the year 2000, FSU rail demand will be between 75% and 80% of its 1990 level[7].

(7) The same authors state: "Many forecasters think that it will be 2005 or so before the former Soviet economies recover to 1988 production levels. The production and associated transport of primary products is likely to fall further and recover more slowly than other sectors, given the effects of moving towards market prices for energy. Some primary sectors are unlikely ever to regain 1988 levels, given high or market-determined energy and transport costs. If the transition to a market-determined system continues, there will be large shifts in mode choice, de-emphasising rail and air, and to a lesser extent water, while increasing the role of road transport. Forecasters expect road transport to reach between 22 and 41 percent of nonenergy (sic) freight transport, compared with an estimated 13 percent in 1992."

(8) As far as rail is concerned, the authors conclude: "A market economy places greater emphasis on meeting consumer demands and those of associated light industries. This emphasis will increase the importance of serving many geographically dispersed small and medium-sized factories competing with one another to produce high-value goods. These enterprises will demand transport services of the kind road transport has been good at and rail has not. Rail traffic in the former Soviet Union in 1992 was down by 20 to 30 percent from 1990 levels, and continued to fall through 1993. Much of the lost traffic is unlikely to return. Unless services are cut back and made more responsive to users' needs, the large financial losses that first appeared in the early 1990s will continue."

7.3 ECONOMIC PROJECTIONS

(1) As already stated, economic projections for the future in Uzbekistan must be clothed in uncertainty. The analysis undertaken in Chapter 2 of this study does at least provide a starting-point, and this section should be read in conjunction with that analysis.

(2) The fact that Uzbekistan has not suffered the same declines in GDP since 1991 as the rest of the former Soviet republics should not lull anyone into a false sense of security. The country comes from a low starting-point. Prior to that year, only Tadjikistan had a lower GDP per capita; by 1992, Uzbekistan had crept ahead of Armenia, Azerbaijan and Kyrgyzystan; the following year, it overtook Georgia, and in 1994 it also surpassed Moldova and Turkmenistan.

(3) Nevertheless GDP per capita continues to decline. There is no reason to suppose that the steady increase in population, ongoing since at least 1940, will not continue at its present rate of 2.34% per annum - indeed, it may even increase given the young age

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7 A fascinating hypothetical study by aviation consultants Aerodevco is also quoted. It suggests that under a market economy (even with a high assumption of economic growth), air passenger kilometres in 2010 in the FSU will be at 83% of their actual 1990 level, and air freight tonne-kilometres at 88%.

profile of the population[8]. At this level of growth, the population will become 32.17 million by the middle of 2010. (See Table 7.3-1)

Table 7.3-1 - Uzbekistan Population Growth at 2.34% per annum

Year	Mid-Year Population (Millions)
1995	22.74
1996	23.27
1997	23.82
1998	24.37
1999	24.94
2000	25.53
2001	26.13
2002	26.74
2003	27.36
2004	28.00
2005	28.66
2006	29.33
2007	30.01
2008	30.72
2009	31.44
2010	32.17

(4) One of the biggest economic challenges facing Uzbekistan, therefore, will be to encompass this growing population. It has been calculated that by the year 2000 the labour force will have increased by approximately one million people[9]. Add to this the substantial numbers who are either currently unemployed or under-employed (estimated by the UN to be up to four million), and it becomes clear that some five million jobs will need to be created if the national workforce is to become fully productive.

(5) Realistically speaking, this level of productive job creation will not be achieved and there will therefore continue to be substantial un- or under-employment well into the next century. Nevertheless, it is pertinent to ask which sectors are most likely to provide the growth required and what obstacles may stand in the way of achieving it.

(6) It seems probable that the agricultural sector will be targeted to provide the initial impetus for growth. It employs 45% of the labour force, and in cotton generates 60% of total export earnings (and 75% of all hard currency receipts). If only because of the

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8 This is the current trend. After a decline in the birth-rate over nine years since 1985, the rate has risen to 2.98% in 1995. At the same time, mortality rates have started to decline, reflecting both the youth of the population as well as improved medical care, to a current rate of 0.64%.

9 See also Clause 2.2.1, (6).

Government's aim for social cohesion, the sector needs attention: reports speak of deteriorating social services, delays in wage payments, and decreasing opportunities for employment. Development of light industry and services to support agriculture in the rural communities appear to offer growth opportunities. In the longer term, adding value to the cotton crop by processing it into cloth may also prove attractive, as may more localised processing and distribution of foodstuffs.

(7) In the short-term, the policy of import substitution is likely to continue, particularly of grain. The president is anxious to achieve self-sufficiency (4.5 to 5 million tonnes per annum), of which the 1996 harvest yielded only 61%.[10]. Because this merely diverts resources away from the more lucrative cotton production, it is unlikely to generate growth.

(8) Import substitution has already made the Republic theoretically self-sufficient in oil and gas. Opportunities to increase exports, though, are likely to be hampered by increasing domestic demand, competition from the huge gas reserves in Turkmenistan, and demands for payment in advance in hard currency[11]. Development of the domestic distribution infrastructure for refined products is a potential area of opportunity.

(9) The artificially high official exchange rate had led to higher consumer goods imports. So far, the response has been to legislate against the importers by means of duties and the placing of hurdles in the way of currency exchange[12]. A further tactic now seems to be a desire by the authorities to satiate the demand by creating Uzbekistan's own consumer goods manufacturing capability. As a potential engine of economic growth, this strategy is doomed to failure if undertaken without the skills and expertise of foreign partners such as Daewoo.

(10) Foreign investment has the potential to provide employment and growth, albeit not to the full extent that Uzbekistan needs. To date, however, comparatively little foreign investment has taken place, even taking account of the well-publicised ventures by

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10 For 1996, 360,000 hectares of land were transferred from cotton to grain production, resulting in an increase of 360,000 tonnes of grain over 1995. Whilst it is simplistic and erroneous to conclude that the additional land yielded only one tonne per hectare (a poor yield by any standards), it nonetheless provides a good example of the dangers of over-zealous import substitution. Had the land been maintained under cotton, foreign currency earnings of $191 million might have been expected; however, and assuming a generous yield of 1.8 tonnes of grain per hectare, turning the land over to grain only saved imports of $150 million, resulting in a net loss of $41 million. To make matters worse, though, making up the shortfall in the harvest forced Uzbekistan into a disadvantageous barter deal with Russia, who agreed on 9 October to supply 400,000 tonnes of (poor quality) grain in return for 77,000 tonnes of (high quality) cotton. At market prices, Uzbekistan lost out to the tune of $50 million.

11 In June 1996, Kyrgyzystan had its gas supply temporarily cut off because of non-payment of some $7.5 million of arrears.

12 This has also had an adverse impact on UTJ's passenger traffic; previously, there was a significant flow of "suitcase trade" to and from Urumchi in China.

Daewoo, BAT, and others. There are no signs at present that the situation will change significantly in the near future. Several factors combine to deter foreign investors as well as domestic ones:

1) The state remains reluctant to give up control. Whilst this is mainly the legacy of managing in a planned economy, and indeed understandable, it does not attract entrepreneurs. Whatever the morally, and even politically, persuasive arguments in favour of state paternalism may be, in economic terms state systems have seldom shown themselves to be efficient mechanisms for allocating scarce resources. Much investment is and will continue to be allocated by administrative diktat rather than by market demand and return on capital. Although the good news for the railways is that transport remains one of the priority sectors for investment, one would question, for example, whether the construction of the three new railway lines to avoid passing through other republics would have occurred in a fully privatised and independent railway company.

   Indeed, the future progress of privatisation seems destined to ensure a retained role for the state. Plans for the creation of Privatisation Investment Funds up to June 1998 leave the door open for the state to keep hold of up to 49% of the equity of the enterprises to be privatised.

2) There are considerable difficulties involved in currency conversion, both for individual businessmen as well as for large corporations. These difficulties are not seemingly acknowledged by Government which points to increased volume of conversion as evidence that no problem exists[13]. But even companies with the supposed clout of BAT were claiming in September 1996 that it took 60 days to obtain hard currency; since January, they had only been able to purchase $1.5 million of their $7 million requirement. It is unlikely that full convertibility will occur for at least five years, according to senior sources, and priority in the meantime will be given to producers over consumers.

3) Several reports claim that there is little confidence in the commercial banking system, which needs radical reform and release from inappropriate state interference. Commercial banks exist to channel depositors' savings into investment funds and working capital for business, which they can only do securely and efficiently if allowed to operate as businesses in their own right.

   They certainly do not exist to provide interest-free loans to the Government to help it finance its budget deficit. Banks which are forced to deny depositors access to their own savings (as happened for 10 days at the end of August 1996), or, even worse, to confiscate them (as effectively happened during the November 1993 and July 1994 currency reforms) will not attract customers, and enterprises will not therefore have a source of the funds they need to conduct business. Much the same comments apply to the development of the domestic capital market (stock exchange), which is not yet being used in the way it should be to marry investors with businesses needing the funds.

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13 Figures supplied orally to the study team indicate that conversion turnover was $85 million in 1994, $1,300 million in 1995, and an expected $3,200 million in 1996.

4) The amount of red-tape and bureaucracy facing a would-be investor in Uzbekistan's economy acts as a serious disincentive. Procedures for registering a business are cumbersome, complex and often unclear. Even if that hurdle is overcome, the daily task of doing business is beset by regulation, supervision and labyrinthine tax laws whose infringement comes with draconian punishment. And as if that were not enough, this study-team received much anecdotal evidence of the existence of illegal protection rackets to which many a blind eye is turned.

5) Finally, there appears to be a reluctance on the part of Government to acknowledge that there are areas in which it should shoulder some of the project risk. In the Telecommunications sector, for example, Uzbekistan will not offer a foreign investor export credit guarantees, or even allow reform of the tariff structure. A spokesman for the Ministry of Communications was reported to have told the Financial Times: "We don't take risks - they [foreign telecommunications companies] take risks." Reports that this view prevails in other sectors are widespread among the diplomatic community. In the real world this is not a tenable position; risk should be borne by the party most capable of managing it. At the very least, political risk should be shouldered by the Government.

(11) Notwithstanding some of these problems, one should not be overly pessimistic, at least not for the longer term. Generally, service industries are likely to flourish as financial, catering and tourism sectors begin to develop. Construction, too, has potential as repair and modernisation of neglected infrastructure is increasingly undertaken.

(12) Taking all of these factors into account, the most likely picture is that the decline in the economy will bottom out in 1997 and start to grow slowly again from 1998. In much the same way that the Government's step-by-step approach to reform has shielded Uzbekistan from the painful economic declines in other FSU republics, it will also act initially as a brake on accelerated growth. This will probably continue for at least five years until the Government feels sufficiently confident behind the wheel of its new car to drive a little faster. Beyond then, a steady path of growth is assumed.

(13) Three scenarios of GDP growth are thus presented in tables 7.3-2 to 7.3-4 below: a Base option, a Base Plus 25% option, and a Base Plus 50% option (the percentages being those of the base growth rate). These show a GDP increase in the year 2010 ranging from 38.9% to 63.2% over its present level. GDP per capita, however, will have only reached its 1996 level by 2007 in the Base scenario, or by 1999 in the most optimistic forecast; in no case does it recover to its 1991 level.

(14) These figures are, of course, largely extrapolated from official statistics. It is also true that there exists a significant black economy which does not feature in the official estimates. To the extent that this black economy will eventually become subsumed within the mainstream one, it can be argued that the figures err slightly on the pessimistic side. It should also be noted that the 'currency' used in the tables is purchasing power parity dollars.

Table 7.3-2 - Uzbekistan Projected Economic Growth: Base Estimate

Year	PPP GDP ($ Billions)	% Increase on Previous Year	PPP GDP Per Capita ($ Thousands)	% Increase on Previous Year
1995	42.5	-1.0	1869	-1.6
1996	42.5	0.0	1826	-2.3
1997	42.7	0.5	1793	-1.8
1998	43.1	1.0	1770	-1.3
1999	44.0	2.0	1764	-0.3
2000	45.0	2.3	1763	0.0
2001	46.1	2.5	1766	0.2
2002	47.5	3.0	1777	0.6
2003	49.2	3.5	1798	1.1
2004	50.7	3.0	1809	0.6
2005	52.2	3.0	1821	0.6
2006	53.5	2.5	1824	0.2
2007	54.8	2.5	1827	0.2
2008	56.2	2.5	1829	0.2
2009	57.6	2.5	1832	0.2
2010	59.0	2.5	1835	0.2

PPP = Purchasing Power Parity. These figures should not be regarded as actual dollars.

Table 7.3-3 - Uzbekistan Projected Economic Growth: Base Plus 25% Estimate

Year	PPP GDP ($ Billions)	% Increase on Previous Year	PPP GDP Per Capita ($ Thousands)	% Increase on Previous Year
1995	42.5	-1.0	1869	-1.6
1996	42.5	0.0	1826	-2.3
1997	42.8	0.625	1796	-1.7
1998	43.3	1.25	1776	-1.1
1999	44.4	2.5	1779	0.2
2000	45.7	2.875	1789	0.5
2001	47.1	3.125	1802	0.8
2002	48.9	3.75	1827	1.4
2003	51.0	4.375	1863	2.0
2004	52.9	3.75	1889	1.4
2005	54.9	3.75	1915	1.4
2006	56.6	3.125	1930	0.8
2007	58.4	3.125	1945	0.8
2008	60.2	3.125	1960	0.8
2009	62.1	3.125	1975	0.8
2010	64.0	3.125	1990	0.8

PPP = Purchasing Power Parity. These figures should not be regarded as actual dollars.

Table 7.3-4 - Uzbekistan Projected Economic Growth: Base Plus 50% Estimate

Year	PPP GDP ($ Billions)	% Increase on Previous Year	PPP GDP Per Capita ($ Thousands)	% Increase on Previous Year
1995	42.5	-1.0	1869	-1.6
1996	42.5	0.0	1826	-2.3
1997	42.8	0.75	1798	-1.6
1998	43.5	1.5	1783	-0.8
1999	44.8	3.0	1795	0.6
2000	46.3	3.45	1814	1.1
2001	48.0	3.75	1839	1.4
2002	50.2	4.5	1878	2.1
2003	52.8	5.25	1931	2.8
2004	55.2	4.5	1972	2.1
2005	57.7	4.5	2014	2.1
2006	59.9	3.75	2041	1.4
2007	62.1	3.75	2070	1.4
2008	64.5	3.75	2098	1.4
2009	66.9	3.75	2127	1.4
2010	69.3	3.75	2156	1.4

PPP = Purchasing Power Parity. These figures should not be regarded as actual dollars.

(15) Equally there are a number of imponderables which cannot sensibly be factored into any forecasts. The most obvious of these is the potential for regional ethnic or religious conflict spreading up from the south. Although this does in fact seem an unlikely scenario, were Uzbekistan to be drawn into civil or military conflict the effects on the economy would be severe, as has been the case in Armenia, Azerbaijan, Georgia and former Yugoslavia.

(16) Taken as a whole, it does not seem that the major sources of economic growth will be those sectors which rail is traditionally good at serving. The growth of rail will

therefore probably be at a lesser rate than the economy as a whole.

7.4 RAILWAY DEMAND IN 2010

7.4.1 General and assumptions

(1) It will be recalled from the Progress Report of January 1997 that demand can be expressed by the following function:

$$D_a = f(P_a , P_1 , P_2 , ...P_n , T, Y)$$

where: D_a is the demand for product/service 'a'
P_a is the price of product/service 'a'
P_1 , P_2 , ...P_n are the prices of competitive or complementary products/services
T is a measure of people's tastes and preferences
Y is the level of personal income

(2) Thus, in a market economy (and equally in a command or transition economy), the demand for rail transport will be a function of:

1) The cost of rail transport, to which demand is negatively correlated i.e. if the cost goes up, demand goes down. This cost does not simply refer to the price of a ticket; in an environment where time costs money, the cost of a rail trip must also take into account journey-time and waiting-time.

2) The cost of competitive/alternative services, to which demand is positively correlated. If the cost of road haulage between points A and B rises in relation to the cost of rail freight charges between the same points, demand for rail will rise. Again, the cost of alternative services includes time-costs.

3) The cost of complementary services, defined as those which normally go hand-in-hand with the principal service. If the cost of reaching a railway station increases (for example because of higher taxi-fares, or the introduction of car-parking charges), then there will be a negative effect on rail demand.

4) The nature of people's tastes and preferences. This is something of a catch-all variable, difficult to measure quantitatively, but is most often used in the context of quality of service. Generally speaking, and everything else being equal, an increase in actual or even perceived level of quality will lead to an increase in demand. Factors might include safety, comfort, reliability, frequency, and so on.

5) The level of personal disposable income. Whilst it is generally the case that the higher the level of personal income, the higher the demand for transport, this ignores the difference between 'normal' and 'inferior' goods. With inferior goods, demand falls as income rises; public transport is often regarded as an inferior good - as income rises, people may choose to trade-up to private cars.

(3) The nature of the interaction between all of these variables changes not only between markets, but also over time within markets. In order to gain an understanding of how they interact, it is necessary to assemble a great deal of historical data. As already explained, the youth of both the Republic of Uzbekistan and of UTJ means that insufficient data has yet been garnered in order for a reliable analysis of this nature to be undertaken. It is firmly to be hoped, however, that this report lays the groundwork for future studies to build upon.

(4) In endeavouring to predict demand for rail services in fourteen years time, there are inevitably a large number of assumptions which have to be made. The principal ones made in this assessment are:

1) Full privatisation of UTJ is unlikely in the foreseeable future, for three reasons. First, the authorities are a long way from determining what model of privatisation would be appropriate. Secondly, if the system were privatised today, it would collapse almost immediately under a burden of structural and financial problems. Thirdly, the Government will continue to view UTJ as a strategic asset for both economic and social purposes, over which they will understandably wish to retain a degree of control.

2) That said, UTJ will undergo a process of commercialisation directed towards increased efficiency and profitability. The Government will increasingly be unable to respond positively to any calls for subsidy. Specifically, this will result in an end to the internal cross-subsidy of UTJ's passenger business by the freight business. This will enable the freight business to lower its tariffs, thereby allowing it to compete more effectively with other modes. It will also result in UTJ withdrawing from most of its non-core activities, including social provision; this might also involve UTJ divesting itself of the maintenance of both fixed and rolling assets.

3) Both freight and passenger businesses will, however, lose market share, mainly to road. New opportunities will nevertheless exist, particularly for intermodal and containerised freight as well as for automotive exports.

7.4.2 Rail freight

(1) Fig 7.4.2-1 shows rail freight performance mapped against economic performance, indexed back to 1991. Visually, there appears to be a relationship between the two, but one must be careful not to assume that economic performance is the only independent variable driving rail freight performance.

(2) Simple regression techniques (going back only to 1992 to avoid any distortions caused by the turbulence of 1991) yield the following relationship equations:

Table 7.4.2-1 - Linear Relationships Between Rail Freight and Economic Performance

Dependent Variable Y	Independent Variable X	Relationship	MPE %	MAPE %	CC %
Tonnes	Uzbek GDP	Y = 709.38X - 26194.19	-0.42	5.77	96
Tonne-Kms	Uzbek GDP	Y = 8978.97X - 367119.38	-0.5	8.83	98

MPE = Mean Percentage Error
MAPE = Mean Absolute Percentage Error
CC = Correlation Coefficient

(3) Despite good measures of forecast accuracy and goodness-of-fit, it must be remembered that the correlations suggested are formed from only five years' worth of data. It is also the case that one would normally expect to see elasticities nearer to unity than are portrayed here.

Fig7.4.2-1 - UTJ Rail Freight and Economic Indicators (1991=100)

(4) Indeed, to use these equations to predict both tonnes and tonne-kilometres in 2010 produces results that are simply not credible. They suggest that under even the Base economic scenario some 156 million tonnes will be transported by rail (an increase of nearly 300% over 1996), covering 162 billion tonne-kilometres (an increase of 700% over 1996).

(5) A more realistic projection will be obtained by assuming that total freight activity will grow in line with economic performance, and that rail will capture a share of that, as shown in Tables 7.4.2-2 and 7.4.2-3 below for each of the three economic scenarios described in Section 7.3. The penultimate column in each table shows the share remaining at its present level, although, as stated earlier, rail will almost certainly lose market share in the long term. For reference purposes, a scenario showing an increase in share is shown in the final columns but these can be ignored for all practicable purposes.

(6) Fig7.4.2-2 maps two eventualities: first, Scenario (A), which shows the tonnage share dropping to 10% under the 'Base' economic case; and secondly Scenario (B) which portrays the tonnage share remaining constant at 17.3% under the 'Base plus 25%' economic case. In Fig7.4.2-3, scenario (D) is the forecast of tonne-kilometres assuming share remains constant at 86.4% under the 'Base plus 25%' economic case.

Table 7.4.2-2 - Growth in Tonnage At Same Rate As Economic Performance

All Modes Total Tonnes (millions) 1995	Economic Scenario	All Modes Total Tonnes (millions) 2010	Rail Tonnes (millions) 2010 Low Scenario (10.0% Share)	Rail Tonnes (millions) 2010 Base Scenario (17.3% Share)	Rail Tonnes (millions) 2010 High Scenario (20.0% Share)
266.7	Base	370.5	37.0	64.1	74.1
266.7	Base + 25%	401.7	40.1	69.5	80.3
266.7	Base + 50%	435.3	43.5	75.3	87.1

Table 7.4.2-3 Growth in Tonne-Kilometres At Same Rate As Economic Performance

All Modes Total T-Kms (millions) 1995	Economic Scenario	All Modes Total T-Kms (millions) 2010	Rail T-Kms (millions) 2010 Low Scenario (80.0% Share)	Rail T-Kms (millions) 2010 Base Scenario (86.4% Share)	Rail T-Kms (millions) 2010 High Scenario (90.0% Share)
19579	Base	27199	21759	23500	24479
19579	Base + 25%	29490	23592	25479	26541
19579	Base + 50%	31957	25566	27611	28761

Fig7.4.2-2 Forecast Range of UTJ Tonnages

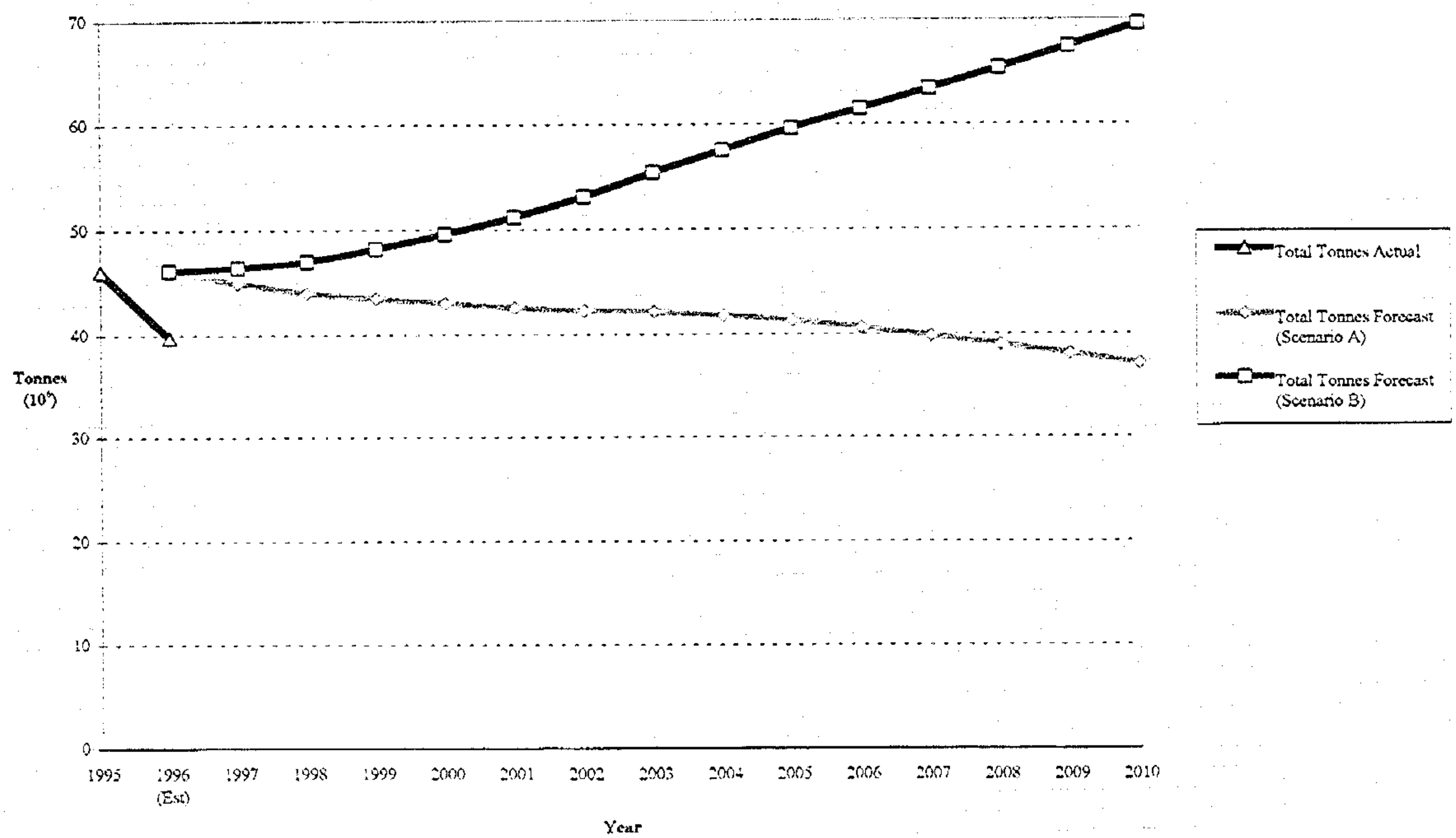
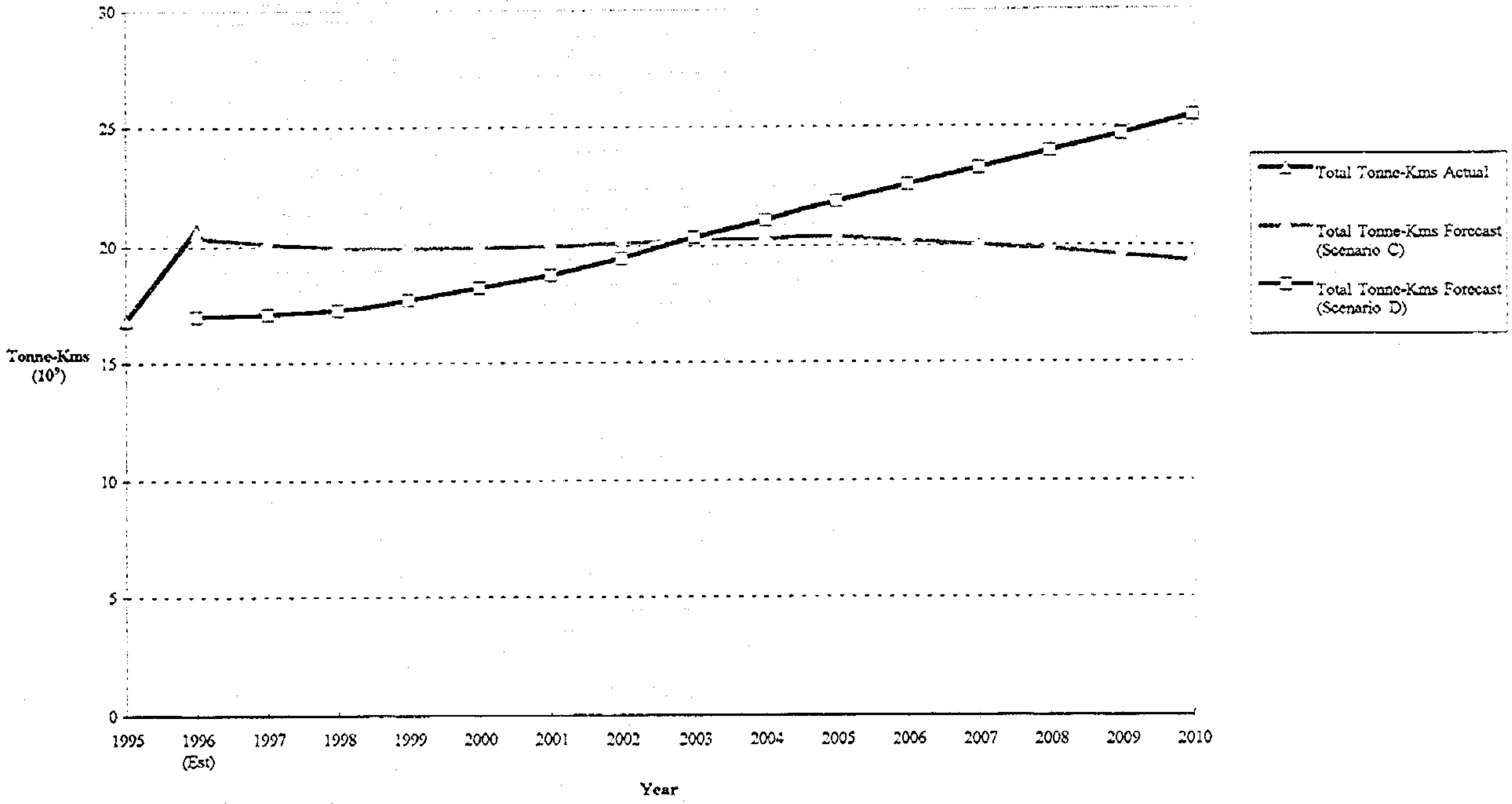


Fig7.4.2-3 Forecast Range of UTJ Tonne-Kilometres



(7) However, it is arguable that correlating growth in tonne-kilometres with economic growth is methodologically flawed. It may be preferable to calculate the growth in tonnage and multiply that by the average length of haul. The difficulty with this approach is that average haul lengths by rail have fluctuated significantly from a high of 773 kilometres in 1992 to a low of 365 kilometres in 1994. The average over the six years since 1991 has been 577 kilometres, and over the last three years 443 kilometres.

(8) Furthermore, if rail increases its share of tonnage, one could expect average haul length to fall as it would be capturing share from road transport with its shorter hauls; conversely, if rail loses its share of tonnage to road transport one would expect average haul length to increase as road picks away at the shorter-haul end of the rail market. Table 7.4.2-4 therefore shows an estimate of tonne-kilometres based on average haul length for each of the projected shares of tonnage. If share of tonnage remains constant, a haul length of 440 kilometres is assumed; if tonnage drops to a 10% share, a haul length of 520 kilometres is assumed; and in the unlikely event of an increase in share, a haul length of 360 kilometres is assumed.

Table 7.4.2-4 - Growth in Tonne-Kilometres Based on Haul Lengths

Economic Scenario	Rail Tonne-Kms (millions) 2010 10% Share of Tonnage 520Km per Tonne	Rail Tonne-Kms (millions) 2010 17.3% Share of Tonnage 440Km per Tonne	Rail Tonne-Kms (millions) 2010 20% Share of Tonnage 360Km per Tonne
Base	19240	28204	26676
Base + 25%	20852	30580	28908
Base + 50%	22620	33132	31356

(9) Fig7.4.2-3, Scenario (C), shows the effect on tonne-kilometres under the 'Base' economic case with tonnages declining to 10% share by 2010, and haul lengths increasing correspondingly to 520 kilometres over the same period.

(10) Whichever method one uses to arrive at forecast tonne-kilometres, the most likely eventuality is that rail will lose its share of tonnage in comparison with the present day. Taking the mid-point between the low share in the 'Base' economic scenario, and the existing share in the 'Base plus 25%' scenario, it would appear that UTJ will be transporting around 23 billion tonne-kilometres in the year 2010.

7.4.3 Rail passengers

(1) Fig7.4.3-1 and 7.4.3-2 show rail passenger performance mapped against GDP per capita, indexed back to 1991. It is acknowledged that GDP per capita may not be an ideal variable against which to measure passenger performance, serving, as it does, as a very blunt proxy for average income (data on which is only partially available). Moreover, it is arguable that using deflated Soms as a yardstick would be better than dollar equivalents on the grounds that Soms are the currency with which individuals

determine their perceived purchasing power.

(2) Unlike the freight market, there is no obvious correlation occurring. Indeed regression analysis produces results showing poor correlation and large margins of error. Part of the problem is the large downward blip in 1995, which is thought to be partly due to tariff increases and partly due to a chronic shortage of serviceable rolling-stock.

(3) What should be particularly worrying for UTJ is that the sector which in theory ought to be most profitable (domestic long-distance), has shown the most dramatic declines. Conversely, domestic suburban services (normally amongst the least profitable of railway services to operate) have actually bucked the economic trend by growing quite substantially since 1991 in both passenger-numbers and passenger-kilometres. International traffic has shown growth in numbers, but decline in passenger-kilometres.

(4) UTJ has set its face against inordinate passenger tariff increases. This is not surprising. Fares, other than on domestic suburban routes, are expensive in comparison with average earnings. At 269 Sum, the price of a ticket from Tashkent to Samarkand represents 12% of the average monthly wage of 2,244 Sum[14].

(5) Nevertheless, it seems inevitable (given the need for freight customers to cease subsidising passengers) that a passenger pricing strategy will emerge which more accurately reflects the cost of providing the service. Even if the state is able or willing to provide an element of subsidy, there are likely to be real tariff increases albeit coupled with significant cuts in costs. None of this bodes very well for UTJ's passenger business.

(6) The domestic suburban service is and will remain the most buoyant. Because of its important role in conveying commuters to work, demand is likely to track the performance of the economy as a whole and projections are therefore made on that basis rather than on the basis of proxies such as per capita GDP. Its share with other modes is assumed to remain constant on the grounds that all modes are likely to implement real tariff increases. The table below indicates likely demand for each of the three economic scenarios. See also Fig7.4.3-3and 7.4.3-7 at the end of this chapter.

Table 7.4.3-1 - Projected Growth in Suburban Passenger Traffic

Suburban Passengers (millions) 1995	Suburban Pass-Kms (millions) 1995	Economic Scenario	Suburban Passengers (millions) 2010	Suburban Pass-Kms (millions) 2010
11.23	683.0	Base	15.60	948.8
11.23	683.0	Base + 25%	16.91	1028.7
11.23	683.0	Base + 50%	18.33	1114.8

14 As at Q1, 1996.

Fig7.4.3-1 · UTJ Rail Passenger Number and Economic Indicators (1991=100)

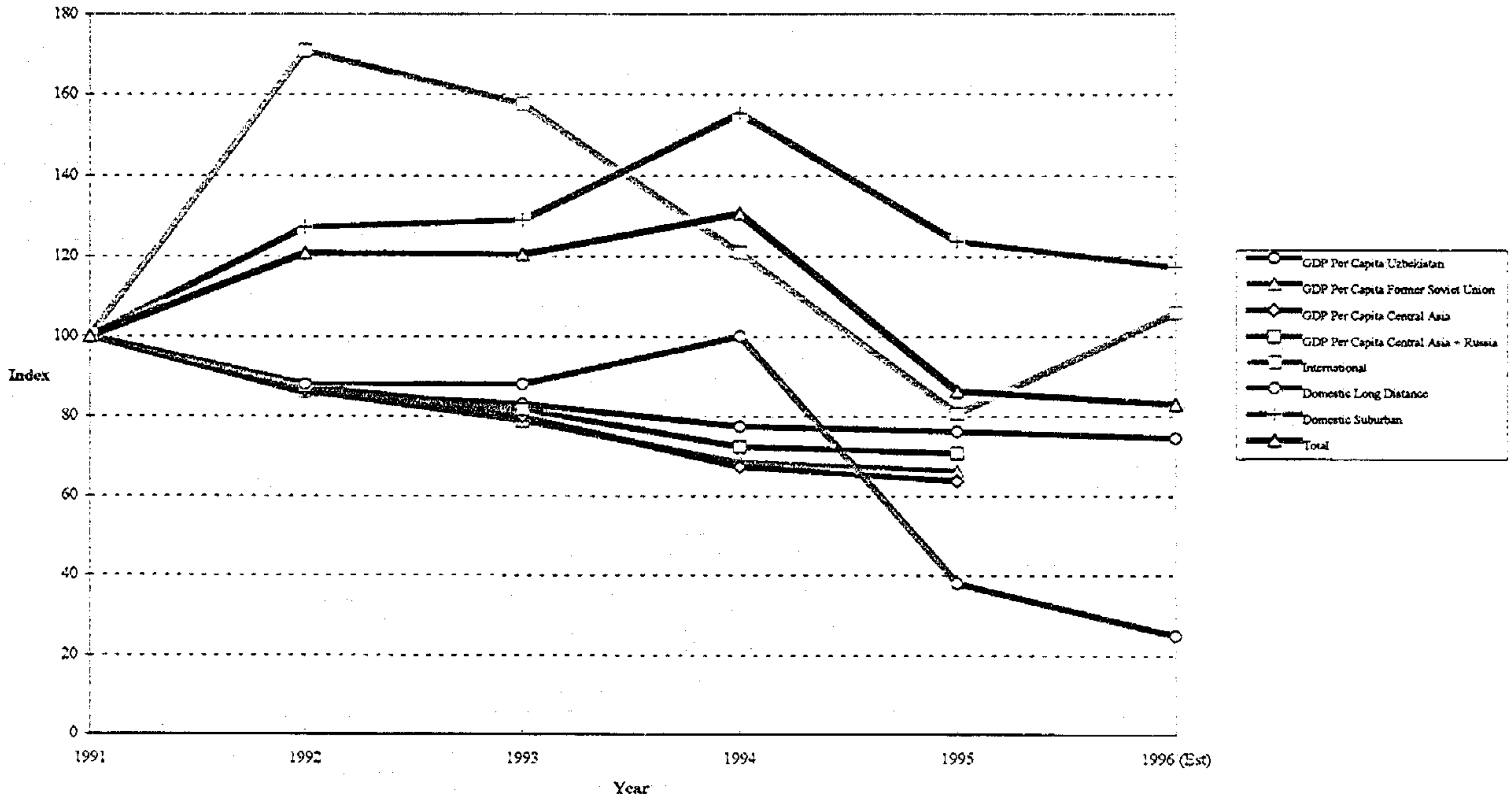
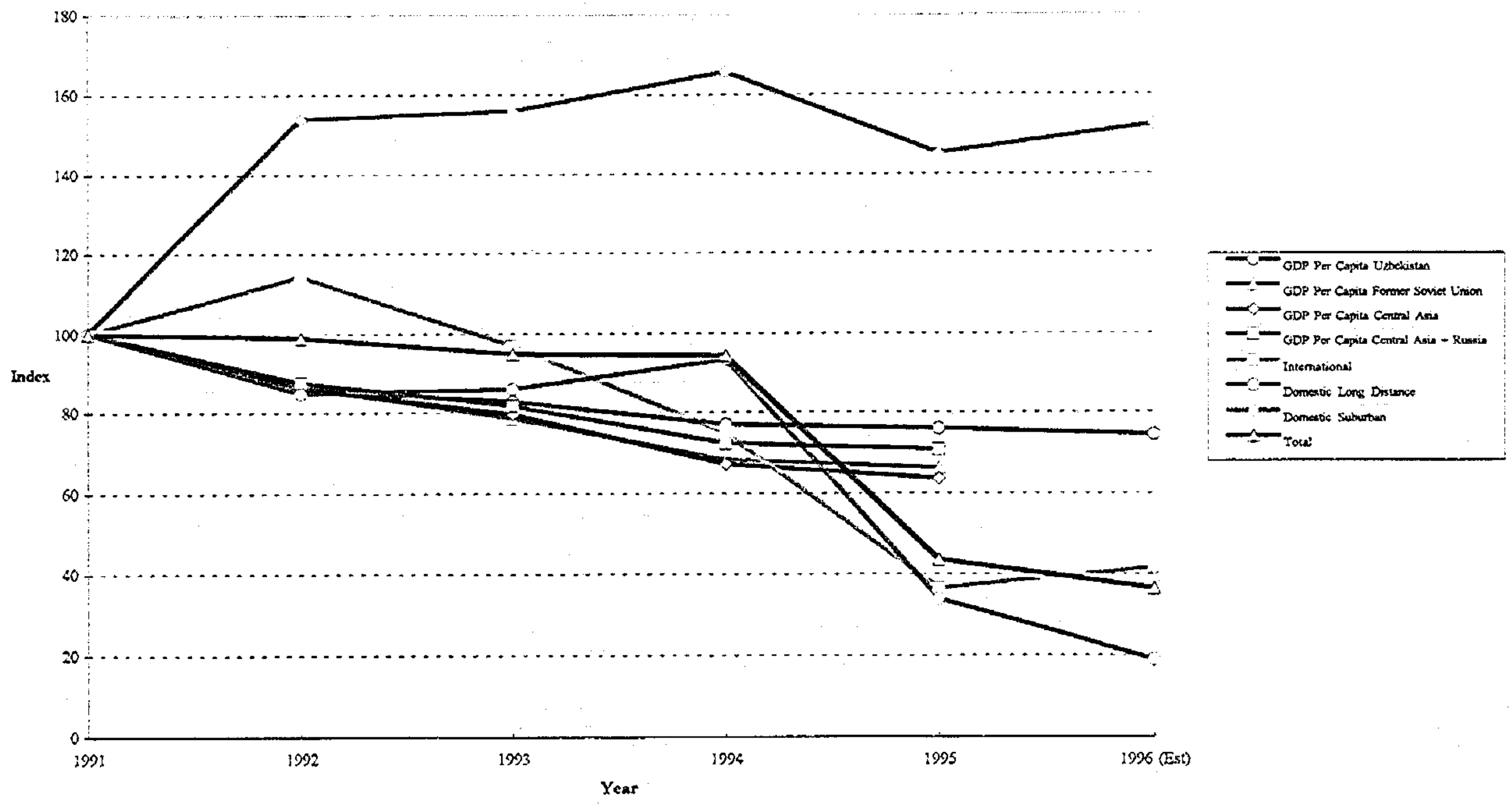


Fig7.4.3-2 - UTJ Rail Passenger-Kilometre and Economic Indicators (1991=100)



(7) The International market has weathered the economic storm well. For the future, though, it is difficult to see on what basis it will be able to compete profitably with what will eventually be a recovering air industry. From the customer's point-of-view, service quality is poor, speed is slow, and although much cheaper than air, ticket-price represents comparatively unattractive value-for-money. From UTJ's point-of view, the allocation of revenues between administrations does not seem to reflect or even cover costs and it is a drain on much-needed foreign currency.

For these reasons, demand and supply are likely to decline in the long-term. As this will be largely independent of national economic performance, a simple 2% per annum decline in passengers and passenger-kilometres is assumed from the year 2000, following an average 6.5% per annum increase until then to allow for a buoyancy factor as the market recovers to a more natural level. See Table 7.4.3-2, and Fig7.4.3-4 and 7.4.3-8.

Table 7.4.3-2 - Projected Growth in International Passenger Traffic

International Passengers (millions) 1995	International Pass-Kms (millions) 1995	International Passengers (millions) 2010	International Pass-Kms (millions) 2010
2.741	580.0	3.07	650.3

(8) Predicting the future level of domestic long-distance traffic is fraught with difficulty. On the one hand, many of the arguments put forward to suggest a future decline in the international market apply equally to the domestic one; indeed, the statistics would seem to indicate that the decline has already firmly set in. On the other hand, however, this is a market in which UTJ ought to be well-placed to compete against both road and air services, certainly for journeys of up to 500km. For this to happen, though, there will need to be significant improvements in journey-time, frequency and whole service quality[15].

(9) Management will need to think seriously about their investment strategy in this sector; a 'more of the same' approach, and like-for-like replacement of old assets, is arguably unwise - certainly without a thorough campaign of market research to support it. In particular, the disproportionately high unit-costs of a strategy based on running services overnight require the strategy to be re-evaluated urgently. With service improvement, one can feel reasonably optimistic that the decline in this sector will be reversed, probably by 1998, and for the purpose of forecasting, it is then assumed that it will increase in line with GDP per capita plus 1% (to factor in service improvement). See Table 7.4.3-3, and Fig7.4.3-4 and 7.4.3-8

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15 By 'whole' service quality is meant the entire customer experience of UTJ, not just the train journey itself, but other aspects including (but not restricted to) initial enquiry, ticket purchase, station facilities, information provision, helpfulness of staff, and so on.

Table 7.4.3-3 - Projected Growth in Domestic Long-Distance Passenger Traffic

Domestic LD Passengers (millions) 1995	Domestic LD Pass-Kms (millions) 1995	Economic Scenario	Domestic LD Passengers (millions) 2010	Domestic LD Pass-Kms (millions) 2010
2.63	1235.0	Base	1.93	773.7
2.63	1235.0	Base + 25%	2.08	835.1
2.63	1235.0	Base + 50%	2.24	901.0

(10) Taken as a whole, therefore, the projected total level of rail passenger traffic in the year 2010 is shown in the table below, and charted in Fig7.4.3-6 and 7.4.3-10

Table 7.4.3-4 - Projected Growth in Total Rail Passenger Traffic

Total Rail Passengers (millions) 1995	Total Rail Pass-Kms (millions) 1995	Economic Scenario	Total Rail Passengers (millions) 2010	Increase Over 1995 (%)	Total Rail Pass-Kms (millions) 2010	Increase Over 1995 (%)
16.60	2498.0	Base	20.60	24.1	2372.8	-5.0
16.60	2498.0	Base + 25%	22.06	32.9	2514.1	0.6
16.60	2498.0	Base + 50%	23.64	42.4	2666.0	6.7

Summarizing clause 7.4, the following figures of railway demand in 2010 are adopted for this Project

Table 7.4.3-5 Demand Forecast in 2010

		2010 year (million)
Tone-Kilometer		23,000
Passenger-Kilometer	International	650
	Domestic	774
	Suburban	949
	Total	2,373

Fig7.4.3-3 Forecast of UTJ Domestic Suburban Passengers

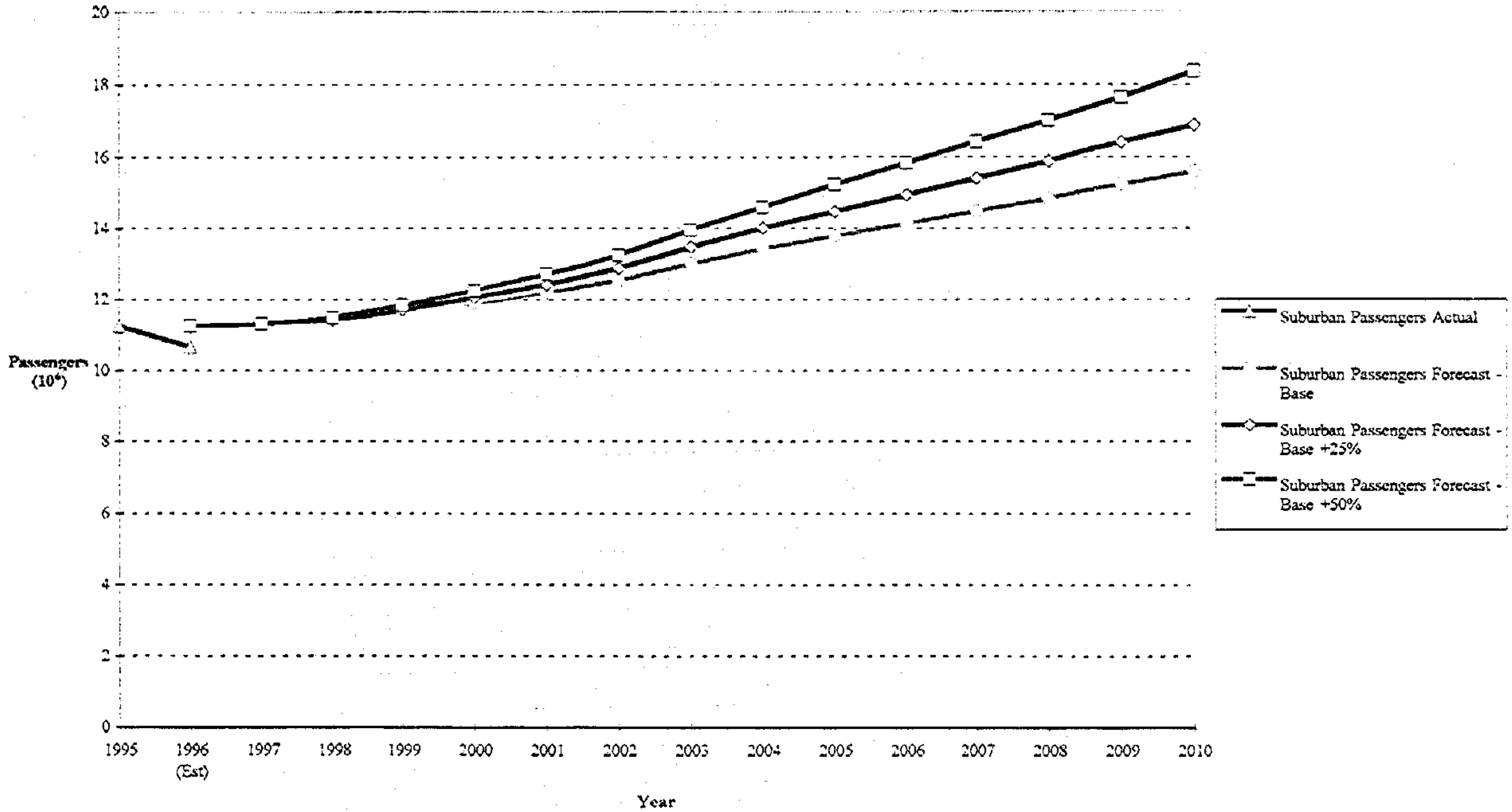


Fig7.4.3-4 Forecast of UTJ Domestic Long-Distance Passengers

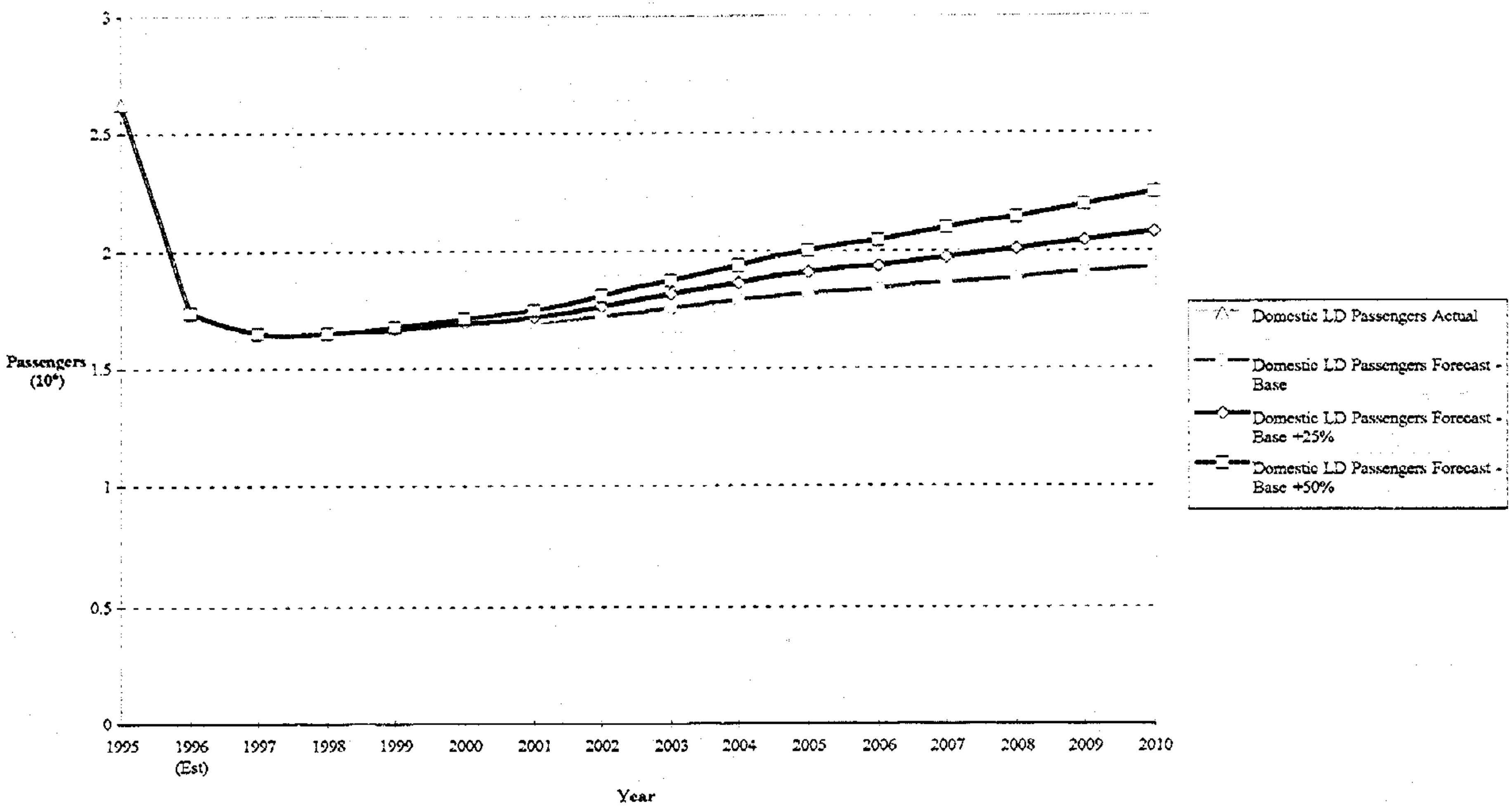


Fig7.4.3-5 : Forecast of UTJ International Passengers

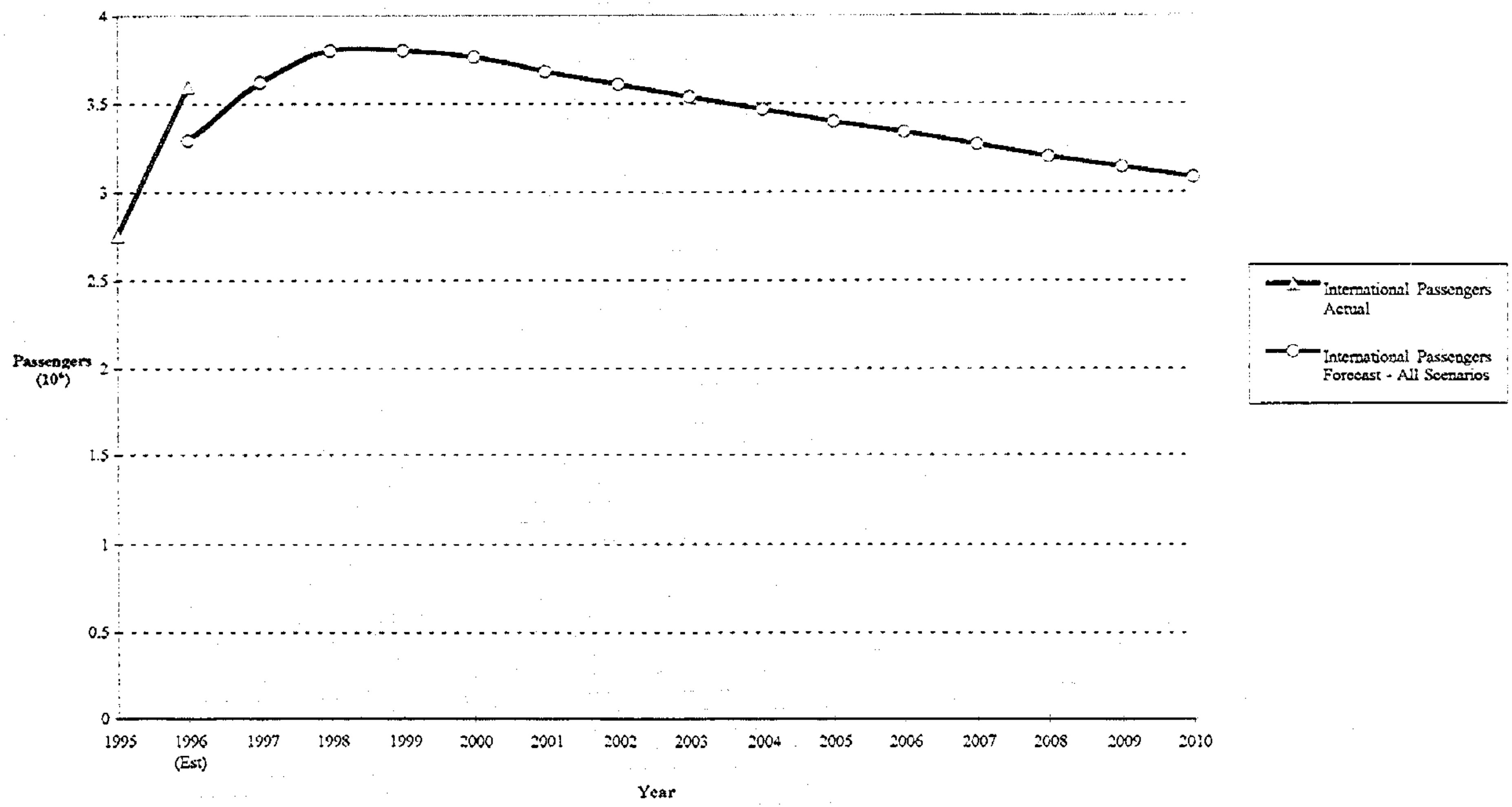


Fig7.4.3-6 . Forecast of UTJ Total Passengers

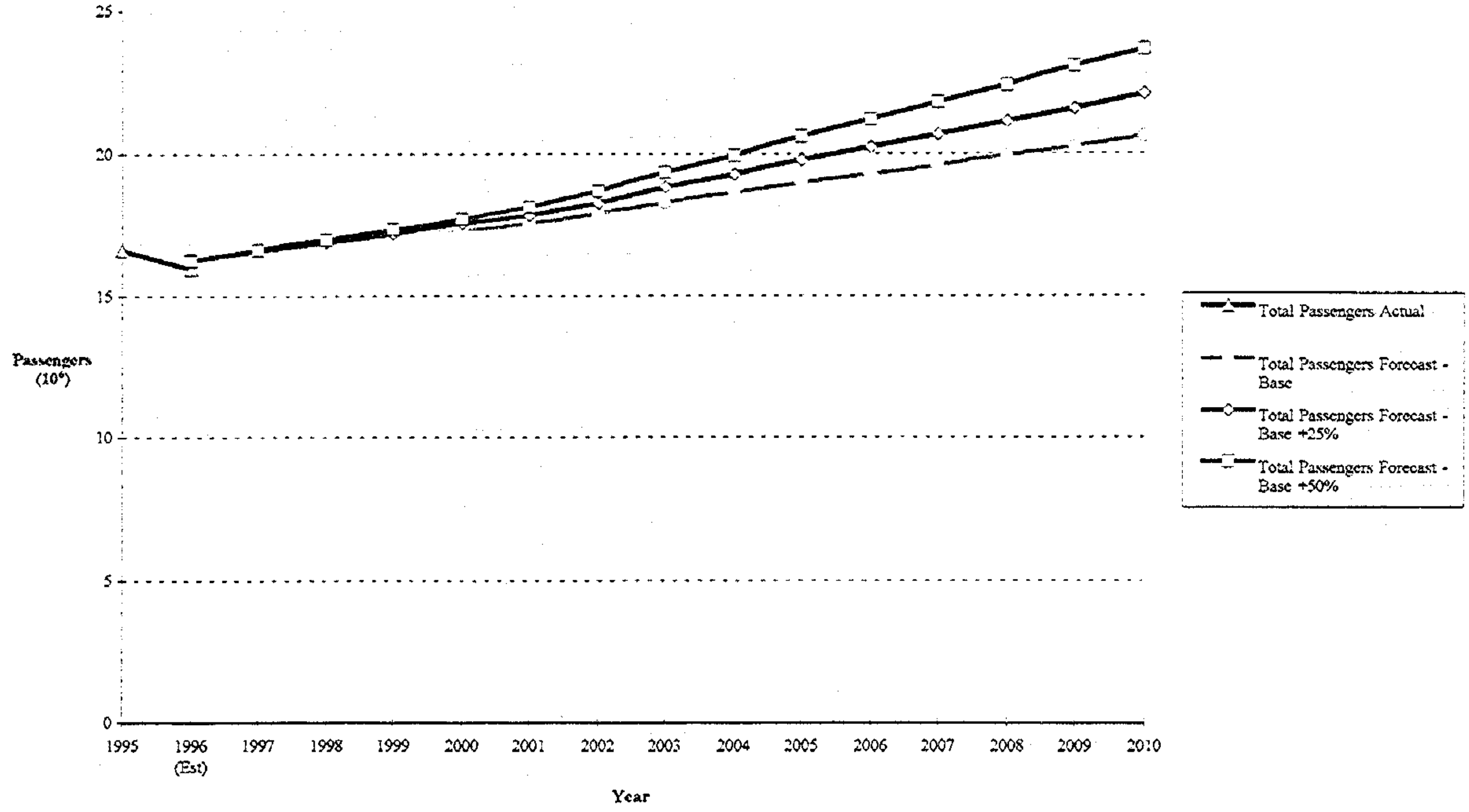


Fig7.4.3-7 · Forecast of UTJ Suburban Passenger-Kilometres

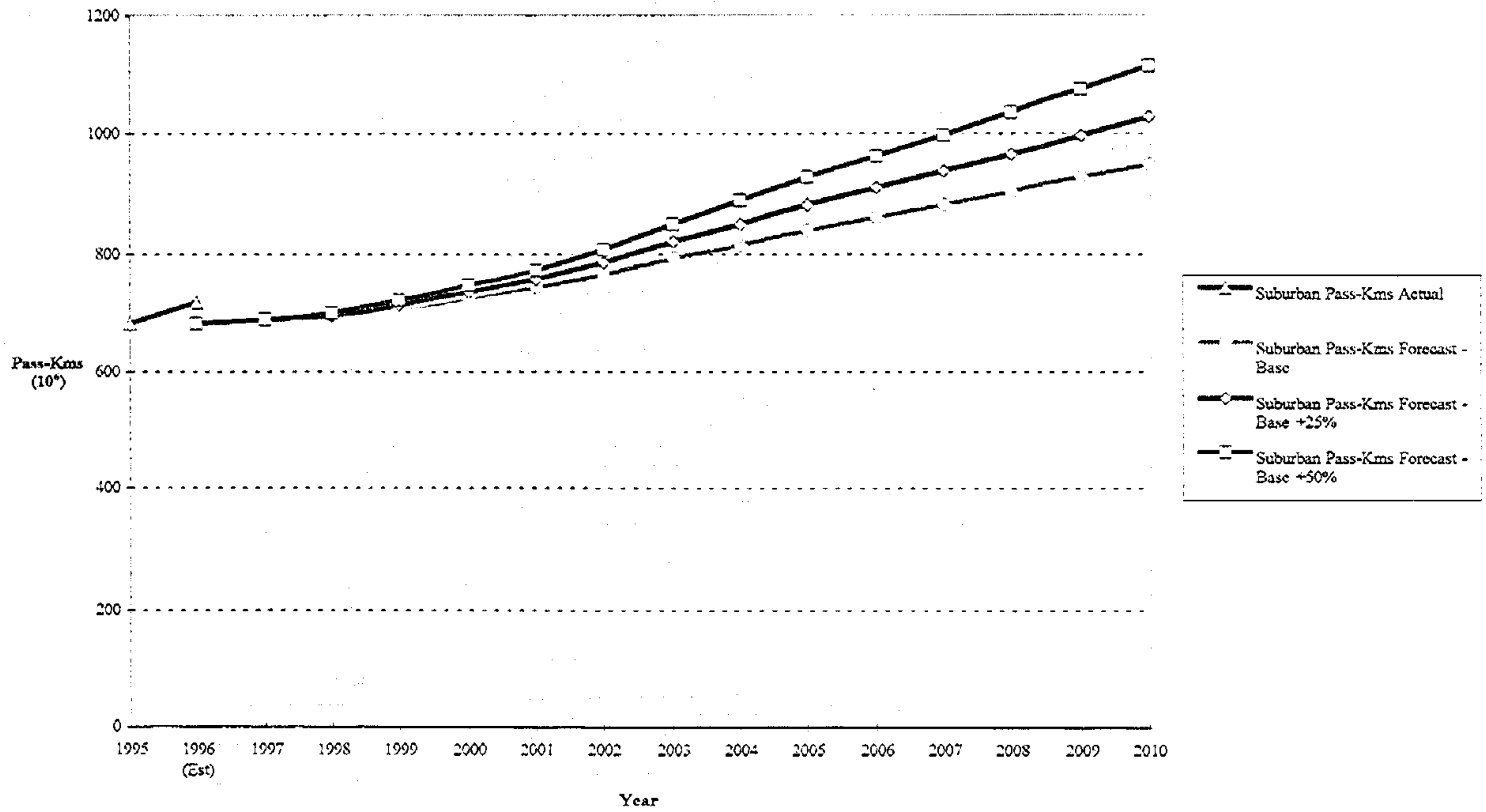


Fig7.4.3-8 .- Forecast of UTJ Domestic Long-Distance Passenger-Kilometres

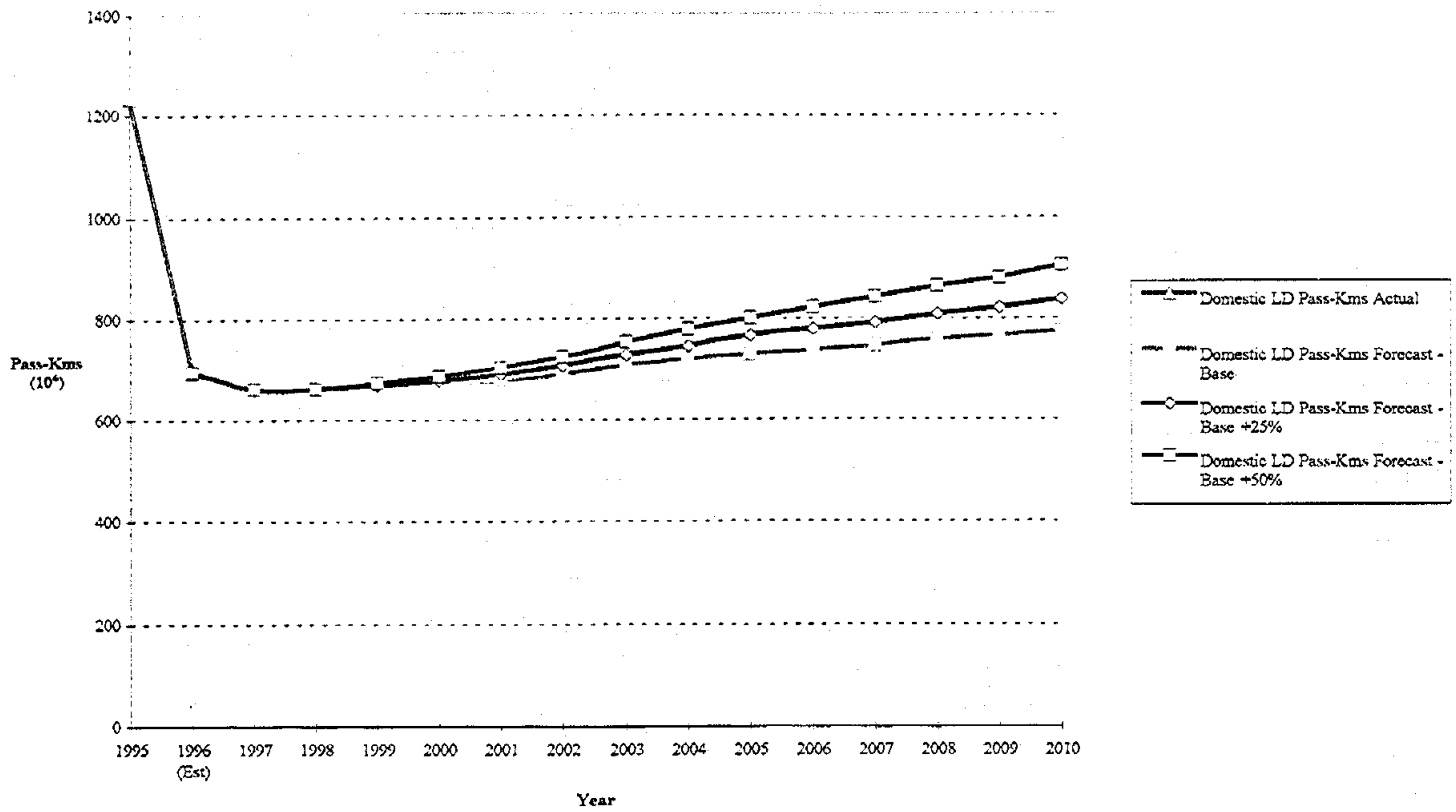


Fig7.4.3-9 . Forecast of UTJ International Passenger-Kilometres

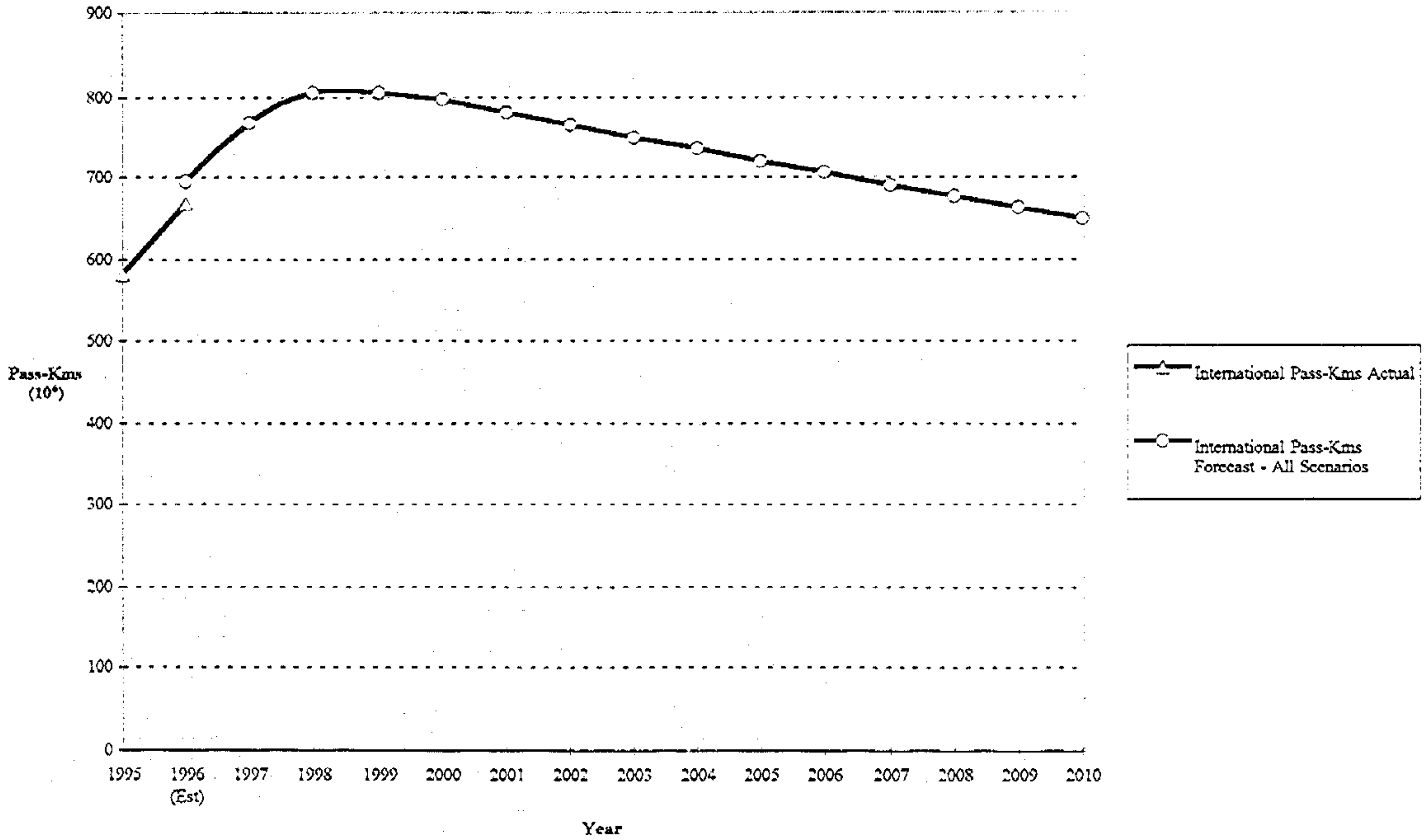
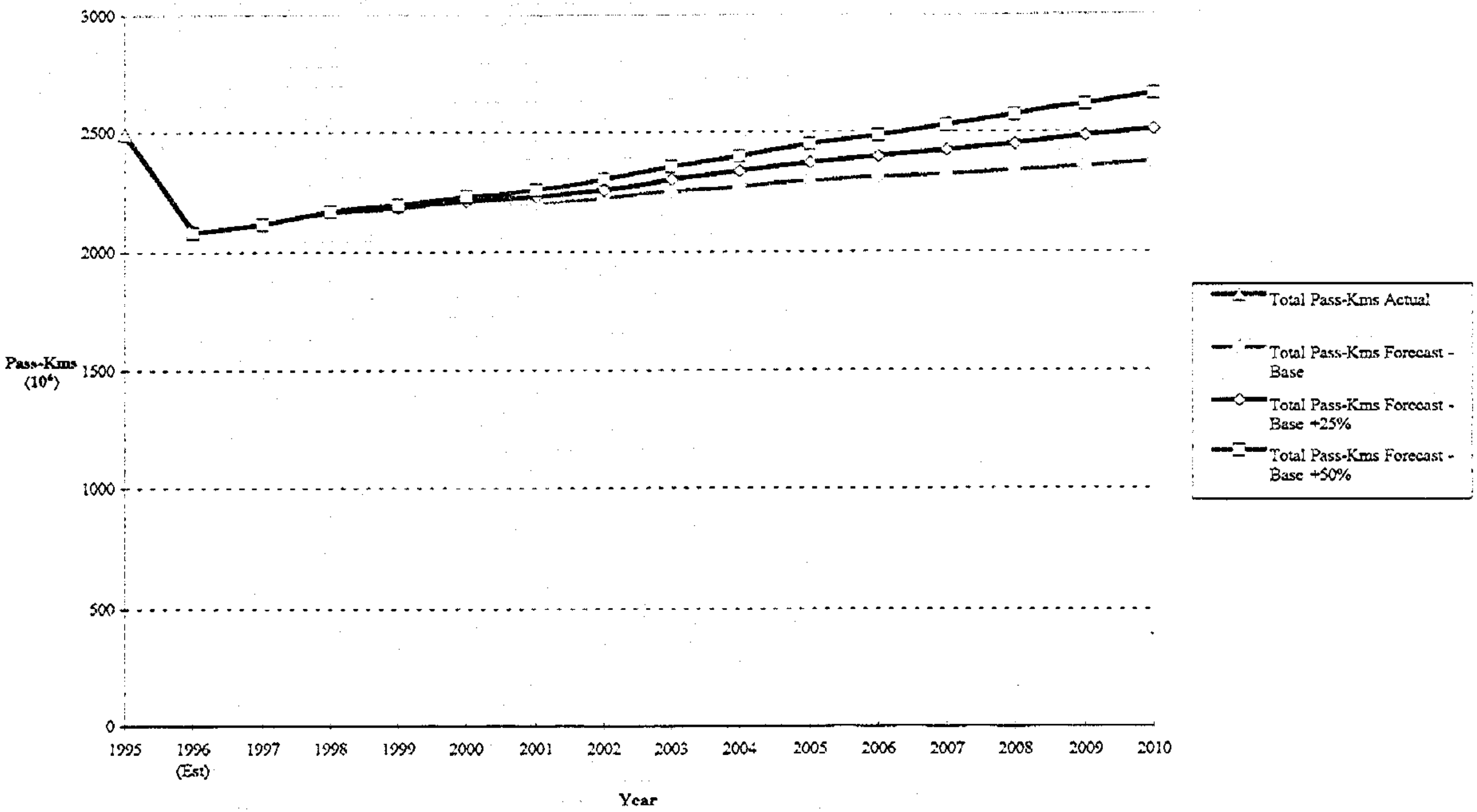


Fig7.4.3-10 - Forecast of UTJ Total Passenger-Kilometres



CHAPTER 8. ROLLING STOCK PLAN

8.1 TRAIN OPERATION PLAN

Train operation scale by hauling locomotive in 2010 is assumed not for individual line section, but for all Uzbekistan lines as a whole, based on the current train operation, adding electrification plane, new line construction plan, increase of passenger-kilometer and ton-kilometer.

8.1.1 Approach for electrified sections

(1) All passenger trains of the following sections will be electric rail-car train.
- Tashkent～Saral～Hozikent
- Kizil～Tukumati～Angeren

(2) Passenger trains of partial sections of Marakand～Buhara～Karushi～Marakand will be electric rail-car trains.

(3) Other trains will be electric locomotive hauled in electrified sections, and diesel locomotive hauled in non-electrified sections.

(4) The following sections will be electrified after 2005; Navoi～Uchikuduk, Nukus～Kunkragan～Beineu, Kokand～Andijyan, new line part of Uchikuduk～Nukus

8.1.2 Approach for new line sections

(1) New line of Angren～Pap will not be completed in 2010.
The other two lines will be completed in 2010, and all present trains via Turkmenistan territory will be transferred to new lines.

(2) Number of international and domestic trains will not be decreased to keep the service level for travelers, in spite of decreasing passenger-kilometer for both international and domestic transport.

(3) Passenger-trains of the suburban transport in 2010, will be all electric rail-car trains.

(4) Train- kilometer in 2010 is estimated, based on assumed passenger-kilimeter, ton-kilometer in 2010 and the above said premise.

8.1.3 Train kilometer

1) Assumed passenger-kilometer in 2010

Table 8.1.3-1 Assumed passenger-kilometer in 2010

		1995	2010	Increase rate
Passenger-kilometer, Total $\times 10^6$		2,498.5	2,372.8	94.9%
Classification	International	580.0	650.3	112.1%
	Domestic	1,235.5	773.7	62.6%
	Suburban	683.0	948.8	138.9%

2) Assumed passenger train-kilometer by hauling locomotive and Electric rail-car

Table 8.1.3-2 Assumed Passenger Train-Kilometer in 2010

(Unit; kilometer)

	Train-kilometer
EL hauled train	21,000 (11,000)
DL hauled train	3,000 (13,000)
Electric rail-car train	11,900 (11,900)

3) Assumed ton-kilometer in 2010

Table 8.1.3-3 Assumed ton-kilometer in 2010

	1995	2010	Increase rate
Ton-kilometer $\times 10^9$	16.8	23.0	136.8 %

4) Estimated freight train-kilometer in 2010 by hauling locomotive

Table 8.1.3-4 Assumed Fright Train-Kilometer in 2010

(Unit; kilometer)

	Train-kilometer
EL hauled train	147,000 (79,000)
DL hauled train	21,600 (89,000)

Note; The number of Train-kilometer in the case of the same electrification scale as in 2005 are shown in the parenthesis.

8.2 ROLLING STOCK PLAN

(1) Based on the train operation plan in 2010, assumed from increase rate of passenger-kilometer and ton-kilometer in 2010, progress of electrification, and extension of completed new lines, necessary number of rolling stock in 2010 is estimated as shown in Table 8.2.1

Table 8.2-1 Necessary Number of Rolling Stock in 2010 Unit; section

Year	Number of rolling stock		Rate to number in 1995 %
	2010	1995	
EL	620 (330)	138	449% (239.1%)
DL	95 (385)	445	21.3% (86.5%)
EC	220 (220)	66	333% (333%)

Note 1; The number of rolling stock in the case of the same electrification scale as in 2005 are shown in the parenthesis.
Note 2; The number of shunting DL is not included
Note 3; Reserved ELs & DLs in 1995 are excluded

(2) Realization of electric rail-car trains with 10 cars.

At present, electric rail-car train is composed of eight cars at maximum, and mostly of six cars, but in 2010, improvement of train operating frequency and electric railcar train with 10 cars will be necessary to meet the increased larger suburban transport.

(3) Approach of rolling stock plan

1) Estimate passenger-kilometer and ton-kilometer by hauling locomotive in 1995, based on passenger-kilometer and ton-kilometer of international, domestic, suburban transport, and moreover the actual train-kilometer in 1995.

2) Estimate hauling locomotive ratio, based on train-kilometer by hauling locomotive with electrification and route change with newly constructed lines.

3) Estimate passenger-kilometer by hauling locomotive, based on international and domestic passenger-kilometer in 2010, and the above mentioned hauling locomotive ratio.

Assume that the suburban passenger-kilometer will be shared by electric rail-car trains.

4) Estimate train-kilometer by hauling locomotive in 2010, out of passenger-kilometer by hauling locomotive in 2010 based on average passenger number of one train, average transport tonnage of one train, calculated from passenger-kilometer , ton-kilometer and train-kilometer in 1995.

5) Estimate train-kilometer multiplied by undulation ratio, considering the past transport undulation.

6) Estimate locomotive-kilometer and electric rail-car-kilometer in 2010, based on train-kilometer in 2010.

7) Calculate number of rolling stock in 2010, based on daily car-kilometer in 2010.

CHAPTER 9 ROLLING STOCK MAINTENANCE PLAN

Maintenance plan was settled, based on the UTJ inspection standards for locomotives as a rule, and on Japanese experiences of maintenance methods and items for principal electric equipment and apparatus.

9.1 ELECTRIC LOCOMOTIVE AND DIESEL LOCOMOTIVE

9.1.1 Preconditions of KP-1 and KP-2

(1) Assumed number of locomotives in 2010.

Unit: section

Type / Case		Number of locomotives			
		EL	DLM	DLS	Total
A	Electrification scale in 2005	330	385	313	1,028
B	80% electrification	620	95	313	1,028

EL : Electric locomotive
DLM : Diesel locomotive for main line
DLS : Diesel locomotive for shunting
Assumed number of DLS is the same as in 1995.

(2) Period of KP-1 and KP-2by locomotive kind

Type / Kind of repair	Number of years		
	EL	DLM	DLS
KP-1	6	4.5	7.5
KP-2	12	9	15

(3) Working days per year in the workshop

Weekly holidays	2 days, Saturday and Sunday
Yearly holidays	9days(Jan.1,Feb.9,Mar.8,Mar.21,Apr18,May.9,Sep.1,Oct.1,Dec.8)
The total working days per year	250 days (365 -2×52-9=252)

(4) Number of locomotives per year for KP-1 and KP-2

Number of locomotives divided by the number of inspection period is shown in the following table, as the number of KP-1 and KP-2.

Case / Type	Number of locomotives(Unit: Section)					
	KP-1		KP-2		Total	
	A	B	A	B	A	B
EL	27	52	28	52	55	104
DLM	43	11	43	11	86	22
DLS	21	21	21	21	42	42
Total	91	84	92	84	183	168

(5) Precondition of KP-1 and KP-2.

1) Plan to average yearly work volume.

9.1.2 Execution plan of KP-1 and KP-2.

(1) Schedule of in-coming

1) In case of A: Eleven sections per three weeks.
   In case of B: Seven sections per two weeks.

2) Locomotive for KP-1 and that for KP-2shops in by turns.

3) The same type of locomotive can not help shopping in successively sometimes, because of the locomotive maintenance number.

4) Considering the above mentioned conditions, assume the six weeks round pace, as shown in Table9.1.2-1.

5) Yearly locomotive in-coming schedule is shown in Table 9.1.2-2(A Case) and Table 9.1.2-3(B Case).

Table 9.1.2-1 Schedule of In-Coming

Week	Working Day	Week Day	A		B	
			Type	KP.	Type	
1st Week	1	Mo.	M	2	E	2
	2	Tu.	E	1	S	1
	3	Wed.				
	4	Th.	S	2	E	2
	5	Fr.	M	1	M	1
2nd week	6	Mo.	E	2	E	2
	7	Tu.				
	8	Wed.	S	1	E	1
	9	Th.				
	10	Fr.	M	2	S	2
3rd week	11	Mo.	M	1	E	1
	12	Tu.	E	2	S	2
	13	Wed.				
	14	Th.	S	1	E	1
	15	Fr.	M	2	M	2

Week	Working Day	Week day	A		B	
			Type	KP.	Type	KP.
4th Week	16	Mo.	M	1	E	1
	17	Tu.	E	2		
	18	Wed.			E	2
	19	Th.	S	1		
	20	Fr.	M	2	S	1
5th Week	21	Mo.	E	1	E	2
	22	Tu.			S	1
	23	Wed.	M	2		
	24	Th.			E	2
	25	Fr.	S	1	M	1
6th Week	26	Mo.	M	2	E	2
	27	Tu.	E	1		
	28	Wed.			E	1
	29	Th.	S	2		
	30	Fr.	M	1	S	2

M: Diesel locomotive for main line S : Diesel locomotive for shunting
E : Electric locomotive

(2) Working process of KP-1 and KP-2.

1) Process from in-coming to inception of locomotive body maintenance
1stday : Locomotive receipt, in-coming inspection
2nd and 3rdday : De-trucking, dismounting of equipment and apparatus
4th day : Air blow cleaning etc.
After 5th day : Locomotive body maintenance

2) Process from finishing of locomotive body maintenance to out-going
Before shop-out,
5th day : Lowering locomotive body, mounting of equipment and apparatus etc.
Do, 4th and 3rd day :Painting
Do,2nd day :Final inspection
Date of out-going :Trial run, delivery

3) Required days for locomotive maintenance in body shop for locomotive will be necessary to be decided, in consideration of the number of locomotives to be repaired and the shop area. For the instance of Tashkent Workshop, in case that the number of required days for locomotive carbody maintenance is the same for both Els and DLs, it will be limited to fifteen days, due to the limitation of locomotive body number staying at the same time in that shop.

4) Schedule of KP-1 and KP-2 for EL and DL
EL KP-1 22 days, KP-2 24days,(UTJ Suggestion)
DL KP-1 12 days, KP-2 20days,(Actual schedule in Tashkent Workshop)
Each schedule is shown in Fig 9.1.2-1,2,3,4 respectively.

5) The inspection method for main equipment and apparatus of electric locomotive is shown in Table 9.1.2-4.

(a) Equipment and apparatus dismounted from locomotive.

a) Pantograph
- Contact pressure with catenary in the range of up-down motion, should be within ruled value.
- Fixing face of supporting insulators should be in the same plane.

b) Lightning arrester
- Clean the insulator surface.

c) Air blast circuit breaker
- The touching condition of each contactor should be exact.

d) Main rectifier
- Maintain rectifier elements shall be inspected as a stack and do not disassemble stacks of rectifier element too much.
- Clean sufficiently cooling pieces and cooling wind passages.

e) Tap changer
- The touching condition of each contactor should be exact.

f) Auxiliary rotating machine (except oil pump of transformer)
- Confirm the performance.

g) Line breaker
- The touching condition of each contacter should be exact.

h) Master controller
- Confirm the performance.
- The touching condition of each contacter should be exact.

i) Electromagnetic valve
- Confirm the performance.

j) Safety valve
- Confirm the performance.

k) Pressure gauge
- Confirm the performance.

l) Coupler
- Confirm no crack sufficiently and specially.

(b) Equipment and apparatus dismounted from bogie.

a) Traction motor
- Decide drying, re-impregnation or coil rewinding after insulation test.

b) Bogie frame
- Confirm no crack sufficiently and specially.

c) Wheel, Axle
- Confirm no crack sufficiently and specially.

(c) Equipment and apparatus mounted on locomotive.

a) Main transformer (Dismounted blower motor)
- Confirm no oil leakage and circulating oil volume.
- Clean sufficiently cooling pieces and cooling wind passages.

b) Earth switch for protector

- The touching condition of each contactor should be exact.

c) Bracket insulator
   - Confirm no crack sufficiently.

d) Porcelain insulate tube for air
   - Confirm no crack sufficiently.

Table 9.1.2-2 Schedule of in-coming in a year (A case) (Unit : Section)

In-coming week \ day			1～30	31～60	61～90	91～120	121～150	151～180	181～210	211～240	241～250	Number of locomotives					
												EL		DLM		DLS	
Week	Week	Type	KP-1 or KP-2									KP-1	-2	-1	-2	-1	-2
1st, 7th,	Mo.	M	2	2	2	2	2	2	2	2	2				9		
13th, 19th	Tu	E	1	1	1	1	1	1	1	1	1	9					
25th, 31st	We.																
37th, 43rd	Th.	S	2	2	2	2	2	2	2	2Ⓔ	2Ⓔ		②				7 8̸
49th, Week	Fri	M	1	1	1	1	1	1	1	1	1Ⓢ			8 9̸		①	
2nd, 8th,	Mo.	M	2	2	2	2	2	2	2	2	2				9		
14th, 20th	Tu.																
26th, 32nd	We.	S	1	1	1	1	1	1	1	1	1					9	
38th, 44th	Th.																
50th, Week	Fri	E	2	2	2	2	2	2	2	2	2		9				
3rd, 9th,	Mo.	M	1	1	1	1	1	1	1	1Ⓢ				7 8̸		①	
15th, 21st	Tu.	S	2	2,	2	2	2	2	2	2Ⓔ			①				7 8̸
27th, 33rd	We.																
39th, 45th	Th.	E	1	1	1	1	1	1	1	1		8					
Week	Fri	M	2	2	2	2	2	2	2	2					8		
4th, 10th,	Mo.	M	1	1	1	1	1	1	1	1Ⓔ		①		7 8̸			
16th, 22nd	Tu.	E	2	2	2	2	2	2	2	2			8				
28th, 34th	We.																
40th, 46th	Th.	S	1	1	1	1	1	1	1	1						8	
Week	Fri	M	2	2	2	2	2	2	2	2					8		
5th, 11th,	Mo.	M	1	1	1	1	1	1	1	1Ⓢ				7 8̸		①	
17th, 23rd	Tu.																
29th, 35th	We.	S	2	2	2	2	2	2	2	2Ⓜ					①		7 8̸
41st, 47th	Th.																
Week	Fri	M	1	1	1	1	1	1	1	1Ⓔ		①		7 8̸			
6th, 12th,	Mo.	E	2	2	2	2	2	2	2	2			8				
18th, 24th	Tu.	M	1	1	1	1	1	1	1	1Ⓢ				7 8̸		①	
30th, 36th	We.																
42nd, 48th	Th.	M	2	2	2	2	2	2	2	2					8		
Week	Fri	E	1	1	1	1	1	1	1	1		8					
												27	+28	+43	+43	+21	+21=183

Note: In the table of "Number of locomotives", 9̸ of DLM, KP-1 means that 9 decreases to 8 and increases by 1 for DLS, KP-1. Increased number ① corresponds to 1Ⓢ in the left table. Another slashed figures mean the similar conditions.

Table 9.1.2-3 Schedul of in-coming in a year (B case) (Unit: Section)

In-coming Week		\ day	1~30	31~60	61~90	91~120	121~150	151~180	181~210	211~240	241~250	Number of locomotives EL KP-1	EL -2	DLW -1	DLW -2	DLS -1	DLS -2
Week	Week	Type	KP-1 or KP-2									KP-1	-2	-1	-2	-1	-2
1st, 7th,	Mo.	E	2	1	2	1	2	1	2	1	2/	4	4 5/				
13th, 19th	Tu.	S	1	2	1	2	1	2	1	2Ⓔ	1/		①			4 5/	3 4/
25th, 31st	We.																
37th, 43rd	Th.	E	2	1	2	1	2	1	2	1	2/	4	4 5/				
49th Week	Fri	M	1	2	1	2	1	2	1	2	1/			4 5/	4		
2nd, 8th,	Mo.	E	2	1	2	1	2	1	2	1	2/	4	4 5/				
14th, 20th	Tu.																
26th, 32nd	We.	E	1	2	1	2	1	2	1	2	1/	4 5/	4				
38th, 44th	Th.																
50th Week	Fri	S	2	1	2	1	2	1	2	1Ⓔ	2/	①				3 4/	4 5/
3rd, 9th,	Mo.	E	1	2	1	2	1	2	1	2		4	4				
15th, 21st	Tu.	S	2	1*	2	1	2	1	2	1Ⓔ		①				3 4/	4
27th, 33rd	We.																
39th, 45th	Th.	E	1	2	1	2	1	2	1	2		4	4				
Week	Fri	M	2	1	2	1	2	1	2	1Ⓔ		①		3 4/	4		
4th, 10th,	Mo.	E	1	2	1	2	1	2	1	2		4	4				
16th, 22th	Tu.																
28th, 34th	We.	E	2	1	2	1	2	1	2	1		4	4				
40th, 46th	Th.																
Week	Fri	S	1	2	1	2	1	2	1	2Ⓔ			①			4	3 4/
5th, 11th,	Mo.	E	2	1	2	1	2	1	2	1		4	4				
17th, 23th	Tu.	S	1	2	1	2	1	2	1	2Ⓔ			①			4	3 4/
29th, 35th	We.																
41th, 47th	Th	E	2	1	2	1	2	1	2	1		4	4				
Week	Fri	M	1	2	1	2	1	2	1	2Ⓔ			①	4	3 4/		
6th, 12th,	Mo	E	2	1	2	1	2	1	2	1		4	4				
18th, 24th	Tu.																
30th, 36th	We.	E	1	2	1	2	1	2	1	2		4	4				
42nd, 48th	Th.																
Week	Fri	S	2	1	2	1	2	1	2	1Ⓔ		①				3 4/	4
												52	+52	+11	+11	+21	+21=168

Note: Some slashed figures in the right side table only decrease by one, corresponding to slashed 2/ or 1/ in the left side table.

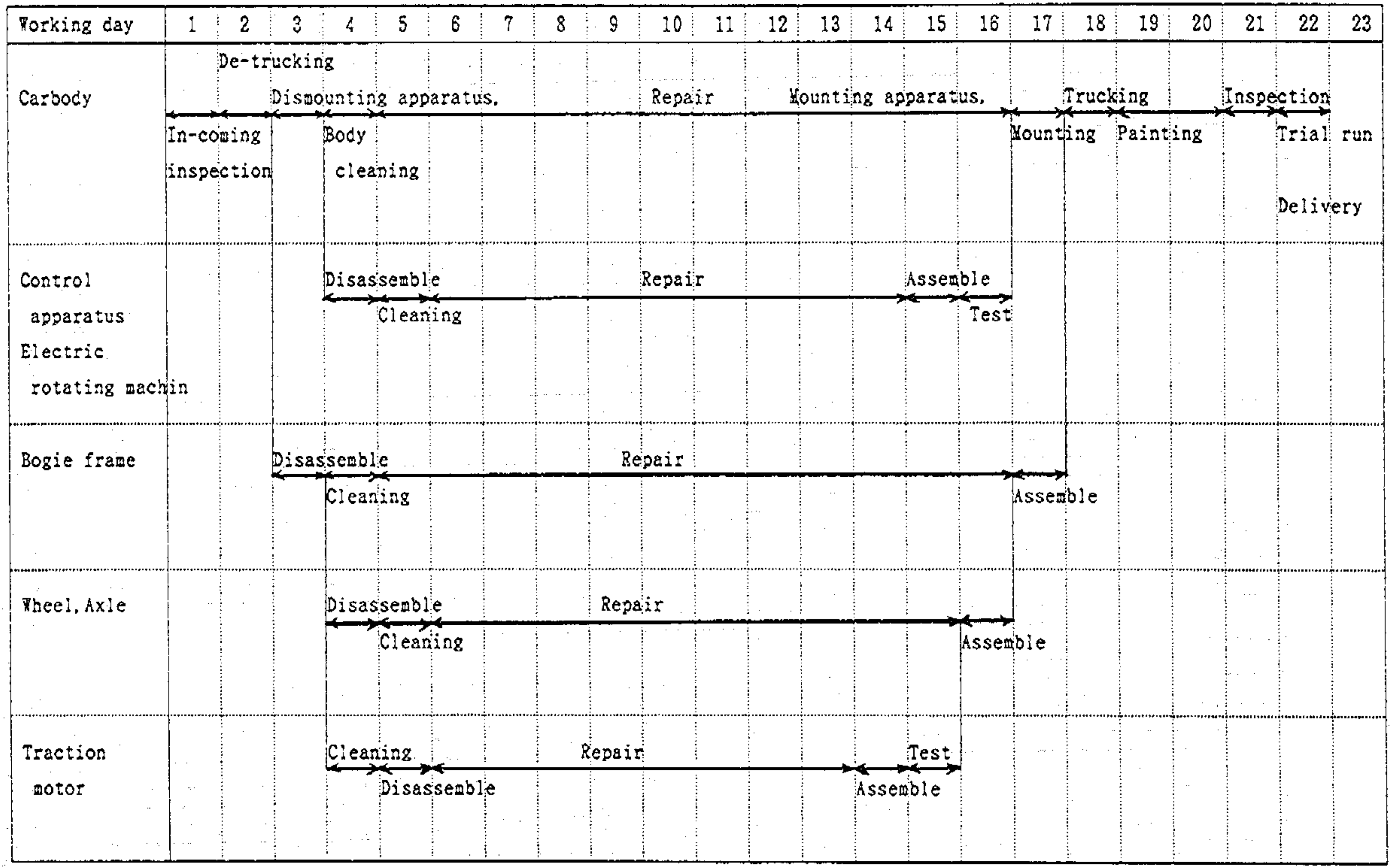


Fig.9.1.2-1 Repair Time Schedule for EL KP-1 at Tashkent Workshop

Table 9.1.2-4 The Inspection Method for Main Equipment and Apparatus of EL

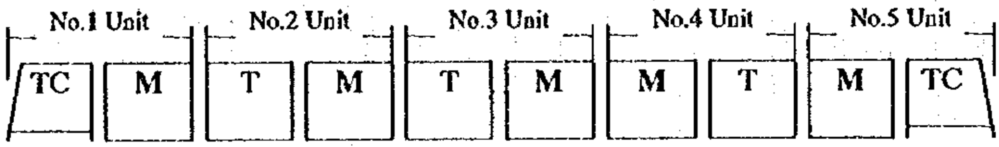
	Name of part	Check items	Method
(a)Dismounted frome locomotive	a)Pantograph	Contact pressuer, leveling of base frame, performance	Performance test
	b)Lightening arrester	Defect, performance	do.
	c)Air blast circuit breaker	Contacting state of each contacter, performance	do.
	d)Main rectifier	Performance of each stacked rectifier cell	do.
	e)Tap changer	Contacting state of each contacter, performance	do.
	f)Auxiliary rotating machine (except oil pump)	Insulation resistance, performance	Performance test, insulation test
	g)Line breaker	Contacting state of each contacter, performance	Performance test
	h)Master controllor	Contacting state of each contacter, performance	do.
	i)Electromagnetic valve	Performance	do.
	j)Safty valve	do.	do.
	k)Pressure gauge	do.	do.
	l)Coupler	Crack, performance	Performance test
(b)Dismounted from bogie	a)Traction motor	Insulation resistance, performance	Insulatione test
	b)Bogie frame	Crack, length, width, height, parallelism	Flaw detection, measurement
	c)Apparatus for braking	Length, width, air leak, performance	Performance test, measurement
(c)Mounted on locomotive	a)Main transformer	Oil leak, performance	Performance test
	b)Earth switch for protection	Contacting state of each contacter, performance	Performance test
	c)Insulator	Dielectric strength, attached dirt	Dielectric test
	d)Porcelain insulate tube for air	Dielectric strength, attached dirt	Dielectric test

Note: 1) For armature and stator, decide repair work items(rectification of commutator, re-impregnation, re-winding of coil,etc)after each insulation test.
2) For the main transformer, check the oil quantity stored in transformer body and flow quantity for cooling purposes without dismounting. In case of KP-2, inspect the insulation resistance of insulating oil.

9.2 ELECTRIC RAILCAR

9.2.1 Preconditions of KP-1 and KP-2

(1) Composition of electric railcar train



TC : Trailer car with driving cab
M : Motor car T : Trailer car

(2) Arrangement of principal equipment

	TC	M	T	M	T	M	M	T	M	TC
Driver's cab	O									O
Pantograph		O		O		O		O	O	
Traction motor		O		O		O		O	O	
Air compressor		O		O		O	O		O	
Transformer		O		O		O		O	O	
Rectifier		O		O		O		O	O	
Pneumatic brake Apparatus	O	O	O	O	O	O	O	O	O	O
Ceiling fan	O	O	O	O	O	O	O	O	O	O
Heater	O	O	O	O	O	O	O	O	O	O
Controller		O		O		O		O	O	

(3) Number of sections of electric railcars in 2010
220cars = 10cars/train × 22trains

(4) Period of KP-1 and KP-2
KP-1 : 6 years
KP-2 : 12 years

(5) Number of sections of EC per year for KP-1 and KP-2
To equalize the work volume, some of newly introduced electric railcar fleets will be shopped in before their inspection date decided by the regular inspection period.
220cars/6 years= 36.7cars≒40cars (10 cars × 4 trains)

(6) Preconditions of KP-1 and KP-2

1) Concurrently staying number of the railcars is one train,10cars.

2) It is necessary to equalize the work volume through the year as much as possible.
Necessary time of KP-2 is longer than that of KP-1. Therefore when the train enters in the workshop for KP-2, the work is busy, but for KP-1, is not so busy. In order to avoid unbalance of the work, it is desirable to divide the 10 car train into two groups, one for KP-1 and another for KP-2. For example KP-1 is carried out for units 1, 3, and 5, KP-2 for units 2, and 4. After 6 years, in contrast , KP-2 will be carried out to the former and KP-1will be carried out to the latter.

3) The spare parts are not used usually. But it is necessary to use them for big repair, if any.

9.2.2 Execution of KP-1 and KP-2

(1) Schedule of in-coming
In-coming interval
(250days) / 4trains = 62.5days ≒ 62days
Staying days in the workshop 62days

KP-1 and KP-2 are carried out for one 10 car train, and to equalize the work volume they are divided into two groups, one for KP-1 anther for KP-2. Therefore ,after completion of repairing for first 2 units(4 cars), repairing for the rest 3 units(6 cars) is started. Half day is necessary for airblow, detrucking, insertion of bogie, dismounting and mounting of electric equipment, and one and half days are necessary for painting. Each process is scheduled in two days interval as shown in Fig.9.2-1. At the first day in-coming inspection is done and, after completion of the work for the former, final inspection is carried out for 4 car train. After completion of the work for the latter, total final inspection and trial run are done for mutually connected 10 car train. Necessary days for each process is as follows.

Body, Electric equipment, Bogie	former 4 cars	13 day	latter 6 cars	17days
Wheel set, Traction motor	//	12 day	//	16 day

(2) Working process of KP-1 and KP-2
Airblow is carried out for roof, underfloor, bogie and carbody side.
The principal equipment to be dismounted are bogie with traction motor and wheel set, brake equipment, coupler, pantograph, arrestor, high voltage circuit breaker, tap changer, rectifier stack, etc. The transformer is not dismounted.
The details of inspection and repair work for the railcar are the same as those for the electric locomotive. Because cycle time from in-coming to out going for KP-1 and KP-2 is long, dismounted equipment will be reused after completion of repair work for them. Namely, spare parts circulating system is not applied, except the case of occurrence of big repair.

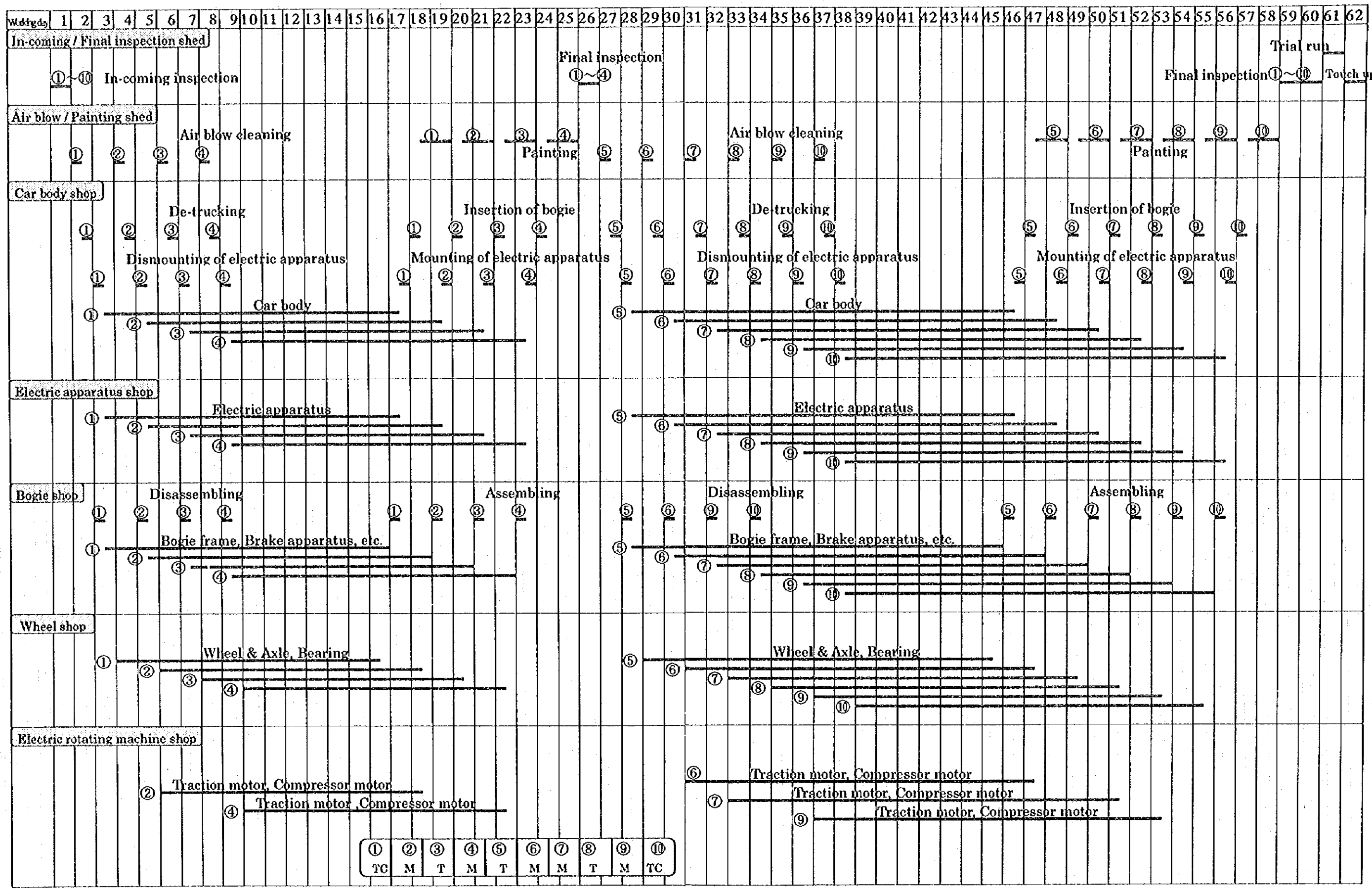


Fig.9.2 - 1 Schedule of KP-1 and KP-2 for EC

CHAPTER 10 ALTERNATIVES AND SELECTION OF THE MOST SUITABLE ALTERNATIVE FOR ELECTRIC LOCOMOTIVE REPAIR WORKSHOP CONSTRUCTION PROJECT

10.1 ALTERNATIVES

The following four alternatives are proposed.

Case 1 : Overhaul of electric locomotive (EL) is conducted in Uzbekistan Depot (the Depot) and that of electric railcar (EC) in Tashkent Locomotive Repair Workshop (the Workshop) (same as the F/S of UTJ) .

Case 2 : Overhaul of both EL and EC is conducted in the Workshop.
(Same as the additional F/S of UTJ)

Case 3 :Overhaul of EL is conducted in the Workshop and that of EC in the Depot.

Case 4 : Overhaul of both EL and EC is conducted in the Depot.

10.2 COMPARISON OF 4 ALTERNATIVES

10.2.1 Precondition

(1) Based on the result of demand forecast, the review on new line construction plan and electrification plan, and the study on train operation plan, number of rolling stock in 2010 and their number per year of KP-1 and KP-2 are shown in Table 10.2.1-1. In consideration of development of electrification, the number of rolling stock in 2010 is calculated for two cases; electrification length remains at 2005 year's plan or electrification is accomplished in 80% of total line length.

(2) The number per year of KP-1 and KP-2 in 2005 year's electrification plan scale is larger than that in 80% electrification scale of total line length. Therefore, the comparison of four alternatives is made on the 2005 year's electrification scale.

Table 10.2.1-1 Number of Rolling stock in 2010 and Their Number per Year of KP-1 and KP-2 (Number of Section)

		DL	EL	DL+EL	EC	
UTJ F/S	Number of rolling stock	863	420	1,283	270	
	Number per year of KP-1 & KP-2	160	78	238	50	
JICA F/S	Number of rolling stock	698	330	1,028	220	2005Year's Electrification Scale
		408	620			Electrification Scale in 80% of Total Line Length
	Number per year of KP-1 & KP-2	128	55	183	40	2005Year's Electrification Scale
		64	104	168		Electrification Scale in 80% of Total Line Length

Remarks: Number of DL includes number of shunting DL (313).

10.2.2 Items for comparison and examination

The following items for comparison are examined.

(1) Land restriction

The Depot locates in the suburbs of Tashkent City, having wide vacant area adjacent to the present building for repair work.

In contrast, the Workshop locates in the center part of the city and is cramped, but has adjacent available area warranted by the City authority.

It is adjacent to Tashkent Station yard and convenient to do shunting and related works of in-coming and out-going rolling stock for repair.

(2) Environmental aspect

1) Water supply: At present, the pumping rate at the Depot is similar to that of the Workshop. In future, the water demand of the Depot will increase and the Depot will need a new installation of water supply system. After a new EL(EC) Repair Workshop is constructed, the water demand of the Depot will be increase for the cases 1, 3 and 4, and the increase of water demand for the case 4 is the highest. The water demand of the Workshop will not change or decrease a little for the case 2. For the other cases, the water demand will decrease. The case 2 is the best.

2) Wastewater: In the Depot, a new wastewater treatment facility will be operated in 1997 in order to eliminate oil product from the wastewater. In the Workshop where the wastewater has much more oil products than in the Depot, a new wastewater treatment system, which has the similar system to that in the Depot and a filter system in order to reduce oil products, will be operated in 1999. After a new EL(EC) Repair Workshop is constructed, the discharge of the wastewater containing oil products will increase for the cases 1, 3 and 4 in the Depot, and the increment will be highest for the case 4. Because the repair work of DL will be reduced and will be replaced with the repair work of EL(EC), the

discharge of the wastewater containing oil products in the Workshop will increase a little but the concentration of oil products in the wastewater will decrease for the case 2. In the other cases, the discharge of the wastewater will decrease and the decrement is the highest for the case 4. It is difficult to say which of the four cases is the best.

3) Air pollution: In the Workshop, the foundry shop and relating facilities emit air contaminants such as dusts and CO. In the Depot, the process of concrete block production and boilers emit air contaminants such as dusts. The air pollution in the Workshop is more serious than in the Depot. After a new EL(EC) Repair Workshop is constructed, the increment of air pollutants' emission will be small. In this respect, the case 4 is the best.

4) Wastes: In the Workshop, the separation and reuse of wastes are well done. Wastes ,which are not reusable, are sent to the municipal final disposal place. In the Depot, wastes are not separated well. Combustible wastes are incinerated in a pit and wastes are buried there in the Depot. After a new EL(EC) Repair Workshop is constructed, the quantity of wastes will increase for the cases 1, 3 and 4 in the Depot, and the increment will be the highest for the case 4. Because the repair work of DL will be reduced and will be replaced with the repair work of EL(EC), the quantity of wastes in the Workshop will increase a little for the case 2. In the other cases, the quantity of wastes will decrease and the decrement is the highest for the case 4.

It is difficult to say which of the four cases is the best.

(3) Power supply

As for power supply, such as electricity, compressed air and steam etc. necessary to rolling stock maintenance work, no new facilities to be installed is needed and there is no difference between the Depot and the Workshop.

(4) Diversion of skilled workers to EL, EC inspection work.

As overhaul of DL is conducted in the Workshop, it has a large number of skilled workers and the quality of work will partially change from that of DL to that of EL.

So the Workshop is advantageous for the workshop construction in both quantity and quality of workers.

(5) Area of working sites

Comparison is made on the difference between necessary area and available one already in use, namely additional area to be newly prepared. The Workshop has much wider available area than the one the Depot does.

(6) Facilities and equipment

Comparison is made on the difference between necessary quantity of additional ones to be installed. Roughly speaking, no facilities and no equipment for overhaul of rolling stock is installed in the Depot, as overhaul of EL and EC is not conducted there.

(7) Rough construction cost

In Case 3, installed facilities and equipment in the Depot will be operated inefficiently, because the work volume for overhaul of EC is small.

Items for comparison and the examined results for four alternatives are shown in Table 10.2.2-1.

10.3 SELECTION OF THE MOST SUITABLE ALTERNATIVE

(1) In comparison and overall evaluation of four alternatives, the Workshop is preferable for construction of electric locomotive repair workshop.

(2) The workshop construction plan is made on the condition that KP-1 and KP-2 of EL and EC are conducted in Tashkent Workshop.

Table 10.2.2-1 Items for comparison and the examined results for four alternatives

Item for comparison / Case			1	2	3	4
Land restriction			△	△	△	○
Environmental Problems	Water supply		△	○	△	△
	Wastewater		○	○	○	○
	Air pollution		△	△	△	○
	Waste		○	○	○	○
Power Supply	Electricity		○	○	○	○
	Compressed air		○	○	○	○
	Stem		○	○	○	○
	Gas		○	○	○	○
Diversion of Skilled Workers			△	○	△	×
Workshop Area(m^2)	Necessary		24,844	22,180	23,760	20,830
	Available	Depot	7,344	—	85,44	85,44
		Workshop	10,000	20,020	12,180	—
		Sub Total	17,344	20,020	20,724	8,544
	To be prepared		7,500	2,160	3,036	12.286
Facilities and Equipment (set)	Necessary		506	394	483	367
	Available	Depot	—	—	—	—
		Workshop	114	162	113	—
		Sub Total	114	162	113	—
	To be installed		392	232	370	367
Construction Cost ($\times 10^6$ yen)	Building	Construction	450	129	182	737
		Reconstruction	191	225	228	94
		Sub Total	641	344	410	831
	Civil & Track		291	121	140	284
	Machinery, Transportation equipment		5,771	2,863	5,508	5,397
	Utility facilities		52	26	47	50
	Electric facilities		93	47	86	92
	Sub Total		6,776	3,411	6,190	6,654
Order of Ranking			4	1	2	3

Note ○ :Advantageous △ :A little advantageous × :Disadvantageous

CHARPTER 11 ELECTRIC LOCOMOTIVE REPAIR WORKSHOP CONSTRUCTION PLAN

11.1 FUNDAMENTAL CONDITION FOR WORKSHOP DESIGN

(1) Utilize the actual machinery, facilities, equipment and available area in the workshop shown in Fig. 11.1-1 as much as possible.

(2) Improvement of maintenance work level shall be taken into consideration in installating or replacement of machinery, facilities and equipment.

(3) Machinery, facilities and equipment to be installed shall be commonly used for maintenance work of both EL and EC, as much as possible.

(4) Measures for environmental problems relating to this Project shall be considered, as the occasions demand.

(5) Catenary over track lines adjacent to the workshop shall be installed for trial run of out-going EL and EC.

11.2 WORKSHOP DESIGN

11.2.1 Workshop layout

Fig. 11.2.1-1 shows the layout of whole workshop

(1) Body shop for locomotives

Inspection of EL is planned to undergo at carbody shop for DL, as DLs are decreasing in number, and repairs of coaches presently being carried out at the body shop is planned to do at other location, resulting in room becoming available for inspection in the shop.

Fig. 11.2.1-1 shows an arrangement of locomotives for inspection and repairs. It is possible to do maintenance on 11 locomotives at the same time with enough room for 2 locos for lifting and 2 locos for lowering. A plan of car's placing is as shown in Fig1of Appendix. 11.2.1.

(2) Body shop for EC

The car body shop for PC will be available for the repair of EC. There are two types of moving cars using machinery. One is by overhead travelling crane and the other is by lifting jack. The former is superior to the latter from view point of efficiency for shifting cars. The height of the present shop, however, prevents the above mentioned crane from being installed. To remould the shop to accommodate the overhead travelling crane will be too expensive. Therefore, the lifting jack will be introduced instead. It is possible to do maintenance on 6 ECs at the same time with enough room for 1 car for lifting and 1 car for lowering. A plan of car's disposition is shown in Fig2 of Appendix. 11.2.1 and drawing for study of height of body shop for EC in Fig3 of

Appendix. 11.2.1.

Body shop for EC is shown in Fig 11.2.1-4

(3) Air blowing shed for EC

Cleaning before inspection and repairs of EC will be made by air blow, because there are many kinds of electric components and no oily adhesion with car-bodies. The air blow cleaning shop for EC is planned separately from the present cleaning facilities for DL. The present tool manufacturing shop will be equipped with the air blow cleaning booth for EC with necessary facilities. Air blow cleaning for EL is planned to share with DL at the present cleaning shop for DL in the shunting area. Fig 4 of Appendix. 11.2.1 shows an arrangement of air blowing shed for EC and Fig 5 of Appendix. 11.2.1 notes an examination of air blow cleaning facilities.

Air blowing shed for EC is shown in Fig 11.2.1-4

(4) Painting shed for EL/EC

Painting of a car-body requires 2 days. In case of the EC, four or six cars occupy the shop for 8 or 12 days in succession for their repairs. In the meantime, painting of electric locomotives cannot be executed. Because of this reason, two plants for painting both of which are in assembly line, will be installed by Tact system. An arrangement of cars in painting and work contents by each tact are shown in Fig 4 of Appendix. 11.2.1 and drawing for study of painting facilities is noted in Fig 6 of Appendix. 11.2.1

Painting shed for EL/EC is shown in Fig 11.2.1-4

(5) Final inspection shed for EL

One track in the final inspection shed is used solely for the inspection of EL before shop-out. In order to carry out inspection on a three-locomotive-set, it is necessary to install catenary of equal length of 3 cars. A transformer of 25 kv is used as the main power source.

A plan of final inspection shed for EL is shown in Fig 7 of Appendix. 11.2.1

(6) In-coming/final inspection shed for EC

EC undergo shop-in inspection and the final inspection after completion of repairs, both in a form of a unit or train-set inspection. For this, an inspection shed of 10-car length will be needed. The shed will be provided adjacent to the wall side of the existing steel casting shop. (Fig. 11.2.1-1) in the test on a train-set, an inspection of a circuit with high voltage and running test at low speed are being planned. Catenary and a transformer with the capacity of 25 kv is required for the above inspection.

A plan of in-coming/final inspection shed are shown in Fig 8 of Appendix. 11.2.1.

(7) Bogie shop

By transferring repair work of passenger cars to other location, there will be ample room for all types of bogies can be repaired. Existing machinery are to be made the best possible use of it.

(8) Wheel shop

The present wheel shop has sufficient capacity for inspection and repairs of wheels ever since the establishment of the shop. Wheels of all sorts of cars can, therefore, be inspected and repaired.

(9) Electric rotating machine shop

The present capacity of the motor repair shop has had sufficient room since the establishment of the shop like the wheel inspection shop. All kinds of motors can be inspected and repaired in the same way as before.

(10) Electric apparatus shop for EL, EC and DL.

Small-size electric apparatus shop is to move to the shed on the south side of the present electric apparatus shop for EL. Machinery which is exclusive to maintenance of EL and EC are to be newly supplied. In order to raise the level of inspection capability, testing apparatus are strengthened in quality and quantity.

(11) Trial run track

For the sake of test run of EL and EC after completion of repairs, catenary is furnished for 1.5km-length of track adjacent to the shop of Tashkent Station side.

(12) Transportation, motive power etc

1) Due to layout of the inspection and repair facilities, EC is to move from one shop to another with much complexity. In order to relief or lessen complexity, it is proposed to introduce a shunting engine available both on rail and road.

2) A traverser is newly furnished for common use of DL, EL and EC. Approaching tracks and necessary facilities around the traverser are to be improved.

3) Steam boiler

The existing steam boilers are 2 x 16t/h and 3 x 10t/h, and loading at peak time in winter is about 70 %. Judging from their capacity, it can cope with the future demand even though repairs of EL and EC may be done.

4) Air compressor

The air compressors of 4 x 100 m^3/m and 2 x 25 m^3/m are owned and loading at peak work time is about 60 %. There will be no problems in the capacity even if EL and EC are repaired.

5) Power facilities

There are two receiving transformers of 35 kv/6 kv, 16,000 kvA and loading at peak work time is about 60 %. The present capacity will be good enough for the future demand.

(13) Building

1) Inspection pits have to be constructed with enough distance between footings of the building and pits, as they are constructed in the existing building for maintenance.

2) In-coming/final inspection shed for EC to be newly constructed is planned to be of steel structure and to have expansion joint in the longitudinal direction.

3) In order to secure working safety, guide sign posts and colour posts are arranged.

(14) Track/civil engineering

1) Formation level

Formation level is 600 mm below the top of rail. The subgrade is replenished with soil of good quality after removing surface soil of 500 mm in depth.

2) Track center distance

Minimum distance between track centers in yard is five meters or more.

3) Track structure

Track structure is composed of ballast with crushed stones, PC sleepers, rails of 60 kg/m and the ballast depth is 300 mm as standard.

4) Turnout

Turnout is a type of no. 10, and is operated by a switch with a weight.

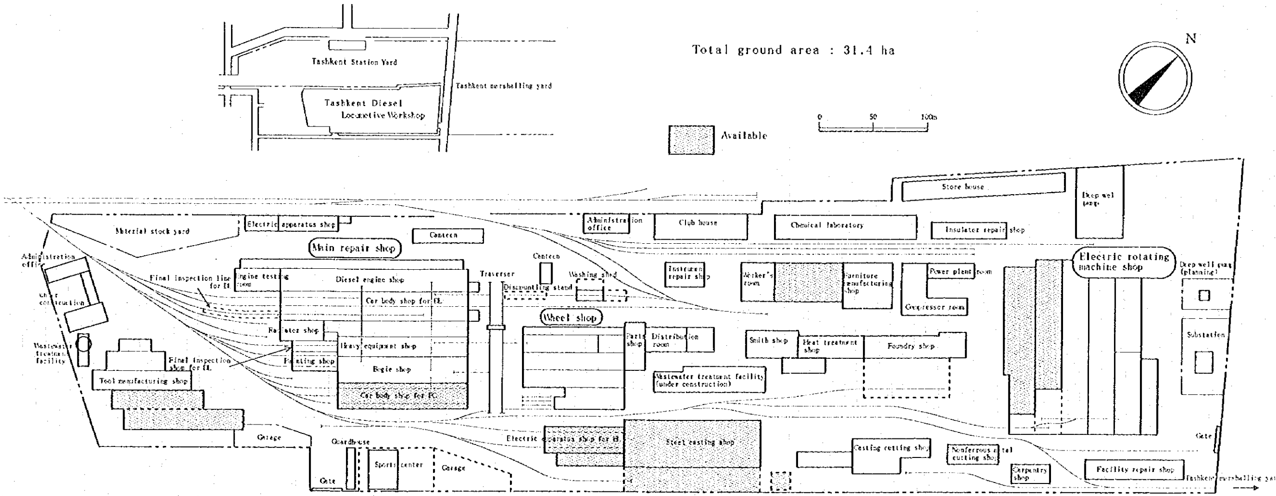


Fig.11.1-1 LAYOUT OF TASHKENT WORKSHOP(Available parts for construction of EL repair workshop)

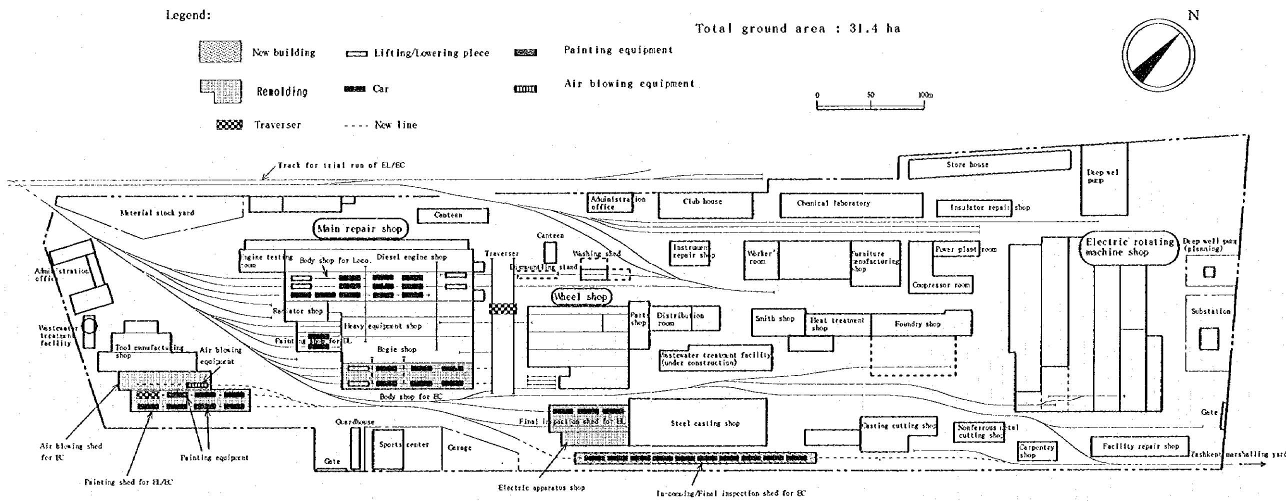


Fig. 11.2.1 - 1 LAYOUT OF TASHKENT Workshop

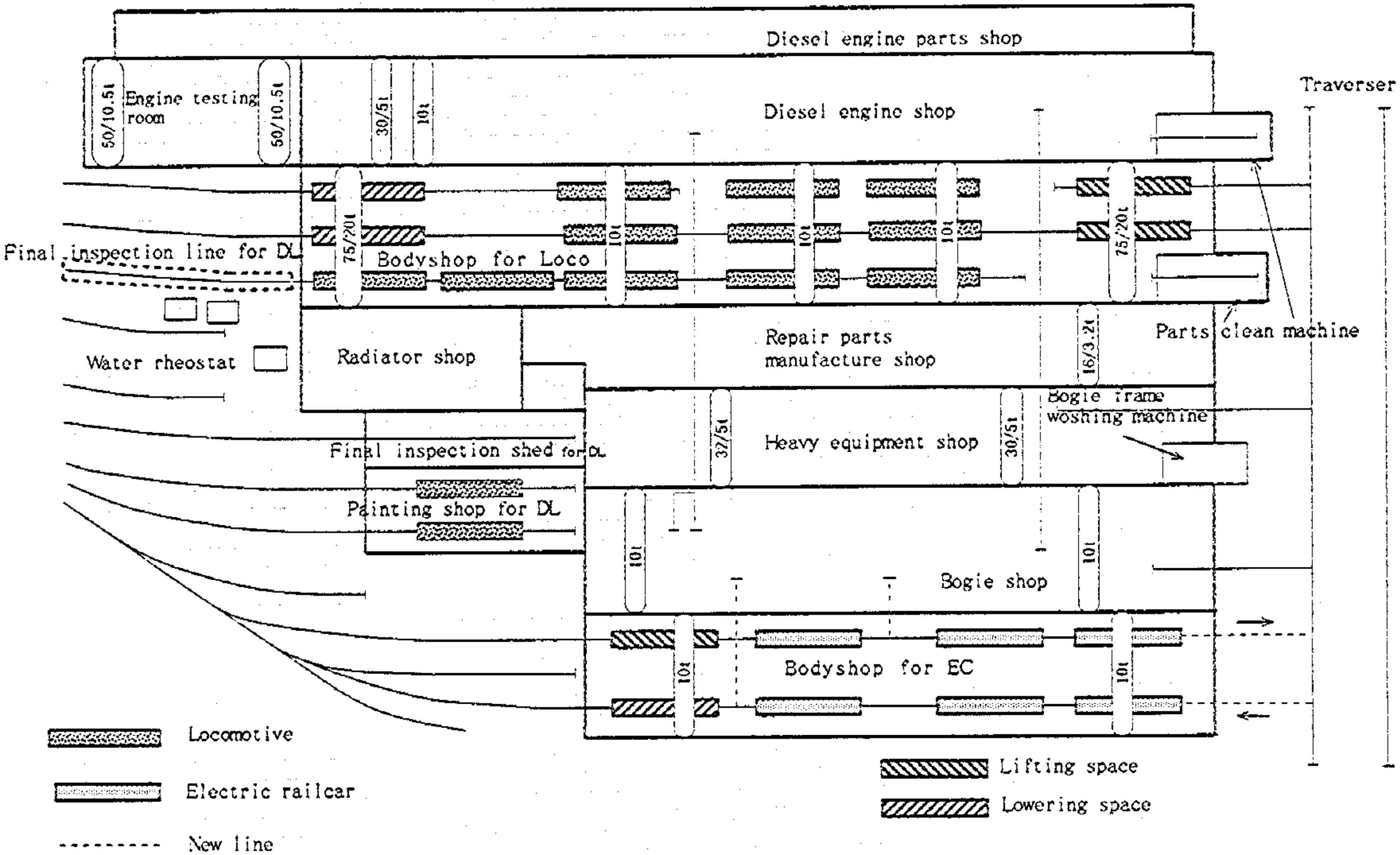
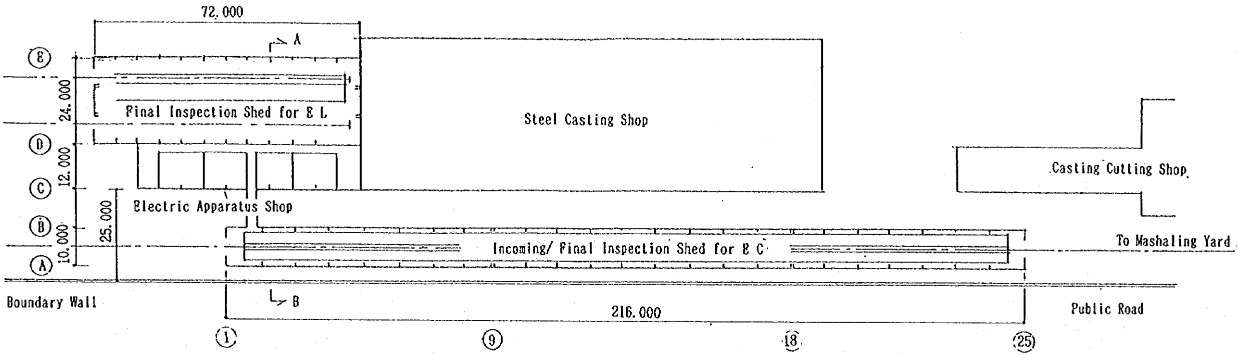
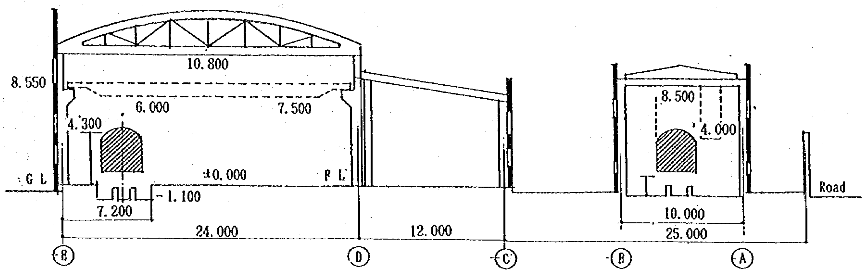


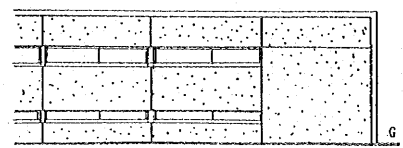
Fig. 11.2.1 - 2 Main Repair Shop



Floor Plan s 1 : 1000



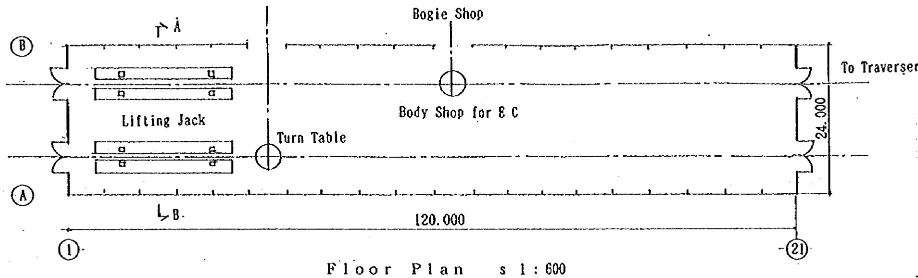
A ~ B Section s 1 : 300

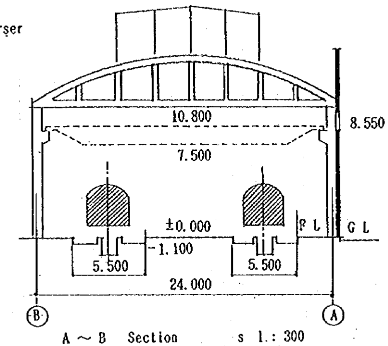


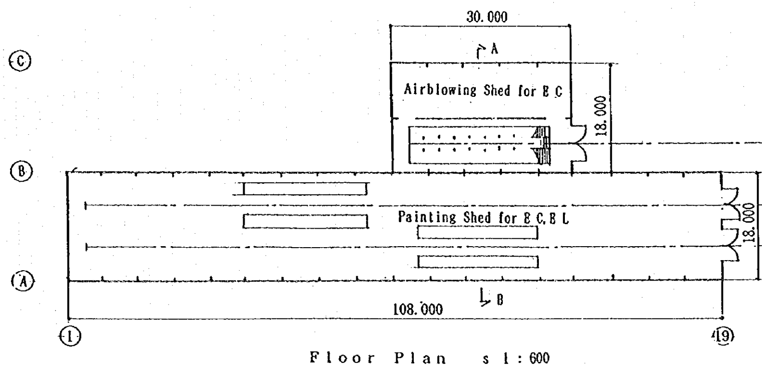
Part Elevation s 1 : 300

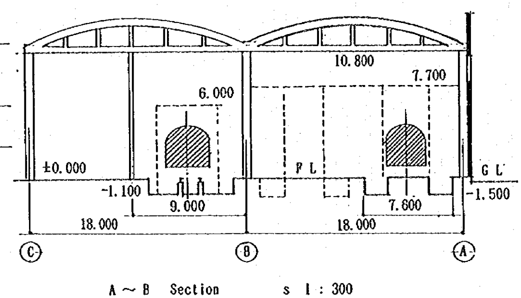
Incoming/Final Inspection Shed for EC, Final Inspection Shed for EL, Electric Apparatus Shop

Fig. 11.2.1-3









Body Shop for EC, Painting Shed for EC/ EL, Air Blowing Shed for EC

Fig. 11.2.1-4

11.2.2 Rough design for construction of electric locomotive repair workshop

(1) Building

1) The existing carbody shop for PC will be converted to carbody shop for EC. Part of the carbody shop for PC (about 300m²) will be remodelled in line with the introduction of lifting jack for inspection.

2) For the final inspection shed for EL, the present electric apparatus shop for EL building will be used with double pits newly constructed (one track for three cars). The vacant adjoining building will be converted to a repair shop for small-size electric parts and so on.

3) The in-coming and final inspection shed for EC will be of steel structure in which 10 cars can be accommodated.

4) The present manufacturing shop of tools will be remodelled for painting and air blow cleaning shop, adding side drain for painting and double pits for air blow cleaning.

Areas of related buildings are shown as under.

Name of building	Area (m^2)
In-coming /final inspection shed for EC	2,160
Body shop for EC	2,880
Final inspection shed for EL	1,728
Electric apparatus shop for EC, EL, DL	720
Painting shed for EC, EL	1,944
Air blowing shed for EC	540
Total area	9,972

(2) Civil and track work

1) A track will be branched off from Tashkent Workshop yard for the access to the final inspection shed.

2) Another track will be branched off from Tashkent Workshop yard for the access to the painting and air blowing shed.

3) Pavement for crossing on these tracks should be carried out at the same time.

Quantities of related facilities are shown as under

Name of work	Quantity
Indoor track	490 m
Outdoor track	450 m
Pavement of crossing	6 set
Inspection pit	224 m
Turnout	3 set
Turntable pit	2 set
Sleeper	800 pcs
Ballast	1000 m^3

(3) Machinery

All the machineries in service of inspection and repairing in Tashkent Workshop at present were examined. The result is shown in the following;

Shop	Quantity
Body shop for locomotives	8
Carbody shop for PC	8
Bogie shop	51
Wheel shop	37
Electric rotating machine shop	79
Electric apparatus shop	7
Transportation , motive power, etc.	13
Overhead travelling crane	30
Total	233

After studying machinery ledger submitted by Tashkent Workshop including the list of overhead travelling crane, some machinery necessary for the inspection and repairs are selected.

Principal machinery and equipment to be used for inspection and repairs of EL and EC are shown as under, and newly installed ones in next page:

Shop	Quantity (Number or Set)	
	Existing Machines	Machines to be installed
Air blowing shed for EC		4
Painting shed for EL/EC		31
In-coming/final inspection shed for EC		7
Final inspection shed for EL		8
Body shop for EC	8	46
Body shop for EL,DL	8	66
Bogie shop	44	18
Wheel shop	31	5
Electric rotating machine shop	64	12
Electric apparatus shop for EL,EC,DL	7	24
Transportation, motive power and etc.		11
TOTAL	162	232

Shop	Machinery	Main function and usage	Quantity
Air blowing shed for EC	Air blow booth	Booth: 5,500(W)×27,000(L)×6,000(H) (mm)	1
	Air compressor	Dust collector, duct 5Kg/cm²	1
	Others		2
	Total		4
Painting shed for EL/EC	Polishing / washing of outer car body	Two each for cleaning and painting	1
	Lifting-type scaffold	Gondola type for end of carbody	4
	Lifting-type scaffold	for side of carbody	4
	Painting booth	Booth: 9,000(W)×24,000(L)×6,000(H) (mm) Flush type dust collector	2
	Painting equipment	Automatic reciprocal type	4
	Painting spray	Airless	6
	Drying booth	4,500(W)×22,000(L)×6,000(H) (mm) Steam heater, Heated wind circulation type	2
	Traverser		1
	Vehicles draw gear	Chain type	2
	Lifting-type scaffolding car	0.5 t	2
	Others		3
	Total		31
In-coming/final inspection shed for EC	Withstand voltage tester	50KV	1
	Overall circuit testing apparatus for EC	Unit test. Multiple – unit test	1
	Direct current power source facilities	Power source outside car	1
	Air compressor	10Kg/cm²	1
	Wheel load measuring apparatus		1 1
	Indication of hot line / safety devices		1
	Other		1
	Total		7
Final inspection shed for EL	Withstand voltage tester		1
	Overall circuit testing apparatus for EL	Partial test. Multiple – unit test	1
	Direct current power source facilities		1
	Air compressor	10 Kg/cm²	1
	Wheel load measuring apparatus		1
	Lifting type scaffolding car		1
	Indication of hot line / safety devices		1
	Other		1
	Total		8

Shop	Machinery	Main function and usage	Quantity
Body shop for EC	Setting/removing equipment of under floor equipment of car	Battery type	4
	Automatic coupler equipment for setting/removing	Battery type	1
	Automatic coupler equipment for setting/removing of buffer	Battery type	1
	Lifting-type scaffolding car	Battery type	3
	Bogie transport equipment		2
	Working stage for roof	Folding type 1,000(W)×22,000(L) (mm)	6
	Carrier for parts	Battery type with capacity of 1 ton loading	2
	Bending machine		1
	Bending roller		1
	Bolt screw cutting machine		1
	Screw cutting machine for pipe		1
	General purpose grinder	Φ of grindstone 400mm	1
	Band sawing machine	For wood work	1
	Wood working circular sawing machine	For wood work	1
	Planing & molding machine	For wood work	1
	Tenoning machine	For wood work	1
	Dust collecter	For wood work	1
	Lifting jack	15t	8
	Accommodation bogie	Each of M/T car	6
	Bogie turn-table	Electric driving type, Φ8m includ' bogie rail	2
	Lifting hook	For accommodation bogie	1
	Total		46
Body shop for Locomotive	Car-body trestle	1,800mm(H),25ton with casteres 4/each-locomotive	48
	Setting/removing equipment of under floor equipment of car	Battery type	2
	Lifting-type scaffolding car	Battery type	6
	Shearing machine	Guilloting type	1
	Painting booth of parts		1
	Painting spray	Airless	2
	Electric welding machine		2
	Pipe bender		1
	Carrier of parts	Battery type 1t	3
	Total		66

Shop	Machinery	Main function and usage	Quantity
Bogie shop	Parts cleaning equipment	With oscillator	1
	Painting booth	Bogie frame, etc.	1
	Painting spray	Airless	2
	Magnetic flaw detector		1
	X-ray flaw detector		1
	Air breake valve tester		1
	Air compressor	For air break valve tester	1
	Assembly equipment of bogie and wheel-set		1
	Equipment of wheel-set rotating tester	For EC	2
	Tester of coil spring		1
	Metal sawing machine		2
	General purpose grinder	Φ of grind stone 400mm	2
	Electric welding machine		2
	Total		18
Wheel shop	Magnetic flaw detector with small gear		1
	Bearing inner race induction heating Equipment		1
	Journal roller bearing cleaning machine	With oscillator	1
	Grease filler		2
	Total		5
Electric rotating machine shop	Amature tester	Electrical characteristics test equipment	1
	Magnetic-frame tester	Electrical characteristics test equipment	1
	Traction motor load test apparatus		1
	Traction motor no load test equipment		1
	Terminal heat resistance test equipment		1
	End cover of motor washing equipment	With oscillator	1
	Carbon brush spring test		1
	Ultrasonic flaw detector	For armature shaft	1
	Parts washer	With oscillator	1
	Pinion heater equipment		1
	Magnetic flaw detector	For pinion	1
	Air compressor test equipment		1
	Total		12

Shop	Machinery	Main function and usage	Quantity
Electric apparatus shop	Pantograph testing devices		1
	Spring testing machine	For pantograph spring	1
	Lightening device tester		1
	Protective device tester		1
	Main-controller testing machine		1
	Main rectifier operating tester		1
	Small-relay tester		1
	Contactless relay tester		1
	Electro-pneumatic change valve test equipment		1
	Washing equipment for air-filter		1
	Filtering slab drying oven		1
	Large current relay test equipment		1
	High speed circuit breaker testing machine		1
	Pneumatic circuit breaker testing machine		1
	Jumper couple tester		1
	Speedometer tester		1
	Voltage/current test corrector		1
	Tap changer test equipment		1
	Withstanding voltage tester		1
	Breaker tester		1
	Battery charger		1
	Battery tester for charge/discharge		1
	Metal sawing machine		1
	Other		1
	Total		24
Transportation, motive power, etc.	Traverser		1
	Shunting engine		1
	Fork-lift truck	Diesel 3t	1
	Fork-lift truck	Diesel 2t	1
	Fork-lift truck	Diesel 1t	2
	Carrier of parts	With battery	2
	Etc.		3
	Total		11
Ground Total			232

(4) Utility facilities

Utility facilities to be installed are shown as under

Name of work	Quantity
Steam pipe line	1
Compressed air pipe line	1
Water-supply pipe line etc.	1

(5) Electric facilities

1) Catenary and transformer with the capacity of 25 kv will be installed for the incoming / final inspection shed for EC and final inspection shed for EL.

2) Catenary over the track line adjacent to the shop will be installed for trial run of out-going EL and EC.

3) Lighting facilities will be installed for inspection and repair pits.

Name of work	Quantity
Power receiving facilities	1 set
Lighting for pit	1 set
Overhead catenary	1790 m

11. 2.3 Pollution control

(1) Introduction

At present, the Tashkent Workshop has following conditions with regard to the environmental issue:

- The water consumption in the Tashkent Workshop is about 80% of the maximum permissible one;

- The Tashkent Workshop has a wastewater treatment system, which does not have sufficient capacity to reduce the contamination to the permissible level. The concentration of oil products in the treated wastewater from the Tashkent Workshop to the municipal sewage system passes the maximum permissible level. The Tashkent Workshop is given a grace in respect of paying fine because of constructing a new wastewater treatment system;

- A wastewater containing oil products occurs in the process of washing bogie frames and other parts during repairing DL. Acidic and alkaline wastewater, which contains heavy metals, occurs in the plating workshop;

- Principal sources of air contaminants are the foundry factory and its relating facilities. Main contaminants from them are dust and carbon monoxide. The concentration of dust sometimes passes the maximum permissible concentration on the border of Tashkent Workshop;

- Other sources of air contaminants are:
    testing room of diesel locomotives --- dust, CO, NOx, and SO_2
    boiler room --- dust, CO, NOx, and SO_2
    painting facilities --- paint-emulsion and solvents
    air blow cleaning facilities --- dust
    machine tool facilities --- dust;

- Relating to solid waste, metals, glass, oil products and so on are recycled. But a part of paper and cloth, slag, rubber, construction wastes, domestic wastes and yard wastes are carried to a municipal final disposal place. In addition, sludge which occurs in the process of wastewater treatment is also carried to a municipal final disposal place; and

- Sources of noise are the foundry factory and its relating facilities, machine tools and so on.

Measures against environmental pollution are taken for facilities directly related to this EL and EC repair workshop, and some recommendations are mentioned for facilities not directly related to this project.

(2) Water Consumption

If the domestic water consumption is in proportion to the number of employees, it is estimated that the domestic water consumption in the Tashkent Workshop will not greatly change from the year1995 to 2010 because the number of employees will be almost constant.

With respect to the industrial water consumption, the following two parts are separately considered:

- the part directly related to the repair work of locomotives and that in boiler; and
- the part related to the other facilities (for example, the foundry factory)

In future, it is estimated that the latter will be constant, and that the former will be in proportion to the number of DL, EL and EC repaired in Tashkent Workshop. The total maximum permissible consumption for the Tashkent Workshop from groundwater and municipal water supply system is 5,460 m^3/day. The part directly relate to the repair work of locomotives and that in boiler is 1,020 m^3/day. The sum of the other part of the industrial and domestic consumption is 4,440 m^3/day. If the water consumption is 80% of the maximum permissible water consumption for each item at present, the former is 820 m^3/day and the latter is 3,550 m^3/day. After the construction of the new wastewater treatment facility, the new addition of reusing treated water will reduce the consumption of 1000 m^3/day of water. The number of DL, EL, and EC to be repaired in the Tashkent Workshop from the year 1995 to 2010 is shown in Table 11.2.3-1.

In the year 2010 (the same level of electrification in 2005) the total water consumption will be 3846 m^3/day, which is below the level of the present water consumption. Therefore, the groundwater consumption will also decrease, and then the possibility of subsidence will be small.

Table 11.2.3-1 UTJ's Estimated Car Number and that to be Repaired

Year		1995	2000	2005	2010(the same level of electrification as in 2005)	2010(80% electrification)
Estimated Car Number	DLM	445	414	344	385	95
	DLS	313	313	313	313	313
	EL	138	157	297	330	620
	EC	66	162	188	220	220
	Total	962	1046	1142	1248	1248
Estimated Number of Car to be Repaired	DLM	99	92	76	86	21
	DLS	42	42	42	42	42
	EL	0	0	50	55	104
	EC	0	0	31	40	40
	Total	141	134	199	223	207
Relative Estimated Number of Car to be Repaired when that is one in 1995		1.00	0.95	1.41	1.58	1.47

(3) Wastewater Treatment System

Though sixty tons of oil products per year are recuperated in the present wastewater treatment facility, the concentration of oil products in the treated wastewater is about 60 mg/l, which surpasses the maximum permissible concentration toward the discharge into the municipal sewage system.

The construction of a new wastewater treatment facility is one of the most important projects planned for the Tashkent Workshop. Now, the construction is interrupted, but it is said that it will be completed by the year 1999. The outline of this new wastewater treatment system including the water supply system is shown in Fig.11.2.3-1.

A1, A2, ---, and A18 are workshop units in which water is supplied and wastewater is produced. B1 and B2 are the control units of circular water supply system such as cooling water. C1, C2, ---, and C5 are following wastewater treatment facilities:

- C1 is the wastewater treatment facility in which the wastewater from the plating workshop (A18) and the workshop of replenishing into battery (A17) is treated (acidic-alkaline wastewater including heavy metals);
- C2 is the treatment facility for the wastewater with oil products;
- C3 is the treatment facility for rain water;
- C4 is the treatment facility for the wastewater from the foundry factory and its relating facilities and the treated water is reused in the foundry factory and so on; and
- C5 is the treatment facility for the cleaning water used in the repair workshops and the treated one is reused.

This wastewater treatment system was approved as a good one by the State Committee of Nature Protection.
The present water flow for the Tashkent Workshop is shown in Fig.11.2.3-2.

The water is supplied from the wells (from the groundwater) and the municipal water supply system. The industrial water is principally supplied from the groundwater, and used as washing equipment, re-supplying to the circular water supply system and so on. High contaminated industrial wastewater is pre-treated in the present wastewater treatment system and then is drained into the municipal sewage system. Low contaminated industrial wastewater is directly drained into the municipal sewage system like the domestic wastewater. One part of rain water also enters into the municipal sewage system.

The water flow for the Tashkent Workshop after the construction of a new wastewater treatment facility is shown in Fig.11.2.3-3.
Utilization of precipitation as industrial water and reuse of wastewater treated in C4 and C5 will reduce the water consumption to 75% level of the present one. The quality of the wastewater treated in C1, C2 and C3 will become better, and a burden to the municipal sewage system will be reduced.
The flowchart of the acidic-alkaline wastewater treatment facility (C1) is shown in Fig.11.2.3-4.

After the wastewater is homogenized and neutralized, ferric ions produced through electrode reaction are coagulated as ferric hydroxide, on which other heavy metal compounds are adsorbed. After the coagulation of ferric hydroxide (the formation of floc), the wastewater is sent into a dissolved-air flotation system. In this system air is dissolved in the wastewater under a pressure of several atmospheres, followed by release of the pressure to the atmospheric level.

The floc of ferric hydroxide is floated with fine air bubbles produced in the dissolved-air flotation system and is collected as a sludge by skimmer mechanism. The sludge contains a lot of water, so it is dehydrated and concentrated. The treated wastewater is filtrated with polyurethane filter, and is sent into the municipal sewage system. The quantity of wastewater from the plating workshop was 677 m^3/day in the original plan, but the quantity in the 1995 data was 50-60 m^3/day. Passing more than ten years since planning, the large discrepancy may occur.

For this reason, it is necessary to review the quantity of wastewater treated in the C1 facility. The recovery and effective utilization of raw material and the minimization of wastewater for the plating factory is well studied. Though the try of reducing waste and wastewater produced in the plating workshop may already have done, the method of minimizing waste and wastewater is described in Appendix 11.2.3-1.

The flowchart of the treatment system for the wastewater which contains oil products (C2) is shown in Fig.11.2.3-5.

Sands and silts adsorbed by oil products are eliminated as sludge with a cyclone separator, and then the treated wastewater is sent into multi-chamber-dissolved-air flotation system. Walls of chambers and fine air bubbles help the separation of oil products from the wastewater. Sludge deposited on the bottom of the flotation system are collected, and scum floated on the surface of the wastewater is also collected with skimmer mechanism. Oil products are further separated from the collected scum.

Some part of the treated wastewater is saturated with air and returns into the multi-chamber-dissolved-air flotation system. The other part of the treated water is purified with the filter, and then the filtrate is sent into the municipal sewage system. The treated volume of this type of wastewater may be reconsidered. A treatment system for the wastewater containing oil products, which is often used in Japanese locomotive repair workshops, is shown in Appendix 11.2.3-2.

The flowchart of the treatment facility for rain water (C3) and of the treatment facility for the wastewater from the foundry factory (C4) is shown in Fig. 11.2.3-6.

Rain water containing sands, silts and oil products is collected into a collecting tank, sludge separated in the collecting tank is sent into a cyclone separator, and then the sludge is concentrated. The water from the collecting tank is treated with a polyurethane filter to recover oil products. The filtrate is sent into the municipal sewage system or is used as industrial water. The solid component is separated from the foundry factory's wastewater with a cyclone separator, and the purified wastewater is reused in the foundry factory.

The flowchart of the treatment facility for cleaning water (C5) is shown in Fig.11.2.3-7.

After the cleaning water which has been used in the locomotive repair workshops is added with anti-emulsifier, the used cleaning water is sent into a multi-chamber-dissolved-air flotation system. Scum, which is floated from the cleaning water, is separated and is concentrated with a cyclone separator and a centrifugal separator. Treated cleaning water is reused in the locomotive repair workshops again.

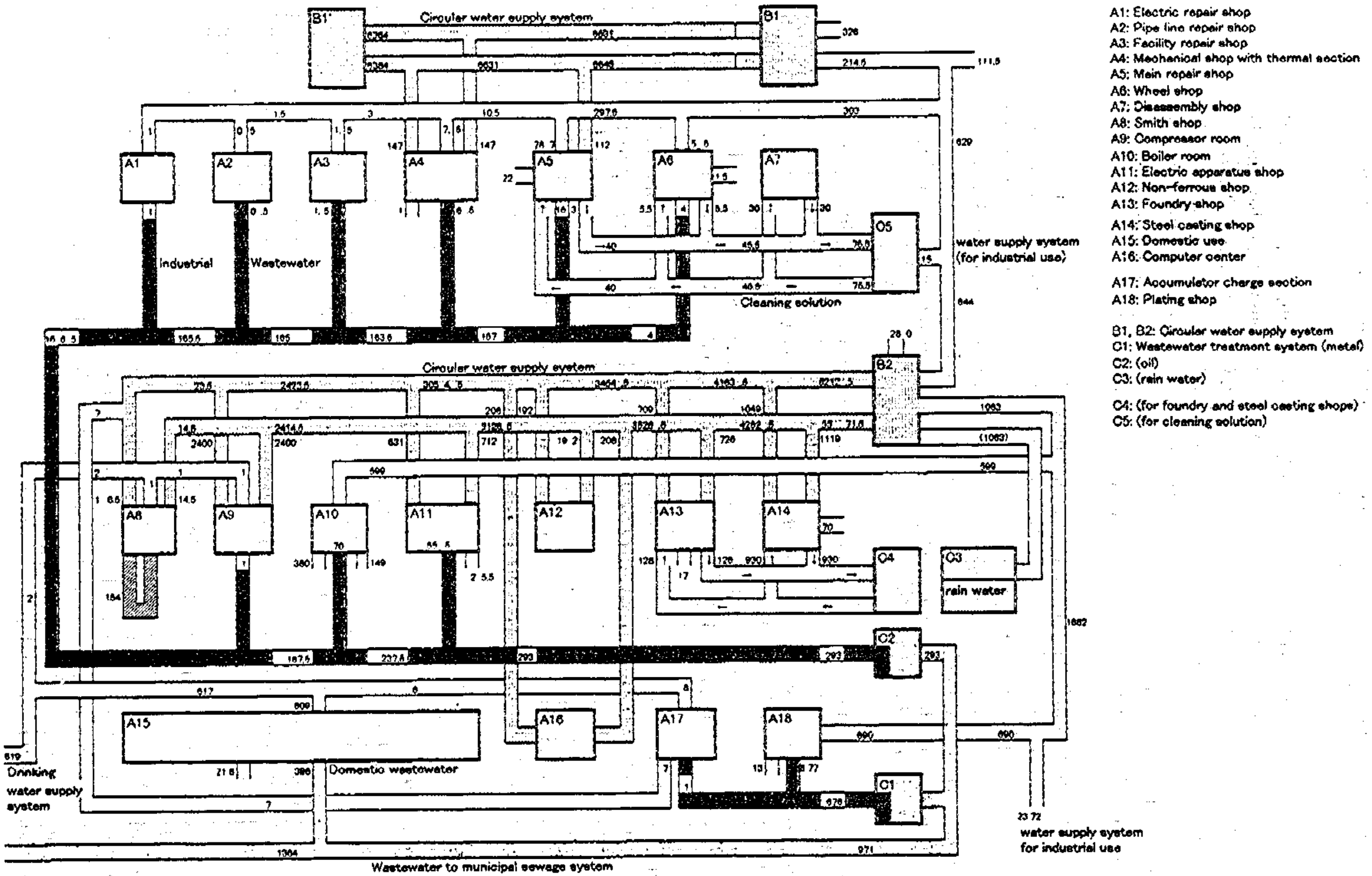


Fig. 11.2.3-1 Outline of New Wastewater Treatment System Including Water Supply System (Source: Tashkent Workshop)

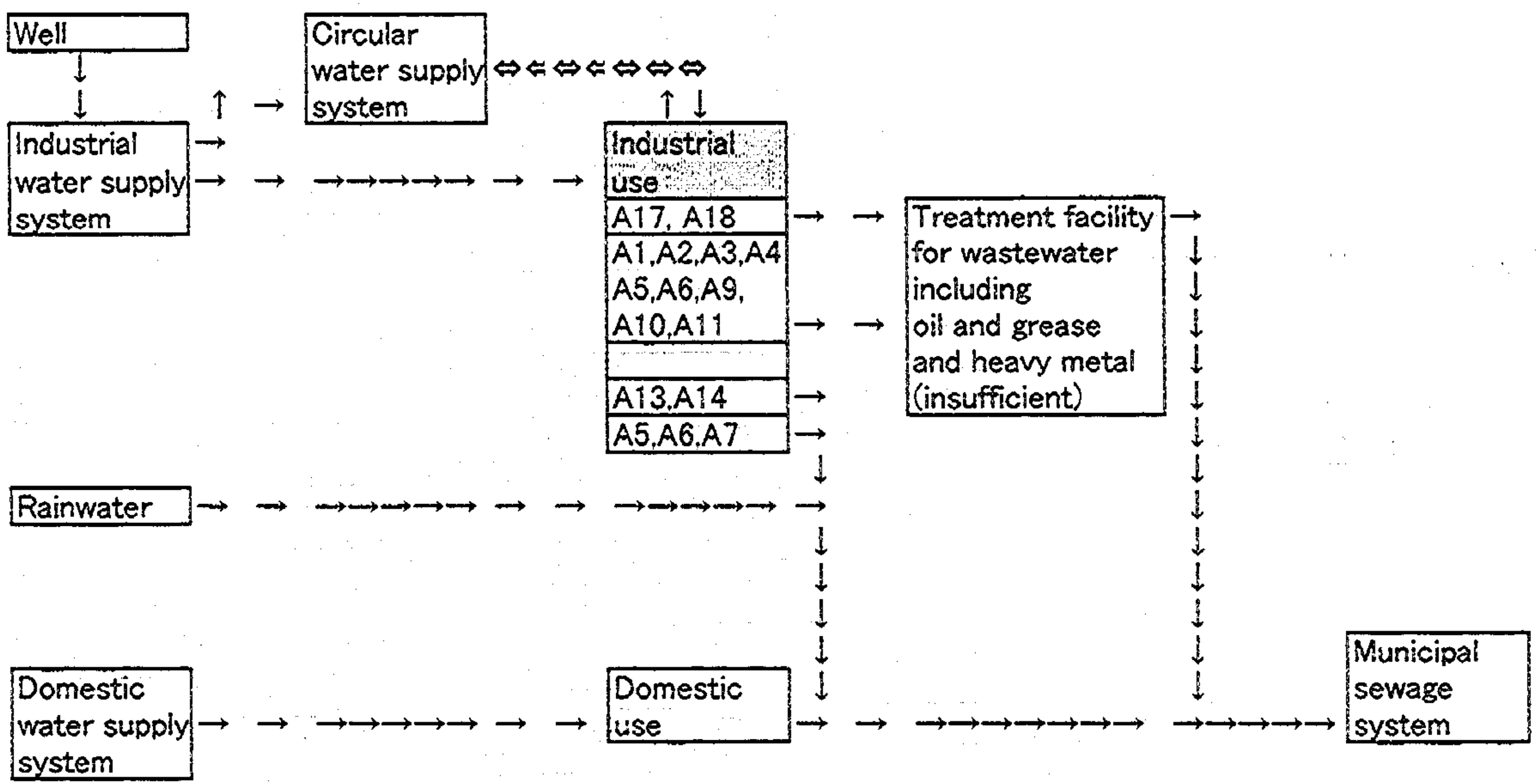


Fig. 11.2.3-2 Present Water Flow for Tashkent Repair Workshop

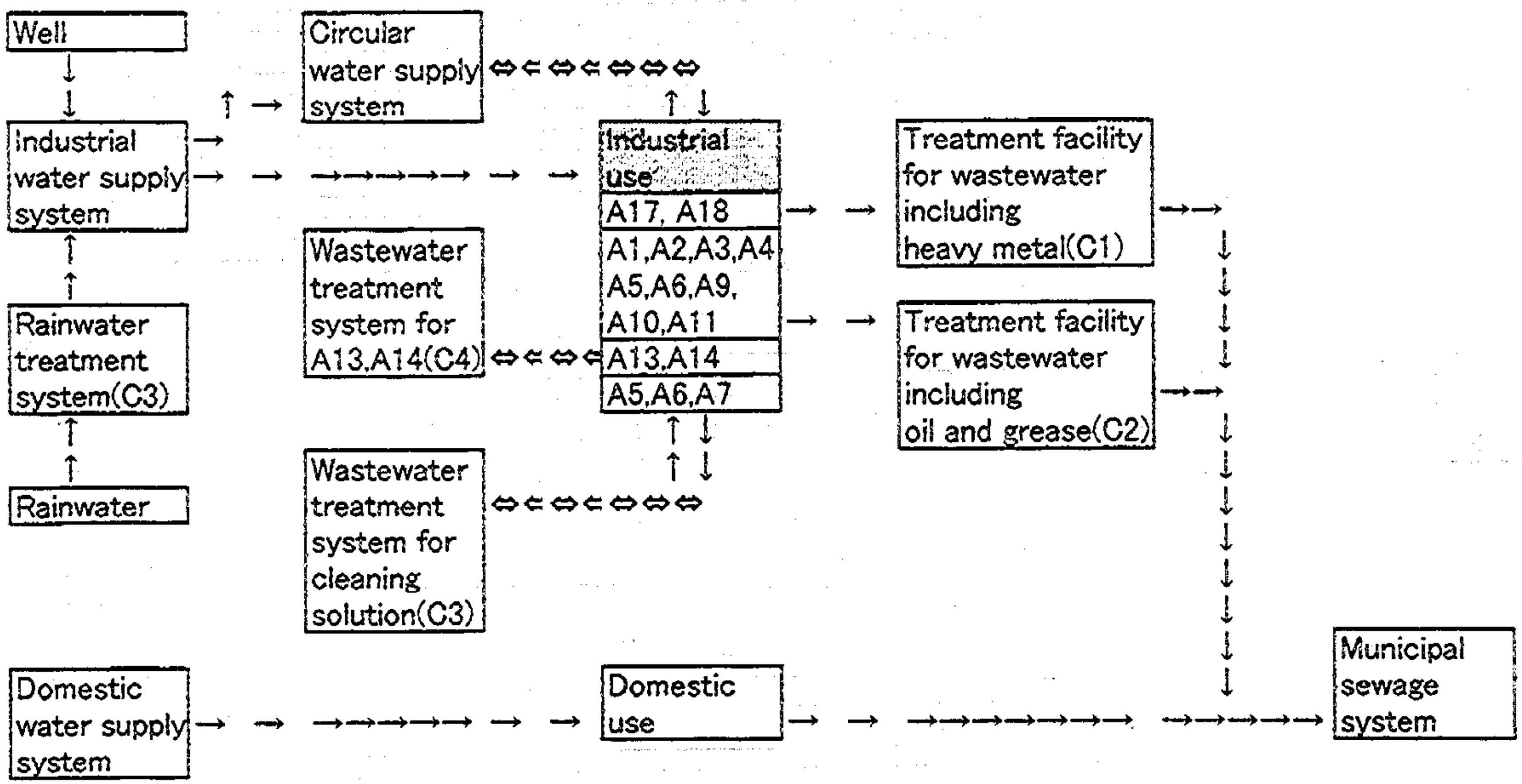
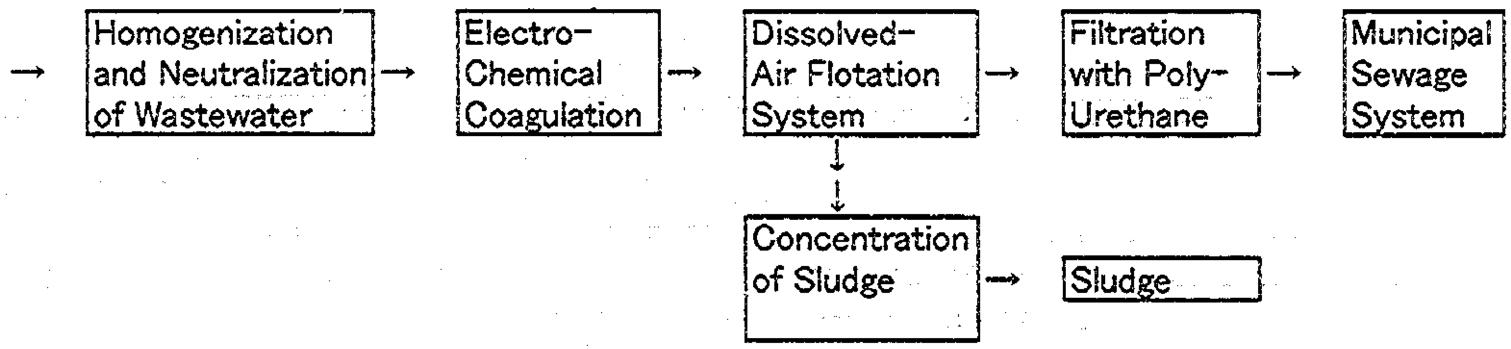
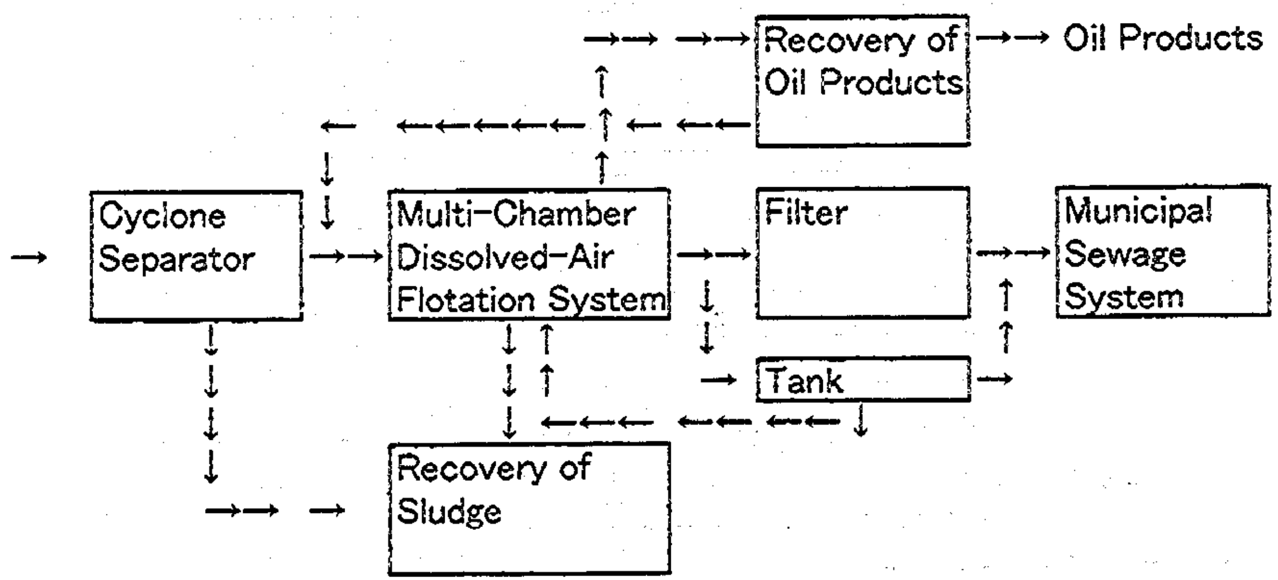


Fig. 11.2.3-3 Water Flow for Tashkent Repair Workshop after Construction of New Wastewater Treatment Facility



1.The wastewater is homogenized and neutralized.
2. Ferric ions are produced through electrode reaction and floc of ferric hydroxide is formed.
3. Floc of ferric hydroxide is floated with fine air bubbles.
4. Treated wastewater is filtrated with polyurethane filter and is sent into the municipal sewage system.
5. Sludge are dehydrized and concentrated.

Fig. 11.2.3-4 Acidic-Alkaline Wastewater Treatment Facility (C1)



1. Sands and silts adsorbed by oil products are separated as sludge with a cyclone separator.
2. Scum are floated in a multi-chamber-dissolved-air flotation system.
3. Sludge deposited on the bottom of this flotation system are collected.
4. Scum floated on the surface of this flotation system are collected and oil products are separated.
5. Wastewater treated with this flotation system are filtrated and are sent into the municipal sewage system.

Fig. 11.2.3-5 Treatment System for Wastewater Containing Oil Products (C2)

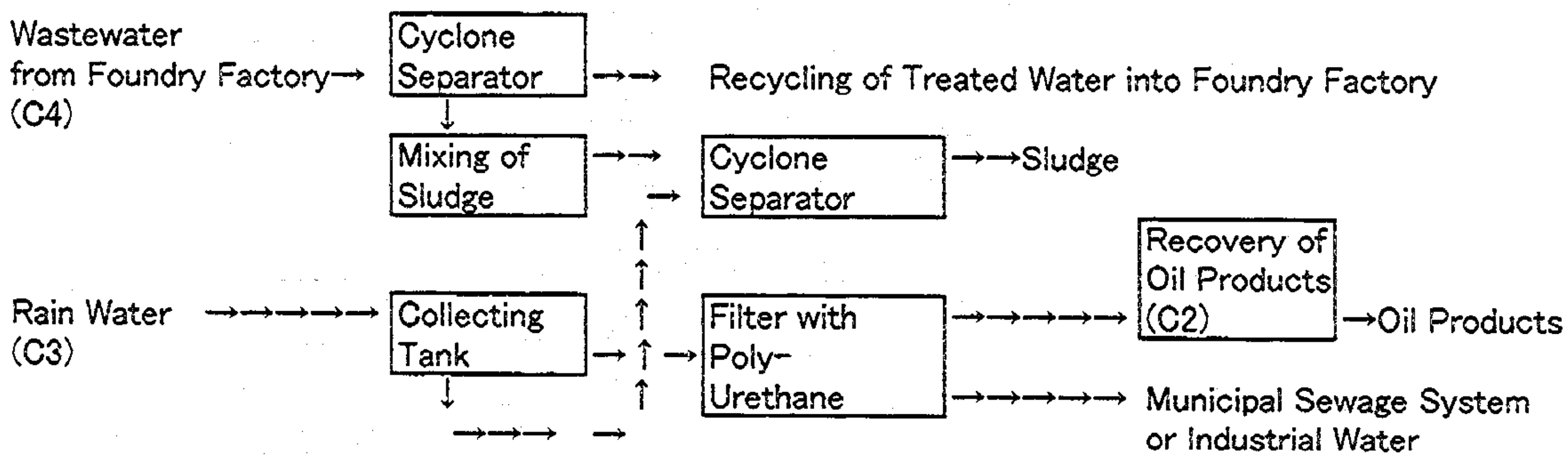


Fig. 11.2.3-6 Treatment System for Rain Water (C3) and for Wastewater from Foundry Factory (C4)

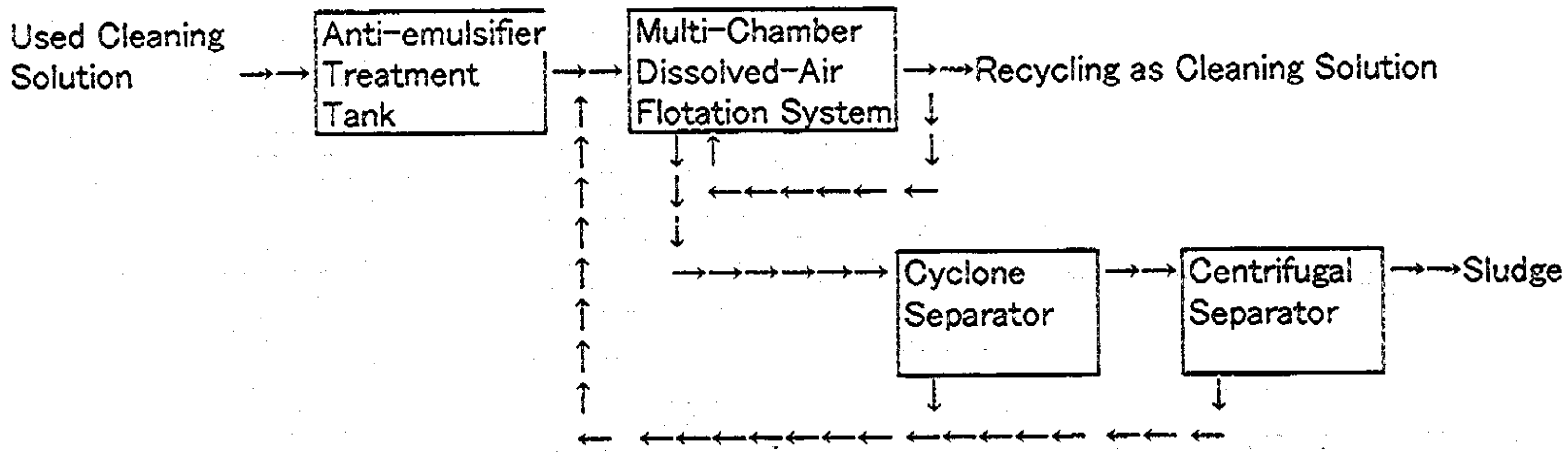


Fig. 11.2.3-7 Treatment System for Cleaning Solution (C5)

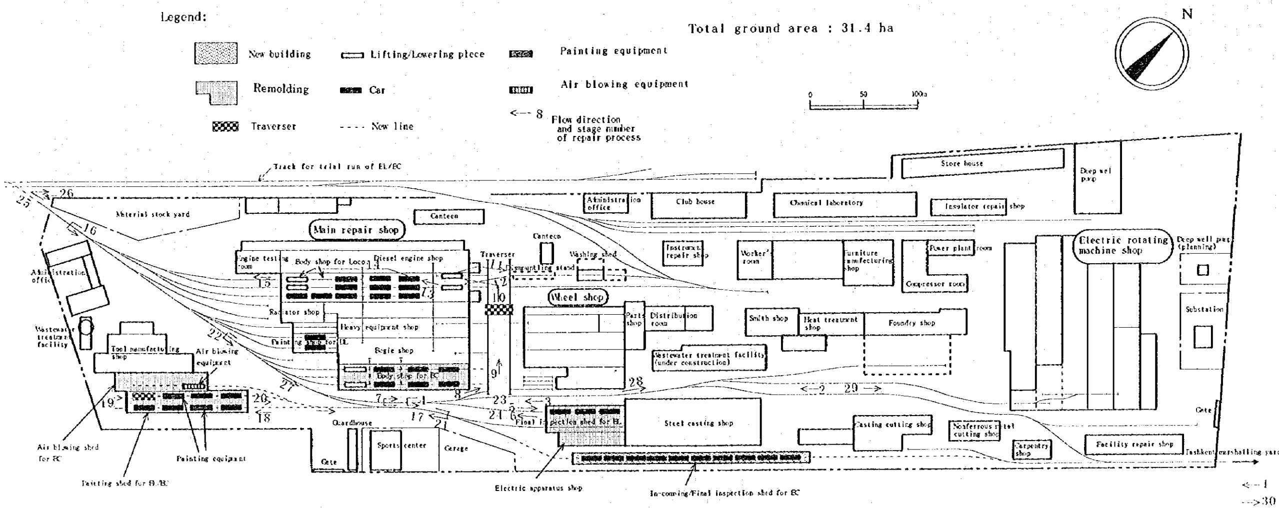


Fig.11.4-2 LAYOUT OF TASHKENT WORKSHOP (Repair process route of EL)

(4) Elimination of Dust from Flue Gas of a New Air Blowing Shed

An air blowing shed is newly prepared in this project. Dusts which occur in the process of air blowing must be eliminated from exhaust gas of this shed. Equipment which is used in the process of eliminating dusts is shown in Appendix 11.2.3-3. A baghouse filter, which is shown in Fig. 2.2 in Appendix 11.2.3-3, is used for the new air blowing shed.

(5) Elimination of Paint-aerosols and Solvents from Exhaust Gas of a New Painting Shed

A painting shed is also newly prepared in this project. Paint-aerosols and evaporated solvents, which are produced in the process of painting, are exhausted as air pollutants. A wet-scrubber is used to eliminate these air pollutants from the exhaust gas of the painting shed. The general explanation on wet scrubbers is done in Appendix 11.2.3-4. Paint-aerosols and evaporated solvents in the exhaust gas of the painting shed are trapped with water which is sprayed from the upper part of a wet scrubber and with packing as shown in Fig.2.1 of Appendix 11.2.3-4 .

Aerosols are treated as sludge, and water-soluble solvents dissolve in wastewater and water-insoluble solvents float on the surface of wastewater. The wastewater is treated in the C-2 wastewater treatment facility.

But it is recommended that used solvents are recovered and then reused in future in order to reduce the air and water contamination with organic solvents. Though organic solvents are captured in the wastewater treatment facility, these organic solvents are mixed ones and are highly contaminated. They are hardly able to be used in any industrial process so that they are disposed as liquid wastes. Solvents should be recovered as near as possible from the source because recovered solvents are less contaminated.

For example, water soluble solvents are recovered with activated carbon after the treatment with wet-scrubber. On the other hand, water-insoluble solvents are recovered from water in the process of decantation before the water is mixed with other wastewater. Furthermore, organic solvent vapor which can pass through the wet scrubber is captured with adsorbents like activated carbon. This is discussed in Appendix 11.2.3-5.

(6) Measures toward Air Pollution of the Tashkent Workshop

The majority of dusts and carbon monoxide which is exhausted at the Tashkent Workshop occurs from the foundry factory and relating facilities. The concentration of dusts on the border of the Tashkent Workshop passes the maximum permissible concentration. This problem should be dissolved by UTJ because this project doesn't directly relate to the foundry factory. Measures toward the emission of dust and carbon monoxide from the foundry factory are:

- Processes or materials are changed to reduce these pollutants;
- Improving the present facility, the reduction of air pollutants is tried. For example, equipment which removes dusts from flue gas (as shown in Appendix 11.2.3-3) is installed like Fig.1 of Appendix 11.2.3-6. Furthermore carbon monoxide is completely combusted and dusts are removed with a equipment as shown in Fig. 2 of Appendix 11.2.3-6; and

- The new factories are constructed with measures towards air pollution.

If the majority of dusts can be recovered from the flue gas, the recovered dusts are recycled in the industrial process to reduce the wastes. And then heavy metals in dusts are concentrated in this process.

It is necessary to install a equipment which removes heavy metals from exhaust gas which occurs in metal finishing processes with machine tools.

At present, both heavy oil and natural gas are used as fuel for the boiler. If natural gas is used more than the present level, the emission of dusts and sulfur dioxide can be reduced.

In plating workshop, dangerous flue gas, such as vapor of acid, hydrogen cyanide, mists of chromic acid and so on, is exhausted. It is necessary to take a measure for each toxic compound.

(7) Measures toward Wastes for the Tashkent Workshop

Glass, metals, oil products, wood, and cardboard are recycled in the Tashkent Workshop. But 22 tons of linoleum, 51 tons of paper, 59 tons of artificial leathers, 61 tons of glass wool, 26 tons of rubber, 65 tons of cloth, 600 tons of slug, 1000 tons of domestic wastes, and 500 tons of construction wastes per year are sent into the municipal final disposal site.

Sludge produced in the process of wastewater treatment is also sent into there. Residual soils produced in the process of construction may be sent into agricultural zones. But it is necessary to check the contamination of residual soils.

Now the reduction of wastes is demanded. The following methods are possible:

- Biowaste (separately collected kitchen waste and green matter) and yard wastes are separated from other wastes and should be treated with the biological treatments such as shown in Appendix 11.2.3-7;
- Processes for wastewater treatment, which reduces the production of sludge as small as possible, should be developed; and
- It is necessary to use a high temperature furnace with which the reduction of paper, cloth, domestic wastes and sludge is done. But it is also necessary to eliminate chlorinated organic compounds in order to prevent from producing dioxins.

(8) Measures against noise in the Tashkent Workshop

At present, the noise from the foundry factory seems to be a little of problem. But this noise doesn't affect sensitive institutions as schools. In this project, several workshops will be constructed or prepared. One of them is a electric apparatus workshop, in which machine tools are operated. The noise from these machine tools is not so large on the border of the Tashkent Workshop because these tools are in the building.

(9) Working Environment

As there are noise and dust problems near machine tools, it is necessary to protect workers from these factors. Workers in the air blowing shed should be protected from dusts, and ones in the painting shed should be protected from solvents. In other workshops, the health and the safety of workers should be considered in various sides.

1) Noise

(a) Reduce the machinery noise from sources as follows:

- One of the main sources of machinery noise is structural vibration caused by the rotation of poorly balanced parts, such as fans, fly wheels, and so on. Measures used to correct this condition involve the addition of counterweights to the rotation unit or the removal of some weight from the unit;

- General cleaning and lubrication of all rotating, sliding, or meshing parts at contact points should go a long way toward fixing the problem; and

- Applying damping materials reduces or restrains the vibrational motion of machines.

(b) In terms of hearing protection, it is preferable to schedule an intensely noisy operation for a short interval of time each day over a period of several days rather than a continuous eight-hour run for a day or two. In industrial or construction operations, an intermittent work schedule would benefit not only the operator or the noisy equipment, but also other workers in the vicinity.

(c) Molded and pliable earplugs, cup-type protectors, and helmets are commercially available as hearing protectors. Such devices may provide noise reductions ranging from 15 to 35 dB. Earplugs are effective only if they are properly fitted by medical personnel. Maximum protection can be obtained when both plugs and muffs are employed. Only muffs that have a certification stipulating the attenuation should be used. It should be noted that protective ear devices interfere with speech communication and can be a hazard in some situations where warning calls may be a routine part of the operation.

2) Air pollution

- Toxic chemicals in the working place should be reduced with ventilation system; and

- If the reduction of toxic chemicals in the working place is insufficient, protective equipment should be used to protect workers from inhalation of toxic chemicals.

(10) Conclusion

1) The following measures against environmental pollution will be taken in this project:

- The removal of dust from the exhaust gas of the new air blowing shed; and

- The removal of paint-aerosol and solvents from the exhaust gas of the new painting shed .

-The removal of wood dust from the exhaust gas of EC carbody shop.

- Others

2) The following measures against already existing environmental pollution will be recommended to be done by the Tashkent Workshop as soon as possible:

- The completion of the new wastewater treatment facilities which is being constructed;

-The solution on the air pollution caused by the foundry shop and its relating facilities.

- Others

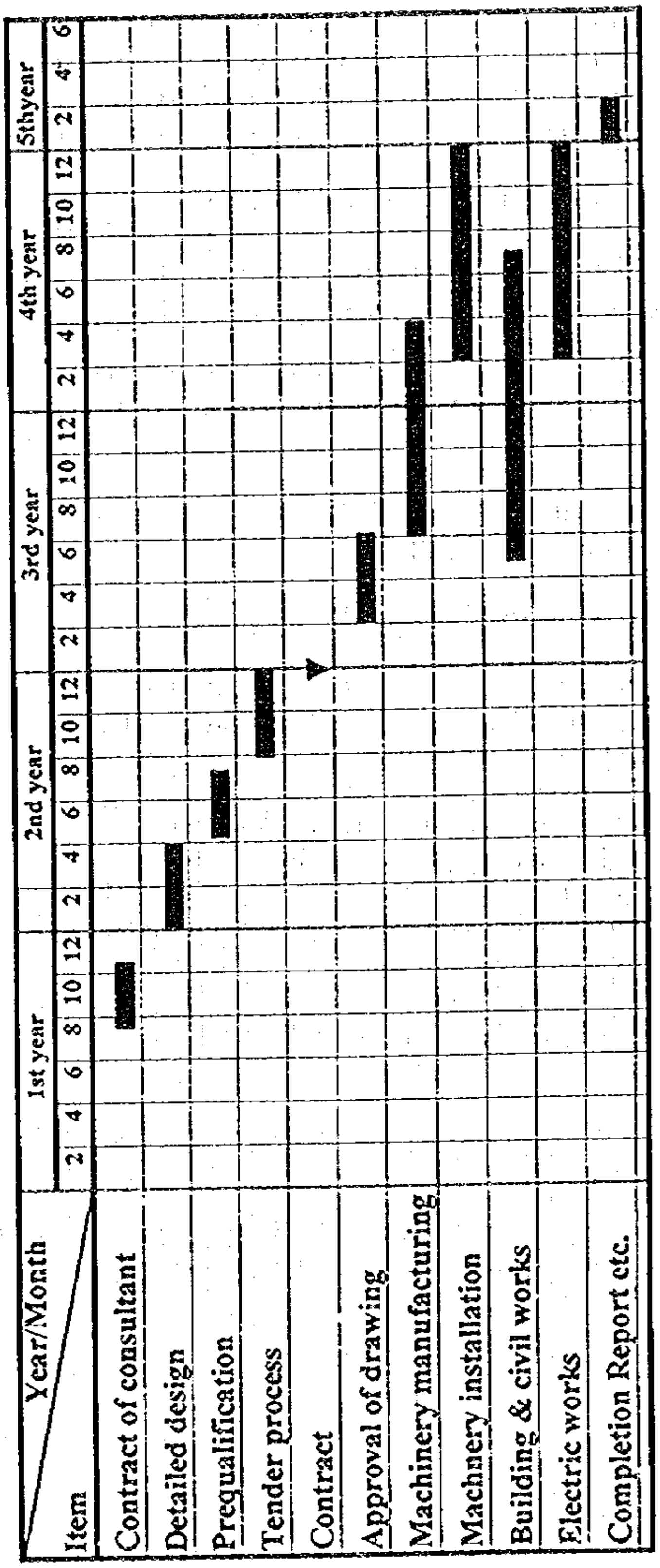
3) It is recommended that the Tashkent Workshop will do the minimization Project on wastewater, wastes and air pollution and will reduce the consumption of natural resources such as water, fuels and so on.

11.2.4 Execution plan

(1) Execution plan of workshop construction

A schedule of workshop construction is as shown in Fig. 11.2.4-1 on the assumption that commencement of construction work would be in the year 2000 and completion in 2001.

Fig 11.2.4.1 Execution plan of workshop construction



(2) Temporary measures of daily maintenance work during construction period

1) In the period of remodeling traverser (2~3 months), as it is impossible to move carbodies directly to the lifting space, cars are conveyed, in the Fig 11.2.1-1 Layout of Tashkent Workshop, from the left side of the lowest line of the body shop for locomotive to the present repair space of entrance side that can accommodate two cars.
The lifting space can be used for storage of car-bodies.

2) In the period of remodeling traverser (2~3 months), as cars are unable to move in the washing shed, the following measures shall be taken;

(a) Temporary cleaning space will be provided in a tent on the left side of the body shop for locomotive in the Fig 11.2.1-1. Cleaning shall be done by manual work for the time being.

(b) Washing will be made with a portable steam generating apparatus (Chemical fluid can be used).

(c) Temporary drainage is prepared.

3) In the period of remodeling traverser(2~3 months), as it is impossible to transfer wheels from the bogie shop to the wheel shop by traverser, trucks or battery cars shall be substituted for it..

4) Work has to be suspended when the electrical apparatus repair shop removes, so installation of an inspection and repair facility for machinery of EL and EC has to be completed before starting the work
In carrying out repairs of DL, it is necessary to keep the sufficient spare parts in hand.

5) Prior to starting remodeling, equipment to be removed in related sheds should be moved away.

6) During construction of new track leading to the new painting and cleaning shops, road traffic in the workshop compound should not be interfered with.

7) Two tracks will be installed for moving bogies between the carbody shop for EC and the bogie shop, and transferring machinery on the bogie shop side should be made,if necessary.

11.3 ESTIMATION OF CONSTRUCTION COST

Construction cost both in foreign and local currency portion is estimated as follows:

Table11.3-1 List of Construction Cost (unit: ¥1,000)

Work Item			Foreign Currency	Local Currency	Total Cost
Construction of Workshop	Building		——	354,000	354,000
	Civil		23,000	98,000	121000
	Machinery	General	1,900,200	81,650	1,981,850
		For environmental problems	723,300	16,700	740,000
	Utility Facilities		——	26,000	26,000
	Transportation equipment		134,500	6,650	141,150
	Electric Facilities		15,000	32,000	47,000
	Sub Total		2,796,000	615,000	3,411,000
Consulting Service (10%)			341,000		341,000
Total			3,137,000	615,000	3,752,000
Contingency (5%)			157,000	31,000	188,000
Grand Total			3,294,000	646,000	3,940,000

The description of cost are described as under.

(1) Building

Table11.3-2 List of Building Construction Cost (unit: ¥1,000)

Work Item	Foreign Currency	Local Currency
In-coming /final inspection shed for EC	-	129,000
Body shop for EC	-	101,000
Final inspection shed for EL	-	17,000
Electric apparatus shop	-	25,000
Painting shed for EC, EL	-	68,000
Air blowing shed for EC	-	14,000
Total	-	354,000

(2) Civil and track work

Table 11.3-3 List of Civil and Track Work Cost (unit: ¥1,000)

Work item	Foreign Currency	Local Currency
Track installation	23,000	46,000
Leveling for ground	-	24,000
Double Pit etc.	-	28,000
Total	23,000	98,000

(3) Machinery

Table 11.3-4 List of Machinery Cost (unit: ¥1,000)

Work item	Foreign Currency	Local currency
Body shop for locomotives	139,000	1,000
Body shop for EC	322,000	16,000
Air blowing shed for EC	115,000	5,000
Painting shed for EL/EC	750,000	21,000
Final inspection shed for EL	89,000	4,000
In-coming / final inspection shed for EC	135,000	6,000
Bogie shop	134,000	6,000
Wheel shop	51,000	2,000
Electric rotating machine shed	303,000	9,000
Electric apparatus shop for EL, EC, DL	439,000	9,000
Transportation and motive power and etc.	281,000	26,000
Total	2,758,000	105,000

(4) Utility facilities

Table 11.3-5 List of Utilities Cost (unit: ¥1,000)

Name of work	Foreign currency	Local Currency
Steam pipe line	-	5,000
Compressed air pipe line	-	5,000
Water-supply pipe line etc.	-	16,000
Total	-	26,000

(5) Electric facilities

Table 11.3-6 List of Electric Facilities Cost (unit: ¥1,000)

Name of work	Foreign Currency	Local Currency
Power receiving facilities and distribution lines, catenary etc.	15,000	29,760
Indoor lighting	-	2,240
Total	15,000	32,000

11.4 REPAIR PROCESS ROUTE FOR EL AFTER WORKSHOP CONSTRUCTION

After construction of EL repair workshop, in-coming Els to be repaired will pass the repair process route shown in Fig 11.4-1 and Fig 11.4-2, during repair in the workshop.

CHAPTER 12 WORKSHOP MANAGEMENT PLAN

Management of enterprise means that the three composing elements of enterprise, man, materials and money shall be effectively utilized to attain its purpose.

Management plans should be, for this purpose, planned on what, when, who and how to do. As far as the rolling stock repair workshop is concerned, essential points of management will be summarized as follows:

(1) To secure the amount of work suitable for the workshop scale, and to keep increase of income.

(2) To save workshop expenditure and to increase the profit.

(3) To secure the quality of repaired rolling stock and not to disturb rolling stock operation because of repair troubles.

(4) To keep the working environment of workshop in good condition for the employee.
To realize the above mentioned four items, several control plans shall be settled as action programs of management plans.
Relations between the four items and several control plans are shown in Table 12.1

Table 12.1 Control Plans for Management

Points of management	Main control plans for management
(1)	Medium or long term management plan
(2)	Financial management, Material control
(3)	Quality control, Process control, Machinery and equipment control
(4)	Safety control, Sanitary control for worker and working Environment

12.1 MEDIUM OR LONG TERM MANAGEMENT PLAN

On the above mentioned "amount of work suitable for workshop scale", the fundamental matters of management like amount of work and workshop scale, would be necessary to be examined standing in long term points of view to some extent, but considering the difficulty of forecasting rolling stock repair market under keen and rapid change of socioeconomic conditions, target term of the long term management plan could not help being within five years at best.

Settlement and practice of management plans in wider range than in " Plan for developing allied production Uzbek Rail Repair Machinery" explained during the site study at the Tashkent Repair Workshop, with necessary revision of them, are unavoidable for workshop management.

Several objects of medium or long term management plan would be shown as under;

- Rolling stock maintenance plan based on transport demand forecast
- Improvement of workshop management and operation system
- Improvement of technical situation
- Training of personnel
- Improvement of total quality control in the workshop
- Improvement of safety and sanitary conditions for personnel
- Improvement of financial situation
- Others

12.2 FINANCIAL MANAGEMENT

Financial problems to be improved in the workshop are as under;

(1) At present, work volume have fallen to about a half of that in the past busiest period, and wages for non-working employee are being paid in according with the law. This makes the workshop profit decrease unfavorably.

Project increasing measures should be positively taken, utilizing work waiting time, such as repair of foreign locomotives, manufacture of parts with technical faculty or potential in the workshop, technical training of personnel and so on.

(2) Unbelievably, many foreign repaired locomotives had been kept in the workshop for several months , waiting out-going, because of no payment, during the site study at the workshop. Oppositely, it was explained that repaired electric locomotives of UTJ were kept in foreign countries because of UTJ's no payment.

Easily taking back and operation of repaired locomotives with resourceful financial measures should be taken each other.

(3) It is necessary that analysis of cost, profit and operation rate or productivity should be held to decrease cost and to increase profit.

Relation between cost and profit is shown as under;

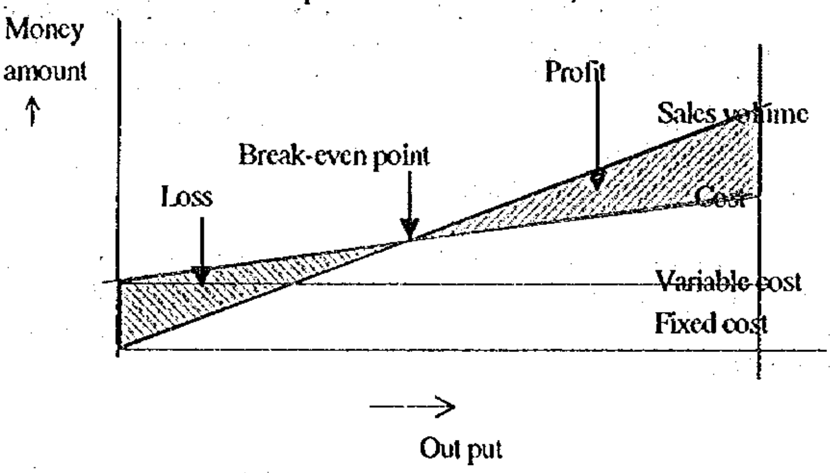


Fig 12.2-1 Cost & Profit

12.3 MATERIAL CONTROL

Materials and parts for repair with necessary quality to rolling stock repair must be procured and supplied timely with necessary, cheep as much as possible, and make process of repair work smooth progress for fulfillment of maintenance plan.

During the site study at the Tashkent Repair Workshop, repairing wheel-sets of diesel locomotive waiting for their parts were seen, improvement or more suitable practice of material control would avoid such kind of undesirable case.

Material control, quality control and financial management are in mutually influenced relations as shown in Table 12-2, and as mentioned

Contents of material control are roughly classified as under;

(1) Material planing

Assumption of necessary quantity, required date, required days for procurement and proper stock, respectively by item, review of the budget for materials etc. shall be done to make the plan.

Past records for repair work of individual rolling stock, periodical comparison between actual delivery results and planned ones, and revision of plans are important for further accurate plans.

(2) Procurement

In accordance with the material plan, fix their specification for quality, quantity, delivery date etc. by item, contract with supplies and procure them. Special attention should be paid to quality, delivery date and economic matters. Saving the procurement expenditure will greatly contribute to the profit.

(3) Storage and distribution

At the receipt of materials, receiving inspection shall be exactly carried out to the contract conditions.

Stored material should be prevented from quality deterioration, shortage and surplus in number, by keeping them in sound condition for quality and grasping their stored number.

Order-deliver situation control of stored materials is specially called " Inventory Control", and that of material planning and procurement " Procurement Control".

12.4 QUALITY CONTROL

Repaired rolling stock are required to be operated until next repair at least, without disturbing train operation, service interruption of passenger and freight transport, because of repair-related failures and troubles. For this purpose, quality control to repair-in the appropriate quality into rolling stock occupies the important part among workshop management. In Japan, the method of quality control called " Total Quality Control (T.Q.C) " has been widely adopted in the industrial field with effective results.

Applying T.Q.C. to rolling stock maintenance work in the workshop, the whole system of quality control which can acceptable agreeable quality to relevant regulations, standards and specifications of maintenance, namely quality control organization, function, procedure etc. should be settled, kept and improved. Specific items are shown as under;

(1) Organization

Fix the organization for quality control and clearly show directing lines, duty, responsibility and authority etc.

(2) Function of quality control

To keep mutual close contact, with related sections of technology, repair, inspection and materials, and to promote quality control work effectively, settle the following functions;

1) Function of promoting standardization

2) Function of confirming the exact execution of work in each section

3) Function of executing quickly and appropriately, the examination on troubles found in and out, and corrective measures for them.

4) Function of executing appropriate management for subcontract and procurement.

(3) Execution of quality control

Settle the following process and sufficiently inform them to related persons

1) Administration of specifications, standards, drawings etc.

Keeping, revision, distribution and withdrawal shall be suitable conducted.

2) Control of environment

Settle the administration process of specially important environment for quality control, such as maintenance work environment, testing one, inspection one, storage one etc. and always keep them in good conditions.

3) Administration of machinery, facilities and equipment

Settle the administration procedure for authorization, correction and inspection of machinery, facilities and equipment necessary to keep the required quality of rolling stock maintained and always to keep them in good conditions.

4) Administration of worker's skill

(a) Nominate dedicated workers to special jobs necessary for quality control.

(b) If necessary, acquisition date and the term of validity of worker's qualification shall be clear and kept.

(c) Carry out necessary pre-planned training for workers, on standards, specifications, work method and quality control etc.

5) Administrations of subcontract and procurement

(a) Settle and execute administration procedure for procurement of materials and subcontract of partial work, necessary to keep the required quality.

(b) Among the above administration procedure, quality confirmation procedure for materials or partial work and administration procedure of subcontractor's quality control.

(c) At receipt of materials procured or subcontracted, acquire, if necessary, information showing their quality characteristics.

6) Inventory control
Inventory control can be mentioned, as a part of material control, as under ;

(a) Store materials, parts and repaired apparatuses without deteriorating required quality in storing places concerned.

(b) Settle administration procedure of materials and parts for which special storage conditions are necessary to quality control.

(c) Settle storage and distribution procedure for parts and apparatuses passed finishing inspection.

7) Repair work process control

(a) Settle and execute the suitable repair work procedure containing quality securing, repair work stabilization, time schedule of repair work and so on.

(b) If necessary, prepare repair work standards etc. for the work in the whole process.

(c) As for the above mentioned (a) and (b), fix necessary items of important orks to be confirmed after execution.

(d) Settle administration procedure of specially important working conditions for quality control in repair work process.

(e) Fix disposal and correcting procedure of inferior goods during the whole process.

(4) Test and inspection
Confirm repaired rolling stock to be in accordance with standards, specifications, drawing etc. and always control their quality.

1) Test and inspection shall be carried out in the following cases;

(a) When the materials, parts, processed goods etc. subcontracted or procured, are received. (Acceptance inspection)

(b) When necessary for quality confirmation during the repair work process. (Intermediate inspection)

(c) After repair work finished. (Final inspection)

2) Settlement of inspection standards etc.
Work standards and judgment standards of test and inspection shall be settled in advance.

3) Indication of inspection
Parts and rolling stock which have passed finishing inspections shall be indicated.

4) Procedure for rejected goods which had not passed inspection shall be settled in advance.

(5) Administration of information on quality

1) The following records and statistics concerning quality control should be utilized inside and outside the workshop for improvement of quality control system.

(a) Records and statistics of control for specially important work condition during the maintenance process.

(b) Results of test and inspection mentioned in (4) 1) and other quality statistics necessary to quality control.

(c) Records of examination on causes of inspection failure and corrective measures during the maintenance process.

(d) Records and statistics of causes, examination and corrective measures for troubles after shop-out

2) Maintenance records of rolling stock
The following items shall be recorded for rolling stock in charge, and be utilized for operation, maintenance work, preparation of materials and parts.

- Date of manufacture
- Name of assigned depot
- Running kilometer
- Date of maintenance
- Main contents of maintenance work
- Main parts, apparatus exchanged
- Other reference to maintenance

Assumption of future maintenance work, maintenance date by rolling stock, content of maintenance work, preparation of materials and parts in advance, accounting works etc. will be executed effectively and efficiently, by utilizing the records.

12.5 PROCESS CONTROL

Maintenance work process control on time schedule is also important to execute maintenance work sufficiently, besides on quality securing mentioned in 12.4 (3) 7).

Daily and weekly time schedule of rolling stock maintenance work will be necessary at least for this purpose, and also close contact between related shops to keep the time schedule will be inevitable, as the occasion demands.

12.6 MACHINERY AND EQUIPMENT CONTROL

Machinery and equipment installed should always keep designed function and designed performance to be operated at any time during rolling stock maintenance work. For their preventive maintenance, the following control procedures will be necessary to be fixed and practiced.

(1) Classify all machinery and equipment to several groups by extent of influence to quality and process time schedule of rolling stock maintenance work during the whole process, and also to safety control. Furthermore it containes the group required to be inspected in accordance with laws and regulations etc.

(2) For the above mentioned each group, settle the following matters.

1) Inspection period ; daily, monthly, yearly etc.

2) Inspection objects or points ; part, article, function, performance etc.

3) Judgment standards ; standard, limit etc.

(3) Maintenance plan shall be fixed and executed by the sections in charge.

(4) Prepare and utilize maintenance records of each machinery and equipment, for the preventive maintenance.

12.7 SAFETY CONTROL

Workers in the workshop must be prevented from accident and injury during the works. Man is the most important one among enterprise composing three elements.

For this purpose, the following matters shall be settled as safety control action program.

(1) Rules, standards, points, prohibition and restriction items for the safety of the concerning work shall be settled.

(2) Rejection of dangerous causes

1) Abolishment of non-safe conditions

(a) Machinery, facility and equipment, building, working place etc. shall be in safe conditions.

(b) Safety devices and protective attachment shall be installed and attached.

(c) Examination and improvement of disasterous potential

2) Prohibition of non-safe behaviors

(a) Obeying rules, standards, prohibition and restriction items for the safety of the work concerned.

(b) Wearing of protective tool

(c) Utilization of examples of shivering and startling with dangerous experience.

3) Execution of safety inspection

4) Preservation of the working site in well-order

(3) Training

Specially, examples of slivering and startling mentioned in (2). 2). (c) are the useful teaching materials to a great extent, and desirable to be collected for training.

Keeping the working site in well-order mention in (2).4), moreover, is fundamental, effective and important to safe working. It should be stressed in training.

12.8 SANITARY CONTROL OF WORKERS AND WORKING ENVIRONMENT

Among the three composing elements of enterprise, much attention should be paid to the most important "man" as mentioned in 12.7. In parallel with safety control, sanitary control of workers and working environment will be inevitable for keeping and improving the workers' health. Concrete matters of sanitary control are shown as follows ;

(1) On the work in the workshop, rules, regulations and points etc. shall be prepared from the sanitary stand point.

(2) Group medical examination for all workers shall be held periodical

(3) Keep working environment sanitary, considering temperature, humidity, brightness, illumination, air pollution, ventilation, noise, vibration etc..

(4) Rejection and improvement of unsanitary, harmful and toxic condition.

12.9 SOME EXAMPLES ON MANAGEMENT OR CONTROL

Actual tables for management or control are shown as examples of JR Group in Appendix .

(1) Weekly schedule of rolling stock maintenance work Appendix Table 12.9-1

(2) Daily schedule of rolling stock maintenance work Appendix Table 12.9-2

(3) Daily directions of rolling stock maintenance work Appendix Table 12.9-3

(4) Table of procurement and stock for parts Appendix Table 12.9-4

12.10 MOTIVATION AND MANAGEMETN CYCLE

The attitude of all employees to work willing in accordance with the guide lines, and steady execution of concrete management plans are essential for the management of workshop.

It will be most important for management to motivate the employees and to move around so-called "management cycle".

12.10.1 Motivation

To attain the purpose and effective results of business, needless to say, enterprise-wide cooperation for business of all employees will be necessary.

The results of business with the cooperation of all employees of the enterprise are much greater than those by one excellent leader. Namely, it is essential for leaders to motivate employees to do the work voluntarily in the direction of business improvement.

As the effective methods of motivating employees, "Q.C. circle" and "Suggestion system" are well known and adopted in Japanese industries.

"Q.C. circle" is a group of workers which voluntarily picks up problems mainly relating to Q.C. in the work, and improve or solve them.

Workers, individually or in a group by themselves, suggest solutions to the problems necessary to be improved, and some suggestions will be adopted, if effective. The system is called " Suggestion system". Any problem in the work will do , to be picked up and solved. Actually, most of them are in regard with work method, tool or device for work, cost decrease, safe working etc..

Incentive system for good Q.C. circle activities and for good suggestion is effective.

12.10.2 Management cycle

" Management or control" means to " Plan" , "Do" ,"See or check" and "Take action or Adjust" in turn. These four items linked in a circle are called "Management cycle".

To manage or control is to move around the management cycle. In execution of management plans, the management cycle shall be steady moved around to gain fruitful results.

CHAPTER 13 WORKSHOP OPERATION PLAN

13.1 OPERATION PLAN OF EL & EC REPAIR

13.1.1 The characteristic of repairing EL & EC

The overhaul work of EL & EC is a totally new work as a scheduled repair work in the Tashkent Workshop, but as for the repair work itself, the Tashkent Workshop has already experienced it once in 1997. And this EL &EC repair work will be a main work in the near future of the Tashknet Workshop.

Fundamentally, the repair work of both EL & EC is divided into the carbody and the driving equipment. Driving equipment including bogies, braking devices, electric equipment, etc., can be repaired in the existing shops. The carbody of EL is repaired in the present DL carbody shop and that of EC in the present PC carbody shop respectively.

13.1.2 The working volume of repairing EL & EC and necessary workers for the repair

The numbers of EL & EC in 2010(refer to clause 9.1.1 and 9.2.1) is supposed as follows;

Table13.1.2-1 Responsible Numbers of EL & EC of the Tashkent Workshop in 2010

Case	E. L.	E. C.
Low case (A)	330 (55)	220 (36.7)
High case (B)	620 (103.3)	220 (36.7)

Here, these are the planned numbers of EL & EC for which The Tashkent Workshop will be responsible. One EL & one unit of EC (2 cars) shall be repaired in every 6 years cycle {( ) parenthesis number shows the number of repairing cars in a year}.

The necessary workers for repairing the EL & EC are as follows;

Table 13.1.2-2 Workers Necessary for the Repair of EL & EC after the plan's completion

Case	E. L.	E. C.	Total	20% Increased
Low case (A)	133	41	174	209
High case (B)	249	41	290	348

Here, the necessary workers for repairing of 40 EC are 41 workers through a year. (In Table 13.1.2-1 the figure of 36.7 is shown, here in the Table 13.2, 41 workers are calculated from the rounded number 40 EC. Precisely, 41 workers are for the repair of 40 EC, and not for the repair of 36.7 EC. Therefore, some contingency is included in the number of 41 workers/ year).

One EL's work volume is 1/0.85 of one unit of EC. Then,

Low case (A), EL = 55, $41 \times 55 \div 40/2 \times 1/0.85 = 133$,

High case (B), EL = 103.3, $41 \times 103{,}3 \div 40/2 \times 1/0.85 = 249$

The above shows the necessary workers of EL & EC repair are from 290 (High case) to174 (Low case).

In this calculation the basic figure is from the typical Japanese workshop, then its facilities and equipment are supposed to be the state of the art, and the outsourcing ratio are also different. To apply this directly to Tashkent Workshop is a little bit too severe. Then the contingency shall be considered some 20% or so. Then the necessary workers' number comes some 20 % increased (as an upper limit including contingency).

As a conclusion, in (B) High case, 290 to 348 workers are necessary for the EL & EC repair, and in (A) Low case, 174 to 209 workers are necessary, respectively.

13.1.3 How to work out the necessary workers for EL & EC

When the EL & EC are introduced to UTJ, the DL shall be decreased gradually. Then the fundamental thought is to apply the workers for DL to the workers for EL & EC.

Tashkent Workshop is responsible for 1,072 DL for main lines and 313 DL for marshaling or shunting yards (in 1996 present). They shall be repaired every 4.5 years or 7.5 years (overhaul). But the actual overhaul DL number in 1996 is 150. Therefore, the Tashkent Workshop has the ability of repairing more than 150 DL in a year.

The responsible numbers of Tashkent Workshop for DL, EL and EC after the plan's completion are shown below;

Table 13.1.3-1 Responsible numbers of DL, EL, & EC of the Tashkent Workshop after the Plan's completion

Case	DL(main lines)	DL (for yards)	EL	EC
Low case (A)	385	313	330	220
High case (B)	95	313	620	220

As stated in the above, DL (for main lines) shall be overhauled every 4.5 years, DL (for marshaling or shunting yards) shall be overhauled every 7.5 years and EL & EC shall be overhauled every 6 years. The work volume of one DL is approximately 4/3 of that of one EL (from the experiences of Japanese cases), and 85 % of the work volume of one EL equals to one unit of EC (2 EC cars) (this coefficient is also derived from the Japanese cases). Then the above table can be converted into the table below (work volume of the Tashkent Workshop is represented by the number of DL);

Table 13.1.3-2 The total work volume of the Tashkent Workshop after the Plan's completion (converted in the number of DL)

Case	DL (M. lines)	DL (Yards)	EL	EC	Total
Low case(A)	86	42	41	12	181>150
High case(B)	21	42	78	12	153≒150

M. lines = for main lines, Yards = for marshaling or shunting yards,

Here, 86 =385×1/4.5, 42 = 313×1/7.5, 41 = 330×1/6×3/4,

12=220×1/2×1/6×3/4×0.85, 21*= 95×1/4.5, 78 = 620×1/6×3/4

*In case B of chapter 9, work volume per year for main line DL is 22. However, It is adopted here, because theoretical number is 21.1.

As stated above, the Tashkent Workshop has repaired 150 DL in 1996. And the figures of 153 or 181 exceeds 150. This will mean the work volume of the Tashkent Workshop after the plan's completion will increase than now? No, it won't. Some explanations will be done in the following.;

(1) Assumption: The DL condition will be the same after the plan's completion, then the actual overhaul number is far below the scheduled number.

In 1996, as mentioned above, the Tashkent Workshop responsible DL were 1,072 for main lines, and 313 for yards. Then the scheduled overhaul number of DL comes 1,072 ×1/4.5 = 238, and 313 ×1/7.5 = 42, respectively, and the total (scheduled overhaul of DL) comes 238 + 42 = 280. But the actual overhaul number which had been necessary was 150, as stated. The circumstance of 1996 surrounding DL didn't need the repair of the 280 DL (theoretically calculated). The conclusion is this; The actual repair ratio of DL may be 150/280 = 0.54 = 54 % of the scheduled (theoretically calculated) repair. Supposing that such condition would be the same in 2010 too, the real necessary overhaul of DL in 2010 is supposed below.;

In the Low case (A) 86 + 42 = 128, 128×(150/280) = 69,

In the High case (B) 21 + 42 = 63, 63×(150/280) = 34,

Then the Table 13.1.3-2 shall be converted to Table 13.1.3-3 below.;

Table 13.1.3-3 The new total work volume of the Tashkent Workshop after the Plan's completion (calculated in the number of DL)

Case	DL (M & Y)	EL	EC	Total
Low case (A)	69	41	12	122<150
High case (B)	34	78	12	124<150

M = for main lines, Y = for marshaling or shunting yards,

Both cases (case A and B) show that the total work volume of the Tashkent Workshop after the plan's completion is smaller than now.

(2) Assumption: The work of the present coach shop will be removed before 2010.

At present, the Tashkent Workshop has the coach shop and its relative sections. These group will be removed when the new coach workshop is established in the other place. In 1996, the coach shop has 150 workers. The total workers' number of all the shops in 1996 is approximately 1000 (excluding two business group, Austenit and Platan). Then the workers' ratio of the coach shop is 15 % of the total line shops in the Tashkent Workshop. The similarity of the work between DL and Coach is relatively scarce, then the repair work of 150 DL has slight connection with Coach repair. This means the potential ability of the Tashkent Workshop for the DL repair is actually 150×(1.00/1.00−0.15) = 176.5, when the coach work is lost or the ability is converted to DL repair.

(3) The result of the Tashkent Workshop in the past:
The numbers of overhauled DL by the Tashkent Workshop are in the following table.;

Table13.1.3-4 DL Repair Numbers (Planned and Resulted) of the Tashkent Workshop in the Past

Year	Scheduled DL repair	Result of DL repair
1970	315	339
1975	336	337
1980	310	222
1985	270	273
1990	292	293
1991	290	284
1992	305	307
1993	309	312
1994	226	226
1995	130	130
1996	130	150

As you see from the table, the Tashkent Workshop has had the ability of repairing DL from130 to more than 300. In recent 5 years its average number is (307 + 312 + 226 + 130 + 150)×1/5 = 225. Therefore, the Tashkent Workshop has a enough ability and experience to complete 200 DL or so.

(4) Calculation of necessary workers' number of the Tashkent Workshop for DL, EL and EC after the plan's completion from the coefficient of Japanese case
Table 13.1.2-2 shows the necessary workers number for EL and EC after the plan's completion. And Table 13.1.3-2 shows the total work volume of the Tashkent Workshop in the same time calculated in the number of DL repair. Here, the repair work of 40 cars of EC needs 41 workers through a year. 40 cars of EC repair equals to 12.75 DL repair (40÷2×0.85×3/4 = 12.75). Then the work volume of DL in 2010 can be calculated into the number of necessary workers for DL repair using Table 13.1.3-2

Low case (A) (86+42)×41/12.75 = 411.6≒412
High case (B) (21+42)×41/12.75 = 202.6≒203

Then comes Table 13.1.3-5, combining the above figures with Table13.1.2-2

Table 13.1.3-5 Workers of the Tashkent Workshop Necessary for the Repair of DL, EL and EC after the Plan's completion

Case	EL & EC	DL (M & Y)	Total	20 % Increased
Low case (A)	174	412	586	703
High case (B)	290	203	493	592

For the repair of DL, EL and EC, approximately 500 to 600 workers will be needed after the plan's completion. If you think of the contingency of 20 %, approximately 600 to 700 workers will be needed. At present, the Tashkent Workshop has 1,000 workers in the shops of the Production Complex (excluding Austenit and Platan), there is no need for new employment.

As a conclusion of this section, the Tashkent Workshop has the enough ability to perform the increased work of EL & EC repair after the plan's completion by the present workers scale without increasing any workers.

13.1.4 How to find reeducation and retraining hours of workers for EL & EC repairing

In the Workshop, the workers' working hours are always scheduled considering that 10 % of them are for the education, training, etc.
Concretely, a worker is scheduled to work 250 days a year. Then 10 % of them are for the education, training, etc., i. e., $0.1 \times 8(\text{hours}) \times 250(\text{days}) = 200$ hours are considered for such works. The convert retraining and reeducation of workers from DL to EL & EC shall be achieved using this scheduled time.

13.2 SUGGESTIONS FOR THE BETTER MANAGEMENT OF TASHKENT WORKSHOP

13.2.1 Prologue

In the study of EL & EC introducing to the Tashkent Workshop , the study team has encountered with several differences with the workshop in Japan. In this section some of them will be mentioned. And they may be useful for the new management of the Tashkent Workshop.

13.2.2 Organization tree

The organization tree of the Tashkent Workshop is a little bit too complex. The formation of a workshop is generally composed of the office (desk work) part and the work site (shops) part. In the the Tashkent Workshop case, there are two stories of office work in the organization. At first, the Tashkent Workshop has an office part, then the production complex has also the office part.

In general, the production complex may be the work site (shops), but in the Tashkent Workshop organization tree, the production complex has the part of office, such as the branches of Deputy Director (Economics & Finance) and of Chief Engineer. These two branches shall be under the General Director directly and shall compose the office part. The branch of Deputy Director (Economics & Finance) shall commit the other branches, such as Social Development Complex, Capital Construction Complex, Procurement Complex, etc., all the branches shall be under the General Director in the finance and accounting and all the branches must be checked in the same level.

In the present formation, it is only responsible for the Production Complex, then the other parts are dropped out of such check and control of the same level with Production Complex.

On the contrary, a part of the Procurement Complex might be better under the Production complex, because of its characteristic of work (its close connection with the Production Complex). Most works of procurement may be the spare parts or the consumer goods arrangement for the assembly and they must be delivered in the shortest time to the shop site.

Therefore, demands or requests (from the site), decision (of purchase, etc.), delivery (to the site) shall be the quicker, the better (for instance, Kanban-houshiki; This word is Japanese). This means the part of the procurement section which has the closest connection with the production complex might be better in the Production Complex.

A simple formation of a workshop organization tree may be drawn in the following.

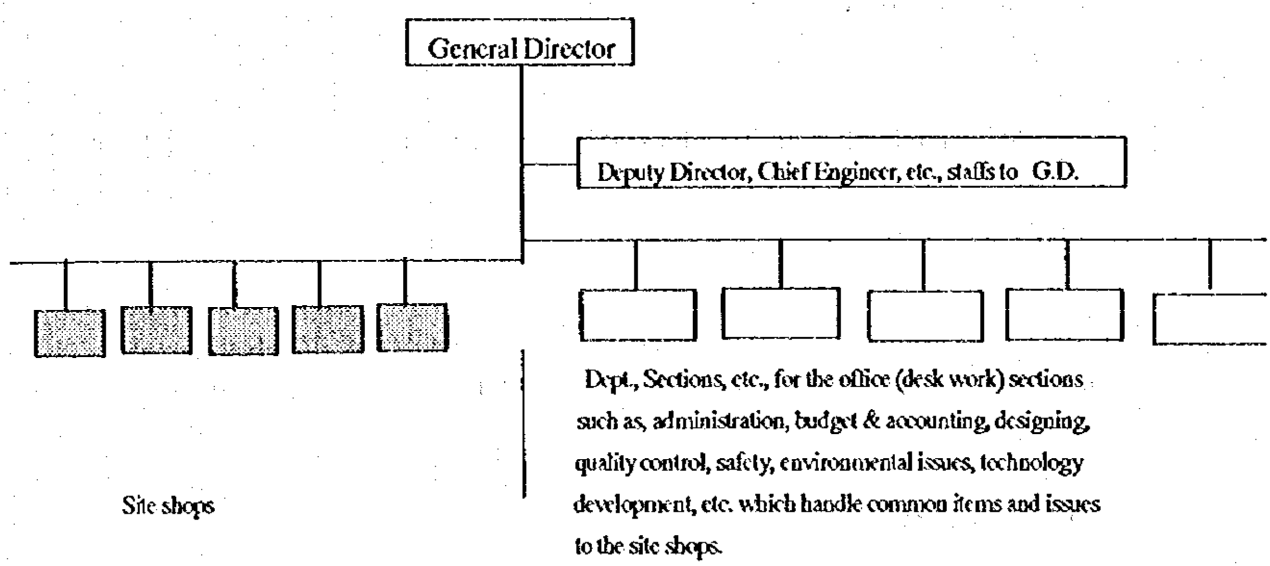


Fig. 13.2.2-1 A Simple Organization Tree of a Workshop

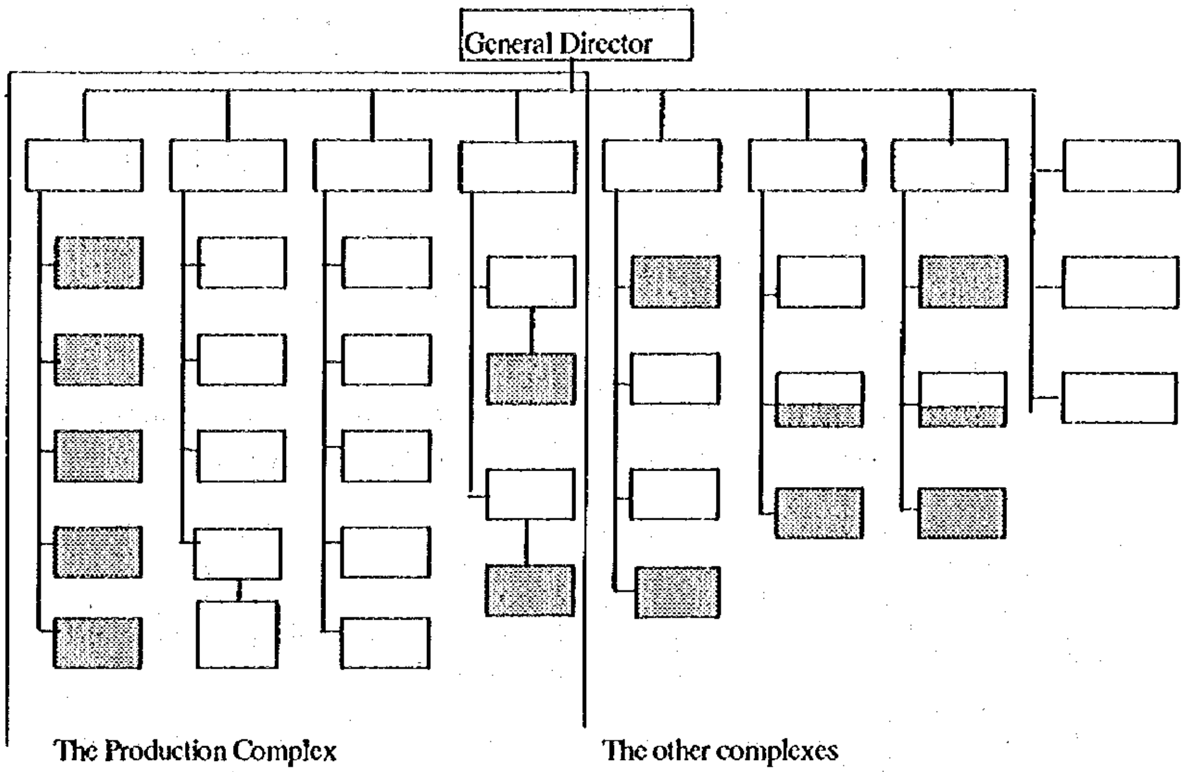
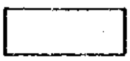
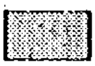
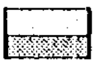


Fig. 13.2.2-2 The Organization Tree of the Tashkent Workshop

 ; A organization or a person directly connected to General Director (Deputy Director, Chief Engineer, Deputy Chief Engineer, Legal Bureau, Security, and Civil Defense)

 ; Office (Desk)or Staff work sections under Deputy Directors, Chief Engineer, etc., under the above sections.

 ;Site work sections (site shops)

 ;Sections (site shops, etc.) which have both office work and site work.

In the above two organizations, the former (Fig 13.2.2-1) has two parts, one is a site work part and the other is a staff part, and they are clearly divided. On the contrary, the Tashkent Workshop (Fig. 13.2.2-2) has only line parts and each subsidiary organization has staff parts and work site parts. Actually the both organizations do the same work. Comparing the two organizations the following suggestions may be said;