

5-3-6 Overall Layout Design and Machine Layout in the Shop

(1) Overall layout

The overall layout will decide the direction of the amplification of the building, its scale, and the location. In addition to the buildings whose necessary areas have been calculated, the following three buildings are added.

1) Car-body major repair shop

Temporary repair works of rolling stock, modification and rejuvenation of rolling stock to lengthen service life are carried out. The area necessary to carry out these works on 318 cars in six years: $90 \times 20 = 1,800 \text{ m}^2$

2) Temporary bogie shed

Temporary bogies storing place which is convenient to take them out to the Car-body Lifting/Lowering Shop whenever necessary. An area for 12 bogies: $36 \times 6 = 216 \text{ m}^2$

3) Warehouse

Warehouse to store materials. An area of about 7% of the total workshop areas: $54 \times 20 = 1,080 \text{ m}^2$

The overall layouts for workshop proposals I, II, and III are planned as explained below.

1) No.1 workshop

a) Amplification Proposal I

Lengthwise amplification Ia

Amplification towards main lines Ib

A study was made of the above two plans and it has become clear that Ib is more desirable for the following reasons.

In the case of lengthwise amplification, the new building will be narrow and long and the layout of the shops will become inefficient. On the other hand, in the case of amplification towards the main lines, the new building will be wide and not too long. As a result, the layout of shops will be facilitated.

From the above, the study on Ia will be terminated in section 5-3, and hereafter, a study is made of Ib.

b) Amplification Proposals II and III

As studied in the above section a), it has become clear that the amplification towards the main lines Ib is desirable for the shop layout. Therefore, only the amplification plans towards the main line will be studied for II and III.

2) No.2 Workshop

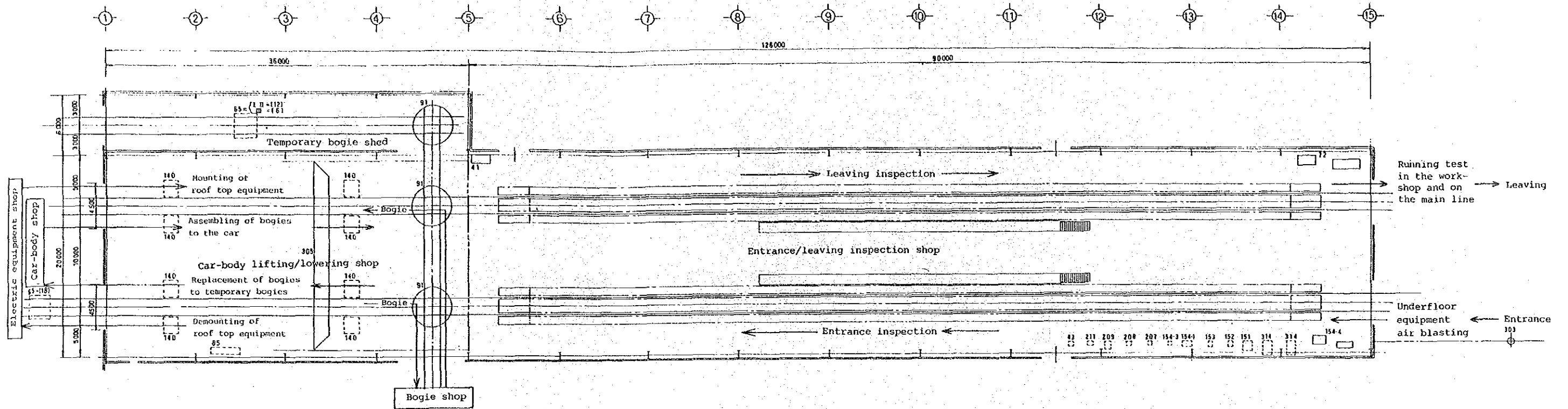
a) A new building will be constructed towards the main line for all three amplification proposals, I, II, and III, and repair shop will be established for rotating equipment, seat and vestibule diaphragm, and cooling unit shop.

b) A new building will be constructed annexed to the main building on the opposite side of the main line, and Car-body Major Repair Shop, Car-body Painting Shop, and Parts Painting Shop will be established in it.

(2) Layout of shop machines and equipment

Figs. 5.3.5 ~ 5.3.11 show the results of the detailed study of the work flow in the overall layout. Figs. 5.3.12 ~ 5.3.18 show the machine layout for each shop.

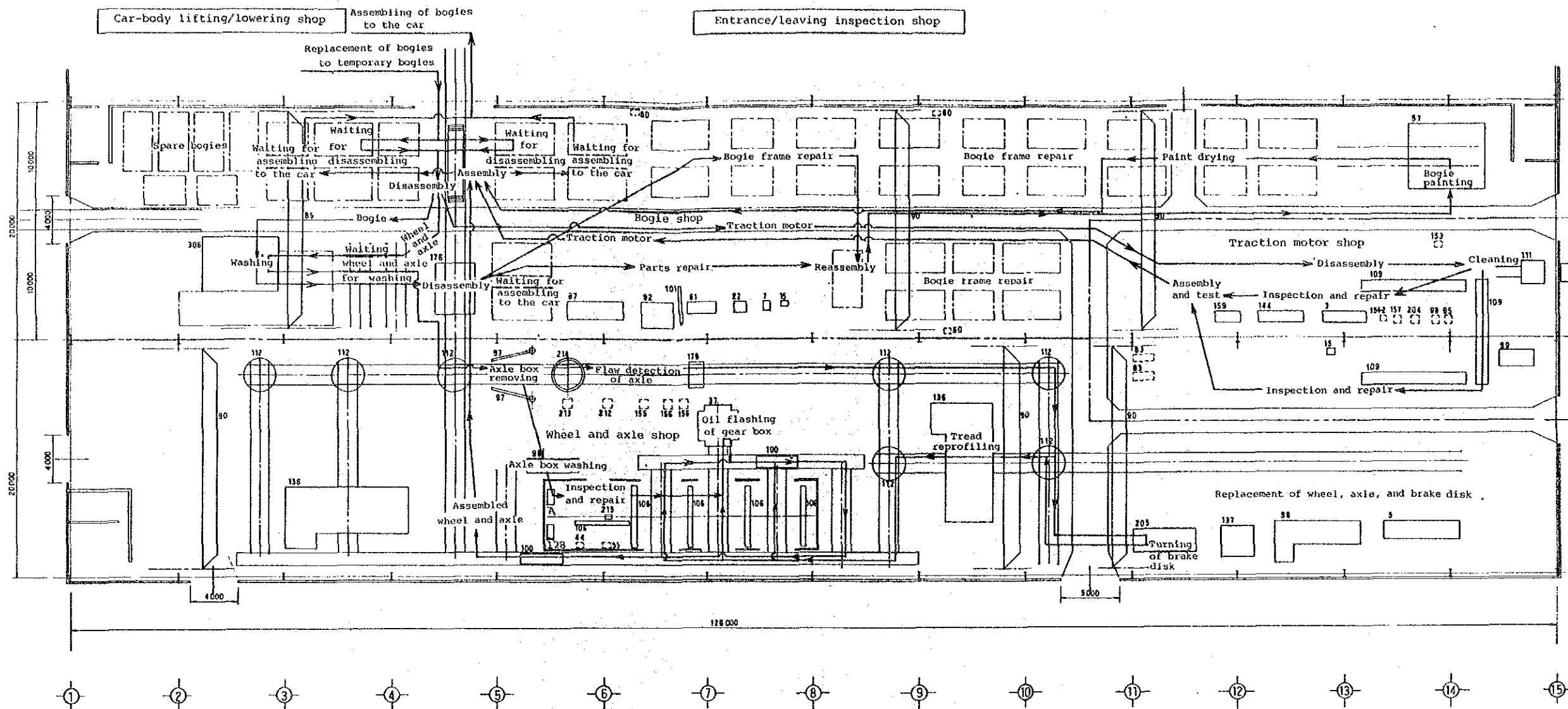
Figure numbers for amplification proposals Ia, Ib, II and III for each shop are shown in Table 5.3.11.



| No. | Name of equipment of respective shop | Qty |
|-----|--------------------------------------|------------|
| 91 | Bogie turntable | 1 |
| 65 | Temporary bogie | 30 (24) |
| | Temporary bogie shed | |
| 305 | Overhead travelling crans 2 ton | 1 |
| 140 | Lifting jack | 8 |
| 91 | Bogie turn table | 2 |
| 85 | Scaffolding car for car-body repair | 1 |
| | Car-body lifting/lowering shop | |
| No. | Name of equipment of respective shop | Qty |

| 314 | Air brake tester | 2 |
|-------|--|-----|
| 303 | Under floor equipment air blast facility | 1 |
| 211 | Main control | 1 |
| 209 | Main rectifier tester | 1 |
| 208 | Running record analyser | 1 |
| 207 | Electric car performance tester | 1 |
| 154-4 | Dielectric strength tester | 1 |
| 154-3 | Dielectric strength tester | 1 |
| 154-1 | Dielectric strength tester 54kV | 1 |
| 153 | Insulation resistance tester | 1 |
| 152 | Vehicle borne A.T.S. device tester | 1 |
| 151 | Electric car wiring tester | 1 |
| 72 | Power source device for testing | 1 |
| 43 | Vacuum cleaner | 1 |
| 41 | Air compressor | 1 |
| | Entrance/leaving inspection shop | |
| No. | Name of equipment of respective shop | Qty |

Fig. 5.3.5 No. 1 Workshop
Shop Sectioning and Work Flow of
Entrance/Leaving Inspection Shop,
Car-body Lifting/Lowering Shop
Proposal Ia, Ib, II, III

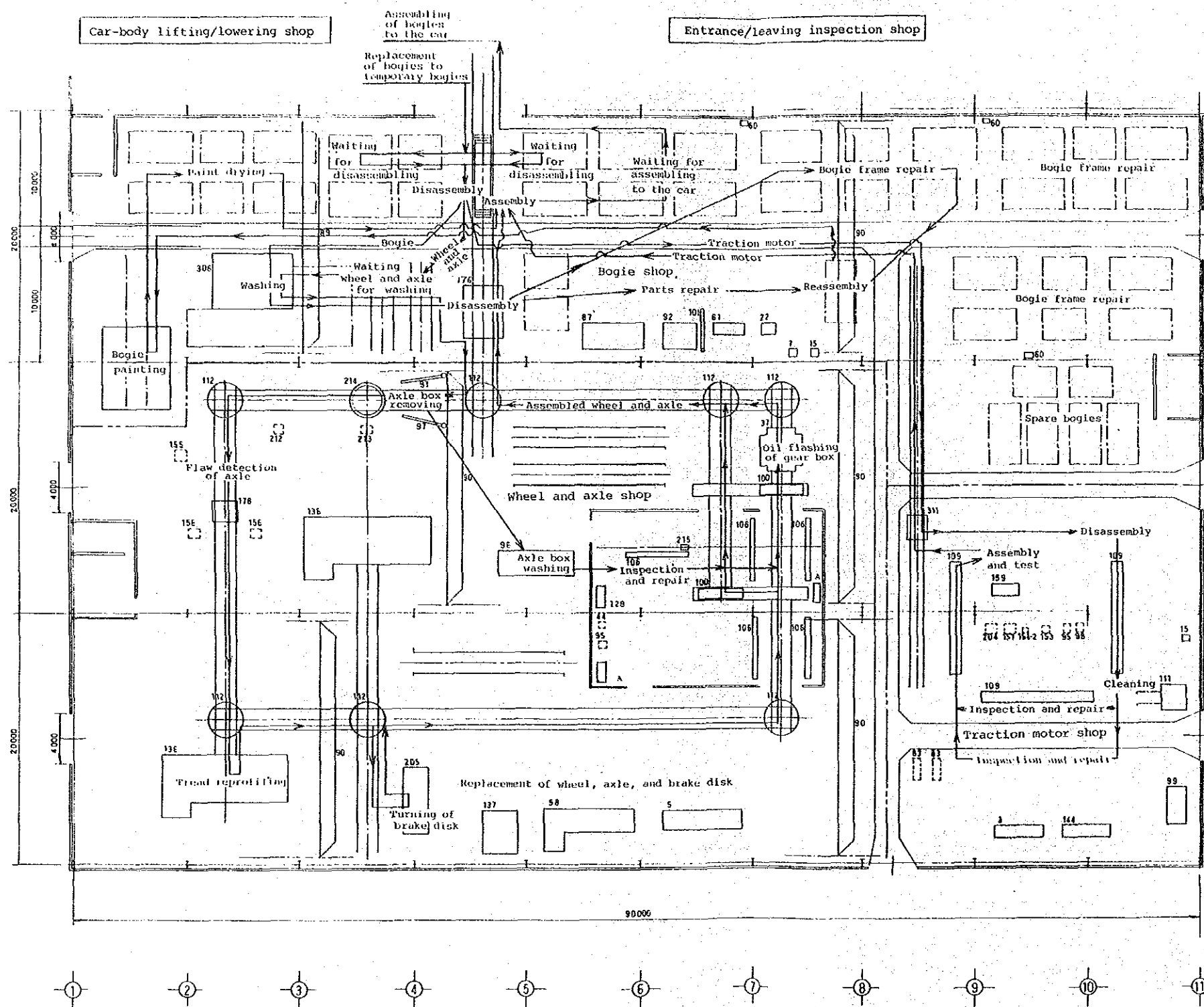


| | | |
|---------------------|--------------------------------------|-----|
| 204 | Layer short - circuiting tester | 1 |
| 159 | Traction motor tester | 1 |
| 157 | Insulation deterioration tester | 1 |
| 154-2 | Dielectric strength tester | 1 |
| 153 | Insulation resistance tester | 1 |
| 144 | Dynamic blanching machine | 1 |
| 111 | Air blast booth | 1 |
| 109 | Slat conveyer | 3 |
| 99 | Parts cleaner | 1 |
| 98 | Axle bearing induction heater | 1 |
| 95 | Pinion heater | 1 |
| 90 | Overhead travelling crane 5 ton | 1 |
| 83 | Low platform cart | 2 |
| 15 | Pedestal grinding machine | 1 |
| 3 | Lathe | 1 |
| Traction motor shop | | |
| No. | Name of equipment of respective shop | Qty |

| | | |
|---------------------|--|-----|
| A | Air conditioner | 1 |
| 215 | Honorasi 1/2 ton | 1 |
| 214 | Turntable with wheel and axle rotating equipment | 1 |
| 213 | Bearing cleaning equipment | 1 |
| 212 | Axle bearing removing machine | 1 |
| 205 | Brake disk lathe | 1 |
| 178 | Wheel and axle rotating equipment | 1 |
| 156 | Ultrasonic flaw detector | 2 |
| 155 | Magnetic flaw detector | 1 |
| 137 | Vertical lathe | 1 |
| 135 | Wheel lathe | 2 |
| 128 | Air conditioner | 1 |
| 112 | Turntable | 7 |
| 106 | Roller conveyer | 5 |
| 100 | Wheel and axle traverser | 2 |
| 97 | Jib crane 1/4 ton | 2 |
| 96 | Axle box washing machine | 1 |
| 95 | Bearing heater | 1 |
| 90 | Overhead travelling crane 5 ton | 3 |
| 58 | Hydraulic wheel press | 1 |
| 44 | Demagnetizer | 1 |
| 37 | Oil flashing equipment | 1 |
| 5 | Axle lathe | 1 |
| Wheel and axle shop | | |
| No. | Name of equipment of respective shop | Qty |

| | | |
|------------|--------------------------------------|-----|
| 306 | Bogie washing equipment | 1 |
| 176 | Bogie disassembling equipment | 1 |
| 101 | Jib crane 1/4 ton | 1 |
| 92 | Magnetic flaw detector | 1 |
| 90 | Overhead travelling crane 5 ton | 1 |
| 89 | Overhead travelling crane 15 ton | 1 |
| 87 | Parts cleaner | 1 |
| 61 | Spring tester | 1 |
| 60 | Electric arc welder | 3 |
| 57 | Bogie painting equipment | 1 |
| 22 | Hydraulic press | 1 |
| 15 | Pedestal grinding machine | 1 |
| 7 | Upright drilling machine | 1 |
| Bogie shop | | |
| No. | Name of equipment of respective shop | Qty |

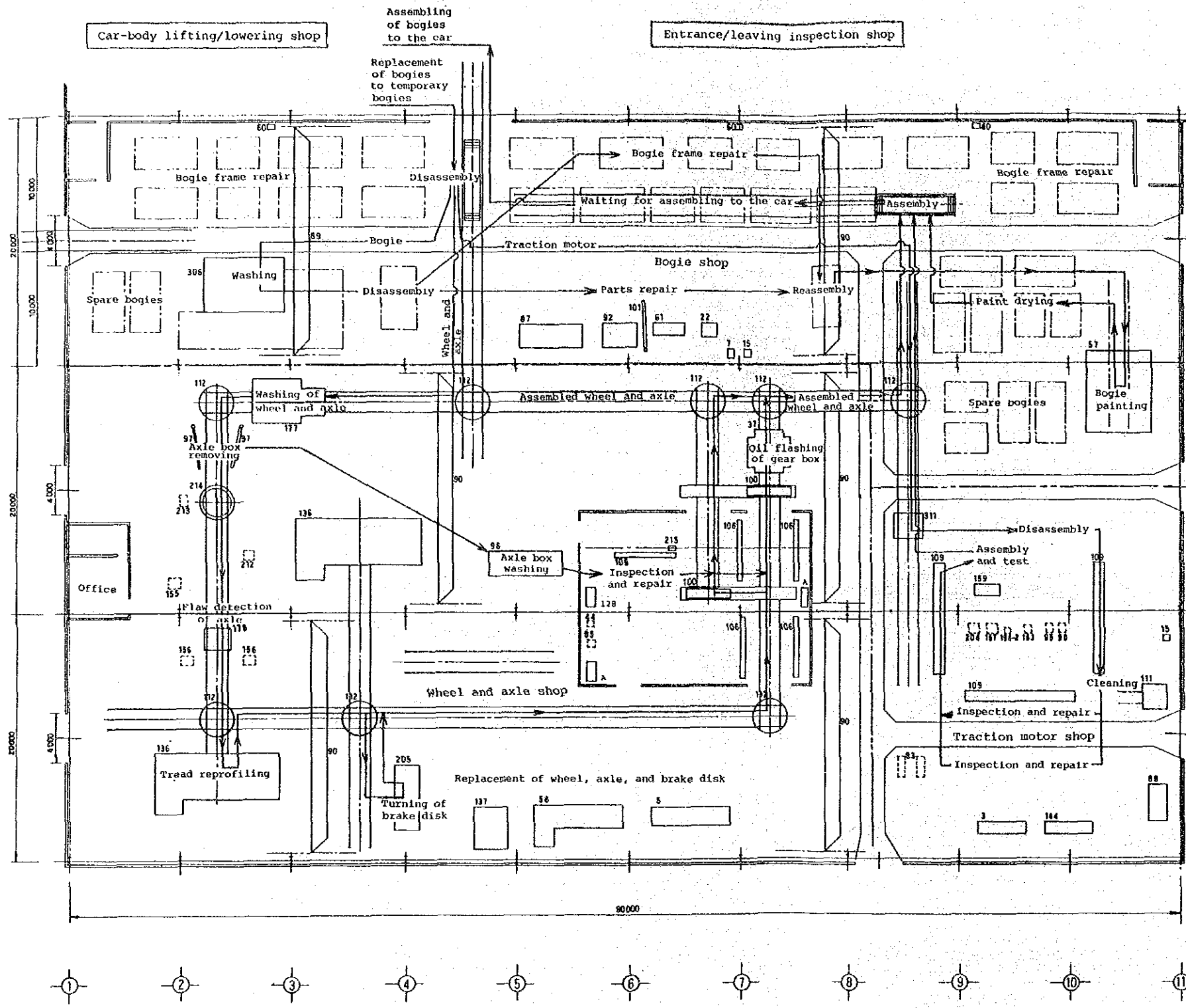
Fig. 5.3.6 No. 1 Workshop
Shop Sectioning and Work Flow of
Bogie Shop, Wheel and Axle Shop,
Traction Motor Shop
Proposal Ia



| | | |
|---------------------|--------------------------------------|-----|
| 311 | Traverser for rotating machine | 1 |
| 304 | Layer short - circuiting tester | 1 |
| 159 | Traction motor tester | 1 |
| 157 | Insulation deterioration tester | 1 |
| 153-2 | Dielectric strength tester | 1 |
| 153 | Insulation resistance tester | 1 |
| 141 | Dynamic blinding machine | 1 |
| 111 | Air blast booth | 1 |
| 133 | Slat conveyer | 3 |
| 99 | Parts cleaner | 1 |
| 98 | Axle bearing induction heater | 1 |
| 95 | Pintou heater | 1 |
| 90 | Overhead travelling crane 5 ton | 1 |
| 83 | Low platform cart | 2 |
| 15 | Pedestal grinding machine | 1 |
| 3 | Lathe | 1 |
| Traction motor shop | | |
| No. | Name of equipment of respective shop | Qty |

| | | |
|---------------------|--|-----|
| A | Air conditioner | 2 |
| 215 | Monorail 1/2 ton | 1 |
| 214 | Turntable with wheel and axle rotating equipment | 1 |
| 213 | Bearing cleaning equipment | 1 |
| 212 | Axle bearing removing machine | 1 |
| 205 | Brake disk lathe | 1 |
| 178 | Wheel and axle rotating equipment | 1 |
| 156 | Ultrasonic flaw detector | 2 |
| 155 | Magnetic flaw detector | 1 |
| 137 | Vertical lathe | 1 |
| 136 | Wheel lathe | 2 |
| 126 | Air conditioner | 1 |
| 111 | Turntable | 2 |
| 106 | Roller conveyer | 5 |
| 100 | Wheel and axle traverser | 2 |
| 97 | Jib crane 1/4 ton | 2 |
| 96 | Axle box washing machine | 1 |
| 95 | Bearing heater | 1 |
| 90 | Overhead travelling crane 5 ton | 3 |
| 58 | Hydraulic wheel press | 1 |
| 44 | Demagnetizer | 1 |
| 37 | Oil flashing equipment | 1 |
| 5 | Axle lathe | 1 |
| Wheel and axle shop | | |
| 306 | Bogie washing equipment | 1 |
| 176 | Bogie disassembling equipment | 1 |
| 141 | Jib crane 1/4 ton | 1 |
| 111 | Magnetic flaw detector | 1 |
| 90 | Overhead travelling crane 5 ton | 1 |
| 89 | Overhead travelling crane 15 ton | 1 |
| 87 | Parts cleaner | 1 |
| 81 | Spring tester | 1 |
| 60 | Electric arc welder | 3 |
| 57 | Bogie painting equipment | 1 |
| 22 | Hydraulic press | 1 |
| 15 | Pedestal grinding machine | 1 |
| 7 | Upright drilling machine | 1 |
| Bogie shop | | |
| No. | Name of equipment of respective shop | Qty |

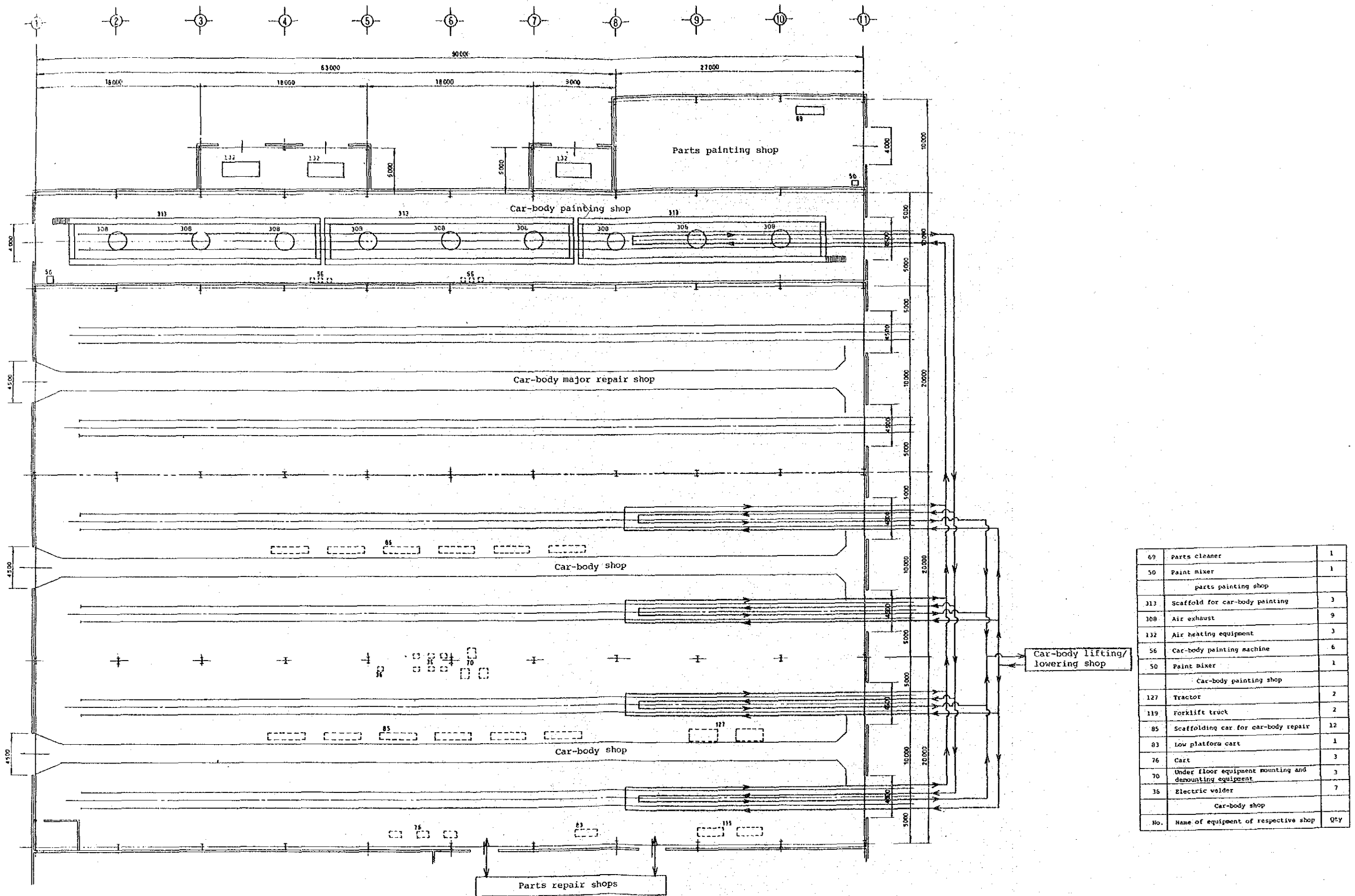
Fig. 5.3.7 No. 1 Workshop
Shop Sectioning and Work Flow of
Bogie Shop, Wheel and Axle Shop,
Traction Motor Shop
Proposal Ib



| No. | Name of equipment of respective shop | Qty |
|---------------------|--------------------------------------|-----|
| 311 | Traverser for rotating machine | 1 |
| 204 | Layer short - circuiting tester | 1 |
| 159 | Traction motor tester | 1 |
| 157 | Insulation deterioration tester | 1 |
| 154-2 | Dielectric strength tester | 1 |
| 153 | Insulation resistance tester | 1 |
| 144 | Dynamic blanching machine | 1 |
| 111 | Air blast booth | 1 |
| 109 | Slat conveyer | 3 |
| 99 | Parts cleaner | 1 |
| 98 | Axle bearing induction heater | 1 |
| 95 | Pinion heater | 1 |
| 90 | Overhead travelling crane 5 ton | 1 |
| 83 | Low platform cart | 2 |
| 15 | Pedestal grinding machine | 1 |
| 3 | Lathe | 1 |
| Traction motor shop | | |
| No. | Name of equipment of respective shop | Qty |

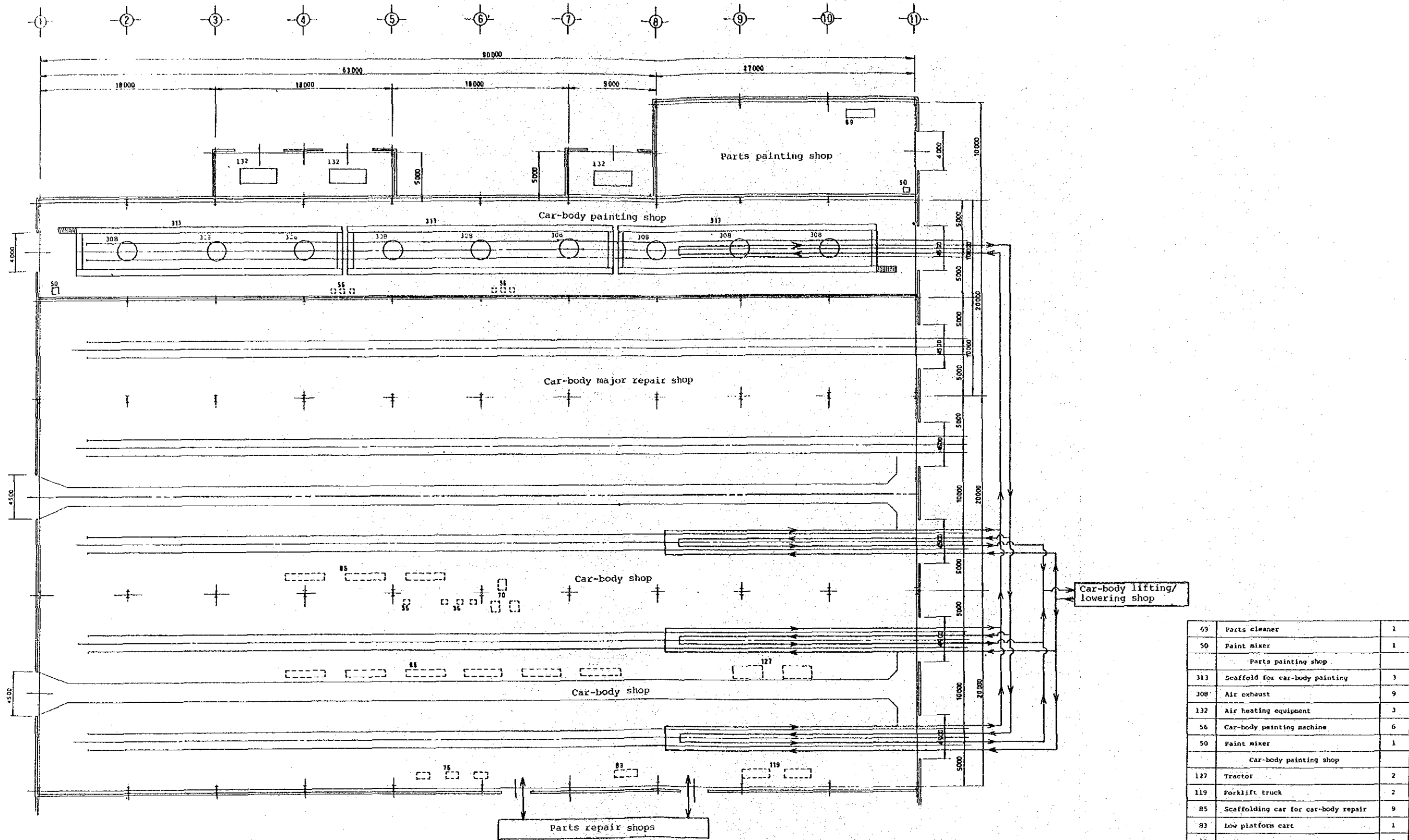
| | | |
|---------------------|--|-----|
| A | Air conditioner | 2 |
| 177 | Wheel and axle washing equipment | 1 |
| 215 | Monorail 1/2 ton | 1 |
| 214 | Turntable with wheel and axle rotating equipment | 1 |
| 213 | Bearing cleaning equipment | 1 |
| 212 | Axle bearing removing machine | 1 |
| 205 | Brake disk lathe | 1 |
| 179 | Wheel and axle rotating equipment | 1 |
| 156 | Ultrasonic flaw detector | 2 |
| 155 | Magnetic flaw detector | 1 |
| 137 | Vertical lathe | 1 |
| 136 | Wheel lathe | 2 |
| 128 | Air conditioner | 1 |
| 112 | Turntable | 8 |
| 106 | Roller conveyer | 5 |
| 100 | Wheel and axle traverser | 2 |
| 97 | Jib crane 1/4 ton | 2 |
| 96 | Axle box washing machine | 1 |
| 95 | Bearing heater | 1 |
| 90 | Overhead travelling crane 5 ton | 3 |
| 59 | Hydraulic wheel press | 1 |
| 44 | Demagnetizer | 1 |
| 37 | Oil flashing equipment | 1 |
| 5 | Axle lathe | 1 |
| Wheel and axle shop | | |
| 306 | Bogie washing equipment | 1 |
| 101 | Jib crane 1/4 ton | 1 |
| 92 | Magnetic flaw detector | 1 |
| 90 | Overhead travelling crane 5 ton | 1 |
| 89 | Overhead travelling crane 15 ton | 1 |
| 87 | Parts cleaner | 1 |
| 81 | Spring tester | 1 |
| 60 | Electric arc welder | 3 |
| 57 | Bogie painting equipment | 1 |
| 22 | Hydraulic press | 1 |
| 15 | Pedestal grinding machine | 1 |
| 7 | Upright drilling machine | 1 |
| Bogie shop | | |
| No. | Name of equipment of respective shop | Qty |

Fig. 5.3.8 No. 1 Workshop
Shop Sectioning and Work Flow of
Bogie Shop, Wheel and Axle Shop,
Traction Motor Shop
Proposal II, III



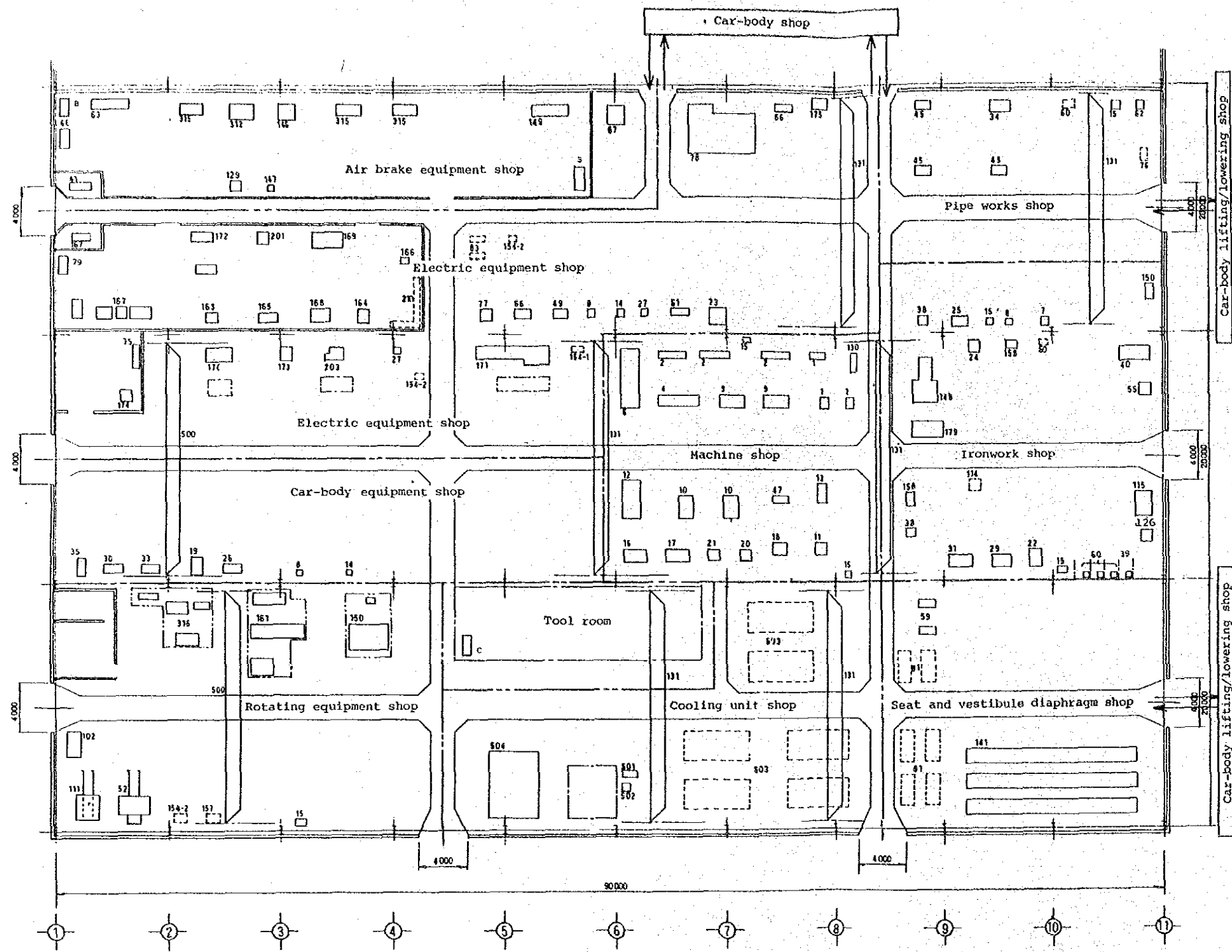
| | | |
|-----|---|-----|
| 69 | parts cleaner | 1 |
| 50 | Paint mixer | 1 |
| | parts painting shop | |
| 113 | Scaffold for car-body painting | 3 |
| 308 | Air exhaust | 9 |
| 132 | Air heating equipment | 3 |
| 56 | Car-body painting machine | 6 |
| 50 | Paint mixer | 1 |
| | Car-body painting shop | |
| 127 | Tractor | 2 |
| 119 | Forklift truck | 2 |
| 85 | Scaffolding car for car-body repair | 12 |
| 81 | low platform cart | 1 |
| 76 | Cart | 3 |
| 70 | Under floor equipment mounting and demounting equipment | 3 |
| 36 | Electric welder | 7 |
| | Car-body shop | |
| No. | Name of equipment of respective shop | Qty |

Fig. 5.3.9 No. 2 Workshop
 Shop Sectioning and Work Flow of
 Car-body Shop, Car-body Painting Shop,
 Parts Painting Shop and Car-body Major
 Repair Shop
 Proposal Ib, II



| | | |
|-----|--|-----|
| 69 | Parts cleaner | 1 |
| 50 | Paint mixer | 1 |
| | Parts painting shop | |
| 313 | Scaffold for car-body painting | 3 |
| 308 | Air exhaust | 9 |
| 132 | Air heating equipment | 3 |
| 56 | Car-body painting machine | 6 |
| 50 | Paint mixer | 1 |
| | Car-body painting shop | |
| 127 | Tractor | 2 |
| 119 | Forklift truck | 2 |
| 85 | Scaffolding car for car-body repair | 9 |
| 83 | Low platform cart | 1 |
| 76 | Cart | 3 |
| 70 | Under floor equipment mounting and dismounting equipment | 3 |
| 36 | Electric welder | 4 |
| | Car-body shop | |
| No. | Name of equipment of respective shop | Qty |

Fig. 5.3.10 No. 2 Workshop
Shop Sectioning and Work Flow of
Car-body Shop, Car-body Painting Shop,
Parts Painting Shop and Car-body
Major Repair Shop
Proposal III



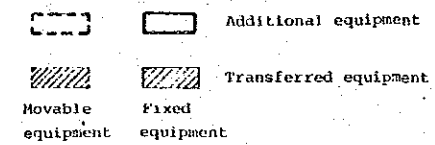
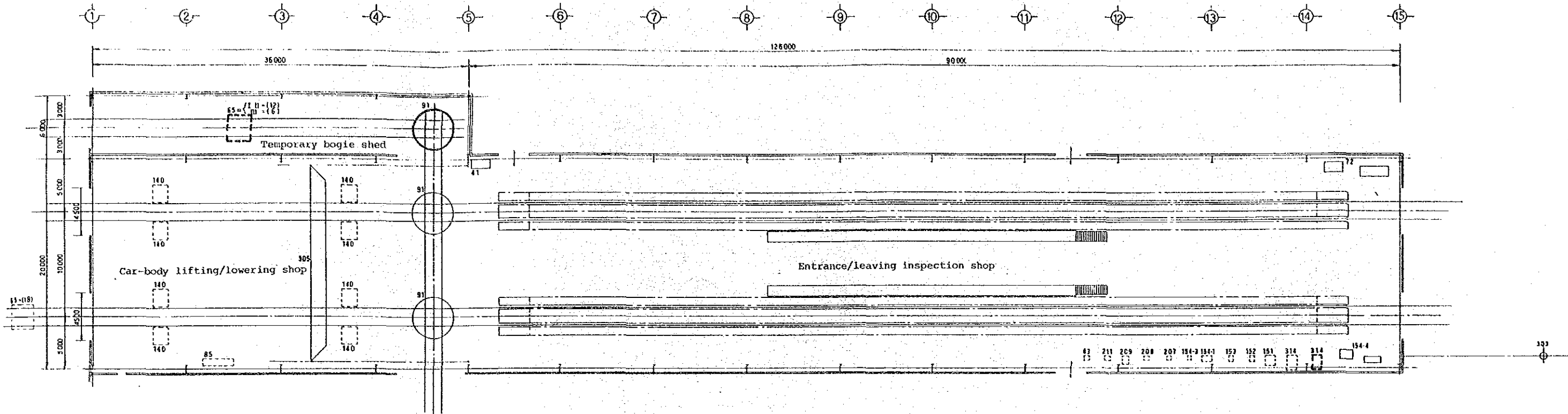
| 141 | Seat storing equipment | 1 |
|-----|--------------------------------------|-----|
| 81 | Seat transfer cart | 6 |
| 59 | Industrial sewing machine | 2 |
| | Seat and vestibule diaphragm shop | |
| 504 | Cooling unit test equipment | 1 |
| 503 | Cooling unit repairing carrier | 6 |
| 502 | Air exhaust | 1 |
| 501 | Cleaning machine | 1 |
| 131 | Overhead travelling crane 2 ton | 2 |
| | Cooling unit shop | |
| No. | Name of equipment of respective shop | Qty |

| 500 | Overhead travelling crane 3 ton | 1 |
|-------|--------------------------------------|-----|
| 316 | Air compressor tester | 1 |
| 161 | Motor alternator tester | 1 |
| 160 | Fan testing machine | 1 |
| 157 | Insulation deterioration tester | 1 |
| 154-2 | Dielectric strength tester | 1 |
| 111 | Air blast booth | 1 |
| 102 | Air filter cleaning machine | 1 |
| 52 | Drying oven | 1 |
| 15 | Pedestal grinding machine | 1 |
| | Rotating equipment shop | |
| No. | Name of equipment of respective shop | Qty |

| C | Air conditioner | 1 |
|-----|--|-----|
| | Tool room | |
| 35 | Nibbling machine | 1 |
| 33 | Bending machine | 1 |
| 30 | Bending roll | 1 |
| 26 | Shearing machine | 1 |
| 19 | CRANK press | 1 |
| 14 | Bench grinding machine | 1 |
| 8 | Bench drilling machine | 1 |
| | Car-body equipment shop | |
| 131 | Overhead travelling crane 2 ton | 1 |
| 130 | Centering machine | 1 |
| 47 | Hacksawing machine | 1 |
| 21 | Drill grinding machine | 1 |
| 20 | Cemented carbide tool grinding machine | 1 |
| 18 | Universal tool grinding machine | 1 |
| 17 | Universal grinding machine | 1 |
| 16 | Surface grinder | 1 |
| 15 | Pedestal grinding machine | 2 |
| 13 | Shaper | 1 |
| 12 | Horizontal boring machine | 1 |
| 11 | Universal milling machine | 1 |
| 10 | Vertical milling machine | 2 |
| 9 | Radial drilling machine | 2 |
| 7 | Upright drilling machine | 2 |
| 6 | Lathe 3,000 | 1 |
| 4 | Lathe 2,000 | 1 |
| 2 | Lathe 1,000 | 1 |
| 1 | Lathe 650 | 1 |
| | Machine shop | |
| 179 | Draft gear disassembling/ assembling machine | 1 |
| 158 | Magnetic flaw detector | 2 |
| 150 | Oil dumper tester | 1 |
| 148 | Tight lock coupler tester | 1 |
| 131 | Overhead travelling crane 2 ton | 1 |
| 126 | Automatic gas cutting machine | 1 |
| 115 | Parts cleaner | 1 |
| 114 | Rust remover | 1 |
| 60 | Electric welder | 4 |
| 55 | Furnace | 1 |
| 40 | Pneumatic power hammer | 1 |
| 39 | Argon gas arc welder | 1 |
| 38 | Spot welder | 2 |
| 31 | Punching/shearing machine | 1 |
| 29 | Bending roll | 1 |
| 25 | Shearing machine | 1 |
| 24 | Hydraulic press 100 ton | 1 |
| 22 | Hydraulic press | 1 |
| 15 | Pedestal grinding machine | 2 |
| 8 | Bench drilling machine | 1 |
| 7 | Upright drilling machine | |
| | Ironwork shop | |
| No. | Name of equipment of respective shop | Qty |

| 131 | Overhead travelling crane 2 ton | 1 |
|-------|---|-----|
| 76 | Cart | 1 |
| 62 | Hydraulic pressure tester | 1 |
| 60 | Electric welder | 1 |
| 45 | Threading machine | 3 |
| 34 | Pipe bender | 1 |
| 15 | Pedestal grinding machine | 1 |
| | Pipe works shop | |
| 8 | Air conditioner | 2 |
| 915 | Air brake valve tester | 3 |
| 312 | Brake valve tester | 1 |
| 149 | Door engine tester | 1 |
| 147 | Pressure gauge tester | 1 |
| 146 | Safety valve tester | 1 |
| 129 | Wiper tester | 1 |
| 67 | Parts cleaner | 1 |
| 66 | Dust arresting equipment | 1 |
| 63 | Ultrasonic washing equipment | 1 |
| 41 | Air compressor | 1 |
| | Air brake equipment shop | |
| 500 | Overhead travelling crane 3 ton | 1 |
| 210 | Various electric measuring apparatus | 1 |
| 203 | Main controller tester | 1 |
| 201 | Contactless relay tester | 1 |
| 175 | Electric power source device for testing | 1 |
| 174 | Battery capacity tester | 1 |
| 173 | Power source device for testing | 1 |
| 172 | Vacuum circuit breaker tester | 1 |
| 171 | Main rectifier tester | 1 |
| 170 | Motor alternator control equipment tester | 1 |
| 169 | Relay tester | 1 |
| 168 | Distributing circuit breaker tester | 1 |
| 167 | A. T. S. tester | 1 |
| 166 | Lightning arrester tester | 1 |
| 165 | Electromagnetic valve tester | 1 |
| 164 | Electric meter calibrating apparatus | 1 |
| 163 | Speedometer generator tester | 1 |
| 154-2 | Dielectric strength tester | 2 |
| 154-1 | Dielectric strength tester | 1 |
| 131 | Overhead travelling crane 2 ton | 1 |
| 83 | Low platform cart | 2 |
| 79 | Air conditioner | 1 |
| 78 | Washing equipment | 1 |
| 77 | Parts cleaner | 1 |
| 75 | Water purifying equipment | 1 |
| 73 | Electric coil drying oven | 1 |
| 65 | Dust arresting equipment | 2 |
| 51 | Coiling machine | 1 |
| 49 | Soft grit blasting machine | 1 |
| 27 | Buffing machine | 2 |
| 14 | Bench grinding machine | 1 |
| 8 | Bench drilling machine | 1 |
| | Electric equipment shop | |
| No. | Name of equipment of respective shop | Qty |

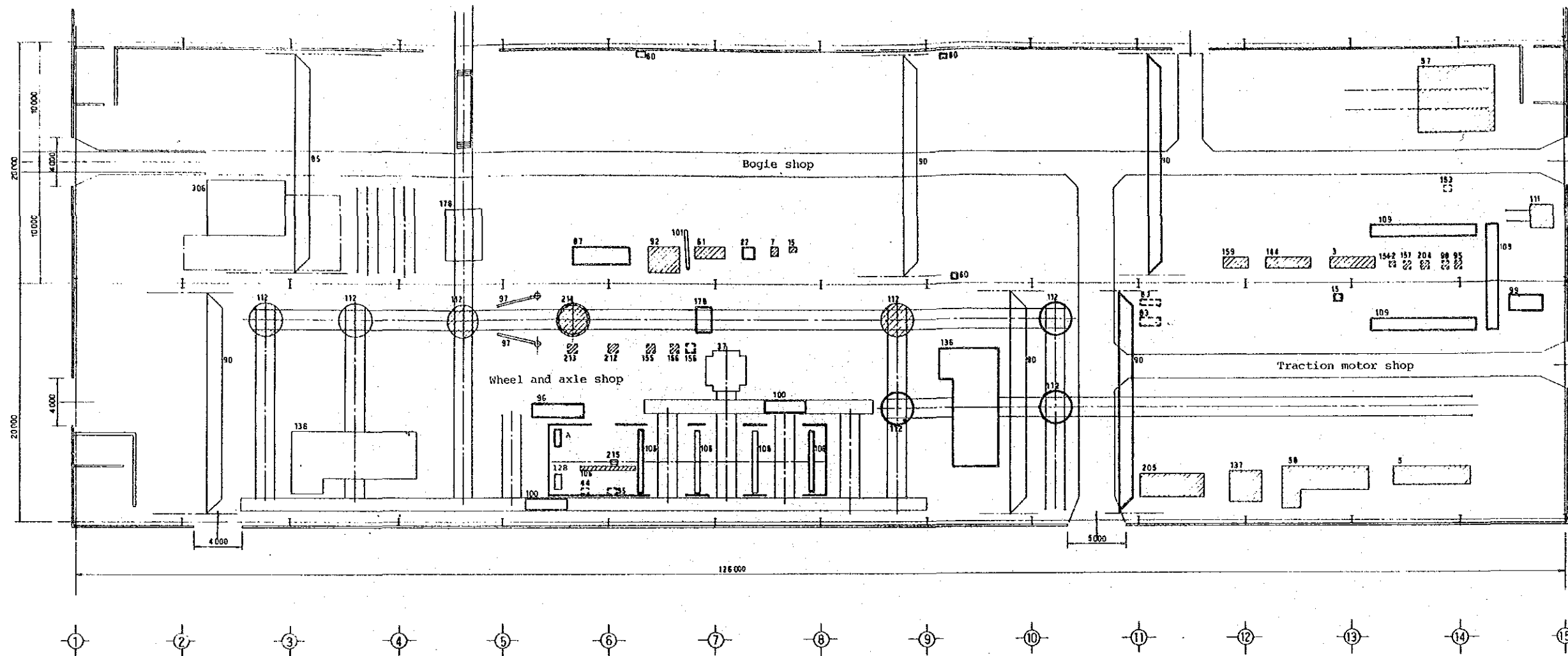
Fig. 5.3.11 No. 2 Workshop
Shop Sectioning and Work Flow of Car-Body Equipment Shop,
Electric Equipment Shop, Air Brake Equipment Shop, Machine Shop,
Ironwork Shop, Rotating Equipment Shop and Others
Proposal Ib, II, III



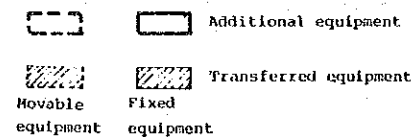
| | | |
|-----|--------------------------------------|-----|
| 91 | Bogie turntable | 1 |
| 65 | Temporary bogie | 1 |
| | Temporary bogie shed | |
| 305 | Overhead travelling crane 2 ton | 1 |
| 140 | Lifting jack | 8 |
| 91 | Bogie turn table | 2 |
| 85 | Scaffolding car for car-body repair | 1 |
| | Car-body lifting/lowering shop | |
| No. | Name of equipment of respective shop | Qty |

| | | |
|-------|--|-----|
| 314 | Air brake tester | 2 |
| 303 | Under floor equipment air blast facility | 1 |
| 211 | Main controller tester | 1 |
| 209 | Main rectifier tester | 1 |
| 208 | Running record analyser | 1 |
| 207 | Electric car performance tester | 1 |
| 154-4 | Dielectric strength tester | 1 |
| 154-1 | Dielectric strength tester | 1 |
| 154-1 | Dielectric strength tester 54kV | 1 |
| 153 | Insulation resistance tester | 1 |
| 152 | Vehicle borne A.T.S. device tester | 1 |
| 151 | Electric car wiring tester | 1 |
| 72 | Power source device for testing | 1 |
| 43 | Vacuum cleaner | 1 |
| 41 | Air compressor | 1 |
| | Entrance/leaving inspection shop | |
| No. | Name of equipment of respective shop | Qty |

Fig. 5.3.12. No. 1 Workshop
Machine Layout Plan of Entrance/Leaving
Inspection Shop and Car-body Lifting/
Lowering Shop
Proposal Ia, Ib, II, III



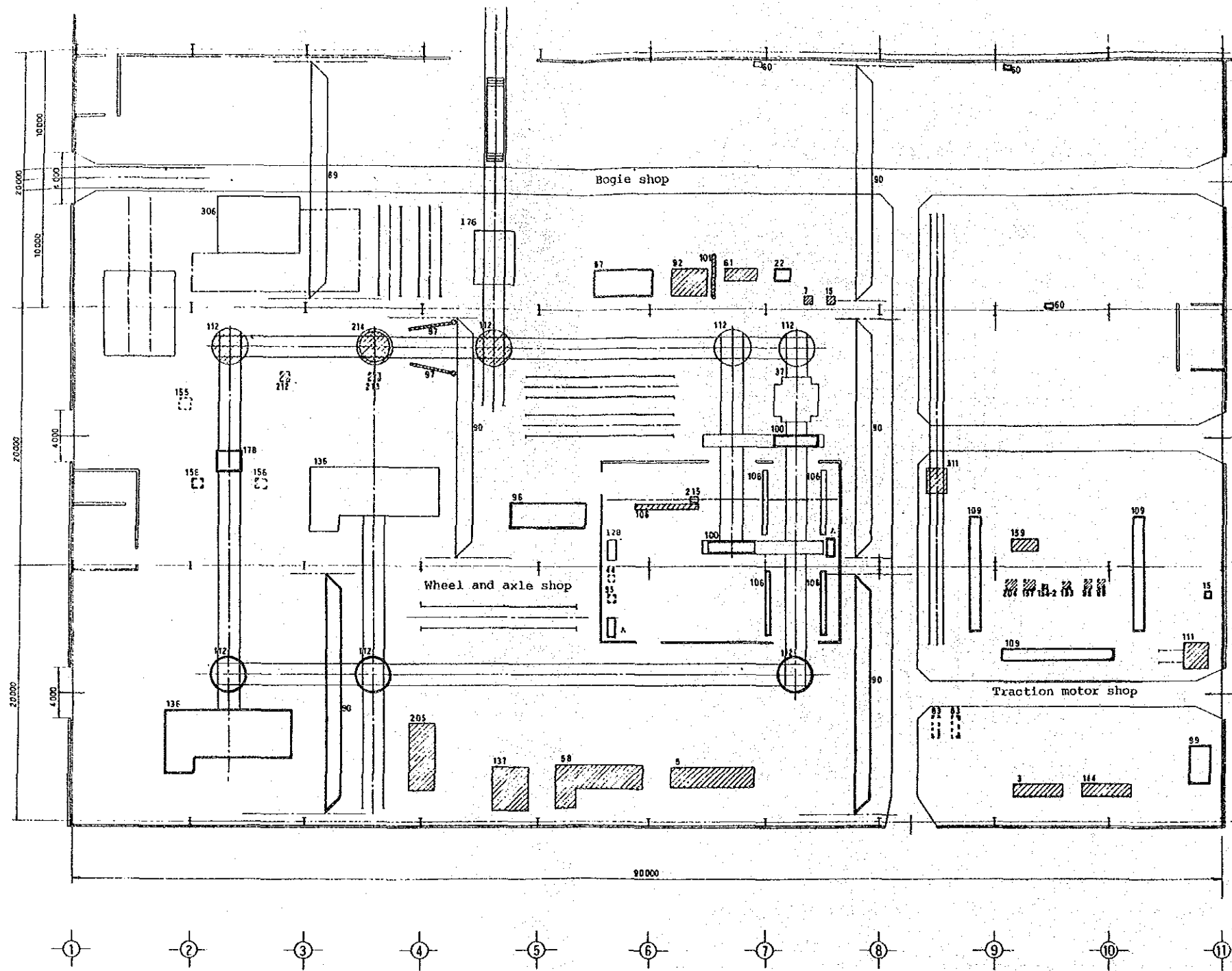
| | | |
|-----------------------|--|-----|
| A | Air conditioner | 1 |
| 415 | Honorall 1/2 ton | 1 |
| 214 | Turntable with wheel and axle rotating equipment | 1 |
| 213 | Bearing cleaning equipment | 1 |
| 212 | Axle bearing removing machine | 1 |
| 205 | Brake disk lathe | 1 |
| 178 | Wheel and axle rotating equipment | 1 |
| 156 | Ultrasonic flaw detector | 2 |
| 155 | Magnetic flaw detector | 1 |
| 137 | Vertical lathe | 1 |
| 136 | Wheel lathe | 2 |
| 120 | Air conditioner | 1 |
| 112 | Turntable | 7 |
| 106 | Roller conveyer | 5 |
| 100 | Wheel and axle traverser | 2 |
| 97 | Jib crane 1/4 ton | 2 |
| 96 | Axle box washing machine | 1 |
| 95 | Bearing heater | 1 |
| 90 | Overhead travelling crane 5 ton | 3 |
| 58 | Hydraulic wheel press | 1 |
| 44 | Demagnetizer | 1 |
| 37 | Oil flashing equipment | 1 |
| 5 | Axle lathe | 1 |
| * Wheel and axle shop | | |
| No. | Name of equipment of respective shop | Qty |



| | | |
|---------------------|--------------------------------------|-----|
| 204 | Layr short - circuiting tester | 1 |
| 159 | Traction motor tester | 1 |
| 157 | Insulation deterioration tester | 1 |
| 154-2 | Dielectric strength tester | 1 |
| 153 | Insulation resistance tester | 1 |
| 144 | Dynamic blancing machine | 1 |
| 111 | Air blast booth | 1 |
| 109 | Slat conveyer | 3 |
| 99 | Parts cleaner | 1 |
| 98 | Axle bearing induction heater | 1 |
| 95 | Pinion heater | 1 |
| 90 | Overhead travelling crane 5 ton | 1 |
| 83 | Low platform cart | 2 |
| 15 | Pedestal grinding machine | 1 |
| 3 | Lathe | 1 |
| Traction motor shop | | |
| No. | Name of equipment of respective shop | Qty |

| | | |
|------------|--------------------------------------|-----|
| 306 | Bogie washing equipment | 1 |
| 176 | Bogie disassembling equipment | 1 |
| 101 | Jib crane 1/4 ton | 1 |
| 92 | Magnetic flaw detector | 1 |
| 90 | Overhead travelling crane 5 ton | 1 |
| 89 | Overhead travelling crane 15 ton | 1 |
| 87 | Parts cleaner | 1 |
| 61 | Spring tester | 1 |
| 60 | Electric arc welder | 3 |
| 57 | Bogie painting equipment | 1 |
| 22 | Hydraulic press | 1 |
| 15 | Pedestal grinding machine | 1 |
| 7 | Upright drilling machine | 1 |
| Bogie shop | | |
| No. | Name of equipment of respective shop | Qty |

Fig. 5.3.13 No. 1 Workshop
Machine Layout Plan of Bogie Shop,
Wheel and Axle Shop, Traction Motor Shop
Proposal Ia

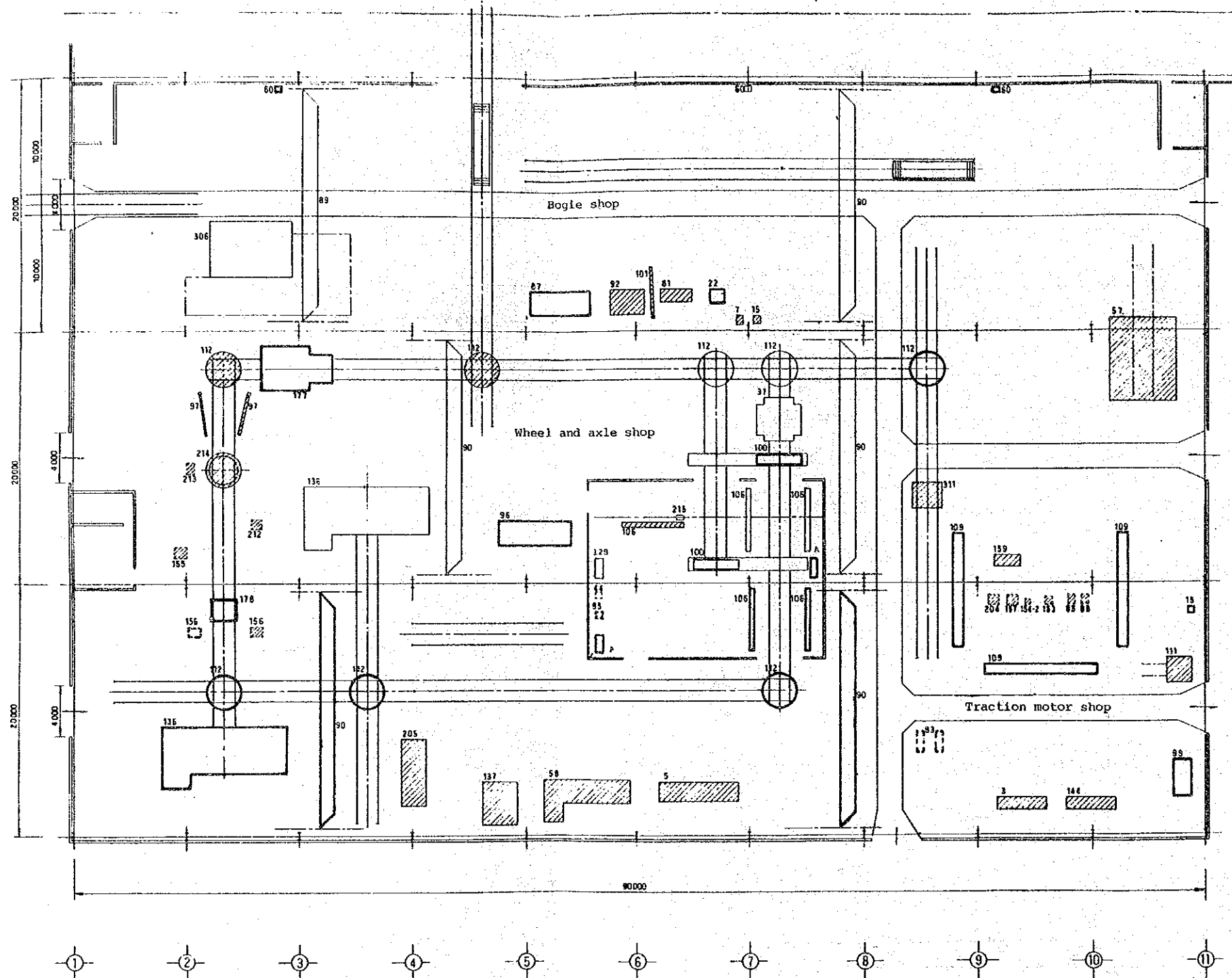


| | | |
|---------------------|--------------------------------------|-----|
| 311 | Traverser for rotating machine | 1 |
| 204 | Layer short-circuiting tester | 1 |
| 159 | Traction motor tester | 1 |
| 157 | Insulation deterioration tester | 1 |
| 154-2 | Dielectric strength tester | 1 |
| 153 | Insulation resistance tester | 1 |
| 144 | Dynamic blanching machine | 1 |
| 111 | Air blast booth | 1 |
| 109 | Slat conveyor | 3 |
| 99 | Parts cleaner | 1 |
| 98 | Axle bearing induction heater | 1 |
| 95 | Pinion heater | 1 |
| 90 | Overhead travelling crane 5 ton | 1 |
| 81 | Low platform cart | 2 |
| 15 | Pedestal grinding machine | 1 |
| 3 | Lathe | 1 |
| Traction motor shop | | |
| No. | Name of equipment of respective shop | Qty |

| | | |
|---------------------|--|-----|
| A | Air conditioner | 1 |
| 215 | Monorail 1/2 ton | 1 |
| 214 | Turntable with wheel and axle rotating equipment | 1 |
| 213 | Bearing cleaning equipment | 1 |
| 212 | Axle bearing removing machine | 1 |
| 205 | Brake disk lathe | 1 |
| 178 | Wheel and axle rotating equipment | 1 |
| 156 | Ultrasonic flaw detector | 2 |
| 155 | Magnetic flaw detector | 1 |
| 137 | Vertical lathe | 1 |
| 136 | Wheel lathe | 2 |
| 126 | Air conditioner | 1 |
| 112 | Turntable | 7 |
| 10b | Roller conveyor | 5 |
| 100 | Wheel and axle traverser | 2 |
| 97 | Jib crane 1/4 ton | 2 |
| 96 | Axle box washing machine | 1 |
| 95 | Bearing heater | 1 |
| 90 | Overhead travelling crane 5 ton | 3 |
| 58 | Hydraulic wheel press | 1 |
| 44 | Demagnetizer | 1 |
| 37 | Oil flashing equipment | 1 |
| 5 | Axle lathe | 1 |
| Wheel and axle shop | | |
| 306 | Bogie washing equipment | 1 |
| 176 | Bogie disassembling equipment | 1 |
| 101 | Jib crane 1/4 ton | 1 |
| 92 | Magnetic flaw detector | 1 |
| 90 | Overhead travelling crane 5 ton | 1 |
| 89 | Overhead travelling crane 15 ton | 1 |
| 87 | Parts cleaner | 1 |
| 61 | Spring tester | 1 |
| 60 | Electric arc welder | 3 |
| 57 | Bogie painting equipment | 1 |
| 22 | Hydraulic press | 1 |
| 15 | Pedestal grinding machine | 1 |
| 7 | Upright drilling machine | 1 |
| Bogie shop | | |
| No. | Name of equipment of respective shop | Qty |

[Dashed box] Additional equipment
 [Hatched box] Transferred equipment
 [Circle with dot] Movable equipment
 [Square with dot] Fixed equipment

Fig. 5.3.14 No. 1 Workshop
Machine Layout Plan of Bogie Shop,
Wheel and Axle Shop, Traction Motor Shop
Proposal 1b

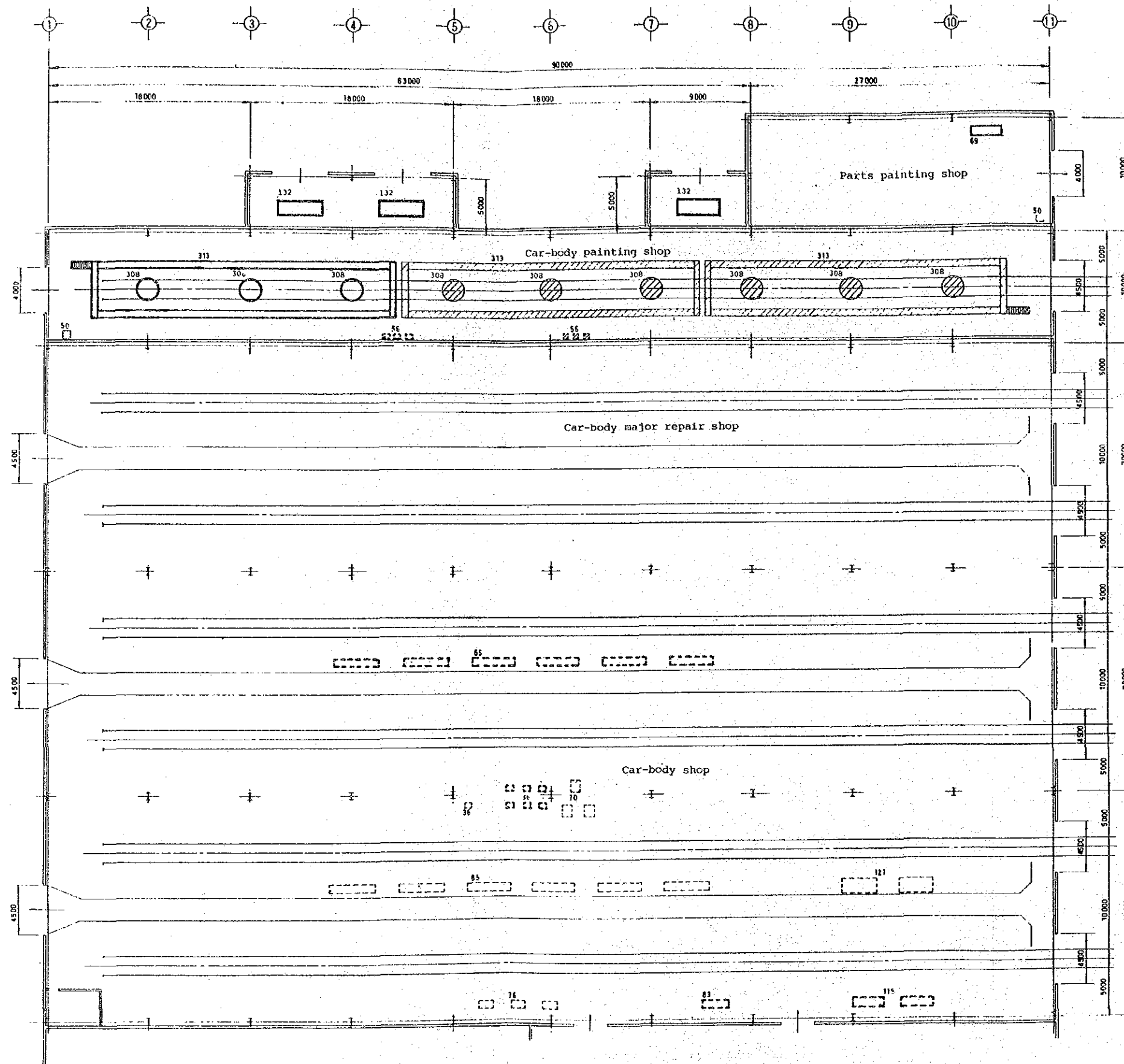


| | | |
|---------------------|--------------------------------------|-----|
| 311 | Traverser for rotating machine | 1 |
| 204 | Layer short-circuiting tester | 1 |
| 159 | Traction motor tester | 1 |
| 157 | Insulation deterioration tester | 1 |
| 154-2 | Dielectric strength tester | 1 |
| 153 | Insulation resistance tester | 1 |
| 144 | Dynamic balancing machine | 1 |
| 111 | Air blast booth | 1 |
| 109 | Slat conveyor | 3 |
| 99 | Parts cleaner | 1 |
| 98 | Axle bearing induction heater | 1 |
| 95 | Pinion heater | 1 |
| 90 | Overhead travelling crane 5 ton | 1 |
| 83 | Low platform cart | 2 |
| 15 | Pedestal grinding machine | 1 |
| 7 | Lathe | 1 |
| Traction motor shop | | |
| No. | Name of equipment of respective shop | Qty |

| | | |
|---------------------|--|-----|
| A | Air conditioner | 2 |
| 177 | Wheel and axle washing equipment | 1 |
| 215 | Monorail 1/2 ton | 1 |
| 214 | Turntable with wheel and axle rotating equipment | 1 |
| 213 | Bearing cleaning equipment | 1 |
| 212 | Axle bearing removing machine | 1 |
| 205 | Brake disk lathe | 1 |
| 178 | Wheel and axle rotating equipment | 1 |
| 156 | Ultrasonic flaw detector | 2 |
| 155 | Magnetic flaw detector | 1 |
| 137 | Vertical lathe | 1 |
| 136 | Wheel lathe | 2 |
| 128 | Air conditioner | 1 |
| 112 | Turntable | 8 |
| 106 | Roller conveyor | 5 |
| 100 | Wheel and axle traverser | 2 |
| 97 | Jib crane 1/4 ton | 2 |
| 96 | Axle box washing machine | 1 |
| 95 | Bearing heater | 1 |
| 90 | Overhead travelling crane 5 ton | 3 |
| 58 | Hydraulic wheel press | 1 |
| 44 | Demagnetizer | 1 |
| 37 | Oil flashing equipment | 1 |
| 5 | Axle lathe | 1 |
| Wheel and axle shop | | |
| 306 | Bogie washing equipment | 1 |
| 101 | Jib crane 1/4 ton | 1 |
| 32 | Magnetic flaw detector | 1 |
| 90 | Overhead travelling crane 5 ton | 1 |
| 89 | Overhead travelling crane 15 ton | 1 |
| 37 | Parts cleaner | 1 |
| 61 | Spring tester | 1 |
| 60 | Electric arc welder | 3 |
| 57 | Bogie painting equipment | 1 |
| 22 | Hydraulic press | 1 |
| 15 | Pedestal grinding machine | 1 |
| 7 | Upright drilling machine | 1 |
| Bogie shop | | |
| No. | Name of equipment of respective shop | Qty |

[Dashed box] Additional equipment
 [Hatched box] Transferred equipment
 [Circle with dot] Movable equipment
 [Square with dot] Fixed equipment

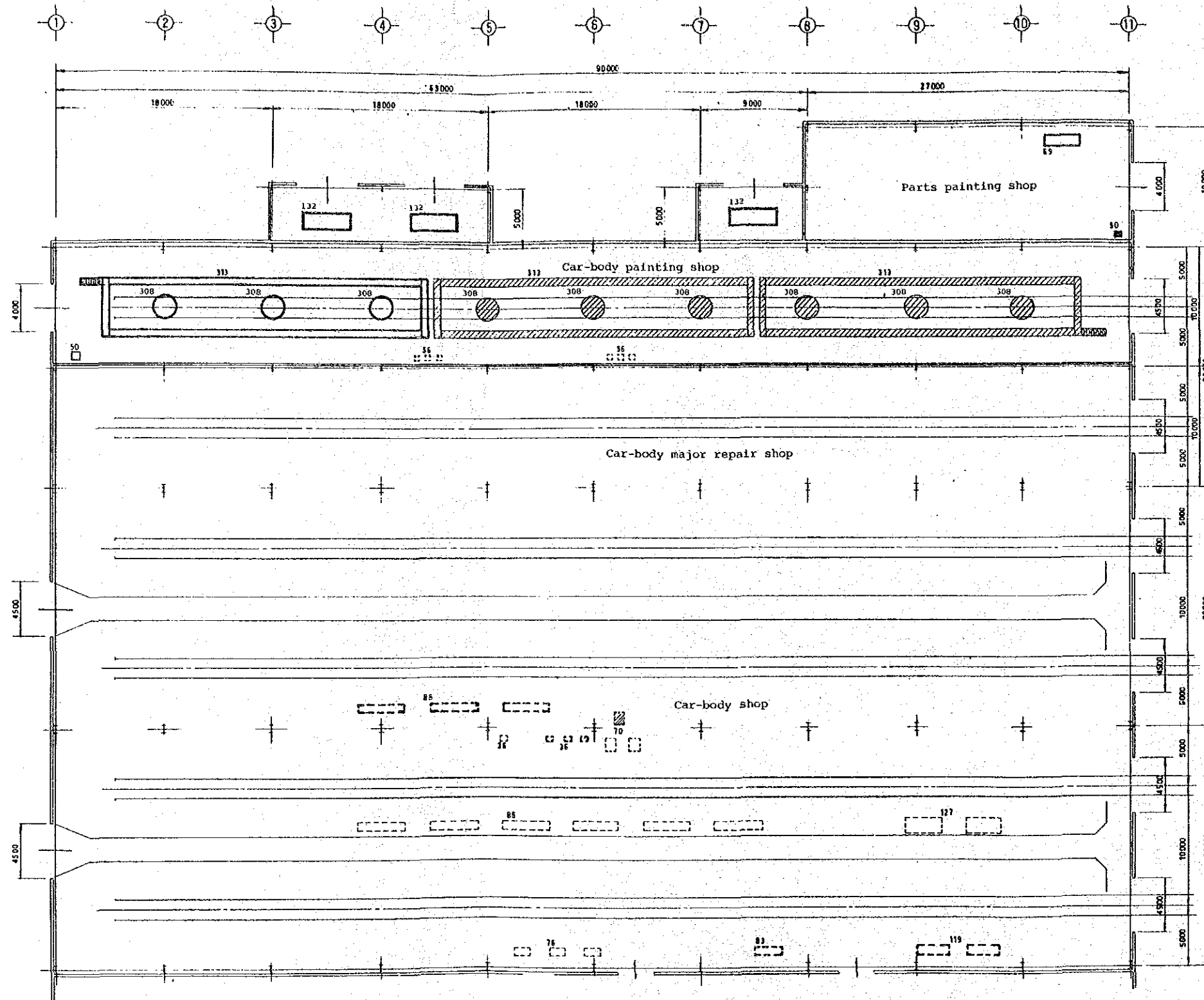
Fig. 5.3.15 No. 1 Workshop
 Machine Layout Plan of Bogie Shop,
 Wheel and Axle Shop, Traction Motor Shop
 Proposal II, III



| | | |
|-----|---|-----|
| 69 | Parts cleaner | 1 |
| 50 | Paint mixer | 1 |
| | parts painting shop | |
| 313 | Scaffold for car-body painting | 3 |
| 308 | Air exhaust | 9 |
| 132 | Air heating equipment | 3 |
| 56 | Car-body painting machine | 6 |
| 50 | Paint mixer | 1 |
| | Car-body painting shop | |
| 127 | Tractor | 2 |
| 119 | Forklift truck | 2 |
| 85 | Scaffolding car for car-body repair | 12 |
| 83 | Low platform cart | 1 |
| 76 | Cart | 3 |
| 70 | Under floor equipment mounting and demounting equipment | 3 |
| 36 | Electric welder | 7 |
| | Car-body shop | |
| No. | Name of equipment of respective shop | Qty |

[Dashed box] Additional equipment
 [Hatched box] Transferred equipment
 [Dotted box] Movable equipment
 [Solid box] Fixed equipment

Fig. 5.3.16 No. 2 Workshop
 Machine Layout Plan of Car-body Shop,
 Car-body Painting Shop, Parts Painting Shop
 and Car-body Major Repair Shop
 Proposal Ia, Ib, II



| | | |
|-----|--|-----|
| 69 | Parts cleaner | 1 |
| 50 | Paint mixer | 1 |
| | parts painting shop | |
| 313 | Scaffold for car-body painting | 3 |
| 308 | Air exhaust | 9 |
| 132 | Air heating equipment | 3 |
| 56 | Car-body painting machine | 6 |
| 50 | Paint mixer | 1 |
| | Car-body painting shop | |
| 127 | Tractor | 2 |
| 119 | Forklift truck | 2 |
| 85 | Scaffolding car for car-body repair | 9 |
| 83 | Low platform cart | 1 |
| 76 | Cart | 3 |
| 70 | Under floor equipment mounting and dismounting equipment | 3 |
| 36 | Electric welder | 4 |
| | Car-body shop | |
| No. | Name of equipment of respective shop | Qty |

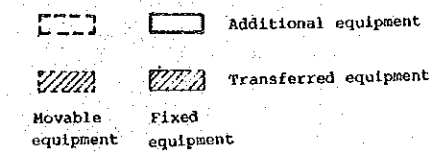
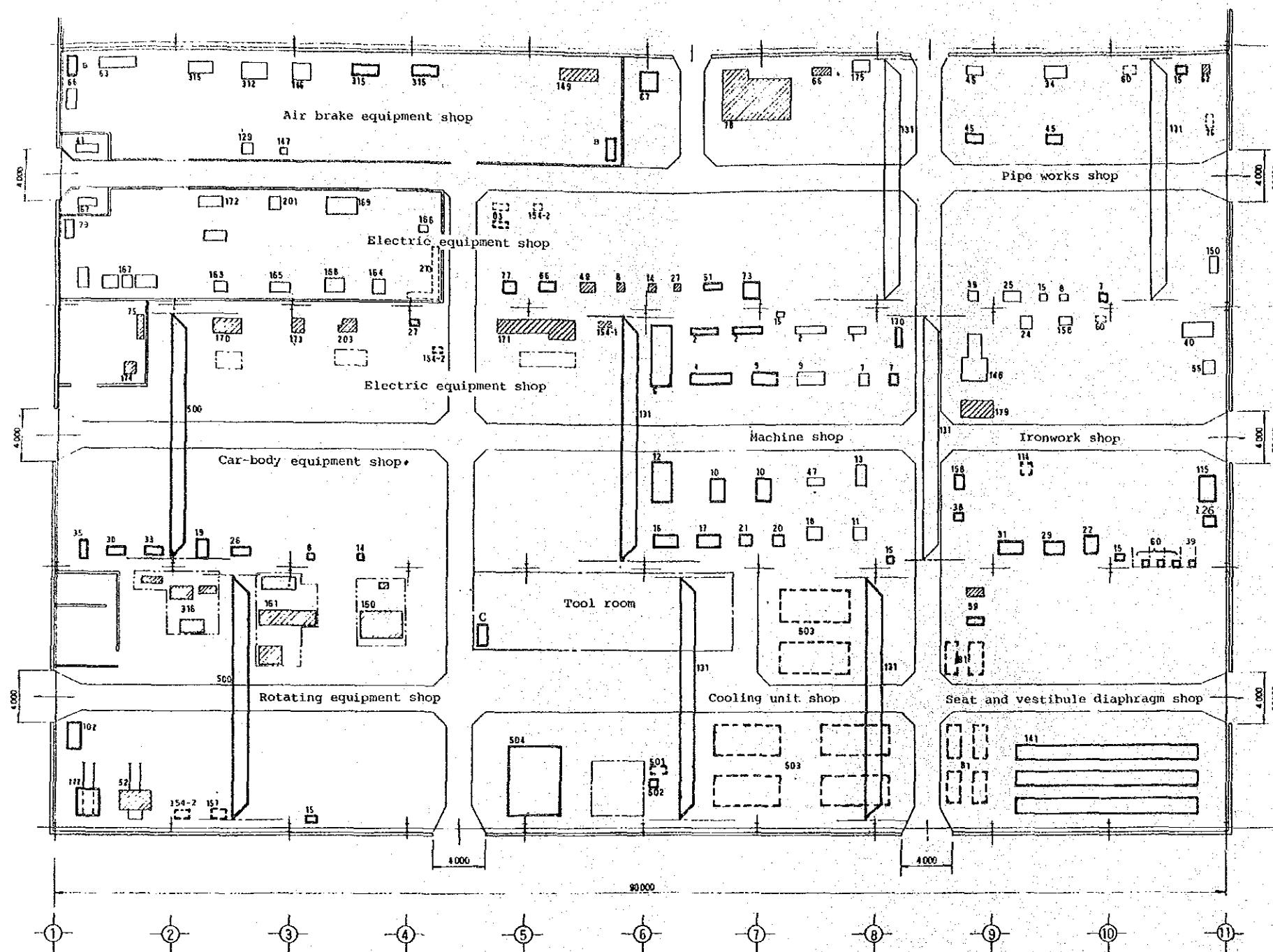


Fig. 5.3.17 No. 2 Workshop
Machine Layout Plan of Car-body Shop,
Car-body Painting Shop, Parts Painting Shop
and Car-body Major Repair Shop
Proposal III



[---] Additional equipment
 [---] Transferred equipment
 [---] Movable equipment
 [---] Fixed equipment

| | | | | | |
|-----|--------------------------------------|-----|-------|---------------------------------|---|
| 141 | Seat storing equipment | 1 | 500 | Overhead travelling crane 3 ton | 1 |
| 81 | Seat transfer cart | 6 | 316 | Air compressor tester | 1 |
| 59 | Industrial sewing machine | 2 | 161 | Motor alternator tester | 1 |
| | Seat and vestibule diaphragm shop | | 160 | Fan testing machine | 1 |
| 504 | Cooling unit test equipment | 1 | 157 | Insulation deterioration tester | 1 |
| 503 | Cooling unit repairing carrier | 6 | 154-2 | Dielectric strength tester | 1 |
| 502 | Air exhaust | 1 | 111 | Air blast booth | 1 |
| 501 | Cleaning machine | 1 | 102 | Air filter cleaning machine | 1 |
| 131 | Overhead travelling crane 2 ton | 2 | 52 | Drying oven | 1 |
| | Cooling unit shop | | 15 | Pedestal grinding machine | 1 |
| No. | Name of equipment of respective shop | Qty | | Rotating equipment shop | |
| | | | | Ironwork shop | |
| | | | | | |
| | | | | | |
| | | | | | |

| | | | | | |
|-----|--|-----|-------|---|-----|
| C | Air conditioner | 1 | 131 | Overhead travelling crane 2 ton | 1 |
| | Tool room | | 76 | Cart | 1 |
| 35 | Milling machine | 1 | 62 | Hydraulic pressure tester | 1 |
| 13 | Bending machine | 1 | 60 | Electric welder | 1 |
| 30 | Bending roll | 1 | 45 | Threading machine | 3 |
| 26 | Shearing machine | 1 | 34 | Pipe bender | 1 |
| 19 | Crank press | 1 | 15 | Pedestal grinding machine | 1 |
| 14 | Bench grinding machine | 1 | | Pipe works shop | |
| 8 | Bench drilling machine | 1 | 8 | Air conditioner | 2 |
| | Car-body equipment shop | | 315 | Air brake valve tester | 3 |
| 131 | Overhead travelling crane 2 ton | 1 | 312 | Brake valve tester | 1 |
| 130 | Centering machine | 1 | 149 | Door engine tester | 1 |
| 47 | Hacksawing machine | 1 | 147 | Pressure gauge tester | 1 |
| 21 | Drill grinding machine | 1 | 146 | Safety valve tester | 1 |
| 20 | Cemented carbide tool grinding machine | 1 | 129 | Niper tester | 1 |
| 18 | Universal tool grinding machine | 1 | 67 | Parts cleaner | 1 |
| 17 | Universal grinding machine | 1 | 66 | Dust arresting equipment | 1 |
| 16 | Surface grinder | 1 | 63 | Ultrasonic washing equipment | 1 |
| 15 | Pedestal grinding machine | 2 | 41 | Air compressor | 1 |
| 13 | Shaper | 1 | | Air brake equipment shop | |
| 12 | Horizontal boring machine | 1 | 500 | Overhead travelling crane 3 ton | 1 |
| 11 | Universal milling machine | 1 | 210 | Various electric measuring apparatuses | 1 |
| 10 | Vertical milling machine | 2 | 203 | Main controller tester | 1 |
| 9 | Radial drilling machine | 2 | 201 | Contactless relay tester | 1 |
| 7 | Upright drilling machine | 2 | 175 | Electric power source device for testing | 1 |
| 6 | Lathe 3,000 | 1 | 174 | Battery capacity tester | 1 |
| 4 | Lathe 2,000 | 1 | 173 | Power source device for testing | 1 |
| 2 | Lathe 1,000 | 3 | 172 | Vacuum circuit breaker tester | 1 |
| 1 | Lathe 650 | 1 | 171 | Main rectifier tester | 1 |
| | Machine shop | | 170 | Motor alternator control equipment tester | 1 |
| 179 | Draft gear disassembling/ assembling machine | 1 | 169 | Relay tester | 1 |
| 156 | Magnetic flaw detector | 2 | 168 | Distributing circuit breaker tester | 1 |
| 153 | Oil dumper tester | 1 | 167 | A. T. S. tester | 1 |
| 148 | Tight lock coupler tester | 1 | 166 | Lightning arrester tester | 1 |
| 131 | Overhead travelling crane 2 ton | 1 | 165 | Electromagnetic valve tester | 1 |
| 126 | Automatic gas cutting machine | 1 | 164 | Electric meter calibrating apparatus | 1 |
| 115 | Parts cleaner | 1 | 163 | Speedometer generator tester | 1 |
| 114 | Rust remover | 1 | 154-2 | Dielectric strength tester | 2 |
| 60 | Electric welder | 4 | 154-1 | Dielectric strength tester | 1 |
| 55 | Furnace | 1 | 131 | Overhead travelling crane 2 ton | 1 |
| 40 | Pneumatic power hammer | 1 | 83 | Low platform cart | 2 |
| 39 | Argon gas arc welder | 1 | 79 | Air conditioner | 1 |
| 38 | Spot welder | 2 | 78 | Washing equipment | 1 |
| 31 | Punching/shearing machine | 1 | 77 | Parts cleaner | 1 |
| 29 | Bending roll | 1 | 75 | Water purifying equipment | 1 |
| 25 | Shearing machine | 1 | 73 | Electric coil drying oven | 1 |
| 24 | Hydraulic press 100 ton | 1 | 66 | Dust arresting equipment | 2 |
| 22 | Hydraulic press | 1 | 51 | Coiling machine | 1 |
| 15 | Pedestal grinding machine | 2 | 49 | Soft grit blasting machine | 1 |
| 8 | Bench drilling machine | 1 | 27 | Buffing machine | 2 |
| 7 | Upright drilling machine | | 14 | Bench grinding machine | 1 |
| | Ironwork shop | | 8 | Bench drilling machine | 1 |
| No. | Name of equipment of respective shop | Qty | | Electric equipment shop | |
| | | | No. | Name of equipment of respective shop | Qty |

Fig. 5.3.18 No. 2 Workshop Machine Layout Plan of Car-body Equipment Shop, Electric Equipment Shop, Air Brake Equipment Shop, Machine Shop, Ironwork Shop, Rotating Equipment Shop and Others Proposal Ib, II, III

Table 5.3.11 Combination of Figures

| Figures for Work Flow | Figures for Machine Layout | Proposal | | | |
|--------------------------|-------------------------------|----------|----|----|-----|
| | | Ia | Ib | II | III |
| Fig. 5.3.5 | Fig. 5.3.12 | o | o | o | o |
| Fig. 5.3.6 | Fig. 5.3.13 | o | | | |
| Fig. 5.3.7 | Fig. 5.3.14 | | o | | |
| Fig. 5.3.8 | Fig. 5.3.15 | | | o | o |
| Fig. 5.3.9 | Fig. 5.3.16 | | o | o | |
| Fig. 5.3.10 | Fig. 5.3.17 | | | | o |
| Fig. 5.3.11 | Fig. 5.3.18 | | o | o | o |

(3) Machines to be transferred

As a result of the layout, it becomes necessary to transfer some machines and they are shown in Table 5.3.12.

Table 5.3.12 Machines to be Transferred

| Shop | Machine | Proposa | | |
|--|-----------------------------------|---------|----|-----|
| | | Ib | II | III |
| D Electric Equipment Shop | Buffing machine | 1 | 1 | 1 |
| | Soft grit blasting machine | 1 | 1 | 1 |
| | Dust arresting equipment | 1 | 1 | 1 |
| | Water purifying equipment | 1 | 1 | 1 |
| | Washing equipment | 1 | 1 | 1 |
| | Dielectric strength tester | 1 | 1 | 1 |
| | M. A. control equipment tester | 1 | 1 | 1 |
| | Main rectifier tester | 1 | 1 | 1 |
| | Power source facility for testing | 1 | 1 | 1 |
| | Battery capacity tester | 1 | 1 | 1 |
| Main controller tester | 1 | 1 | 1 | |
| F Air Brake Equipment Shop | Door engine tester | 1 | 1 | 1 |
| H Seat and Vestibule Diaphragm Shop | Industrial sewing machine | 1 | 1 | 1 |
| K Car-body Painting Shop | Air exhaust | 6 | 6 | 6 |
| | Scaffold for car-body painting | 2 | 2 | 2 |
| | Paint mixer | 1 | 1 | 1 |
| L Bogie Shop | Upright drilling machine | 1 | 1 | 1 |
| | Pedestal grinding machine | 1 | 1 | 1 |
| | Bogie painting equipment | 0 | 1 | 1 |
| | Spring tester | 1 | 1 | 1 |
| | Magnetic flaw detector | 1 | 1 | 1 |
| | Jib crane (1/4 t) | 1 | 1 | 1 |

| Shop | Machine | Proposal | | |
|--------------------------------|--|----------|----|-----|
| | | Ib | II | III |
| M Wheel and Axle Shop | Axle lathe | 1 | 1 | 1 |
| | Hydraulic wheel press | 1 | 1 | 1 |
| | Jib crane (1/4 t) | 2 | 2 | 2 |
| | Turntable | 2 | 2 | 2 |
| | Vertical lathe | 1 | 1 | 1 |
| | Brake disk lathe | 1 | 1 | 1 |
| | Bearing cleaning equipment | 1 | 1 | 1 |
| | Turntable with wheel and axle rotating equipment | 1 | 1 | 1 |
| | Roller conveyer | 1 | 1 | 1 |
| | N Traction Motor Shop | Lathe | 1 | 1 |
| Pinion heater | | 1 | 1 | 1 |
| Air blast booth | | 1 | 1 | 1 |
| Dynamic balancing machine | | 1 | 1 | 1 |
| Dielectric strength tester | | 1 | 1 | 1 |
| Traction motor tester | | 1 | 1 | 1 |
| Traverser for rotating machine | | 1 | 1 | 1 |
| O Rotating Equipment Shop | Drying oven | 1 | 1 | 1 |
| | Fan testing machine | 1 | 1 | 1 |
| | Air compressor tester | 1 | 1 | 1 |
| | Motor alternator tester | 1 | 1 | 1 |
| P Ironwork Shop | Draft gear disassembling/ assembling machine | 1 | 1 | 1 |
| TOTAL | | 50 | 51 | 51 |

5-4 Study of Buildings, Civil Engineering and Facilities for Amplification of Workshop

5-4-1 Buildings

The amplification of inspection/repairing buildings of the KM 10 Workshop No. 1 Workshop and No. 2 Workshop will be carried out according to the shop layout studied in the preceding section.

In carrying out the amplification work for the No. 1 Workshop Building (Bogie, Wheel and Axle, and Traction Motor Shops) and the No.2 Workshop Building (equipment shops, warehouse) on the main line side, the work should be studied taking into account the use of an overhead travelling crane to transfer various pieces of equipment in the buildings and working spaces necessary for inspection/repairing activities.

Amplification work will be carried out on the Administrative Building, Energy Center, and Incidental Buildings (heating machine room, temporary bogie shed, garage, dangerous items storage, etc.) in addition to the inspection/repairing buildings mentioned above.

The amplification of buildings for each proposal is shown in Figs. 5.4.1 and 5.4.2. The building areas at present (1st Step electrification) and for the amplification proposals are shown in Table 5.4.1.

5-4-2 Civil Engineering

Tracks and roads in the workshop for each proposal are shown in Figs. 5.4.3 and 5.4.4.

(1) Tracks

In line with the amplification of the Car-body Shop and the new construction of Car-body Major Repair Shop, some new construction of tracks will be carried out.

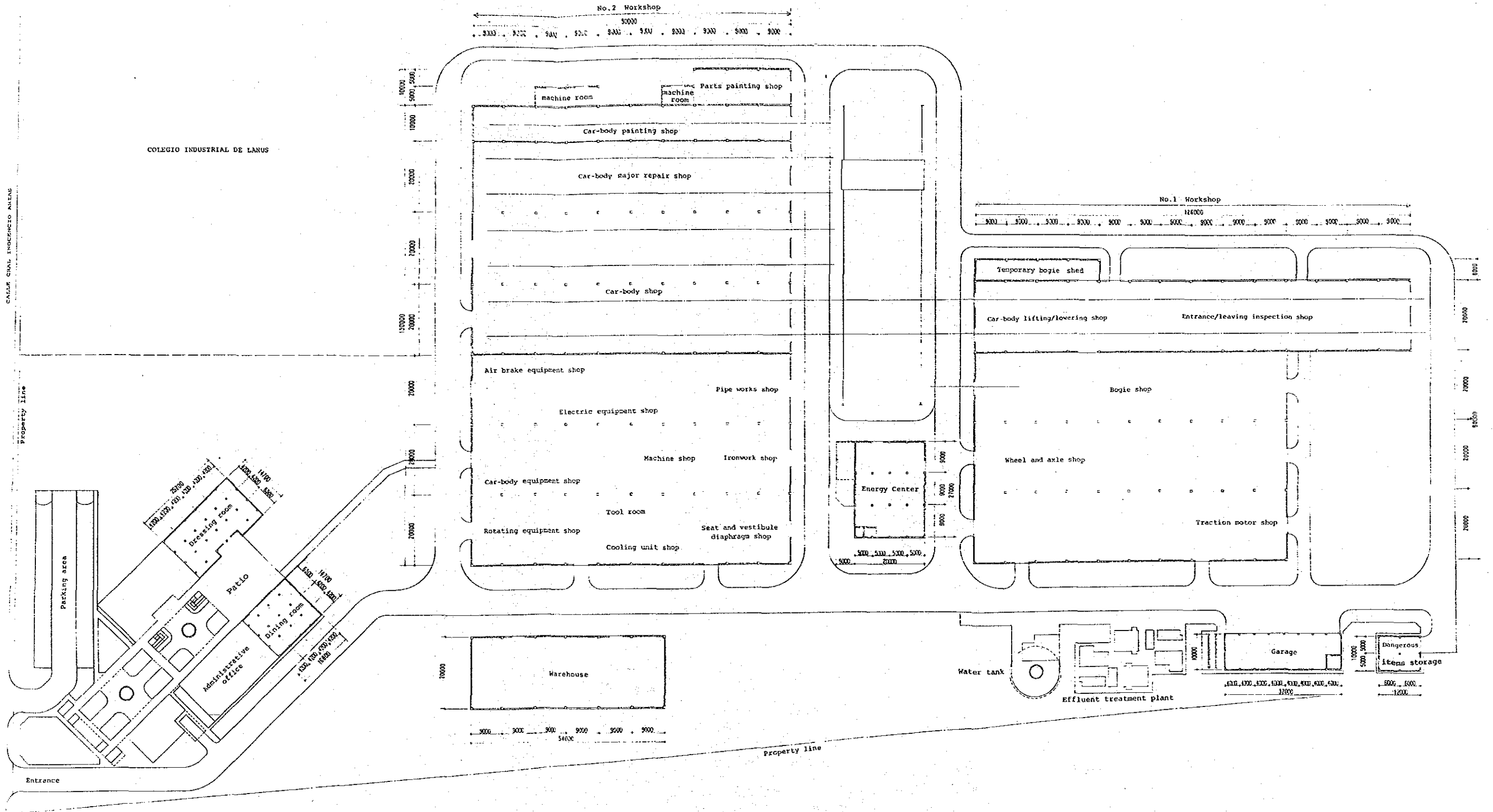


Fig. 5.4.1 Layout of KM 10 Workshop Buildings Proposal Ib, II

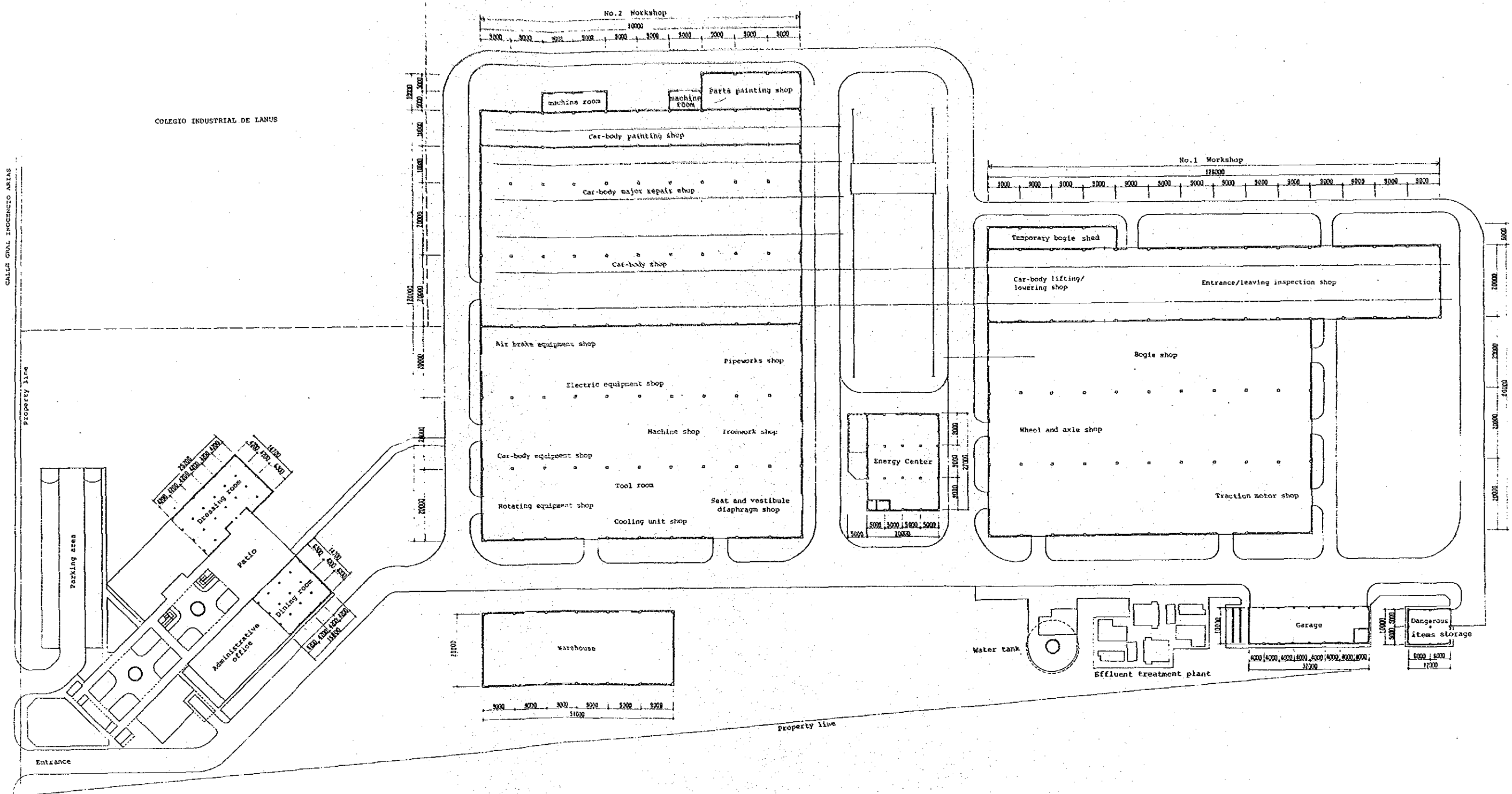


Fig. 5.4.2 Layout of KM 10 Workshop Buildings Proposal III

Table 5.4.1 Building Area for Each Proposal

Unit: m²

| Building | Classification Shop | 1st Step Electri- fication | Proposal | | |
|------------------------|-----------------------------------|----------------------------------|----------|--------|--------|
| | | Present Condition | Ib | II | III |
| No. 1 Workshop | Car-body lifting/lowering shop | 720 | 720 | 720 | 720 |
| | Entrance/leaving inspection shop | 1,800 | 1,800 | 1,800 | 1,800 |
| | Bogie shop | 1,425 | 2,055 | 2,055 | 2,055 |
| | Wheel and axle shop | 1,135 | 2,515 | 2,515 | 2,515 |
| | Traction motor shop | 600 | 750 | 750 | 750 |
| | Lavatory | 50 | 50 | 50 | 50 |
| | Office | 30 | 30 | 30 | 30 |
| | Building area(1) | 5,760 | 7,920 | 7,920 | 7,920 |
| | Added building area(1) | | 2,160 | 2,160 | 2,160 |
| No. 2 Workshop | Car-body painting shop | 720 | 900 | 900 | 900 |
| | Car-body shop | 1,760 | 3,560 | 3,560 | 2,660 |
| | Air brake equipment shop | 310 | 430 | 430 | 430 |
| | Electric equipment shop | 1,030 | 1,360 | 1,360 | 1,360 |
| | Pipe works shop | 230 | 345 | 345 | 345 |
| | Machine shop | 360 | 440 | 440 | 440 |
| | Ironwork shop | 690 | 575 | 575 | 575 |
| | Warehouse | 310 | 1,080 | 1,080 | 1,080 |
| | Car-body equipment shop | 270 | 410 | 410 | 410 |
| | Seat and vestibule diaphragm shop | 360 | 460 | 460 | 460 |
| | Rotating equipment shop | 0 | 620 | 620 | 620 |
| | Tool room | 0 | 220 | 220 | 220 |
| | Cooling unit shop | 0 | 500 | 500 | 500 |
| | Parts painting shop | 0 | 270 | 270 | 270 |
| | Car-body major repair shop | 0 | 1,800 | 1,800 | 1,800 |
| | Lavatory | 50 | 50 | 50 | 50 |
| | Office | 30 | 30 | 30 | 30 |
| | Building area(2) | 6,120 | 3,050 | 13,050 | 12,150 |
| Added building area(2) | | 6,930 | 6,930 | 6,030 | |

Unit: m²

| Building | Classification | 1st Step Electri- fication | Proposal | | |
|-------------------------|--|----------------------------------|----------|--------|--------|
| | | Present Condition | Ib | II | III |
| Energy Center | Machine room | 435 | 615 | 615 | 615 |
| | Lavatory | 5 | 5 | 5 | 5 |
| | Dressing room | 10 | 10 | 10 | 10 |
| | Building area(3) | 450 | 630 | 630 | 630 |
| | Added building area(3) | | 180 | 180 | 180 |
| Incidental Building | Machine room (for painting shop) | 0 | 135 | 135 | 135 |
| | Temporary bogie shed | 0 | 216 | 216 | 216 |
| | Shunting locomotive shed | 84 | 84 | 84 | 84 |
| | Garage | 250 | 330 | 330 | 330 |
| | Dangerous items storage | 60 | 120 | 120 | 120 |
| | Sanitary room | 70 | 70 | 70 | 70 |
| | Effluent treatment plant | 270 | 540 | 540 | 540 |
| | Building area(4) | 734 | 1,495 | 1,495 | 1,495 |
| | Added building area(4) | | 761 | 761 | 761 |
| Administrative Building | Office | 793 | 793 | 793 | 793 |
| | Dressing room | 353 | 706 | 706 | 706 |
| | Dining room | 232 | 464 | 464 | 464 |
| | Patio | 897 | 1,180 | 1,180 | 1,180 |
| | Building area(5) | 2,275 | 3,143 | 3,143 | 3,143 |
| | Added building area(5) | | 868 | 868 | 868 |
| Total Area | Total building area of No.1 workshop and No.2 workshop | 11,880 | 20,970 | 20,970 | 20,070 |
| | Total added building area of No.1 workshop and No.2 workshop | | 9,090 | 9,090 | 8,190 |
| | Total building area of other buildings | 3,459 | 5,268 | 5,268 | 5,268 |
| | Total added building area of other buildings | | 1,809 | 1,809 | 1,809 |
| | Grand Total of building area | 15,339 | 26,238 | 26,238 | 25,338 |

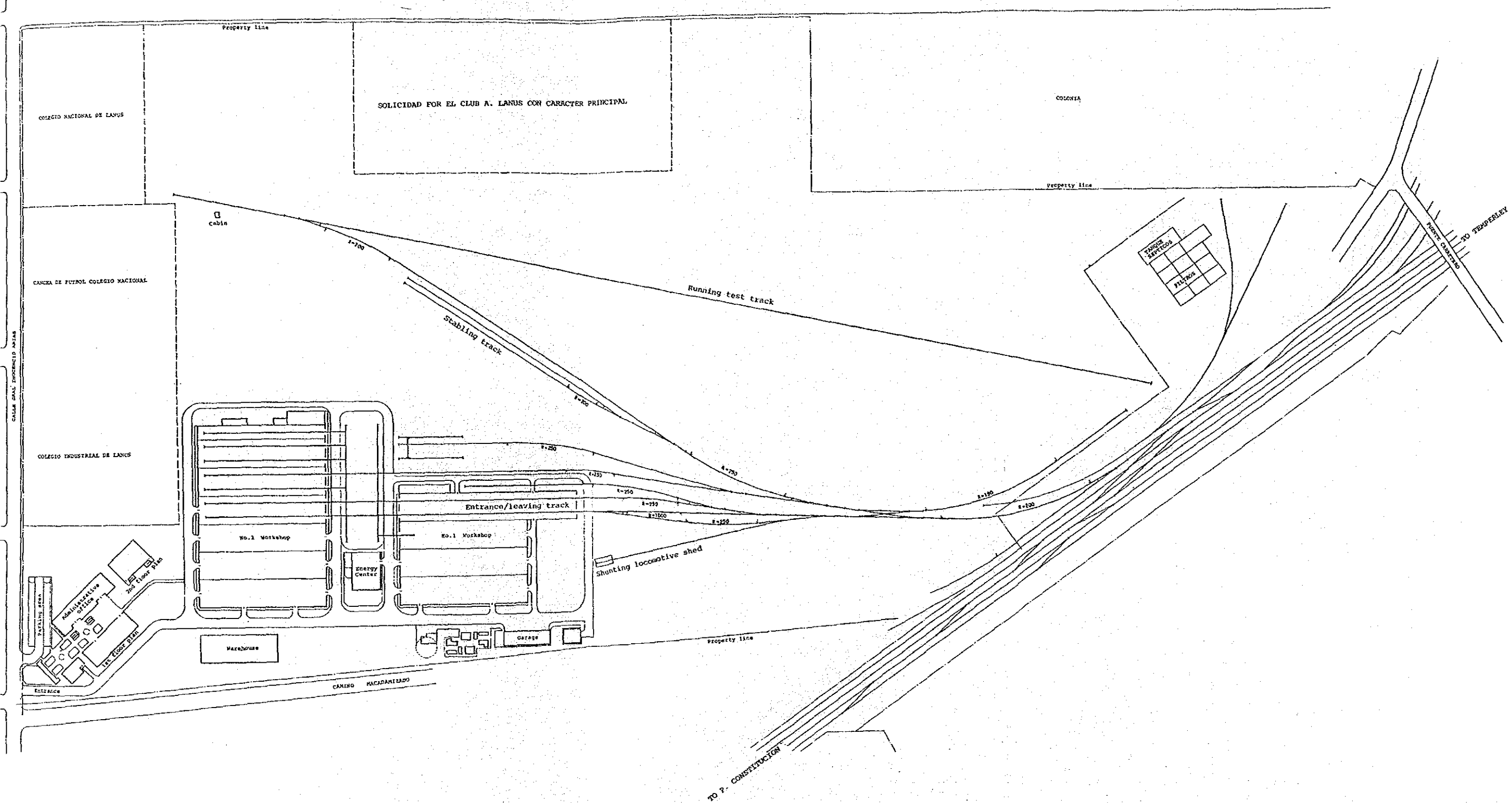


Fig. 5.4.3 Layout of KM 10 Workshop Proposal Ib, II

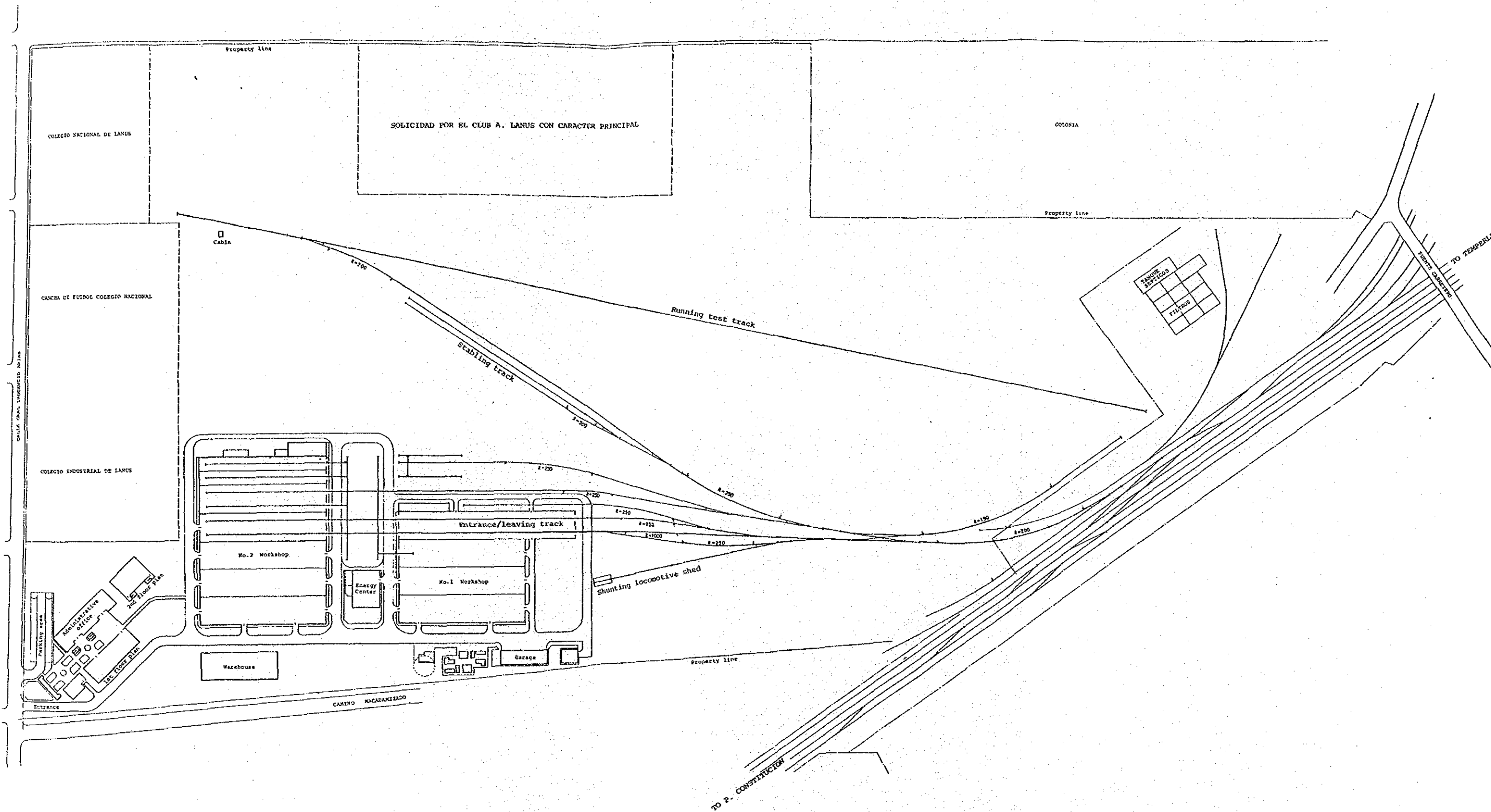


Fig. 5.4.4 Layout of KM 10 Workshop Proposal III

(2) Roads

Along with the amplification of buildings, some new construction and removal of roads in the workshop will be carried out. The roads are used to carry heavy equipment of electric railcars and should be constructed taking this into consideration.

5-4-3 Facilities of Buildings

Facilities of buildings are plumbing facilities, air conditioning facilities, ventilation facilities and fire hydrant facilities. In adding these facilities, the same standard will be applied in principle as with the KM 10 Workshop (1st Step electrification).

The necessary capacities of these facilities are shown as follows:

Water supply facilities Table 5.4.2

Drainage facilities Table 5.4.3

5-4-4 Electric Facilities

Electric facilities include power receiving/distributing facilities, communication facilities, catenary system and signal facilities.

Electric power receiving/distributing facilities will be increased because their capacity will be insufficient for the amplified workshop.

Capacity of lighting facilities for each proposal is shown in Table 5.4.4 and Table 5.4.5, and capacity of motive power facilities for each plan is shown in Table 5.4.6 and Table 5.4.7.

Communication facilities, catenary system and signal facilities will be added or newly installed according to the requirements.

These increases of facilities are planned based on the formation of facilities of the 1st Step Workshop. Accordingly, when implementing additional installation of machines and equipments, the relations between the conditions of the present facilities and those of the planned will be fully taken into consideration.

Table 5.4.2 Water Supply Capacity for Each Proposal

| Classification Building | 1st Step Electrification Present Condition(m ³ /day) | Proposal (capacity of increase) (liter/hour) | | |
|----------------------------|--|---|--------|--------|
| | | Ib | II | III |
| No.1 Workshop | 50 | 6,060 | 6,560 | 6,560 |
| No.2 Workshop | 75.5 | 6,850 | 6,850 | 6,850 |
| Energy Center | 80 | 6,000 | 6,000 | 6,000 |
| Incidental building | 4 | 0 | 0 | 0 |
| Administrative building | ----- | 22,200 | 22,200 | 22,200 |
| Total | 209.5 | 41,110 | 41,610 | 41,610 |

Table 5.4.3 Drainage Capacity for Each Proposal

| Classification Building | 1st Step Electrification Present Condition(m ³ /day) | Proposal (capacity of increase) (liter/hour) | | |
|----------------------------|--|---|--------|--------|
| | | Ib | II | III |
| No.1 Workshop | 45 | 60 | 60 | 60 |
| No.2 Workshop | 49.5 | 1,150 | 1,150 | 1,150 |
| Energy Center | 10 | 3,000 | 3,000 | 3,000 |
| Incidental building | 4 | ----- | ----- | ----- |
| Administrative building | ----- | 22,200 | 22,200 | 22,200 |
| Total | 108.5 | 26,410 | 26,410 | 26,410 |

Table 5.4.4 Capacity of Lighting Facilities for Each Proposal(normal use)

| Classification Building | 1st Step Electrification Present Condition | Proposal (capacity of increase) (kW) | | |
|----------------------------|---|---|-------|-------|
| | | Ib | II | III |
| No.1 Workshop | ---- | 86.4 | 86.4 | 86.4 |
| No.2 Workshop | ---- | 277.2 | 277.2 | 241.2 |
| Energy Center | ---- | 7.2 | 7.2 | 7.2 |
| Incidental building | ---- | 30.4 | 30.4 | 30.4 |
| Administrative building | ---- | 34.7 | 34.7 | 34.7 |
| Total | | 435.9 | 435.9 | 399.9 |

Table 5.4.5 Capacity of Lighting Facilities for Each Proposal(emergency use)

| Classification Building | 1st Step Electrification Present Condition | Proposal (capacity of increase) (kW) | | |
|----------------------------|---|---|------|------|
| | | Ib | II | III |
| No.1 Workshop | ---- | 17.3 | 17.3 | 17.3 |
| No.2 Workshop | ---- | 55.4 | 55.4 | 48.2 |
| Energy Center | ---- | 1.4 | 1.4 | 1.4 |
| Incidental building | ---- | 6.1 | 6.1 | 6.1 |
| Administrative building | ---- | 6.9 | 6.9 | 6.9 |
| Total | | 87.1 | 87.1 | 79.9 |

Table 5.4.6 Capacity of Motive Power Facilities for Each Proposal
(normal use)

| Classification Building | 1st Step Electrification Present Condition(kVA) | Proposal (capacity of increase) (kW) | | |
|----------------------------|--|---|---------|---------|
| | | Ib | II | III |
| No.1 Workshop | 1,039 | 239.2 | 309.2 | 309.2 |
| No.2 Workshop | 512 | 538.0 | 538.0 | 492.4 |
| Energy Center | 468 | 45.0 | 45.0 | 45.0 |
| Incidental building | 90 | 181.1 | 181.1 | 181.1 |
| Administrative building | ---- | 17.2 | 17.2 | 17.2 |
| Total | 2,109 | 1,020.5 | 1,090.5 | 1,044.9 |

Table 5.4.7 Capacity of Motive Power Facilities for Each Proposal
(emergency use)

| Classification Building | 1st Step Electrification Present Condition(kVA) | Proposal (capacity of increase) (kW) | | |
|----------------------------|--|---|-------|-------|
| | | Ib | II | III |
| No.1 Workshop | 51 | 47.8 | 61.8 | 61.8 |
| No.2 Workshop | 0 | 107.6 | 107.6 | 98.5 |
| Energy Center | 10 | 9.0 | 9.0 | 9.0 |
| Incidental building | 0 | 36.2 | 36.2 | 36.2 |
| Administrative building | -- | 3.4 | 3.4 | 3.4 |
| Total | 61 | 204.0 | 218.0 | 208.9 |

5-4-5 Utility Facilities

Utility facilities include effluent treatment facilities, natural gas supply facilities, compressed air facilities, liquid fuel storage facilities and steam supply facilities.

These facilities will be increased if the capacity of respective facilities of the 1st Step KM 10 Workshop is insufficient when amplified.

Steam, compressed air, and natural gas consumptions and effluent treatment capacity are shown in the following tables.

| | |
|-----------------------------|--------------|
| Steam consumption | Table 5.4.8 |
| Compressed air consumption | Table 5.4.9 |
| Natural gas consumption | Table 5.4.10 |
| Effluent treatment capacity | Table 5.4.11 |

As studied above, additions of facilities for water, electric power, steam, compressed air, natural gas, and drainage are needed for each shop in the amplified building for each amplification proposal. At the same time, their supply facilities and effluent treatment facilities should be amplified for increased capacities.

Table 5.4.8 Steam Consumption for Each Proposal

Unit: kg/hour

| Classification Building | 1st Step Electrification Present Condition | Proposal (capacity of increase) | | |
|----------------------------|---|---------------------------------|-------|-------|
| | | Ib | II | III |
| No.1 Workshop | 1,595 | 1,230 | 1,375 | 1,375 |
| No.2 Workshop | 500 | 1,290 | 1,290 | 1,290 |
| Energy Center | 0 | ----- | ----- | ----- |
| Incidental building | 0 | ----- | ----- | ----- |
| Administrative building | 0 | ----- | ----- | ----- |
| Total | 2,095 | 2,520 | 2,665 | 2,665 |

Table 5.4.9 Compressed Air Consumption for Each Proposal

Unit: m³/min.

| Classification Building | 1st Step Electrification Present Condition | Proposal (capacity of increase) | | |
|----------------------------|---|---------------------------------|-----|-----|
| | | Ib | II | III |
| No.1 Workshop | 18.8 | 1.4 | 1.7 | 1.7 |
| No.2 Workshop | 19.8 | 2.7 | 2.7 | 2.7 |
| Energy Center | ----- | --- | --- | --- |
| Incidental building | 1.0 | --- | --- | --- |
| Administrative building | ----- | --- | --- | --- |
| Total | 39.6 | 4.1 | 4.4 | 4.4 |

Table 5.4.10 Natural Gas Consumption for Each Proposal

Unit: m³/hour

| Classification Building | 1st Step Electrification Present Condition | Proposal (capacity of increase) | | |
|----------------------------|---|---------------------------------|-------|-------|
| | | Ib | II | III |
| No.1 Workshop | 0 | ----- | ----- | ----- |
| No.2 Workshop | 23 | ----- | ----- | ----- |
| Energy Center | 282.2 | 264.5 | 264.5 | 264.5 |
| Incidental building | 0 | 285 | 285 | 285 |
| Administrative building | 0 | ----- | ----- | ----- |
| Total | 305.2 | 549.5 | 549.5 | 549.5 |

Table 5.4.11 Effluent Treatment Capacity for Each Proposal

| Classification Building | 1st Step Electrification Present Condition(m ³ /day) | Proposal (capacity of increase) (liter/hour) | | |
|----------------------------|--|--|--------|--------|
| | | Ib | II | III |
| No.1 Workshop | 26 | 6,000 | 6,500 | 6,500 |
| No.2 Workshop | 27.5 | 5,700 | 5,700 | 5,700 |
| Energy Center | 0 | 0 | 0 | 0 |
| Incidental building | 0 | 0 | 0 | 0 |
| Administrative building | 0 | 0 | 0 | 0 |
| Total | 53.5 | 11,700 | 12,200 | 12,200 |

5-5 Personnel Plan

The total number of personnel for the workshop after the amplification is as shown in Table 5.5.1. The number is calculated according to the ratio (318/156 = 2.038) of the amount of electric railcars assigned to the workshop.

Table 5.5.1 Workshop Personnel Calculation

| Steps Classification | For the 1st Step A (persons) | After the Amplification $A \times 2.038$ (persons) |
|-------------------------|---------------------------------|---|
| Direct workers | 105 | 214 |
| Indirect workers | 11 | 23 |
| Foremen | 10 | 21 |
| Management staff | 15 | 31 |
| Total | 141 | 289 |

In case the scale of the workshop is doubled, the number of direct personnel¹⁾ will be doubled primarily in proportion to the ratio. The number of indirect personnel²⁾ does not necessarily need to be doubled and a smaller number will be enough.

This chapter, however, compares the relative merits of a number of amplification proposals and each is presumed to have the same amount of personnel. Therefore, the calculation of the number of classified employees is carried out by a simple proportion.

1): direct workers, indirect workers

2): foreman, management staff

Later on, the optimum amplification plan will be selected and the preliminary design for the optimum plan will be drawn up. The personnel plan will be studied in further detail at the stage.

CHAPTER 6 SELECTION OF THE OPTIMUM PLAN FOR
THE WORKSHOP AMPLIFICATION PLAN
AND ITS PRELIMINARY DESIGN

CHAPTER 6 SELECTION OF THE OPTIMUM PLAN FOR THE WORKSHOP AMPLIFICATION PLAN AND ITS PRELIMINARY DESIGN

In drawing up the amplification plan for the KM 10 workshop, first, adoptable proposals will be chosen on the basis of a technical study, and then, a financial study will be made of them. Finally, the optimum plan for the workshop amplification will be selected based on the results of the technical and financial studies.

6-1 Technical Study

In Chapter 5, four amplification proposals were chosen from 54 (three processes \times nine differences in shop-in days \times two modified proposals) possible amplification proposals. The contents of these four proposals are as follows.

Proposal Ia : Process A, shop-in day difference +2

Proposal Ib : Process A, shop-in day difference +2

Proposal II : Process C, shop-in day difference +2

Proposal III: Process C, shop-in day difference -1

The amplification of the No. 1 Workshop building is carried out oblongly on the entrance gate side in Proposal Ia and on the main track side in Proposal Ib, Proposal II, and Proposal III. Proposal Ia, Proposal Ib, and Proposal II have four tracks for the car-body shop building's amplification in comparison with Proposal III's three tracks.

The above four proposals are chosen for having the fewest number of parts units in each shop so as to minimize fluctuations in work volume there, to raise the operating ratio of the workers and equipment, and to keep the amount of investment and operating expenses as low as possible.

In the previous Chapter, "work flow charts" and "machine layout plans" were drawn up for these four Proposals. In this section, a study is made focussing attention on the flow of parts within each shop, the ability to cope with shop work fluctuations, and so on, based on these "work flow

charts" and "machine layout plans," and the superiority or inferiority of each plan is determined on the basis of these technical evaluations. Proposal Ia, however, is eliminated from the study for reasons explained in section 5-3-6 (1) on the overall layout. Therefore, the following comparative study is concerned with Proposal Ib, Proposal II, and Proposal III.

In studying these amplification proposals, the following two points which may particularly raise problems are taken up.

- (1) The suitability of the work flow and the ability to cope with work fluctuations at the following shops, from the raising of the car-body (bogie demounting) to the lowering of the car-body (bogie mounting)
 - 1) Bogie shop
 - 2) Wheel and axle shop
 - 3) Traction motor shop

- (2) The ability of the car-body shop to cope with work fluctuations

A table comparing the superiority or inferiority of each amplification proposal is shown in Table 6.1.1.

As may be understood from the table, it was decided not to adopt Proposal Ib because it would be difficult to stay on schedule due to the excessive movement of bogies, wheels and axles, and the high operating rate of the overhead travelling crane needed for their movement.

Proposal II has no problems from the standpoint of work flow or ability to cope with work fluctuations and is the best of these proposals.

From the facilities standpoint, Proposal III merely has one track fewer than Proposal II when comparing car-body shop sizes (Proposal II four tracks, Proposal III three tracks), but it has no leeway in its process, and therefore, it may have difficulties in coping with irregularities in the process. In other respects, though, being the same as Proposal II, it has no problems.

Therefore, the financial study in the next section will be carried out in regard to these two proposals, Proposal II and Proposal III.

Table 6.1.1 Comparison of Technical Superiority and Inferiority

| Item | | Proposal | | |
|--|---|-----------|--------------|--------------|
| | | Ib | II | III |
| Suitability of Work Flow | | | | |
| Bogies | Number of Movements | Many | Few | Few |
| | Overhead Travelling Crane Operation | High | Low | Low |
| Wheels /Axles | Number of Movements | Many | Few | Few |
| | Overhead Travelling Crane Operation | High | Low | Low |
| Ability to Cope with Work Fluctuations | | | | |
| Bogies, Wheels /Axles | Ability to Cope with Change in Entrance/ Leaving Date | Difficult | Easy | Easy |
| | Ability to Cope with Work Process Fluctuations | Difficult | Easy | Easy |
| Car-body | Ability to Cope with Change in Entrance/ Leaving Date | Easy | Easy | Difficult |
| | Ability to Cope with Work Process Fluctuations | Easy | Easy | Difficult |
| Technical Evaluation | | No good | 1st priority | 2nd priority |

6-2 Financial Study

In deciding whether or not to adopt this project, both technical and financial studies are carried out. A technical study was made in the previous section. This section will carry out a financial study.

6-2-1 Preconditions for Analysis

In this analysis, the proposal for workshop amplification will be considered in accordance with the aims set forth in Chapter 5, section 5-1, and will not take up any alternative proposals such as the outside consignment of repairs.

In addition, since the workshop itself will produce no business income, an analysis will only be made of the amount of investment and operating expenses. The following are the preconditions for this analysis.

(1) Prices

The amount of investment and operating expenses will be calculated according to current market prices as of December 1984.

(2) Calculation of CIF Prices

Taxes and charges imposed on foreign goods are shown in Table 6.2.1.

(3) Foreign exchange rate

Exchange rates will be fixed as follows:

US\$1.00 = 178.7 Argentine Pesos = ¥251.0

Table 6.2.1 Calculation of CIF Prices

| Item | Formula |
|-----------------------------------|-------------------------|
| (1) Price of imported goods (FOB) | |
| (2) Sea cargo rate | $(1) \times 0.15$ |
| (3) Subtotal | $(1) + (2)$ |
| (4) Marine insurance | $(3) \times 0.03$ |
| (5) Subtotal | $(3) + (4)$ |
| (6) Storage charges | $(5) \times 0.045$ |
| (7) Bank account handling charges | $(5) \times 0.055$ |
| (8) Local transportation costs | $(5) \times 0.03$ |
| (9) Total | $(5) + (6) + (7) + (8)$ |

Note: Only the above are necessary for imported goods used by the Argentine Railways based on S908, 1972 and the following taxes are exempted. Import duties, marine promotion fund, statistics fund, export promotion fund, excise tax.

(4) Residual value, useful life, etc.

Residual value, useful life, etc. will be based on Argentine Railways rules.

(5) No inflation

The above-mentioned prices will be taken as fixed prices with no consideration for inflation.

(6) Required construction time

The period of time required for the amplification construction will be one year.

6-2-2 Calculation of Approximate Construction Costs

Initial investment costs for Proposal II and Proposal III as presented in the previous section are computed in local currency and in foreign currency. These results are shown in Table 6.2.2.

6-2-3 Calculation of Approximate Operating Expenses

Operating expenses will be divided into two types; rolling stock repair costs and workshop facilities and equipment maintenance costs. The former is the costs for needed for rolling stock repairs and the latter the costs for the maintenance of facilities and equipment to sustain the rolling stock repair capacity.

The approximate operating costs for Proposals II and III are shown in Table 6.2.3. According to these proposals, inspections/repairs will be carried out on a total of 194 cars annually which breaks down to 81 cars for Overall Inspection, 81 cars for Intermediary Inspection, and 32 cars (about 10% of the rolling stock assigned) for special repair. The number of workers needed is 289.

Table 6.2.2 Initial Investment Amount by Proposal

Unit: US\$1,000

| Item | Proposal | II | | III | |
|--------------------------------|----------------|----------------------------|-----------------------|----------------------|-----------------------|
| | | Quantity | Amount | Quantity | Amount |
| Civil Eng. Works/ Tracks | Local Currency | Roads 6,244 m ² | 850.4 | 6,034 m ² | 818.8 |
| | For. Currency | Tracks 955 m | | 840 m | |
| | Total | | 850.4 | | 818.8 |
| Buildings | Local Currency | 9,090 m ² | 11,149.8 | 8,190 m ² | 10,320.6 |
| | For. Currency | | | | |
| | Total | | 11,149.8 | | 10,320.6 |
| Machines | Local Currency | 160 units | 2,699.5 | 148 units | 2,670.5 |
| | For. Currency | | 2,265.9 | | 2,265.9 |
| | Total | | 4,965.4 | | 4,936.4 |
| Electric Facilities | Local Currency | 2,315 kVA | 1,319.7 | 2,315 kVA | 1,295.2 |
| | For. Currency | | | | |
| | Total | | 1,319.7 | | 1,295.2 |
| Rolling Stock | Local Currency | ----- | | 3 cars (1 unit) | 800.0 |
| | For. Currency | | | | 2,356.0 |
| | Total | | | | 3,156.0 |
| Others | Local Currency | ----- | 996.5 | ----- | 996.5 |
| | For. Currency | | | | |
| | Total | | 996.5 | | 996.5 |
| Total | Local Currency | ----- | 17,015.9 (1,040.1) | ----- | 16,901.6 (1,040.1) |
| | For. Currency | | 2,265.9 | | 4,621.9 |
| | Total | | 19,281.8 (1,040.1) | | 21,523.5 (1,040.1) |

Note: Figures in parenthesis are partial relocation costs for the 1st Step workshop in parallel with the amplification work. These are mentioned elsewhere.

Table 6.2.3 Operating Expenses by Amplification Plan

Unit: US\$1,000

| Item | Proposal | | II | III |
|---|-------------------------------|-----------------|---------|---------|
| | Rolling Stock Repair Costs | Personnel Costs | | 1,309.4 |
| Material Costs | | | 2,126.0 | 2,126.0 |
| Fuel & Light Expenses (Initial Year) | | | 276.2 | 274.4 |
| Fuel & Light Expenses (From 2nd Year) | | | 273.7 | 272.1 |
| Total (Initial Year) | | | 3,711.6 | 3,709.8 |
| Total (From 2nd Year) | | | 3,709.1 | 3,707.5 |
| Workshop Faci- lities and Equipment Maintenance Costs | Civil Engineering Works | | 8.5 | 8.2 |
| | Buildings | | 306.1 | 284.1 |
| | Machines | | 173.8 | 172.8 |
| | Electricity | | 13.2 | 13.0 |
| | Others | | 34.9 | 34.9 |
| | Total | | 536.5 | 513.0 |
| Operating Expenses (Total) | Total (Initial Year) | | 4,248.1 | 4,222.8 |
| | Total (From 2nd Year) | | 4,245.6 | 4,220.5 |

6-2-4 Financial Evaluation

A railway transportation system offers transportation service organically combining various factors such as marketing, train operation, track maintenance, and rolling stock repair, and it is a business entity earning an income in compensation for this. Looking at it from the opposite viewpoint, for example, rolling stock repair work shares in the production activity called transportation along with other sectors. The ratio of this share is unclear, but it does contribute to the earning of transportation income. Therefore, when the transportation system is considered as a whole system, it is impossible and inappropriate to discuss the profitability only of the rolling stock inspection/repairing workshop, taking it as a closed system. It is for this reason that this analysis will be restricted to the analysis of expenses as previously stated.

The two Proposals will be compared in regard to the amount of investment (Table 6.2.2) and the annual operating expenses (Table 6.2.3) for each Proposal. As for operating expenses, there is almost no difference, but the amount of investment for Proposal II is equal to about 90% of that for Proposal III. In view of only this, Proposal II is superior. Furthermore, looking at the ratio of domestic goods included in the amount of initial investment in each Proposal, it is 90% for Proposal II and 80% for Proposal III. Thus, the selection of Proposal II can be considered desirable in this respect too. In the above, attention was given only to the amount of investment as the difference in operating expenses is small enough to ignore. The following, however, analyses the relationship between the amount of investment and operating expenses from another point of view.

If the period under study is taken as 30 years, an investment table covering the whole period as shown in Table 6.2.4 can be obtained when the replacement investment at the end of the useful life is considered in addition to the initial investment. These investment amounts are all at the beginning of the fiscal year, and the residual value is subtracted from the replacement investment. The value at the beginning of the 31st year is the total of that year's unamortized amount and the residual value. The minus sign for both proposals in the last row signifies the amount subtracted to make the two Proposals comparable.

Table 6.2.4 Comparison of Investment Amounts

Unit : US\$1,000

| Calculation year | Operation year | Proposal II | Proposal III | III - II |
|------------------|----------------|-------------|--------------|----------|
| 1 | | 20,322.0 | 22,563.7 | 2,241.7 |
| 12 | 11 | 189.6 | 189.6 | 0 |
| 17 | 16 | 4,804.7 | 4,778.6 | -26.1 |
| 22 | 21 | 189.6 | 0 | |
| 31 | 30 | -6,900.8 | -6,901.0 | -0.2 |

A comparison of the operating expenses of both Proposals can be obtained as in Table 6.2.5 from the aforementioned Table 6.2.3. From this, the following can be concluded. That is to say, the replacement investment for Proposal III at certain time during the period is less than that for Proposal II, but its initial investment is 10% higher. However, operating expenses for Proposal III can be met with as much as US\$25,000 a year less than Proposal II.

Table 6.2.5 Comparison of Operating Expenses

Unit : US\$1,000

| Calculation year | Operation year | Proposal II | Proposal III | III - II |
|------------------|----------------|-------------|--------------|----------|
| 2 | 1 | 4,248.1 | 4,222.8 | -25.3 |
| 3...30 | 2...29 | 4,245.6 | 4,220.5 | -25.1 |

The following will study whether or not the increment of the total investment including replacement investment of Proposal III in comparison with Proposal II can be made up for by its operating expenses decrement. For this, it is necessary to match all values for a particular year using a discount rate.

Now, if the discount rate is assigned the value α and all prices are revised on the basis of the 1st year, a balance between Proposal III's investment increment and operating expenses decrement is shown by the following formula:

$$2241.7 - \frac{26.1}{(1+\alpha)^{16}} - \frac{0.2}{(1+\alpha)^{30}} - \frac{25.3}{(1+\alpha)} - 25.1 \sum_{t=2}^{29} \frac{1}{(1+\alpha)^t} = 0$$

The solution to this equation is $\alpha \approx -0.062$.

This negative value for the discount rate is meaningless, and thus, Proposal III's operating expenses decrement does not fulfill the purpose of making up for the investment increment. Therefore, the selection of Proposal II is desirable.

It was stated before that a discussion of the rolling stock inspection/repairing workshop's profitability as a closed system is irrelevant. If based on the above concept, it amounts to the consideration of an imaginary implied workshop income.

Accordingly, the returns from rolling stock repair work for Proposal II and Proposal III will be represented by R_{II} and R_{III} , respectively, and operating expenses as E_{II} and E_{III} , respectively. If the capital expenses on the investments are ignored, the difference between the net profits for the two Proposals is :

$$\begin{aligned} (R_{III} - E_{III}) - (R_{II} - E_{II}) &= (R_{III} - R_{II}) - (E_{III} - E_{II}) \\ &= -(E_{III} - E_{II}) \end{aligned}$$

In the end, this amounts to the same as comparing only the operating expenses. It is noted that since the number of cars repaired is the same for both Proposals, $R_{III} - R_{II} = 0$.

6-3 Selection of the Optimum Plan by a General Evaluation

Both technical and financial studies are carried out in regard to the amplification plan. Table 6.3.1 shows the results of these evaluations and general evaluations.

Table 6.3.1 Evaluations of Proposals for the Workshop Amplification Plan

(Shown by ranking)

| | Proposal II | Proposal III |
|----------------------|--------------|--------------|
| Technical Evaluation | 1st priority | 2nd priority |
| Financial Evaluation | 1st priority | 2nd priority |
| General Evaluation | 1st priority | 2nd priority |

It is clear from Table 6.3.1 that Proposal II is superior to Proposal III both technically and financially. Therefore, Proposal II is recommended for the Argentine Railways.