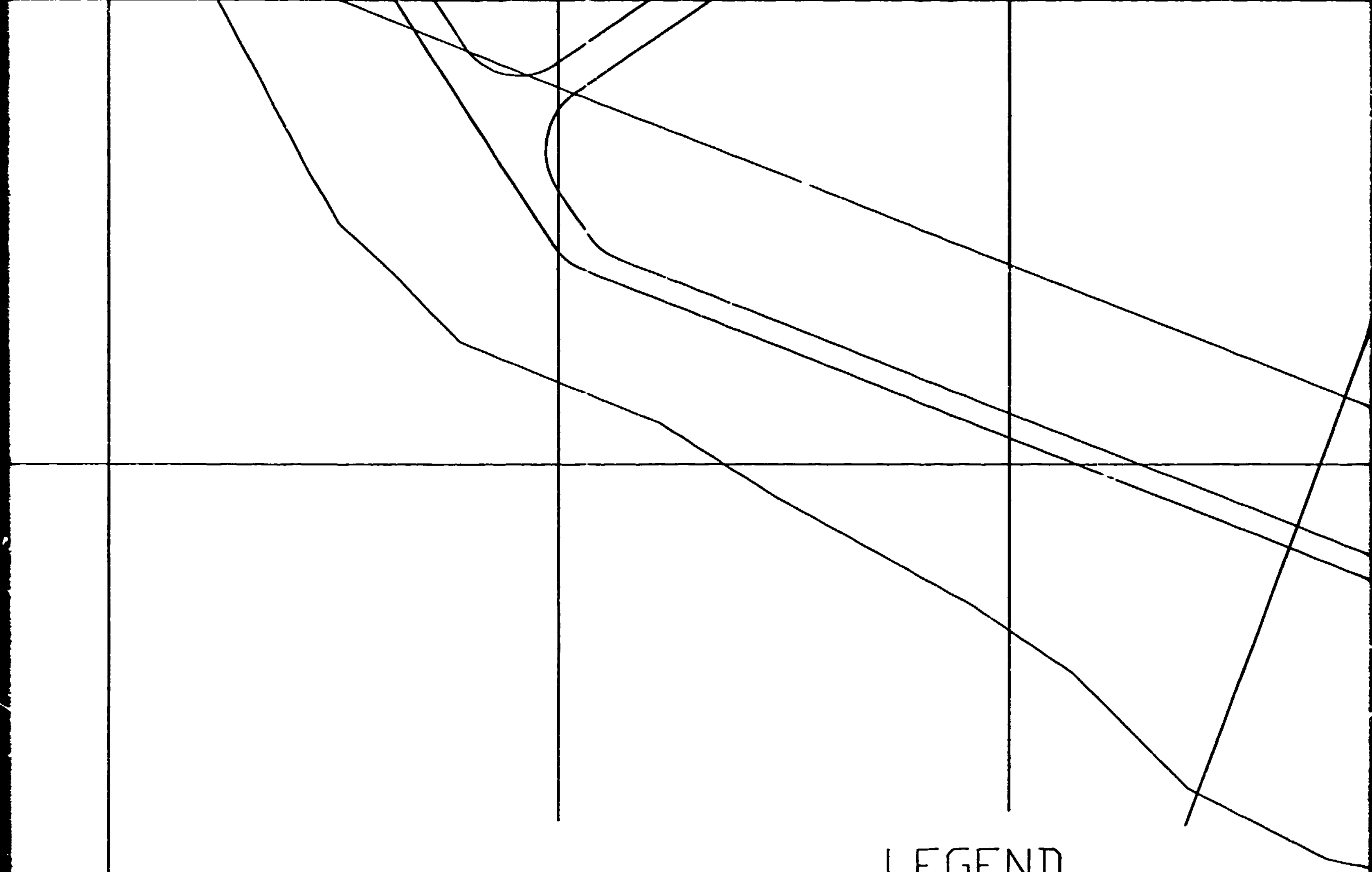

Y=21 800
Y=21 600
Y=21 400


SECTION 2


SECTION 3


SECTION 4

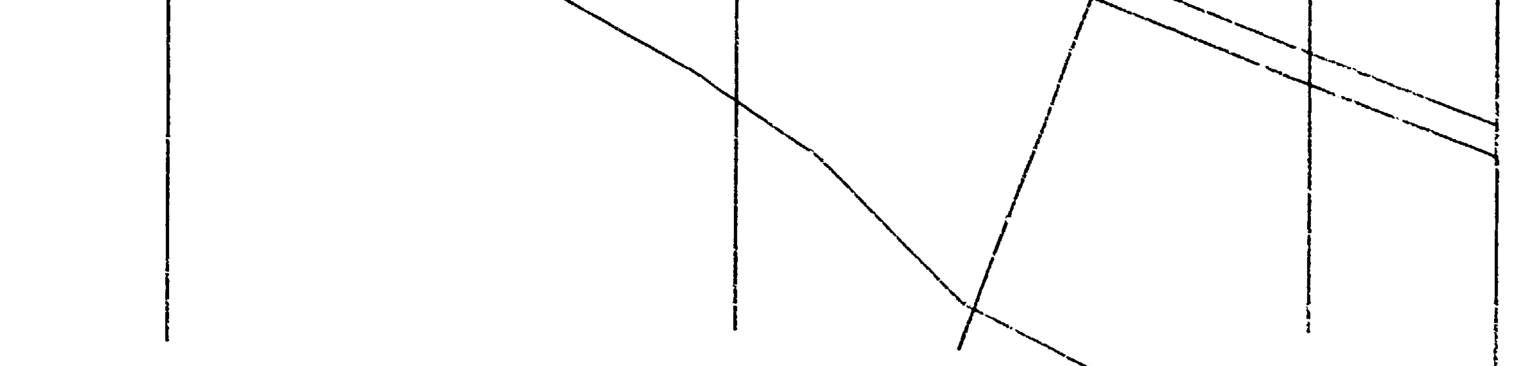

SECTION 5



SECTION 6

LEGEND

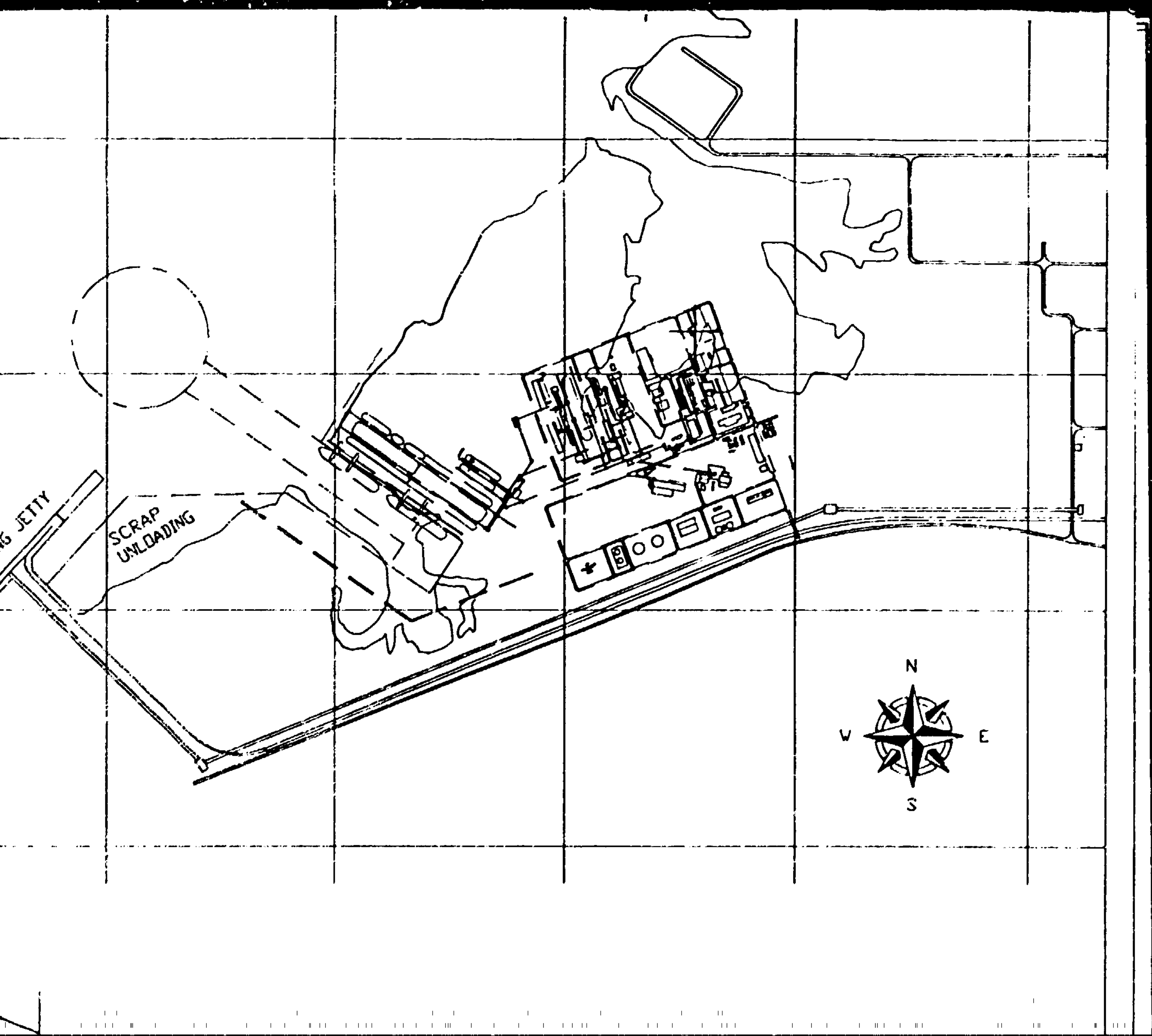
1 SCRAP YARD
2 LD-STEEL PLANT
3 THIN SLAB CASTER
4 REHEATING FURNACE
5 HOT STRIP MILL
6 COIL STORAGE YARD
7 ROLL SHOP + MAINTENANCE
8 SCALE PIT
9 WATER TREATMENT PLANT
10 DEDUSTING PLANT
11 LABORATORY
12 OXYGEN PLANT
13 BUILDING FOR FLUX & FERRO
15 ELECTRIC MAIN STATION
16 OIL TANK DEPOT
17 GAS HOLDER
18 POWER PLANT
19 BLOWER STATION
20 WATER TREATMENT PLANT - B
21 SLAG CRUSHING & SCREENING
22 PIG CASTING MACHINE

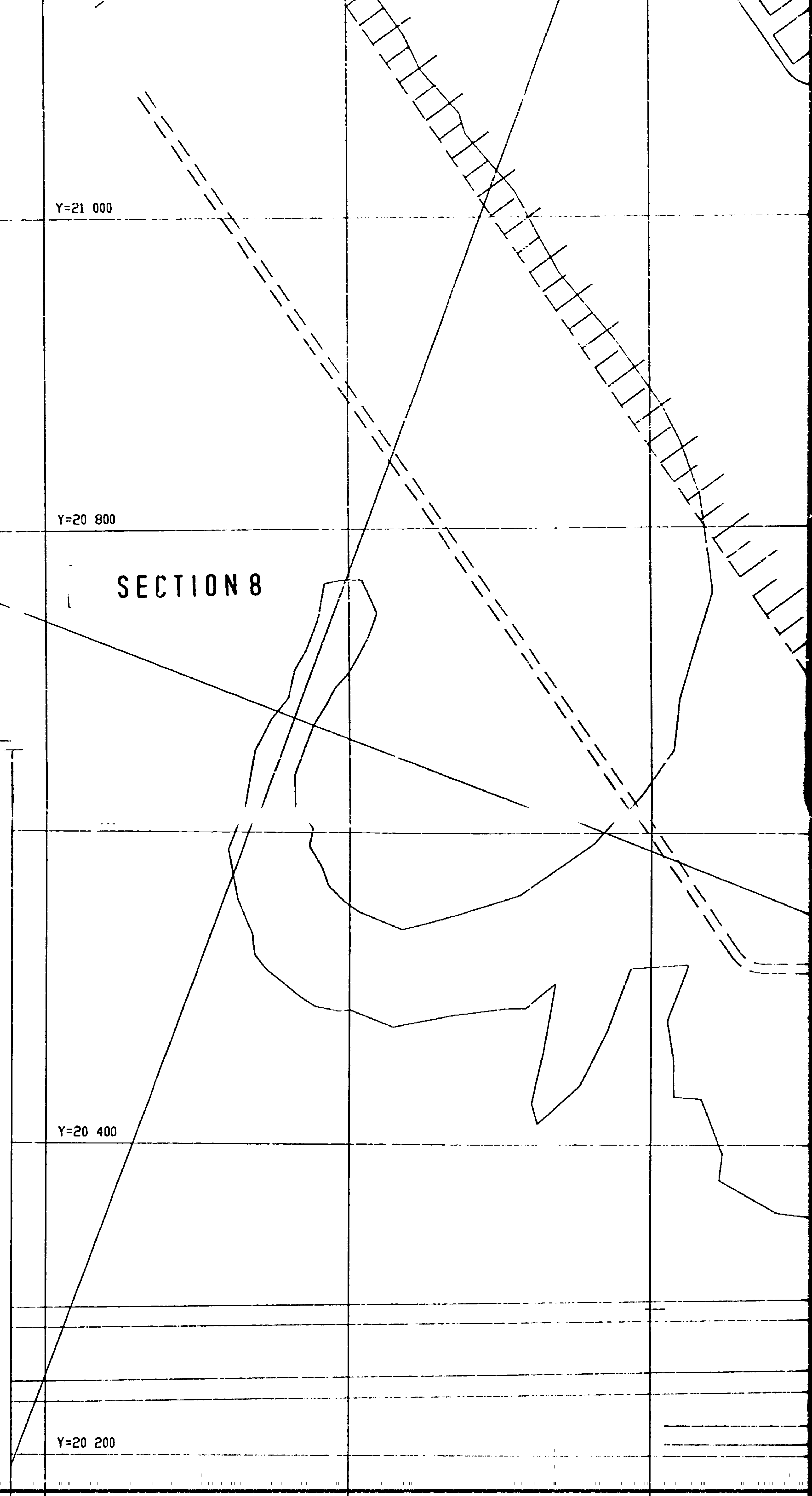


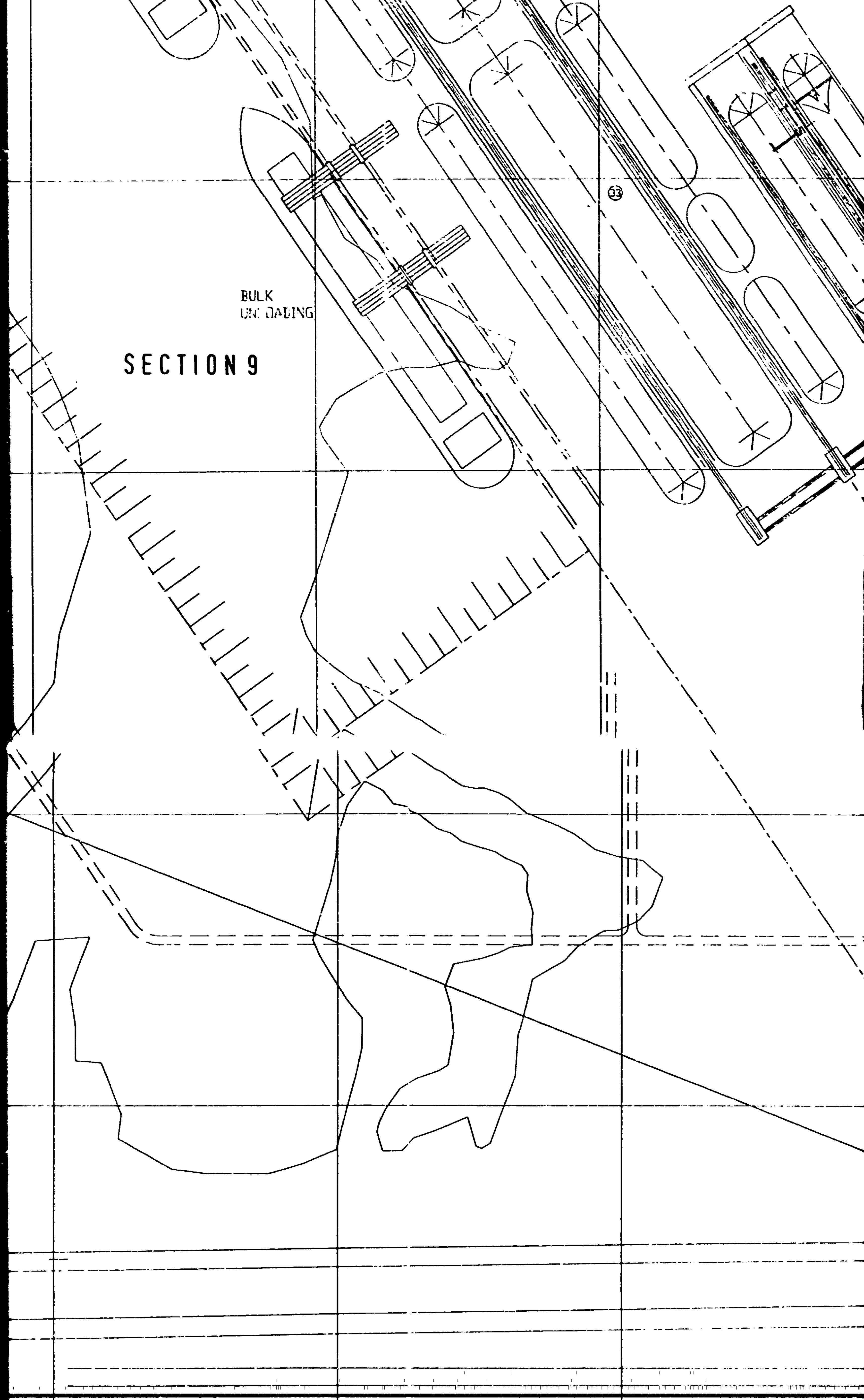
LEGEND

1 SCRAP YARD
2 LD-STEEL PLANT
3 THIN SLAB CASTER
4 REHEATING FURNACE
5 HOT STRIP MILL
6 COIL STORAGE YARD
7 ROLL SHOP + MAINTENANCE
8 SCALE PIT
9 WATER TREATMENT PLANT
10 DEDUSTING PLANT
11 LABORATORY
12 OXYGEN PLANT
13 BUILDING FOR FLUX & FERRO ALLOYS
15 ELECTRIC MAIN STATION
16 OIL TANK DEPOT
17 GAS HOLDER
18 POWER PLANT
19 BLOWER STATION
20 WATER TREATMENT PLANT - BF
21 SLAG CRUSHING & SCREENING PLANT
22 PIG CASTING MACHINE
23 LADLE SHOP, REFRACTORIES STORE

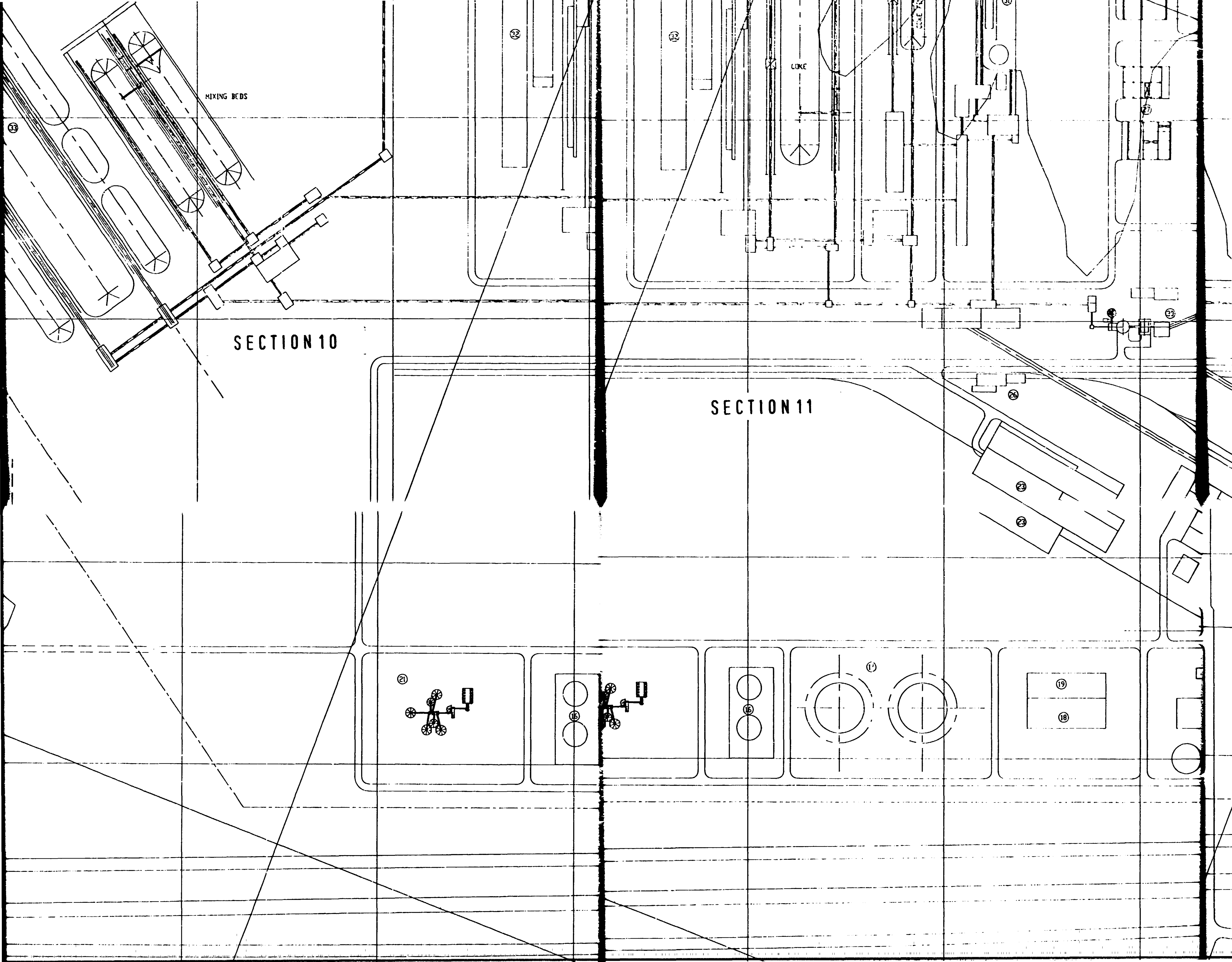
SECTION 7

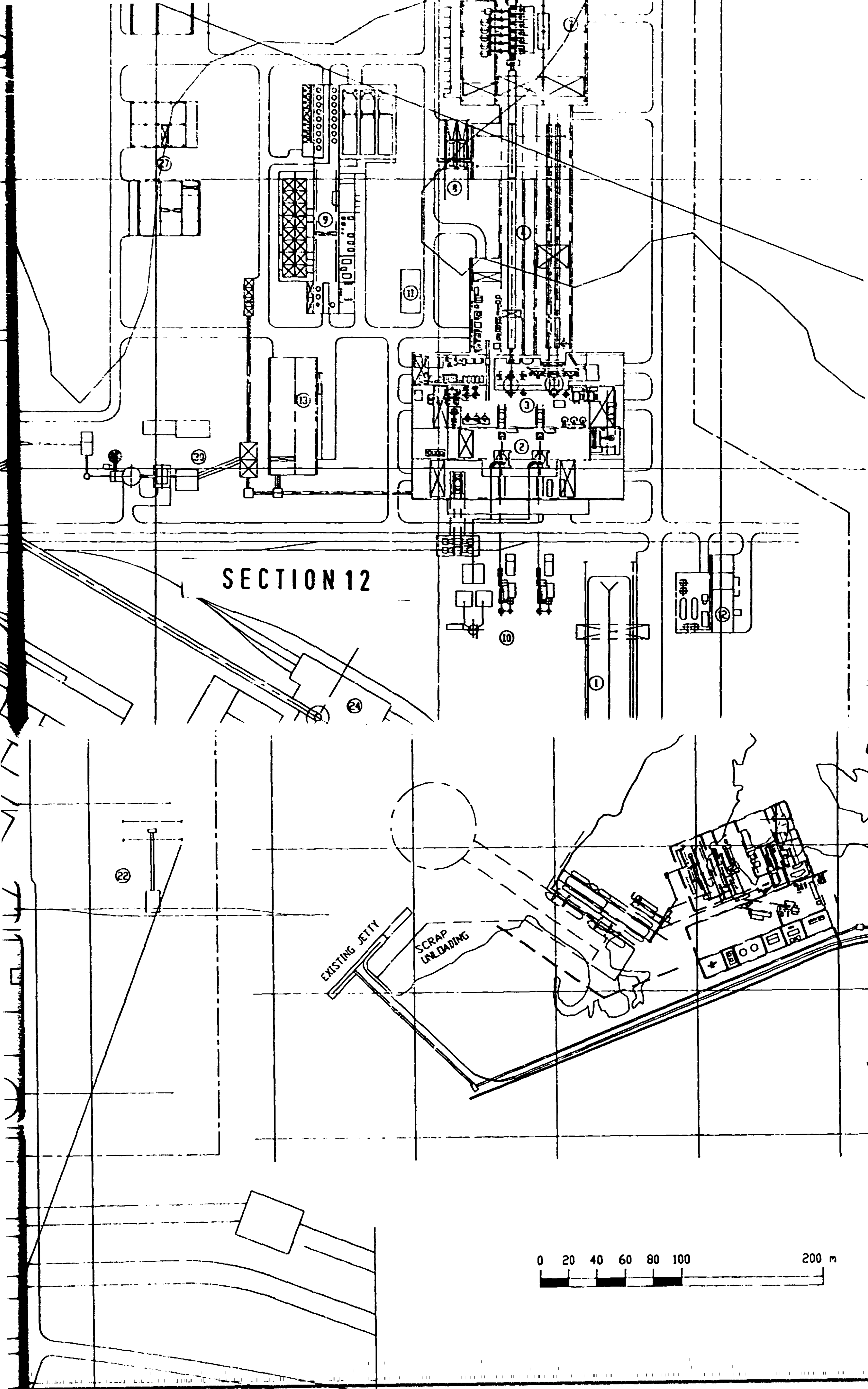


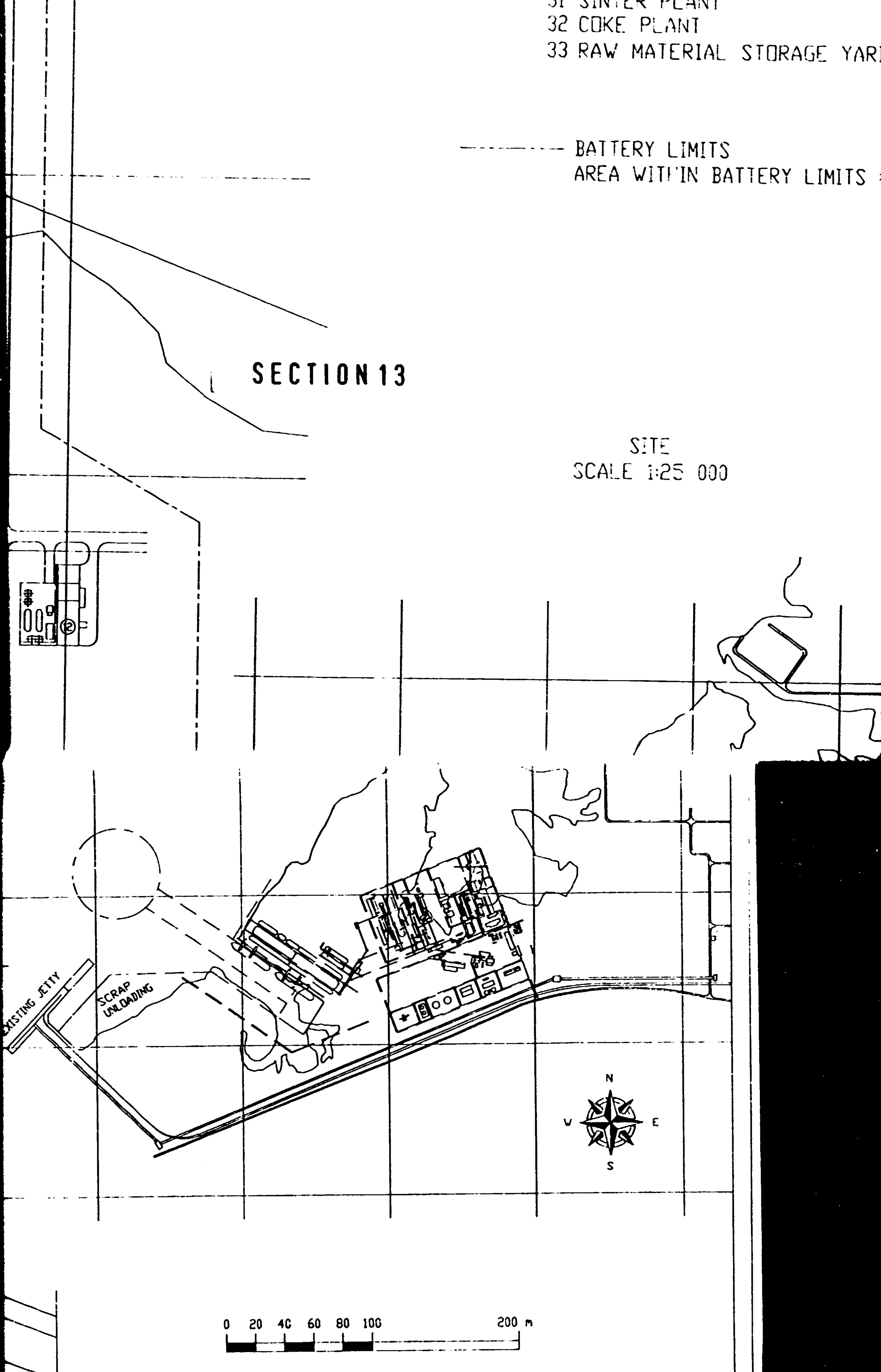

Y=21 000
Y=20 800
SECTION 8
Y=20 400
Y=20 200



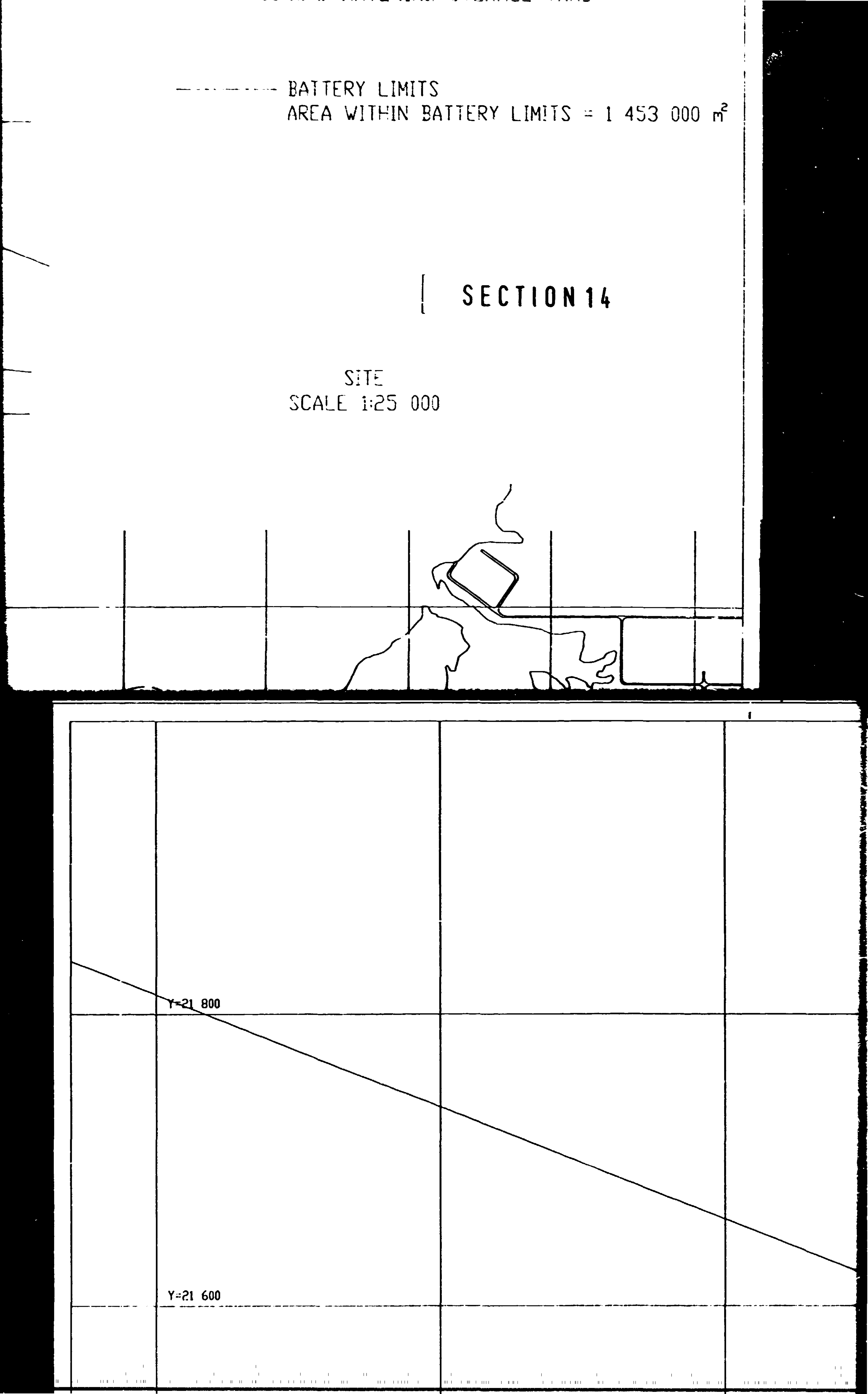
BULK
UNI OADING
SECTION 9
33

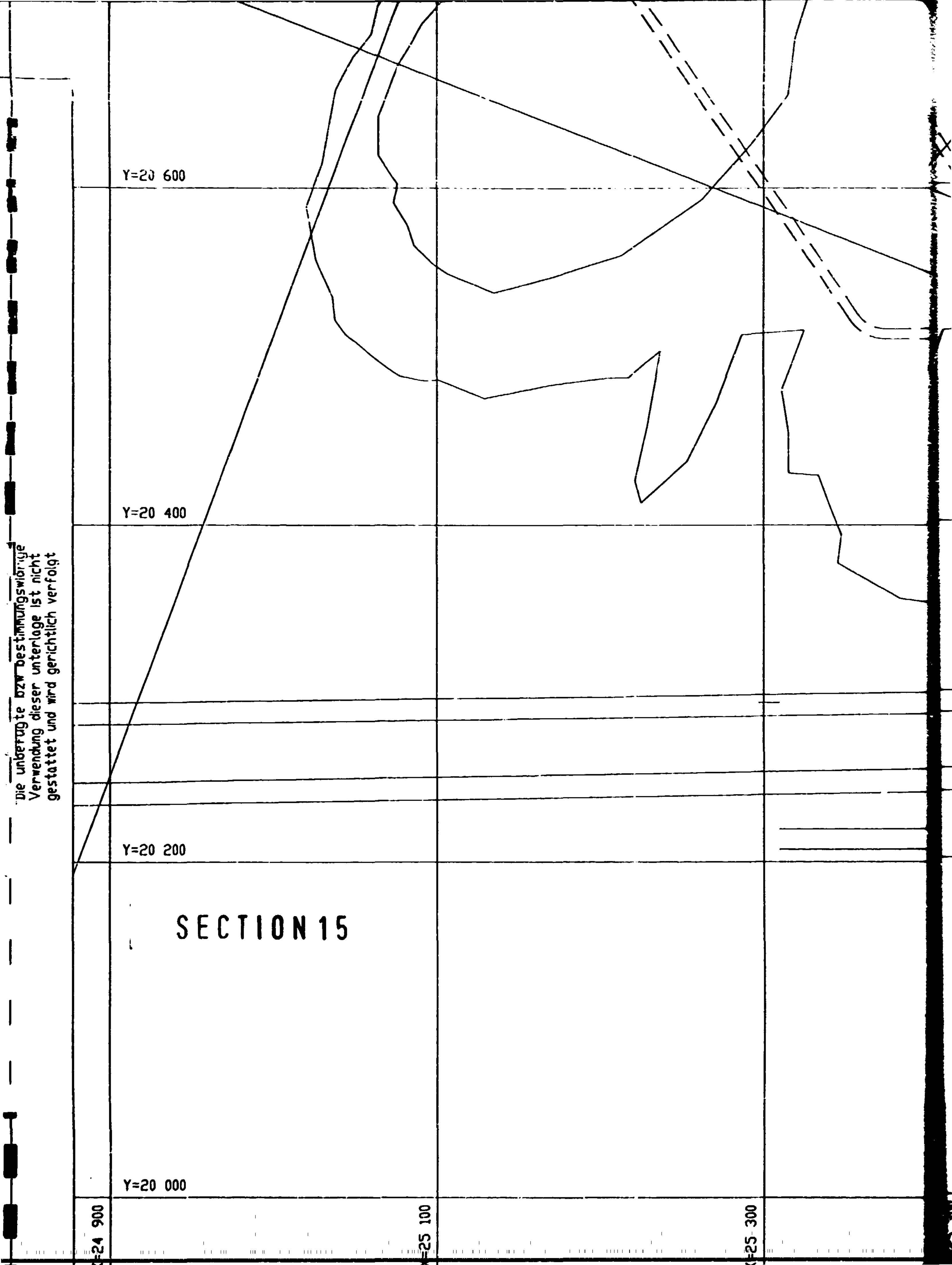

MIXING BEDS
SECTION 10
SECTION 11
COKE

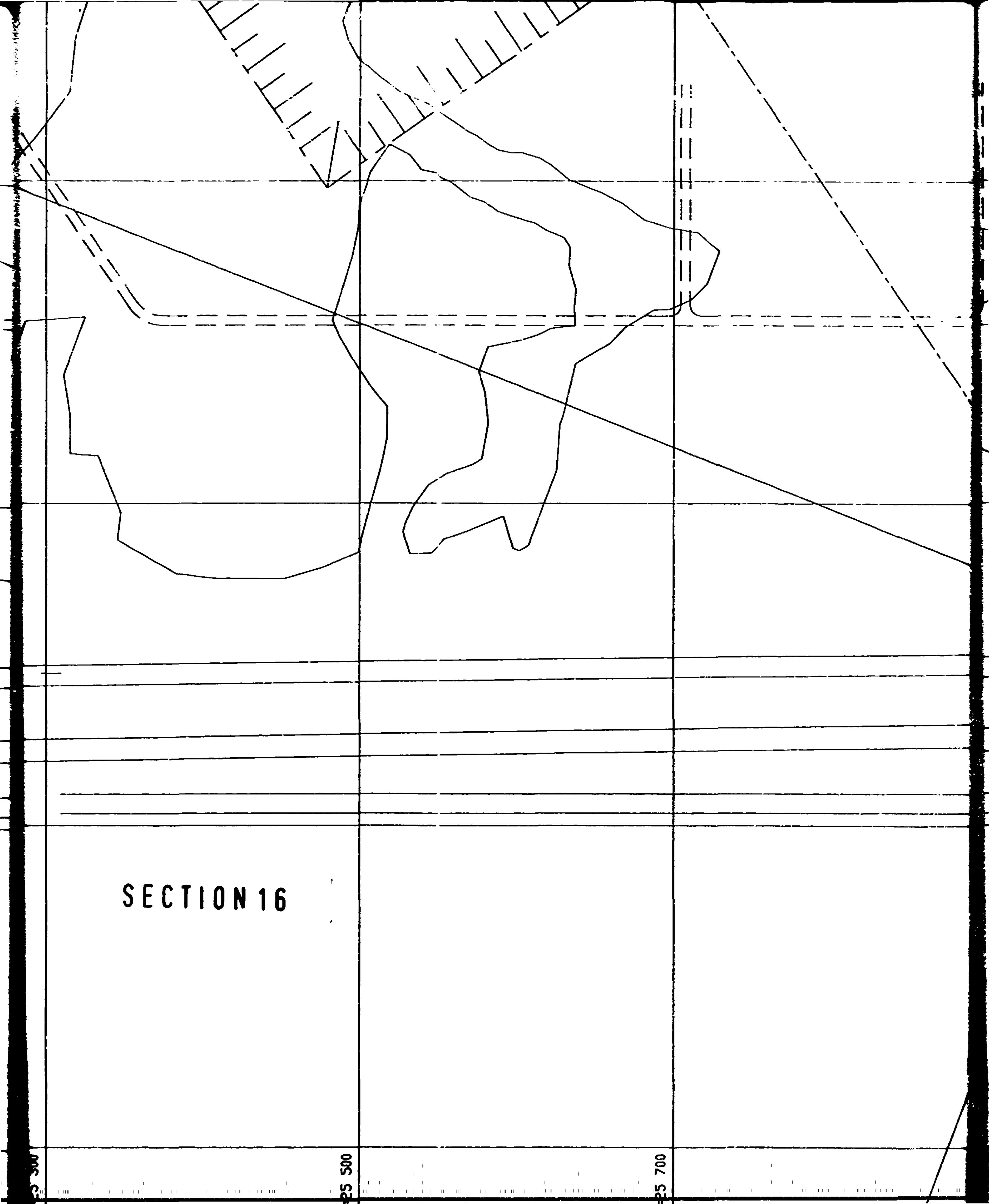

SECTION 12
EXISTING JETTY
SCRAP UNLOADING
0 20 40 60 80 100 200 m

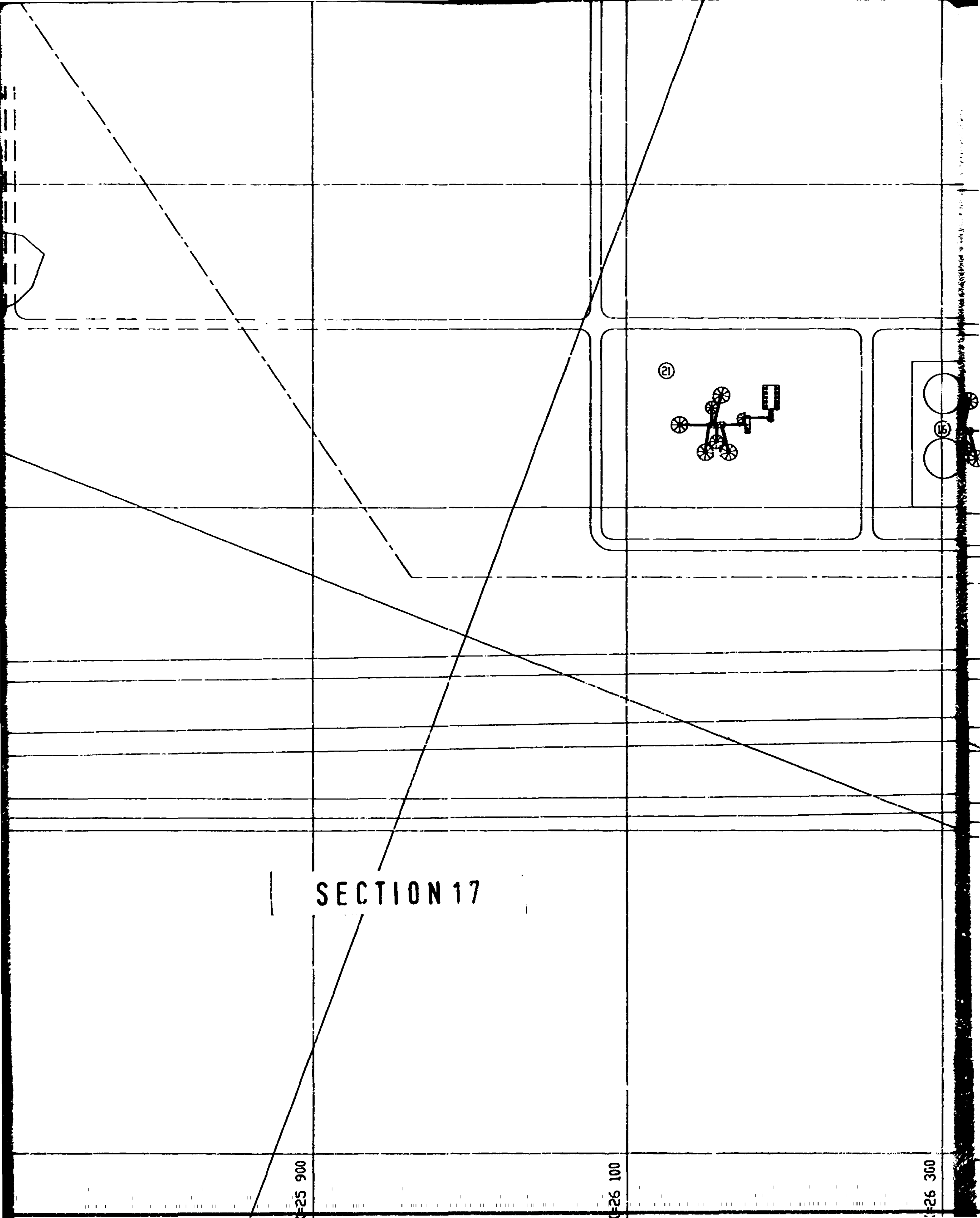


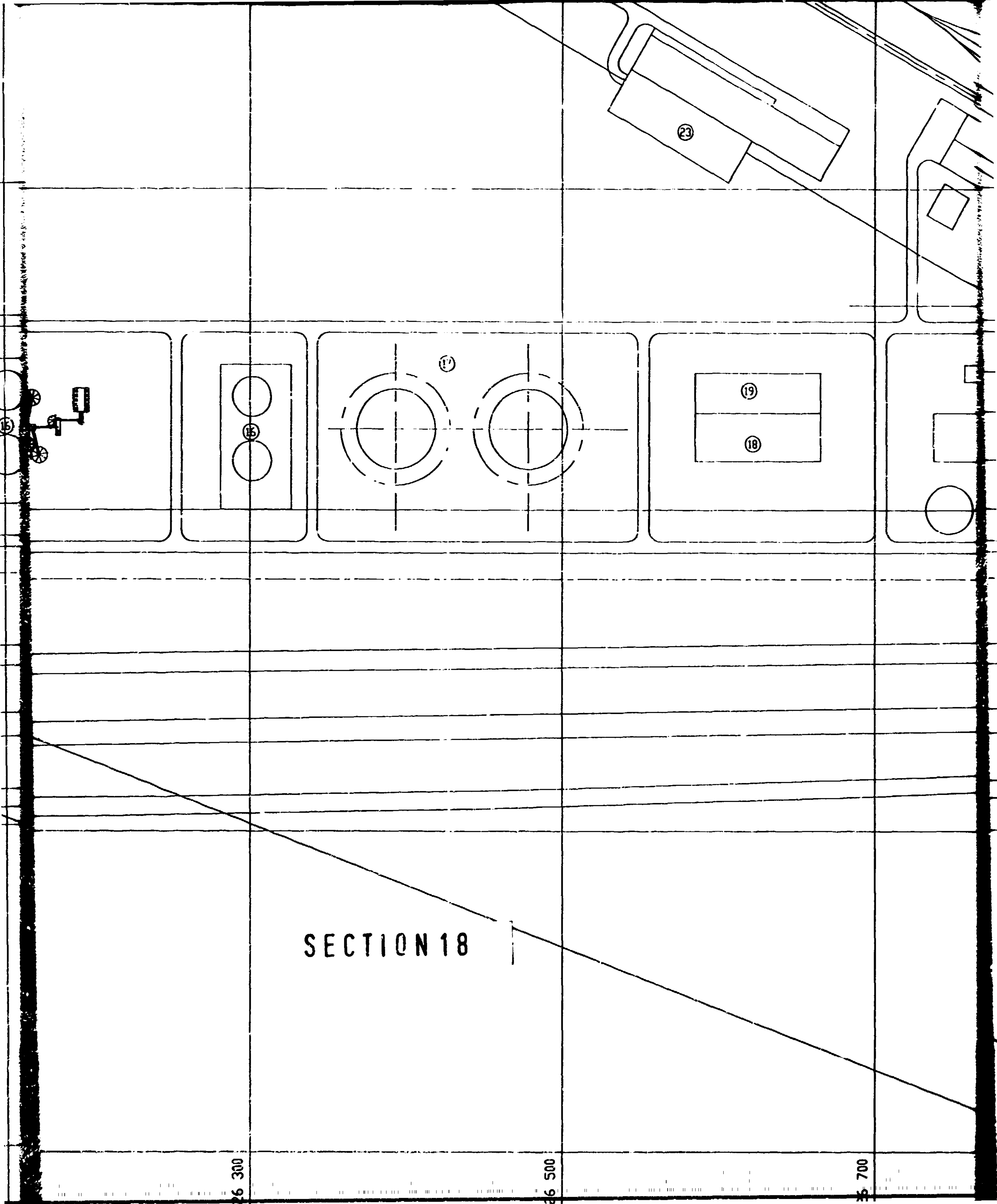
31 SINTER PLANT
32 COKE PLANT
33 RAW MATERIAL STORAGE YARD
BATTERY LIMITS
AREA WITHIN BATTERY LIMITS =
SECTION 13
SITE
SCALE 1:25 000
EXISTING JETTY
SCRAP UNLOADING
N
W
E
S
0 20 40 60 80 100 200 m


BATTERY LIMITS
AREA WITHIN BATTERY LIMITS = 1 453 000 m²
SECTION 14
SITE
SCALE 1:25 000
Y=21 800
Y=21 600

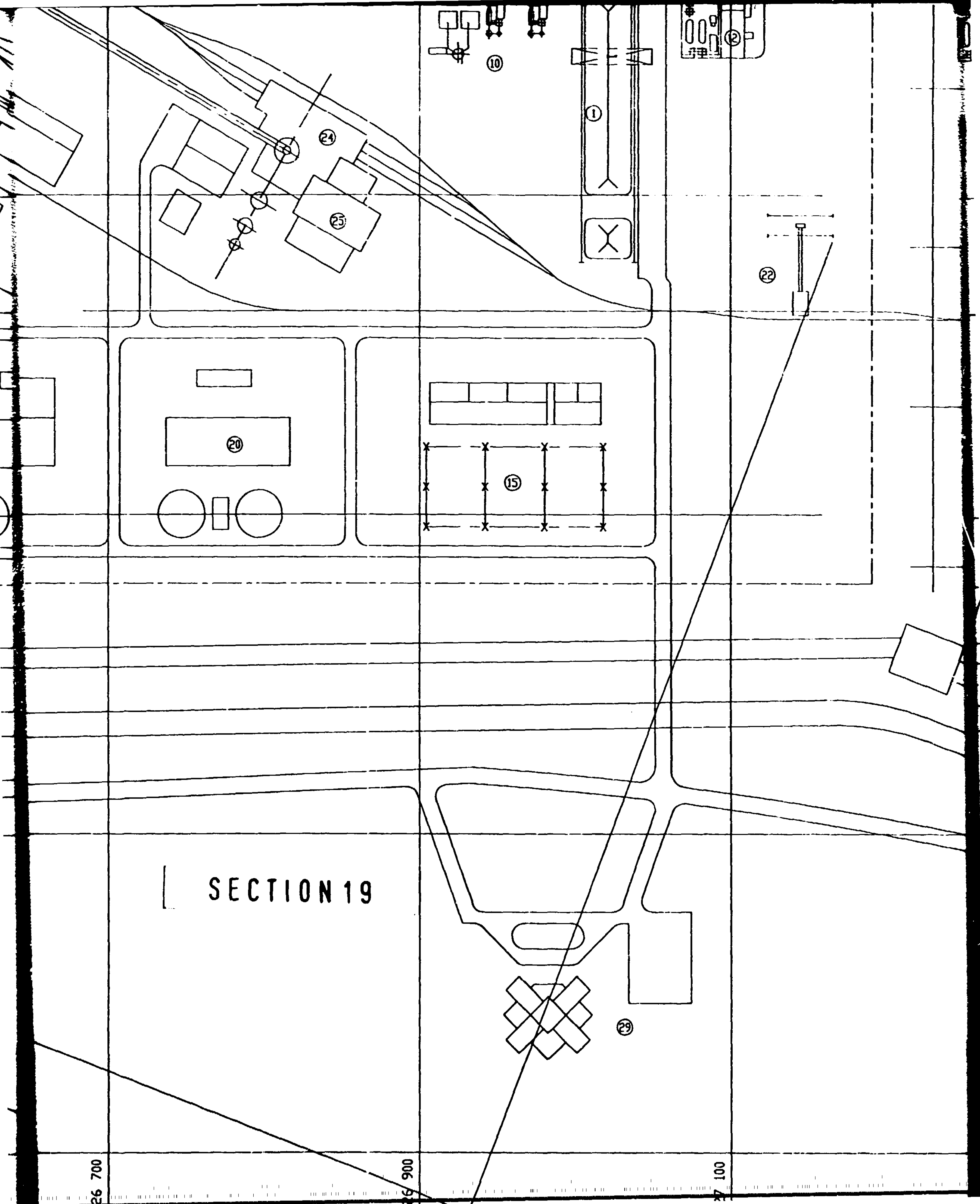

Y=20 600
Y=20 400
Y=20 200
Y=20 000
SECTION 15
24 900
25 100
25 300


SECTION 16
25 500
25 700

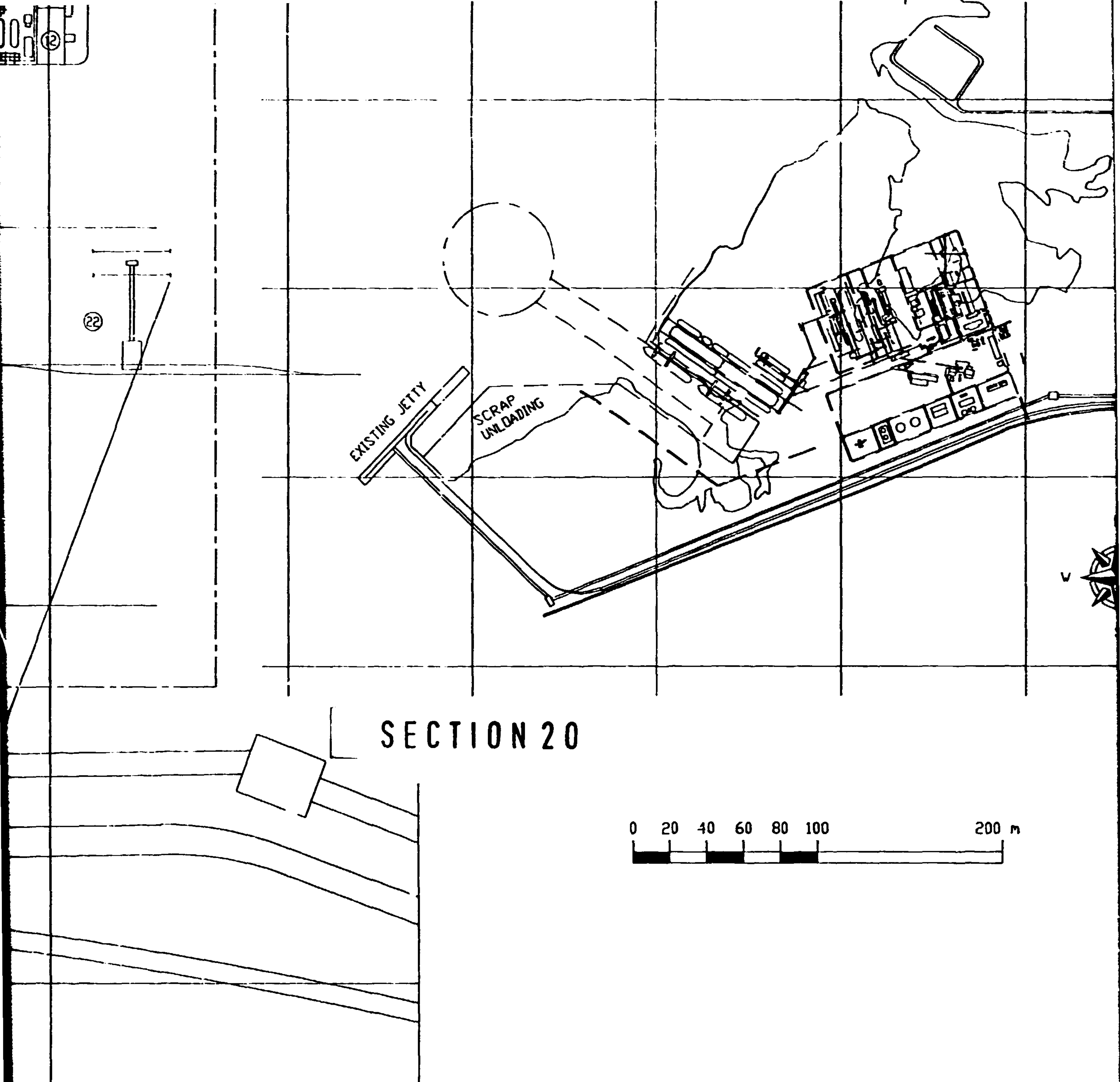

SECTION 17
21
16
25 900
26 100
26 300



23
16
17
19
18
SECTION 18
26 300
26 500
700



⑩
⑫
①
㉔
㉕
㉒
⑳
⑮
SECTION 19
㉙
26 700
26 900
27 100



Änderung Revision | Anz. d. Änd. No. of Mod. | Änderungsinhalt Modification | Datum Date

1993 | Datum Date | Name Name

Bearbeitet Made by | 12-01 | P.F.

Geprüft Checked by

CAD

VAR. 1/2

BF-LD-ROUTE

AS/AC/BS/RB/SL 2.47/CD/V

Benennung Title

PROJECT SGSM/INDONESIA

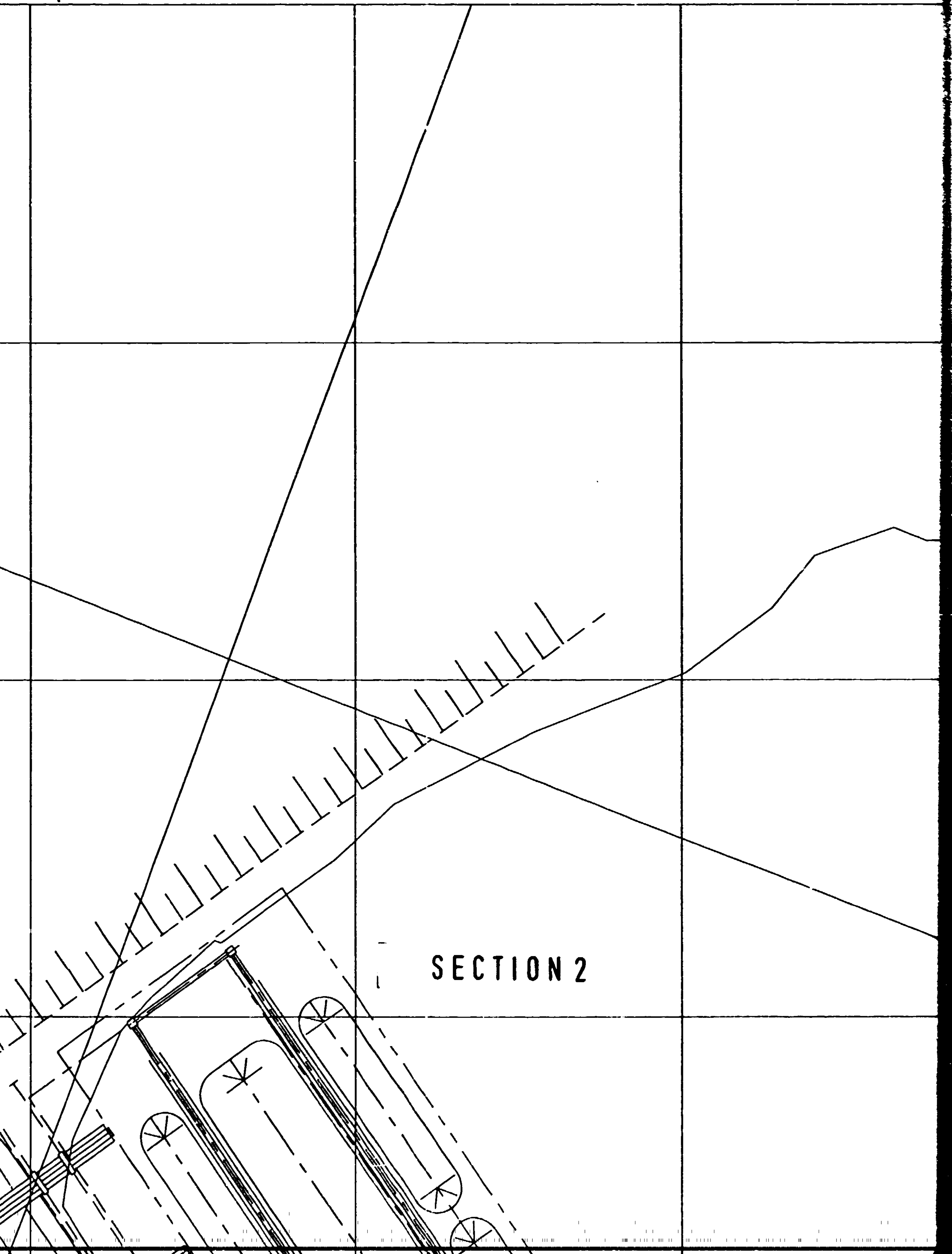
FEASIBILITY STUDY

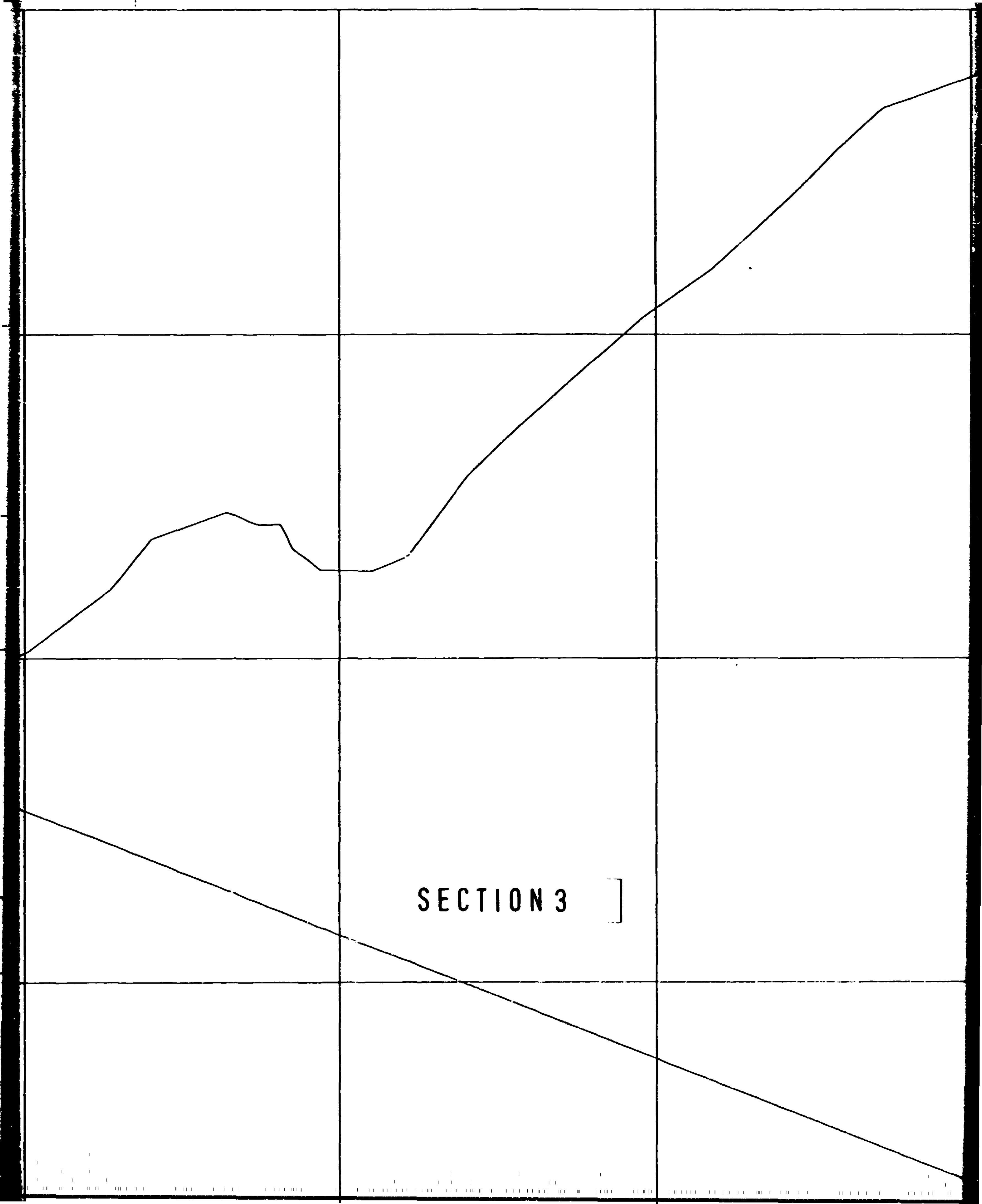
GENERAL LAYOUT

Maßstab Scale 1:250

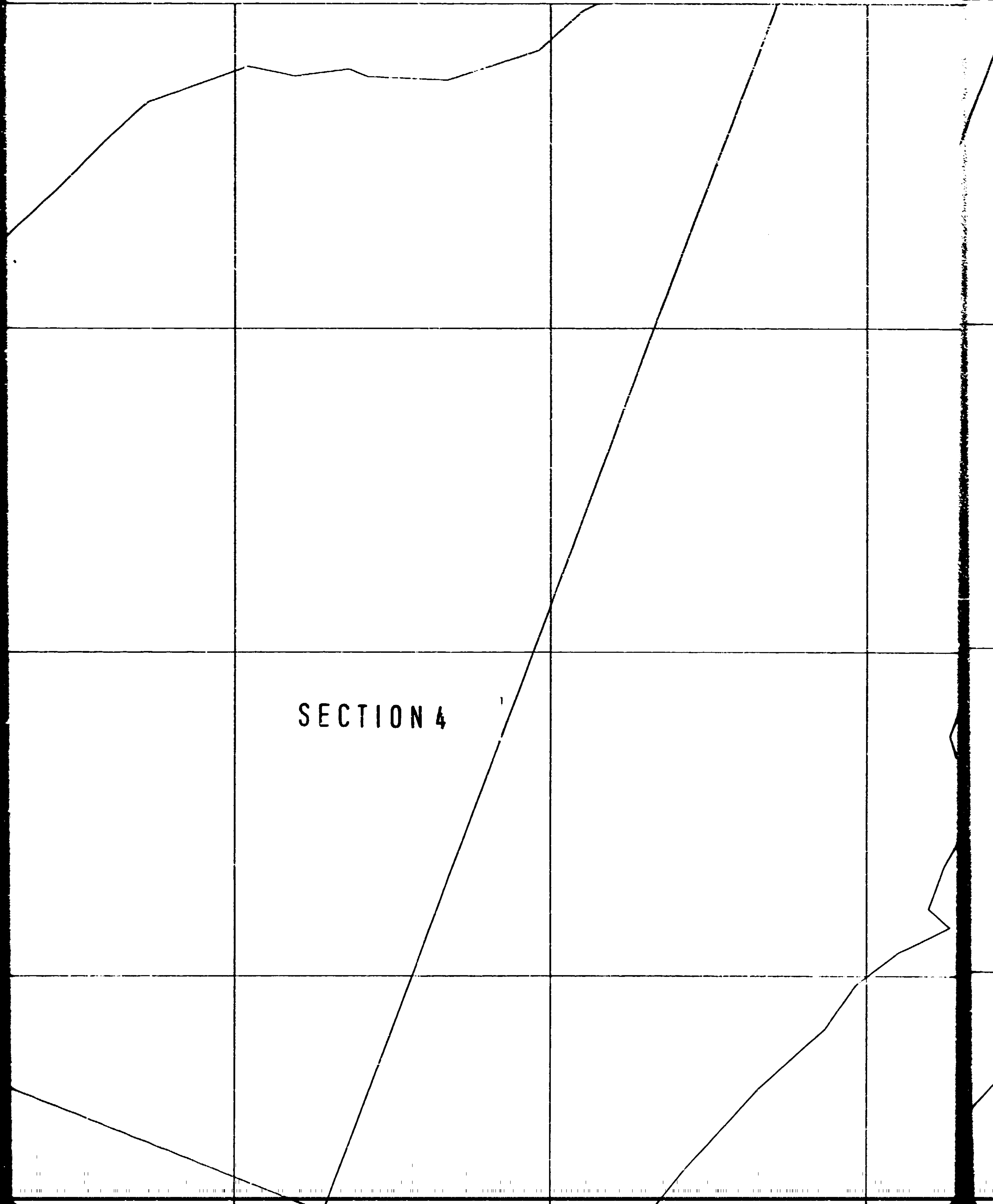
Werkstoff Material

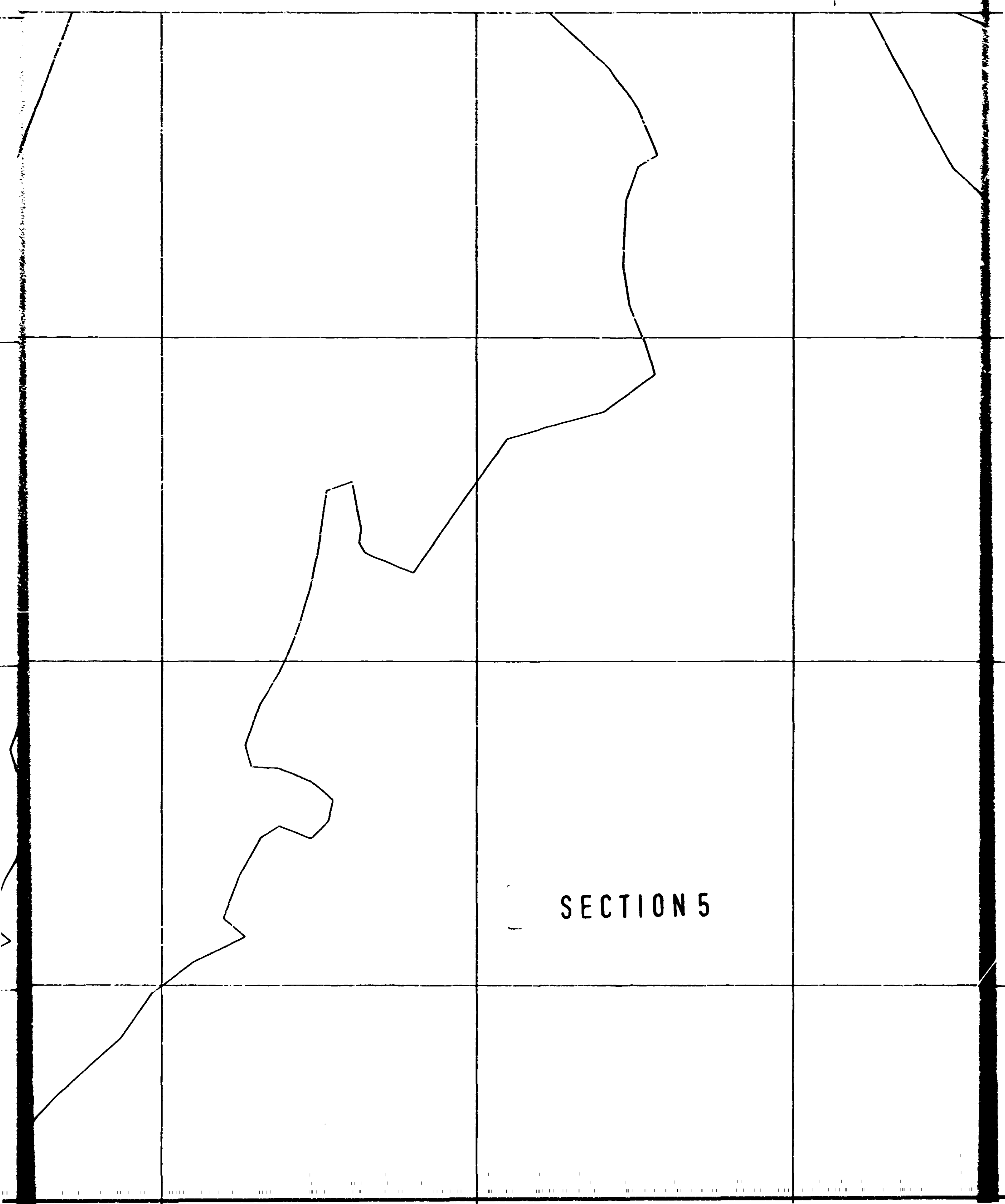
100

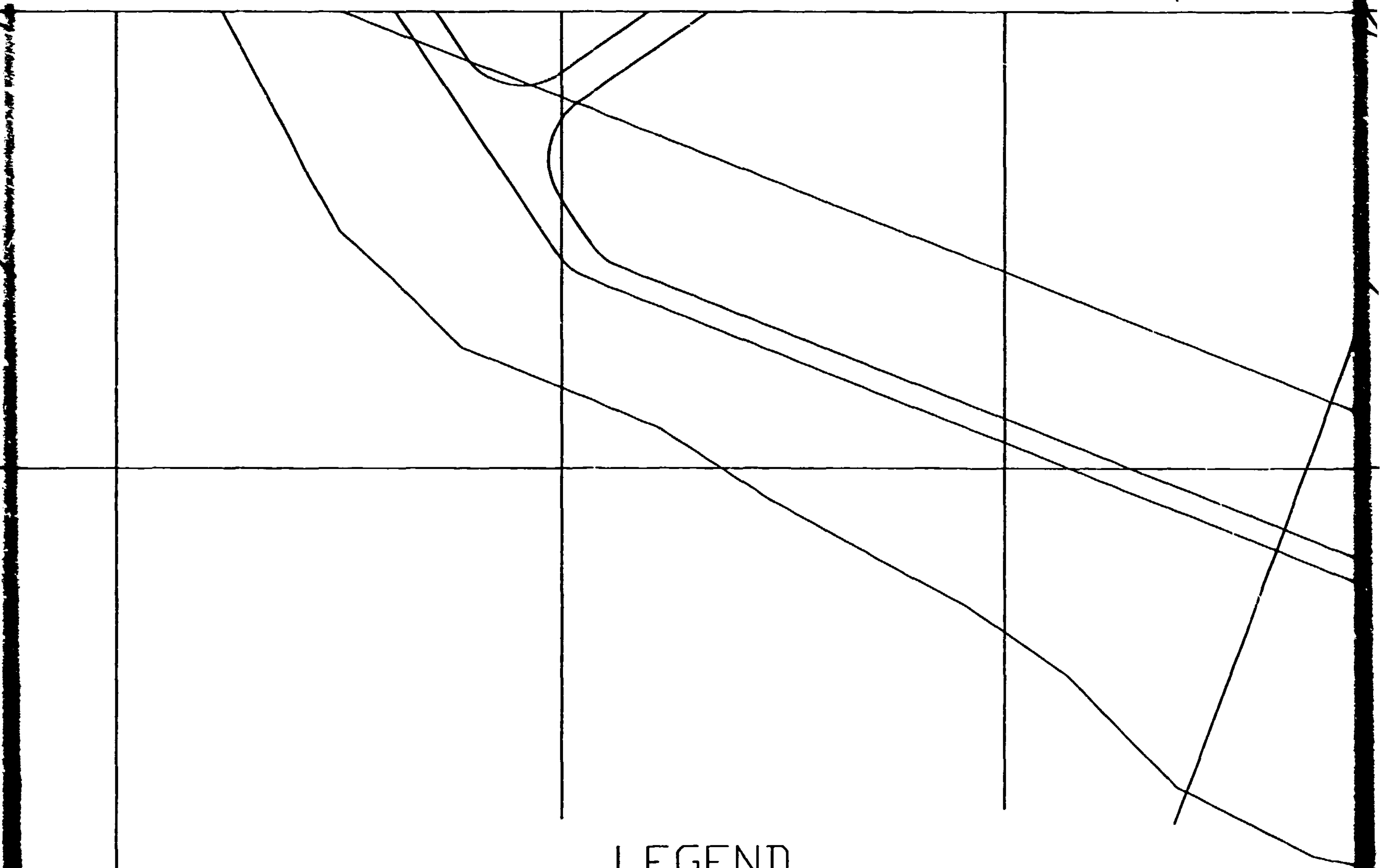

SECTION 2



SECTION 3


SECTION 4

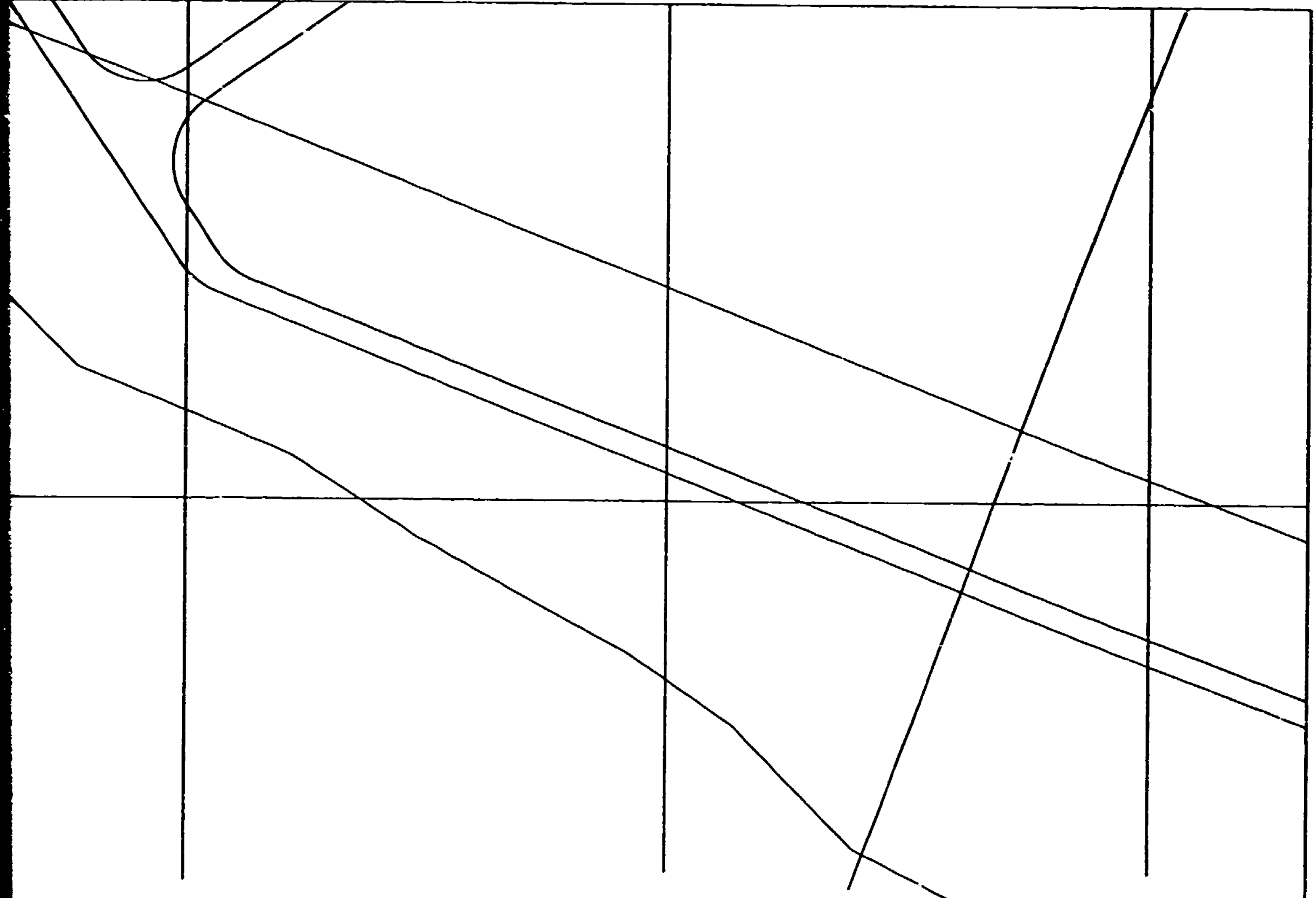

SECTION 5



SECTION 6

LEGEND

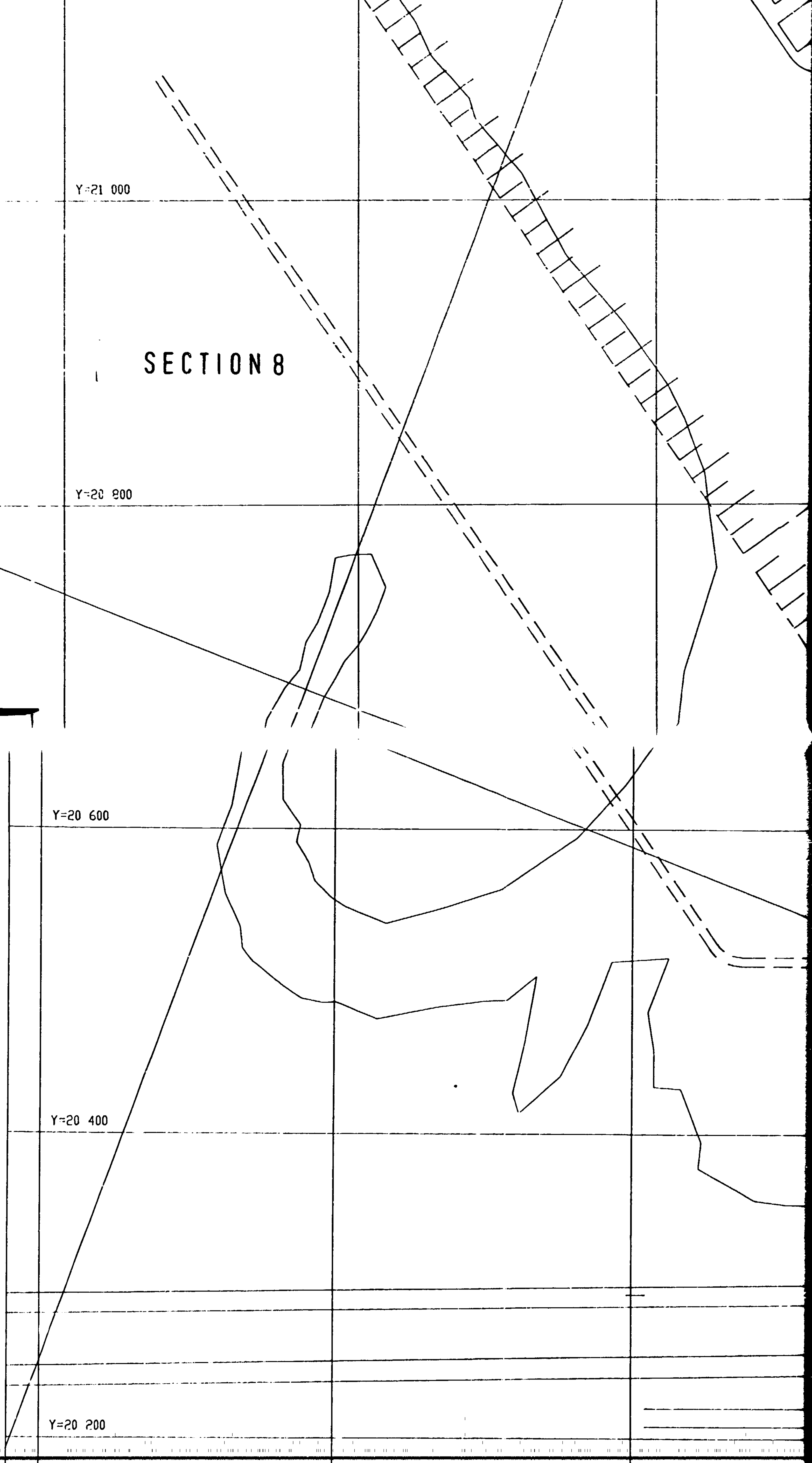
1 SCRAP YARD
2 LD-STEEL PLANT
3 THIN SLAB CASTER
4 REHEATING FURNACE
5 HOT STRIP MILL
6 COIL STORAGE YARD
7 ROLL SHOP + MAINTENANCE
8 SCALE PIT
9 WATER TREATMENT PLANT FOR MELT SHOP & C
10 DEDUSTING PLANT FOR STEEL MELT SHOP
11 LABORATORY
12 OXYGEN PLANT
13 LIME PLANT
14 RAW MATERIAL STORAGE YARD
15 ELECTRIC MAIN STATION
16 GAS HOLDER
17 SLAG CRUSHING & SCREENING PLANT
18 PIG CASTING MACHINE
19 LADLE SHOP, REFRACTORIES STORE
20 DESULPHURIZING STAND
21 CENTRAL STORE
22 CENTRAL MAINTENANCE

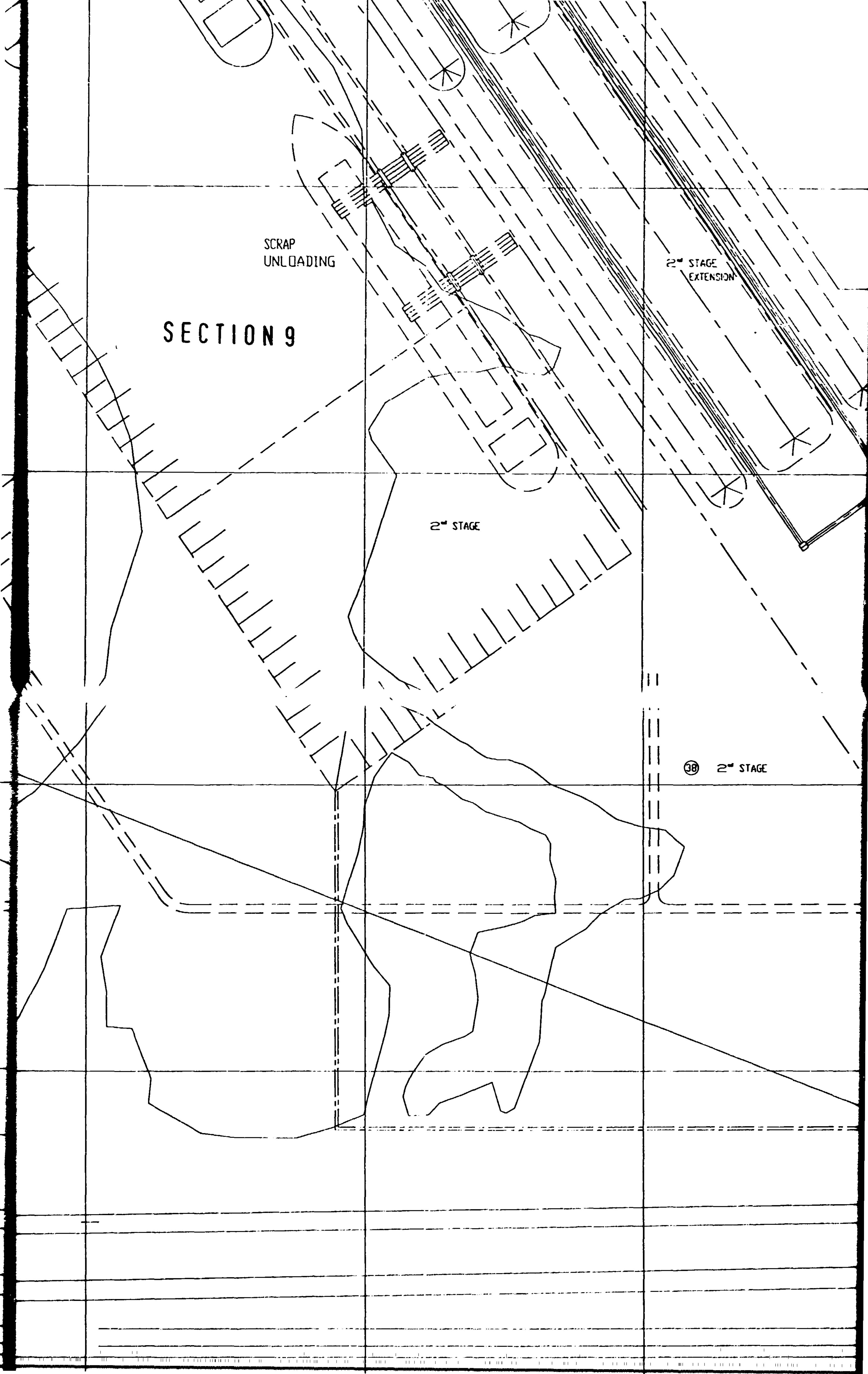


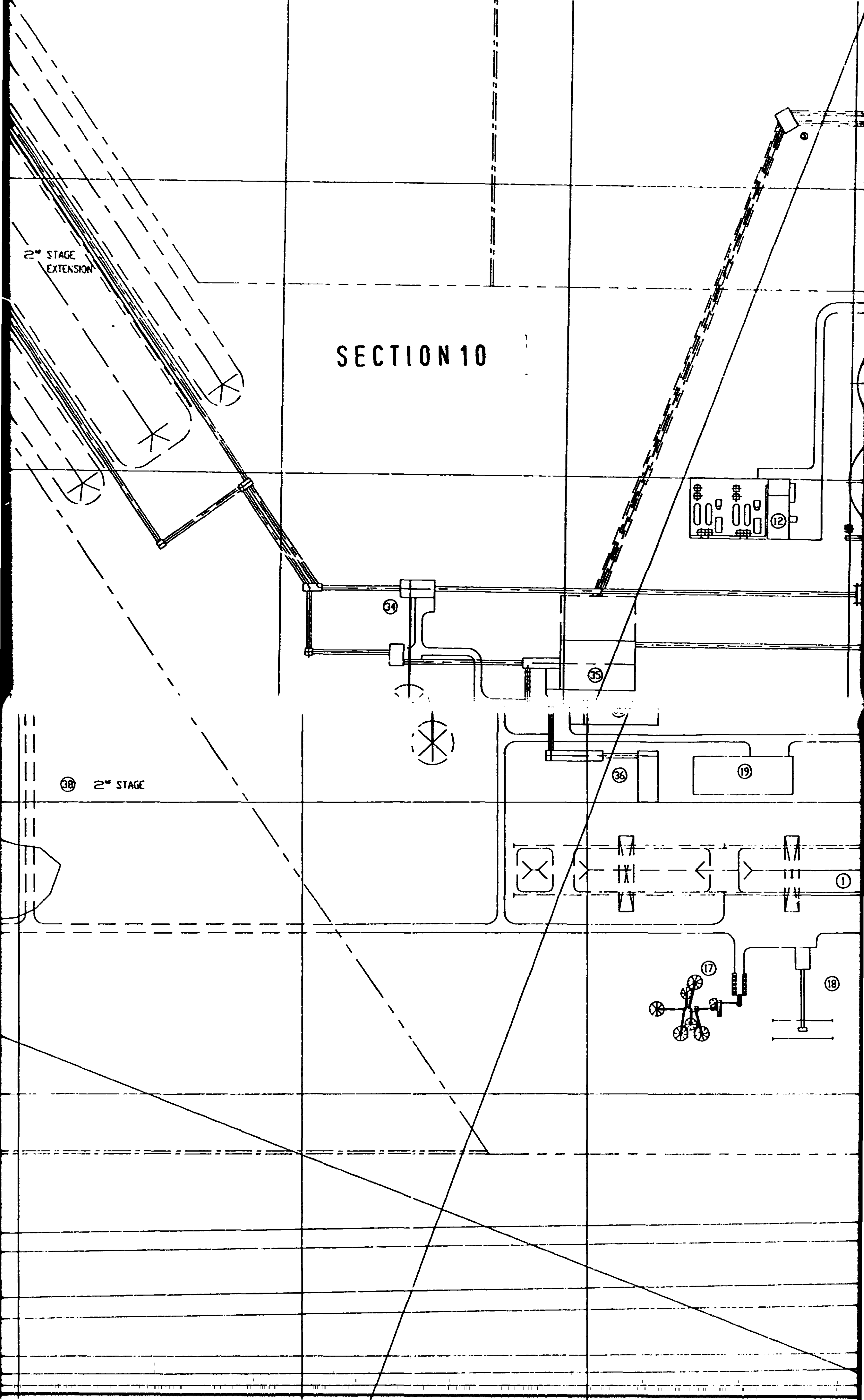
LEGEND

SECTION 7

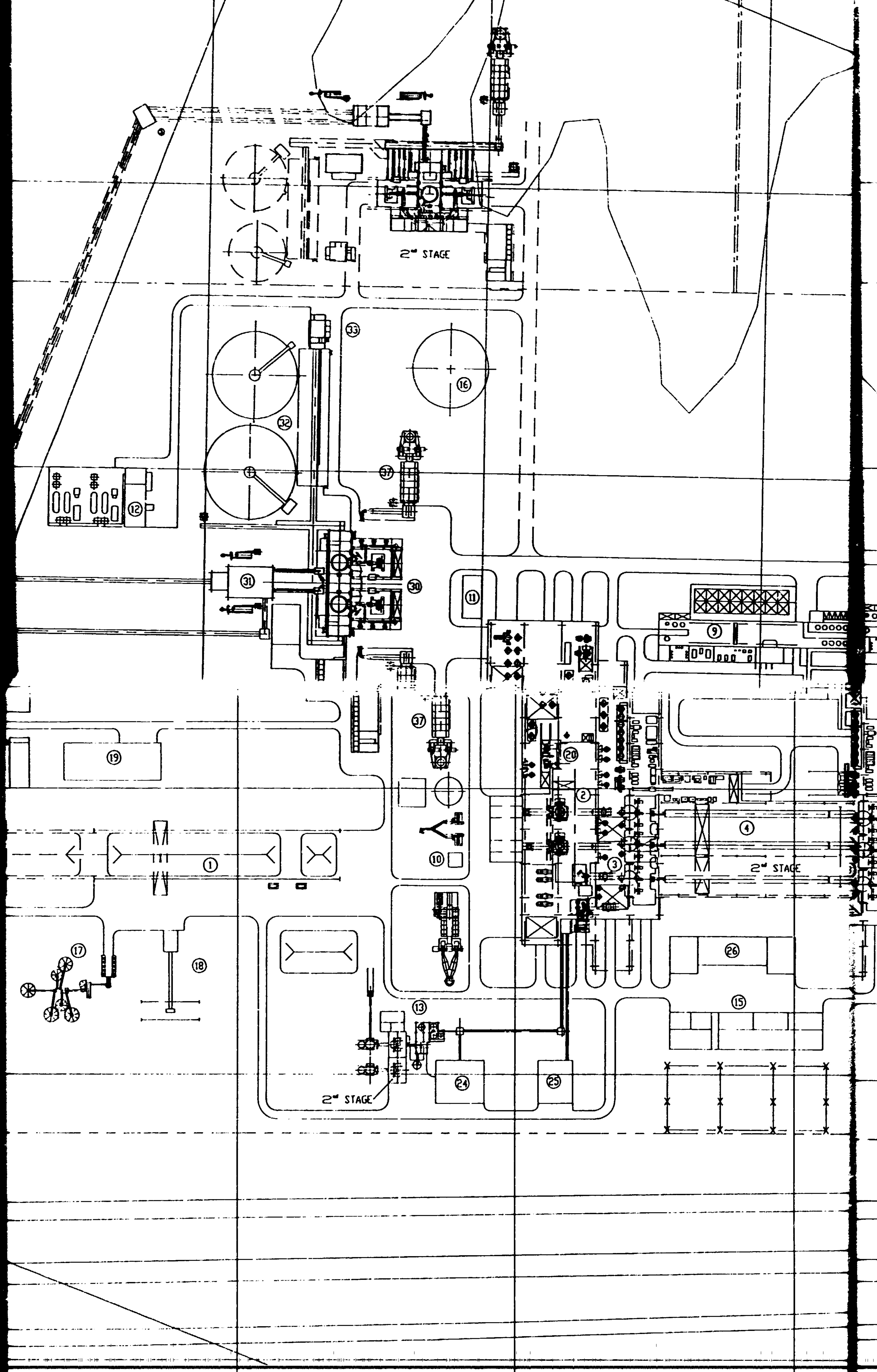
1 SCRAP YARD
2 LD-STEEL PLANT
3 THIN SLAB CASTER
4 REHEATING FURNACE
5 HOT STRIP MILL
6 COIL STORAGE YARD
7 ROLL SHOP + MAINTENANCE
8 SCALE PIT
9 WATER TREATMENT PLANT FOR MELT SHOP & CONROLL PLANT
10 DEDUSTING PLANT FOR STEEL MELT SHOP
11 LABORATORY
12 OXYGEN PLANT
13 LIME PLANT
14 RAW MATERIAL STORAGE YARD
15 ELECTRIC MAIN STATION
16 GAS HOLDER
17 SLAG CRUSHING & SCREENING PLANT
18 PIG CASTING MACHINE
19 LADLE SHOP, REFRACTORIES STORE
20 DESULPHURIZING STAND
21 CENTRAL STORE
22 CENTRAL MAINTENANCE

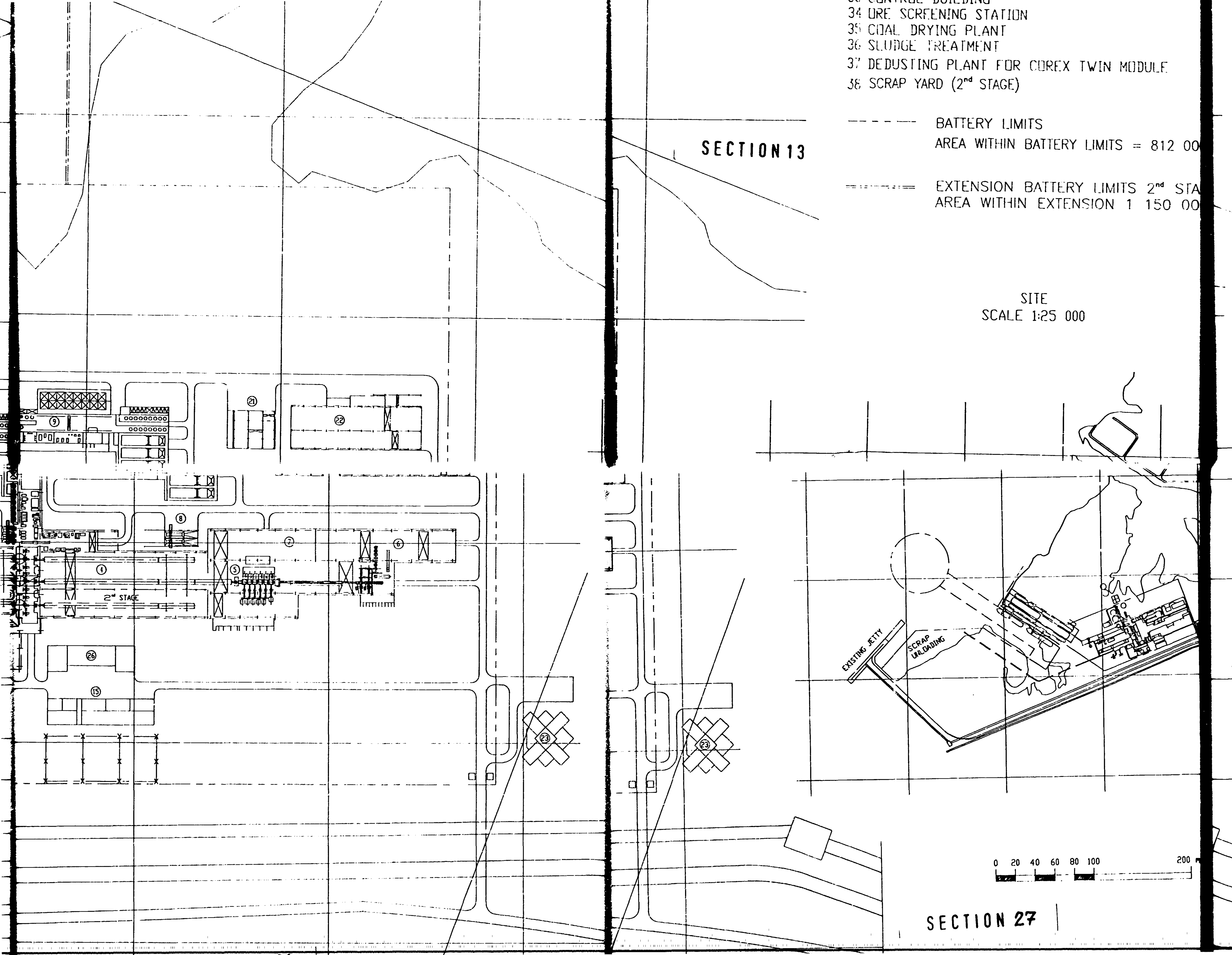

Y=21 000
SECTION 8
Y=20 800
Y=20 600
Y=20 400
Y=20 200


SCRAP
UNLOADING
SECTION 9
2nd STAGE
EXTENSION
2nd STAGE
38
2nd STAGE



2nd STAGE EXTENSION
SECTION 10
34
12
35
38 2nd STAGE
36
19
1
17
18


2nd STAGE
33
16
32
37
12
31
30
11
9
20
2
4
3
2nd STAGE
19
37
1
10
17
18
26
13
15
24
25
2nd STAGE

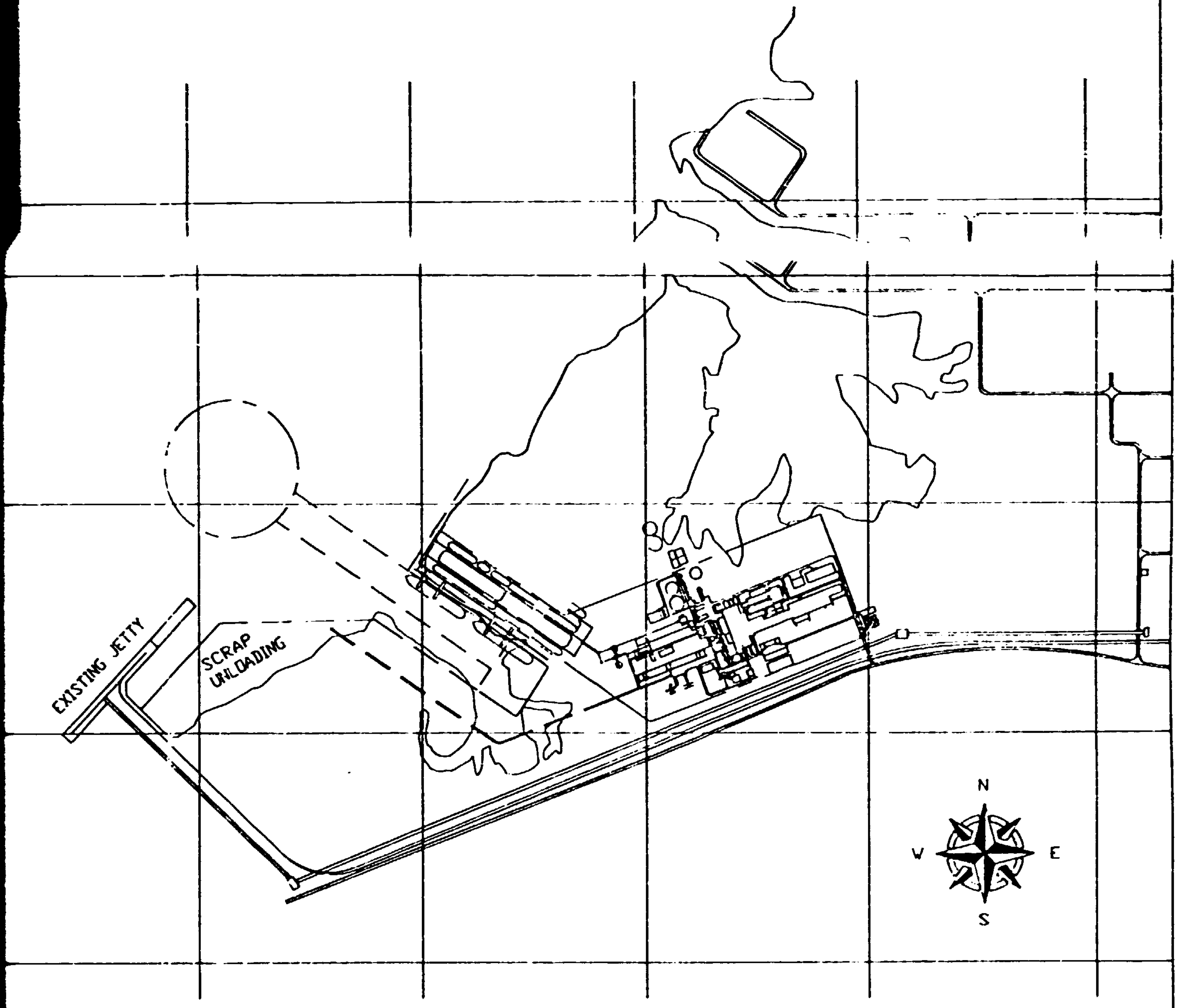

34 ORE SCREENING STATION
35 COAL DRYING PLANT
36 SLUDGE TREATMENT
37 DEDUSTING PLANT FOR COREX TWIN MODULE
38 SCRAP YARD (2nd STAGE)
BATTERY LIMITS
AREA WITHIN BATTERY LIMITS = 812 00
EXTENSION BATTERY LIMITS 2nd STA
AREA WITHIN EXTENSION 1 150 00
SECTION 13
SITE
SCALE 1:25 000
9
21
22
8
7
6
4
5
2nd STAGE
26
15
23
23
EXISTING JETTY
SCRAP UNLOADING
0 20 40 60 80 100
200
SECTION 27

34 ORE SCREENING STATION
35 COAL DRYING PLANT
36 SLUDGE TREATMENT
37 DEDUSTING PLANT FOR COREX TWIN MODULE
38 SCRAP YARD (2nd STAGE)

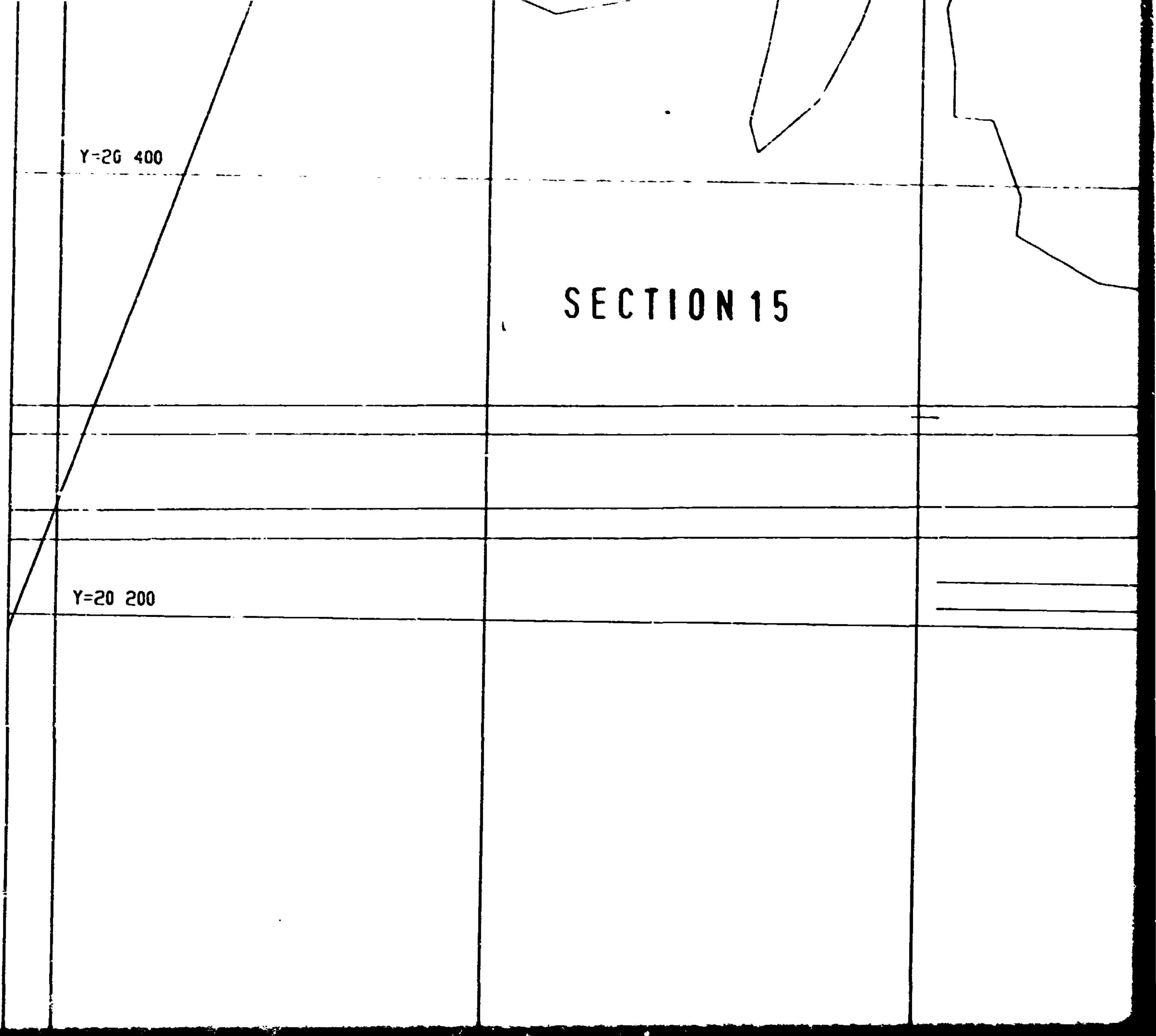
- - - - - - BATTERY LIMITS
AREA WITHIN BATTERY LIMITS = 812 000 m²

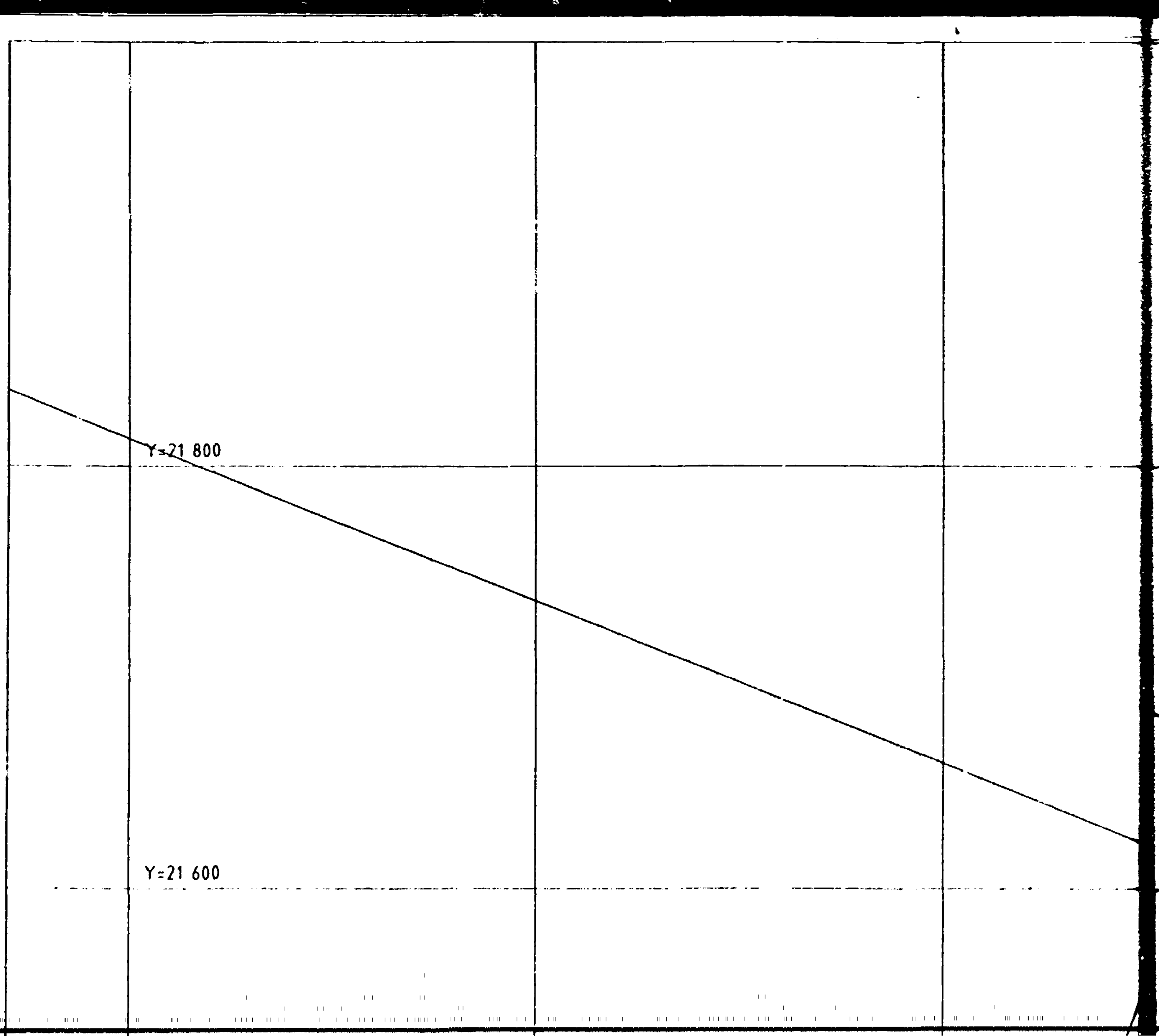
- - - - - - EXTENSION BATTERY LIMITS 2nd STAGE
AREA WITHIN EXTENSION 1 150 000 m²

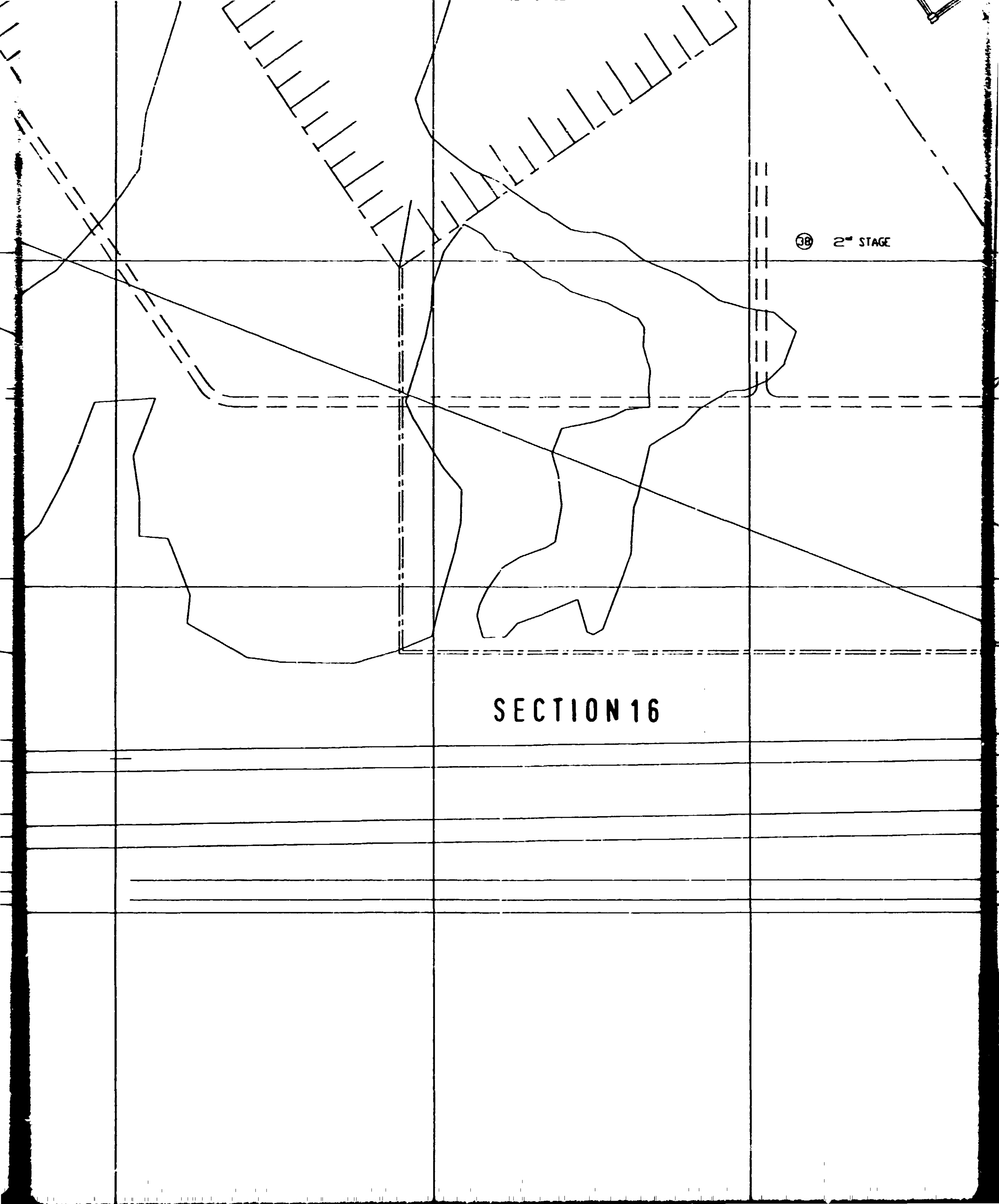
SITE
SCALE 1:25 000



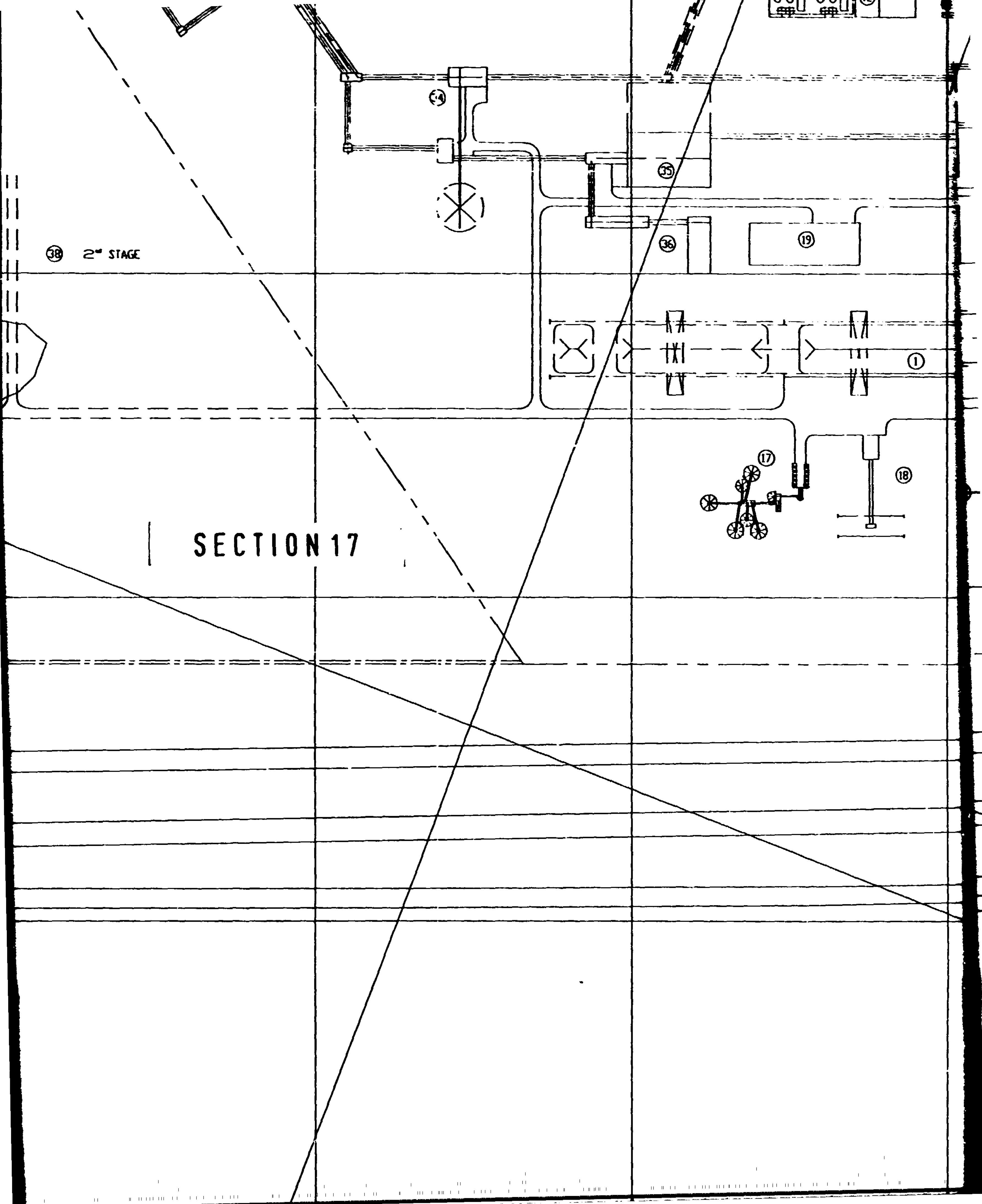
SECTION 28


Y=20 400
SECTION 15
Y=20 200

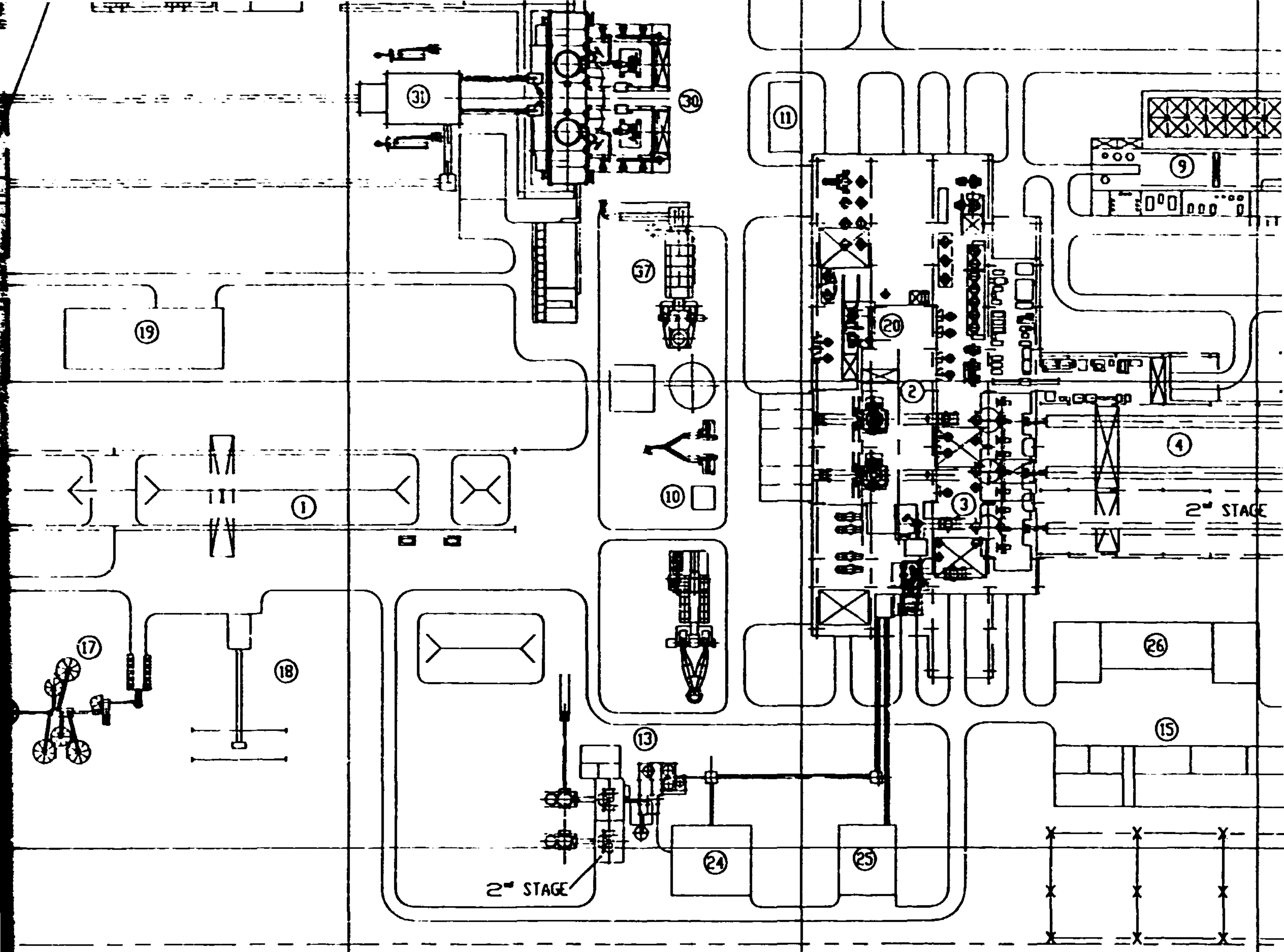

Y=21 800
Y=21 600



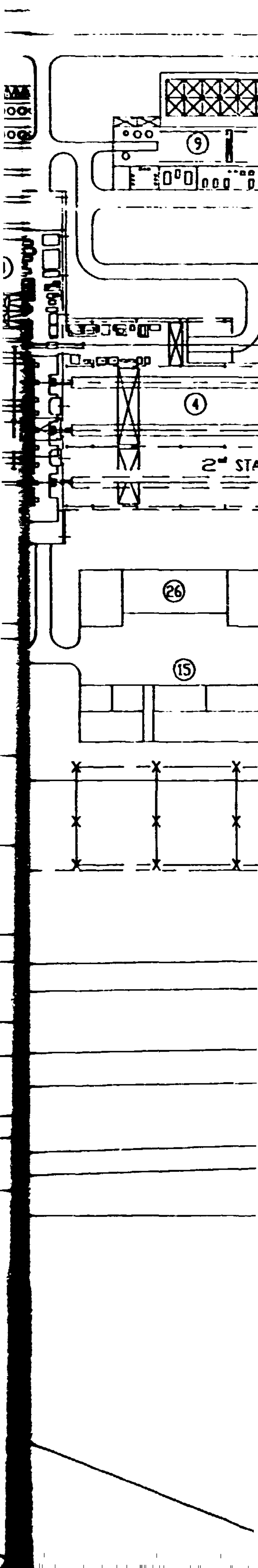
38 2nd STAGE
SECTION 16



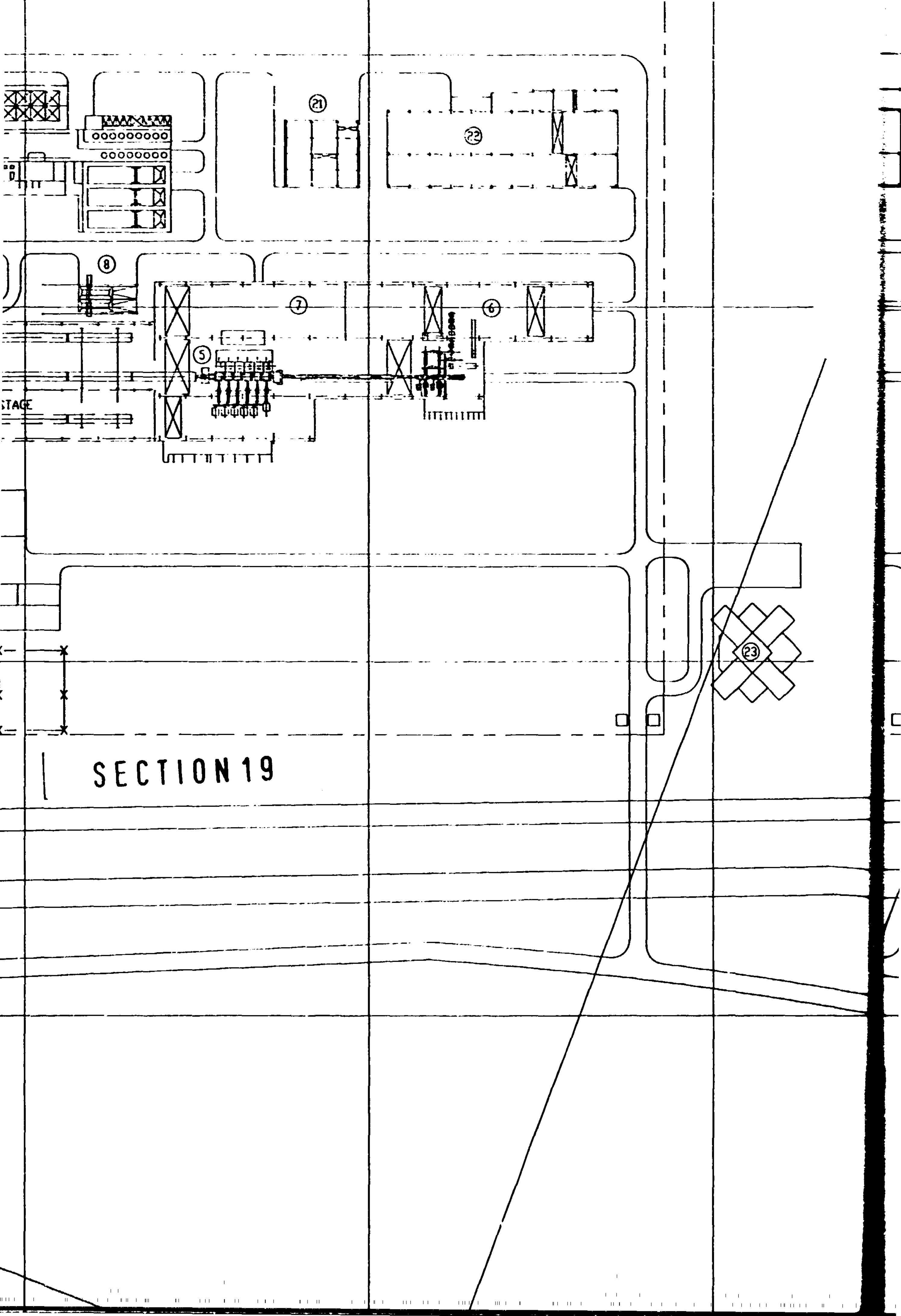
34
35
36
38 2nd STAGE
19
1
17
18
SECTION 17

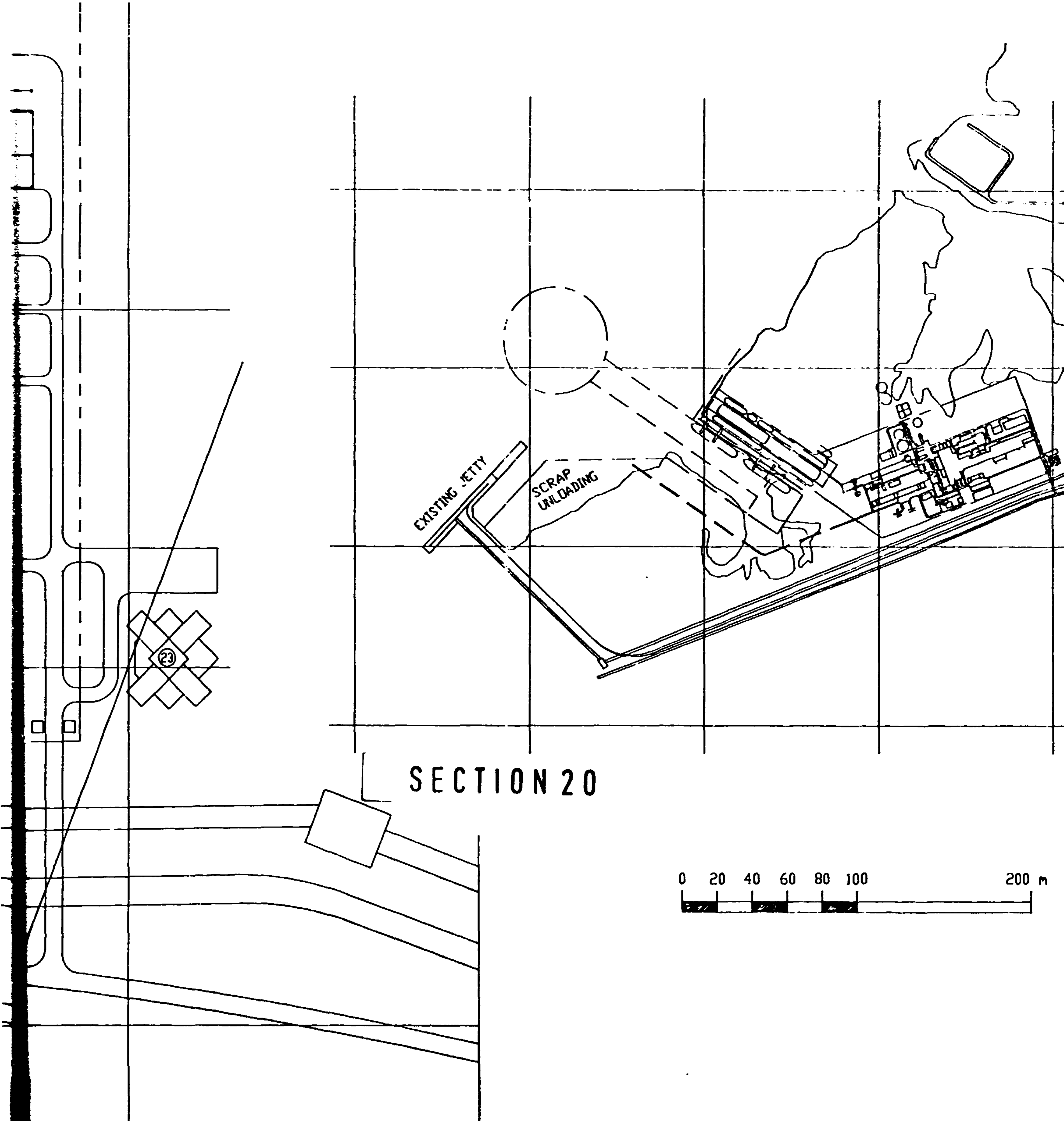


SECTION 18

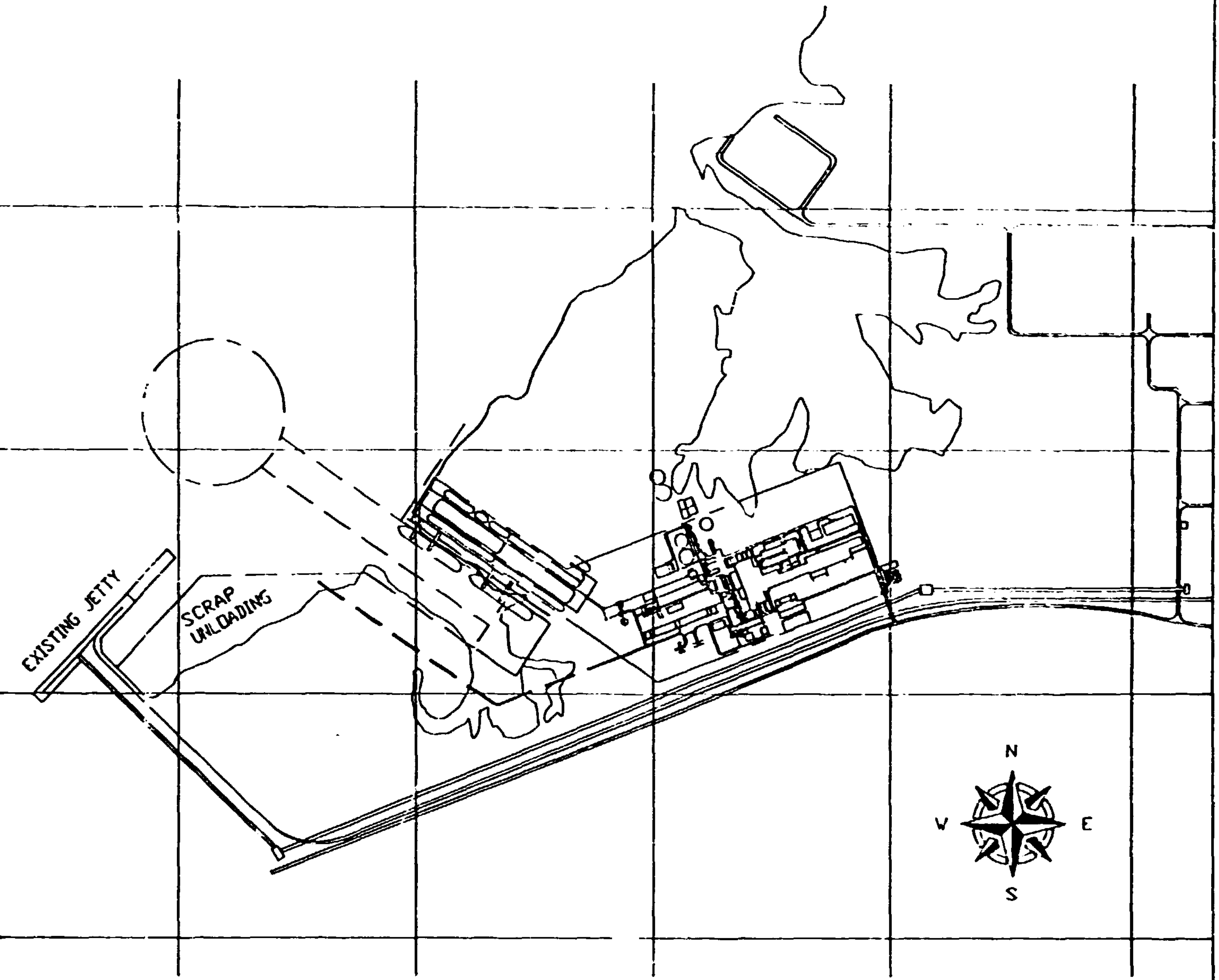


9
4
2nd STA
26
15


21
22
8
7
6
5
STAGE
23
SECTION 19



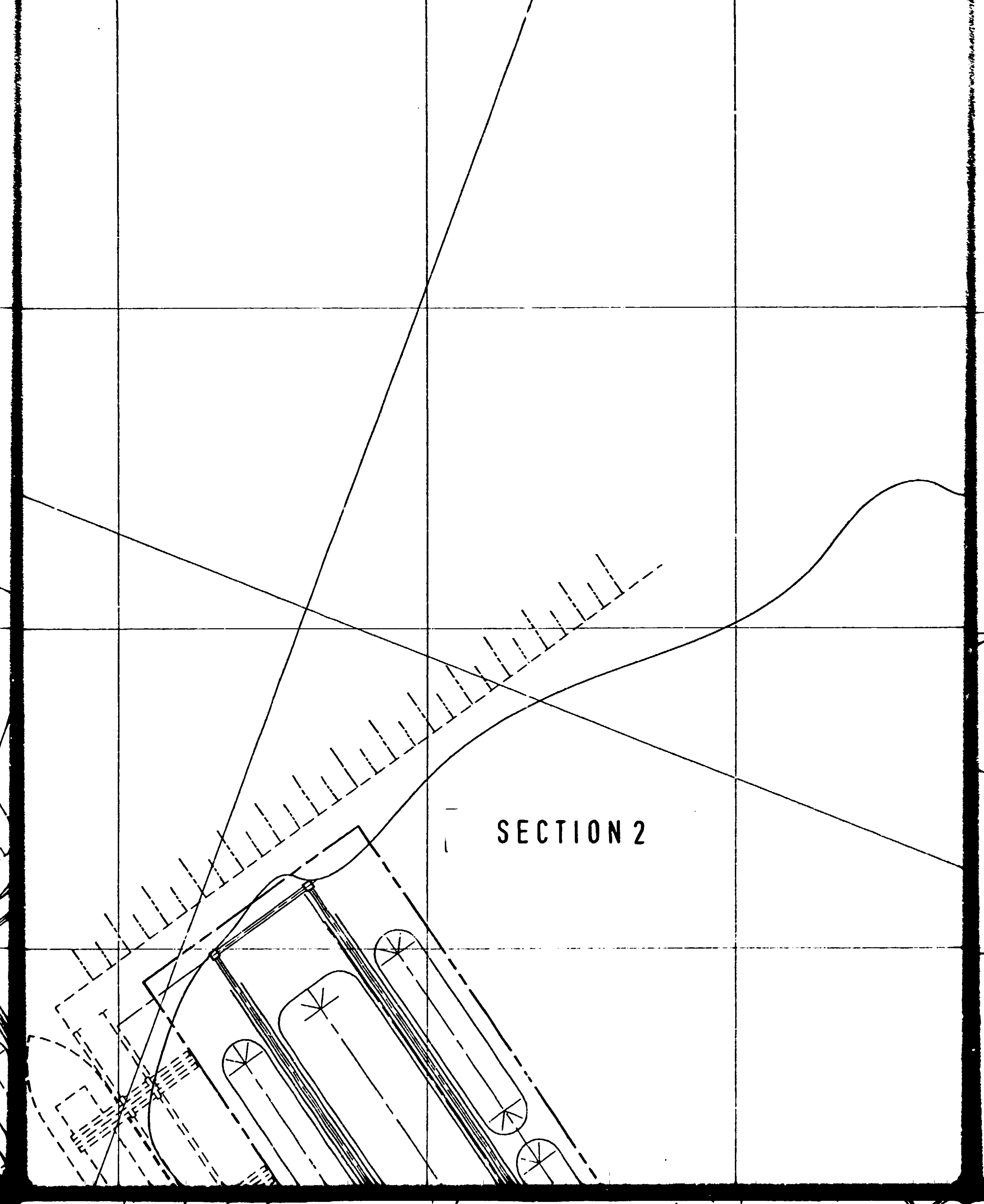
Änderung Revision	Anz. d. Änd. No. of Mod.	Änderungsinhalt Modification		
1993	Datum Date	Name Name		VAR. 2\2
Bearbeitet Made by	11-25	P.F.		COREX-LD-R
Geprüft Checked by			CAD	BS/RC/SL 2.35/CD
Benennung Title	PROJECT SGSM/INDONESIA			



SECTION 21

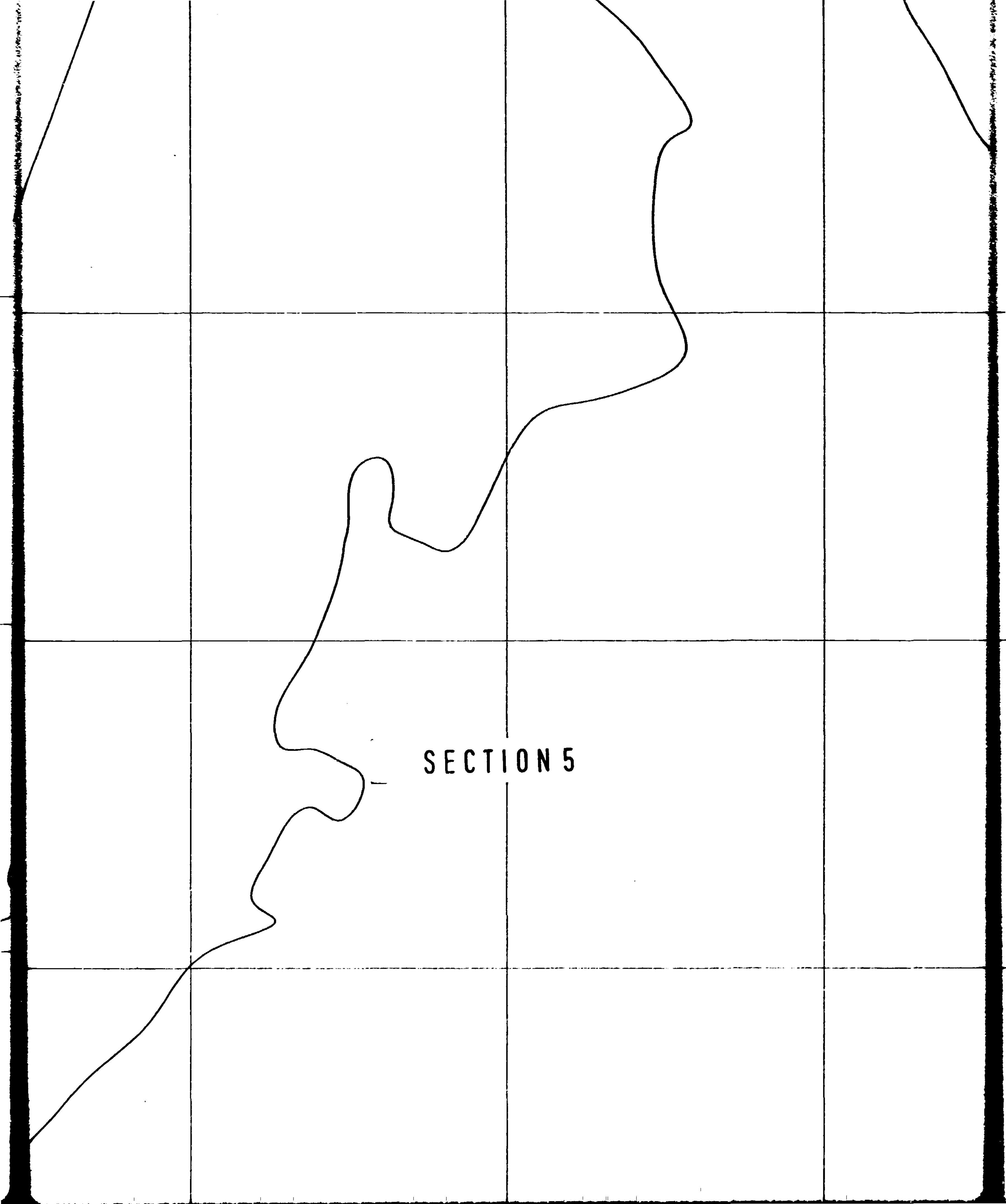
Änderung Revision	Anz. d. Änd. No. of Mod.	Änderungsinhalt Modification	Datum Date	Bearbeitet Made by	Geprüft Checked by

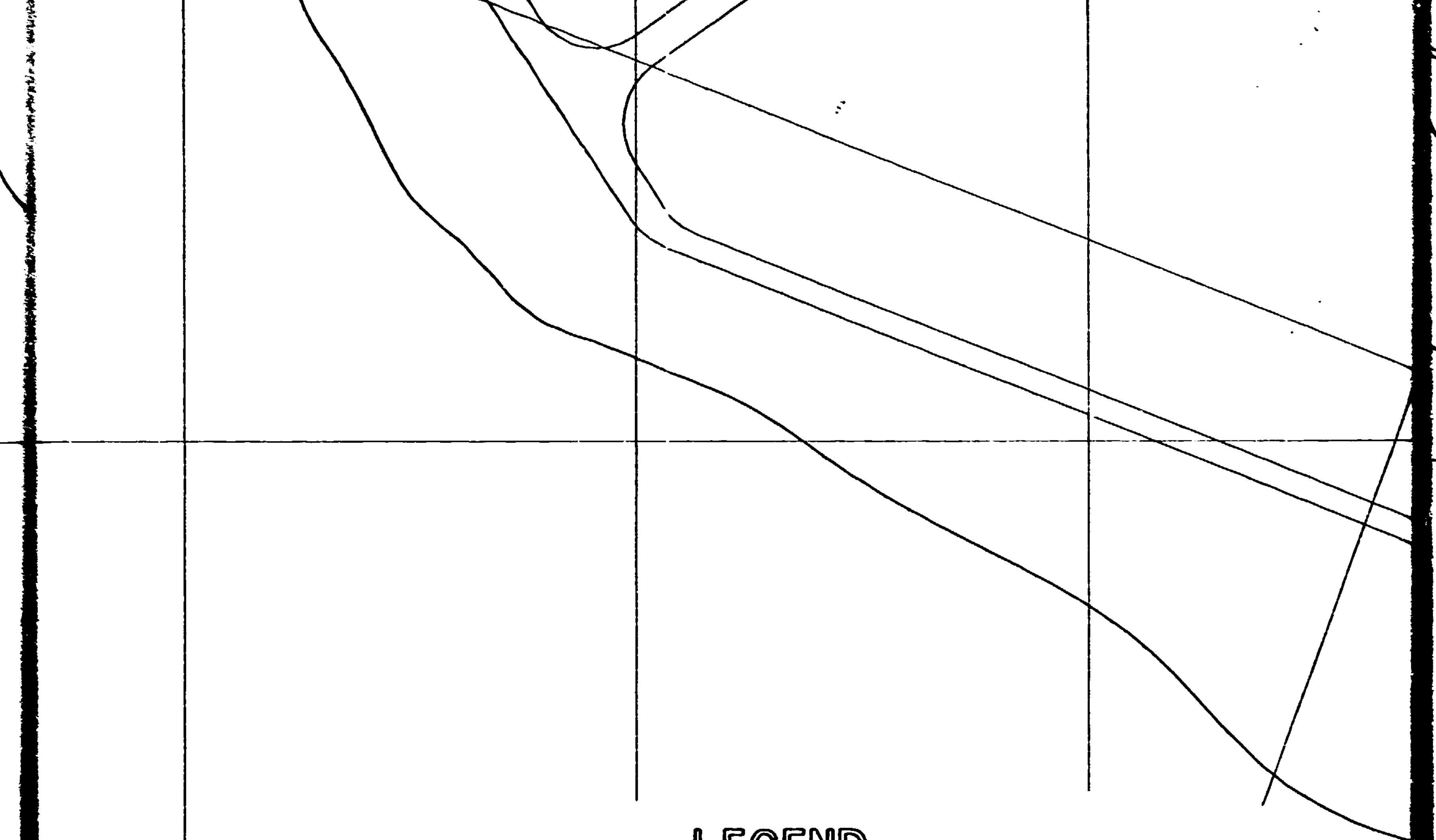
1993	Datum Date	Name Name	CAD	VAR. 2\2
Bearbeitet Made by	11-25	P.F.		COREX-LD-ROUTE
Geprüft Checked by				BS/RC/SL 2.35/CD/WT/IH


SECTION 2

SECTION 3

SECTION 4

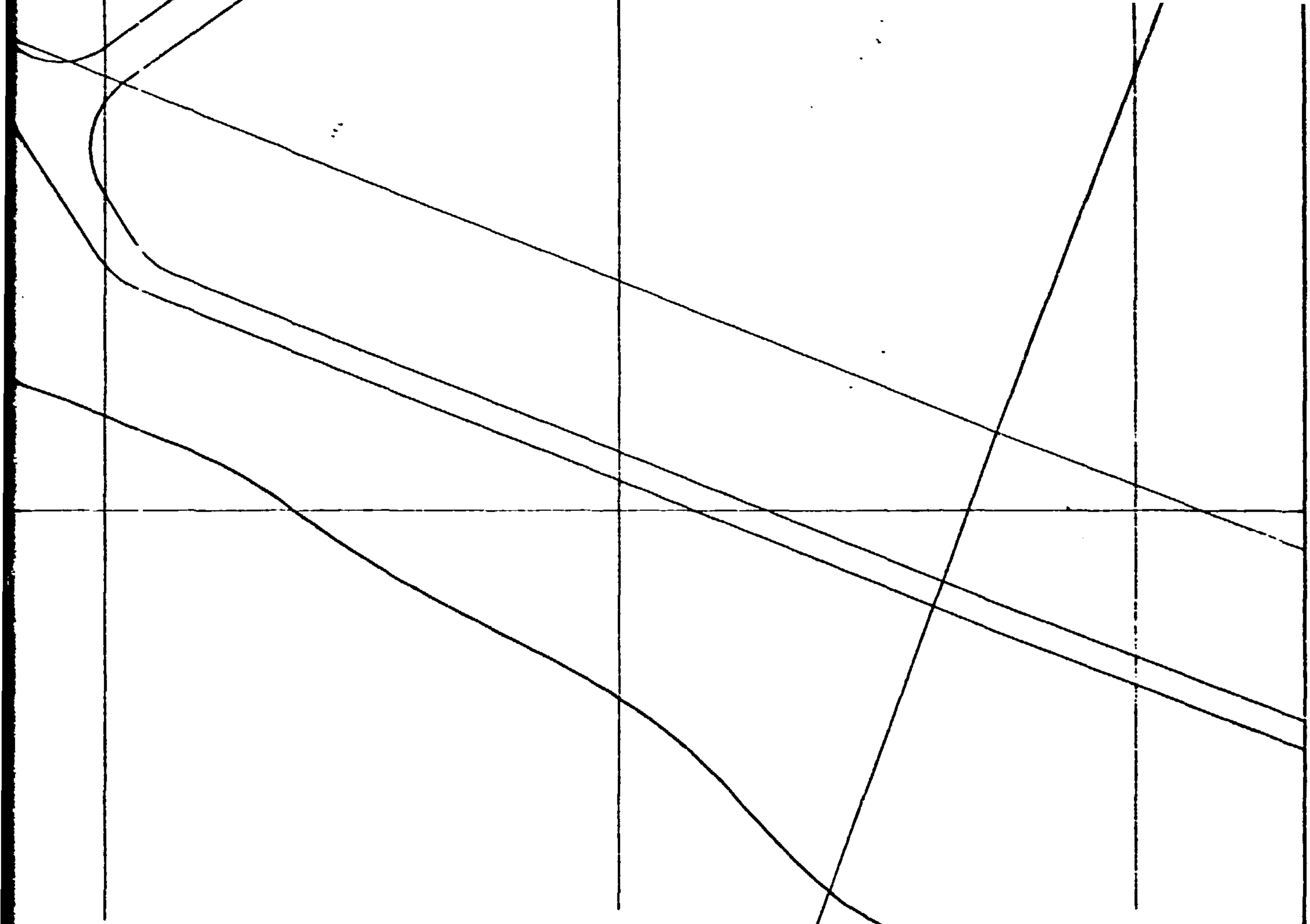

SECTION 5



LEGEND

1 SCRAP YARD
2 LD-STEEL PLANT
3 THIN SLAB CASTER
4 REHEATING FURNACE
5 HOT STRIP MILL
6 COIL STORAGE YARD
7 ROLL SHOP + MAINTENANCE
8 SCALE PIT
9 WATER TREATMENT PLANT FOR MELT SHOP &
10 DEDUSTING PLANT FOR STEEL MELT SHOP
11 LABORATORY
12 OXYGEN PLANT
13 LIME PLANT
14 RAW MATERIAL STORAGE YARD
15 ELECTRIC MAIN STATION
16 GAS HOLDER
17 SLAG CRUSHING & SCREENING PLANT
18 PIG CASTING MACHINE
19 LADLE SHOP, REFRACTORIES STORE
20 DESULPHURIZING STAND
21 CENTRAL STORE
22 CENTRAL MAINTENANCE

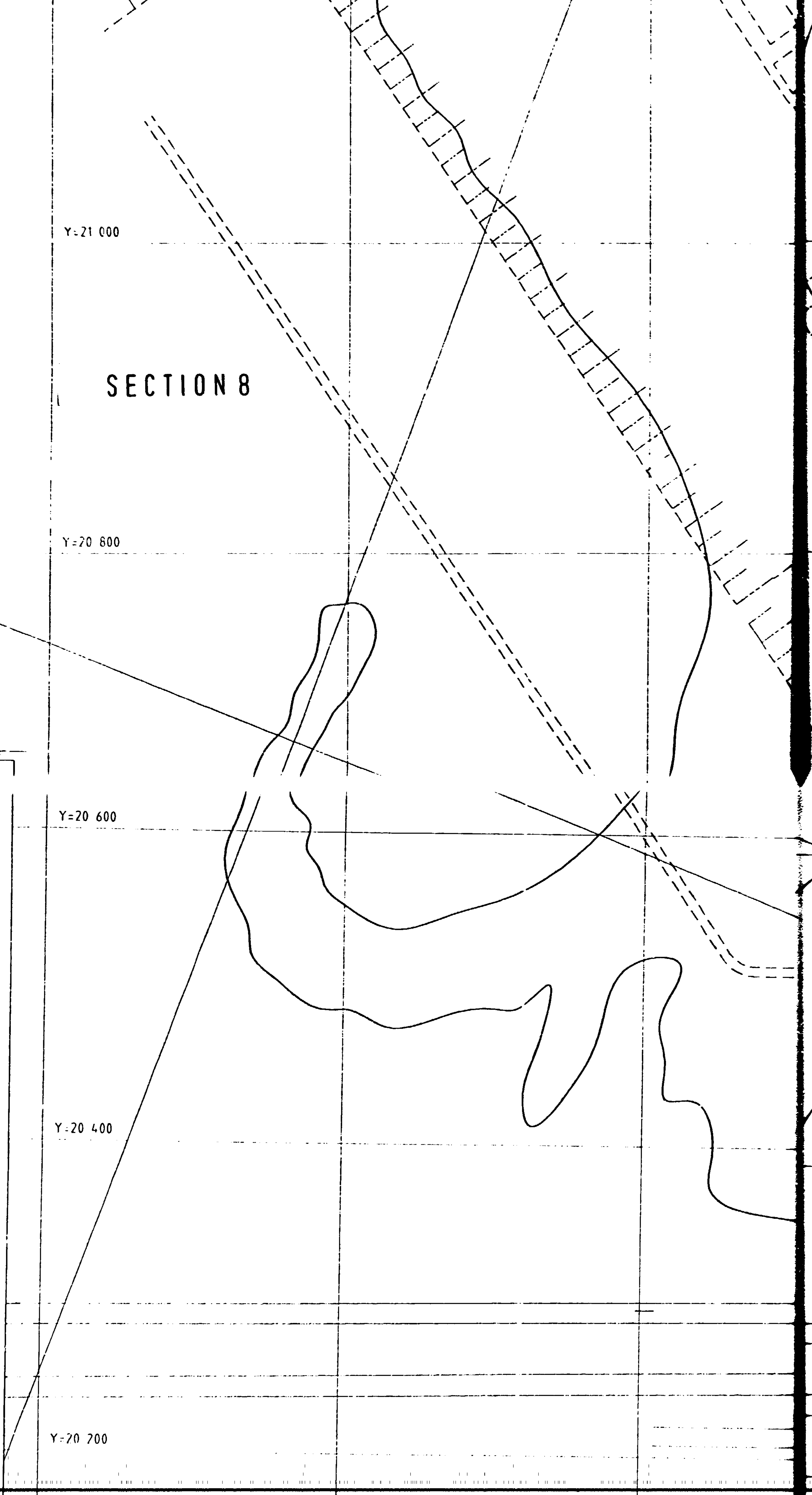
SECTION 6 (items 6–7)

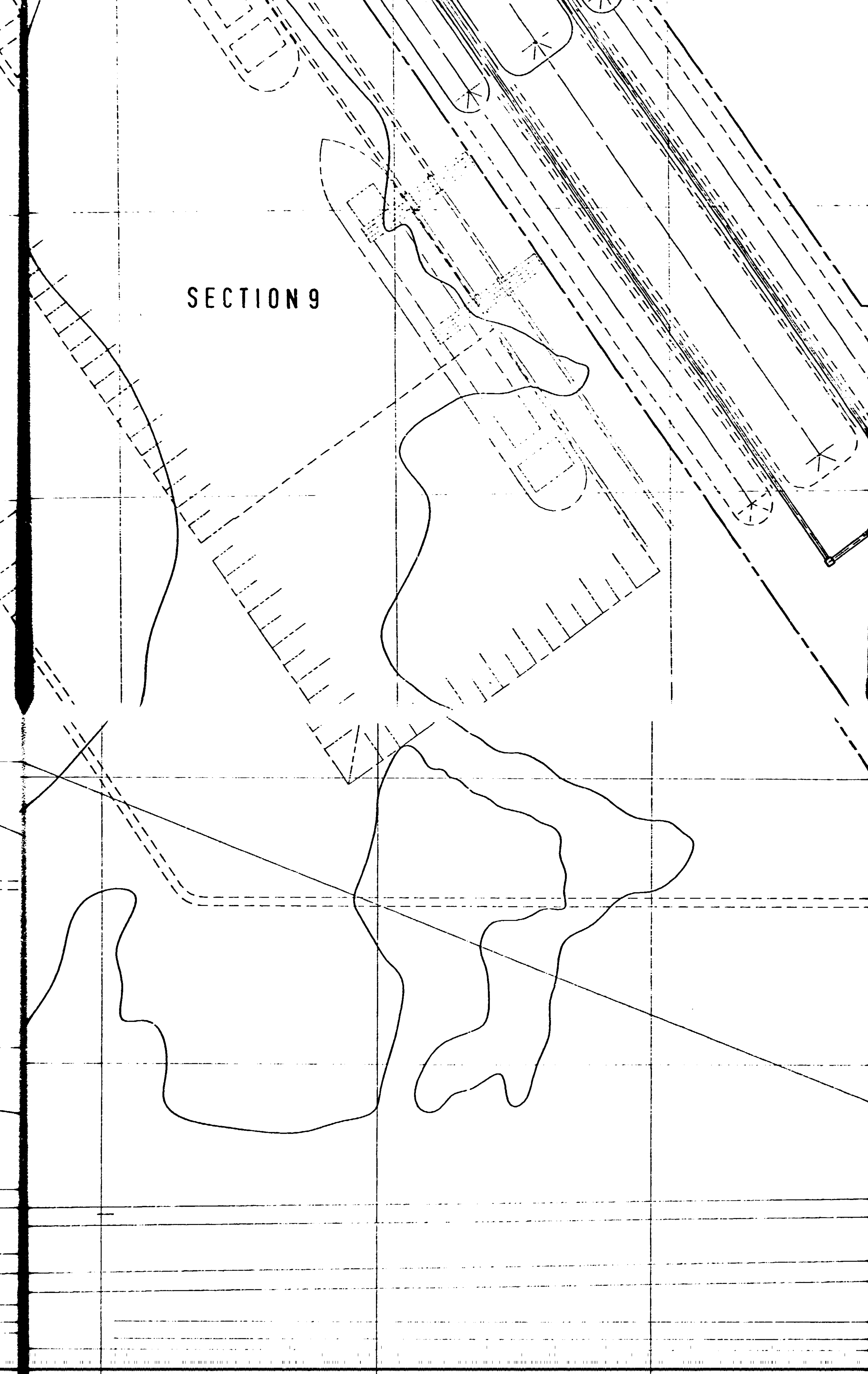


LEGEND

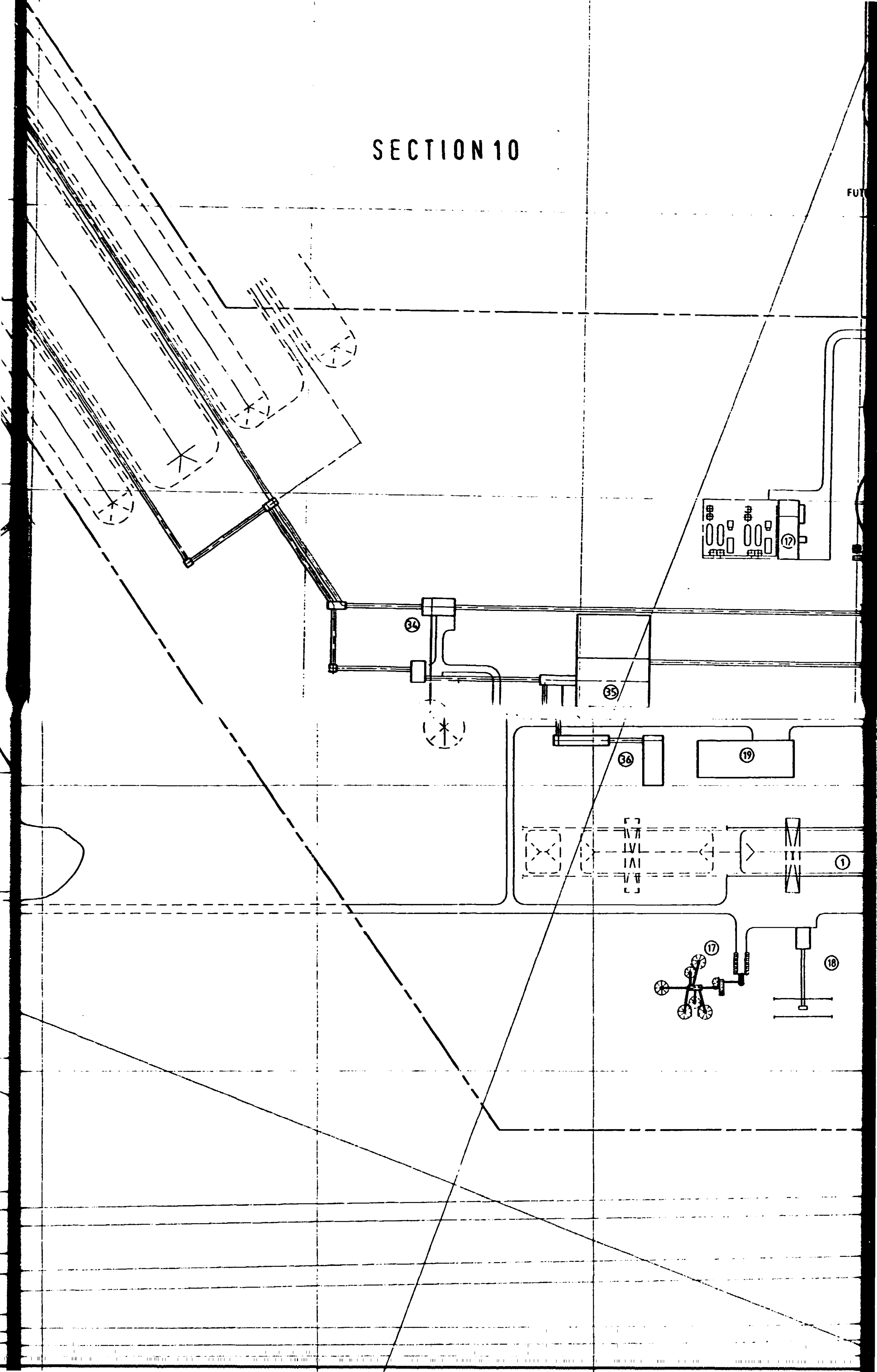
1 SCRAP YARD
2 LD-STEEL PLANT
3 THIN SLAB CASTER
4 REHEATING FURNACE
5 HOT STRIP MILL
6 COIL STORAGE YARD
7 ROLL SHOP + MAINTENANCE
8 SCALE PIT
9 WATER TREATMENT PLANT FOR MELT SHOP & CONROLL PLANT
10 DEDUSTING PLANT FOR STEEL MELT SHOP
11 LABORATORY
12 OXYGEN PLANT
13 LIME PLANT
14 RAW MATERIAL STORAGE YARD
15 ELECTRIC MAIN STATION
16 GAS HOLDER
17 SLAG CRUSHING & SCREENING PLANT
18 PIG CASTING MACHINE
19 LADLE SHOP, REFRACTORIES STORE
20 DESULPHURIZING STAND
21 CENTRAL STORE
22 CENTRAL MAINTENANCE

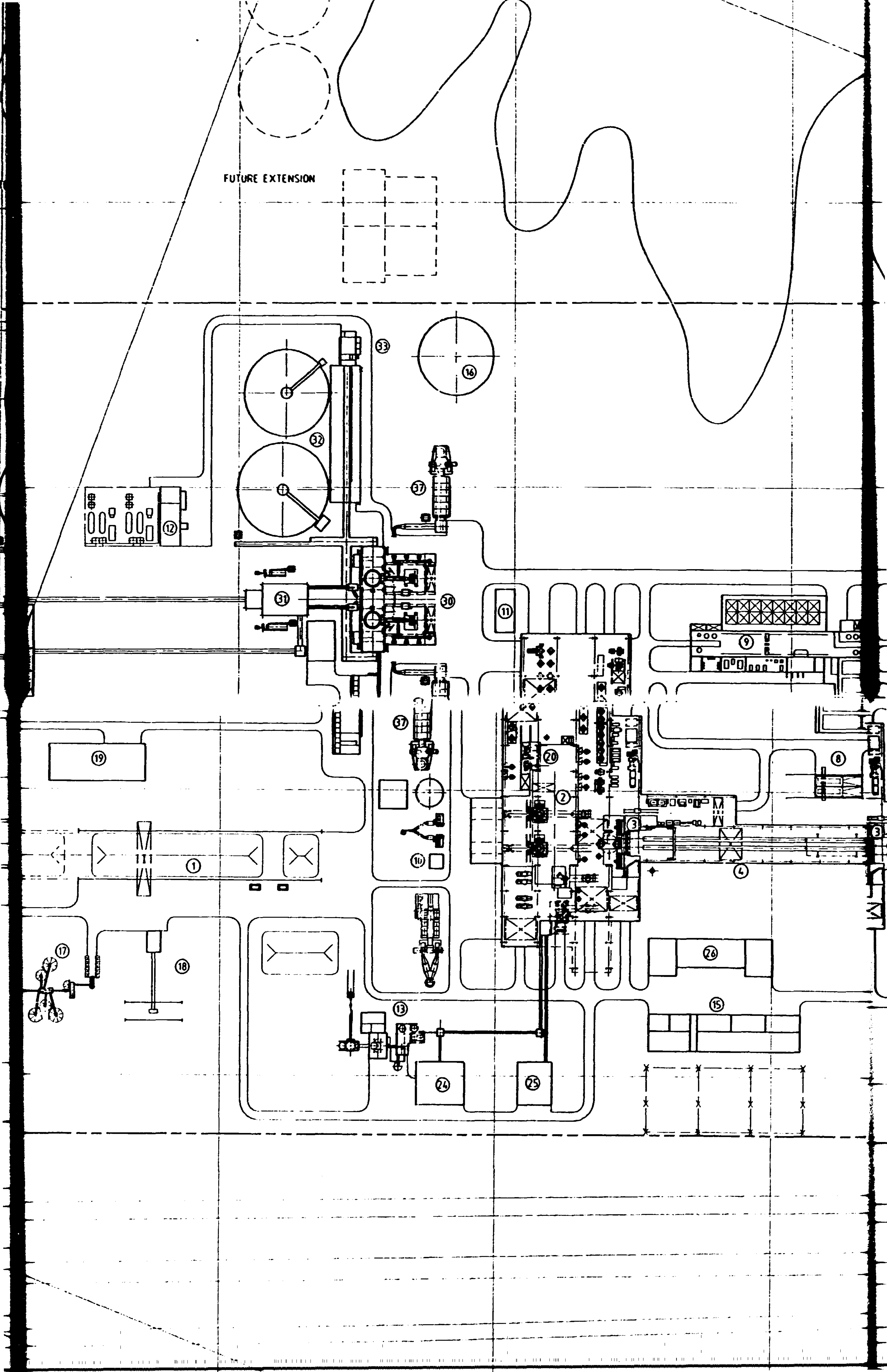
SECTION 7


SECTION 8
Y=21 000
Y=20 800
Y=20 600
Y=20 400
Y=20 200

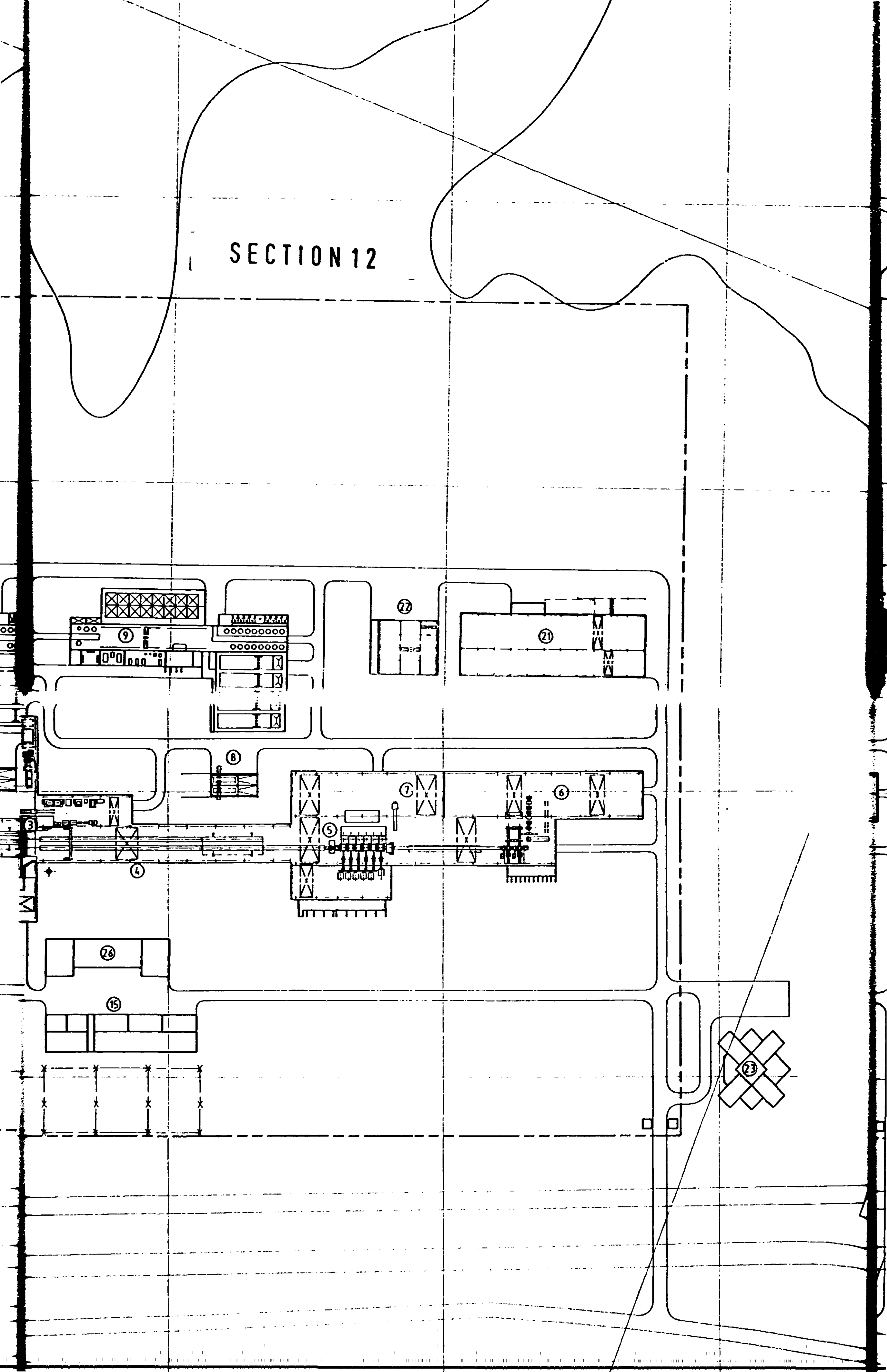

SECTION 9

SECTION 10



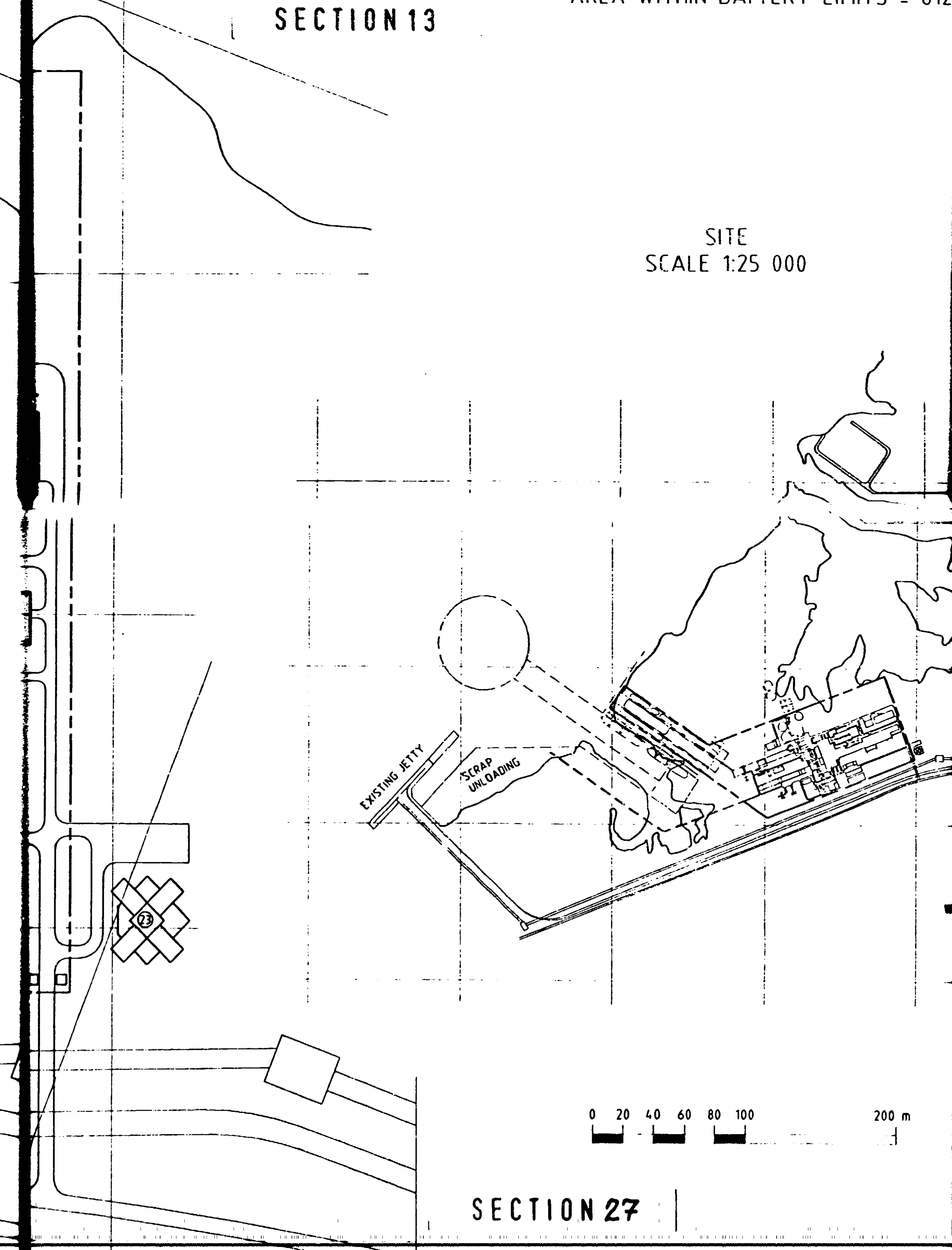


FUTURE EXTENSION
33
16
32
37
12
31
30
11
9
19
20
8
2
3
3
1
4
10
37
17
18
26
13
15
24
25


SECTION 12
9
22
21
8
7
6
5
3
4
26
15
23

33 CONTROL BUILDING
34 ORE SCREENING STATION
35 COAL DRYING PLANT
36 SLUDGE TREATMENT
37 DEDUSTING PLANT FOR COREX TWIN MODULE

BATTERY LIMITS
AREA WITHIN BATTERY LIMITS = 812

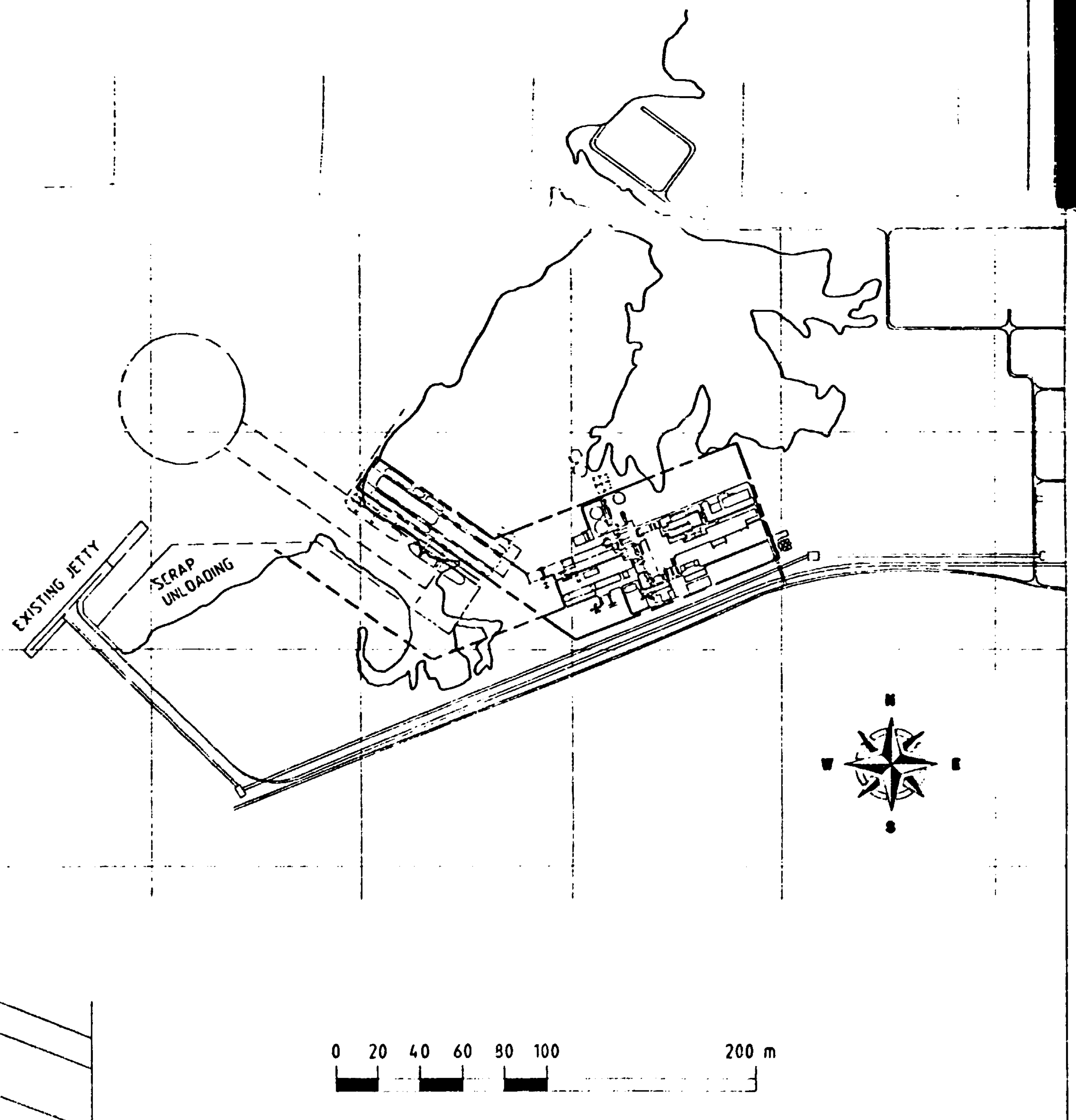


32 WATER TREATMENT PLANT COREX
33 CONTROL BUILDING
34 ORE SCREENING STATION
35 COAL DRYING PLANT
36 SLUDGE TREATMENT
37 DEDUSTING PLANT FOR COREX TWIN MODULE

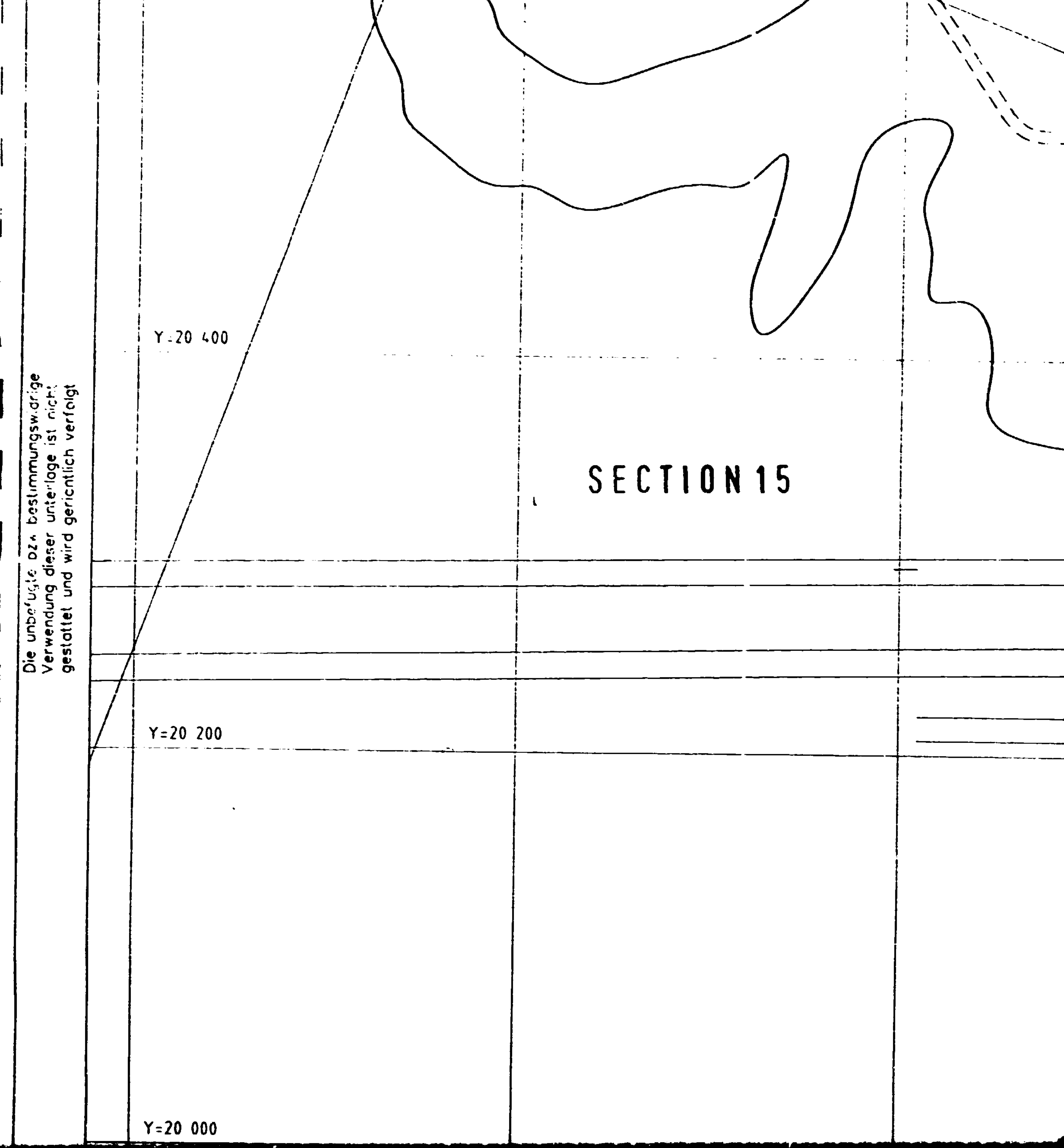
SECTION 14

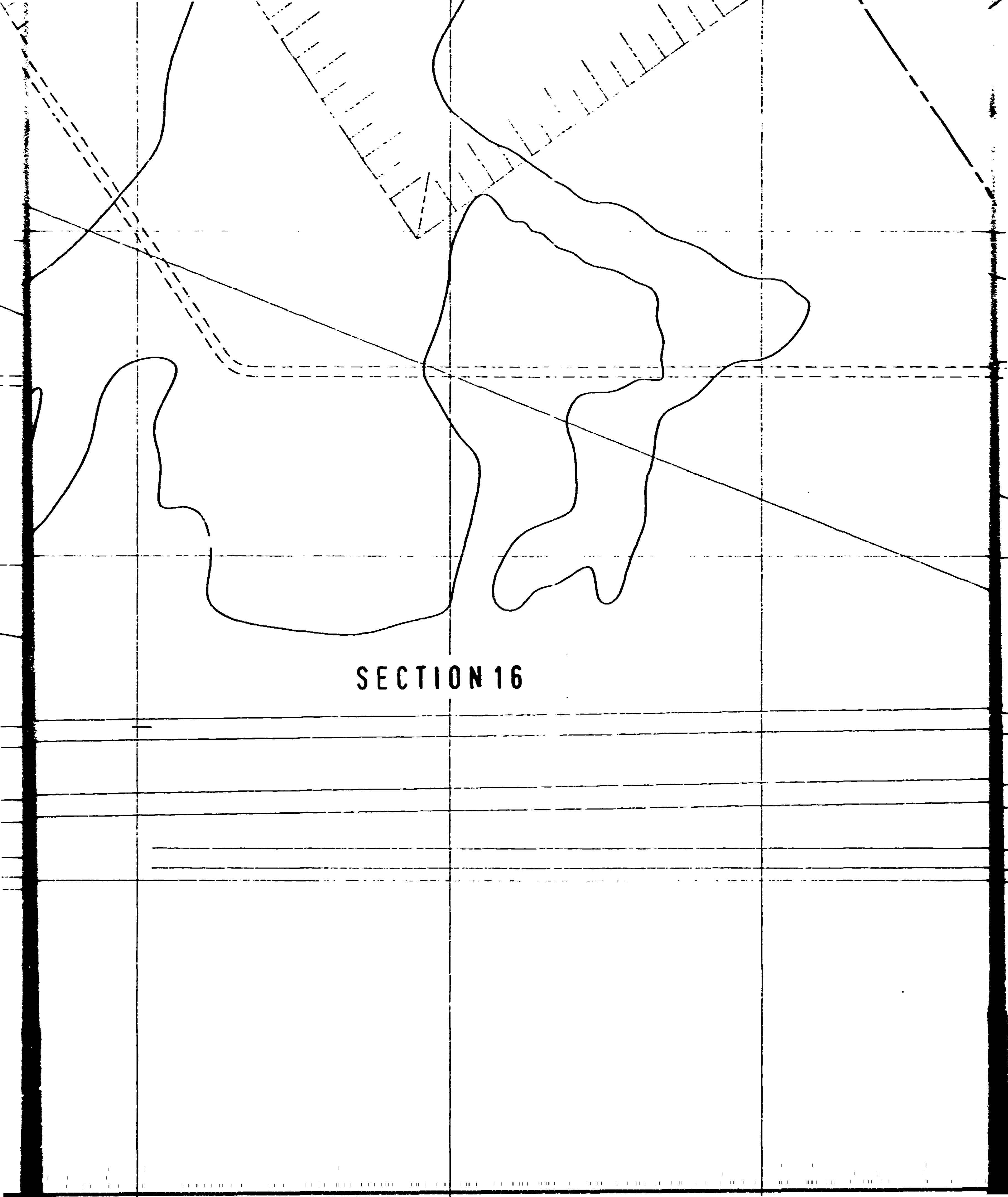
------ BATTERY LIMITS
AREA WITHIN BATTERY LIMITS = 812 000 m²

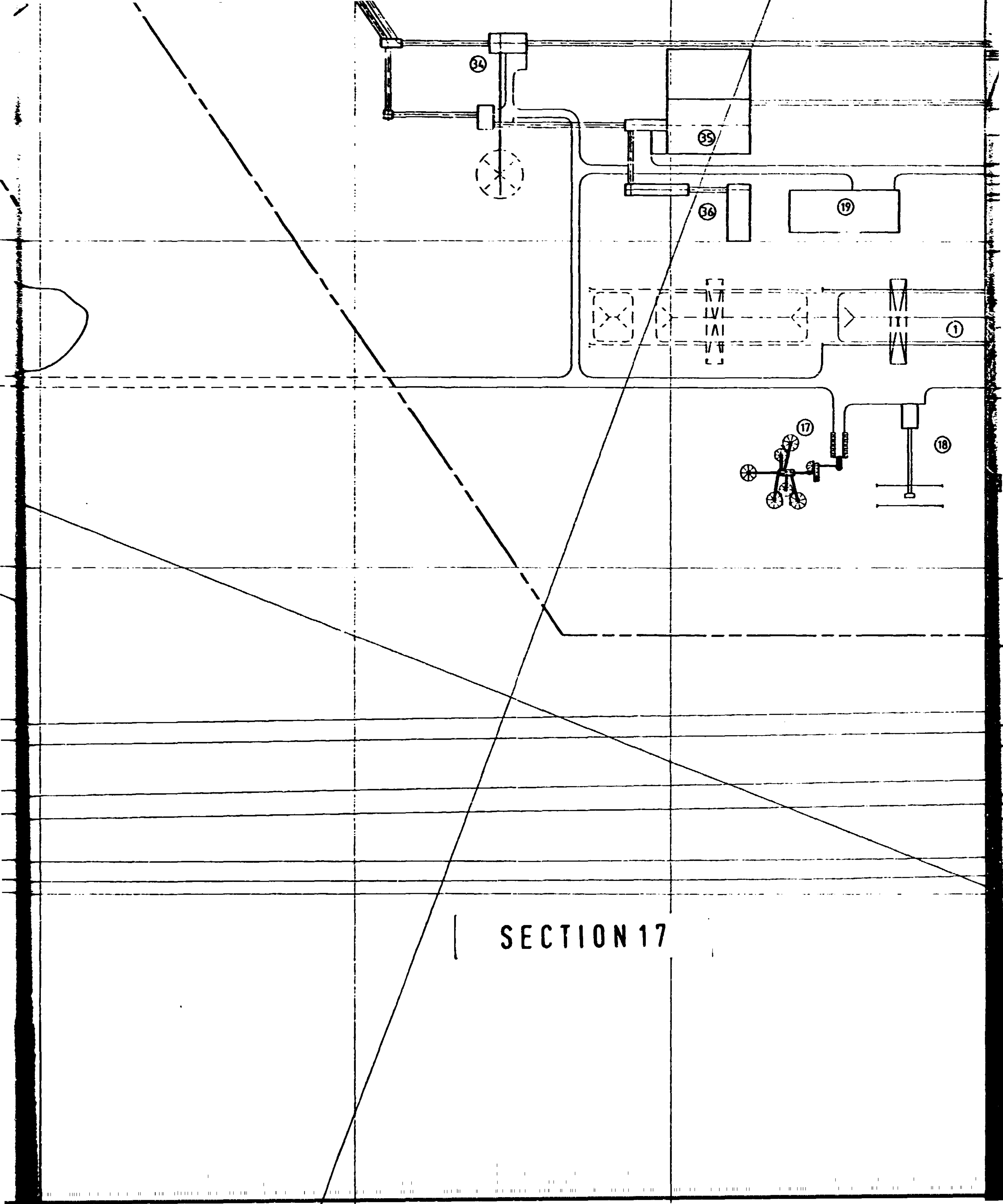
SITE
SCALE 1:25 000

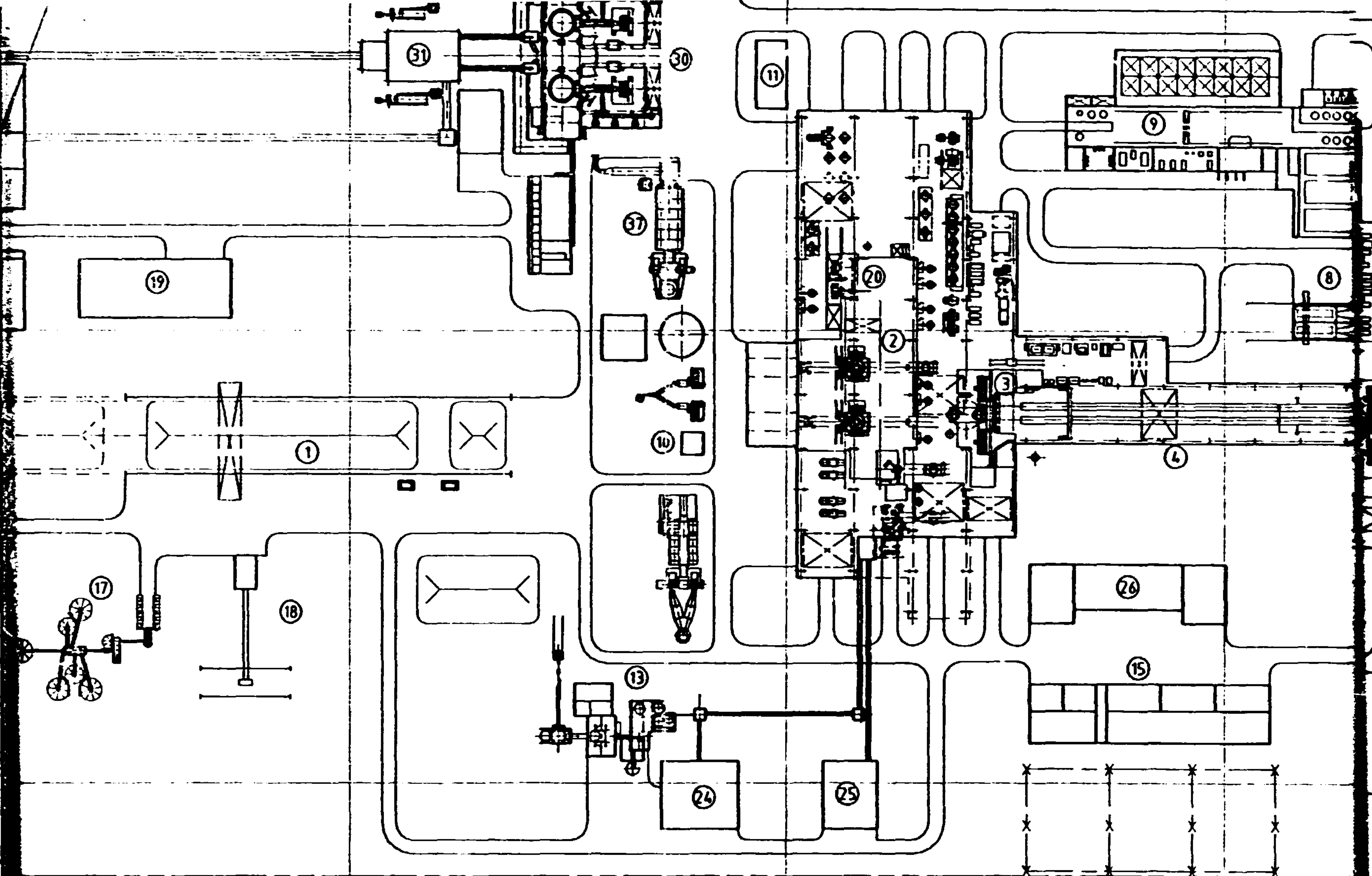


SECTION 28

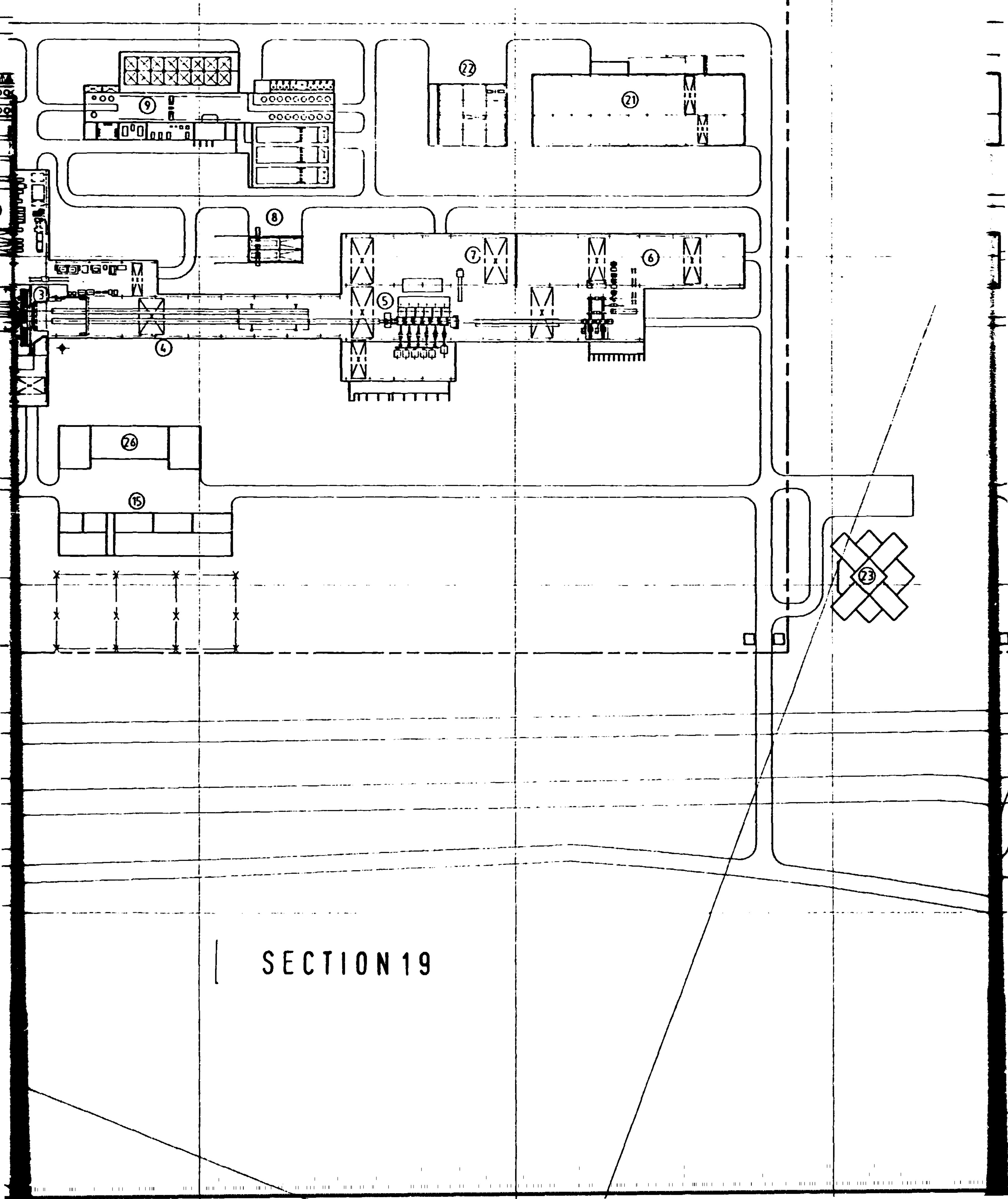

Die unbefugte bzw. bestimmungswidrige Verwendung dieser Unterlage ist nicht gestattet und wird gerichtlich verfolgt
Y=20 400
SECTION 15
Y=20 200
Y=20 000

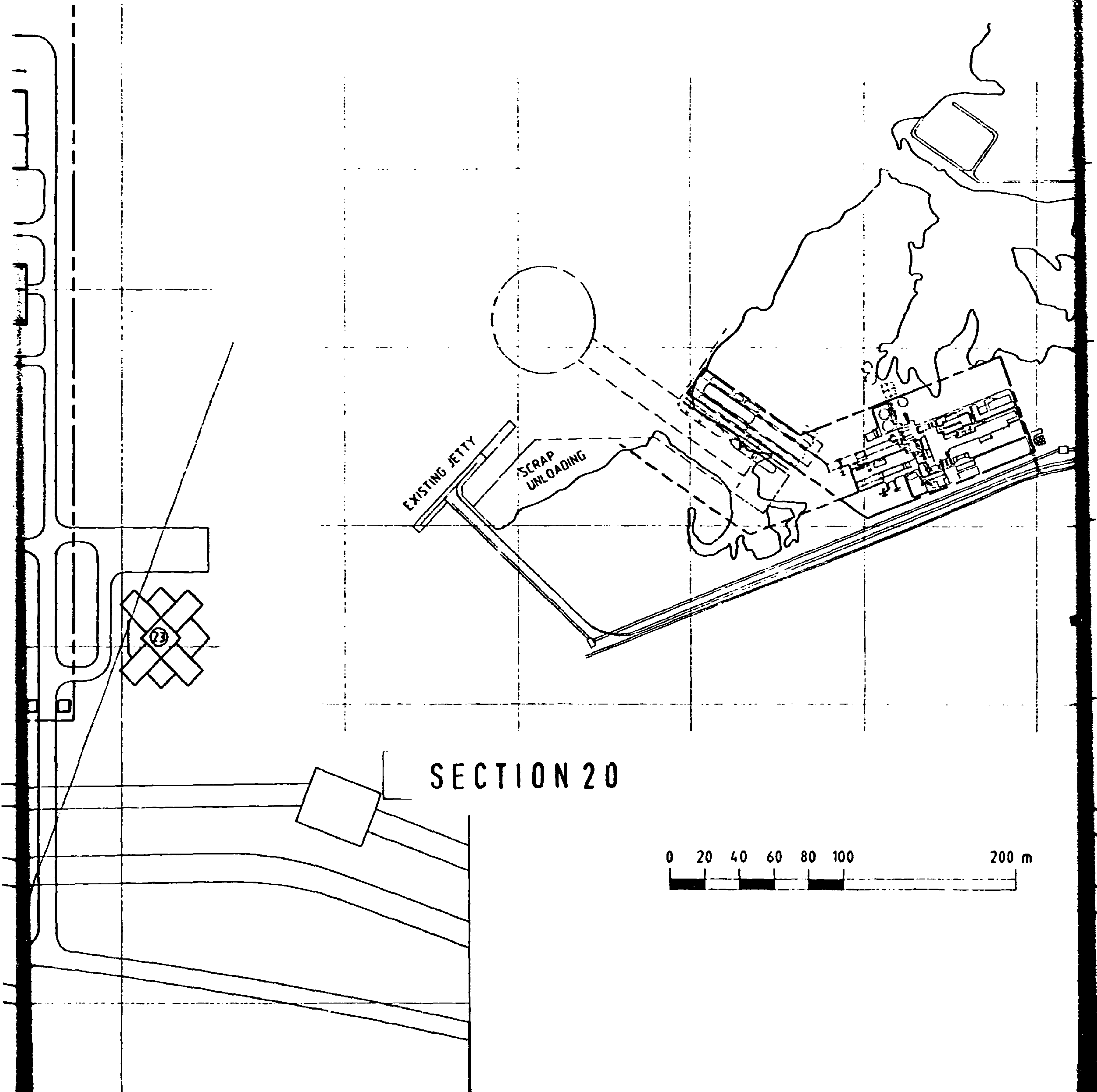

SECTION 16


34
35
36
19
1
17
18
SECTION 17



SECTION 18


22
21
9
8
7
6
5
3
4
26
15
23
SECTION 19

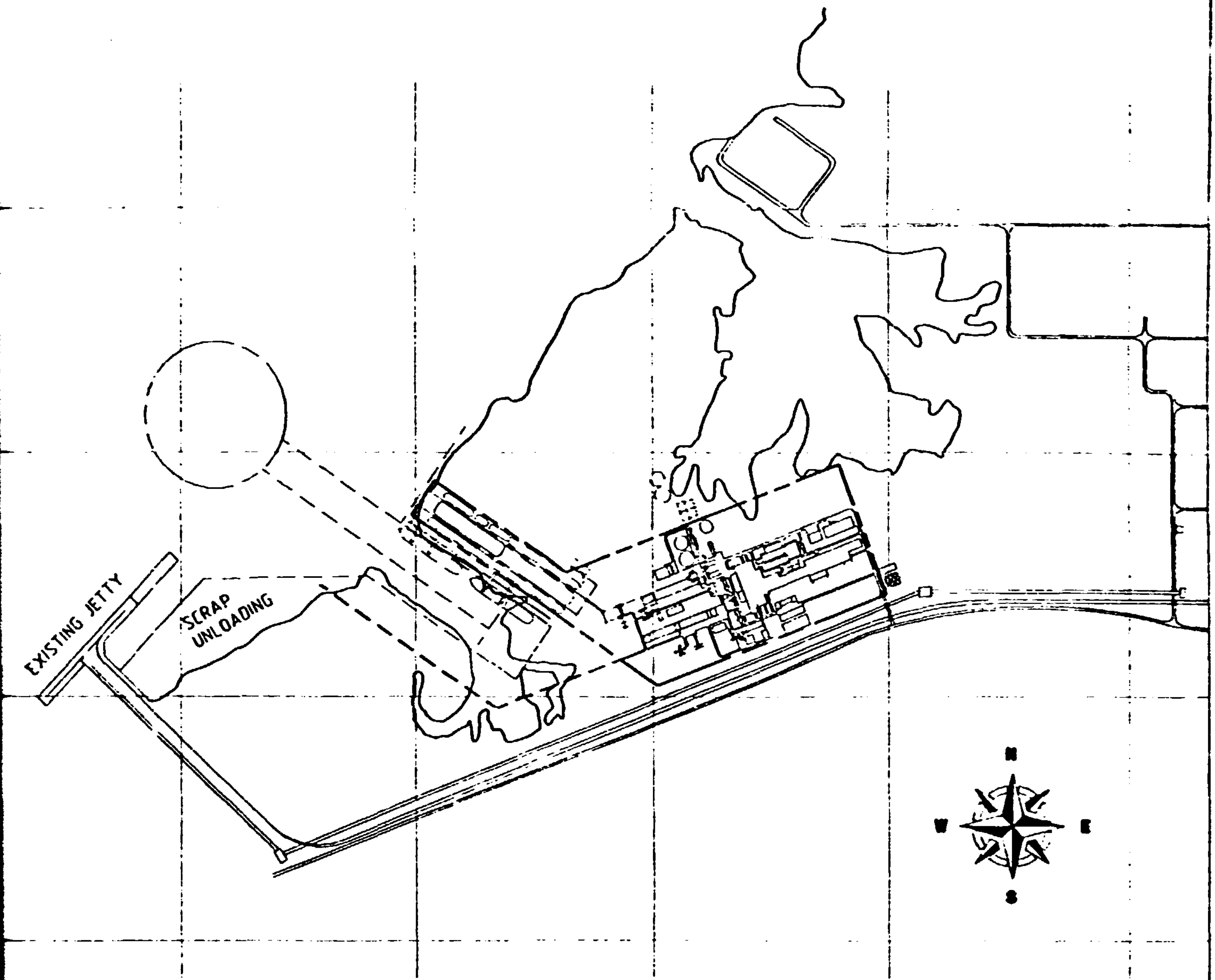


Änderung Revision	Anz. d. Änd. No. of Mod.	Änderungsinhalt Modification	Datum Date
0		GENERAL REVISION	08-

	Datum Date	Name Name		
1993				
Bearbeitet Made by	04-13	AUER		COREX-LD-RO
Geprüft Checked by			CAD	BS/RC/SL/CD/WT/IH

Benennung Title PROJECT SGSM/INDONESIA

Maßstab Scale



SECTION 21

0 20 40 60 80 100 200 m

0		GENERAL REVISION	08-18	AUER	
Änderung Revision	Anz. d. Änd. No. of Mod.	Änderungsinhalt Modification	Datum Date	Bearbeitet Made by	Geprüft Checked by

1993	Datum Date	Name Name		
Bearbeitet Made by	04-13	AUER		COREX-LD-ROUTE
Geprüft Checked by			CAD	BS/RC/SL/CD/WT/IH/155

UNIDO

8. PROJECT IMPLEMENTATION SCHEDULE AND BUDGETING

The detailed implementation programme proposed for the realization of the project is shown in Fig. 26.

Also attached in Table 32 is the capital expenditures during implementation. Please note that considerable savings may be achieved timewise, if the project is contracted out as turnkey implementation. The current proposal is based on process key contracting with global sourcing.

Some of the main assumptions made in drawing up the programme are that:

(a) Key personnel and resources would be available to start work
(b) All enquiries would be issued within the anticipated dates and the number of contracts would be kept to a minimum
(c) Enquiry documents would ensure that information received in offers would enable foundation and building drawing arrangements to be commenced without delay.
(d) Design would be staged so that construction could commence before final design is completed.

According to the programme, various executive activities, such as purchase of machinery and equipment, construction, buildings and other civil works, personnel recruitment and personnel training, delivery of machinery and equipment, and erection of machinery and equipment are planned to be undertaken according to a phased programme in order to achieve the best economic way of realizing the project.

To a considerable degree, delivery-schedules will depend on the location and identity of the manufacturers and other suppliers from which the machinery and equipment will be procured, based on global sourcing.

Fig. 26: **Implementation Schedule**

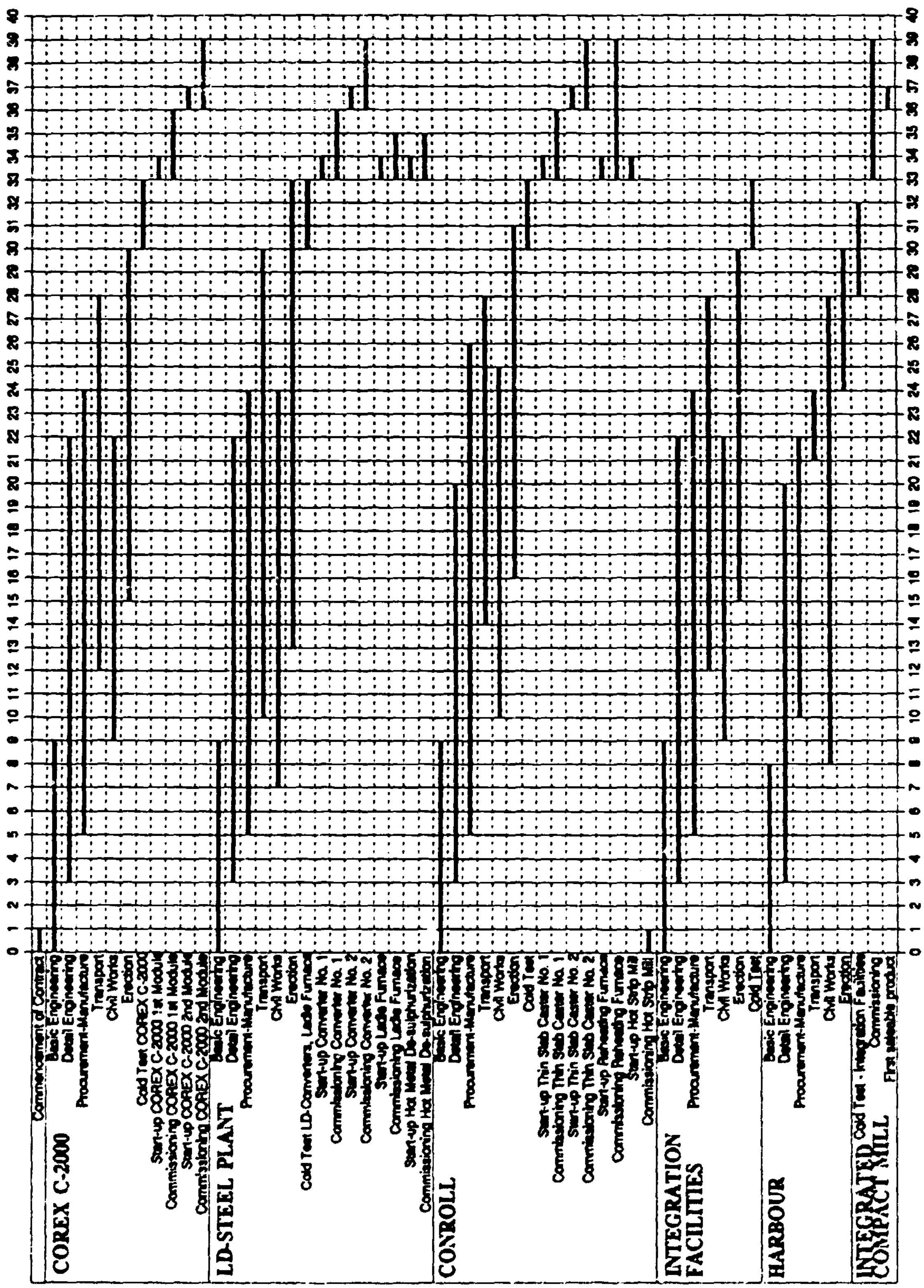


Table 32: Implementation Budgeting

	Half years							
Input Table	1	2	3	4	5	6	7	Total
Land								0
Site preparation and development								0
Structures and civil (a)		3,47	13,86	13,86	3,47			34,66
Structures and civil (b)								0
Incorporated fixed assets, constructio		2,57	7,71	10,28	12,86	12,86	5,14	51,42
Incorporated fixed assets, technology,	0,75	1,25	1,00	0,75	0,75	0,25	0,25	5
Incorporated fixed assets, other (c)		0,50	2,00	2,50	2,50	1,50	1,00	10
Plant machinery and equipment (a)		31,63	126,50	158,13	158,13	94,88	63,25	632,5
Plant machinery and equipment (b)						7,92	7,92	15,83
Auxiliary and service facilities		7,04	28,15	35,19	35,19	21,11	14,08	140,75
Pre-production expenditures	0,60	0,93	0,34	0,55	1,87	7,30	8,66	20,25
Inventory, working capital							11,21	11,21
TOTAL foreign	1,35	47,39	179,56	221,26	214,77	145,82	111,51	921,66
Land	10,00							10
Site preparation and development	4,16							4,16
Structures and civil (a)		23,58	94,33	94,33	23,58			235,83
Structures and civil (b)		12,50	50,00	50,00	12,50			125
Incorporated fixed assets, constructio		6,21	18,63	24,83	31,04	31,04	12,42	124,17
Incorporated fixed assets, technology,	0,06	0,11	0,08	0,06	0,06	0,02	0,02	0,42
Incorporated fixed assets, other (c)		0,13	0,50	0,63	0,63	0,38	0,25	2,5
Plant machinery and equipment (a)		5,93	23,70	29,63	29,63	17,78	11,85	118,5
Plant machinery and equipment (b)						0,42	0,42	0,83
Auxiliary and service facilities		0,40	1,58	1,98	1,98	1,19	0,79	7,92
Pre-production expenditures	0,60	0,93	0,34	1,87	1,87	7,30	8,66	21,57
Inventory, working capital							10,00	10,00
TOTAL local	14,82	49,79	189,16	203,33	101,29	58,13	44,41	660,93
GRAND TOTAL	16,17	97, 18	368,72	424,59	316,06	203,95	155,92	1.582,59

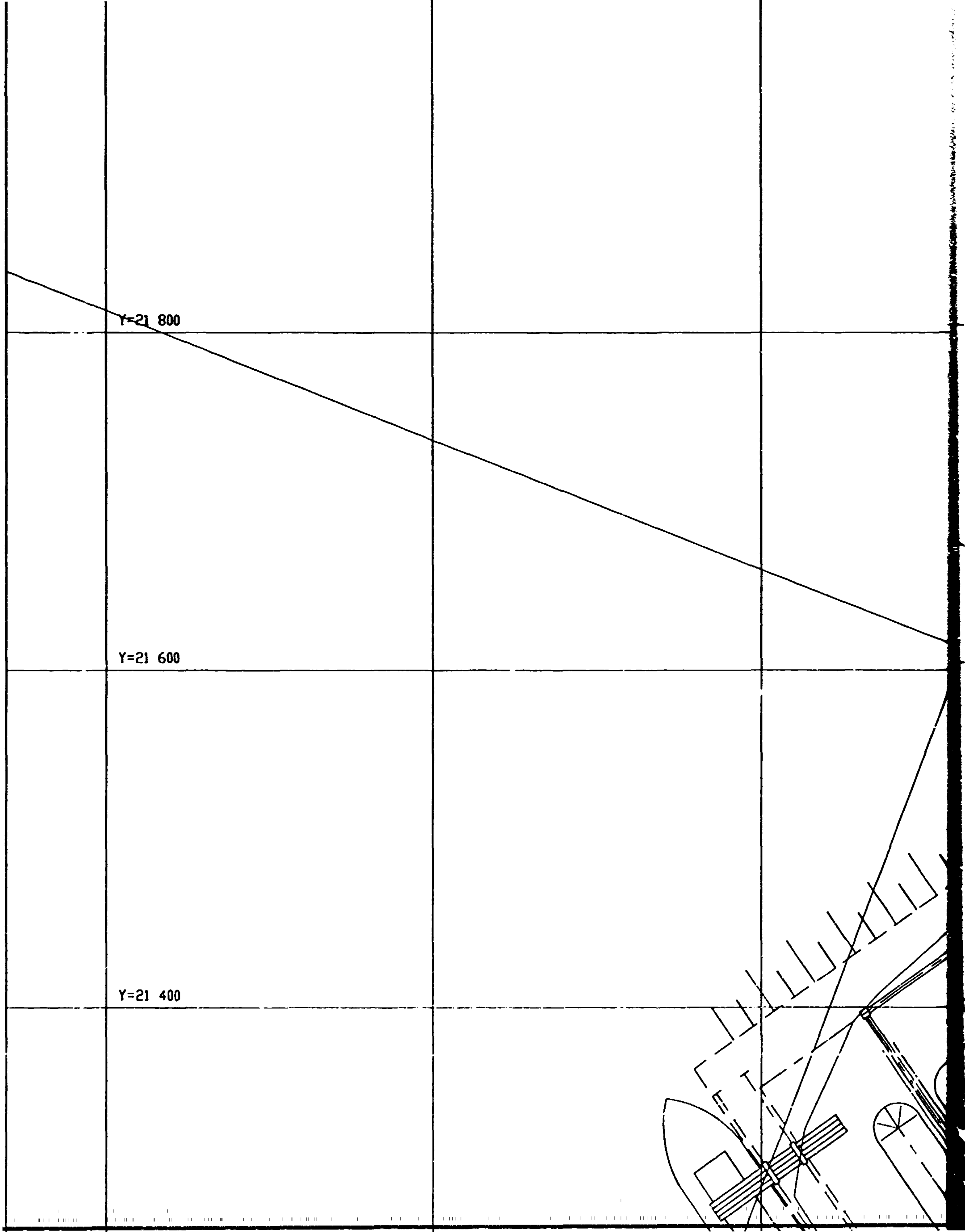
	RC COREX PLANT	SL LD - PLANT	CD CONT CASTING THIN SLABS	WT THIN SLAB MILL	IH INTEGRATION FACILITIES	SUB-SERIES
						00
						01
						02
						03
						04
						05
						06
						07
						08
						09
	RAW MAT.HANDL. & BURDEN SYST.	**RAW & CHARGING MAT. TREATMENT**		**CHARG.TREATM. & REHEATING FURN.**	**RAW MAT. HANDLING & TREATMENT**	
						10
		SCRAP HANDLING			RAW MATERIAL UNLOADING	11
	OXYD HANDLING	ALLOY HANDLING SYSTEM			RAW MATERIAL STORAGE YARD	12
	COAL HANDLING	ADDITIVE HANDLING			RAW MATERIAL HANDLING	13
	ADDITIVE HANDLING				SCRAP HANDLING & TREATMENT	14
	CIRCULATING MATERIAL HANDLING	HOT METAL HANDLING		REHEATING FURNACE		15
	BURDEN SYSTEM	HOT METAL TREATMENT				16
						17
	LADLE HANDLING	LADLE HANDLING				18
	DEDUSTING SYSTEM	DEDUSTING SYSTEM				19
	RED. SHAFT & MELTER GASIFIER	**BLOWING OPERATION**	**THIN SLAB CASTING MACHINE**	**ROLLING FACILITIES**		
				AUXILIARY EQUIPMENT		20
	FURNACE CHARGING SYSTEM	CONVERTER CHARGING SYSTEM	LADLE EQUIPM. & EMERG CASTING			21
	REDUCTION SHAFT	CONVERTER	TUNDISH FACILITIES			22
	MELTER GASIFIER & FACILITIES	LANCE BLOWING DEVICE	ADDITIONAL EQUIPMENT			23
		AUXILIARY EQUIPMENT	SUPPORTING STR & COOLING CHAMBER	FINISHING MILL		24
	PROCESS GAS SYSTEM	WASTE GAS COOLING & CLEANING	MOLD & OSCILLATING FACILITIES			25
		LADLE ALLOY./ADDITIVE SYSTEM	STRAND GUIDE & WITHDRAWAL UNIT			26
		LIQUID STEEL HANDLING	DUMMY BAR & CUTTING FACILITIES	STRIP COOLING		27
	TAPPING EQUIPMENT		RUN-OUT FACILITIES	DOWN COILER		28
	GAS CLEANING & DEDUSTING SYST.	DEDUSTING SYSTEM		COIL CONVEYING SYSTEM		29
D	**HOT METAL HANDLING**	**SECONDARY METALLURGY**		**STRIP ADJUSTAGE & INSP.**	**SITE/TEMPORARY FACILITIES**	
						30
	HOT METAL HANDLING	ALLOYING SEC. METALLURGICAL FAC.			PLANT/SITE AREA	31
		LADLE STIRRING/BUBBLING/INJECTION		STRIP INSPECTION LINE		32
		LADLE FURNACE			CAMP/CATERING	33
		AUXILIARY EQUIPMENT			CONSTRUCTION/SITE INSTALLATION	34
						35
					CONSTRUCT.BUILDG./SITE OFFICE	36
					TEMPORARY TRANSPORT FACILITIES	37
				PRODUCT STORE & DISPATCH	CONSTRUCTION UTILITIES	38
	DEDUSTING SYSTEM	DEDUSTING SYSTEM			CONSTRUCTION POWER	39
	SLAG HANDLING & RECYCLING	**SLAG TR. & RECYCL. FACILITIES**			**PERIPHERAL FACILITIES**	
						40
						41
						42
						43
						44
	SLUDGE RECYCLING	WASTE GAS RECYCLING				45
	DUST RECOVERY	DUST RECOVERY			AIR SEPARATION PLANT	46
						47
					SLAG HANDLING & TREATMENT	48
	SLAG HANDLING & TREATMENT	SLAG HANDLING			SCALE HANDLING & TREATMENT	49
	MAINTENANCE & STORE	**MAINTENANCE & STORE**	**MAINTENANCE & STORE**	**MAINTENANCE & STORE**	**MAINTENANCE & STORE**	
						50
		LANCE REPAIR SHOP	MACHINE MAINTENANCE	ROLL SHOP	CENTRAL MAINTENANCE (MECHANIC)	51
			TUNDISH RELINING		CENTRAL MAINTENANCE (ELECTRIC)	52
	MAINTENANCE POST	MAINTENANCE POST		MAINTENANCE POST	MAINTENANCE RAILWAY/VEHICLES	53
			SPARE PARTS DEPOT	SPARE PARTS DEPOT	GENERAL SPARE PARTS DEPOT	54
					BUILDING SERVICES	55
			CONSUMABLES	ROLL STORE		56
			REFRACTORY STORE		CENTRAL REFRACTORY STORE	57
			OPERATING PARTS STORE	FIRSTFILLINGS	CENTRAL OPERATING PARTS STORE	58
			MEASURING & AUXILIARY EQUIPM.			59
	INFORMATION SYSTEM	**INFORMATION SYSTEM**	**INFORMATION SYSTEM**	**INFORMATION SYSTEM**	**INFORMATION SYSTEM**	
						60
					PLANNING SYSTEM/MANAGEMENT INFO	61
	PROD. & PROCESS CONTROL SYSTEM	PROD. & PROCESS CONTROL SYSTEM	PROD. & PROCESS CONTROL SYSTEM	PROD. & PROCESS CONTROL SYSTEM		62
	GENERAL INSTRUMENTATION	GENERAL INSTRUMENTATION	GENERAL INSTRUMENTATION	GENERAL INSTRUMENTATION	GENERAL INSTRUMENTATION	63
	BASIC AUTOMATION	BASIC AUTOMATION	BASIC AUTOMATION	BASIC AUTOMATION	BASIC AUTOMATION	64
	SAMPLING/MATERIAL TESTING					65
						66
				LABORATORY	CENTRAL LABORATORY	67
						68
	COMMUNICATION SYSTEM	COMMUNICATION SYSTEM	COMMUNICATION SYSTEM	COMMUNICATION SYSTEM	COMMUNICATION SYSTEM	69
L.	**INFRASTR. & AUXILIARY EQUIPM.**	**INFRASTR. & AUXILIARY EQUIPM.**	**INFRASTR. & AUXILIARY EQUIPM.**	**INFRASTR. & AUXILIARY EQUIPM.**	**INFRASTR. & AUXILIARY EQUIPM.**	
						70
	PLANT OFFICE				ADMINISTRATION BUILDING	71
						72
					LOCKER BUILDING & CANTEEN	73
					FIRST AID & SECURITY DEVICE	74
	FIRE ALARM & FIGHTING SYSTEM	FIRE ALARM & FIGHTING SYSTEM	FIRE ALARM & FIGHTING SYSTEM	FIRE ALARM & FIGHTING SYSTEM	FIRE ALARM & FIGHTING SYSTEM	75
						76
					ROAD TRANSPORT	77
					RAIL TRANSPORT	78
						79
	UTILITY SUPPLY/TREATMENT	**UTILITY SUPPLY/TREATMENT**	**UTILITY SUPPLY/TREATMENT**	**UTILITY SUPPLY/TREATMENT**	**UTILITY SUPPLY/TREATMENT**	
						80
	WATER SUPPLY/TREATMENT	WATER SUPPLY/TREATMENT	WATER SUPPLY/TREATMENT	WATER SUPPLY/TREATMENT	WATER SUPPLY/TREATMENT	81
	WATER CIRCUITS & COOLING SYSTEM	WATER CIRCUITS & COOLING SYSTEM	WATER CIRCUITS & COOLING SYSTEM	WATER CIRCUITS & COOLING SYSTEM	WATER CIRCUITS & COOLING SYSTEM	82
AIR	INCOMBUSTIBLE GASES & COMPR. AIR	INCOMBUSTIBLE GASES & COMPR. AIR	INCOMBUSTIBLE GASES & COMPR. AIR	INCOMBUSTIBLE GASES & COMPR. AIR	INCOMBUSTIBLE GASES & COMPR. AIR	83
	COMBUSTIBLE GASES	COMBUSTIBLE GASES	COMBUSTIBLE GASES	COMBUSTIBLE GASES	COMBUSTIBLE GASES	84
						85
	STEAM/HOT WATER/HEAT RECOVERY	STEAM/HOT WATER/HEAT RECOVERY	STEAM/HOT WATER/HEAT RECOVERY	STEAM/HOT WATER/HEAT RECOVERY	STEAM/HOT WATER/HEAT RECOVERY	86
						87
						88
M			HYDRAULIC & LUBRICATION SYSTEM	HYDRAULIC & LUBRICATION SYSTEM		89
	ELECTRIC ENERGY SUPPLY	**ELECTRIC ENERGY SUPPLY**	**ELECTRIC ENERGY SUPPLY**	**ELECTRIC ENERGY SUPPLY**	**ELECTRIC ENERGY SUPPLY**	
						90
	HIGH VOLTAGE FACILITIES	HIGH VOLTAGE FACILITIES		HIGH VOLTAGE FACILITIES	HIGH VOLTAGE FACILITIES	91
	LOW VOLTAGE FACILITIES	LOW VOLTAGE FACILITIES	LOW VOLTAGE FACILITIES	LOW VOLTAGE FACILITIES	LOW VOLTAGE FACILITIES	92
	ELECTRICAL EQUIPMENT	ELECTRICAL EQUIPMENT	ELECTRICAL EQUIPMENT	ELECTRICAL EQUIPMENT	ELECTRICAL EQUIPMENT	93
						94
						95
						96

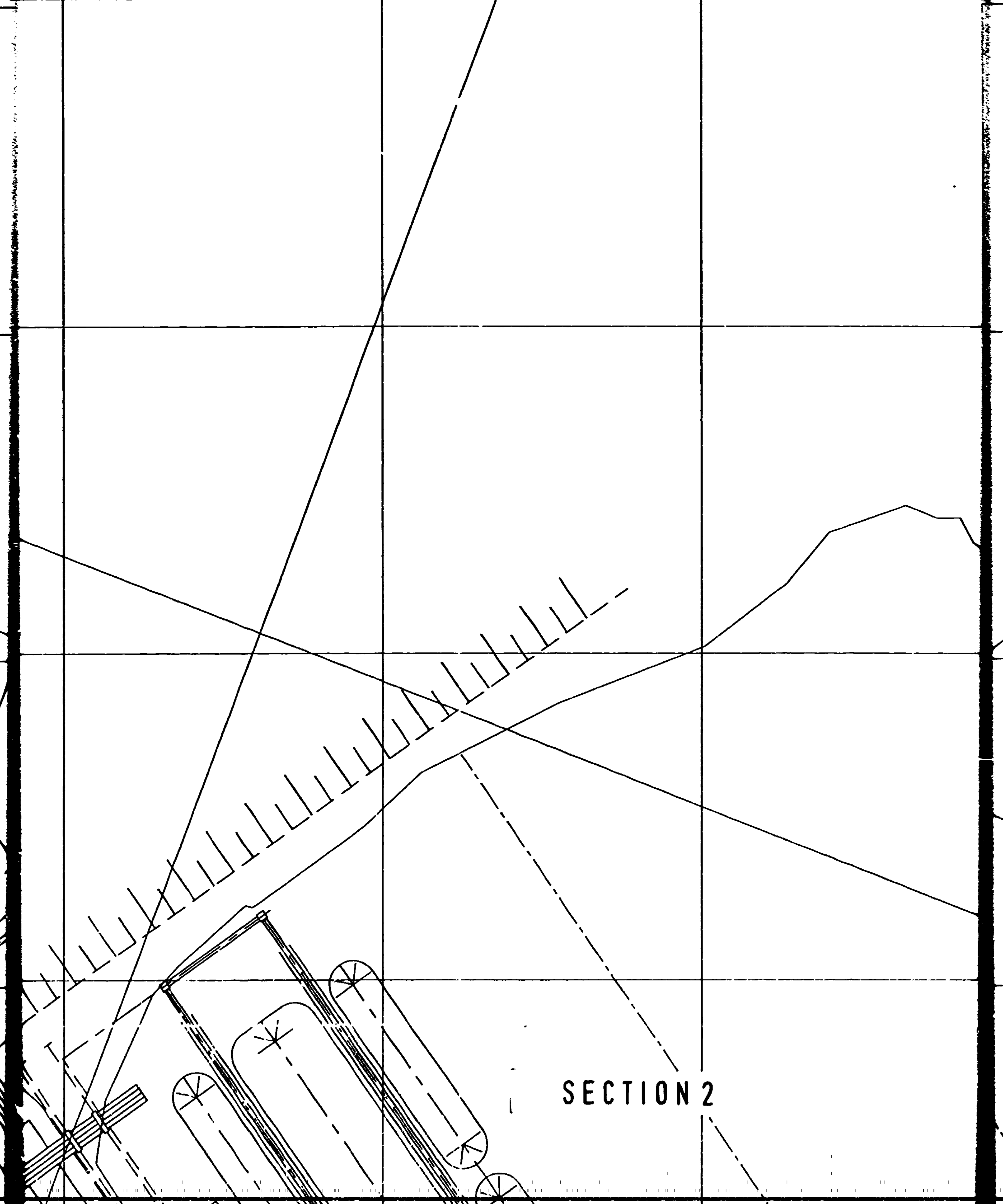
9. PLANT STRUCTURE

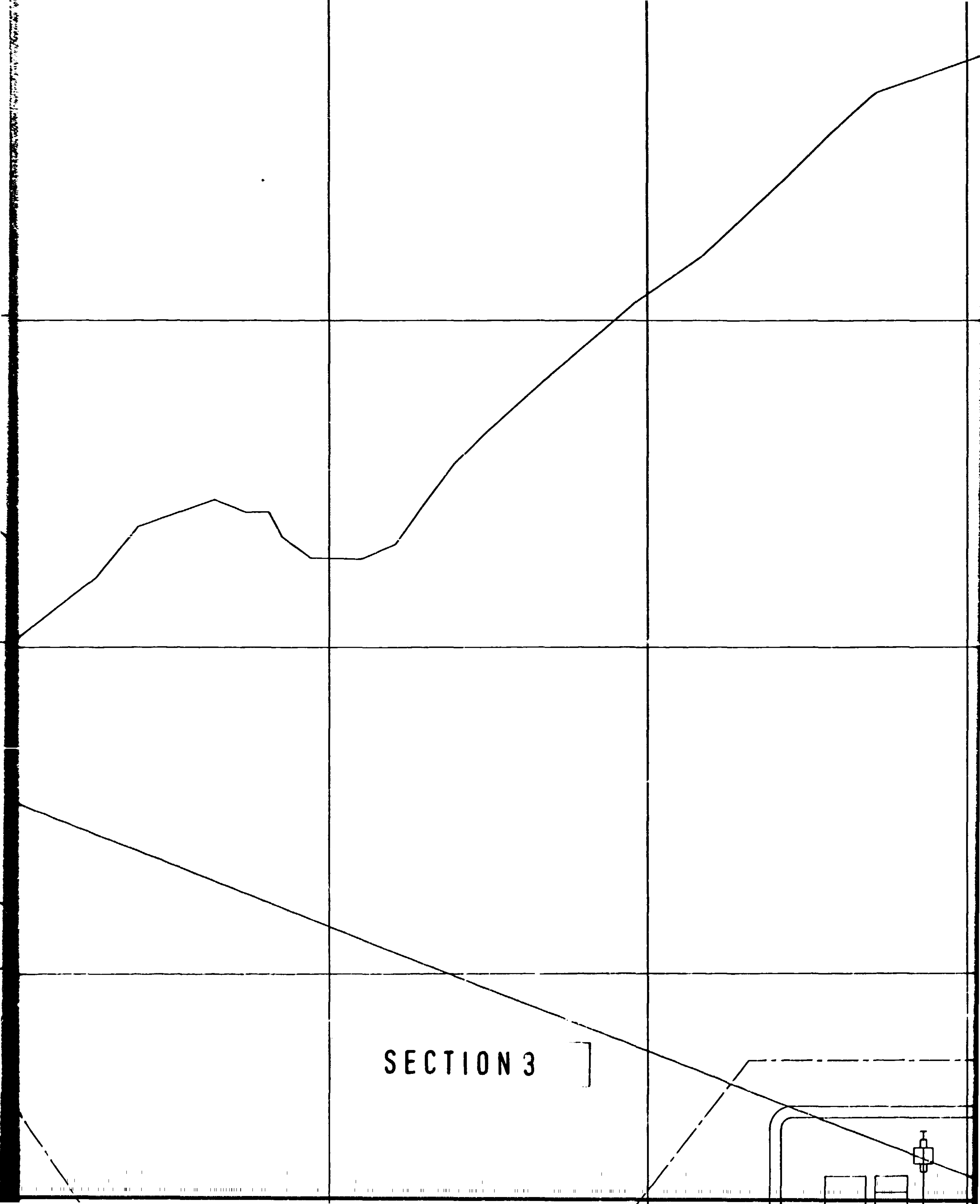
Table 33: Plant Structure

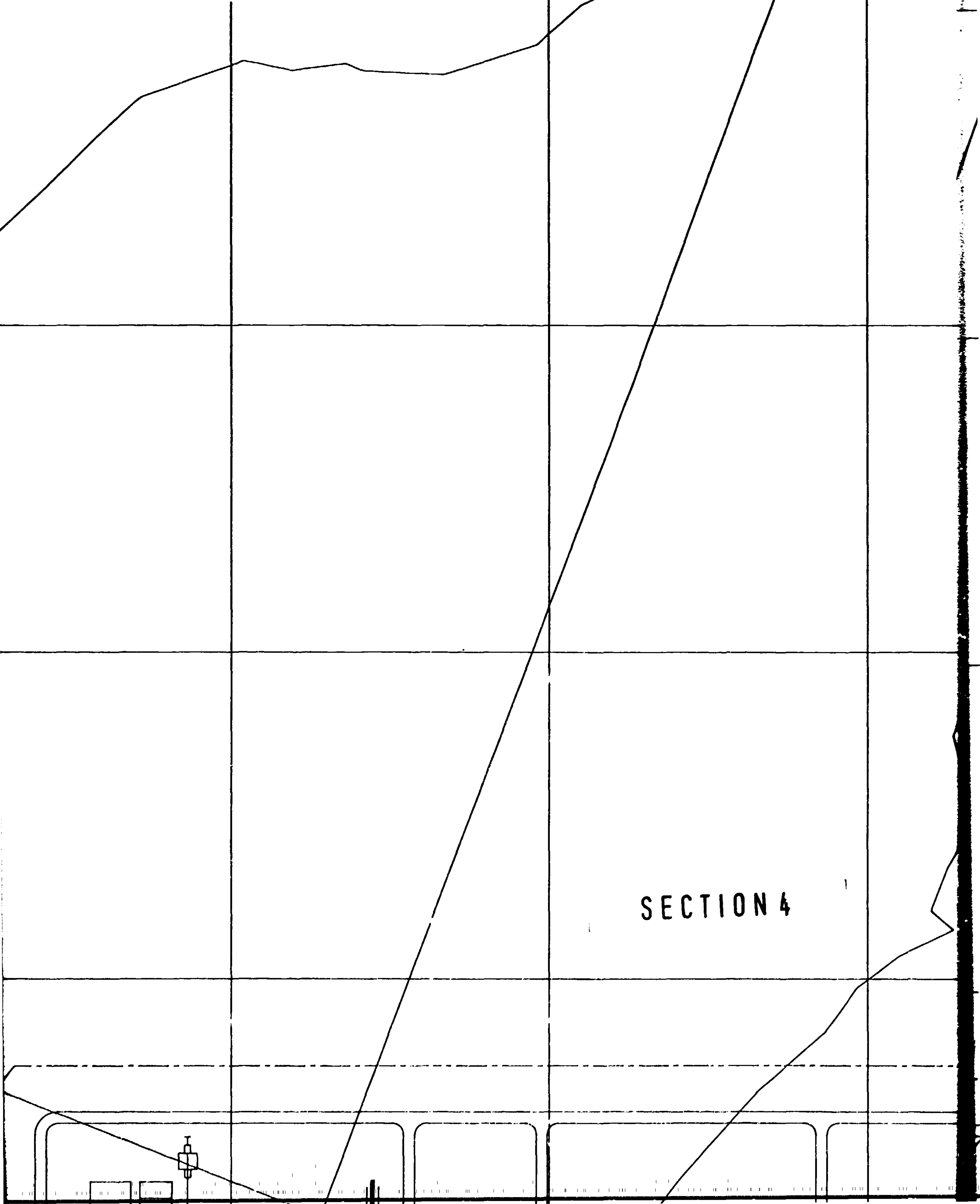
SUB-SERIE	
00 01 02 03 04 05 06 07 08 09	SERIE 0 STRUCTURE & TRANSFER ELEMENTS
10 11 12 13 14 15 16 17 18 19	SERIE 1 PRE PROCESS FACILITIES
20 21 22 23 24 25 26 27 28 29	SERIE 2 PROCESS EQUIPMENT
30 31 32 33 34 35 36 37 38 39	SERIE 3 DOWN STREAM FACILITIES
40 41 42 43 44 45 46 47 48 49	SERIE 4 PERIPHERAL FACILITIES
50 51 52 53 54 55 56 57 58 59	SERIE 5 MAINTENANCE & STORES
60 61 62 63 64 65 66 67 68 69	SERIE 6 INFORMATION
70 71 72 73 74 75 76 77 78 79	SERIE 7 INFRASTRUCTURE & AUXILIARY EQUIPMENT
80 81 82 83 84 85 86 87 88 89	SERIE 8 UTILITIES
90 91 92 93 94 95 96 97 98 99	SERIE 9 ELECTRIC ENERGY

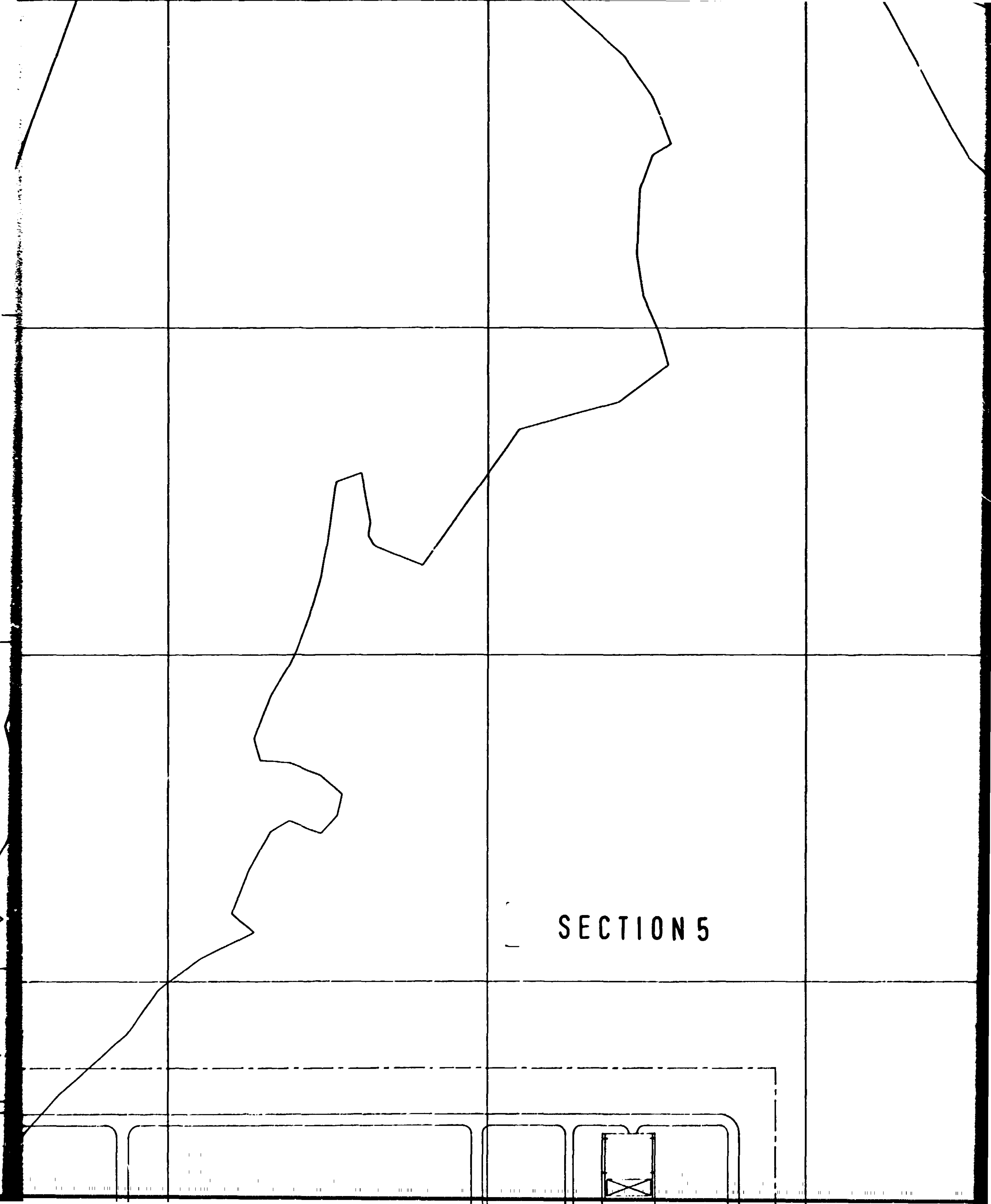
10. PLANT LAYOUT

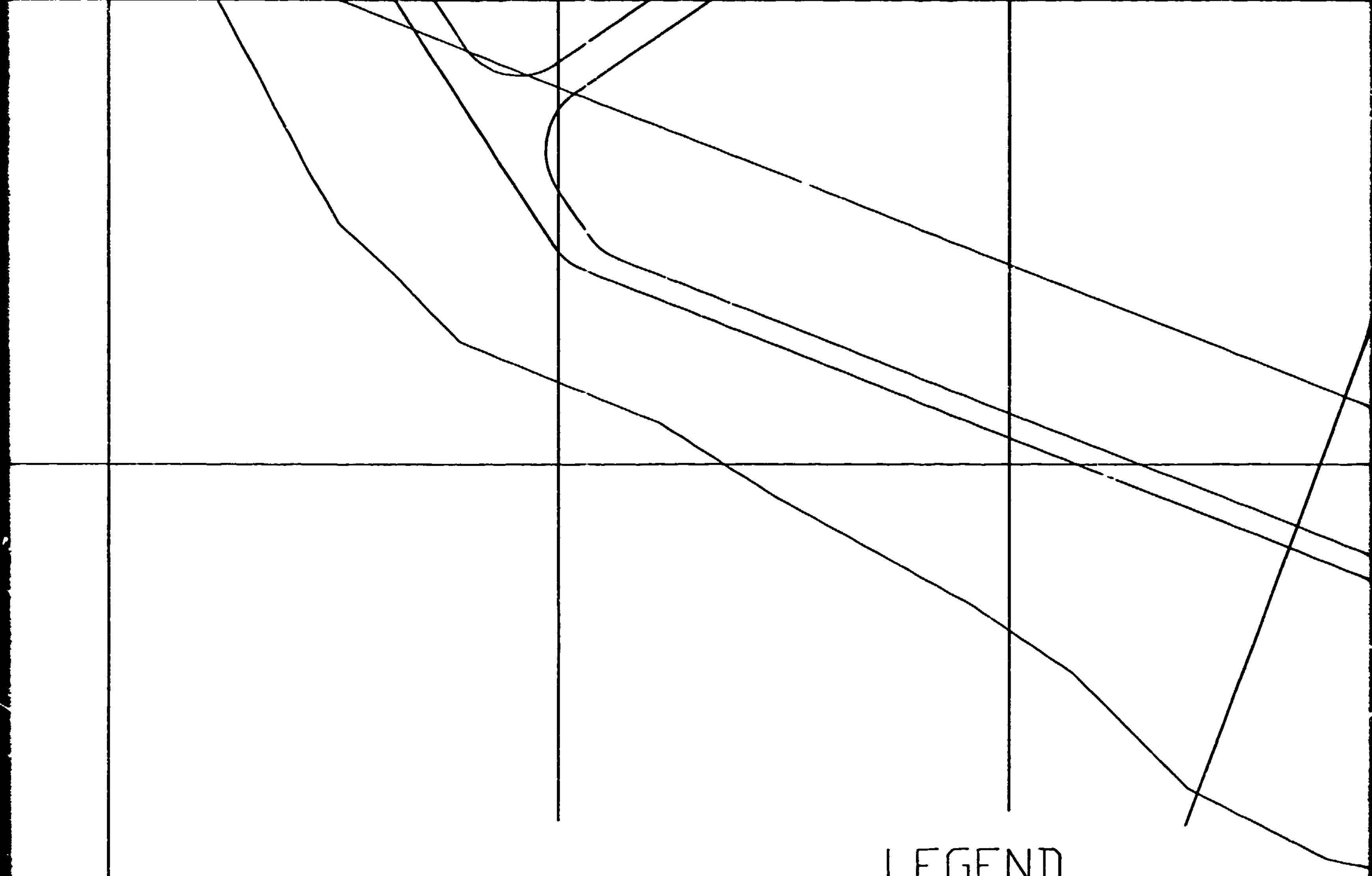

Y=21 800
Y=21 600
Y=21 400


SECTION 2


SECTION 3


SECTION 4

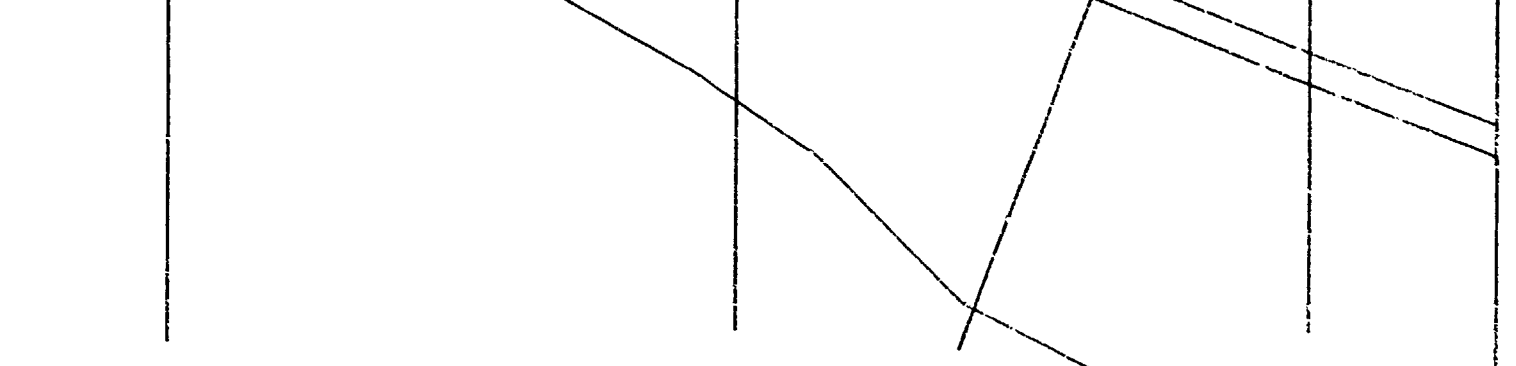

SECTION 5



LEGEND

1 SCRAP YARD
2 LD-STEEL PLANT
3 THIN SLAB CASTER
4 REHEATING FURNACE
5 HOT STRIP MILL
6 COIL STORAGE YARD
7 ROLL SHOP + MAINTENANCE
8 SCALE PIT
9 WATER TREATMENT PLANT
10 DEDUSTING PLANT
11 LABORATORY
12 OXYGEN PLANT
13 BUILDING FOR FLUX & FERRO
15 ELECTRIC MAIN STATION
16 OIL TANK DEPOT
17 GAS HOLDER
18 POWER PLANT
19 BLOWER STATION
20 WATER TREATMENT PLANT - B
21 SLAG CRUSHING & SCREENING
22 PIG CASTING MACHINE

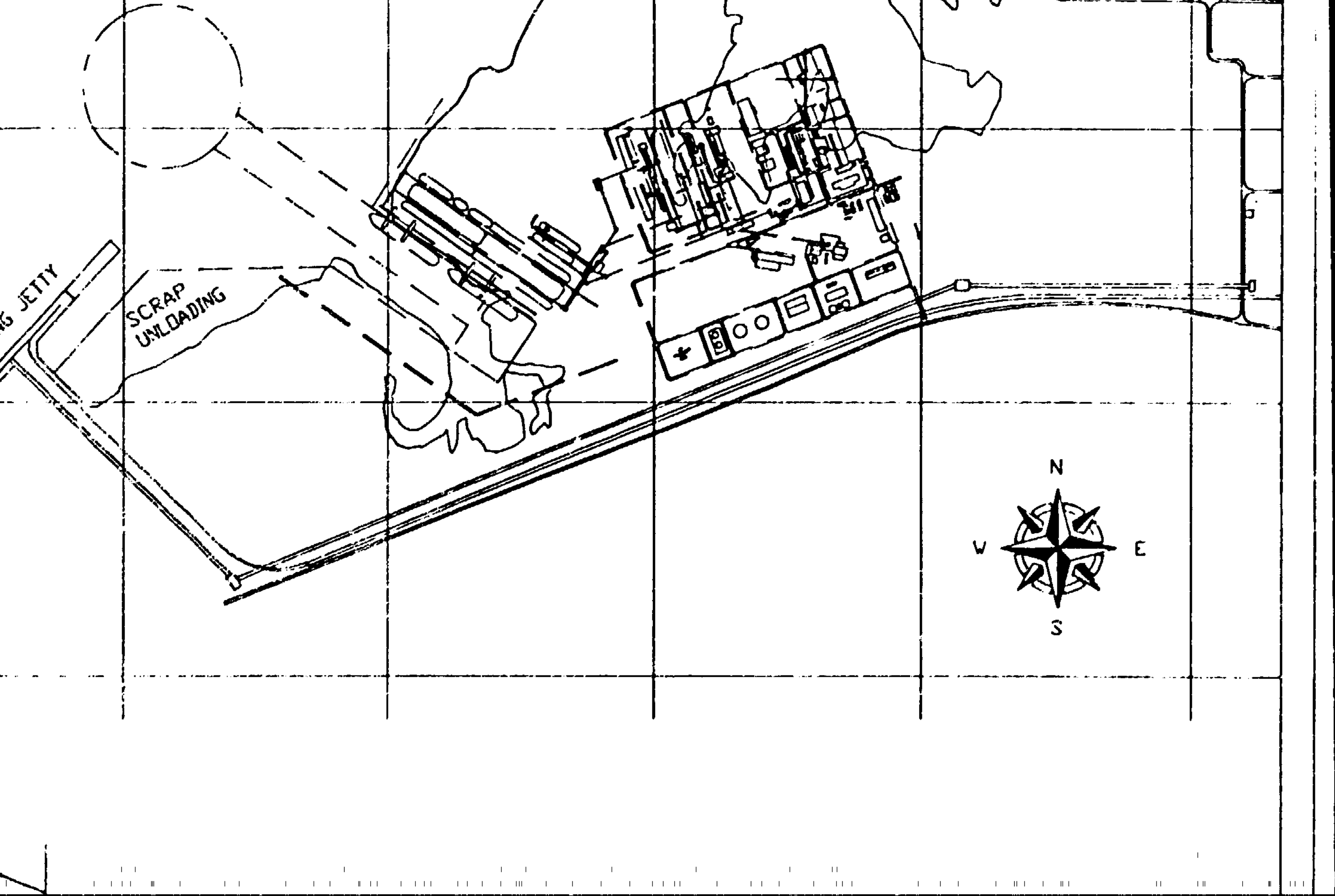
SECTION 6

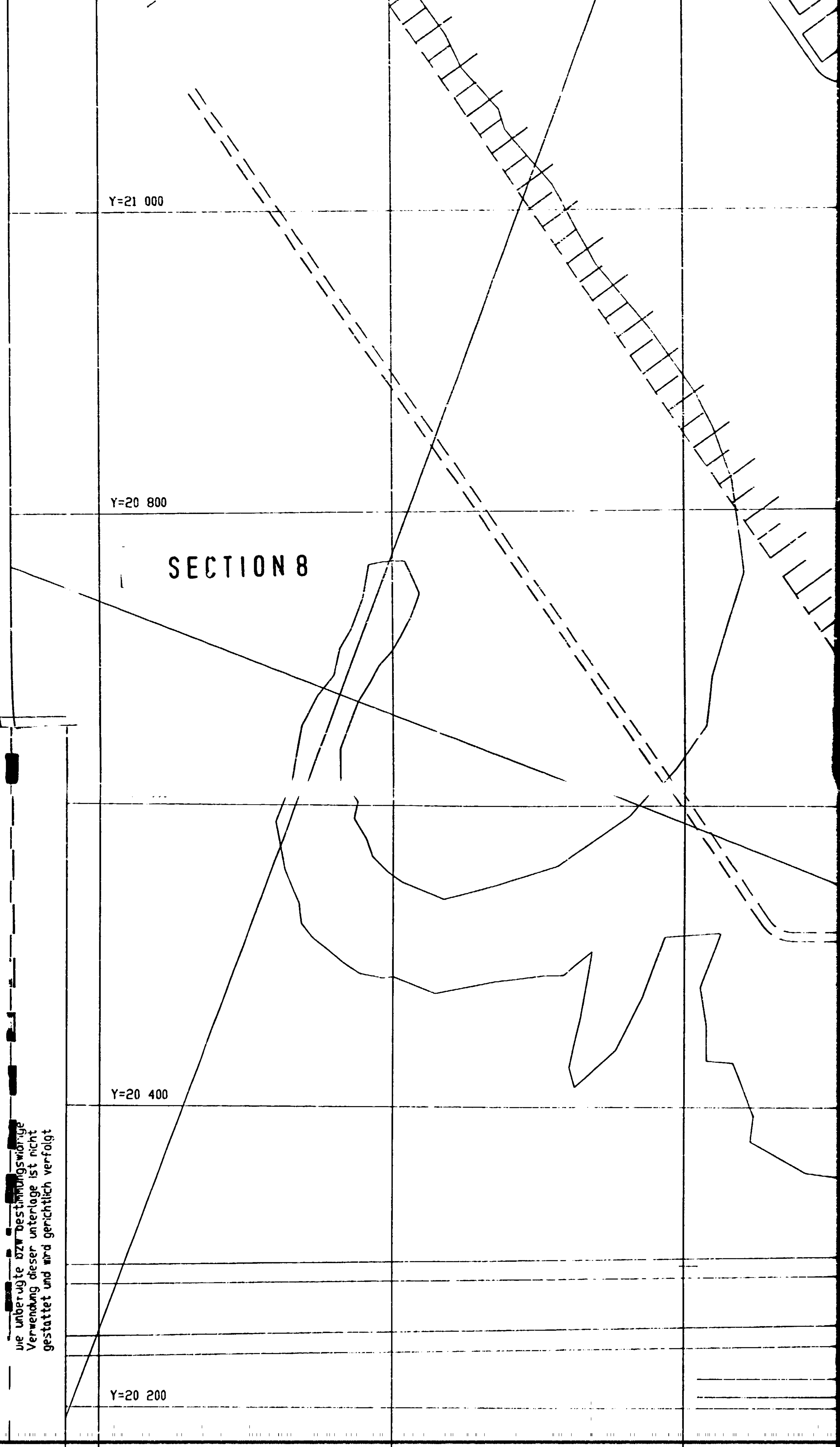


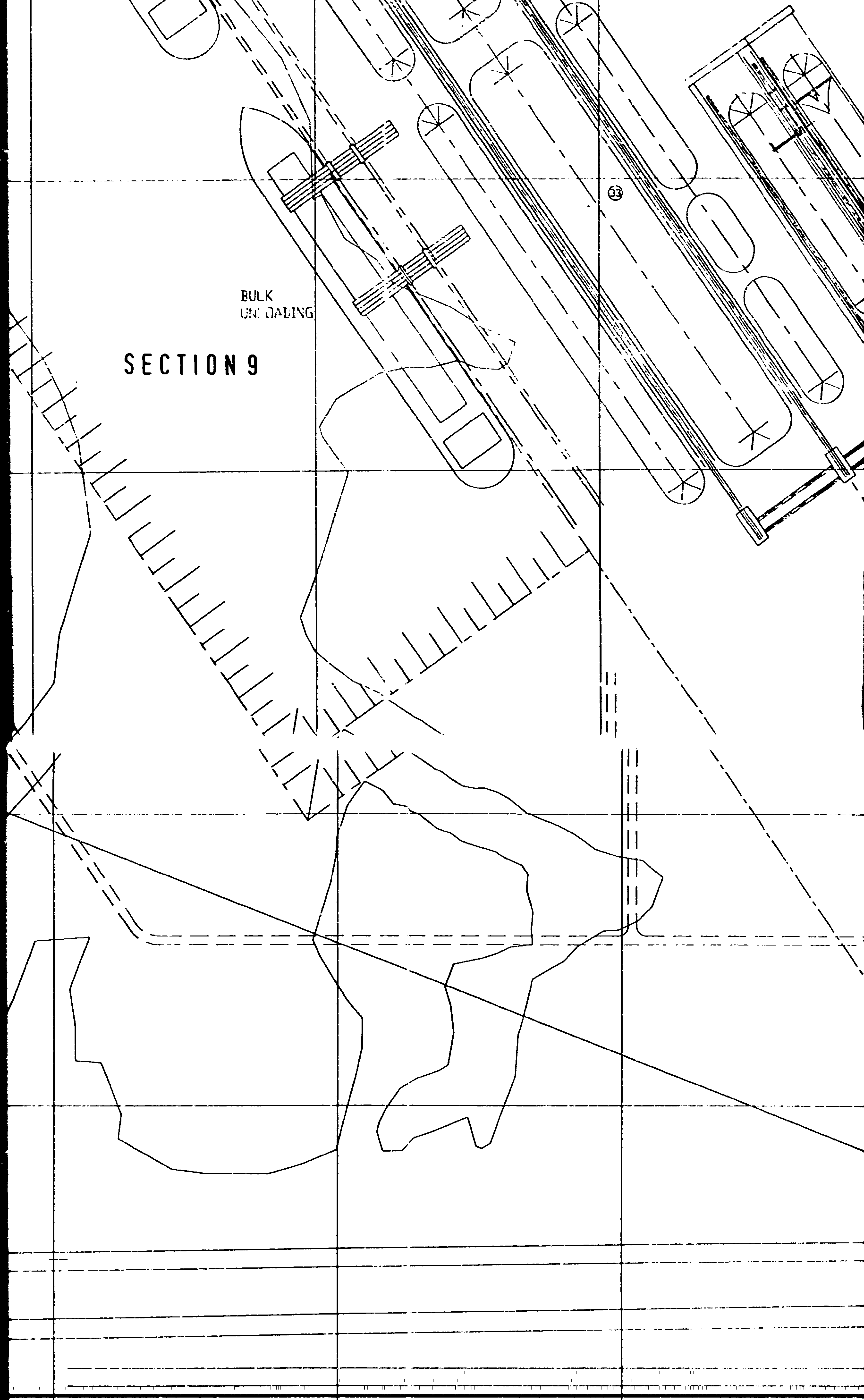
LEGEND

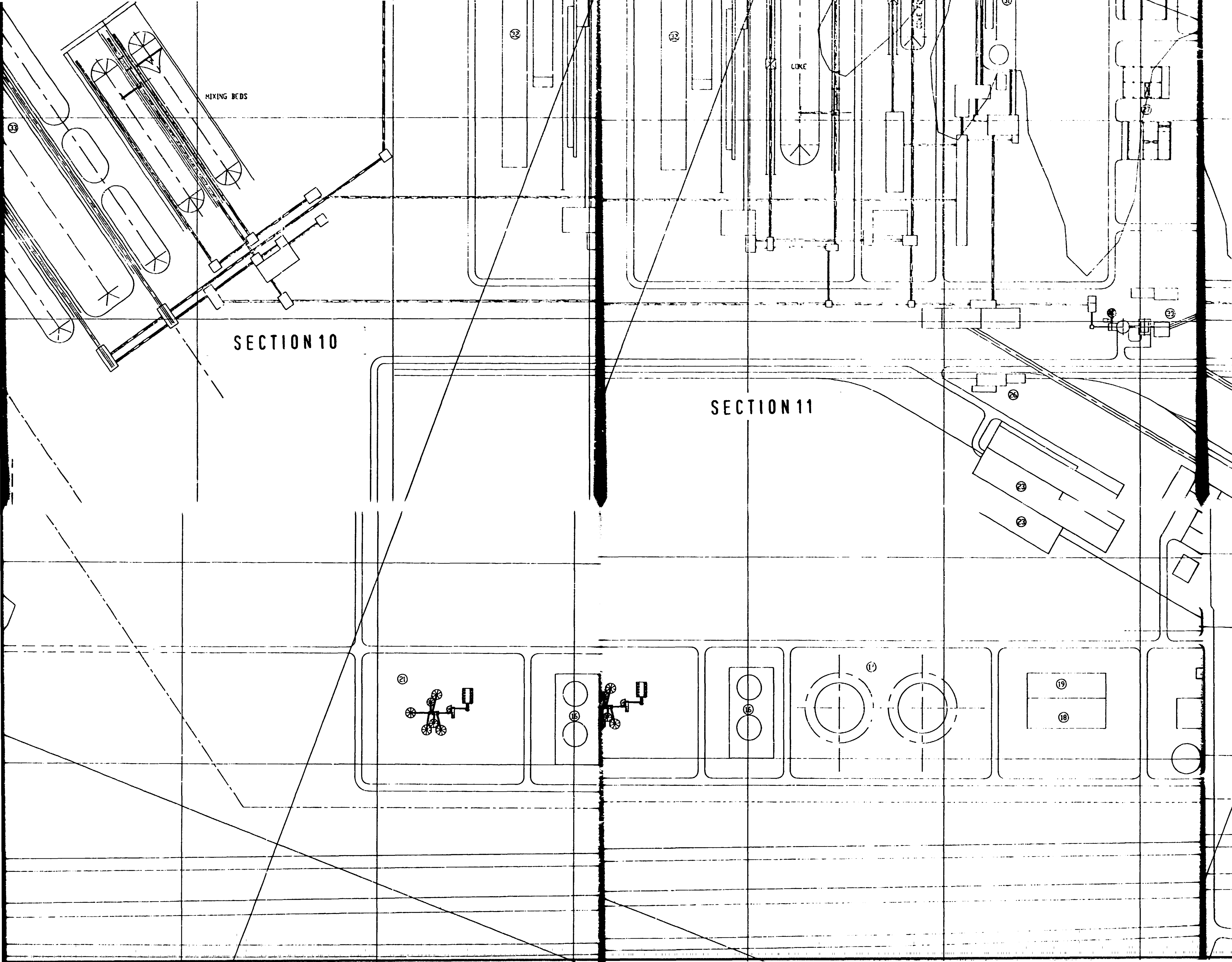
1 SCRAP YARD
2 LD-STEEL PLANT
3 THIN SLAB CASTER
4 REHEATING FURNACE
5 HOT STRIP MILL
6 COIL STORAGE YARD
7 ROLL SHOP + MAINTENANCE
8 SCALE PIT
9 WATER TREATMENT PLANT
10 DEDUSTING PLANT
11 LABORATORY
12 OXYGEN PLANT
13 BUILDING FOR FLUX & FERRO ALLOYS
15 ELECTRIC MAIN STATION
16 OIL TANK DEPOT
17 GAS HOLDER
18 POWER PLANT
19 BLOWER STATION
20 WATER TREATMENT PLANT - BF
21 SLAG CRUSHING & SCREENING PLANT
22 PIG CASTING MACHINE
23 LADLE SHOP, REFRACTORIES STORE

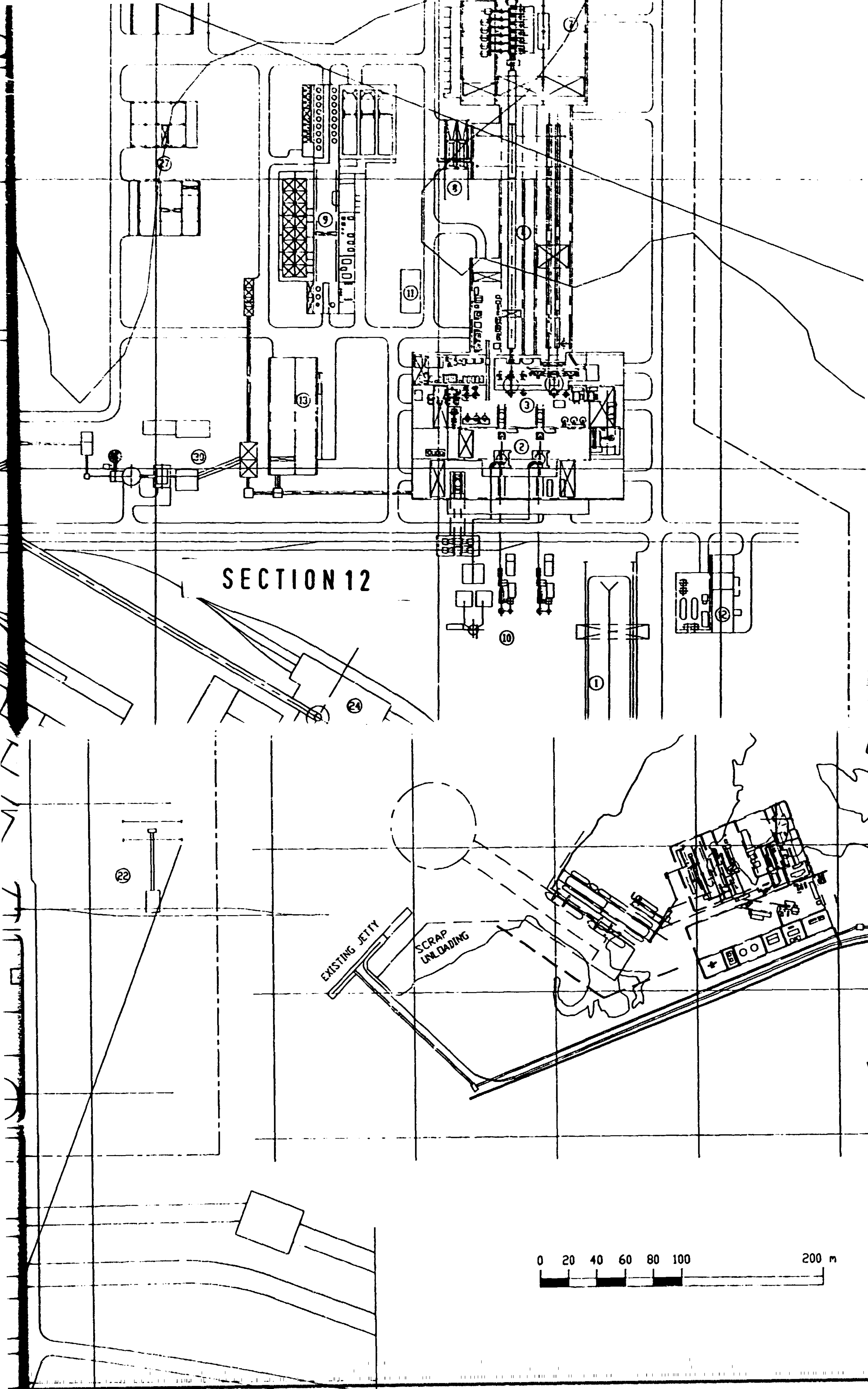
SECTION 7

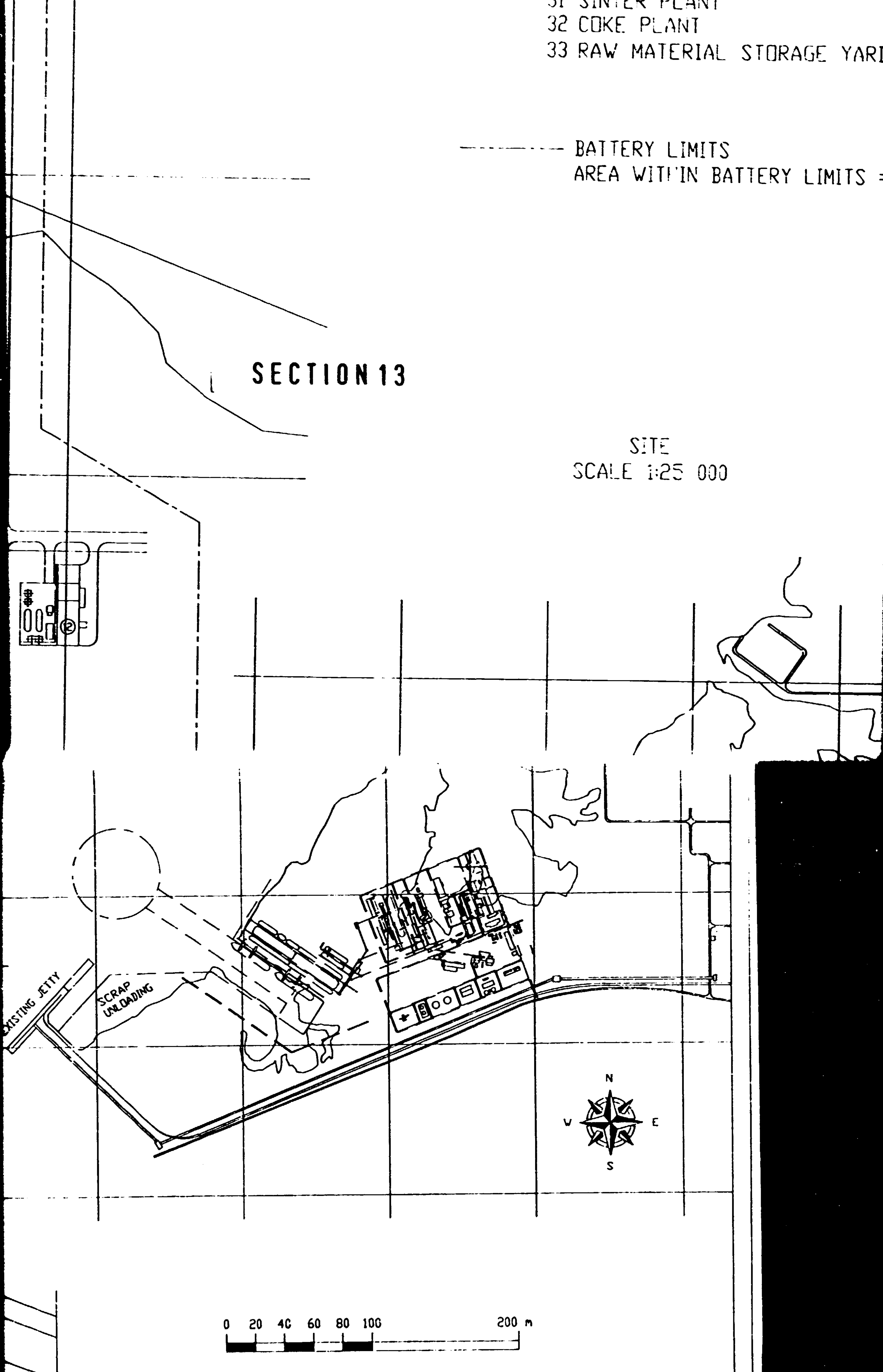



Y=21 000
Y=20 800
SECTION 8
Y=20 400
Y=20 200


BULK
UNLOADING
SECTION 9
33


MIXING BEDS
SECTION 10
SECTION 11
COKE
33
32
32
30
27
26
23
23
21
16
16
17
19
18


SECTION 12
EXISTING JETTY
SCRAP UNLOADING
0 20 40 60 80 100 200 m

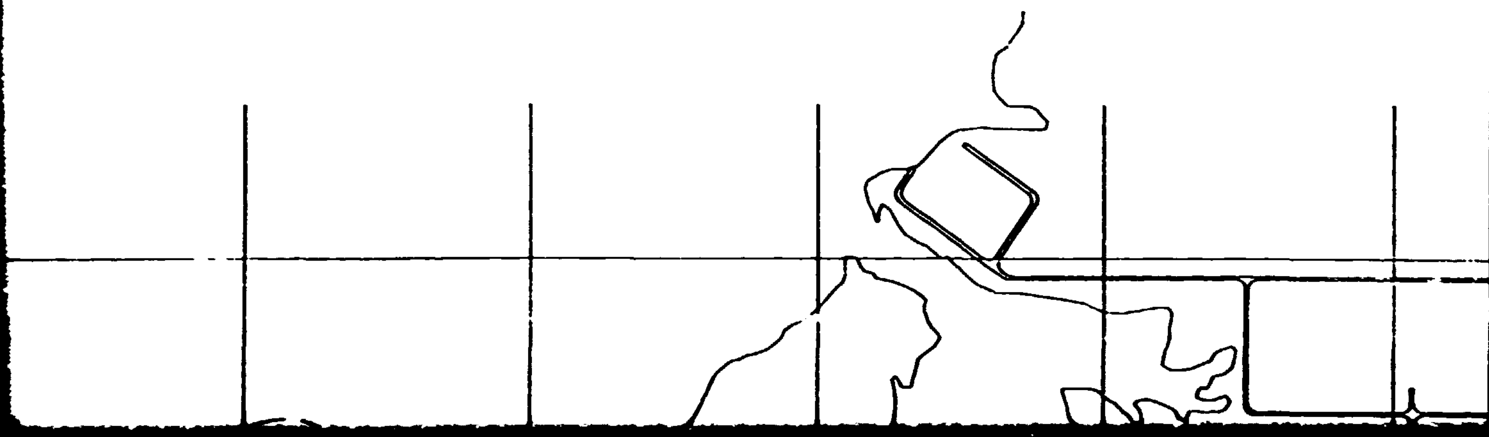


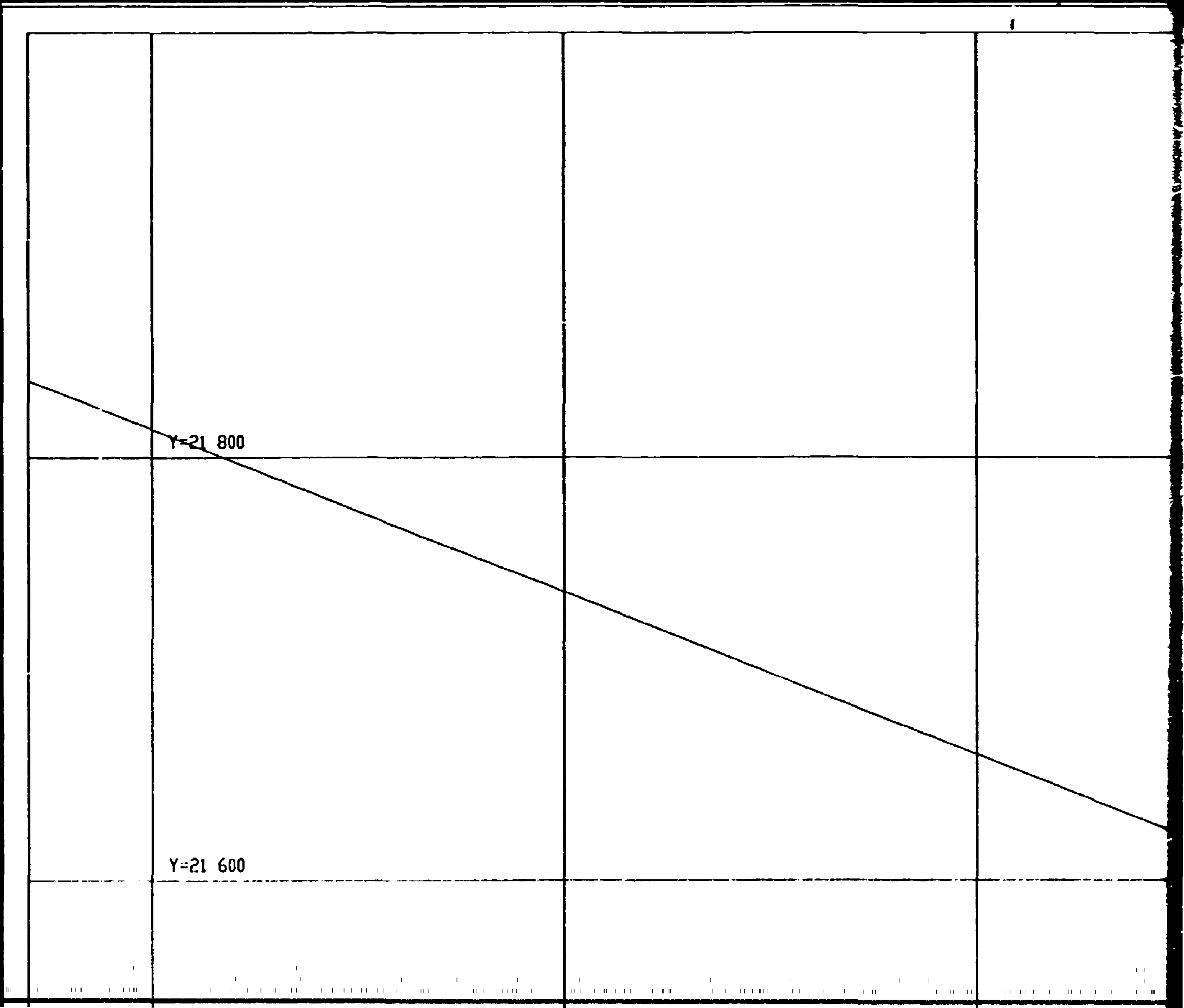
32 COKE PLANT
33 RAW MATERIAL STORAGE YARD
BATTERY LIMITS
AREA WITHIN BATTERY LIMITS =
SECTION 13
SITE
SCALE 1:25 000
EXISTING JETTY
SCRAP UNLOADING
N
W
E
S
0 20 40 60 80 100 200 m

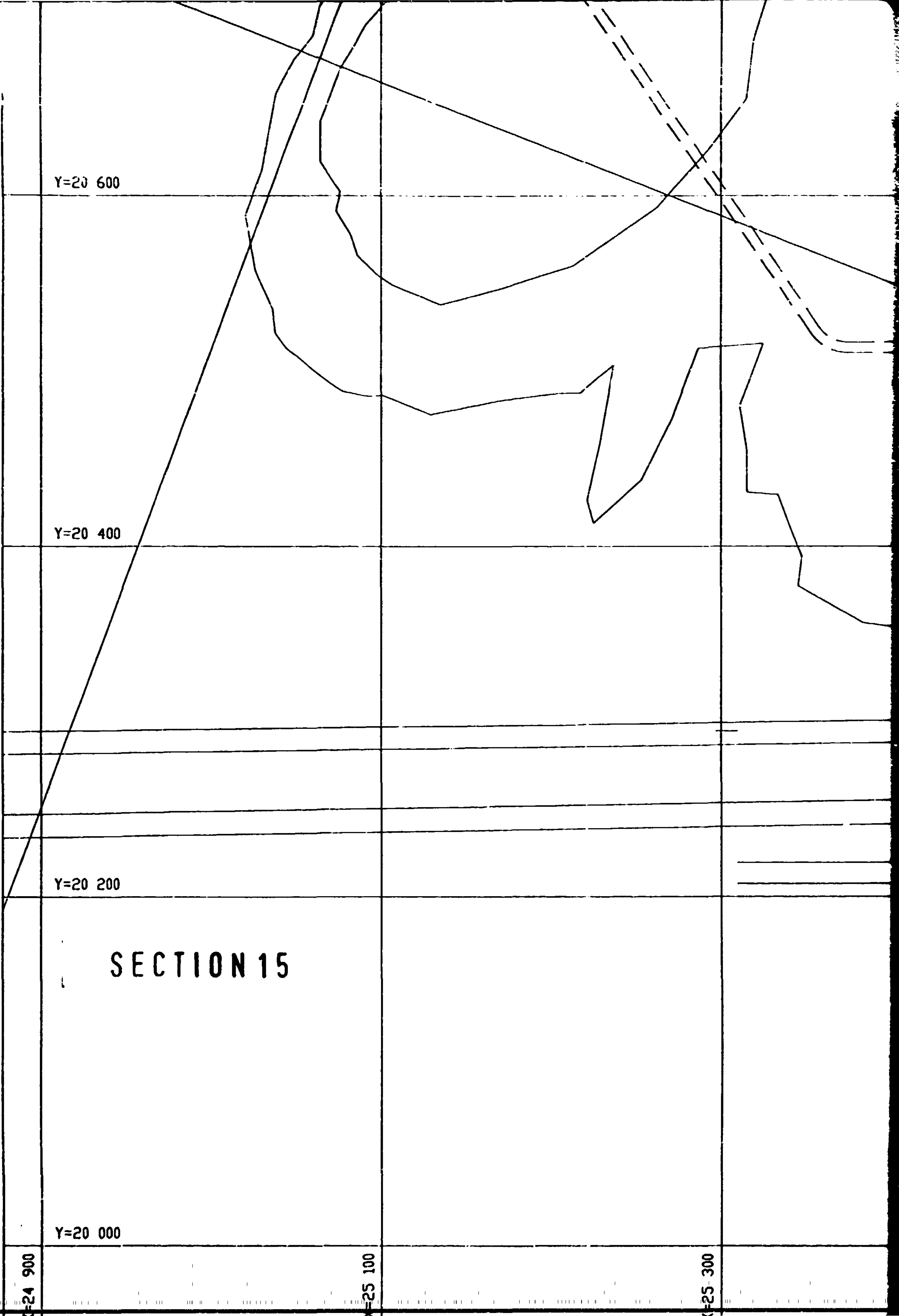
BATTERY LIMITS
AREA WITHIN BATTERY LIMITS = 1 453 000 m^2

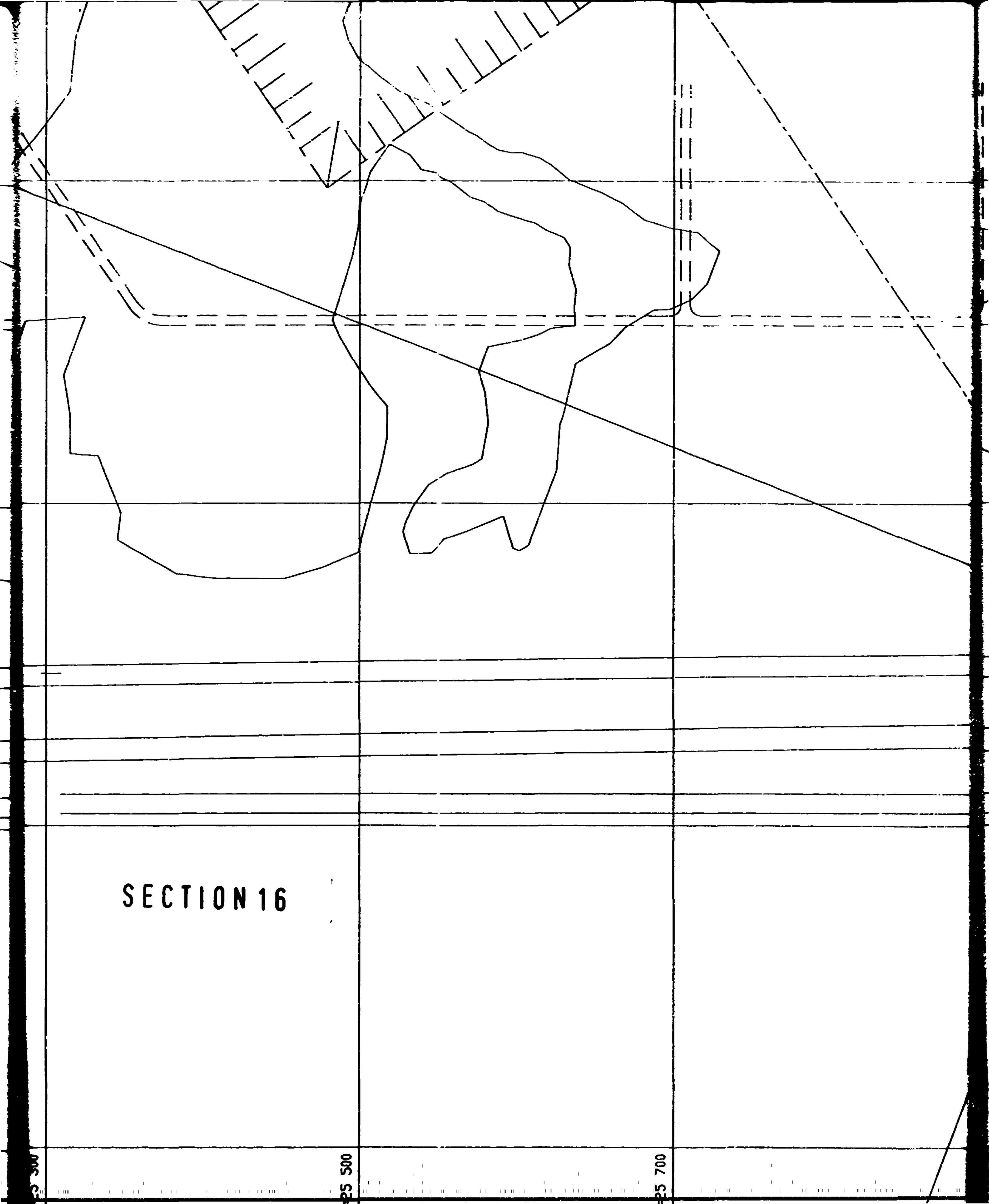
SECTION 14

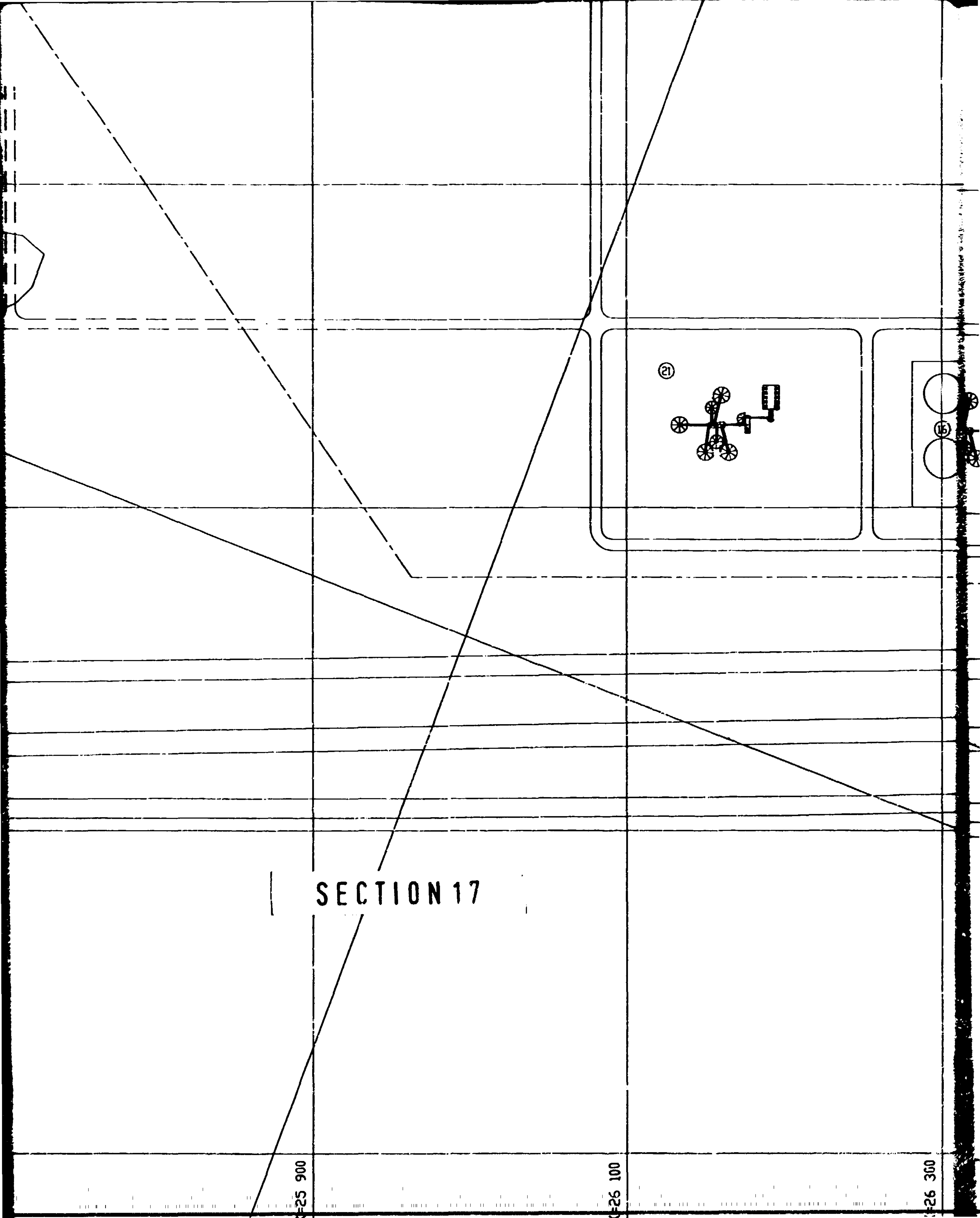
SITE
SCALE 1:25 000

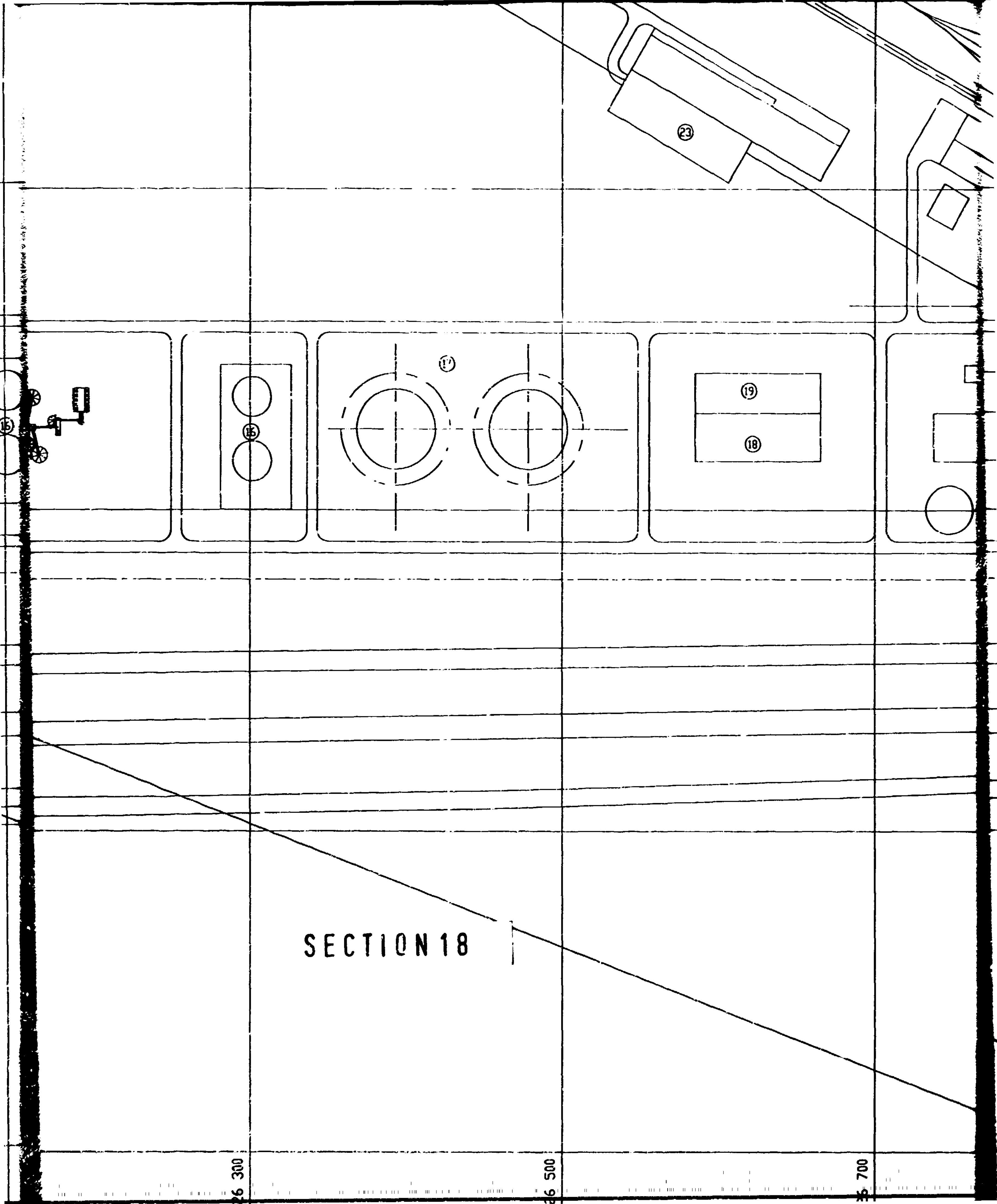


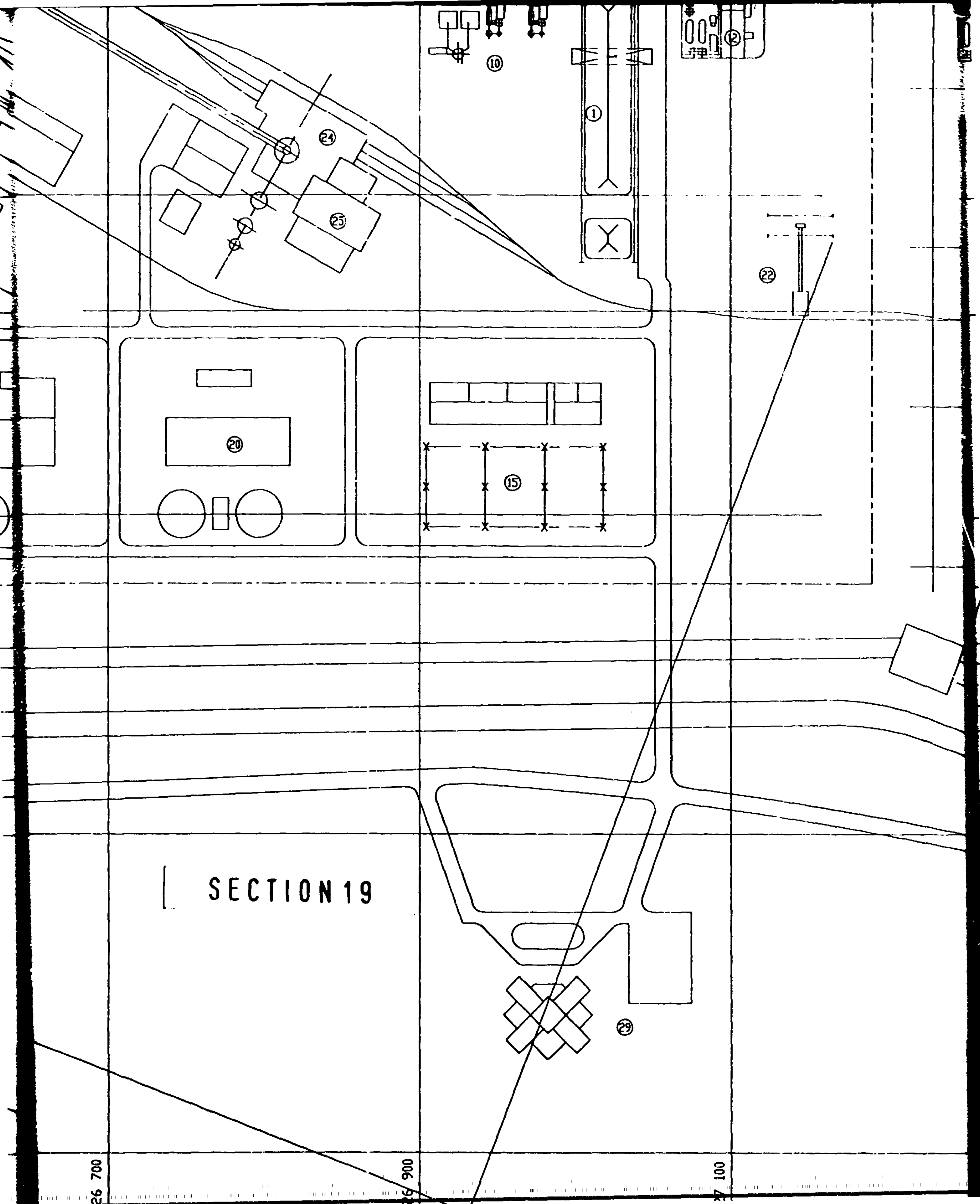



Y=20 600
Y=20 400
Y=20 200
SECTION 15
Y=20 000
24 900
25 100
25 300

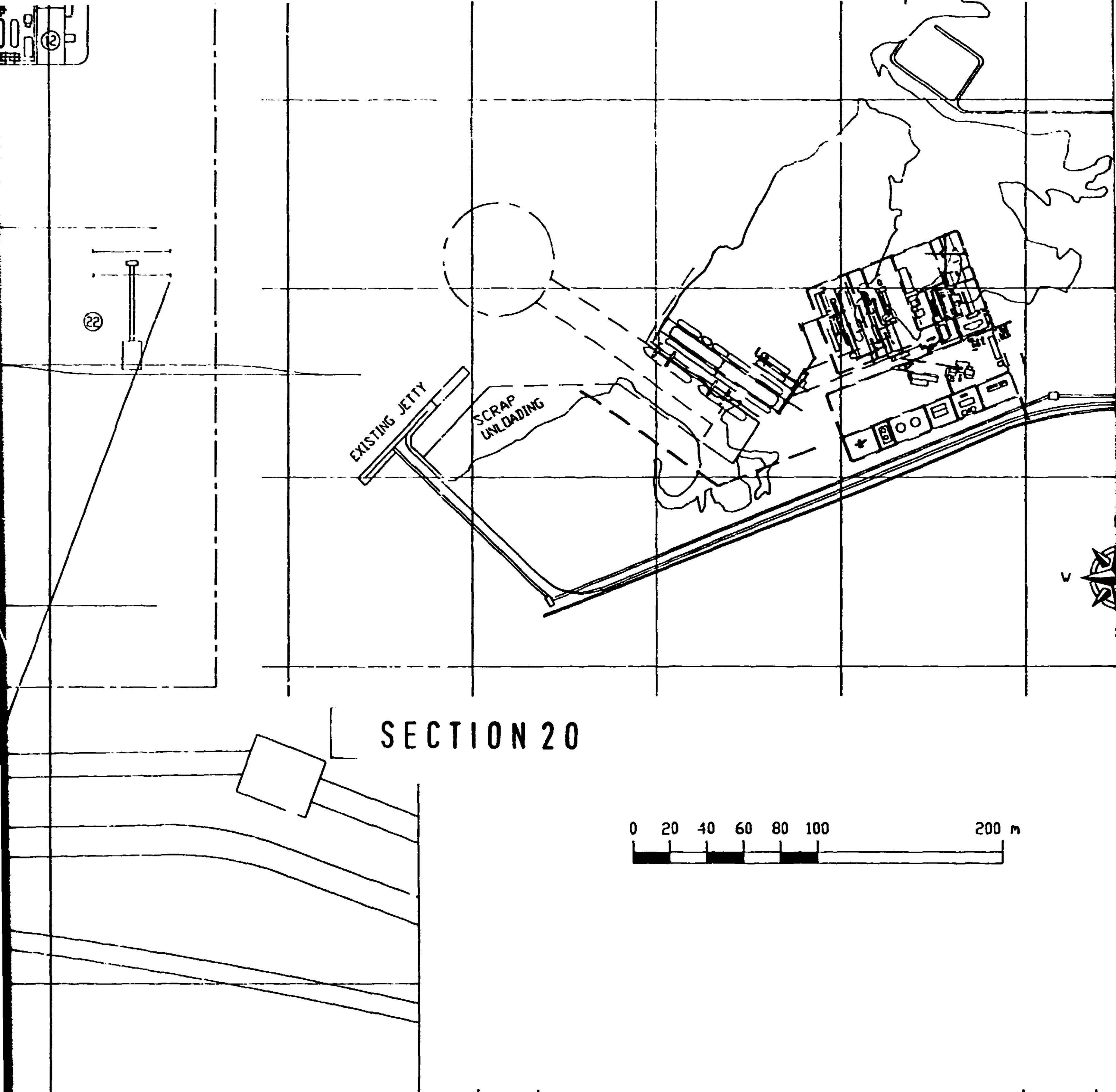

SECTION 16
500
700


SECTION 17
21
16
25 900
26 100
26 300


23
17
15
16
19
18
SECTION 18
26 300
26 500
700



SECTION 19
10
1
12
24
25
22
20
15
29
26 700
900
100



Änderung Revision	Anz. d. Änd. No. of Mod.	Änderungsinhalt Modification	Datum Date

1993	Datum Date	Name Name	CAD	VAR. 1/2
Bearbeitet Made by	12-01	P.F.		BF-LD-ROUTE
Geprüft Checked by				AS/AC/BS/RB/SL 2.47/CD/V

Benennung Title

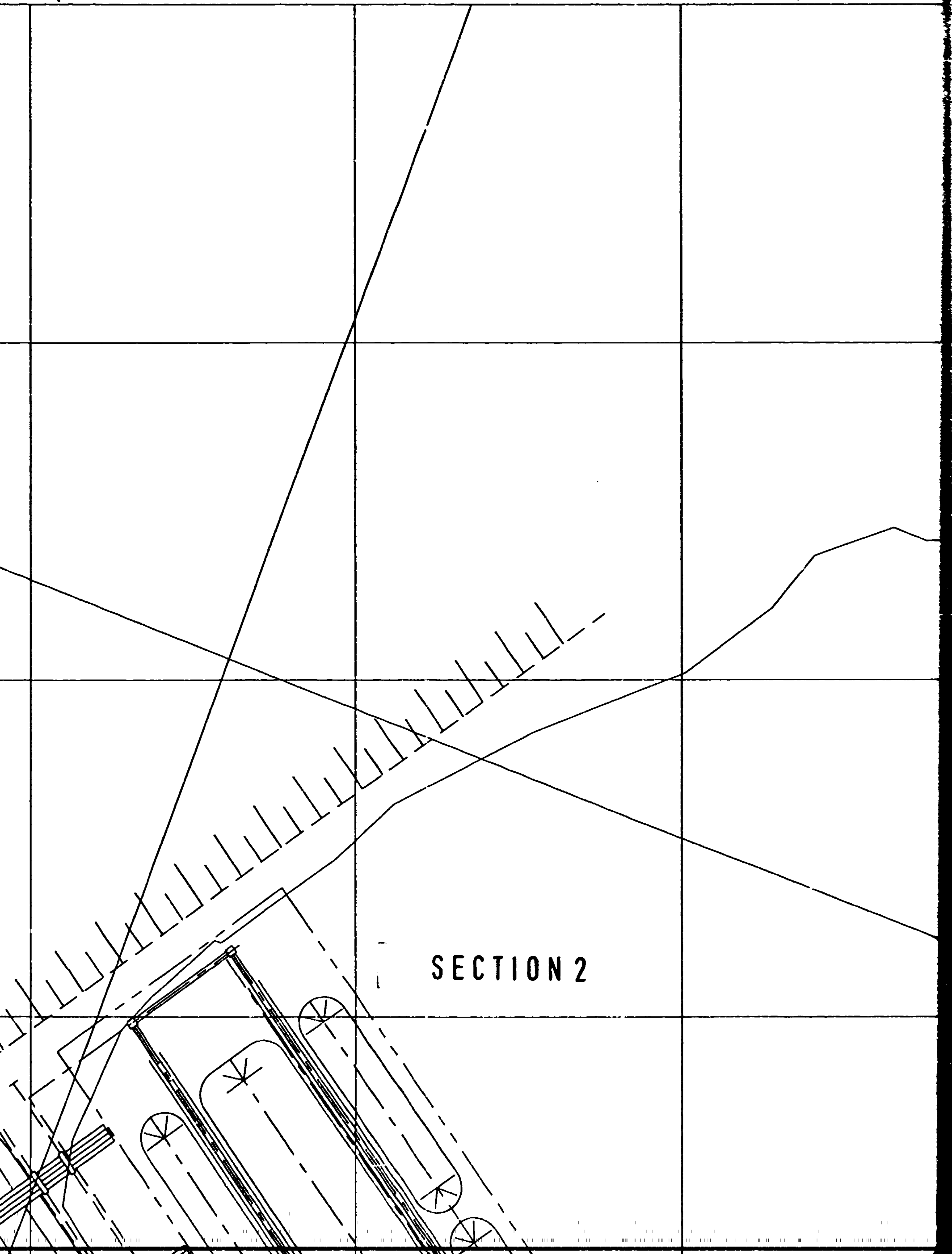
PROJECT SGSM/INDONESIA
FEASIBILITY STUDY

GENERAL LAYOUT

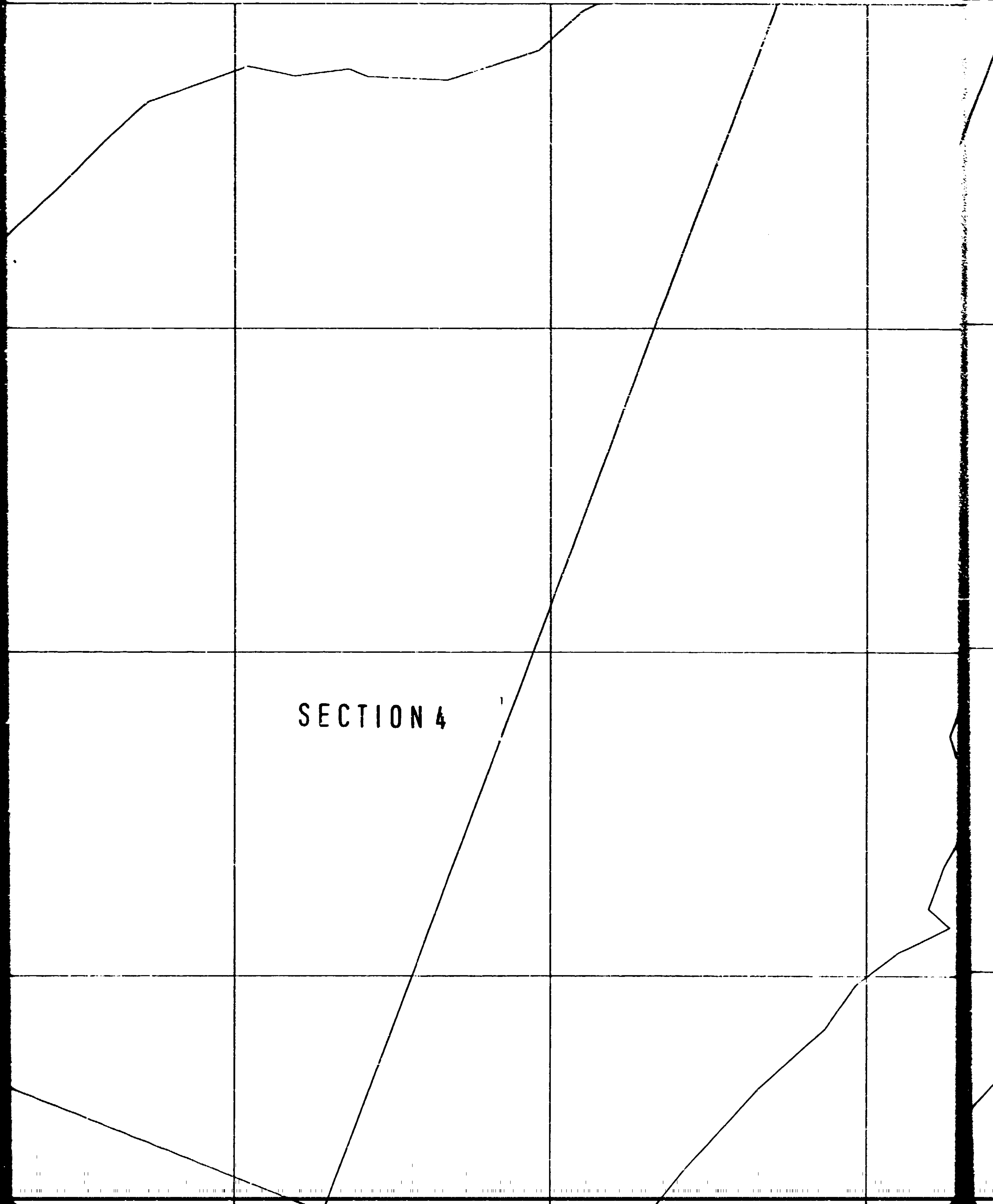
Maßstab Scale 1:2500

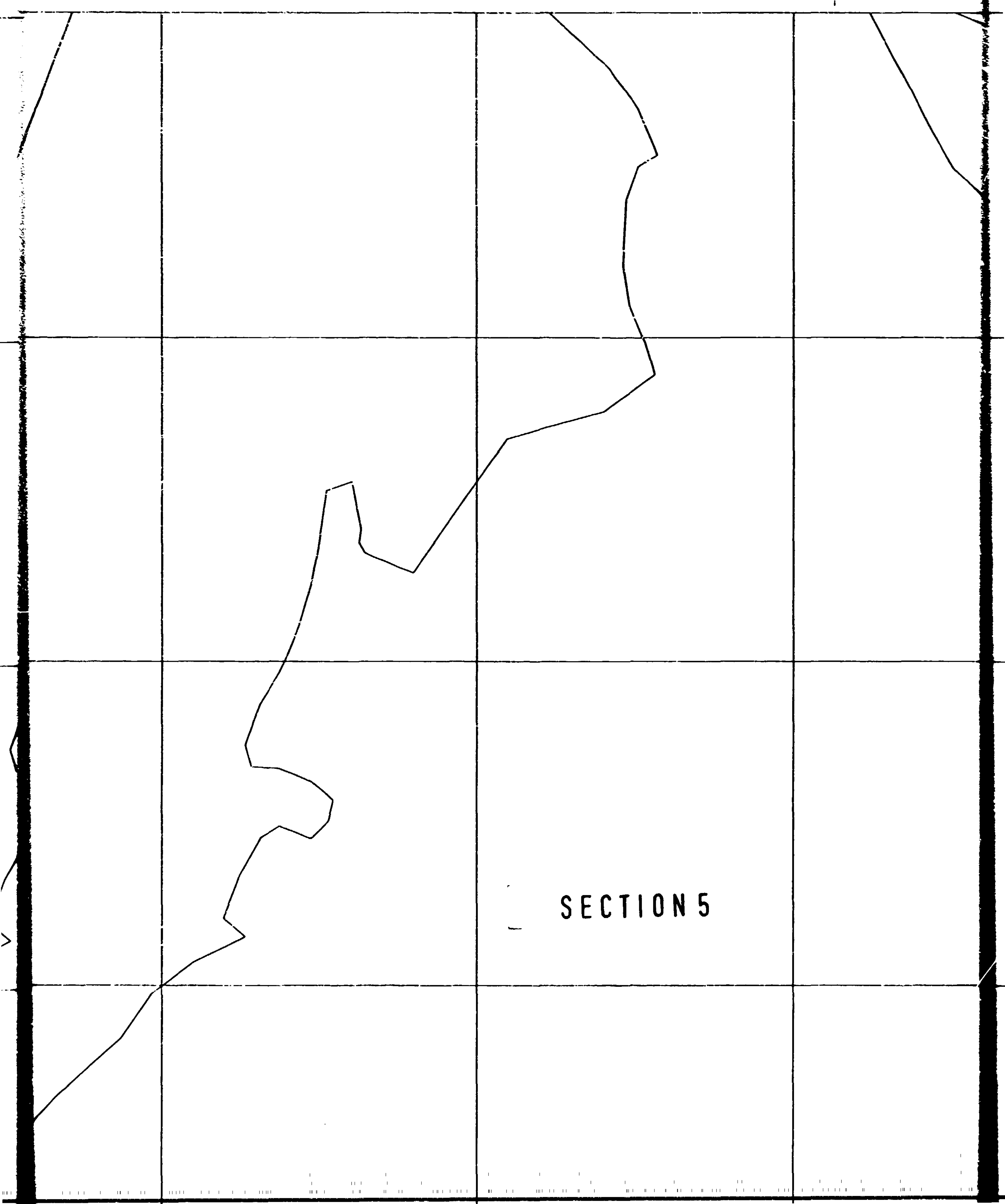
Werkstoff Material

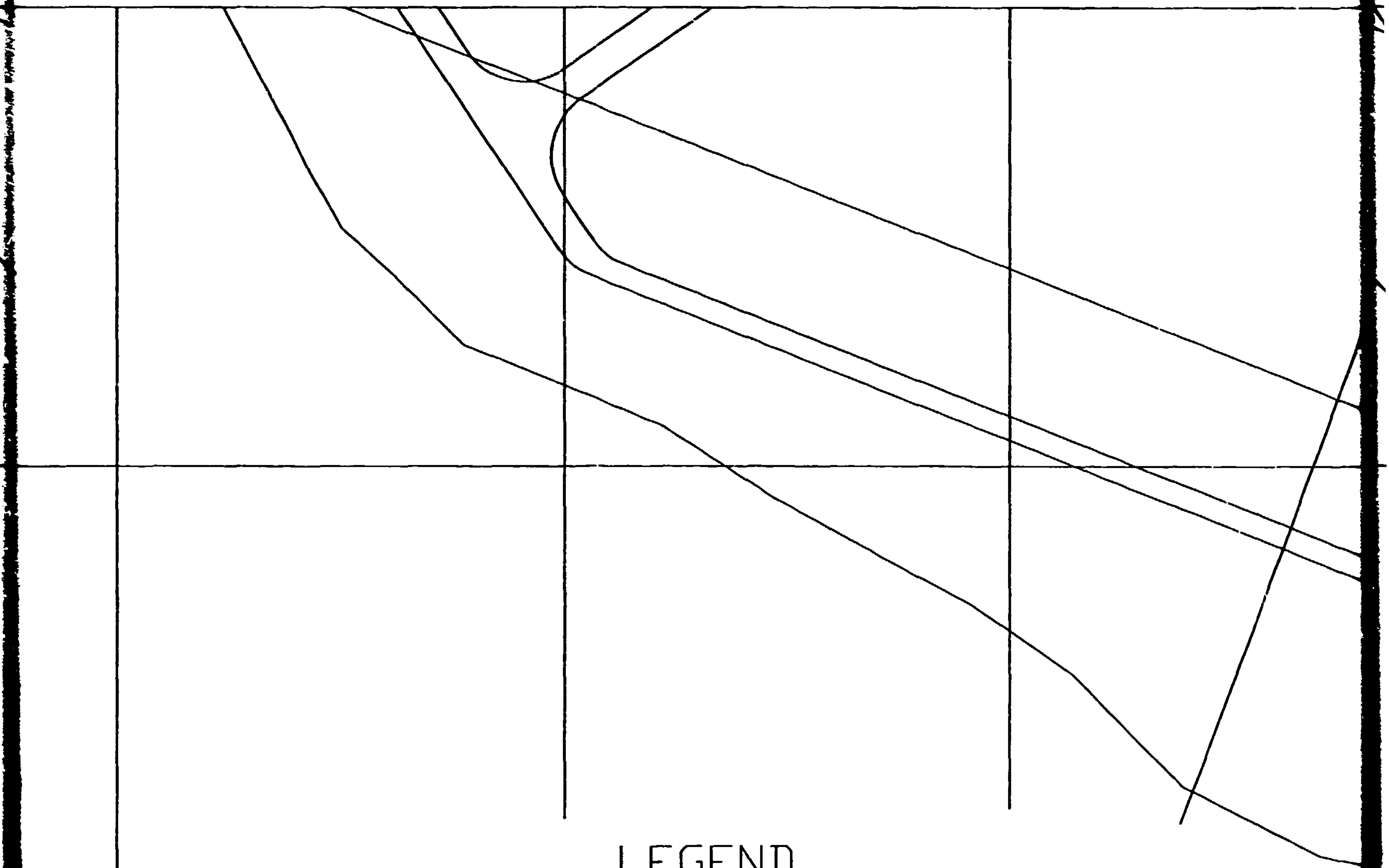
100


SECTION 2

SECTION 3


SECTION 4

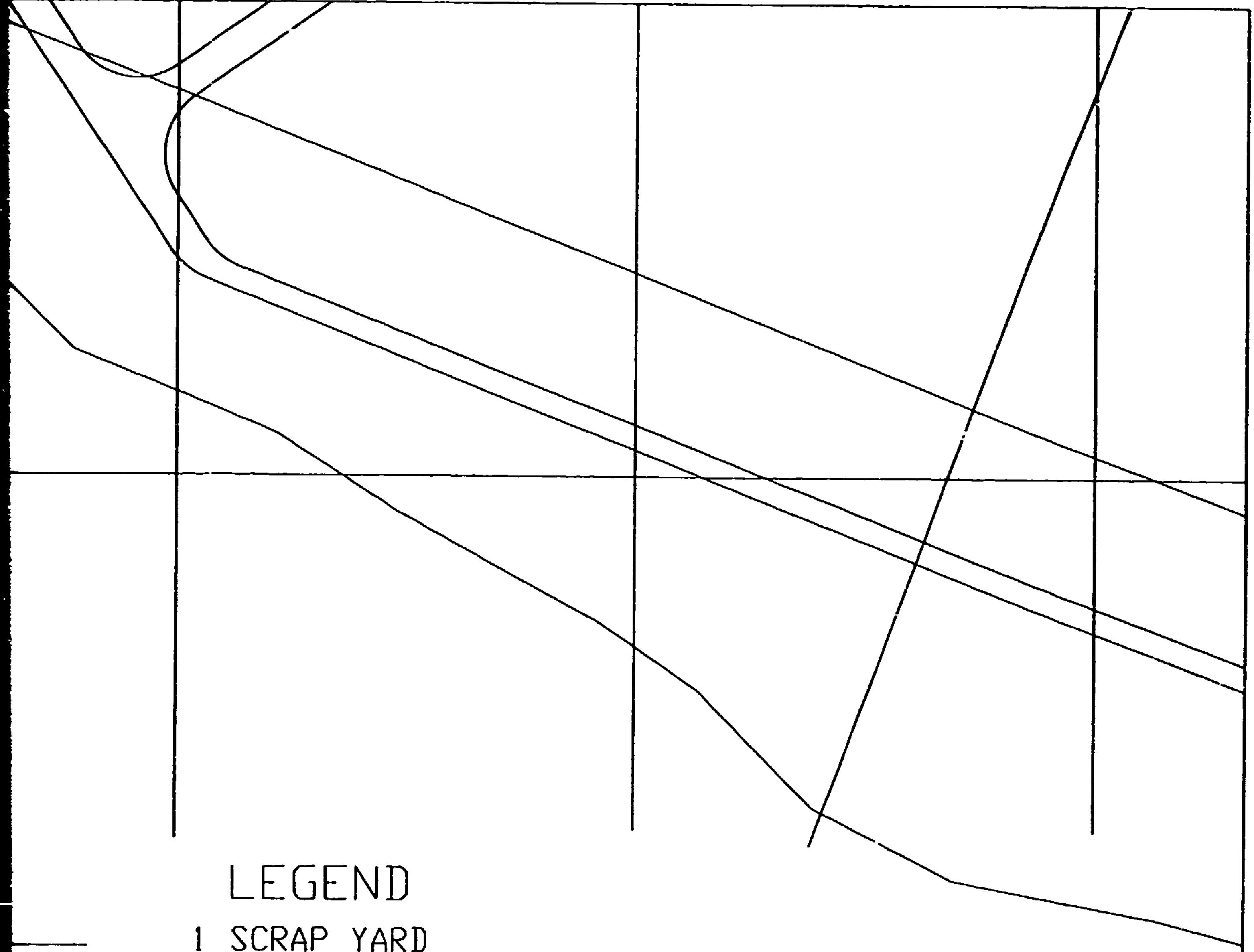

SECTION 5



LEGEND

1 SCRAP YARD
2 LD-STEEL PLANT
3 THIN SLAB CASTER
4 REHEATING FURNACE
5 HOT STRIP MILL
6 COIL STORAGE YARD
7 ROLL SHOP + MAINTENANCE
8 SCALE PIT
9 WATER TREATMENT PLANT FOR MELT SHOP & C
10 DEDUSTING PLANT FOR STEEL MELT SHOP
11 LABORATORY
12 OXYGEN PLANT
13 LIME PLANT
14 RAW MATERIAL STORAGE YARD
15 ELECTRIC MAIN STATION
16 GAS HOLDER
17 SLAG CRUSHING & SCREENING PLANT
18 PIG CASTING MACHINE
19 LADLE SHOP, REFRACTORIES STORE
20 DESULPHURIZING STAND
21 CENTRAL STORE
22 CENTRAL MAINTENANCE

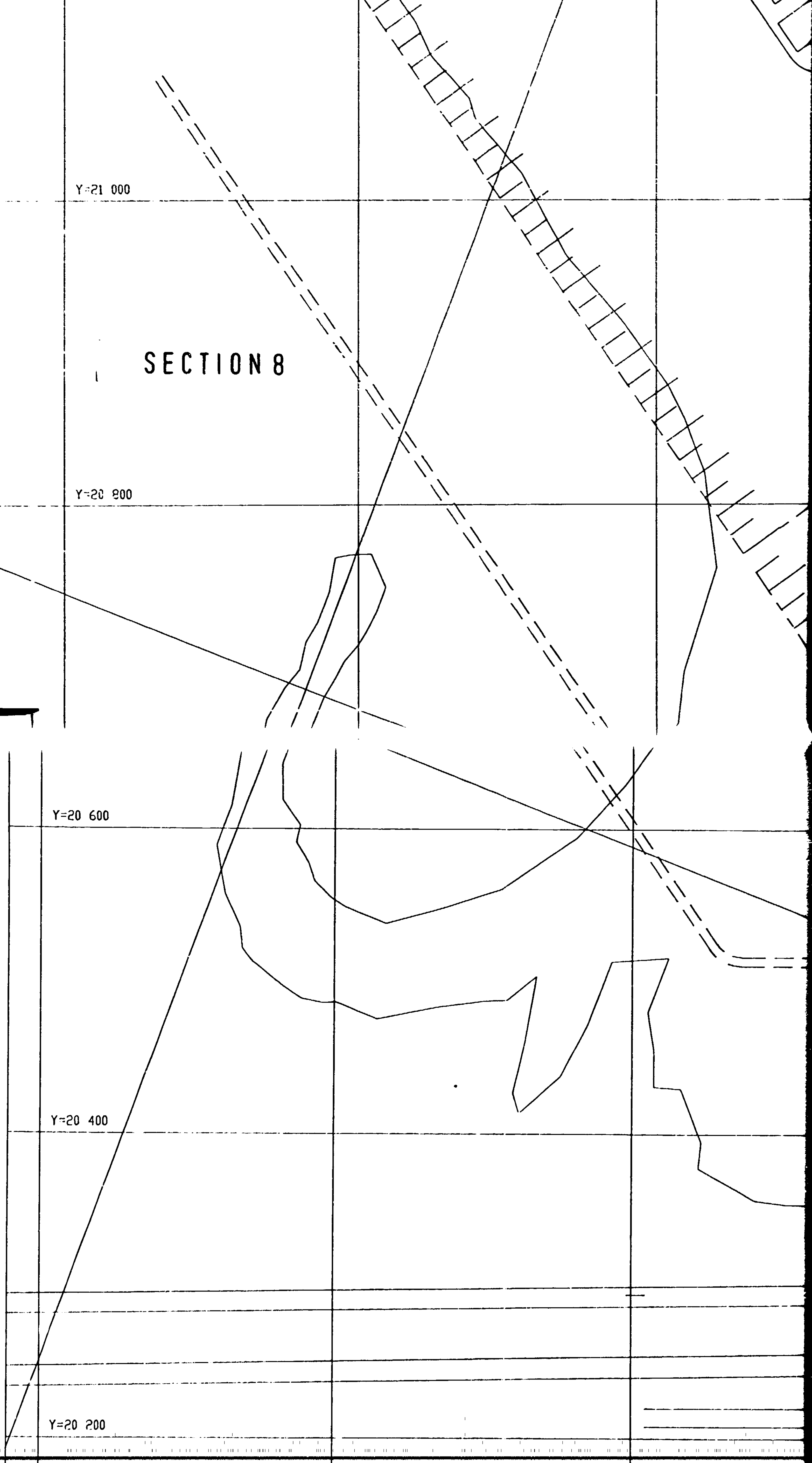
SECTION 6

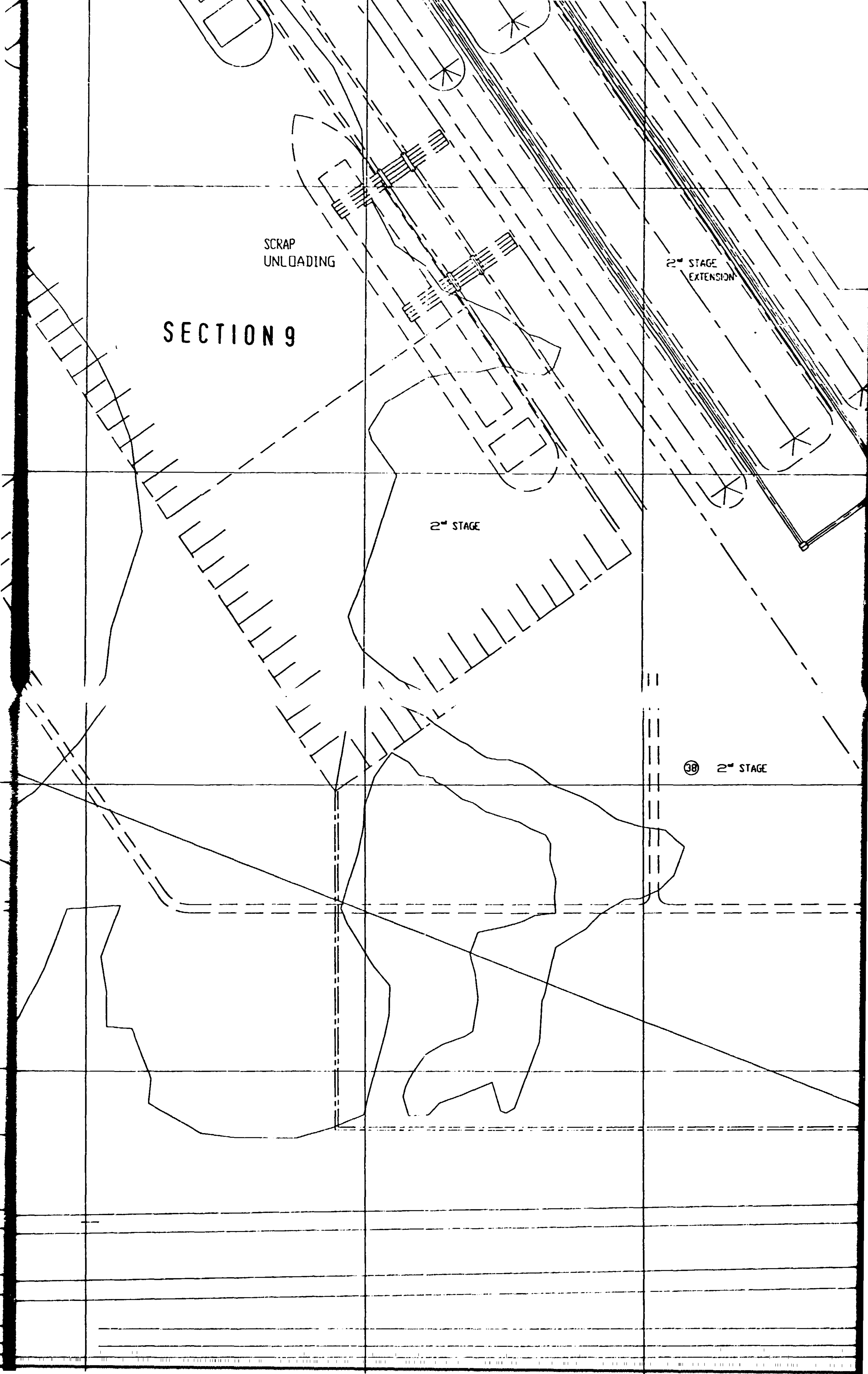


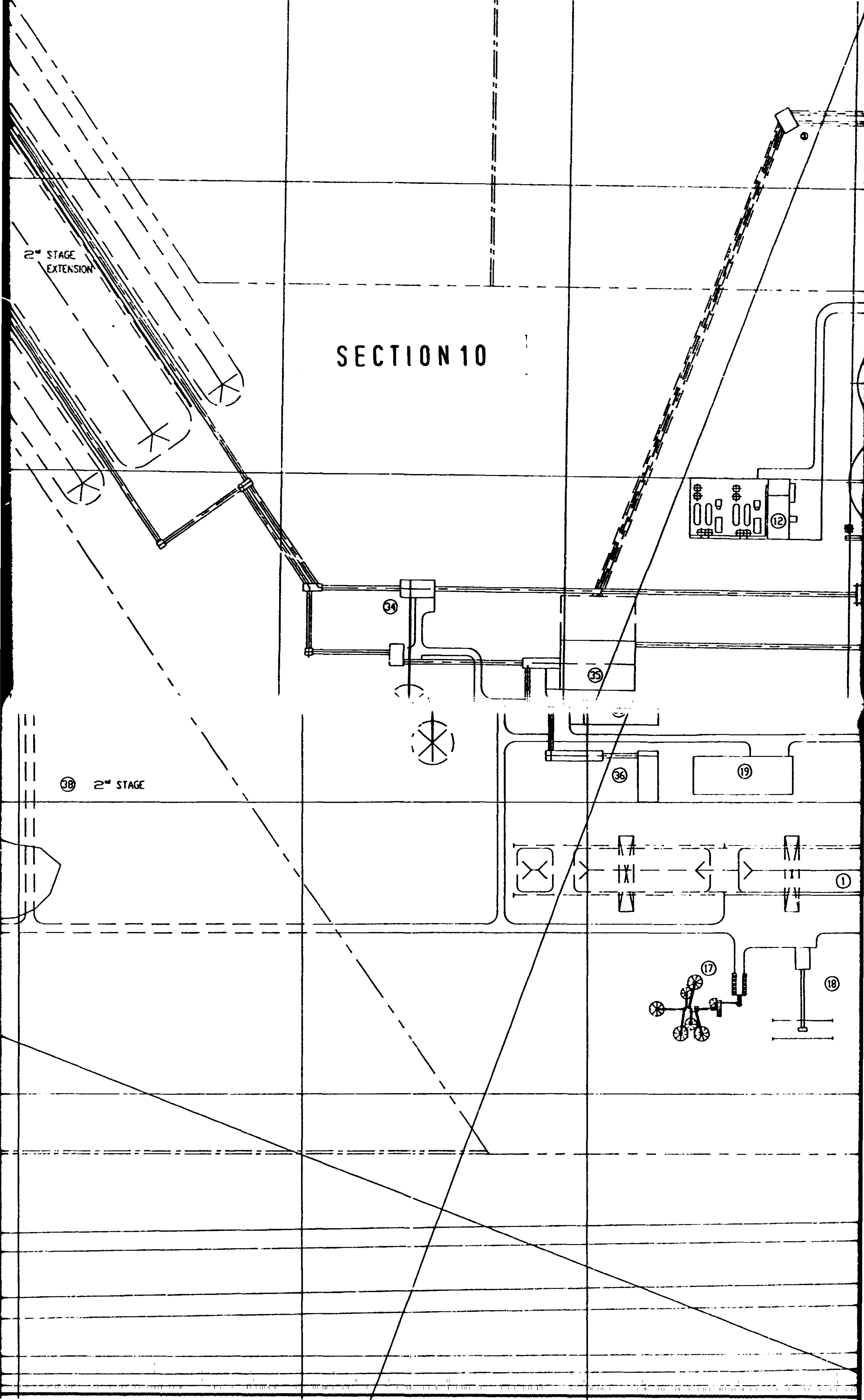
SECTION 7

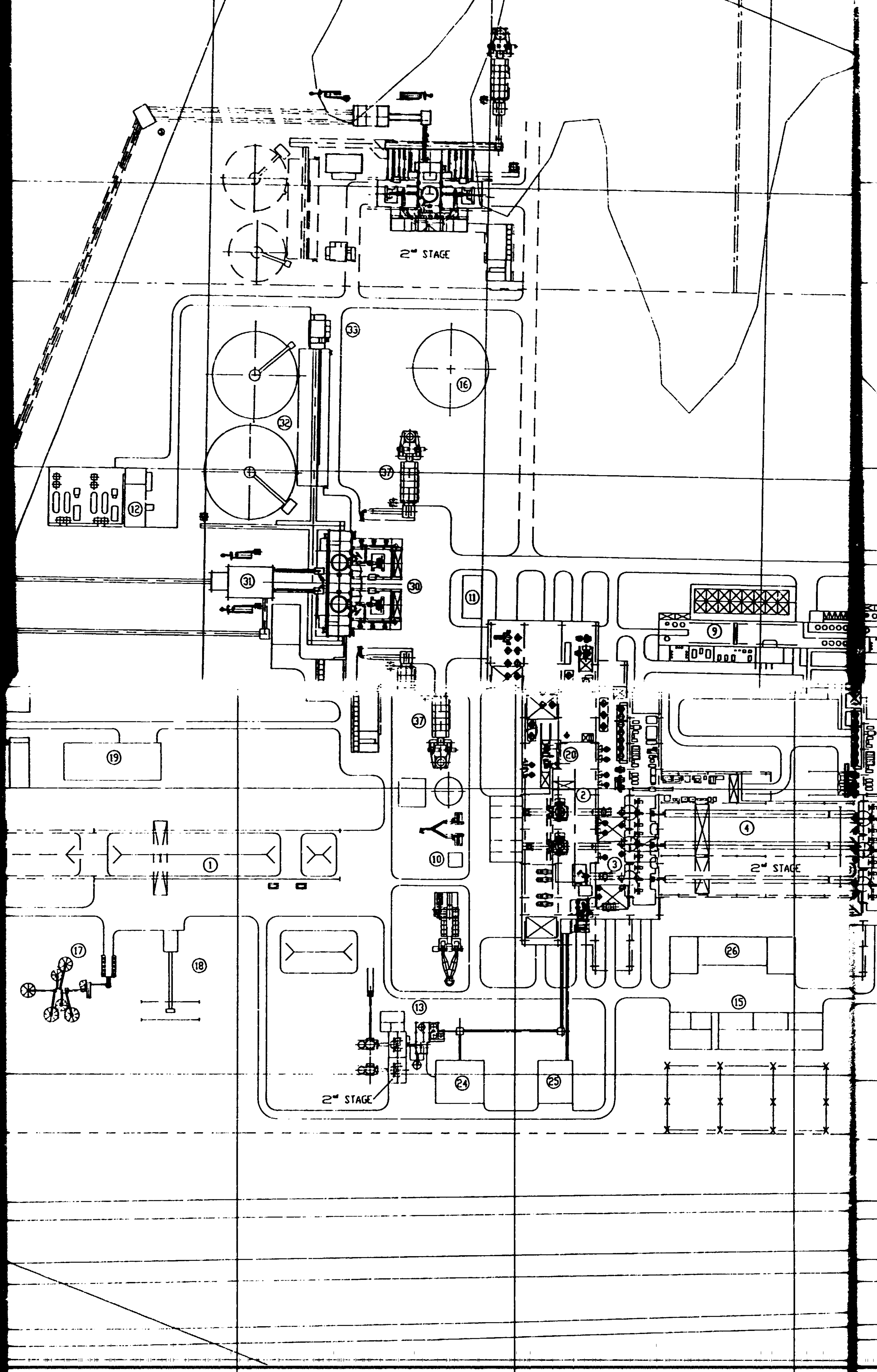
LEGEND

1 SCRAP YARD
2 LD-STEEL PLANT
3 THIN SLAB CASTER
4 REHEATING FURNACE
5 HOT STRIP MILL
6 COIL STORAGE YARD
7 ROLL SHOP + MAINTENANCE
8 SCALE PIT
9 WATER TREATMENT PLANT FOR MELT SHOP & CONROLL PLANT
10 DEDUSTING PLANT FOR STEEL MELT SHOP
11 LABORATORY
12 OXYGEN PLANT
13 LIME PLANT
14 RAW MATERIAL STORAGE YARD
15 ELECTRIC MAIN STATION
16 GAS HOLDER
17 SLAG CRUSHING & SCREENING PLANT
18 PIG CASTING MACHINE
19 LADLE SHOP, REFRACTORIES STORE
20 DESULPHURIZING STAND
21 CENTRAL STORE
22 CENTRAL MAINTENANCE

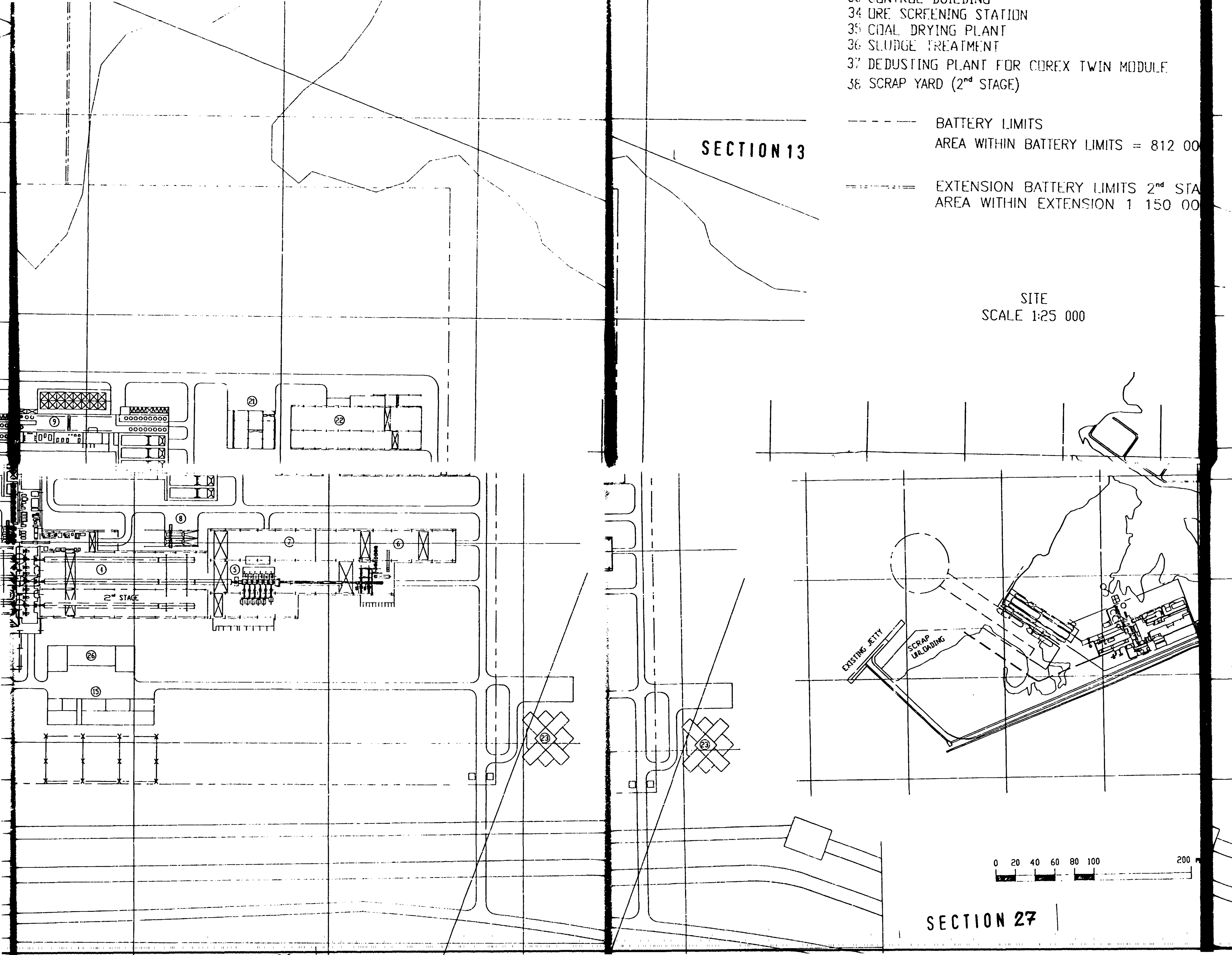

SECTION 8
Y=21 000
Y=20 800
Y=20 600
Y=20 400
Y=20 200


SCRAP
UNLOADING
SECTION 9
2nd STAGE
EXTENSION
2nd STAGE
38 2nd STAGE


2nd STAGE EXTENSION
SECTION 10
(12)
(34)
(35)
(36)
(19)
(38) 2nd STAGE
(1)
(17)
(18)



2nd STAGE
33
16
32
37
12
31
30
11
9
20
2
19
37
4
1
10
3
2nd STAGE
17
18
26
13
15
24
25
2nd STAGE

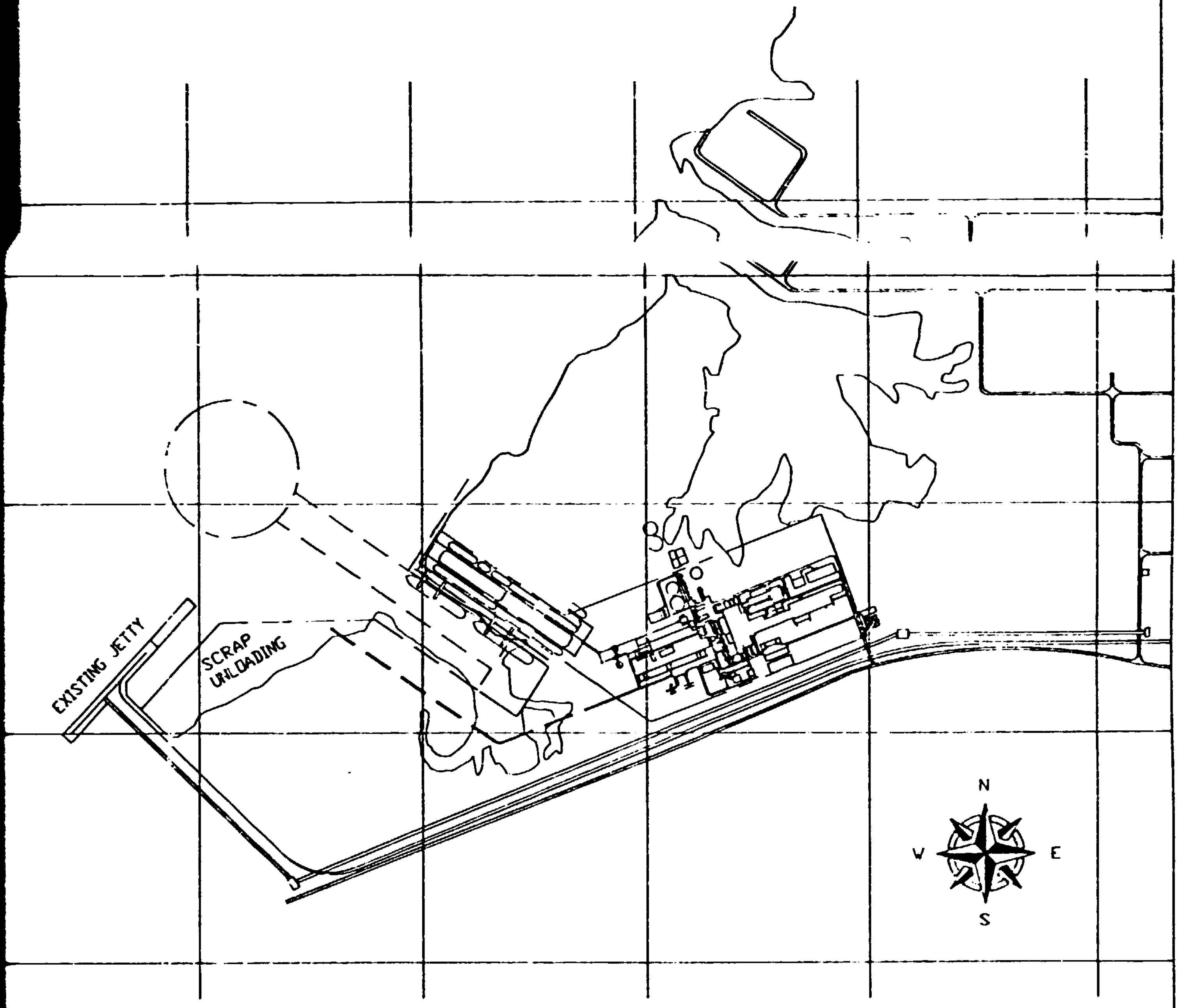

34 ORE SCREENING STATION
35 COAL DRYING PLANT
36 SLUDGE TREATMENT
37 DEDUSTING PLANT FOR COREX TWIN MODULE
38 SCRAP YARD (2nd STAGE)
BATTERY LIMITS
AREA WITHIN BATTERY LIMITS = 812 00
EXTENSION BATTERY LIMITS 2nd STA
AREA WITHIN EXTENSION 1 150 00
SECTION 13
SITE
SCALE 1:25 000
2nd STAGE
EXISTING JETTY
SCRAP UNLOADING
0 20 40 60 80 100
200
SECTION 27

33 CONTROL BUILDING
34 ORE SCREENING STATION
35 COAL DRYING PLANT
36 SLUDGE TREATMENT
37 DEDUSTING PLANT FOR COREX TWIN MODULE
38 SCRAP YARD (2nd STAGE)

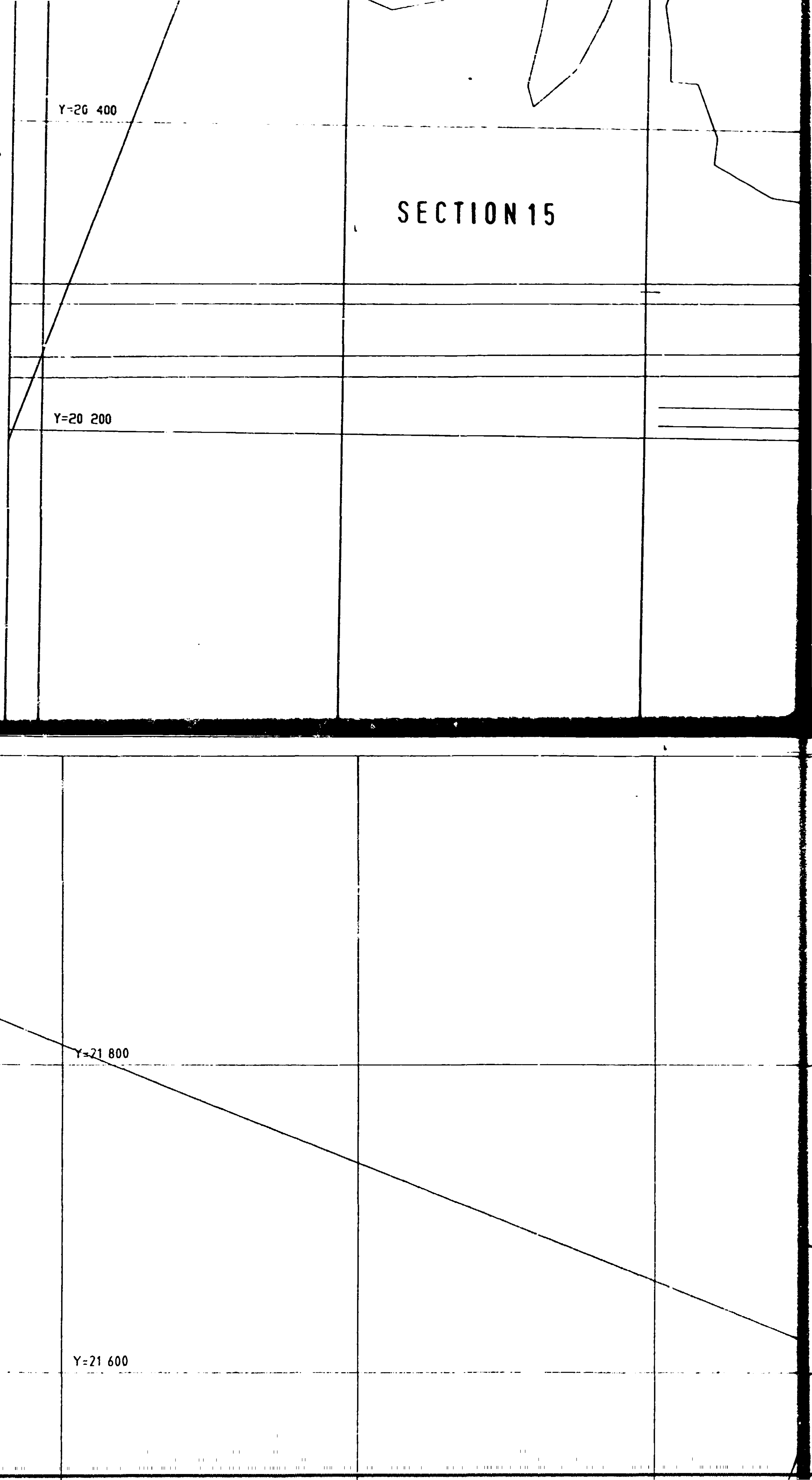
- - - - - - BATTERY LIMITS
AREA WITHIN BATTERY LIMITS = 812 000 m²

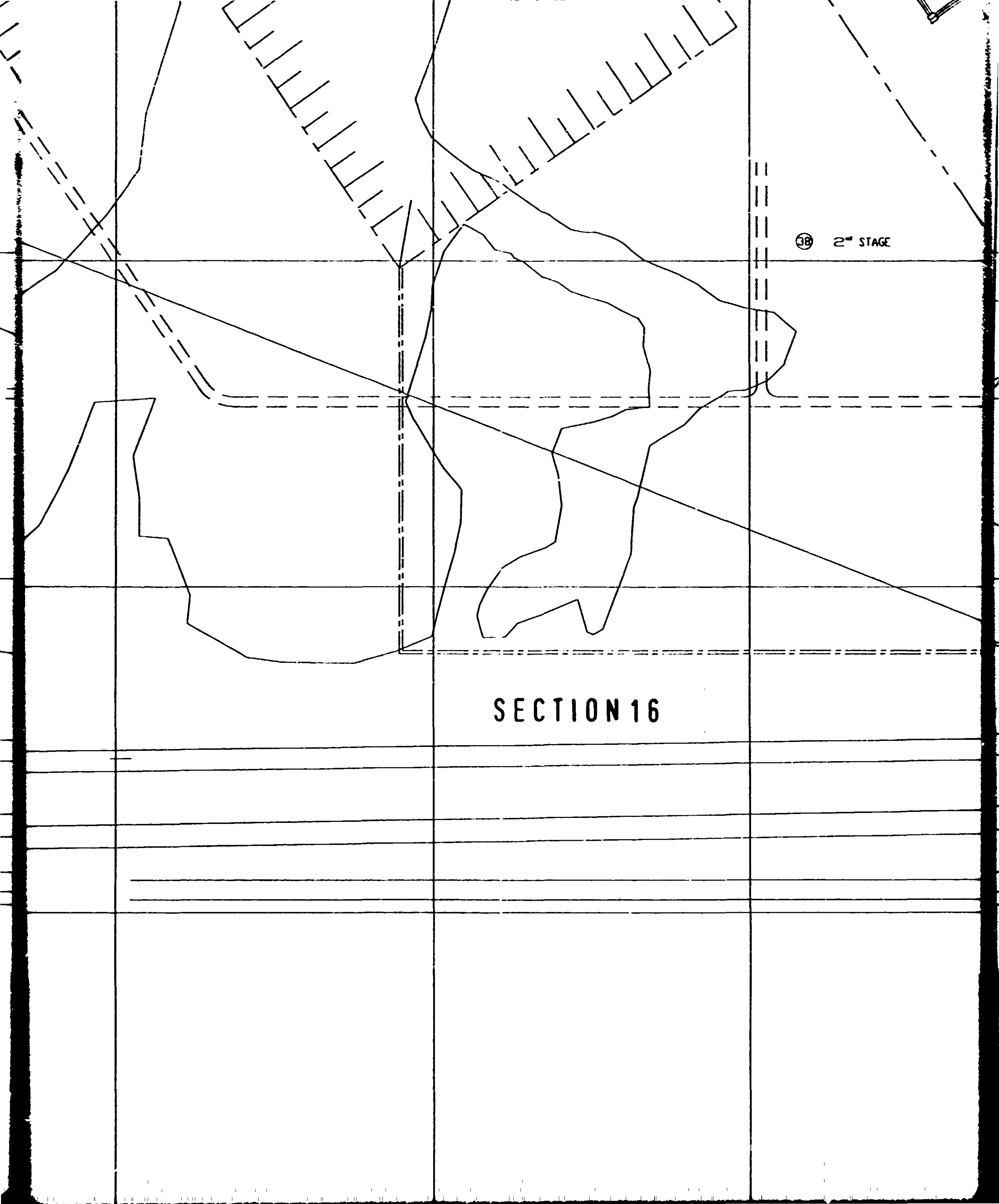
- - - - - - EXTENSION BATTERY LIMITS 2nd STAGE
AREA WITHIN EXTENSION 1 150 000 m²

SITE
SCALE 1:25 000

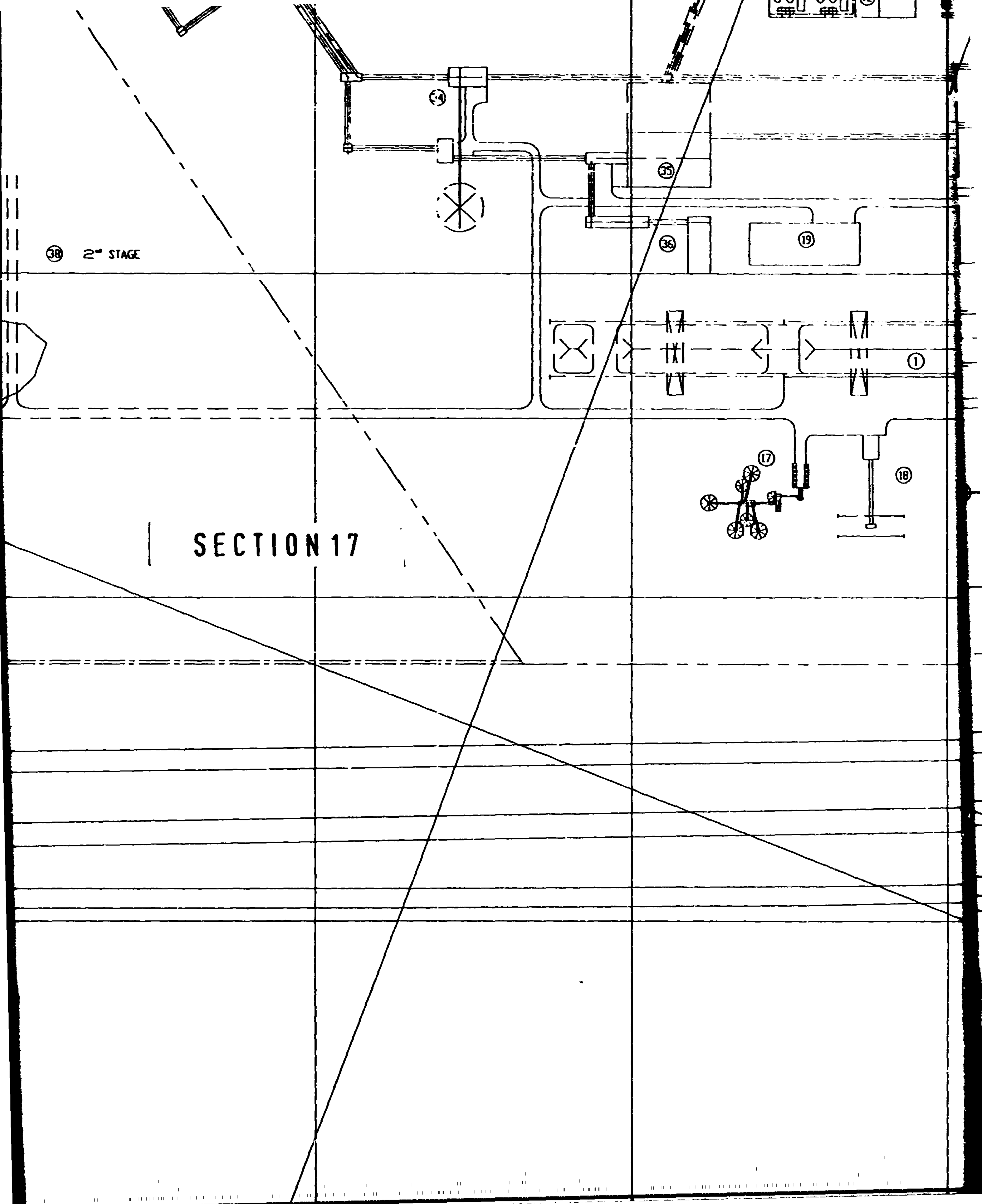


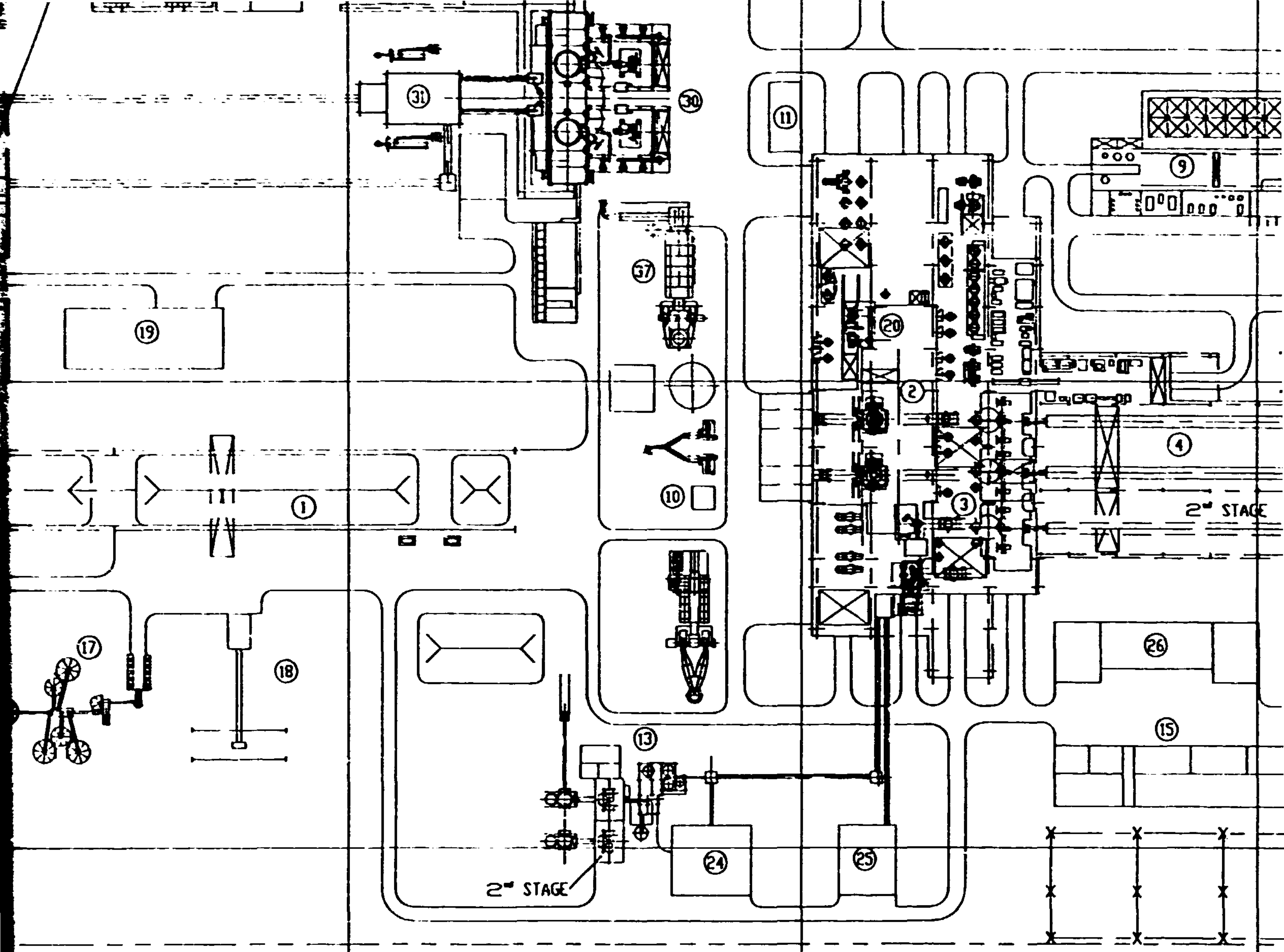
SECTION 28


Y=20 400
SECTION 15
Y=20 200
Y=21 800
Y=21 600

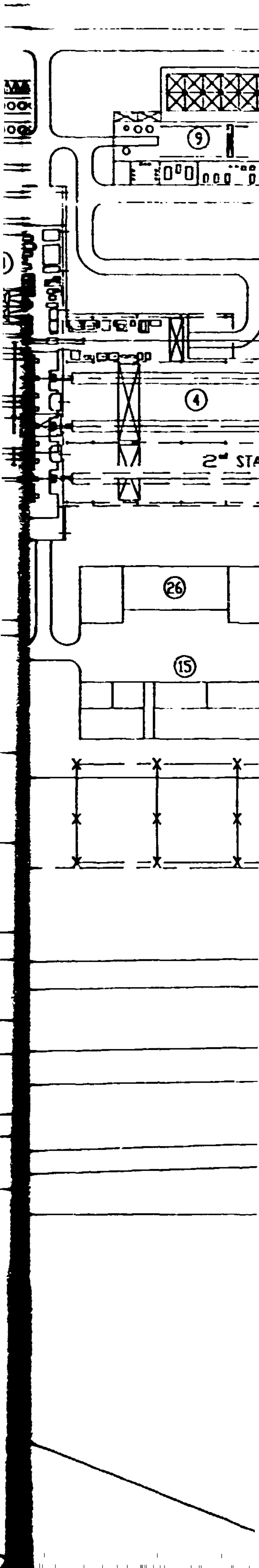


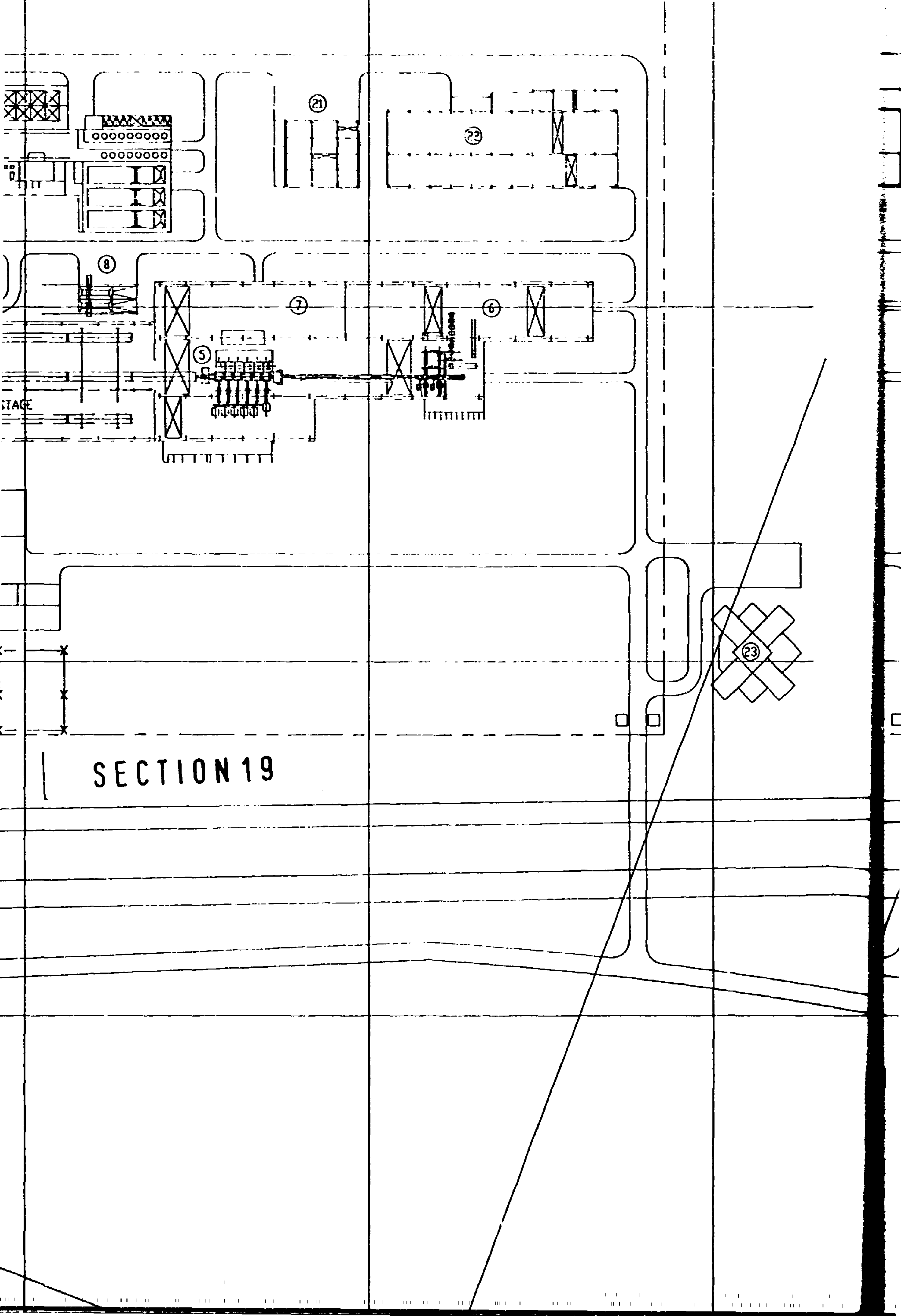
38 2nd STAGE
SECTION 16

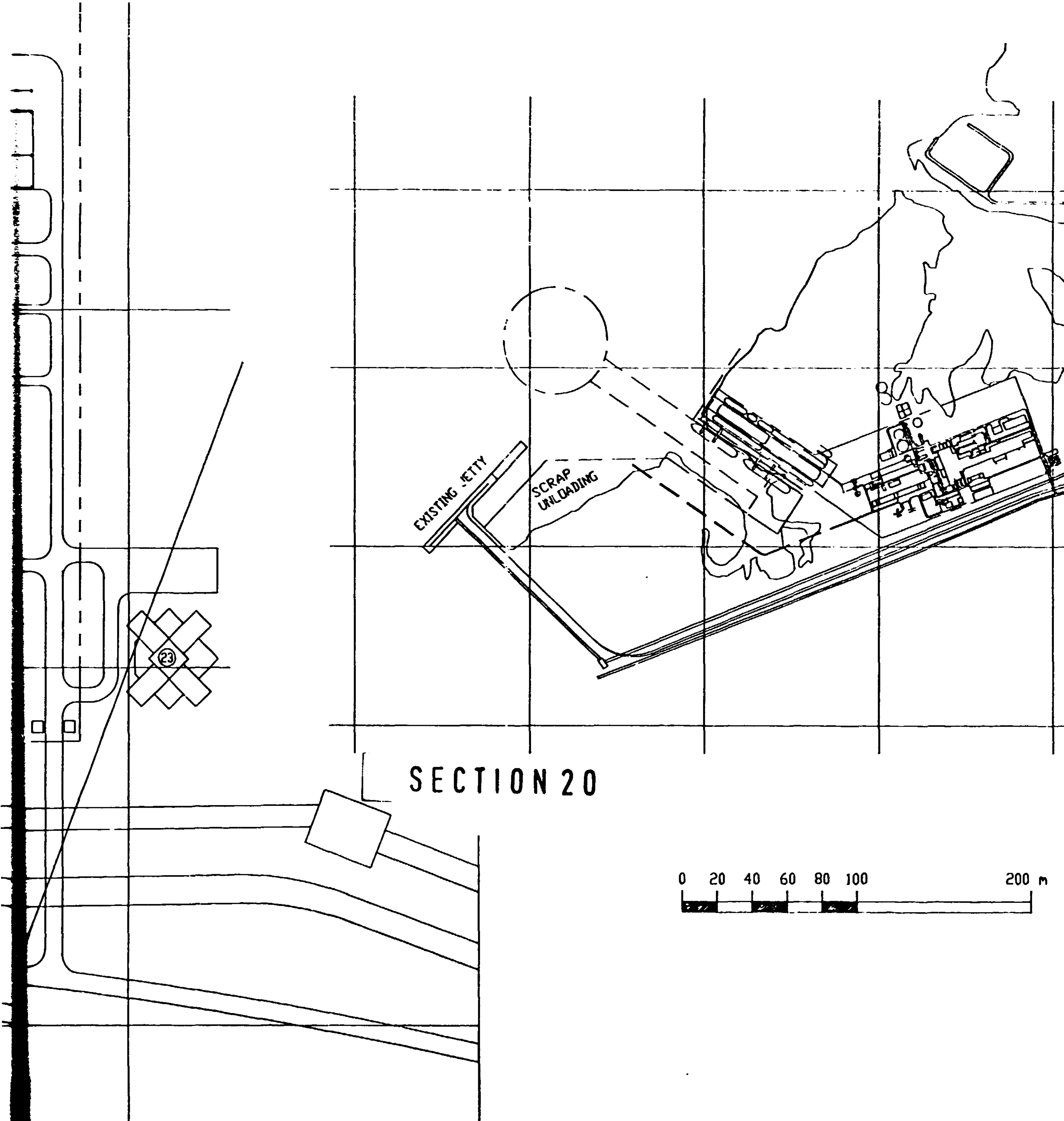

34
35
36
19
38 2nd STAGE
1
17
18
SECTION 17



SECTION 18


9
4
2nd STA
26
15

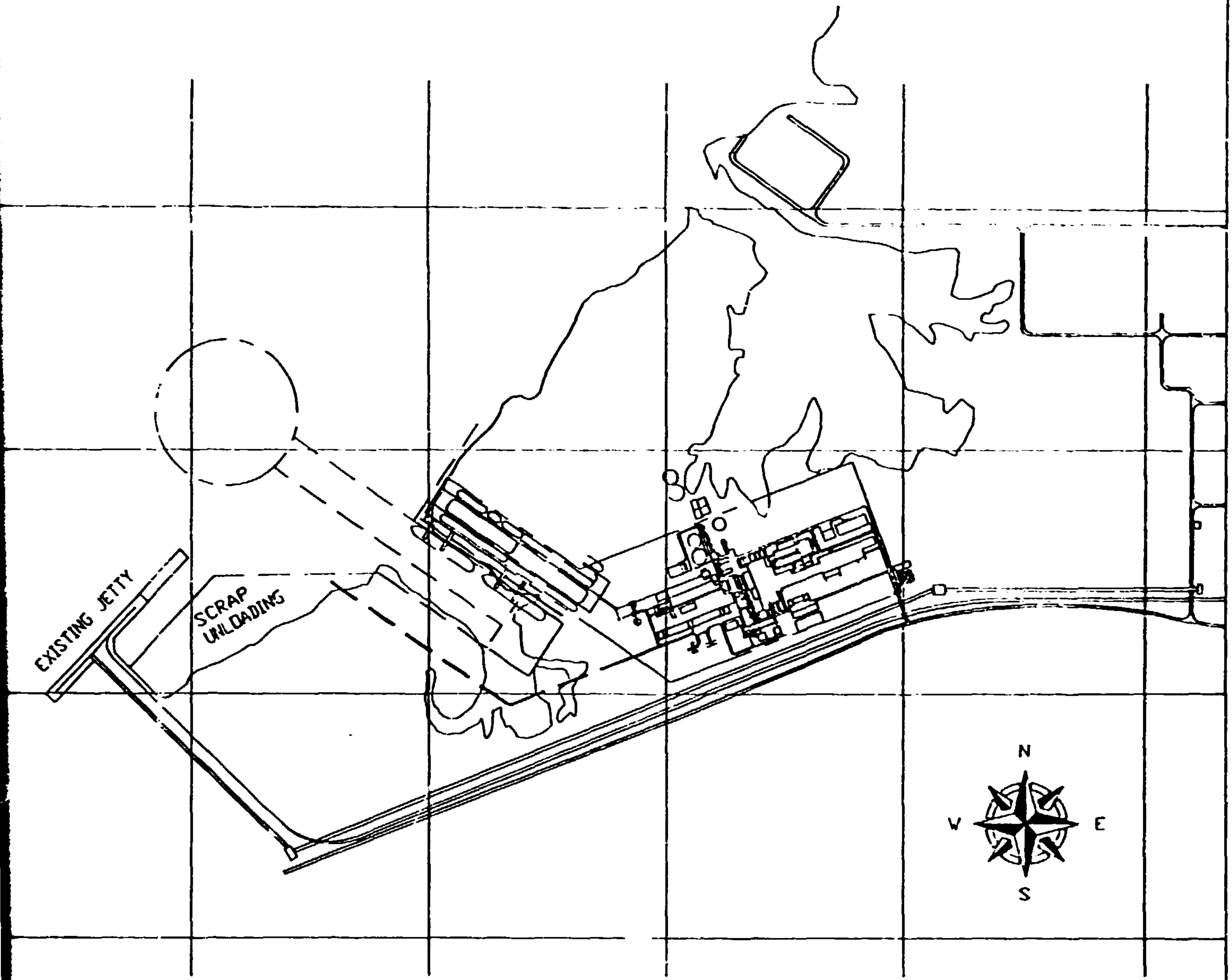

21
22
8
7
6
5
STAGE
23
SECTION 19



Anderung Revision	Anz. d. And. No. of Mod.	Anderungsinhalt Modification

1993	Datum Date	Name Name		VAR. 2\2
Bearbeitet Made by	11-25	P.F.		COREX-LD-R
Geprüft Checked by			CAD	BS/RC/SL 2.35/CD

Benennung Title: PROJECT SGSM/INDONESIA



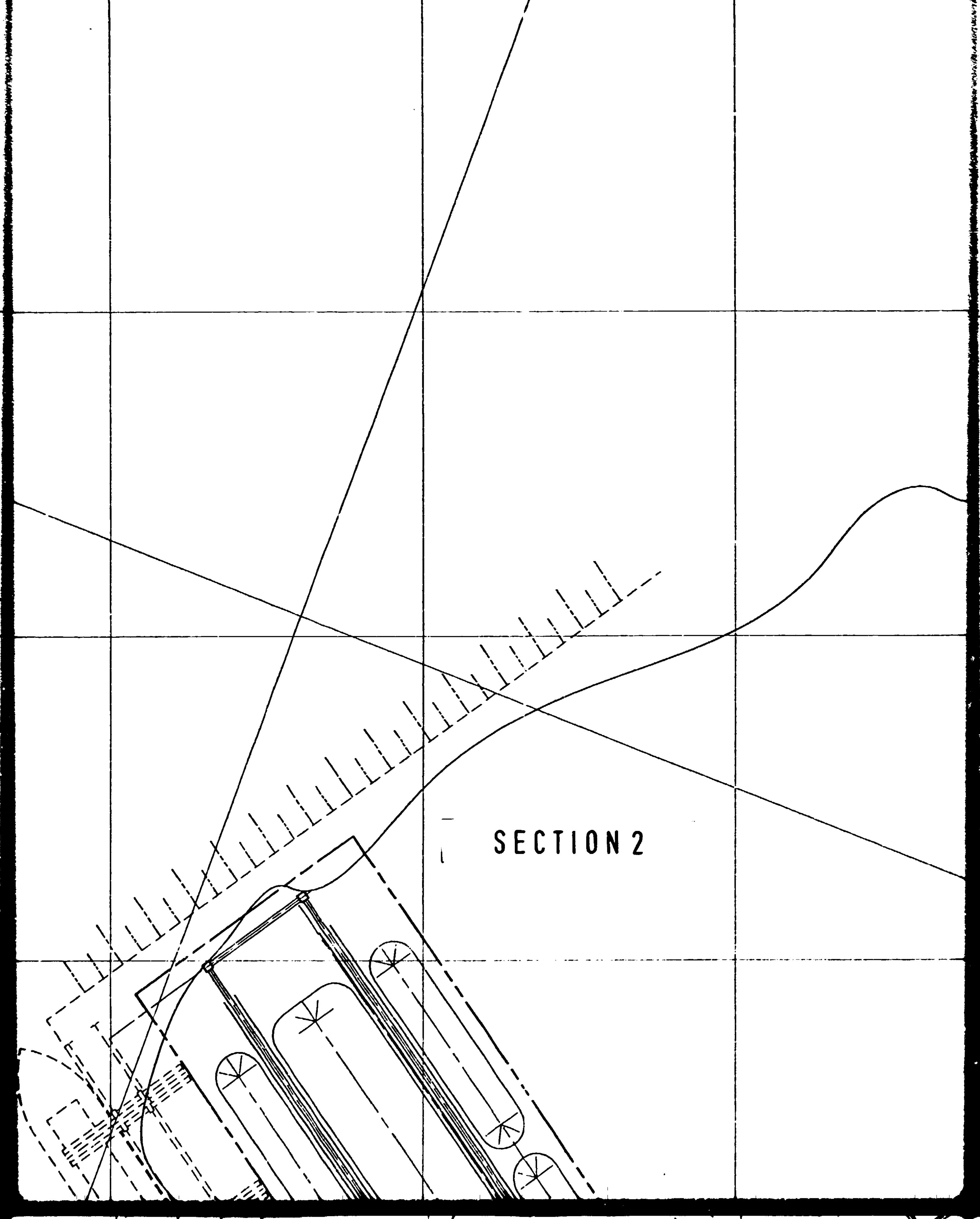
SECTION 21

0 20 40 60 80 100 200 m

Änderung Revision	Anz. d. Änd. No. of Mod.	Änderungsinhalt Modification	Datum Date	Bearbeitet Made by	Geprüft Checked by

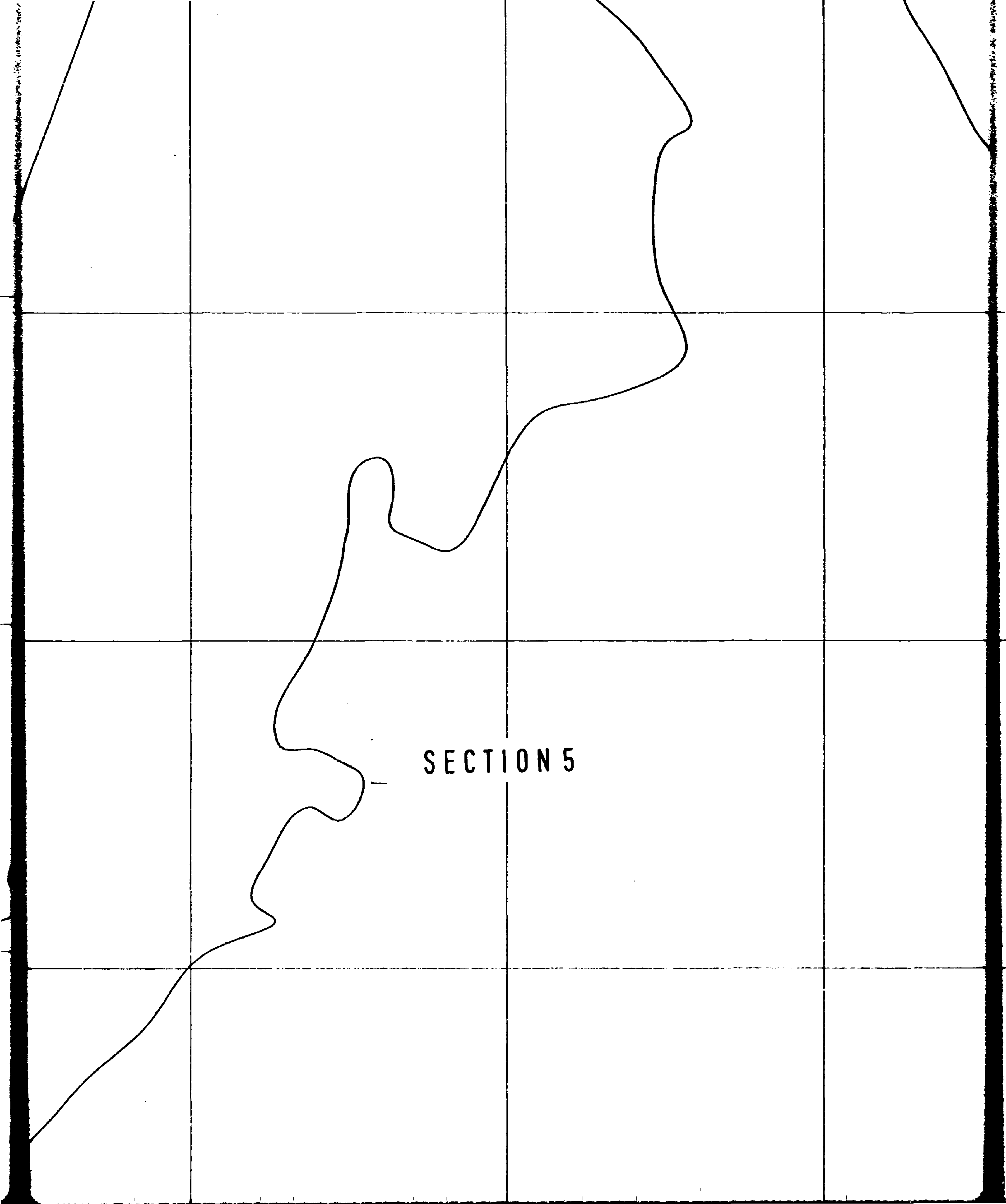
	Datum Date	Name Name		
1993				VAR. 2\2
Bearbeitet Made by	11-25	P.F.		COREX-LD-ROUTE
Geprüft Checked by			CAD	BS/RC/SL 2.35/CD/WT/IH

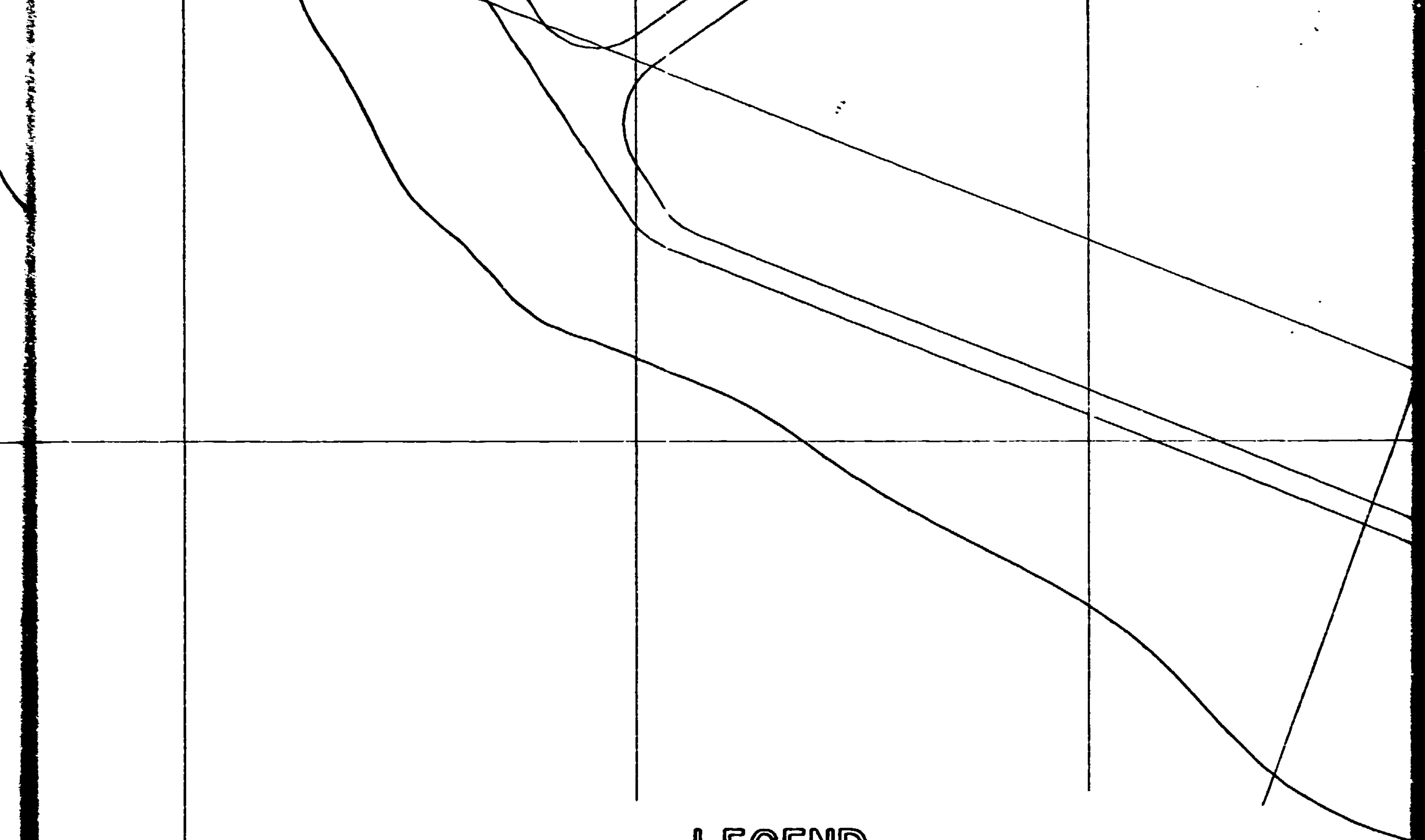
UNIDO


SECTION 2

SECTION 3

SECTION 4

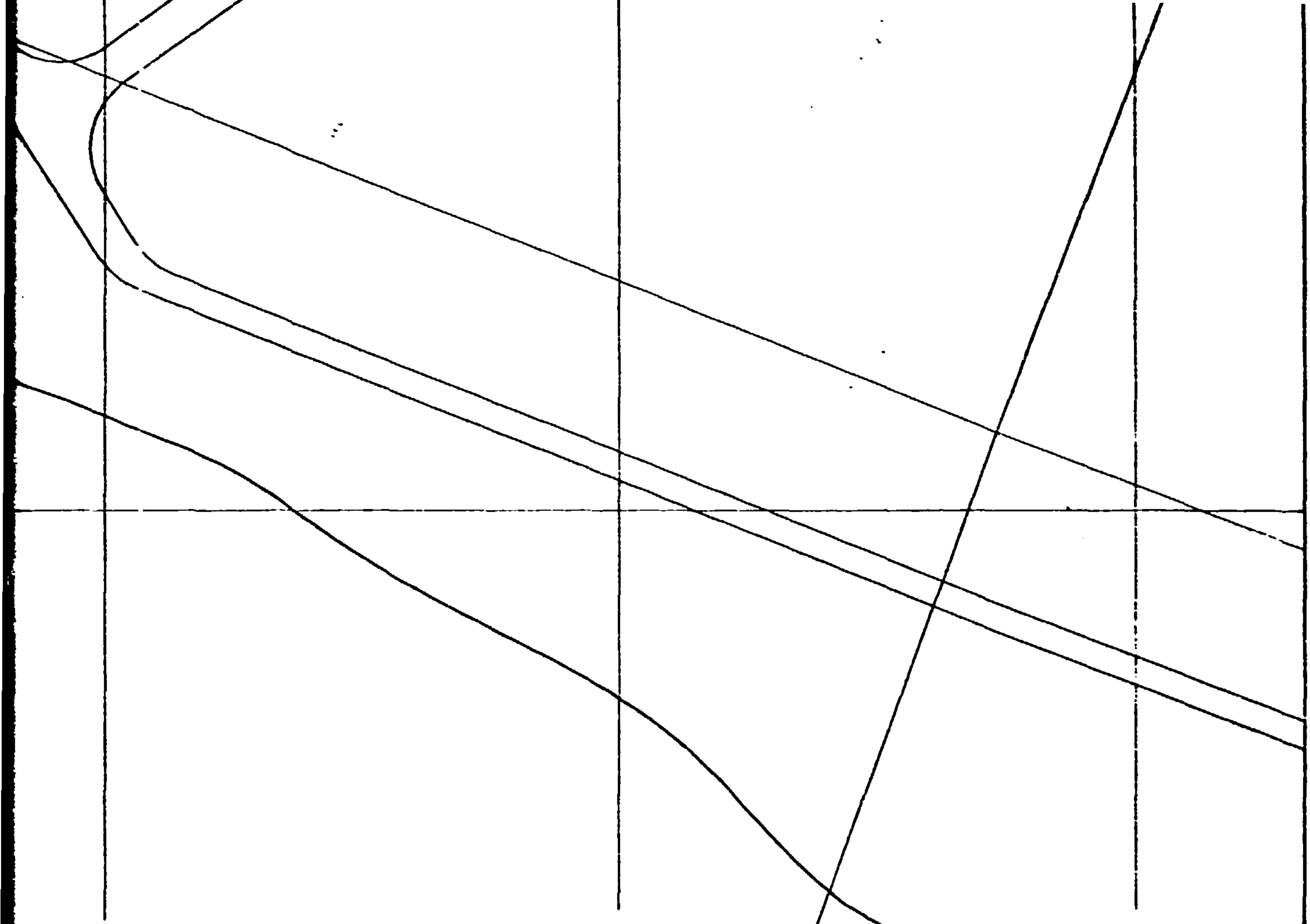

SECTION 5



LEGEND

SECTION 6

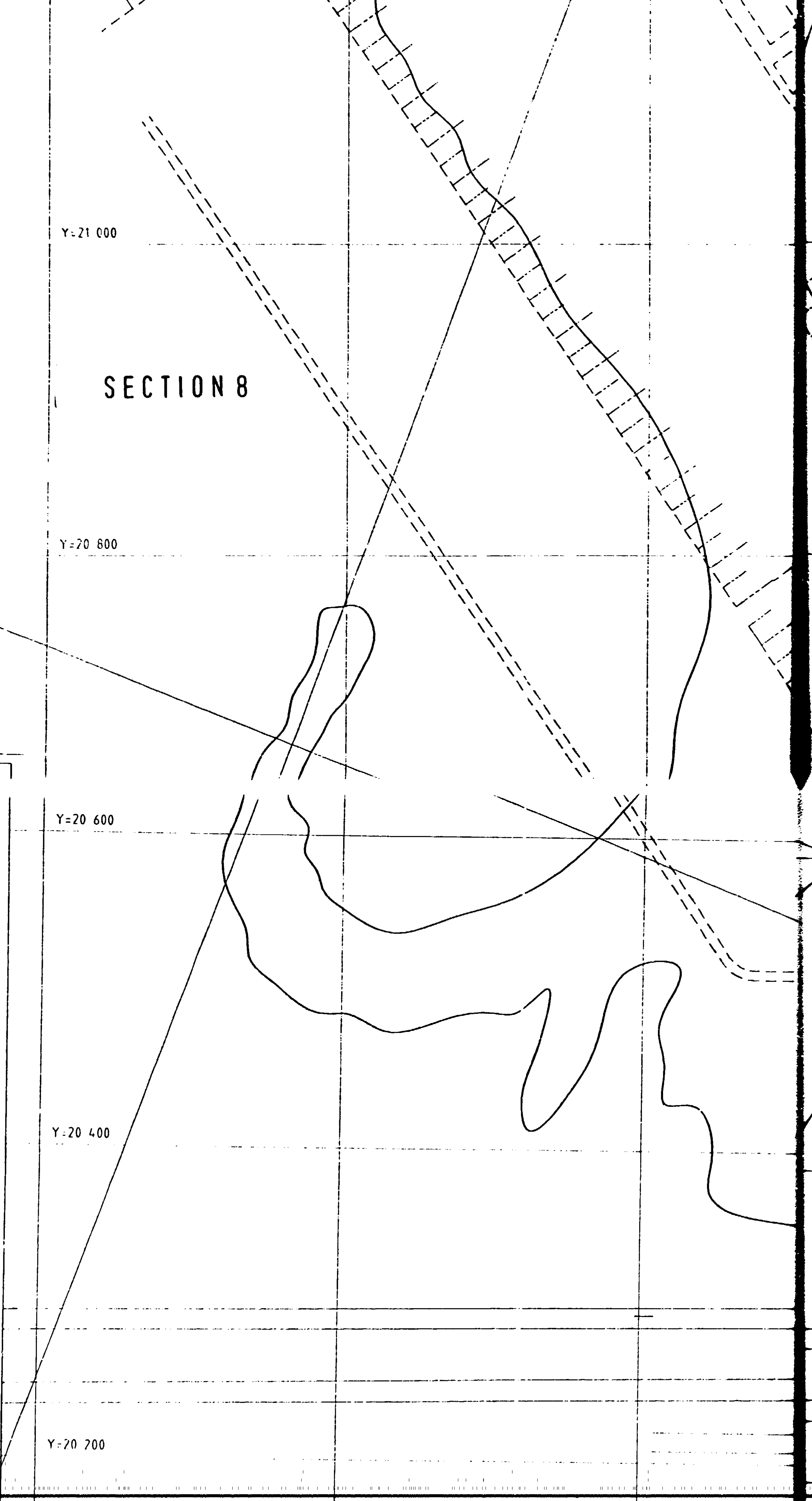
1 SCRAP YARD
2 LD-STEEL PLANT
3 THIN SLAB CASTER
4 REHEATING FURNACE
5 HOT STRIP MILL
6 COIL STORAGE YARD
7 ROLL SHOP + MAINTENANCE
8 SCALE PIT
9 WATER TREATMENT PLANT FOR MELT SHOP &
10 DEDUSTING PLANT FOR STEEL MELT SHOP
11 LABORATORY
12 OXYGEN PLANT
13 LIME PLANT
14 RAW MATERIAL STORAGE YARD
15 ELECTRIC MAIN STATION
16 GAS HOLDER
17 SLAG CRUSHING & SCREENING PLANT
18 PIG CASTING MACHINE
19 LADLE SHOP, REFRACTORIES STORE
20 DESULPHURIZING STAND
21 CENTRAL STORE
22 CENTRAL MAINTENANCE



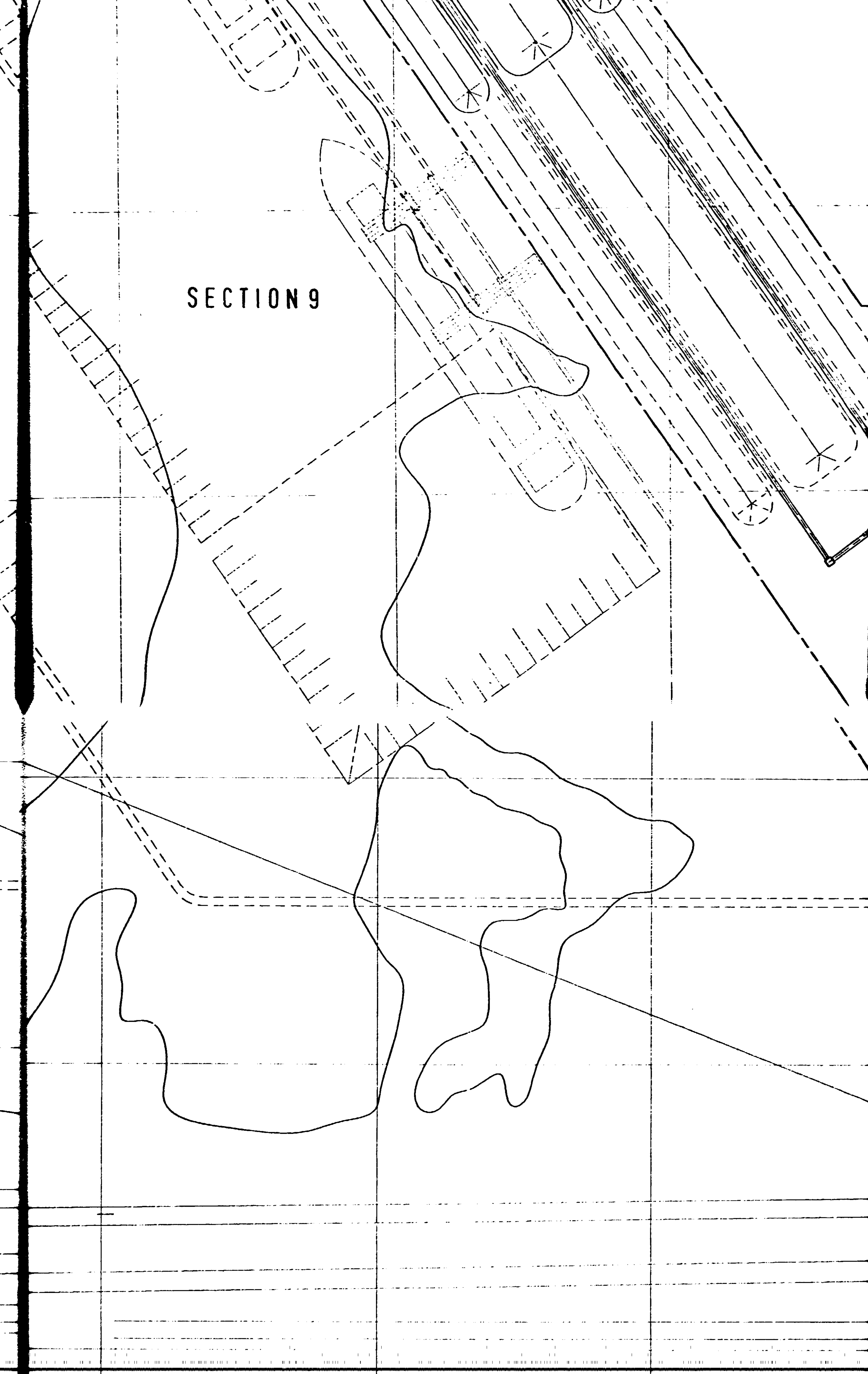
LEGEND

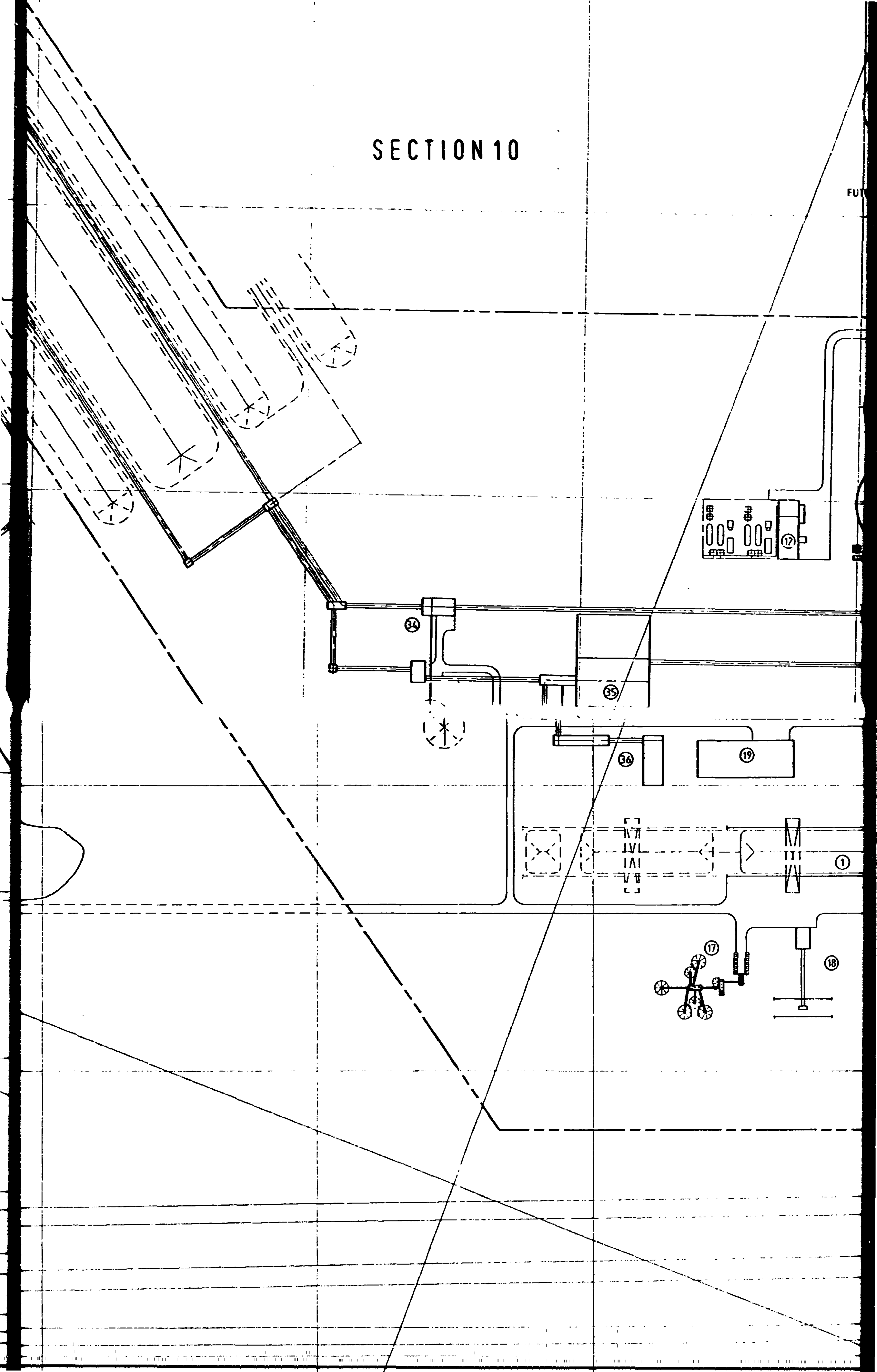
1 SCRAP YARD
2 LD-STEEL PLANT
3 THIN SLAB CASTER
4 REHEATING FURNACE
5 HOT STRIP MILL
6 COIL STORAGE YARD
7 ROLL SHOP + MAINTENANCE
8 SCALE PIT
9 WATER TREATMENT PLANT FOR MELT SHOP & CONROLL PLANT
10 DEDUSTING PLANT FOR STEEL MELT SHOP
11 LABORATORY
12 OXYGEN PLANT
13 LIME PLANT
14 RAW MATERIAL STORAGE YARD
15 ELECTRIC MAIN STATION
16 GAS HOLDER
17 SLAG CRUSHING & SCREENING PLANT
18 PIG CASTING MACHINE
19 LADLE SHOP, REFRACTORIES STORE
20 DESULPHURIZING STAND
21 CENTRAL STORE
22 CENTRAL MAINTENANCE

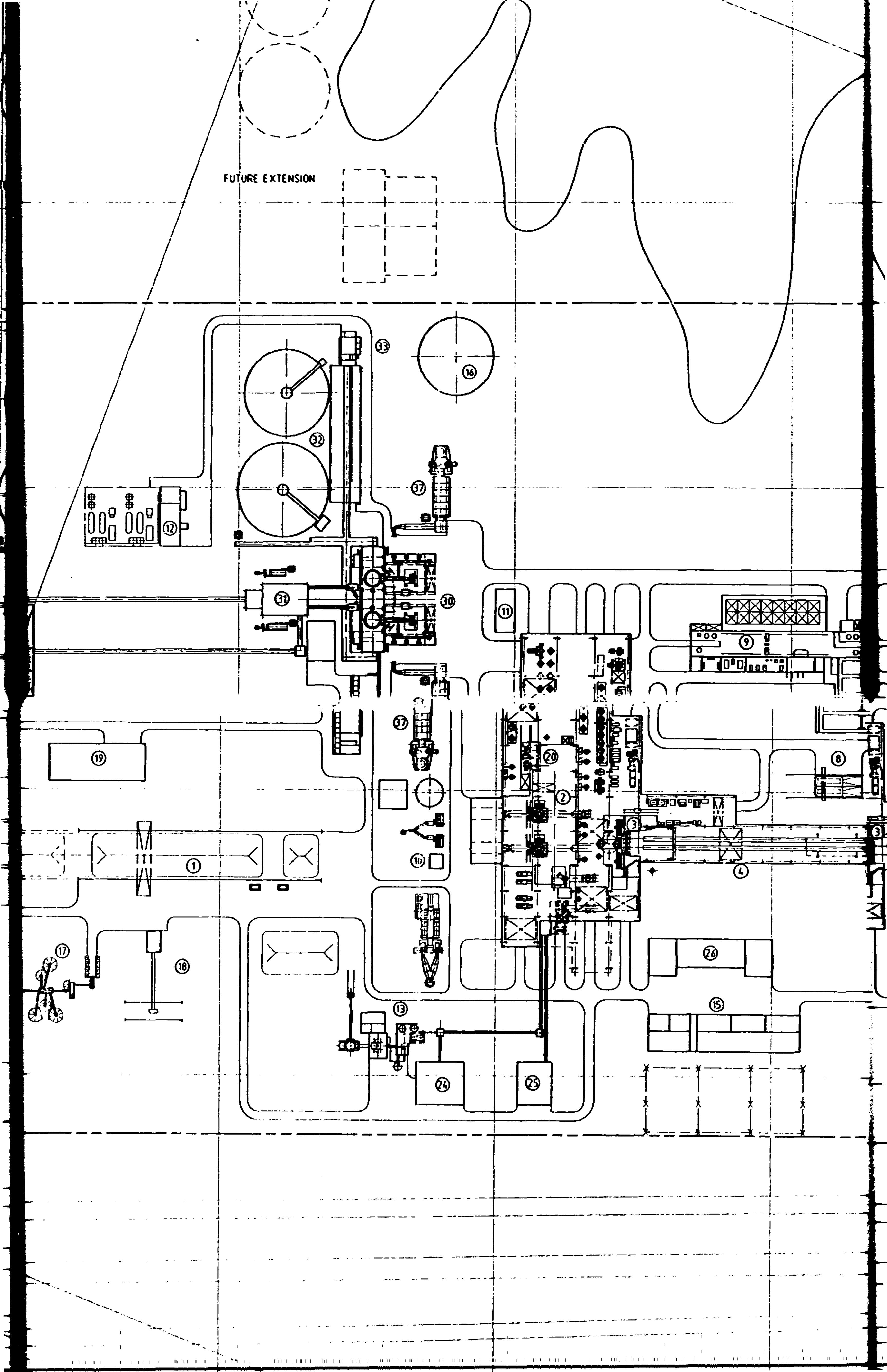
SECTION 7

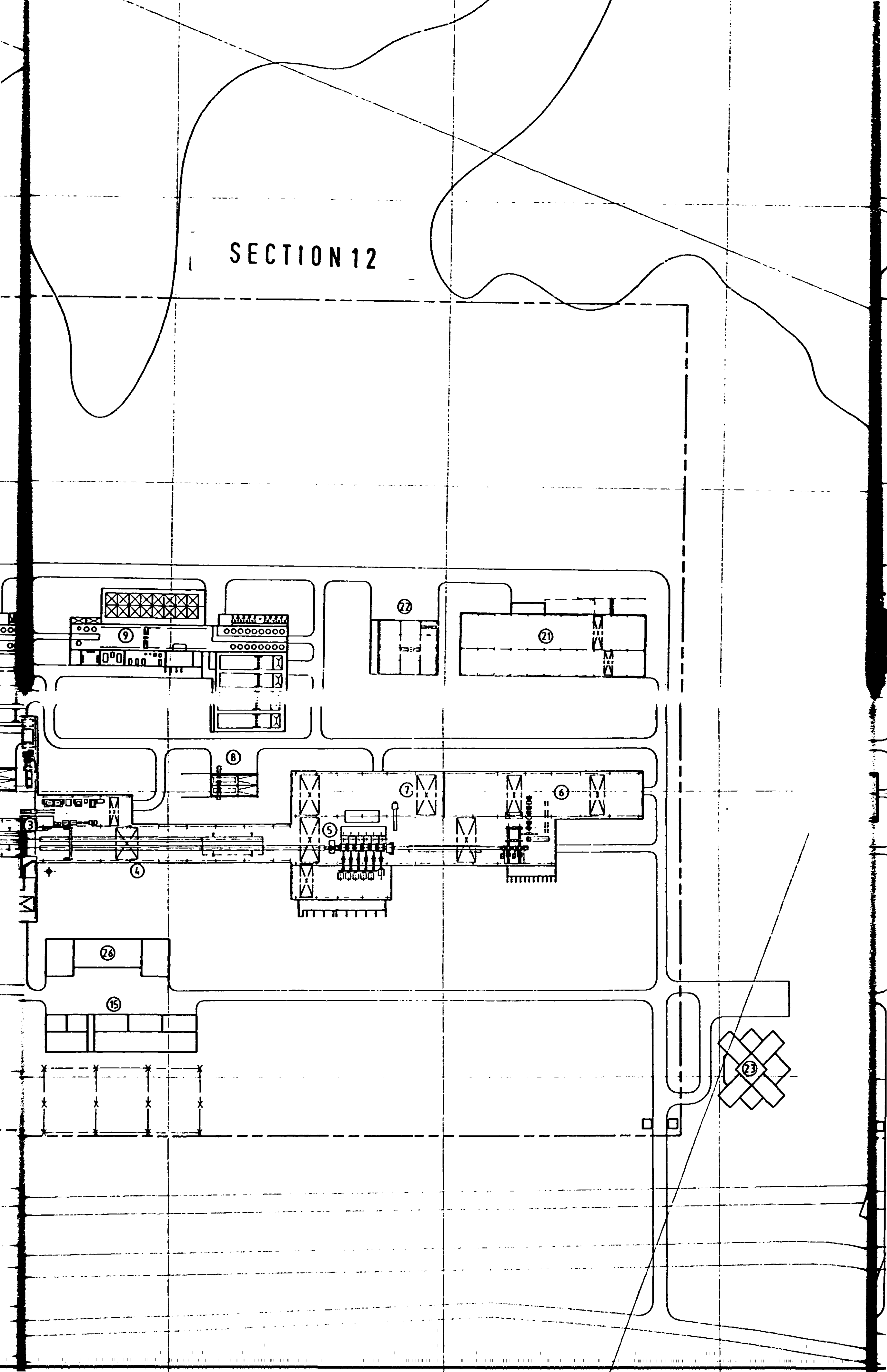


Y=21 000
SECTION 8
Y=20 800
Y=20 600
Y=20 400
Y=20 200

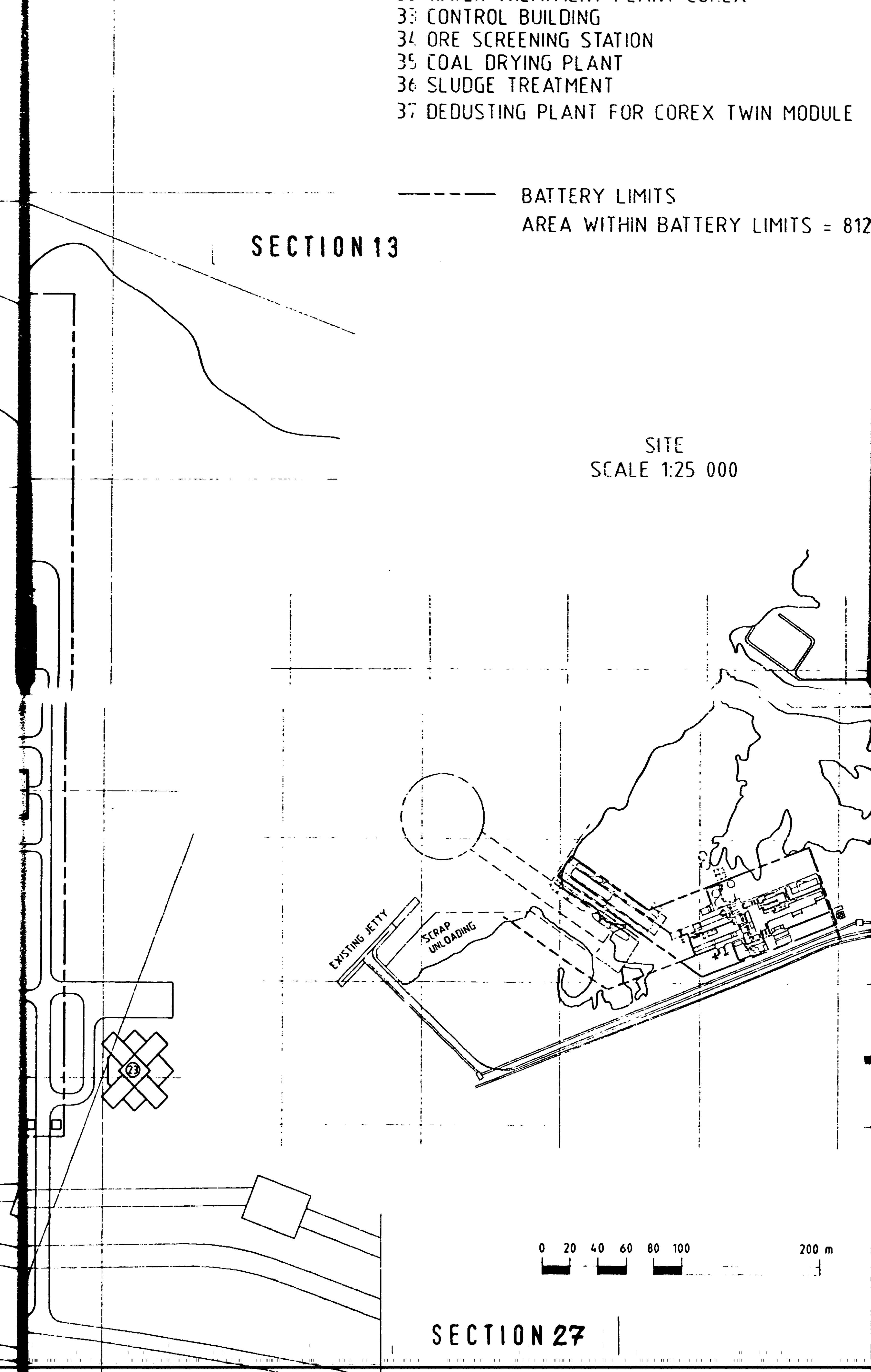

SECTION 9


SECTION 10
FUT
17
34
35
36
19
1
17
18


FUTURE EXTENSION
33
16
32
37
12
31
30
11
9
20
8
2
3
3
19
4
1
10
17
18
26
13
15
24
25



SECTION 12
22
21
9
8
7
6
5
3
4
26
15
23

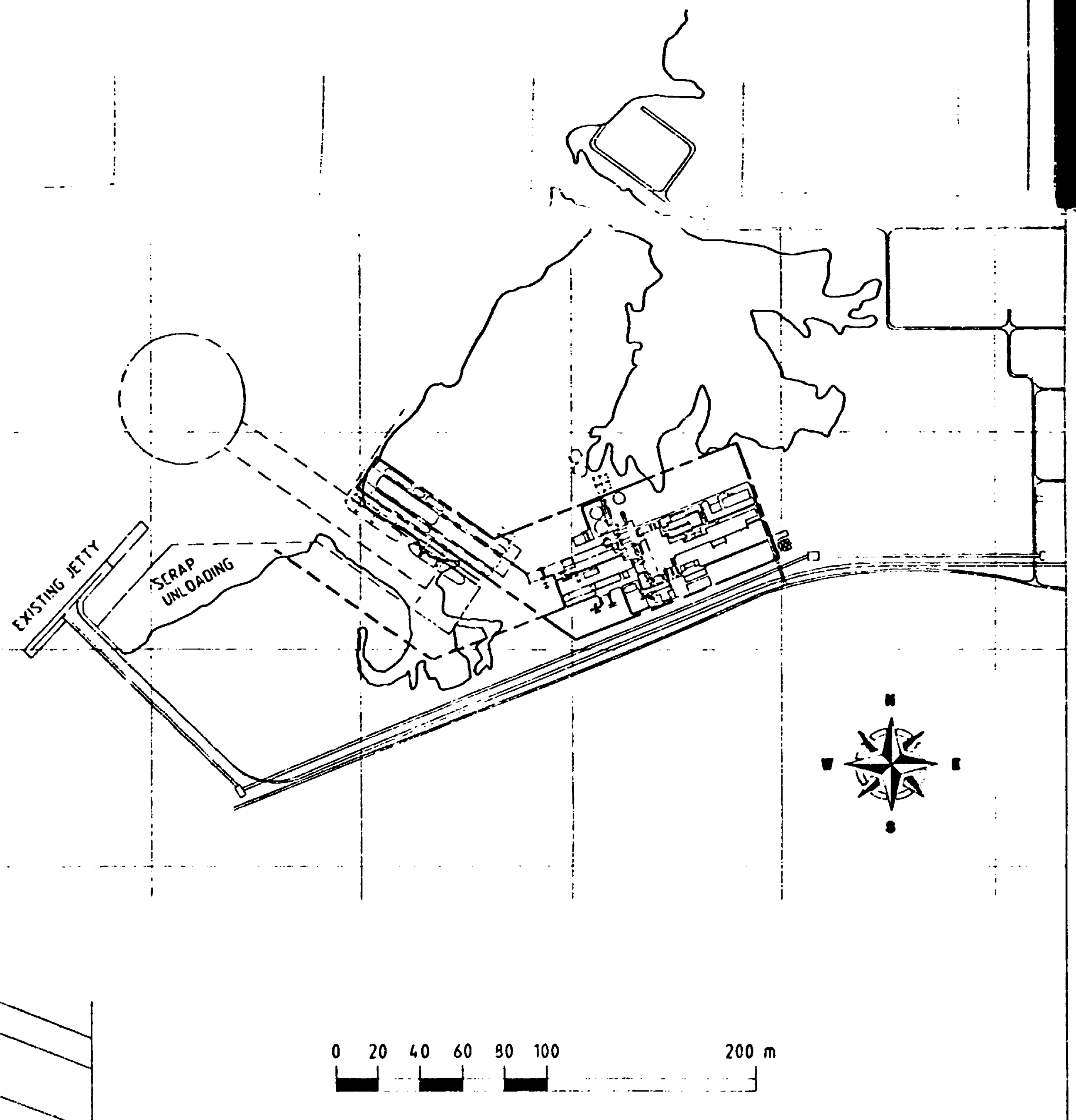

33 CONTROL BUILDING
34 ORE SCREENING STATION
35 COAL DRYING PLANT
36 SLUDGE TREATMENT
37 DEDUSTING PLANT FOR COREX TWIN MODULE
BATTERY LIMITS
AREA WITHIN BATTERY LIMITS = 812
SECTION 13
SITE
SCALE 1:25 000
EXISTING JETTY
SCRAP UNLOADING
23
0 20 40 60 80 100
200 m
SECTION 27

32 WATER TREATMENT PLANT COREX
33 CONTROL BUILDING
34 ORE SCREENING STATION
35 COAL DRYING PLANT
36 SLUDGE TREATMENT
37 DEDUSTING PLANT FOR COREX TWIN MODULE

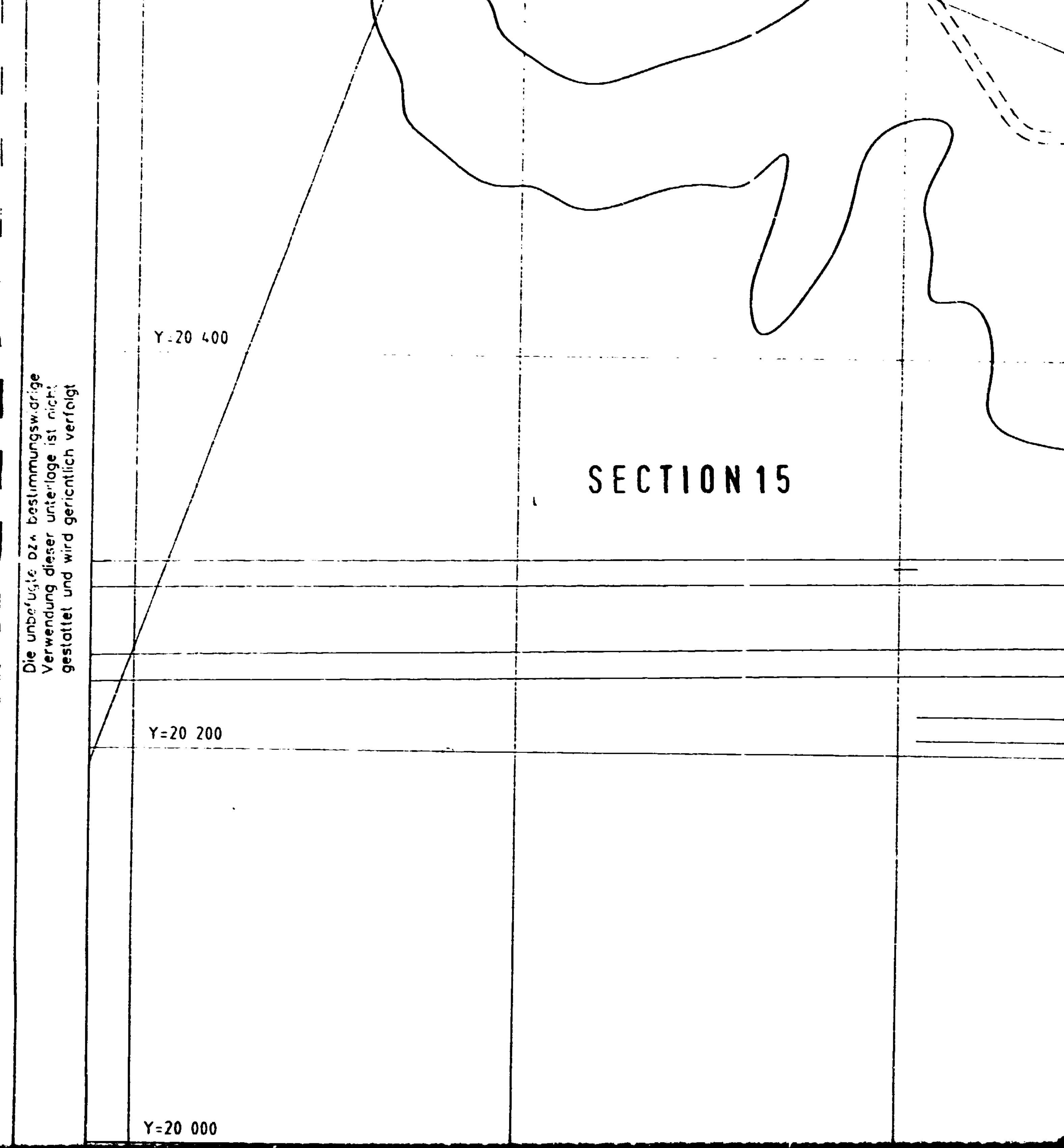
SECTION 14

---- BATTERY LIMITS
AREA WITHIN BATTERY LIMITS = 812 000 m²

SITE
SCALE 1:25 000

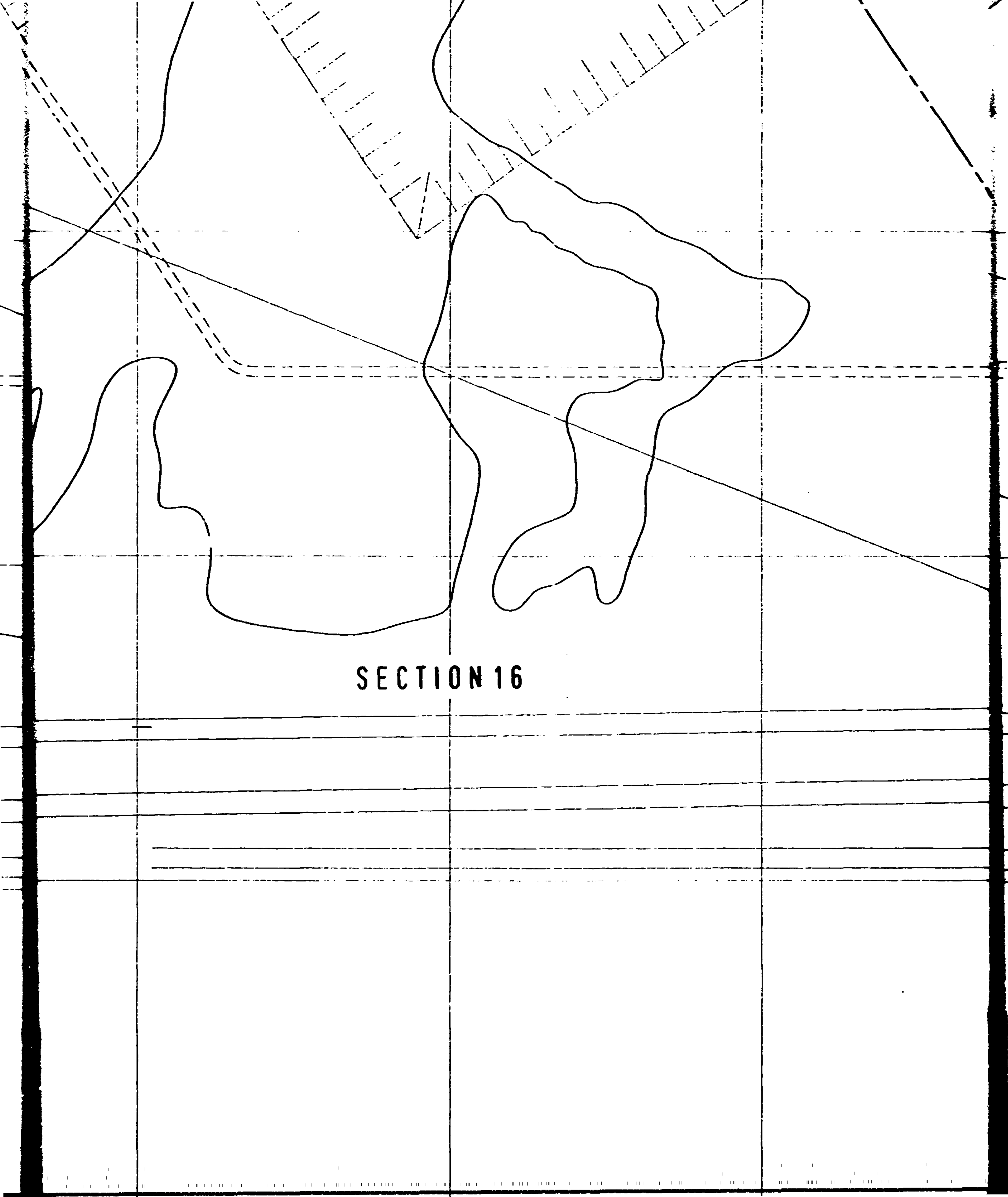


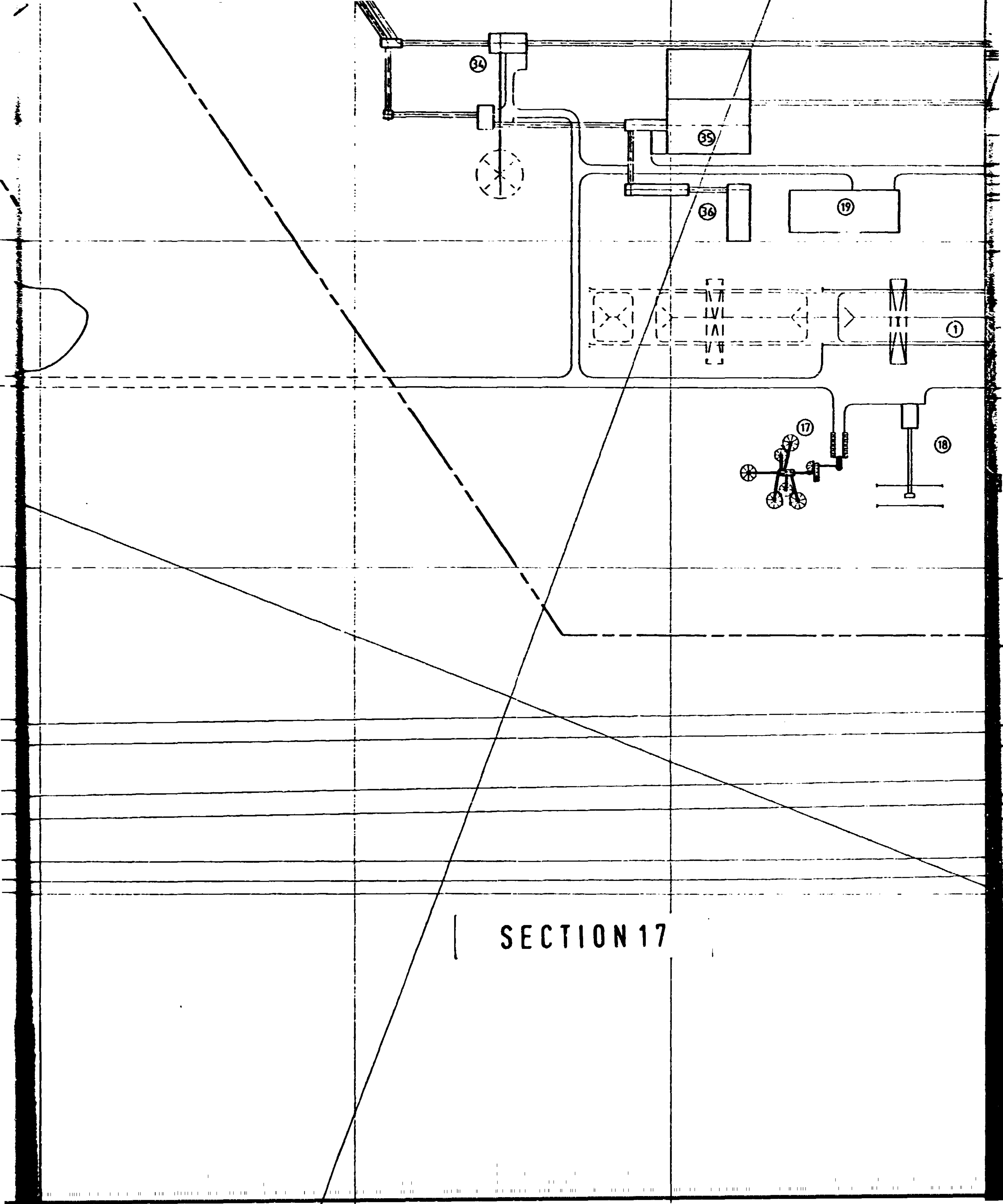
SECTION 28



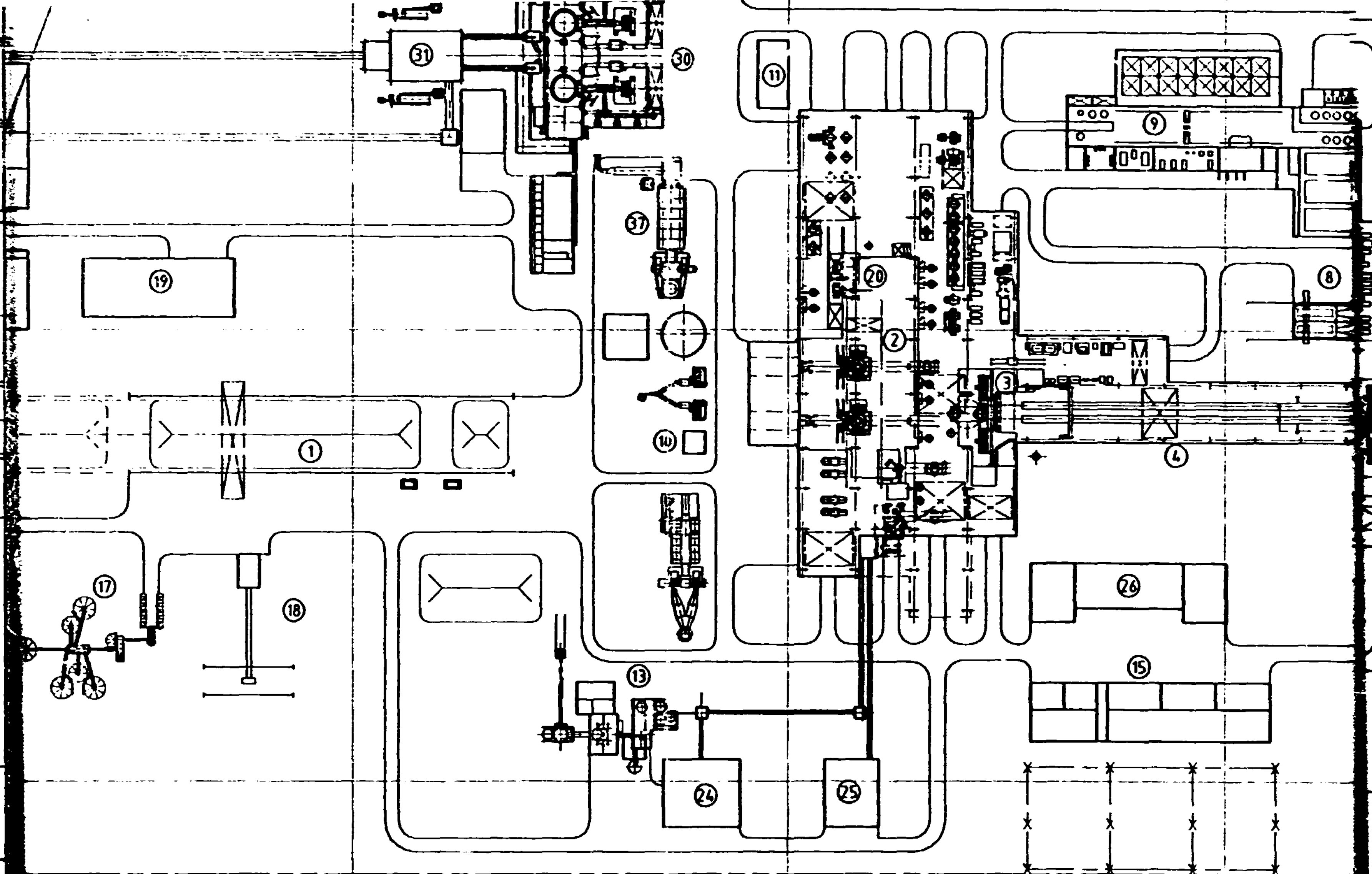
L T267

95 07 14

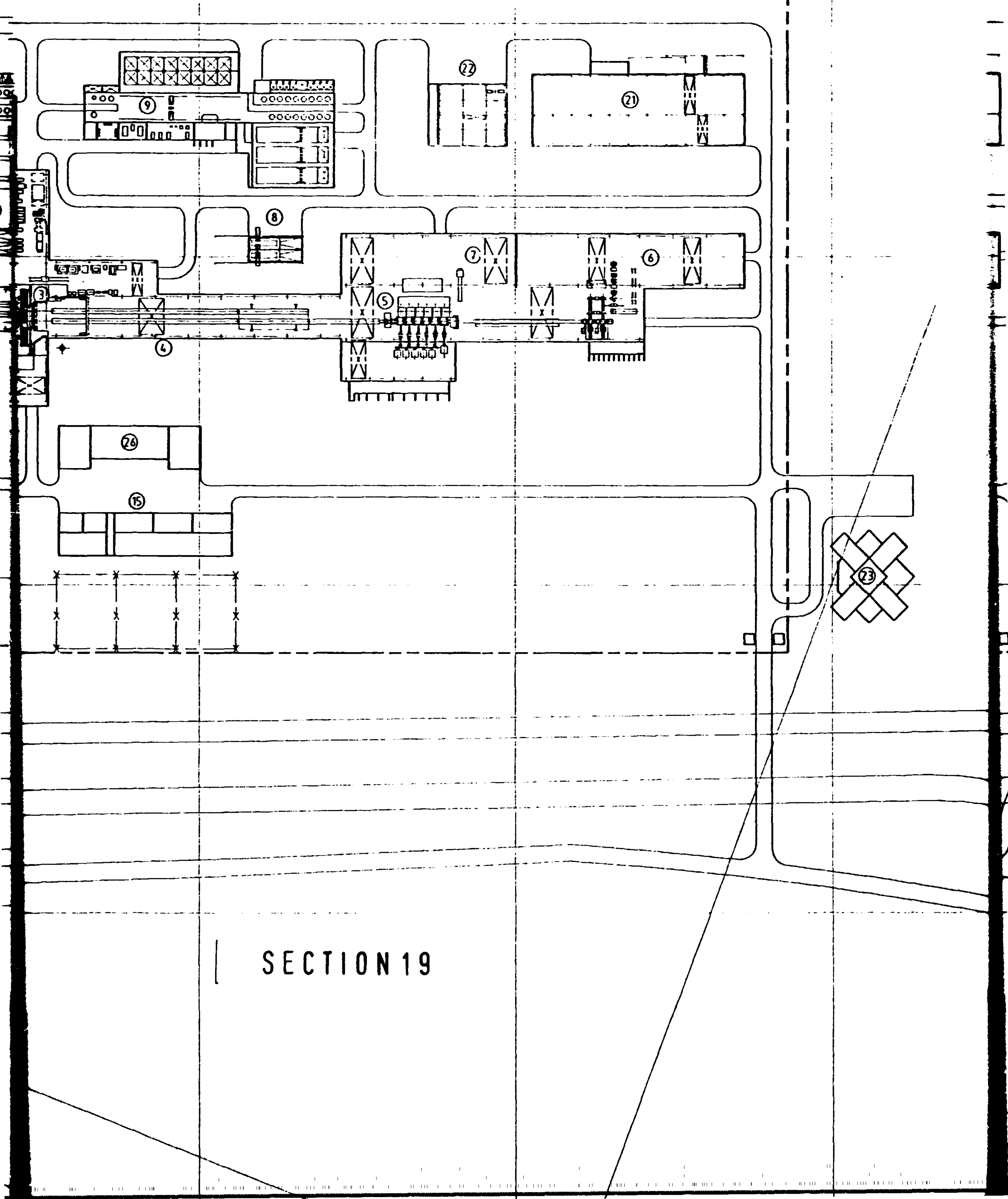

SECTION 16



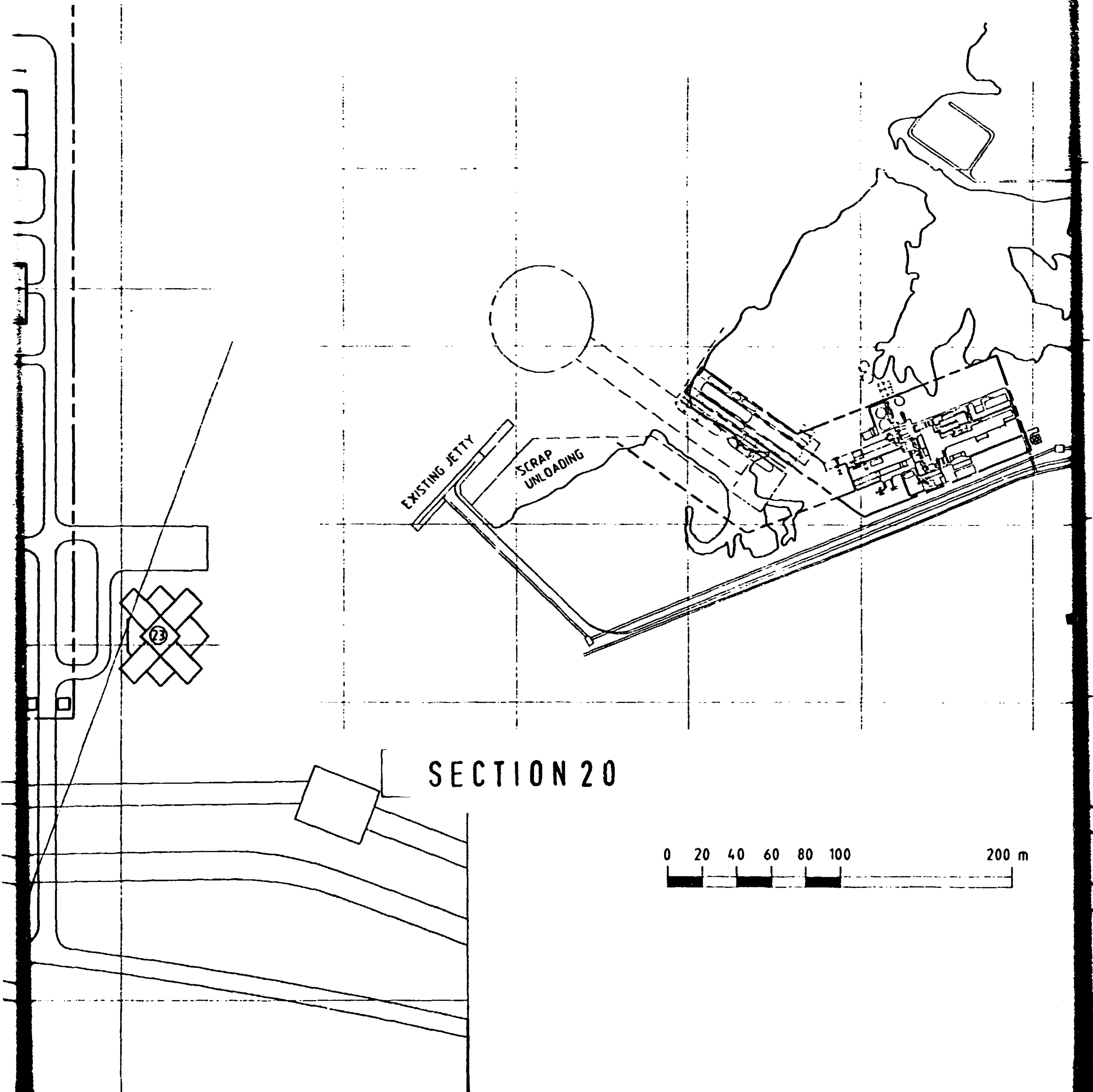
SECTION 17



SECTION 18



SECTION 19

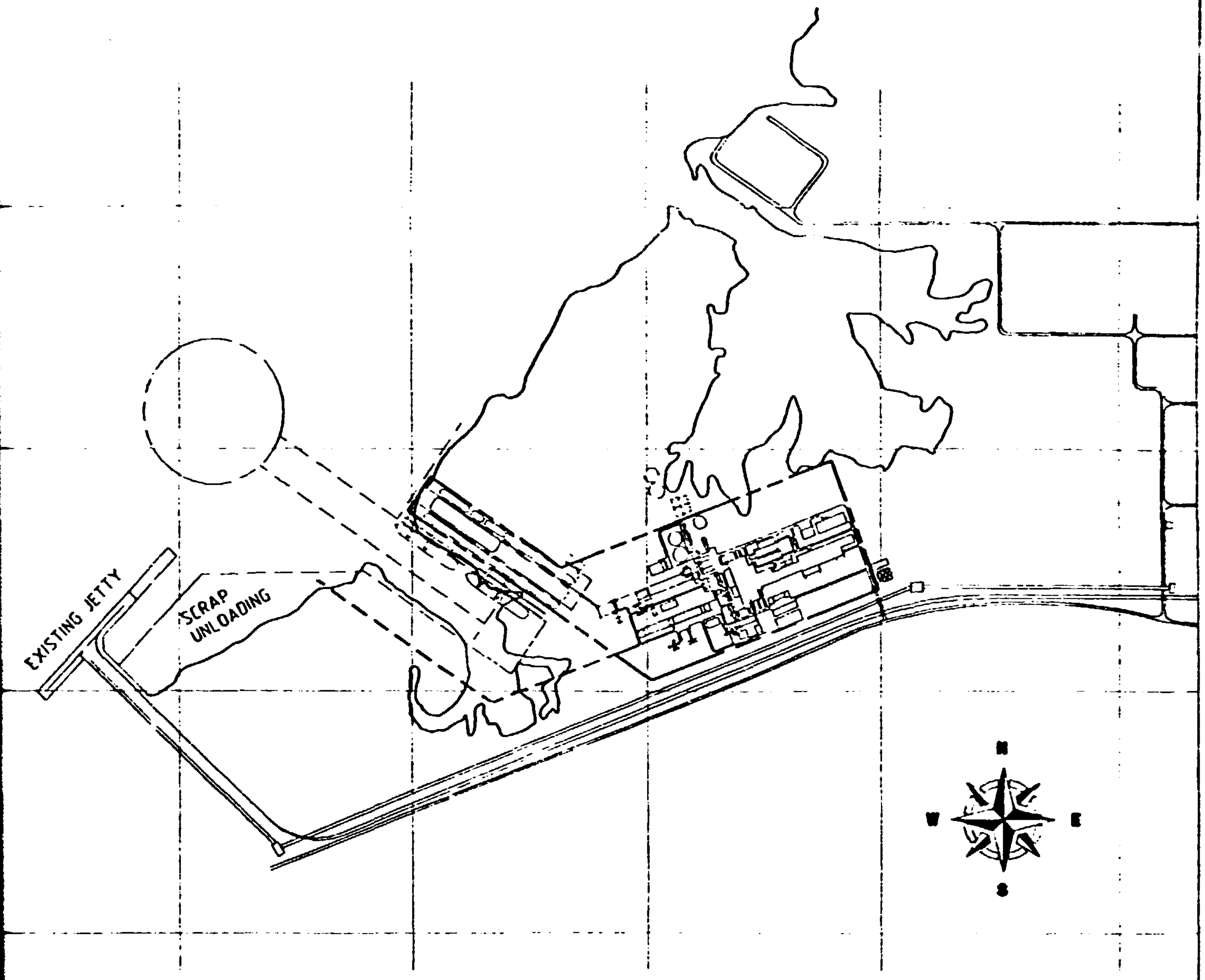


0		GENERAL REVISION	08-
Änderung Revision	Anz. d. Änd. No. of Mod.	Änderungsinhalt Modification	Datum Date

1993	Datum Date	Name Name		
Bearbeitet Made by	04-13	AUER		COREX-LD-RO
Geprüft Checked by			CAD	BS/RC/SL/CD/WT/IH

Benennung Title: PROJECT SGSM/INDONESIA

Maßsta Scale



SECTION 21

0		GENERAL REVISION	08-18	AUER	
Änderung Revision	Anz. d. Änd. No. of Mod.	Änderungsinhalt Modification	Datum Date	Bearbeitet Made by	Geprüft Checked by

1993	Datum Date	Name Name
Bearbeitet Made by	04-13	AUER
Geprüft Checked by		

CAD

COREX-LD-ROUTE

UNIDO

BS/RC/SL/CD/WT/IH/155