

Appendix 10.1.1 Economic Analysis for JAVA Main Line Electrification Project

BASE CASE

(Unit: Mil. RP.)

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016		
INVESTMENT DIFF.	46916	108025	43625	117443	28846	6730	92059	60006	-21872	-39095	-18477	-42049	-43806	-26827	-48699	123844	-61372	-61725	-59649	-62006	20627	-63176	-66167	-53571	-63583	-47729	-61100	-29396	-61562	-221942		
WITH	48972	139817	78132	161497	74135	58979	165349	122747	41806	28244	99963	26761	26790	45672	26484	227321	1068	117	2386	574	87955	5507	22367	13494	2504	19019	5994	37265	5038	-492548		
ELECTRIFICATION	34259	11580		32598	4601		11675	28676	11193		23740					111389					58556	4686		11864	1346		3949	11135	4135			
SIGNALS & TELECOM	13011	3330		10630	1944		5366	7526	1445	2319	3961		281	119		26414					58556	4686		11864	1346		3949	11135	4135			
CIVIL WORK	1445	21021		15325	8609		64735	25978	1605	50	2042	74				31738					16637	821	119	1631	1157	356	2046	3883	903	308		
WORKSHOP		24086		43157							43157					22248																
ROLLING STOCK	78969		78132	59004	58776	58979	58801	59613	27499	25875	26687	26687	26509	26890	26484							22248					18562		22248			
LAND	258	831		783	205		24772	975	64		377																					
-SALVAGE VALUE																						553									492856	
WITHOUT	2056	31792	34507	44055	45289	52249	73290	62742	63678	67339	118440	68810	70596	72499	75183	103477	62440	61841	62035	62580	67328	68683	68534	67065	66087	66748	67095	66662	66600	-270605		
RAILWAY	2056	22544	16012	20179	16032	17611	33272	17253	16127	17834	66920	15247	15019	14938	15432	41809	796	197	359	891	5652	6859	26769	5486	4443	5104	5389	5002	4775	-131381		
SIGNALS & TELECOM	2056	5923		4192	20	1574	3500	1216	980	2384	10829		356	122	160	1804	796	197	359	891	5652	1987	258	1223	180	841	1126	739	1121	1036		
CIVIL WORK							13938									20243																
WORKSHOP											41103												22248									
ROLLING STOCK		16621	16012	15987	16012	16037	15834	16037	15147	15450	14663	15247	14663	14816	15272	19416						4872	4253	4263	4263	4263	4263	4263	4263	3654	4263	
LAND											325					346																
-SALVAGE VALUE																															136680	
ROAD		9247	18495	23876	29257	34638	40019	45489	47550	49505	51520	53563	55577	57560	59752	61668	61644	61644	61676	61690	61676	61824	61765	61579	61644	61644	61706	61660	61824	-139224		
BUS, TRUCK		9247	18495	23876	29257	34638	40019	45489	47550	49505	51520	53563	55577	57560	59752	61668	61644	61644	61676	61690	61676	61824	61765	61579	61644	61644	61706	61660	61824	61765	200970	
-SALVAGE VALUE																																
MAINT/OPE COST DIFF		-11957	-26881	-36149	-41404	-49832	-59199	-66504	-67575	-71364	-76334	-79511	-83764	-88025	-92312	-96670	-84949	-83988	-83888	-83888	-83888	-80585	-80585	-80585	-80585	-80585	-80585	-80585	-80585	-80585	-80585	
FACILITY MAINT COST DIFF		-5382	-11365	-14809	-17353	-20610	-24156	-26050	-26782	-28230	-30032	-31557	-33229	-34904	-36600	-38279	-35358	-35374	-35374	-35374	-35374	-34372	-34372	-34372	-34372	-34372	-34372	-34372	-34372	-34372	-34372	
RAIL DIFF		1407	2212	2708	4100	4782	5176	7218	7934	7937	7582	7509	7282	7058	6812	6581	9502	9486	9486	9486	9486	10488	10488	10488	10488	10488	10488	10488	10488	10488	10488	
ELECTRIC FACIL		465	628	628	1115	1198	1198	1378	1791	1958	1958	2262	2262	2262	2262	2262	3917	3917	3917	3917	3917	4564	4564	4564	4564	4564	4564	4564	4564	4564	4564	
SIGNALS & TELECOM		356	279	279	503	568	519	593	807	827	760	543	543	543	543	541	1398	1379	1379	1379	1379	1529	1529	1529	1529	1529	1529	1529	1529	1529	1529	
CIVIL		63	249	249	488	581	581	1521	2225	2292	2292	2375	2375	2375	2375	2375	2785	2787	2787	2787	2787	2993	2993	2993	2993	2993	2993	2993	2993	2993	2993	
WORKSHOP		524	1057	1552	1994	2435	2877	3327	3111	2861	2573	2329	2102	1878	1632	1402	1402	1402	1402	1402	1402	1402	1402	1402	1402	1402	1402	1402	1402	1402	1402	
ROAD		6789	13578	17517	21453	25392	29332	33268	34717	36167	37615	39065	40511	41962	43412	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	
BUS, TRUCK MAINT COST		6789	13578	17517	21453	25392	29332	33268	34717	36167	37615	39065	40511	41962	43412	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	
OPERATING COST DIFF		-6575	-15516	-21340	-24051	-29222	-35043	-40454	-40792	-43133	-46301	-47955	-50535	-53122	-55712	-58391	-49591	-48513	-48513	-48513	-48513	-46213	-46213	-46213	-46213	-46213	-46213	-46213	-46213	-46213	-46213	
PSHL COST DIFF		-3798	-7633	-9781	-11848	-13979	-16125	-18234	-19090	-19986	-20828	-21789	-22705	-23622	-24544	-25457	-25457	-25457	-25457	-25457	-25457	-25457	-25457	-25457	-25457	-25457	-25457	-25457	-25457	-25457	-25457	
RAIL DIFF		666	1294	1705	2195	2623	3036	3464	3503	3484	3517	3432	3390	3349	3304	3266	3266	3266	3266	3266	3266	3266	3266	3266	3266	3266	3266	3266	3266	3266	3266	
ROAD		4464	8927	11486	14043	16602	19161	21718	22593	23470	24345	25221	26095	26971	27848	28723	28723	28723	28723	28723	28723	28723	28723	28723	28723	28723	28723	28723	28723	28723	28723	
FUEL COST DIFF		-2777	-7883	-11559	-12203	-15243	-18919	-22220	-21702	-23148	-25473	-26165	-27830	-29499	-31169	-32935	-24135	-23057	-23057	-23057	-23057	-20757	-20757	-20757	-20757	-20757	-20757	-20757	-20757	-20757	-20757	
RAIL DIFF		3701	5073	5156	8268	8987	9070	9525	11425	11363	10418	11110	10824	10539	10253	9868	18668	19746	19746	19746	19746	22046	22046	22046	22046	22046	22046	22046	22046	22046	22046	
ROAD		6478	12956	16715	20471	24230	27989	31745	33127	34511	35891	37275	38654	40038	41422	42803	42803	42803	42803	42803	42803	42803	42803	42803	42803	42803	42803	42803	42803	42803	42803	
TIME SAVING BENE		3773	7087	10402	13716	17030	20344	23658	27079	30499	33920	37341	40762	44182	47603	51023	51023	51023	51023	51023	51023	51023	51023	51023	51023	51023	51023	51023	51023	51023	51023	
NORMAL TRAFIC		3111	5539	7967	10396	12824	15252	17681	21004	24327	27650	30973	34296	37619	40941	44265	44265	44265	44265	44265	44265	44265	44265	44265	44265	44265	44265	44265	44265	44265	44265	
DIVERTED TRAFIC		663	1548	2434	3320	4206	5092	5977	6075	6173	6271	6368	6466	6564	6662	6759	6759	6759	6759	6759	6759	6759	6759	6759	6759	6759	6759	6759	6759	6759	6759	
NET FLOW	-46916	-92295	-9657	-70892	26274	60132	-12515	30156	116525	140958	128730	158902	168332	159035	168614	23850	197344	196636	194560	196917												

Appendix 10.1.2 Economic Analysis for JAVA Main Line Electrification Project

(Unit: Mil. RP.)

CASE 1

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016			
INVESTMENT DIFF.	51608	119753	49837	131574	34657	10867	105266	70555	-19304	-38054	-15172	-40898	-42629	-23753	-47594	142395	-61344	-61733	-59446	-62038	28857	-63311	-66607	-52770	-63777	-46338	-61040	-26170	-61536	-258059			
WITH	53870	153799	85945	177647	81549	64877	181884	135022	45987	31069	109960	29437	29469	50239	29132	250053	1175	128	2625	631	96751	6058	24604	14844	2754	20921	6594	40992	5541	-541802			
ELECTRIFICATION	37684	12738		35858	5061		12843	31543	12313		26114					122528					64412	5155		13050	1481		4344	12248	4548				
SIGNALS & TELECOM	14312	3663		11693	2139		5903	8256	1590	2551	4357		309	131		29056					457	128	2625	631	13429	903	131	1794	1273	2250	4271	993	339
CIVIL WORK	1589	23123		16857	9470		71208	28576	1765	55	2246	81				34911					718				18301								
WORKSHOP		26495		47473							47473					24472							24472										
ROLLING STOCK		86866	85945	64904	64654	64877	64681	65574	30249	28462	29356	29356	29160	29579	29132	37916																	
LAND	284	914		661	225		27249	1072	71		414					1170																	
-SALVAGE VALUE																						609											
WITHOUT	2262	34046	36108	46073	46892	54010	76617	64467	85291	69122	125132	70335	72098	73992	76726	107658	62520	61861	62071	62670	67893	69369	91211	67613	66531	67258	67633	67162	67077	-283743			
RAILWAY	2262	24799	17613	22197	17635	19372	36599	18978	17740	19618	73612	16772	16521	16432	16975	45990	876	217	395	980	6217	7545	29446	6034	4887	5614	5928	5502	5253	-149519			
SIGNALS & TELECOM		8516		4611	22	1732	3850	1338	1079	2623	11911		392	134	175	1984	876	217	395	980	6217	2186	264	1345	198	925	1238	813	1233	1140			
CIVIL WORK							15332									22268																	
WORKSHOP											45213		16772	16129	16298	16799							24472										
ROLLING STOCK		18283	17613	17586	17613	17641	17417	17641	16662	16995	16129	16772	16129	16298	16799	21358							5359	4689	4689	4689	4689	4689	4689	4689	4689	4689	
LAND											358					300																	
-SALVAGE VALUE																																	
ROAD		9247	18495	23876	29257	34638	40019	45489	47550	49505	51520	53563	55577	57560	59752	61668	61644	61644	61676	61690	61676	61824	61765	61579	61644	61644	61706	61660	61824	61824	61765	150348	
BUS,TRUCK		9247	18495	23876	29257	34638	40019	45489	47550	49505	51520	53563	55577	57560	59752	61668	61644	61644	61676	61690	61676	61824	61765	61579	61644	61644	61706	61660	61824	61824	61765	-139224	
-SALVAGE VALUE																																	61765
MAINT/OPE COST DIFF	-11868	-26766	-36034	-41194	-49597	-58970	-66115	-67092	-70856	-75833	-78993	-83246	-87507	-91794	-96152	-84139	-83079	-83079	-83079	-83079	-83079	-79676	-79676	-79676	-79676	-79676	-79676	-79676	-79676	-79676	-79676	-79676	
FACILITY MAINT COST DIFF	-5294	-11250	-14693	-17142	-20376	-23926	-25660	-26300	-27723	-29531	-31039	-32711	-34386	-36082	-37761	-34548	-34566	-34566	-34566	-34566	-34566	-33463	-33463	-33463	-33463	-33463	-33463	-33463	-33463	-33463	-33463	-33463	
RAIL DIFF	1495	2328	2823	4311	5017	5405	7607	8417	8445	8083	8027	7800	7576	7330	7099	10312	10294	10294	10294	10294	10294	11397	11397	11397	11397	11397	11397	11397	11397	11397	11397	11397	
ELECTRIC FACIL	511	690	690	1227	1318	1318	1515	1970	2153	2153	2488	2488	2488	2488	2488	2488	4308	4306	4308	4308	4308	5020	5020	5020	5020	5020	5020	5020	5020	5020	5020	5020	
SIGNALS & TELECOM	392	307	307	553	624	571	652	888	909	836	597	597	597	597	597	595	1538	1517	1517	1517	1517	1682	1682	1682	1682	1682	1682	1682	1682	1682	1682	1682	
CIVIL	69	274	274	537	639	639	2113	2447	2521	2521	2612	2613	2613	2613	2613	2613	3064	3066	3066	3066	3066	3293	3293	3293	3293	3293	3293	3293	3293	3293	3293	3293	
WORKSHOP	524	1057	1552	1994	2435	2877	3327	3111	2661	2573	3329	2102	1878	1632	1402	1402	1402	1402	1402	1402	1402	1402	1402	1402	1402	1402	1402	1402	1402	1402	1402	1402	
ROAD	6789	13578	17517	21453	25392	29332	33268	34717	36167	37615	39065	40511	41962	43412	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	
BUS,TRUCK MAINT COST	6789	13578	17517	21453	25392	29332	33268	34717	36167	37615	39065	40511	41962	43412	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	
OPERATING COST DIFF	-6575	-15516	-21340	-24051	-29222	-35043	-40454	-40792	-43133	-46301	-47955	-50535	-53122	-55712	-58391	-49591	-48513	-48513	-48513	-48513	-48513	-46213	-46213	-46213	-46213	-46213	-46213	-46213	-46213	-46213	-46213	-46213	
PSHL COST DIFF	-3798	-7633	-9781	-11848	-13979	-16125	-18234	-19090	-19986	-20828	-21789	-22705	-23622	-24544	-25457	-25457	-25457	-25457	-25457	-25457	-25457	-25457	-25457	-25457	-25457	-25457	-25457	-25457	-25457	-25457	-25457	-25457	
RAIL DIFF	666	1294	1705	2195	2623	3036	3484	3503	3484	3517	3432	3390	3349	3304	3266	3266	3266	3266	3266	3266	3266	3266	3266	3266	3266	3266	3266	3266	3266	3266	3266	3266	
ROAD	4464	8927	11486	14043	16602	19161	21718	22593	23470	24345	25221	26095	26971	27848	28723	28723	28723	28723	28723	28723	28723	28723	28723	28723	28723	28723	28723	28723	28723	28723	28723	28723	28723
FUEL COST DIFF	-2777	-7883	-11559	-12203	-15243	-18919	-22220	-21702	-23148	-25473	-26165	-27830	-29499	-31169	-32935	-24135	-23057	-23057	-23057	-23057	-23057	-23057	-20757	-20757	-20757	-20757	-20757	-20757	-20757	-20757	-20757	-20757	
RAIL DIFF	3701	5073	5156	8268	8987	9070	9525	11425	11363	10418	11110	10824	10539	10253	9868	18668	19746	19746	19746	19746	19746	22046	22046	22046	22046	22046	22046	22046	22046	22046	22046	22046	
ROAD	6478	12956	16715	20471	24230	27989	31745	33127	34511	35891	37275	38654	40038	41422	42803	42803	42803	42803	42803	42803	42803	42803	42803	42803	42803	42803	42803	42803	42803	42803	42803	42803	
TIME SAVING BENE	3019	5670	8321	10973	13624	16275	18926	21663	24400	27136	29873	32609	35346	38083	40819	40819	40819	40819	40819	40819	40819	40819	40819	40819	40819	40819	40819	40819	40819	40819	40819	40819	
NONPAID TRAFIC	2488	4431	6374	8316	10259	12202	14145	16083	19461	22120	24778	27436	30095	32753	35412	35412	35412	35412	35412	35412	35412	35412	35412	35412	35412	35412	35412	35412	35412	35412	35412	35412	
DIVERTED TRAFIC	530	1239	1947	2656	3365	4073	4782	4860																									

Appendix 10.1.3 Economic Analysis for JAVA Main Line Electrification Project

(Unit: Mil. RP.)

CASE 2

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016		
INVESTMENT DIFF.	56299	131480	56049	145706	40467	15004	118474	81104	-16736	-37013	-11868	-39747	-41452	-20680	-46489	160946	-61317	-61741	-59243	-62070	37088	-63447	-67048	-51969	-63971	-44946	-60979	-22944	-61510	-294176		
WITH	58767	167780	93758	193797	88962	70775	198419	147297	50167	33893	119956	32113	32148	54806	31781	272785	1282	140	2863	689	105546	6609	26840	16193	3004	22822	7193	44719	6045	-591057		
ELECTRIFICATION	41110	13896		39117	5521		14010	34411	13432		28488					133667																
SIGNALS & TELECOM	15613	3996		12756	2333		6440	9007	1734	2783	4753		337	143		31697						70267	5623		14236	1615		4739	13362	4962		
CIVIL WORK	1734	25225		18390	10331		77682	31174	1926	60	2450	89				38085						14650	985	143	1957	1389	428	2455	4660	1084	370	
WORKSHOP		28903		51789							51789					22395						19964										
ROLLING STOCK		94763	93758	70805	70531	70775	70561	71536	32999	31050	32024	32024	31811	32268	31781	41363							26697			22395		26697				
LAND	310	998		940	246		29726	1170	77		452					1277																
-SALVAGE VALUE																						664										
WITHOUT	2468	36301	37709	48091	48495	55771	79945	66193	66903	70906	131824	71860	73600	75486	78270	111839	62599	61881	62107	62759	68459	70055	93888	68162	66975	67769	68172	67662	67555	-296881		
RAILWAY	2468	27053	19214	24215	19238	21134	39926	20704	19353	21401	80303	18296	18023	17926	18518	50171	955	237	431	1069	6782	8231	32123	6583	5331	6125	6467	6002	5730	-157657		
SIGNALS & TELECOM	2468	7108		5031	24	1889	4200	1459	1177	2861	12994			146	191	2165	955	237	431	1069	6782	2394	310	1467	216	1009	1351	887	1345	1243		
CIVIL WORK							16725									24292																
WORKSHOP											49323													26697								
ROLLING STOCK		19945	19214	19184	19214	19244	19001	19244	18176	18540	17596	18296	17596	17779	18326	23299						5846	5116	5116	5116	5116	5116	5116	5116	4385	5116	
LAND											390					415																
-SALVAGE VALUE																																
ROAD		9247	18495	23876	29257	34638	40019	45489	47550	49505	51520	53563	55577	57560	59752	61668	61644	61644	61676	61690	61676	61824	61765	61579	61644	61644	61706	61660	61824	61824	164016	
BUS,TRUCK		9247	18495	23876	29257	34638	40019	45489	47550	49505	51520	53563	55577	57560	59752	61668	61644	61644	61676	61690	61676	61824	61765	61579	61644	61644	61706	61660	61824	61824	-139224	
-SALVAGE VALUE																																61765
MAINT/OPE COST DIFF	-11780	-26650	-35918	-40983	-49363	-58740	-65726	-66610	-70348	-75332	-78475	-82728	-86989	-91276	-95635	-83329	-82271	-82271	-82271	-82271	-82271	-78768	-78768	-78768	-78768	-78768	-78768	-78768	-78768	-78768	-78768	
FACILITY MAINT COST DIFF	-5205	-11134	-14578	-16932	-20141	-23696	-25271	-25818	-27215	-29030	-30521	-32193	-33868	-35564	-37243	-33738	-33757	-33757	-33757	-33757	-33757	-32554	-32554	-32554	-32554	-32554	-32554	-32554	-32554	-32554	-32554	
RAIL DIFF	1583	2444	2939	4521	5251	5635	7997	8899	8952	8584	8545	8318	8094	7848	7617	11122	11103	11103	11103	11103	11103	12306	12306	12306	12306	12306	12306	12306	12306	12306	12306	
ELETRIC FACI	558	753	753	1338	1438	1438	1653	2150	2349	2349	2715	2715	2715	2715	2715	4700	4700	4700	4700	4700	4700	5476	5476	5476	5476	5476	5476	5476	5476	5476	5476	
SIGNALS & TELCOH	427	335	335	603	681	623	711	969	992	912	651	651	651	651	650	1677	1655	1655	1655	1655	1655	1835	1835	1835	1835	1835	1835	1835	1835	1835	1835	
CIVIL	75	299	299	586	698	698	2305	2670	2750	2751	2850	2850	2850	2850	2850	3342	3345	3345	3345	3345	3345	3592	3592	3592	3592	3592	3592	3592	3592	3592	3592	
WORKSHOP	524	1057	1552	1994	2435	2877	3327	3111	2861	2573	2329	2102	1878	1632	1402	1402	1402	1402	1402	1402	1402	1402	1402	1402	1402	1402	1402	1402	1402	1402	1402	
ROAD	6789	13578	17517	21453	25392	29332	33268	34717	36167	37615	39065	40511	41962	43412	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	
BUS,TRUCK MAINT COST	6789	13578	17517	21453	25392	29332	33268	34717	36167	37615	39065	40511	41962	43412	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	
OPERATING COST DIFF	-6575	-15516	-21340	-24051	-29222	-35043	-40454	-40792	-43133	-46301	-47955	-50535	-53122	-55712	-58391	-49591	-48513	-48513	-48513	-48513	-48513	-46213	-46213	-46213	-46213	-46213	-46213	-46213	-46213	-46213	-46213	
PSHL COST DIFF	-3798	-7633	-9781	-11848	-13979	-16125	-18234	-19090	-19986	-20828	-21789	-22705	-23622	-24544	-25457	-25457	-25457	-25457	-25457	-25457	-25457	-25457	-25457	-25457	-25457	-25457	-25457	-25457	-25457	-25457	-25457	
RAIL DIFF	666	1294	1705	2195	2623	3036	3484	3503	3484	3517	3432	3390	3349	3304	3266	3266	3266	3266	3266	3266	3266	3266	3266	3266	3266	3266	3266	3266	3266	3266	3266	
ROAD	4464	8927	11406	14043	16602	19161	21718	22593	23470	24345	25221	26095	26971	27848	28723	28723	28723	28723	28723	28723	28723	28723	28723	28723	28723	28723	28723	28723	28723	28723	28723	
FUEL COST DIFF	-2777	-7883	-11559	-12203	-15243	-18919	-22220	-21702	-23148	-25473	-28165	-27830	-29499	-31169	-32935	-24135	-23057	-23057	-23057	-23057	-23057	-20757	-20757	-20757	-20757	-20757	-20757	-20757	-20757	-20757	-20757	
RAIL DIFF	3701	5073	5156	8268	8987	9070	9525	11425	11363	10418	11110	10824	10539	10253	9868	18668	19746	19746	19746	19746	19746	22046	22046	22046	22046	22046	22046	22046	22046	22046	22046	
ROAD	6478	12956	16715	20471	24230	27989	31745	33127	34511	35891	37275	38654	40038	41422	42803	42803	42803	42803	42803	42803	42803	42803	42803	42803	42803	42803	42803	42803	42803	42803	42803	
TIME SAVING BENE	2641	4961	7281	9601	11921	14241	16561	18955	21350	23744	26139	28533	30928	33322	35716	35716	35716	35716	35716	35716	35716	35716	35716	35716	35716	35716	35716	35716	35716	35716	35716	
NORMAL TRAFIC	2177	3877	5577	7277	8977	10677	12377	14073	15769	17465	19161	20857	22553	24249	25945	27641	27641	27641	27641	27641	27641	27641	27641	27641	27641	27641	27641	27641	27641	27641	27641	
DIVERTED TRAFIC	464	1084	1704	2324	2944	3564	4184	4253	4321	4389	4458	4526	4595	4663	4731	4731	4731	4731	4731	4731	4731	4731	4731	4731	4731	4731	4731	4731	4731	4731	4731	
NET FLOW	-56299	-117058	-24438	-102507	10117	46280	-45494	1182	102301	128711</																						

Appendix 10.1.4 Economic Analysis for JAVA Main Line Electrification Project

CASE 3

(Unit: Mil. RP.)

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016		
INVESTMENT DIFF.	60991	143207	62261	159838	46277	19140	131682	91654	-14168	-35972	-8563	-38595	-40275	-17607	-45384	179498	-61290	-61749	-59041	-62101	45318	-63582	-67488	-51168	-64165	-43555	-60919	-19717	-61483	-330293		
WITH	63664	181762	101572	209946	96376	76673	214954	159572	54348	36717	129953	34789	34827	59373	34429	295517	1389	151	3102	746	114342	7159	29077	17543	3255	24724	7793	48445	6549	-640312		
ELECTRIFICATION	44536	15054		42377	5981		15178	37278	14551		30862					144806					76123	6092		15423	1750		5133	14475	5375			
SIGNALS & TELECOM	-16914	4329		13819	2528		6976	9757	1879	3015	5149			365	155	34339					540	151	3102	746	15671	1068	155	2120	1505	463	5133	
CIVIL WORK	1878	27327		19922	11192		84155	33772	2086	65	2654	96				41259					849			21628					5048	1174	401	
WORKSHOP		31312		56104							56104					24261																
ROLLING STOCK		102660	101572	76705	76409	76673	76441	77497	35749	33637	34693	34693	34462	34957	34429	44810							28922			24261					28922	
LAND	336	1061		1018	266		32293	1267	83		490					1383																
-SALVAGE VALUE																								719								
WITHOUT	2673	38555	39310	50108	50098	57532	83272	67918	68516	72689	138516	73385	75102	76980	79813	116020	62679	61900	62143	62848	69024	70741	96565	68711	67419	68279	68711	68162	68032	-310019		
RAILWAY	2673	29308	20816	26233	20842	22695	43253	22429	20966	23185	86995	19821	19525	19419	20061	54352	1035	256	466	1158	7348	8917	34800	7131	5776	6635	7005	6502	6208	-170795		
SIGNALS & TELECOM	2673	7700		5450	26	2047	4550	1561	1275	3100	14077		463	159	207	2345	1035	256	466	1158	7348	2583	336	1589	234	1093	1464	961	1458	1347		
CIVIL WORK							18119																									
WORKSHOP											53433																					
ROLLING STOCK		21607	20816	20783	20816	20848	20584	20848	19691	20085	19062	19821	19062	19261	19854	25241							28922									
LAND											423					450								6334	5542	5542	5542	5542	5542	5542	4750	5542
-SALVAGE VALUE																																
ROAD		9247	18495	23876	29257	34638	40019	45489	47550	49505	51520	53563	55577	57560	59752	61668	61644	61644	61676	61690	61676	61824	61765	61579	61644	61644	61644	61706	61660	61824	177684	
BUS,TRUCK		9247	18495	23876	29257	34638	40019	45489	47550	49505	51520	53563	55577	57560	59752	61668	61644	61644	61676	61690	61676	61824	61765	61579	61644	61644	61706	61660	61824	-139224		
-SALVAGE VALUE																																200990
MAINT/OPE COST DIFF	-11692	-26534	-35803	-40772	-49128	-58510	-65336	-66128	-69841	-74831	-77957	-82210	-86471	-90758	-95117	-82519	-81462	-81462	-81462	-81462	-81462	-77859	-77859	-77859	-77859	-77859	-77859	-77859	-77859	-77859	-77859	
FACILITY MAINT COST DIFF	-5117	-11018	-14462	-16721	-19906	-23466	-24882	-25335	-26707	-28530	-30003	-31675	-33350	-35046	-36725	-32928	-32949	-32949	-32949	-32949	-32949	-31646	-31646	-31646	-31646	-31646	-31646	-31646	-31646	-31646	-31646	
RAIL DIFF	1672	2559	3055	4732	5486	5865	8386	9381	9460	9085	9063	8836	8612	8366	8135	11932	11911	11911	11911	11911	11911	13214	13214	13214	13214	13214	13214	13214	13214	13214	13214	
ELECTRIC FACL	604	816	816	1450	1557	1557	1791	2329	2545	2545	2941	2941	2941	2941	2941	5092	5092	5092	5092	5092	5092	5933	5933	5933	5933	5933	5933	5933	5933	5933	5933	
SIGNALS & TELECOM	463	362	362	653	738	675	770	1049	1075	988	705	705	705	705	705	704	1817	1793	1793	1793	1793	1988	1988	1988	1988	1988	1988	1988	1988	1988	1988	
CIVIL WORK	81	324	324	635	756	756	2497	2892	2980	2980	3087	3088	3088	3088	3088	3821	3624	3624	3624	3624	3624	3891	3891	3891	3891	3891	3891	3891	3891	3891	3891	
WORKSHOP	524	1057	1552	1994	2435	2877	3327	3111	2861	2573	2329	2102	1878	1632	1402	1402	1402	1402	1402	1402	1402	1402	1402	1402	1402	1402	1402	1402	1402	1402	1402	
ROAD	6789	13576	17517	21453	25392	29332	33268	34717	36167	37615	39065	40511	41962	43412	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	
BUS,TRUCK MAINT COST	6789	13576	17517	21453	25392	29332	33268	34717	36167	37615	39065	40511	41962	43412	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	44860	
OPERATING COST DIFF	-6575	-15516	-21340	-24051	-29222	-35043	-40454	-40792	-43133	-46301	-47955	-50535	-53122	-55712	-58391	-49591	-48513	-48513	-48513	-48513	-48513	-46213	-46213	-46213	-46213	-46213	-46213	-46213	-46213	-46213	-46213	
MSNL COST DIFF	-3798	-7633	-9781	-11648	-13979	-16125	-18234	-19090	-19986	-20828	-21789	-22705	-23622	-24544	-25457	-25457	-25457	-25457	-25457	-25457	-25457	-25457	-25457	-25457	-25457	-25457	-25457	-25457	-25457	-25457	-25457	
RAIL DIFF	666	1294	1705	2195	2623	3036	3484	3503	3484	3517	3432	3390	3349	3304	3266	3266	3266	3266	3266	3266	3266	3266	3266	3266	3266	3266	3266	3266	3266	3266	3266	
ROAD	4464	8927	11486	14043	16602	19161	21718	22593	23470	24345	25221	26095	26971	27848	28723	28723	28723	28723	28723	28723	28723	28723	28723	28723	28723	28723	28723	28723	28723	28723	28723	
FUEL COST DIFF	-2777	-7883	-11559	-12203	-15243	-18919	-22220	-21702	-23146	-25473	-26165	-27830	-29499	-31169	-32935	-24135	-23057	-23057	-23057	-23057	-23057	-20757	-20757	-20757	-20757	-20757	-20757	-20757	-20757	-20757	-20757	
RAIL DIFF	3701	5073	5156	8268	8987	9070	9525	11425	11363	10418	11110	10824	10539	10253	9868	18668	19746	19746	19746	19746	19746	22046	22046	22046	22046	22046	22046	22046	22046	22046	22046	
ROAD	6478	12956	16715	20471	24230	27989	31745	33127	34511	35891	37275	38654	40038	41422	42803	42803	42803	42803	42803	42803	42803	42803	42803	42803	42803	42803	42803	42803	42803	42803	42803	
TIME SAVING BENE	3773	7087	10402	13716	17030	20344	23658	27079	30499	33920	37341	40762	44182	47603	51023	51023	51023	51023	51023	51023	51023	51023	51023	51023	51023	51023	51023	51023	51023	51023	51023	
NORMAL TRAFIC	3111	5539	7967	10396	12824	15252	17681	21004	24327	27650	30973	34296	37619	40941	44265	44265	44265	44265	44265	44265	44265	44265	44265	44265	44265	44265	44265	44265	44265	44265	44265	
DIVERTED TRAFIC	663	1548	2434	3320	4206	5092	5977	6875	6173	6271	6368	6466	6564	6662	6759	6759	6759	6759	6759	6759	6759	6759	6759	6759	6759	6759	6759	6759	6759	6759	6759	
NET FLOW	-60991	-127742	-26640	-113634	8211	47018	-52628	-2659	107375</																							

Appendix 10.2.1 Financial Analysis for JAVA Main Line Electrification Project

BASE CASE

(Unit: Mil. RP.)

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	
OPERATING PROFIT		28563	38406	53505	60886	74810	89957	101456	105882	114236	123990	128483	137368	146236	155124	163624	167982	146889	146889	146889	146889	141789	141789	141789	141789	141789	141789	141789	141789	141789	
OPERATING REVENUE		39156	57906	76656	95407	114157	132907	151657	161530	171404	181278	191151	201025	210898	220772	230646	230646	230646	230646	230646	230646	230646	230646	230646	230646	230646	230646	230646	230646	230646	
PASSENGERS		31370	46999	62628	78256	93885	109513	125142	134069	142996	151922	160849	169776	178703	187630	196557	196557	196557	196557	196557	196557	196557	196557	196557	196557	196557	196557	196557	196557	196557	
FREIGHT		7786	10907	14029	17150	20272	23394	26515	27462	28408	29355	30302	31249	32195	33142	34089	34089	34089	34089	34089	34089	34089	34089	34089	34089	34089	34089	34089	34089	34089	
OPERATING EXPENSE		10593	19500	23151	34520	39347	42950	50201	55648	57168	57287	62668	63656	64663	65648	67022	62664	83757	83757	83757	83757	88857	88857	88857	88857	88857	88857	88857	88857	88857	
WORKING COST		6607	10326	11929	17793	20264	21815	25728	29348	30160	29845	31500	31603	31713	31816	32041	44245	45325	45325	45325	45325	48894	48894	48894	48894	48894	48894	48894	48894	48894	
MAINTENANCE COST		1782	3045	3760	5625	6553	7214	9830	10887	11156	11133	11661	11636	11614	11588	11620	15024	15026	15026	15026	15026	16295	16295	16295	16295	16295	16295	16295	16295	16295	
PERSONNEL COST		852	1663	2259	2936	3549	4147	4779	4977	5131	5334	5423	5550	5683	5810	6004	6004	6004	6004	6004	6004	6004	6004	6004	6004	6004	6004	6004	6004	6004	
ENERGY COST		3974	5618	5911	9232	10162	10454	11119	13484	13872	13378	14417	14417	14417	14417	14417	23217	24295	24295	24295	24295	26595	26595	26595	26595	26595	26595	26595	26595	26595	
DEPRECIATION		3986	9174	11222	16727	19084	21135	24473	26300	27009	27443	31168	32053	32949	33832	34981	38419	38432	38432	38432	38432	39962	39962	39962	39962	39962	39962	39962	39962	39962	
NET PROFIT		22794	30569	40890	46500	59226	69589	77958	82171	90761	98460	102986	112029	120507	129615	131950	117428	117485	118567	119703	118057	113989	114512	115300	116422	117043	118059	118130	119176	120365	
TOTAL ASSETS	51494	192277	261235	420500	479556	519451	678951	781239	790371	782482	851024	849906	844645	857634	850285	1055812	1018464	980149	944061	906206	961063	926688	909245	882992	845562	824886	790994	788652	753790	714137	
INTEREST ON TOTAL ASSETS		5768	7037	12615	14387	15584	20369	23497	23711	23474	25531	25497	25339	25729	25509	31674	30554	29404	28322	27186	28832	27801	27277	26490	25367	24747	23730	23660	22614	21424	
INVESTMENT	51494	144769	78132	170487	75783	58979	180635	128761	42567	28255	105120	26761	26792	45938	26484	240508	1071	117	2344	577	93289	5587	22520	13709	2533	19286	6071	37620	5100	310	
FOREIGN TOTAL	30075	113979	78132	112802	65601	58979	89277	89108	36020	28093	69136	26761	26764	44274	26484	143930	984	106	2176	464	52242	4712	21568	11406	2220	17556	5125	34357	4302	257	
LOCAL TOTAL	21419	30790		57685	10182		91358	39653	6547	162	35984			1664		96578	87	11	168	113	41047	675	952	2303	313	1730	946	3263	798	53	
ELECTRIFICATION	35210	11935		33657	4787		12074	29588	11552		24228				115009						60152	4733		11995	1353		4012	11263	4176		
FOREIGN CURRENCY	22193	7426		20309	2716		7199	17989	7035		15409				69648						40205	4063		10196	1235		3274	9531	3597		
LOCAL CURRENCY	13025	4509		13348	2071		4875	11599	4517		8819				45361						19947	670		1799	118		738	1732	579		
SIGNALS & TELECOM	14348	3902		12729	2261		5863	8887	1674	2330	4581		283	120	31487	418	117	2344	577	13901	854	120	1714	1180	358	2059	3957	924	310		
FOREIGN CURRENCY	7218	1115		2763	671		3208	2075	734	2168	1371		255	108	6695	331	106	2176	464	5206	649	110	1210	985	280	1851	3368	705	257		
LOCAL CURRENCY	7130	2787		9966	1590		2655	6812	940	162	3210		28	12	24792	87	11	168	113	8695	205	10	504	195	78	208	589	219	53		
CIVIL WORK	1586	23702		17178	9688		71087	29382	1757	50	2243	74			35734	653				18503											
FOREIGN CURRENCY	664	7890		5960	3438		20069	9431	752	50	903	74			11660	653				6831											
LOCAL CURRENCY	922	15812		11218	6250		51018	19951	1005		1340				24074					11672											
WORKSHOP		25160		46882							46882			18928		22400							22400			18928		22400			
FOREIGN CURRENCY		18579		24766							24766			17276		21458							21458			17276		21458			
LOCAL CURRENCY		6581		22116							22116			1652		942							942			1652		942			
ROLLING STOCK		78969	78132	59004	58776	58979	58801	59613	27499	25875	26687	26687	26509	26890	26484	34469															
FOREIGN CURRENCY		78969	78132	59004	58776	58979	58801	59613	27499	25875	26687	26687	26509	26890	26484	34469															
LAND	342	1101		1037	271		32810	1291	85		499				1409							733									
LOCAL CURRENCY	342	1101		1037	271		32810	1291	85		499				1409							733									
-SALVAGE VALUE																															52060

- Cont'd -

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016		
FINANCE PROGRAM																																
=====																																
FINANCE TOTAL																																

BORROWING	51494	144769	78132	170487	75783	58979	180635	128761	42567	28255	105120	26761	26792	45938	26484	240508	1071	117	2344	577	93289	5587	22520	13709	2533	19286	6071	37620	5100	310		
REPAYMENT								1504	7203	11109	16749	20029	22978	27442	31898	33699	35103	38560	39898	41236	43450	44774	51971	52020	52025	52134	52157	53266	47802	44974		
BALANCE	51494	196263	274395	444882	520665	579644	760279	887536	922901	940046	1028417	1035148	1038962	1057458	1052044	1258853	1224821	1186378	1148824	1108165	1158003	1118816	1089365	1051055	1001562	968714	922628	906982	864280	819616		
INTEREST		1804	8643	13331	20099	24035	27574	32931	38187	39916	40935	44078	44482	44709	45719	45394	52008	49961	47654	45390	42944	43472	41068	39244	36807	33819	31744	28922	27787	25177		
FINANCE IN FOREIGN CCY																																

BORROWING	30075	113979	78132	112802	65601	58979	89277	89108	36020	28093	69136	26761	26764	44274	26484	143930	984	106	2176	464	52242	4712	21568	11406	2220	17556	5125	34357	4302	257		
REPAYMENT								1504	7203	11109	16749	20029	22978	27442	31898	33699	35103	38560	39898	41236	43450	44774	51971	52020	52025	52134	52157	53266	47802	44974		
BALANCE	30075	144054	222186	334988	400589	459568	548845	636449	665267	682250	734637	741368	745154	761986	756572	866803	832684	794230	756508	715736	724527	684465	654062	613449	563643	529065	482033	463124	419624	374907		
INTEREST		1804	8643	13331	20099	24035	27574	32931	38187	39916	40935	44078	44482	44709	45719	45394	52008	49961	47654	45390	42944	43472	41068	39244	36807	33819	31744	28922	27787	25177		
FINANCE IN LOCAL CCY																																

BORROWING	21419	30790		57685	10182		91358	39653	6547	162	35984		28	1664		96578	87	11	168	113	41047	875	952	2303	313	1730	946	3263	798	53		
REPAYMENT																																
BALANCE	21419	52209	52209	109894	120076	120076	211434	251087	257634	257796	293780	293780	293808	295472	295472	392050	392137	392148	392316	392429	433476	434351	435303	437606	437919	439649	440595	443858	444656	444709		
INTEREST																																
SUBSIDY																																

NET CASHFLOW		30744	38937	51396	57514	69858	83518	91494	86793	90219	93749	95543	101961	107033	111339	119512	99290	96800	97769	98694	98927	93506	88713	90488	92920	95799	97851	99564	106162	111600		
=====																																
CASH IN	51494	177318	125712	235214	153396	152872	291727	254690	174750	169500	256553	186412	196213	225123	215440	439113	187472	185438	187665	185898	278610	187339	204272	195461	184285	201038	187823	219372	186852	182062		
OPERATING PROFIT		28563	38406	53505	60886	74810	89957	101456	105982	114236	123990	126483	137368	146236	155124	163624	147982	146889	146889	146889	146889	141789	141789	141789	141789	141789	141789	141789	141789	141789	141789	
DEPRECIATION		3986	9174	11222	16727	19084	21135	24473	26300	27009	27443	31168	32053	32949	33832	34981	38419	38432	38432	38432	39962	39962	39962	39962	39962	39962	39962	39962	39962	39962	39962	
BORROWING	51494	144769	78132	170487	75783	58979	180635	128761	42567	28255	105120	26761	26792	45938	26484	240508	1071	117	2344	577	93289	5587	22520	13709	2533	19286	6071	37620	5100	310		
CASH OUT	51494	146573	86775	183818	95882	83014	208209	163195	87957	79280	162804	90869	94253	118089	104101	319601	88183	88638	89896	87204	179683	93833	115559	104973	91365	105239	89972	119808	80690	70461		
INVESTMENT	51494	144769	78132	170487	75783	58979	180635	128761	42567	28255	105120	26761	26792	45938	26484	240508	1071	117	2344	577	93289	5587	22520	13709	2533	19286	6071	37620	5100	310		
REPAYMENT								1504	7203	11109	16749	20029	22978	27442	31898	33699	35103	38560	39898	41236	43450	44774	51971	52020	52025	52134	52157	53266	47802	44974		
INTEREST		1804	8643	13331	20099	24035	27574	32931	38187	39916	40935	44078	44482	44709	45719	45394	52008	49961	47654	45390	42944	43472	41068	39244	36807	33819	31744	28922	27787	25177		
CASHFLOW <ROI>	-51494	-112220	-30552	-105760	1830	34914	-69543	-2832	89616	112990	46313	132890	142629	133247	162472	-41903	185330	185204	182977	184744	92032	176165	159232	168043	179219	162466	175681	144132	176652	701502		
IRR <ROI>	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336		

Appendix 10.2.2 Financial Analysis for JAVA Main Line Electrification Project

(Unit: Mil. RP.)

CASE 1

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	
OPERATING PROFIT		28563	38406	53505	60866	74810	89957	101456	105882	114236	123990	128483	137368	146236	155124	163624	147982	146889	146889	146889	146889	141789	141789	141789	141789	141789	141789	141789	141789	141789	
OPERATING REVENUE		39156	57906	76656	95407	114157	132907	151657	161530	171404	181278	191151	201025	210898	220772	230646	230646	230646	230646	230646	230646	230646	230646	230646	230646	230646	230646	230646	230646	230646	
PASSENGERS		31370	46999	62628	78256	93885	109513	125142	134089	142996	151922	160849	169776	178703	187630	196557	196557	196557	196557	196557	196557	196557	196557	196557	196557	196557	196557	196557	196557	196557	
FREIGHT		7786	10907	14029	17150	20272	23394	26515	27462	28408	29355	30302	31249	32195	33142	34089	34089	34089	34089	34089	34089	34089	34089	34089	34089	34089	34089	34089	34089	34089	
OPERATING EXPENSE		10593	19500	23151	34520	39347	42950	50201	55640	57168	57287	62668	63656	64663	65648	67022	82664	83757	83757	83757	83757	88857	88857	88857	88857	88857	88857	88857	88857	88857	
WORKING COST		6607	10326	11929	17793	20264	21815	25728	29348	30160	29845	31500	31603	31713	31816	32041	44245	45325	45325	45325	45325	48894	48894	48894	48894	48894	48894	48894	48894	48894	
MAINTENANCE COST		1782	3045	3760	5625	6553	7214	9830	10887	11156	11133	11661	11636	11614	11588	11620	15024	15026	15026	15026	15026	16295	16295	16295	16295	16295	16295	16295	16295	16295	
PERSONNEL COST		852	1663	2259	2936	3549	4147	4779	4977	5131	5334	5423	5550	5683	5810	6004	6004	6004	6004	6004	6004	6004	6004	6004	6004	6004	6004	6004	6004	6004	
ENERGY COST		3974	5618	5911	9232	10162	10454	11119	13484	13872	13378	14417	14417	14417	14417	14417	23217	24295	24295	24295	24295	26595	26595	26595	26595	26595	26595	26595	26595	26595	
DEPRECIATION		3986	9174	11222	16727	19084	21135	24473	26300	27009	27443	31168	32053	32949	33832	34981	38419	38432	38432	38432	38432	39962	39962	39962	39962	39962	39962	39962	39962	39962	
NET PROFIT		22794	30569	40890	46500	59226	69589	77958	82171	90761	98460	102986	112029	120507	129615	131950	117428	117485	118567	119703	118057	113989	114512	115300	116422	117043	118059	118130	119176	120365	
TOTAL ASSETS	51494	192277	261235	420500	479556	519451	670951	783239	790371	782482	851024	849906	844645	857634	850285	1055812	1018464	980149	944061	906206	961063	926688	909245	882992	845562	824886	790994	788652	753790	714137	
INTEREST ON TOTAL ASSETS		5768	7837	12615	14387	15584	20369	23497	23711	23474	25531	25497	25339	25729	25509	31674	30554	29404	28322	27186	28832	27801	27277	26490	25367	24747	23730	23660	22614	21424	
INVESTMENT	51494	144769	78132	170487	75783	58979	180635	128761	42567	28255	105120	26761	26792	45938	26484	240508	1071	117	2344	577	93289	5587	22520	13709	2533	19286	6071	37620	5100	310	
FOREIGN TOTAL	30075	113979	78132	112802	65601	58979	89277	89108	36020	28893	69136	26761	26764	44274	26484	143930	984	106	2176	464	52242	4712	21568	11406	2220	17556	5125	34357	4302	257	
LOCAL TOTAL	21419	30790	57685	10182	58979	91358	39653	6547	162	35984	162	1664	28	1664	28	96578	87	11	168	113	41047	875	952	2303	313	1730	946	3263	798	53	
ELECTRIFICATION	35218	11935		33657	4787		12074	29588	11552		24228					115009					60152	4733		11995	1353		4012	11263	4176		
FOREIGN CURRENCY	22193	7426		20309	2716		7199	17989	7035		15409					69648					40205	4063		10196	1235		3274	9531	3597		
LOCAL CURRENCY	13025	4509		13348	2071		4875	11599	4517		8819					45361					19947	670		1799	118		738	1732	579		
SIGNALS & TELECOM	14340	3902		12729	2261		5863	8887	1674	2330	4581		283	120		31487	418	117	2344	577	13901	854	120	1714	1180	358	2059	3957	924	310	
FOREIGN CURRENCY	7218	1115		2763	671		3208	2075	734	2168	1371		255	108		6695	331	106	2176	464	5206	649	110	1210	985	280	1851	3368	705	257	
LOCAL CURRENCY	7130	2787		9966	1590		2655	6812	940	162	3210		28	12		24792	87	11	168	113	8695	205	10	504	195	78	208	589	219	53	
CIVIL WORK	1586	23702		17178	9688		71087	29382	1757	50	2243	74				35734	653				18503										
FOREIGN CURRENCY	664	7890		5960	3438		20069	9431	752	50	903	74				11660	653				6831										
LOCAL CURRENCY	922	15812		11218	6250		51018	19951	1005		1340					24074					11672										
WORKSHOP		25160		46882							46882			18928		22400							22400			18928		22400			
FOREIGN CURRENCY		18579		24766							24766			17276		21458							21458			17276		21458			
LOCAL CURRENCY		6581		22116							22116			1652		942							942			1652		942			
ROLLING STOCK		78969	78132	59004	58776	58979	58801	59613	27499	25875	26687	26687	26509	26890	26484	34469															
FOREIGN CURRENCY		78969	78132	59004	58776	58979	58801	59613	27499	25875	26687	26687	26509	26890	26484	34469															
LAND	342	1101		1037	271		32810	1291	85		499					1409						733									
LOCAL CURRENCY	342	1101		1037	271		32810	1291	85		499					1409						733									
-SALVAGE VALUE																															520060

- Cont'd -

CASE 1

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	
FINANCE PROGRAM																															
=====																															
FINANCE TOTAL																															
BORROWING	51494	144769	78132	170487	75783	58979	180635	128761	42567	28255	105120	26761	26792	45938	26484	240508	1071	117	2344	577	93289	5587	22520	13709	2533	19286	6071	37620	5100	310	
REPAYMENT											1504	7203	11109	16749	20029	22978	27442	31898	33699	35103	38560	39898	41236	43450	44774	51971	52020	52025	52134	52157	
BALANCE	51494	196283	274395	444882	520665	579644	760279	889040	931607	959862	1063478	1083037	1098719	1127908	1134362	1351892	1325521	1293740	1262305	1227859	1282588	1248277	1229561	1199819	1157578	1124893	1078945	1064539	1017505	965658	
INTEREST		902	4322	6666	10050	12018	13787	16465	19139	20219	21062	23091	23678	24147	24973	25167	28795	28002	27048	26192	25063	25473	24418	23828	22866	21590	20557	19150	18620	17185	
FINANCE IN FOREIGN CCY																															
BORROWING	30075	113979	78132	112802	65601	58979	89277	89108	36020	28093	69136	26761	26764	44274	26484	143930	984	105	2176	464	52242	4712	21568	11406	2220	17556	5125	34357	4302	257	
REPAYMENT											1504	7203	11109	16749	20029	22978	27442	31898	33699	35103	38560	39898	41236	43450	44774	51971	52020	52025	52134	52157	
BALANCE	30075	144054	222186	334988	400589	459568	548845	637953	673973	702066	769698	789257	804911	832436	838890	959842	933384	901592	870069	835430	849112	813926	794258	762213	719659	685244	638350	620681	572849	520949	
INTEREST		902	4322	6666	10050	12018	13787	16465	19139	20219	21062	23091	23678	24147	24973	25167	28795	28002	27048	26102	25063	25473	24418	23828	22866	21590	20557	19150	18620	17185	
FINANCE IN LOCAL CCY																															
BORROWING	21419	30790		57685	10182		91358	39653	6547	162	35984		28	1664		96578	87	11	168	113	41047	875	952	2303	313	1730	946	3263	798	53	
REPAYMENT																															
BALANCE	21419	52209	52209	109894	120076	120076	211434	251087	257634	257796	293780	293780	293808	295472	295472	392050	392137	392148	392316	392429	433476	434351	435303	437606	437919	439649	440595	443858	444656	444709	
INTEREST																															
SUBSIDY																															
NET CASHFLOW																															
		31646	43258	58061	67564	81876	97305	109464	113044	121025	128867	129357	134634	138288	143954	150460	130164	125422	124575	124116	121698	116380	116098	114474	114111	108191	109174	110576	110997	112409	
CASH IN																															
	51494	177318	125712	235214	153396	152872	291727	254690	174750	169500	256553	186412	196213	225123	215440	439113	187472	185438	187665	185898	278610	187339	204272	195461	184285	201038	187823	219372	186852	182062	
OPERATING PROFIT																															
		28563	38486	53505	60886	74810	89957	101456	105882	114236	123990	128483	137368	146236	155124	163624	147982	146889	146889	146889	146889	141789	141789	141789	141789	141789	141789	141789	141789	141789	141789
DEPRECIATION																															
		3986	9174	11222	16727	19084	21135	24473	26300	27009	27443	31168	32853	32949	33832	34981	38419	38432	38432	38432	38432	39962	39962	39962	39962	39962	39962	39962	39962	39962	39962
BORROWING																															
	51494	144769	78132	170487	75783	58979	180635	128761	42567	28255	105120	26761	26792	45938	26484	240508	1071	117	2344	577	93289	5587	22520	13709	2533	19286	6071	37620	5100	310	
CASH OUT																															
	51494	145671	82454	177153	85833	70997	194422	145226	61706	48474	127686	57055	61579	86835	71487	288653	57309	60016	63098	61782	156912	70959	88174	80987	70174	92847	78648	108796	75854	69653	
INVESTMENT																															
	51494	144769	78132	170487	75783	58979	180635	128761	42567	28255	105120	26761	26792	45938	26484	240508	1071	117	2344	577	93289	5587	22520	13709	2533	19286	6071	37620	5100	310	
REPAYMENT																															
											1504	7203	11109	16749	20029	22978	27442	31898	33699	35103	38560	39898	41236	43450	44774	51971	52020	52025	52134	52157	
INTEREST																															
		902	4322	6666	10050	12018	13787	16465	19139	20219	21062	23091	23678	24147	24973	25167	28795	28002	27048	26102	25063	25473	24418	23828	22866	21590	20557	19150	18620	17185	
CASHFLOW <ROI>																															
	-51494	-112220	-30552	-105760	1830	34914	-69543	-2832	89616	112990	46313	132890	142629	133247	162472	-41903	185330	185204	182977	184744	92032	176165	159232	168043	179219	162466	175681	144132	176652	701502	
IRR <ROI>																															
	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336

Appendix 10.2.3 Financial Analysis for JAVA Main Line Electrification Project

(Unit: Mil. RP.)

CASE 2

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	
OPERATING PROFIT		28563	38406	53505	60886	74810	89957	101456	105882	114236	123990	128403	137368	146236	155124	163624	147982	146889	146889	146889	146889	141789	141789	141789	141789	141789	141789	141789	141789	141789	
OPERATING REVENUE		39156	57906	76656	95407	114157	132907	151657	161530	171404	181278	191151	201025	210898	220772	230646	230646	230646	230646	230646	230646	230646	230646	230646	230646	230646	230646	230646	230646	230646	230646
PASSENGERS		31370	46999	62628	78256	93885	109513	125142	134069	142996	151922	160849	169776	178703	187630	196557	196557	196557	196557	196557	196557	196557	196557	196557	196557	196557	196557	196557	196557	196557	196557
FREIGHT		7786	10907	14029	17150	20272	23394	26515	27462	28408	29355	30302	31249	32195	33142	34089	34089	34089	34089	34089	34089	34089	34089	34089	34089	34089	34089	34089	34089	34089	34089
OPERATING EXPENSE		10593	19500	23151	34520	39347	42950	50201	55648	57168	57287	62668	63656	64663	65648	67022	82664	83757	83757	83757	83757	88857	88857	88857	88857	88857	88857	88857	88857	88857	88857
WORKING COST		6607	10326	11929	17793	20264	21815	25728	29348	30160	29845	31500	31603	31713	31816	32041	44245	45325	45325	45325	45325	48894	48894	48894	48894	48894	48894	48894	48894	48894	48894
MAINTENANCE COST		1782	3045	3760	5625	6553	7214	9830	10887	11156	11133	11661	11636	11614	11588	11620	15026	15026	15026	15026	15026	16295	16295	16295	16295	16295	16295	16295	16295	16295	16295
PERSONNEL COST		852	1663	2259	2936	3549	4147	4779	4977	5131	5334	5423	5550	5683	5810	6004	6004	6004	6004	6004	6004	6004	6004	6004	6004	6004	6004	6004	6004	6004	6004
ENERGY COST		3974	5618	5911	9232	10162	10454	11119	13484	13872	13378	14417	14417	14417	14417	14417	23217	24295	24295	24295	24295	26595	26595	26595	26595	26595	26595	26595	26595	26595	26595
DEPRECIATION		3986	9174	11222	16727	19084	21135	24473	26300	27009	27443	31168	32053	32949	33832	34981	38419	38432	38432	38432	38432	39962	39962	39962	39962	39962	39962	39962	39962	39962	39962
NET PROFIT		22794	30569	40890	46500	59226	69589	77958	82171	90761	98460	102986	112029	120507	129615	131950	117428	117485	118567	119703	118057	113989	114512	115300	116422	117043	118059	118130	119176	120365	
TOTAL ASSETS	51494	192277	261235	420500	479556	519451	678951	783239	790371	782482	851024	849906	844645	857634	850285	1055812	1018464	980149	944061	906206	961063	926688	909245	882992	845562	824886	790994	788652	753790	714137	
INTEREST ON TOTAL ASSETS		5768	7837	12615	14387	15584	20369	23497	23711	23474	25531	25497	25339	25729	25509	31674	30554	29404	28322	27186	28832	27801	27277	26490	25367	24747	23730	23660	22614	21424	
INVESTMENT	51494	144769	78132	170487	75783	58979	180635	128761	42567	28255	105120	26761	26792	45938	26484	240508	1071	117	2344	577	93289	5587	22520	13709	2533	19286	6071	37620	5100	310	
FOREIGN TOTAL	30075	113979	78132	112802	65601	58979	89277	89108	36020	28093	69136	26761	26784	44274	26484	143930	984	106	2176	464	52242	4712	21568	11406	2220	17556	5125	34357	4302	257	
LOCAL TOTAL	21419	30790		57685	10182		91358	39653	6547		35984		28	1664		96578	87	11	168	113	41047	875	952	2303	313	1730	946	3263	798	53	
ELECTRIFICATION	35218	11935		33657	4787		12074	29588	11552		24228					115009					60152	4733		11995	1353		4012	11263	4176		
FOREIGN CURRENCY	22193	7426		20309	2716		7199	17989	7035		15409					69648					40205	4063		10196	1235		3274	9531	3597		
LOCAL CURRENCY	13025	4509		13348	2071		4875	11599	4517		8819					45361					19947	670		1799	118		738	1732	579		
SIGNALS & TELECOM	14348	3902		12729	2261		5863	8887	1674	2330	4581		283	120		31487	418	117	2344	577	13901	854	120	1714	1180	358	2059	3957	924	310	
FOREIGN CURRENCY	7218	1115		2763	671		3208	2075	734	2168	1371		255	108		6695	331	106	2176	464	5206	649	110	1210	985	280	1851	3368	705	257	
LOCAL CURRENCY	7130	2787		9966	1590		2655	6812	940	162	3210		28	12		24792	87	11	168	113	8695	205	10	504	195	78	208	589	219	53	
CIVIL WORK	1584	23702		17178	9688		71087	29382	1757	50	2243	74				35734	653				18503										
FOREIGN CURRENCY	664	7890		5960	3470		20069	9431	752	50	903	74				11660	653				6831										
LOCAL CURRENCY	920	15812		11218	6218		51018	19951	1005		1340					24074					11672										
WORKSHOP		25160		46882							46882			18928		22400							22400				18928		22400		
FOREIGN CURRENCY		18579		24766							24766			17276		21458							21458				17276		21458		
LOCAL CURRENCY		6581		22116							22116			1652		942							942				1652		942		
ROLLING STOCK		78969	78132	59004	58776	58979	58801	59613	27499	25875	26687	26687	26509	26890	26484	34469															
FOREIGN CURRENCY		78969	78132	59004	58776	58979	58801	59613	27499	25875	26687	26687	26509	26890	26484	34469															
LAND	342	1101		1037	271		32810	1291	85		499					1409							733								
LOCAL CURRENCY	342	1101		1037	271		32810	1291	85		499					1409							733								
-SALVAGE VALUE																															520060

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CASE 2

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	
FINANCE PROGRAM																															
=====																															
FINANCE TOTAL																															

BORROWING	-51494	144769	78132	170487	75783	58979	180635	128761	42567	28255	105120	26761	26792	45938	26484	240508	1071	117	2344	577	93289	5587	22520	13709	2533	19286	6071	37620	5100	310	
REPAYMENT					3570	8702	8702	19819	27215	31122	48419	53176	57216	52093	60848	62649	48832	45958	46204	63612	59843	61169	68389	68179	75026	59184	59352	60842	55403	52844	
BALANCE	51494	196263	274395	444882	517095	567373	739306	848248	863599	860732	917434	891019	860595	854441	820076	997935	950174	904333	860473	797438	830884	775302	729433	674963	602470	562571	509291	486069	435766	383232	
INTEREST		4696	15691	20379	34935	39764	42128	58643	66780	66691	65030	68756	64685	60294	58201	53967	69711	65822	62518	59426	53974	57830	53331	49419	45111	39060	36267	32602	30885	27357	
FINANCE IN FOREIGN CCY																															

BORROWING	30075	113979	78132	112802	65601	58979	89277	89108	36020	28093	69136	26761	26764	44274	26484	143930	984	106	2176	464	52242	4712	21568	11406	2220	17556	5125	34357	4302	257	
REPAYMENT								1504	7203	11109	16749	20029	22978	27442	31898	33699	35103	38560	39898	41236	43450	44774	51971	52020	52025	52134	52157	53266	47802	44974	
BALANCE	30075	144054	222186	334988	400589	459568	540845	636449	665267	682250	734637	741368	745154	761986	756572	866803	832684	794230	756508	715736	724527	684465	654062	613449	563643	529065	482033	463124	419624	374907	
INTEREST		1804	8643	13331	20099	24035	27574	32931	38187	39916	40935	44078	44482	44709	45719	45394	52008	49961	47654	45390	42944	43472	41068	39244	36807	33819	31744	28922	27787	25177	
FINANCE IN LOCAL CCY																															

BORROWING	21419	30790		57685	10182		91358	39653	6547	162	35984		28	1664		96578	87	11	168	113	41047	875	952	2303	313	1730	946	3263	798	53	
REPAYMENT					3570	8702	18316	20013	20013	31669	33146	34238	24650	28951	28951	13729	7398	6106	22376	16393	16395	16418	16160	23001	7050	7194	7576	7601	7870		
BALANCE	21419	52209	52209	109894	116506	107805	190461	211798	198333	178482	182797	149651	115441	92455	63504	131131	117489	110103	103965	81702	106356	90836	75370	61514	38826	33506	27258	22944	16142	8325	
INTEREST		2892	7048	7048	14836	15728	14554	25712	28593	26775	24095	24678	20203	15585	12481	8573	17703	15861	14864	14035	11030	14358	12263	10175	8304	5242	4523	3680	3098	2179	
SUBSIDY																															

NET CASHFLOW		27853	31880	44348	39108	45428	60263	47467	38188	43432	37984	37719	47521	66798	69907	81988	67858	73542	76599	62284	71504	62753	60032	64154	61615	83507	86133	88308	95464	101551	
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CASH IN	51494	177318	125712	235214	153396	152872	291727	254690	174750	169500	256553	186412	196213	225123	215440	439113	187472	185438	187665	185898	278610	187339	204272	195461	184285	201038	187823	219372	186852	182062	
OPERATING PROFIT		28563	38406	53505	60886	74810	89957	101456	105882	114236	123990	128483	137368	146236	155124	163624	147982	146889	146889	146889	146889	141789	141789	141789	141789	141789	141789	141789	141789	141789	141789
DEPRECIATION		3986	9174	11222	16227	19084	21135	24473	26300	27009	27443	31168	32053	32949	33832	34981	38419	38432	38432	38432	38432	39962	39962	39962	39962	39962	39962	39962	39962	39962	39962
BORROWING	51494	144769	78132	170487	75783	58979	180635	128761	42567	28255	105120	26761	26792	45938	26484	240508	1071	117	2344	577	93289	5587	22520	13709	2533	19286	6071	37620	5100	310	
CASH OUT	51494	149465	93823	190866	114288	107444	231464	207223	136562	126068	218569	148693	148693	158324	145533	357125	119614	111897	111066	123615	207106	124586	144240	131307	122670	117530	101690	131064	91388	80511	
INVESTMENT	51494	144769	78132	170487	75783	58979	180635	128761	42567	28255	105120	26761	26792	45938	26484	240508	1071	117	2344	577	93289	5587	22520	13709	2533	19286	6071	37620	5100	310	
REPAYMENT					3570	8702	8702	19819	27215	31122	48419	53176	57216	52093	60848	62649	48832	45958	46204	63612	59843	61169	68389	68179	75026	59184	59352	60842	55403	52844	
INTEREST		4696	15691	20379	34935	39764	42128	58643	66780	66691	65030	68756	64685	60294	58201	53967	69711	65822	62518	59426	53974	57830	53331	49419	45111	39060	36267	32602	30885	27357	
CASHFLOW <ROI>	-51494	-112220	-30552	-105760	1830	34914	-69543	-2832	89616	112990	46313	132890	142629	133247	162472	-41903	185330	185204	182977	184744	-92032	176165	159232	168043	179219	162466	175681	144132	176652	701502	
IRR <ROI>	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	16.336	

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Appendix 10.3 Personell Training Accompanying Electrification. Modernization

An outline of the plans, etc. for the training facilities to provide for the personell of individual departments is presented below.

10.3.1 Train Operation

(1) The Required Number of Trainees and Training Period

Appendix 10.3.1 shows the employees required for operations by each stage of electrification (electric and diesel locomotive drivers, assistants, conductors, inspectors and maintenance workers for each type of vehicle at the depot). Based on Appendix 10.3.2, the following two tables have been prepared. Appendix 10.3.3 gives the number of trainees for electric locomotive driver and assistant, and the period of their training. Appendix 10.3.4 gives the training schedule of maintenance staff for electric locomotives at depots.

For the best use of educational facilities and to minimize the number of instructors, simultaneous training of the locomotive drivers and assistant, or that of inspectors and maintenance workers is preferable. Appendix 10.3.3 shows the necessity of uninterrupted training.

Training the maintenance staff of diesel locomotives, passenger and freight cars, and the conductors, has been omitted since PJKA has already experience for those training.

(2) Contents of Education and the Number of Training Days

Appendix 10.3.5 shows each type of training courses and number of days for training. The longest period of training is 155 days for the electric locomotive drivers and only 2 classes can be opened per year if a single series of training is undertaken.

(3) Number of Instructors Required

The number of instructors required for a class by type of job is as follows.

As observed in Appendix 10.3.3 and Appendix 10.3.4, the number of instructors given below will be sufficient since almost every class for each type of job is given in series.

Appendix 10.3.1

Type	Electric locomotive driver	Assistant	Inspector of EL	Maintenance worker of EL
Special instructor	7	3	5	6
Temporary instructor	9		5	
Total	16	12	10	11

(4) Educational Material

The following material will be required for training electric locomotive drivers and their assistants (actual equipments, models and wall charts, etc.)

a. Rolling stock

- Major equipments and parts related to the main circuit
- Major equipments and parts related to auxiliary circuit
- Major equipments and parts related to braking device
- Equipments and parts related to the track and coupling device
- Major equipments and parts related to other auxiliary devices

b. Track

- Main parts such as rails and sleepers, etc.
- Main equipments for points and crossings

c. Signals

- Main equipments and parts for signaling system
- Main equipments and parts for blocking device
- Main equipments and parts for interlocking device

d. Catenaries

- Main parts for catenaries and feeders

e. Markers

- Track markers and operation markers

f. Model equipments

- Movable model of drivers' cab
- Movable model for interlocking device and signaling system
- Movable model for brake device

g. Audiovisual equipments and materials

- Slide
- VTR
- Others

These can be also used for the training of maintenance staff of rolling stock.

Appendix 10.3.2 The Number of Crew Related to Operation by Step of Electrification

Type of Job	Type of Car	1988	'89	'91	'92	'94	'95	'96	2003	'08	Remarks
Electric locomotive driver and assistant	EL	310	418	592	656	1,212	1,440	1,508	2,072	2,222	Locomotive crew is the total of locomotive drivers and their assistants.
		78	102	146	166	216	286	308	512	550	
Electric locomotive inspection and repair staff	EL										

Appendix 10.3.3 Training of Electric Locomotive Driver and Assistant

Item	Year	'86	'87	'88	'89	'90	'91	'92	'93	'94	'95	'96	'97
Number of increase of locomotive driver and assistant			310		174		556		68		228		
				108		64							
Training of locomotive driver													
Training of assistant locomotive driver													
Item	Year	1997	'98	'99	2000	'01	'02	'03	'04	'05	'06	'07	'08
Number of increase of locomotive driver and assistant.					564				150				
Training of locomotive driver													
Training of assistant locomotive driver													

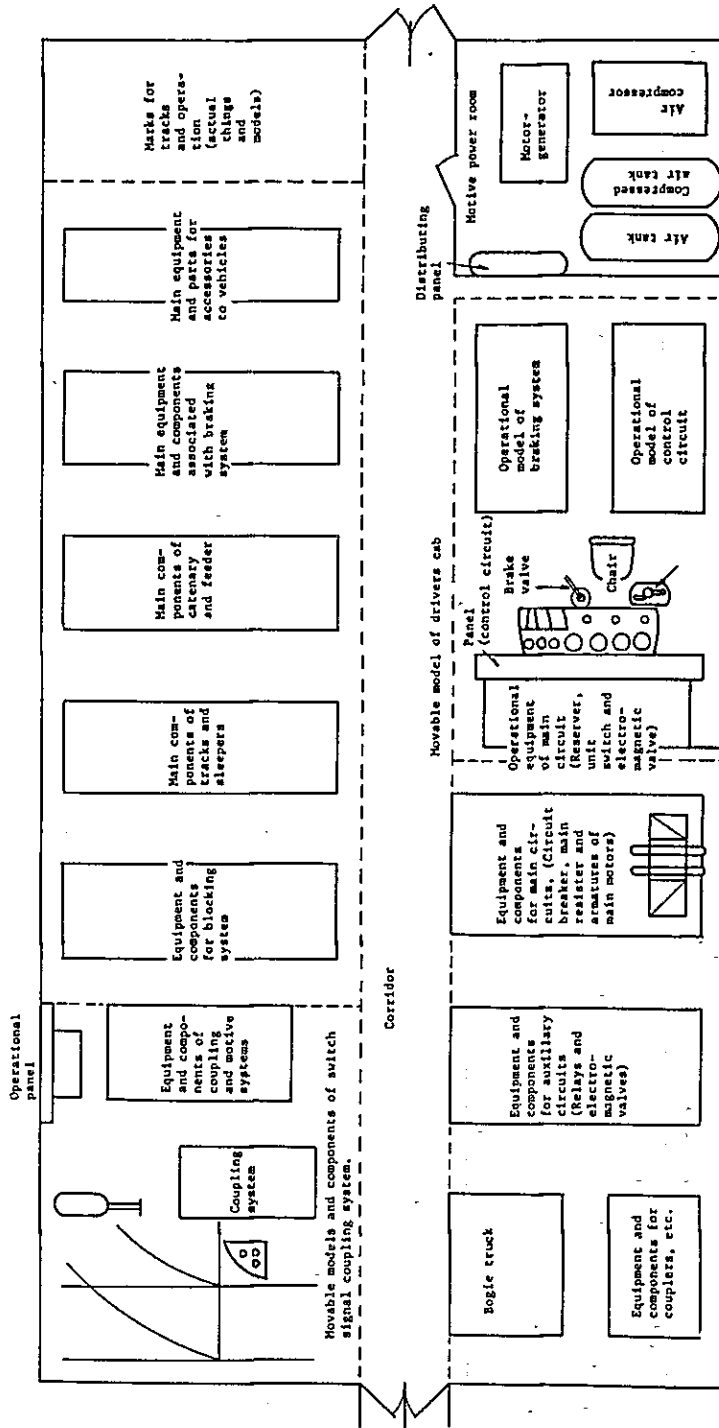
Appendix 10.3.4 Training of Maintenance Staff of Electric Locomotive at Depot

Item	1986	'87	'88	'89	'90	'91	'92	'93	'94	'95	'96	'97
Number of increase of maintenance staff of electric locomotive		78	24	44	20	50	70	22				
Training of inspector												
Training of maintenance worker												
Item	1997	'98	'99	2000	'01	'02	'03	'04	'05	'06	'07	'08
Number of increase of maintenance staff of electric locomotive			204						38			
Training of inspector												
Training of maintenance worker												

Appendix 10.3.5 Training Course and Training Period by Course

Item	Electric Locomotive driver	Assistant Electric Locomotive driver	Electric Locomotive Inspector	Maintenance Worker of Electric Locomotive
Course	(1) Operation laws and regulation (2) Operation theory (3) Prevention of operation accident (4) Railway electricity (5) Railway rolling stock (6) Signals, track and safety (7) Work safety (8) Field and shop training (9) Others	(1) Operation laws and regulation (2) Prevention of operation accident (3) Railway electricity (4) Rolling stock maintenance (5) Signals, track and safety (6) Work safety (7) Field and shop training (8) Others	(1) Rolling stock maintenance (2) Rolling stock materials (3) Method of engineering work (4) Method of tilting and grinding (5) Railway electricity (6) Drawing (7) Accounting and material control (8) Work safety (9) Field and shop training (10) Others	(1) Rolling stock maintenance (2) Method of engineering work (3) Railway electricity (4) Work safety (5) Field and shop training (6) Others
Hours of training	740 hours	490 hours	520 hours	590 hours
Number of days required	155 days	90 days	95 days	115 days

App. Plan of Classroom (Area: 420 m²) Unit: m



Appendix 10.3.6 Equipment for On-the-Job Training of Locomotive Crew and Depot Maintenance Men (Electric Locomotive and Railcar)

10.3.2 Electrification Facilities

(1) Maintenance of Electrification Facilities

a. Way of thinking about maintenance

Thinking about maintenance of the electrification facilities is based on securing normal operation of trains and restoring normal functions as early as possible should breakdown or troubles in the facilities.

For these reasons it is necessary to adopt appropriate maintenance measures for each facilities as well as to be thoroughly familiar with the features of each facilities and its operating conditions.

For instance, in the case of contact wire which are vibrated and worn with the constant sliding of pantograph, regular control of wear at appropriate period is required. Structures as Concrete Poles will not require any maintenance for 30 ~ 50 years because of the construction material, on the other hand.

In constructing the electrification facilities consideration must be given to facilities which requires little maintenance and which will not cause accidents or failures.

Therefore, the system must be simply made, adopting highly reliable equipments and materials and making major facilities with prolixity system into duplex system.

Also as maintenance measures after the operation of the facilities, the introduction of equipment that can be monitored automatically and inspected must be considered.

For instance, the introduction and use of such vehicles as the electric equipment inspection railcar, with monitoring equipment capable of checking the condition of overhead contact system installations and measuring data, and which can run by it's own traction power while doing this and the substation inspection motorcar, mounted with equipment capable of automatically detecting the conditions of the switchboards of substations, etc.

b. Maintenance depot and operational staff

The number of operational staff and depot for maintenance must be determined according to the time required for restoring any failure

or breakdown of the facilities, rather than by the amount of equipment installed for electrification.

For the electrification of the main railway lines in Java, a operational staff of 14 men covering about 50 km is considered appropriate. However, this figure is only an estimate and must be studied further according to maintenance conditions after electrification.

Appendix 10.3.7 Estimated Required for Each Stage of Electrification

Year electrified	1988	1989	1991	1992	1994
Personnal required	65	26	78	15	34
Year electrified	1995	1996	1998	2003	2008
Personnal required	65	27	32	268	105

(2) Education and Training Program for the Electrification System

In order to carry out maintenance of facilities smoothly after electrification, training of the staff related to PJKA electric power needs careful programming.

For training the staff, the following 3 methods are considered.

- Learning techniques to attend the electrification project
- Education at training school
- On-the-job training

a. Learning techniques to attend the electrification project

Railway electrification project of the main railway lines in Java will be carried out for over the entire lines of PJKA for a long period of time.

The construction will be carried out under contract and when the staff of PJKA actually experiences work, they will be able to learn techniques of electrification and learn the main points of equipment maintenance.

b. Education at training school

Electrification brings about a total change in the railway system and required skills and knowledge become more special and sophisticated. For this reason, education and training at school become indispensable to acquire such skills and knowledge. Corresponding educational content and training facilities need to be developed.

Examples of necessary courses and education and training facilities at school are as given below.

• Examples of curriculum

Outline of electric railway

Theories of electric railways:

Substation equipment, overhead contact system equipment

Laws and regulations:

Facilities related to electrification system, Inspection standards, etc.

Tools and materials:

General tools, measuring instruments, electric materials

Work fundamentals:

Work order, inspection work, repair work training in actual techniques

Accident prevention:

protection of trains, training for restoration

• Examples of education and training facilities

A set of extra-high voltage switchboards:

Multiple unit control panel, AC feeding switchboard, etc.

Equipment and apparatus:

Circuit breaker, disconnecting switch, etc.

Mockup overhead contact system:

Overhead contact system for training

Substation inspection motorcar and electric inspection railcar handling equipment

c. On-the-job training

On-the-job training is carried out daily using the actual equipment for each job and it is indispensable for carrying out maintenance work. Since on-the-job training tends to be rather academic, it is desired to increase the amount of learning actual techniques matched to the presently used equipment and to relay such skills to the trainees. The content of training includes that carried out at the time of roll calls every day, regular training for learning skills of new equipment and apparatus, re-education, and work fundamentals training, etc.

At on-the-job training, senior workers must take leadership roles and persons qualified for particular skills must carry out the training and education.

An example of an education and training program for electrification is as illustrated below.

Attend in electrification
construction 6M

School education 3M

On-the-job training

Start of electrification

d. Education and training plan with main railway lines electrification in Java

- Curriculum and number of teaching hours

Appendix 10.3.8 Curriculum Items

Curriculum	Hours	Item	Details
Outline of electrification	10		History of electrification Electrification system Effects of electrification Outline of electrification facilities
Outline of power generation and transmission line	10	Power generation Power transmission line	Summary of power generation system Summary of power transmission line facilities
Overhead contact system	50	Overhead contact system Supporting structures Insulator Overhead contact wire Overhead contact system auxiliary equipment	Definition, composition Contact wire system Construction gauge Pole Stay, strut Pole foundation Beam, cantileter Suspension insulator Stem insulator Messenger wire Contact line Hanger, dropper Connector Hinged pull-off arm Steady arm Sectioning device Automatic tensioning equipment

Curriculum	Hours	Item	Details
		Feeding circuit	Overhead crossing Marker Feeder Feeding branch Switching device Feeding system Voltage drop
		Return circuit	Return circuit functions
		Protective equipment	Lightning arrester Grounding equipment Gap arrester Protective wire, protective network
		Electric inspection railcar	Functions Measuring equipment Data processing
Substation facilities	50	General sub-stations	Role, type and form Electric power dispatch work
		Outline of equipment	Connection diagram DC Substation AC Substation Sectioning post Sub-sectioning post
		Substation facilities	Disconnecting switch Circuit breaker Transformer Power condenser Instrument transformer Remote control units Control power source device Switchboard
		Sequence	Basics of sequence Time chart Sequence diagram

Curriculum	Hours	Item	Details
Outline of maintenance	30	Maintenance of electrification facilities	Maintenance and construction Maintenance system Outline and classification of troubles and accidents Maintenance management system Statistics management
Outline of signalling facilities	10		Summary of signalling protection device
Outline of telecommunications equipment	10		Summary of the communications equipment
Outline of Train Operation	10		Summary of train operation work Train operation Train protection
Outline of track maintenance	10		Structure of permanent way Turnout types and structure
Related laws and regulations	10		Connections between laws, management regulations and standards regulations Related departmental regulations
Accident prevention	20	Prevention of operating accidents Prevention of injurious accidents	Gravity of the train operation work Operating accidents Importance of early restoration from accidents Significance of safety Countermeasures of electrical shock accidents Countermeasures running over accident Countermeasures of falling accident Safety activities on site Emergency measures

Curriculum	Hours	Item	Details
Health and physical education	30		
On-site training	30		
Others	10		
Total	290		

• Training facilities and educational details

Appendix 10.3.9 Overhead Contact System Items (80 hours)

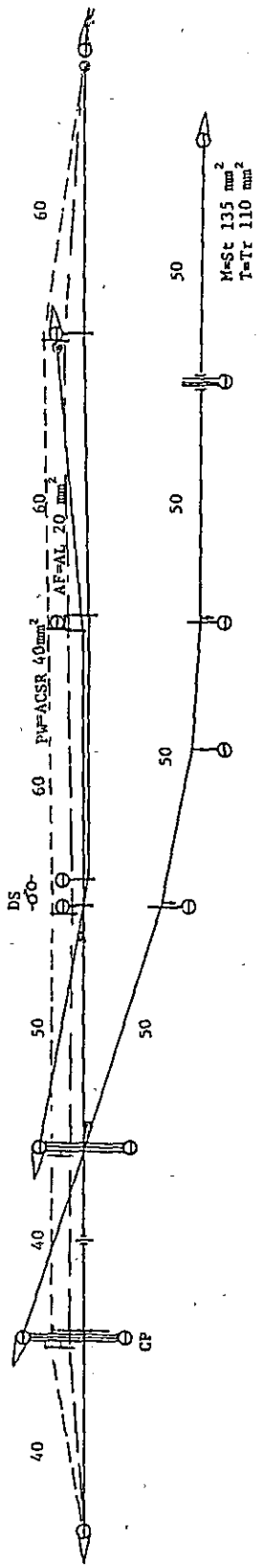
Principal Equipment	Principal Educational Details
Supporting structures of overhead contact system for training	Install and removal of temporary poles, method of installing temporary stay, installation of temporary beams, restoration of broken poles and damaged and sagging beams.
Insulators	Replacement of feeder and messenger insulators, replacement of span type steadyarm insulators
Overhead contact wire	Method of adjusting height deviation and strength, Restoration of snapping of contact wire and snapping of messenger wire
Accessorial equipment of overhead contact wire	Method of replacing hangers and droppers, method of inspection, repair and replacement of connectors, method of makeup various hinged pull-off, method of replacing hinged pull-off arm and steady arm, method of replacing insulators and connecting rods of anchoring equipment, method of inspection and adjustment of automatic tensioning equipment, Restoration of broken wire ropes of automatic tensioning equipment.
Feeder	Method of connecting the wires, method of restoring snapping feeder, dividing and anchoring the feeder.
Disconnecter	Method of inspection and adjustment of the operational mechanism of the disconnecter, emergency measures to take when the disconnecter is damaged or ineffective.

Appendix 10.3.10 Substation Items (80 hours)

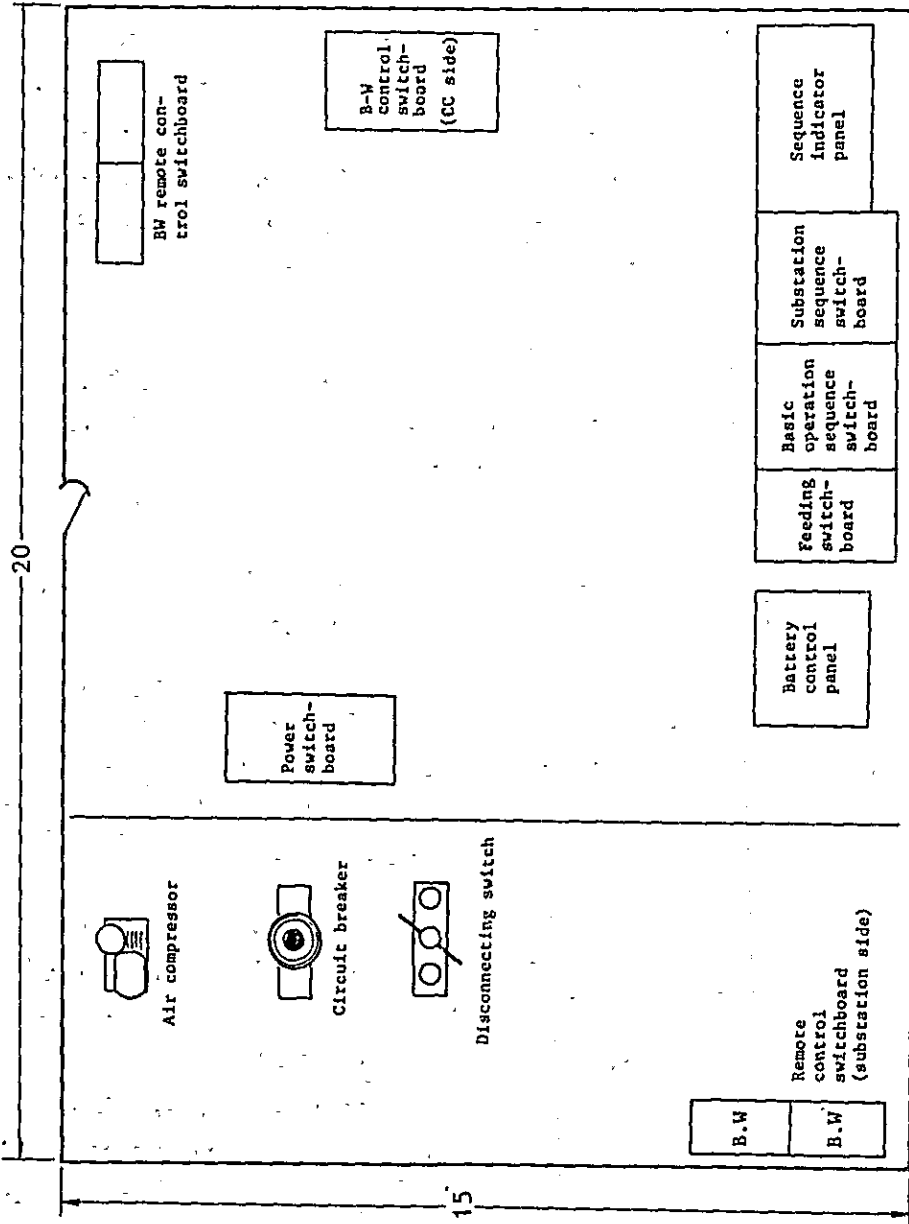
Principal Equipment	Principal Educational Details
Basic operation sequence switchboard	Fundamental and applied sequence training
Substation sequence switchboard	Practical training in operation and sequential protection, voltage and current measurements and method of using the recorder.
Circuit breaker	Method of indication and inspection of device and various measurement and tests, treatment of uncontrollable state
Switchboard	Practical training in control and various sequential protection, method of handling during emergencies and disposition when sequence action delayed.
Air compressor	Operational function and various measurement tests, method of inspecting the control panel and accessory devices, disposition when inoperative and during leakage of compressed air.
Power operated disconnecter	Method of inspecting the contactor, operating mechanism and relays, disposition when switch is inoperative and disposition when switch action not smooth.
Battery control panel	Inspection of the rectifier control function relay and instrument, disposition when control is ineffective and disposition when output drops.
Battery	Method of inspection and repairs, researching trouble in wire connectors.

Outlines of the training equipment are shown in Appendix 10.3.11 and 10.3.12. School education and training with the electrification of the main railway lines in Java, should be carried out on a scale matching the required number of personnel for each stage of electrification. Though the number of people appears to be uneven, they are averaged out in the 3rd stage. From the standpoint of effective use of the school and planned training of operational staff, we believe it desirable to carry out training in groups of 30 each year.

Furthermore, the necessary full time instructors will be 2 for overhead contact system and 2 for substation facilities training.



Appendix 10.3.11 Training Facility of Overhead Contact System



Appendix 10.3.12 Training Facilities of Substation

10.3.3 Signalling and Telecommunication

Signalling and telecommunication systems are fundamental systems of a railway system providing safe, accurate and rapid mass transportation. The failure of these systems not only lowers transportation service but also greatly affects the railway management, bringing about human and property loss due to train accidents, etc.

Since these systems must be maintained in a normal condition at all times through daily maintenance, reliable systems must be constructed in the design and execution stages and people engaged in construction and maintenance must learn new skills and acquire knowledge on new equipment.

(1) Method of Education and Training

The method of education and training of the staff is largely grouped into 3 types, on-the-job training, education at educational institutions and commissioned education.

a) On-the-job training

Supervisors carry out training, lessons, lectures and skill contests, etc., for their staff through daily work.

b) Education at special schools

Education at special school is conducted in organized fashion for training newly recruited employees, for teaching changes in jobs and work method, following the modernization of facilities, and for improving skills and knowledge of particular jobs.

c) Commissioned education

The staff is dispatched to outside educational institutions to learn sophisticated or special skills which cannot be acquired through on-the-job training or the PJKA educational institutions.

In PJKA, as mentioned in 5.1.2 (2), education of signalling and telecommunication employees at educational institutions is given at DIKLAT I and DIKLAT II, and commissioned education is given at SATKA. For the signalling division, the education is given of the mechanical signalling, and for the telecommunication division, it is given mainly of the telegraph, telephone and radio equipment, but sufficient educational equipment is not provided.

Therefore, the education related to the modernization of signalling and telecommunication systems following electrification must have its first object placed on developing personnel serving as educational leaders at the PJKA educational institutions through provision of the training equipment at the educational institutions and commissioning of the education.

The commissioned education should be such that the personnel be dispatched to SATKA and foreign countries where modern signalling and telecommunication equipment is well provided so that they will learn the necessary knowledge and acquire the skill on such equipment as the leaders of education and training.

Education at educational institutions is carried out by providing educational materials for modern systems at signal and telecommunication systems factories and by leaders who have learned their skills through commissioned education.

Also, technicians well versed in the technology of modern equipment are invited, as required, from abroad as lecturers, and special schooling in accord with modernized signalling and telecommunication systems is given.

On-the-job training is carried out mostly for that staff which has acquired modern equipment skills at the special schools. As a first step, skills are learned through experience in the field for construction work, testing and adjustments. Then, after construction is completed, advanced skills and knowledge of modern equipment are given mostly the supervisory staff through daily maintenance work.

(2) Education and Training Program

Education courses for the staff and comprised of beginners' education, supervisors' education, education of clerical staff, special technical education and converting education that accompanies systems modernization.

Here, we have taken up educational institutions and education for the maintenance crew of modernized signalling and telecommunication systems following electrification.

Separate courses have to be given for other items to improve the content of education.

a. Content of education

Education consists of giving general information and undertaking preventive maintenance and repair work at the time of failure of equipment for systems planned under this electrification project and those expected to be introduced in the near future, operational principles required for maintenance, tests, adjustments and the method of maintaining functions. Further, education regarding modernization of other related systems is also given. Education is effectively given by academic courses and practice, slides, movies, VTR and other audio-visual equipment. Appendix 10.3.13 shows roughly curriculum and training hours.

b. Time of education and number of trainees

Converting education, following the modernization of signalling and the communication systems, is programmed under the assumption that all district main lines will be modernized in the future.

Education and training program following electrification must give full information and technology about modern equipment to the maintenance crews in the each area at the time of start of electrification.

Therefore, by 1988, when Bekasi-Cirebon and Cikampek-Bandung are scheduled to open as the 1st work period, converting education must be given to the maintenance crews in the respective districts.

Practice facilities need to be completed by then and instructor training must be finished.

Education for maintenance crews in other districts must be given priority over district electrification work.

One class is composed of 15-30 trainees and the period of training is 3 months.

Appendix 10.3.14 gives the number of trainees for each year.

c. Education practice facilities

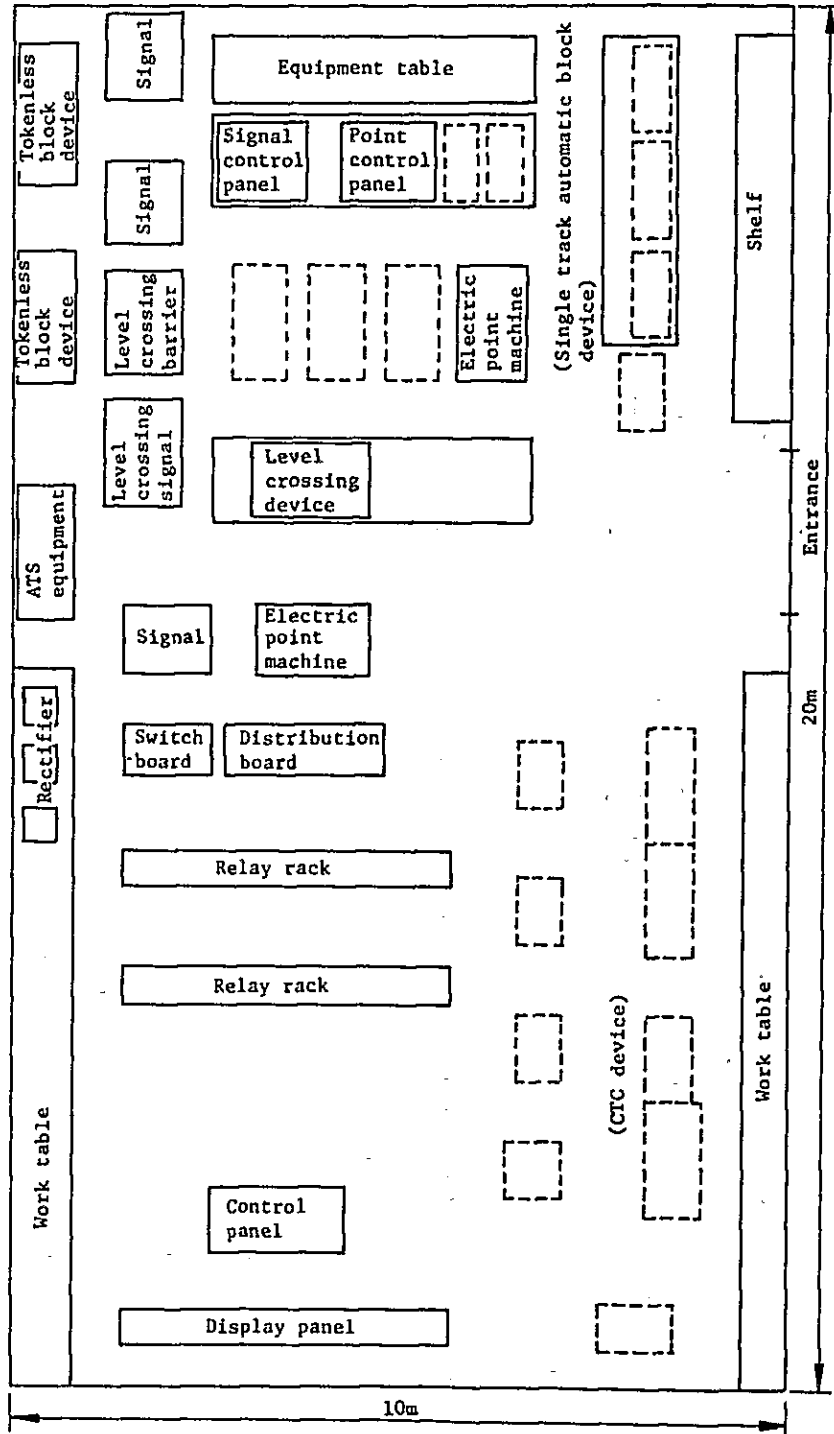
Practice facilities of signalling systems are given in Appendix 10.3.15 and those of telecommunication systems are given in Appendix 10.3.16.

Appendix 10.3.13 Education Courses and Estimate Hours of
Education Communication

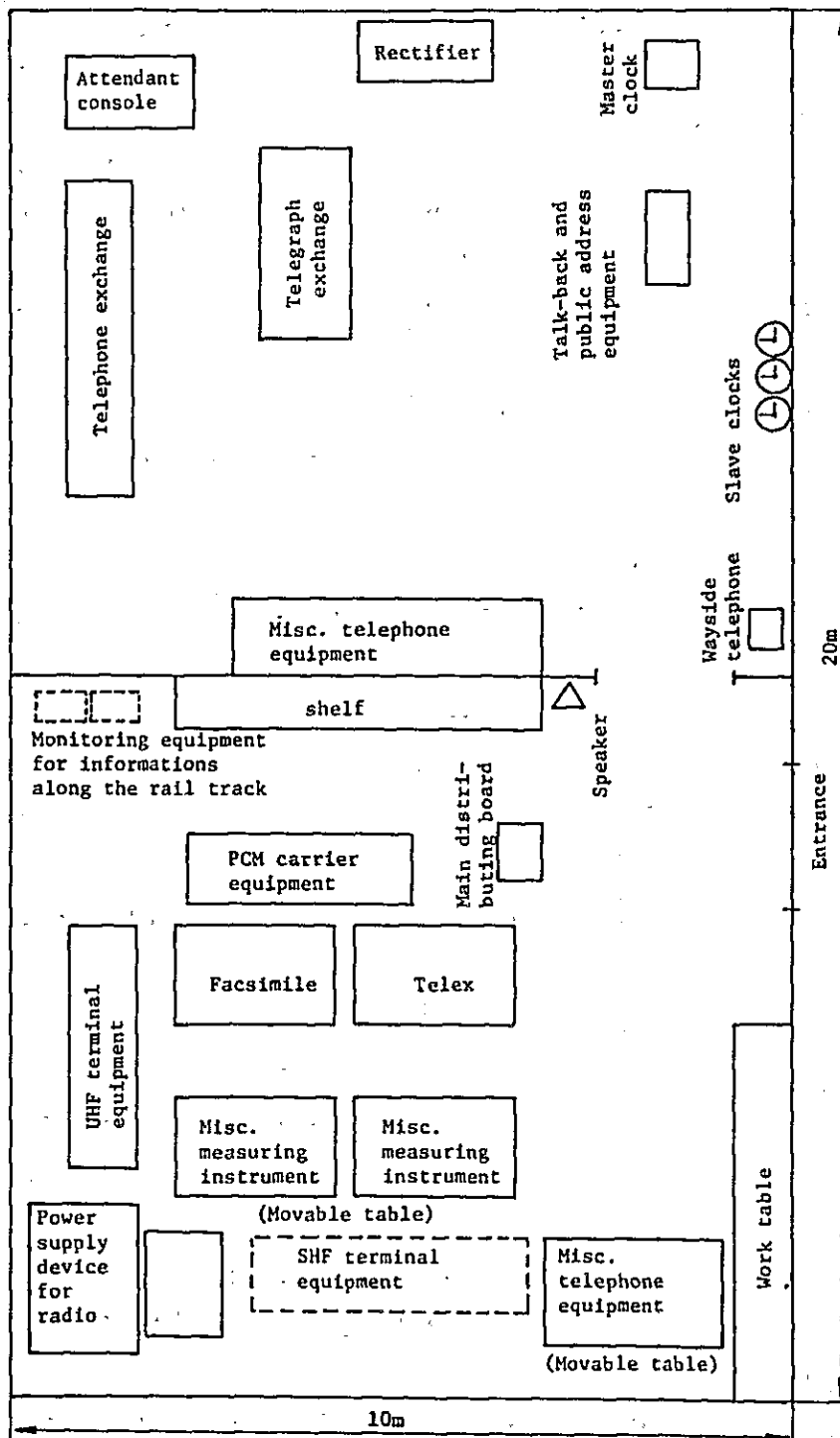
Signalling			Telecommunication		
Courses		Hours	Courses		Hours
Signalling system	Outline of signalling system	6	Telecommunication system	Outline of telecommunication cable line	6
	Signal device	14		Circuit network	6
	Block device	18		Telecommunication cable line	20
	Interlocking device	60		Radio communication	26
	Point machine	12		Carrier communication	30
	Track circuit	24		Data transmission	12
	ATS	18		Exchange	36
	CTC	22		Telephone	12
	Levels crossing safety device	24		Facsimile	18
	Signal cable line	6		Telex	12
Laws and regulations		18	Talk-back equipment	6	
Work safety		12	Misc. apparatus	12	
Outline of maintenance		18	Power source for communication	12	
Practice		60	Laws and regulations	18	
Re-operations	Operations	6	Work safety	12	
	Telecommunication	6	Outline of maintenance	18	
			Practice	60	
	Traction substation	2	Re-operations	Operation	2
	Contact wire systems	2		Signal	6
	Power	2		Traction substation	2
		Contract wire system		2	
		Power	2		
Tests, events, etc.		30	Tests, events, etc.		30
Total		360	Total		360

Appendix 10.3.14 Education and Training Program

Item	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	
Maintenance of education and training facilities																						
Commissioned education																						
Training at educational institution																						
Training of instructors			10						5						5							
Trainees			10						5						5							
Signal																						
Telecommunication																						
Signal				60	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	(30)
Telecommunication				50	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	(30)



Appendix 10.3.3.15 Layout of Equipment in Signal Practice Room



Appendix 10.3.16 Layout of Equipment in the Telecommunication Practice Room

10.3.4 Construction and Maintenance

(1) Content of Courses

This courses is mainly establishment in charge of education for maintenance-of-way depots, construction depots, mecanized track maintenance and machinery depots.

Education and training for the staff of Indonesian State Railways accomodate to cope with the modernized railway facilities rather than covering electrification project.

The content of courses of education and training is roughly classified as follows.

1) Facilities control course

Education in civil works, rail maintenance technology and practice with training facilities.

2) Land acquisition course

Education and training regarding contract of land acquisition.

3) Civil engineering course

Fandamental engineering regarding various work and education in advanced technology, practice with training facilities and training track.

4) Architectual course

Education in architectural technology, practice with training facilities and field training.

(2) Education System

The system of education and training for modernized railway facilities may duplicate some of the present education system but is roughly classified as follows.

1) Facilities control course

The facilities control course promotes education for clerical staff for facilities and provides management control knowledge to technical staff.

Main curruculum include control of working place, rail maintenance technology, rail maintenance work, environmental assessment, inspection of structure, safety control, etc.

2) Land acquisition course

The land acquisition course cover the contract business and acquisition of land.

Main curriculum include contract for constructing, environmental assessment, land acquisition, etc.

3) Civil engineering course

The civil engineering course gives advance education for high technological skill for projects, compensation for damage due to construction work, education for planning and designing of station yard, buridges, tunnels, track structure and track maintenance.

Main curriculum include the project planning, safety control, supervision of design and construction work, cost estimation, inspection of tracks, track maintenance equipment, measuring technology, environmental assesment, etc.

4) Architectural course

The architectural course educates in the skills and knowlege regarding desigen technology and relate to work execution.

Main curriculum include field instruction, facilities control business, method of construction, construction cost estimation, design drawing, etc.

(3) Training System

The training system for construction is preferably to be made through a practice system using related equipments. Slides, movies, VTR and other audiovisual equipment can be effectively used also.

The most urgent training to be conducted to cope with modern transportation seems to be the improvement of skills in maintenance.

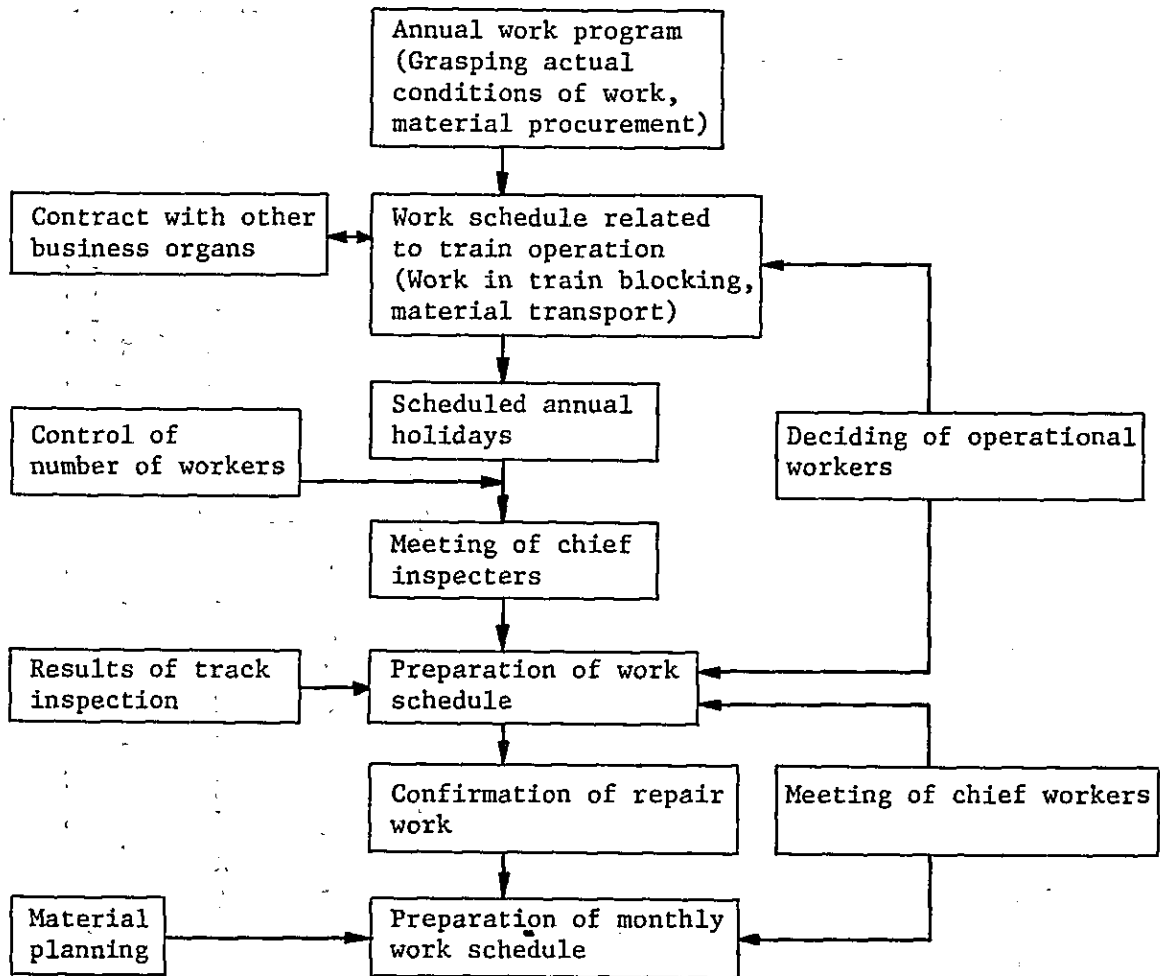
It is said that track maintenance has been most economically carried out by non-periodical repairs. Since train frequency has increased and track occupancy hours for maintenance are restricted, periodical repair system is being adopted to improve the quality of work as well as to speed up work by automating track maintenance work.

Training in track maintenance work comprises exercise in field and practice at training school.

But it is desirable to practice all these work systematically at training school. Track maintenance work is carried out according to weekly work program after establishing a monthly work schedule based on the annual work program as shown in Appendix 10.3.17.

Track maintenance work comprises repair work, material repair work and material renewal work.

Appendix 10.3.18 gives the content of maintenance works and main equipment used.



Appendix 10.3.17 Track Maintenance Work Flow

Appendix 10.3.18 Track Maintenance Work

Track Maintenance Work	Content of Work	Main Machines
<p>1. Track repair work</p> <p>(1) Track space</p> <p>(2) Mending of levelling and overall tamping</p> <p>(3) Straightening</p> <p>(4) Mending joint lifting</p> <p>(5) Adjustment of joint gaps</p> <p>(6) Correcting rail canting</p> <p>(7) Aligning sleepers</p>	<p>Temporarily loosen fastening device, move rails laterally and secure proper track space.</p> <p>Compact ballast to the level of rail face.</p> <p>Correct deformation of side pressure by vehicles</p> <p>To correct the drop of rail joints, treat joint plate and compact ballast on the joint</p> <p>A space between rail joint is corrected to proper distance.</p> <p>Correct slanted vertical axis of rail due to rotted tie, worn rail and improper counting.</p> <p>Correct space between sleepers which will cause uneven rail face, track space and wrong passage.</p>	<p>Power wrench</p> <p>Tie tamper</p> <p>Curve lining corrector</p> <p>Joint plate corrector</p> <p>Space adjuster</p> <p>Tie replacer</p>
<p>2. Parts repair and correction</p> <p>(1) Repair of fastening devices</p> <p>(2) Repair of sleepers</p> <p>(3) Repair of bridge sleepers and accessories</p> <p>(4) Screening ballast</p> <p>(5) Supplementing ballast</p>	<p>Refastening and mending work of screw spikes, tie plates, track pat, etc.</p> <p>Repair of cracks and dents on sleepers</p> <p>Repair packing and hook bolts to fasten sleepers with bridge rails.</p> <p>Screen ballast mixed with earth and sand</p> <p>Replenish ballast which becomes short due to filling in the road bed and screening.</p>	<p>Power wrench</p> <p>Sleepers replacing device</p> <p>Bolt unfastener</p> <p>Ballast cleaner</p> <p>Ballast spreading, tie tamper</p>
<p>3. Replacement work</p> <p>(1) Replacing rails</p> <p>(2) Replacing sleepers</p> <p>(3) Replacing ballast</p>	<p>Replace with same type of rail or heavier rail for reinforcing the track</p> <p>Replace defective sleepers</p> <p>Remove existing ballast, which becomes defective, and place new ballast from the under surface of ties on the road bed.</p>	<p>Rail renewal machine</p> <p>Sleepers renewal machine</p> <p>Ballast distributing</p> <p>Tie tamper</p>

(4) Education and Training Period

Education and training of the construction staff of the Indonesian State Railway is presently conducted at Railway Engineering College and Training Center, also at each work site for practical training.

The Railway Engineering College mostly gives rail maintenance and civil work courses for a period of 3 years to 30 students. Bandung Training Center gives courses mostly on civil works and management and technical control for a period of 3 ~ 6 months, 2 ~ 4 times a year, to 60 ~ 120 trainees.

From the foregoing, education and training to meet modern railway systems is carried out with the existing system. Training of instructors, review of curriculum and development of various training equipment will become most urgent.

10.3.5 Rolling Stock Workshop

(1) Change of Work by Electrification and Education and Training of Staff in the Workshop

When this electrification project is executed, because all big diesel locomotives presently used for the main lines will be replaced with high performance electric locomotives, the type of work at locomotive workshops must be greatly changed in both quality and quantity.

Repair work of electric locomotives compared with that of diesel locomotives are given below. It is necessary to shift to a new rolling stock repair system and carry out education and training of the staff based on these features.

a. Features of electric locomotive repair work

The following 4 features are noted as electric locomotive repair work from the standpoint of both its construction and operation.

① Procurement of a large staff with fundamental knowledge and technology in electricity

The workshop carries out periodic inspections of rolling stock and guarantees the performance and functioning of rolling stock for a long period until the next periodic checkup.

Therefore, in carrying out repair of electric locomotives, a large staff which has electric knowledge and technology, covering direct working crew and supervisory staff, is required. Education and training must be planned to complement the staff.

② Decrease of dismantling and mechanical work and increase of measuring work

Compared with diesel locomotives, mechanical parts of electric locomotives wear less through revolving and sliding. Therefore, the volume of dismantling and mechanical work largely decreases, while measurement of electrical characteristics and determination of conditions and confirmation of functions greatly increase, requiring greater precision.

For determining conditions, since the changes of characteristics over time must be ascertained to establish reliability control, accumulation of measured data and analysis technology are indispensable. Therefore, development of various measuring instruments and qualified technicians is one of the most important item.

③ Countermeasures for improving reliability and increasing work load due to the extension of inspection cycles

Since mechanical parts wear less with electric locomotives, as mentioned in the preceding section, and reliability is remarkably improved by the introduction of electronic parts for electric parts and the advance of design technology and materials used, it has become possible to greatly extend the cycle of periodic inspections.

The extension of this inspection cycle improves the operation rate of locomotives and increases profitability, but the following effects will be brought upon the workshop.

- Decrease of total work volume due to the decrease of frequency of periodic inspections.
- Increased volume of dust attached and accumulated on rolling stock due to its continued use over a longer period of time (increased amount of cleaning work).
- Increased amount of fatigue of mechanical parts due to their continued use for a long period of time (improvement of precision of inspection and diagnosis, increased rate of repair, and improved repair accuracy).

Therefore, it is necessary to establish countermeasures for items 2 and 3 above.

④ Increase of the number of rolling stock handled

Since a-② and a-③ above lead to abridgement of the number of work days for repair in the workshop and decrease of the total work volume, when the workshop specialized in the repair of diesel locomotives converts to the repair of electric locomotives, a greater number of rolling stock can be repaired.

Therefore, to make effective use of workshop capacity, modernization— such as introduction of scientific control measures including entry/exit planning, process control, crew management, material

control, workshop management and control work —is required.

b. Education and training program

As mentioned in the preceding section, there are fundamentally great differences between the repair of diesel locomotives and electric locomotives and it is necessary to convert the control and management system of the work system and overall workshop as well as to make technical changes in individual jobs.

Therefore, in carrying out the repair work of electric locomotives, it is best to undertake integrated conversion education, including modernization of control and management as well as the new technology of locomotive repair, and advance conversion mostly by those given such education.

The following are given as the courses of education and training for above.

- Technical course for directly working on electric locomotive repair
- Course on electric and mechanical measurement
- Course on electronic technology
- Course on data control, such as inspection data
- Course on production control
- Course on rolling stock plan and maintenance
- Course on safety and sanitation
- Course on workshop facilities
- Course on clerical control, such as accounting, personnel and materials
- Course on technical control, such as control of shops and general technical control.

These courses are given in two forms: general courses for workers and higher courses for supervisory and management personnel.

It is desirable to give these courses progressively, according to the present condition of workshop staff and management policy of PJKA, by assigning priorities to the courses.

(2) Examples of Technical Courses for Directly Working on Electric Locomotive Repair

It is most desirable to have persons with experience in the corresponding section of diesel locomotives for those assigned in each work section of electric locomotive repair for high reliability of repair technique. It is at least necessary to have persons with experience in similar technology on other rolling stock. The following are examples based on such criteria.

a. Type of education and training

The courses of education and training are in 3 types: course for direct workers, course for foremen who lead direct workers and carry out instruction and promotion of work; and a course for educate instructors to direct workers and leaders.

With regard to supervisors in the field and technicians of rolling stock in the control department, separate courses are prepared according to the job and are excluded from this example as learned from the above instructors.

b. Items of education and number of hours

The main items of education and the rough number of hours for each course are as given in Appendix 10.3.19. The content is prepared on the basis of the following thinking.

① The special work section is roughly classified into body, bogie, air brake equipment and general electric equipment and light electric equipment sections.

The greatest number of hours is allocated to special field practice with the greatest emphasis upon special education.

For high precision and high efficiency work, special academic courses are given secondary importance (to special practice) since the work requires knowledge of the construction and features of locomotive equipment, and full understanding of the method of rational inspection and repair.

② For maintaining high precision and high efficiency work, its position and role in overall electric locomotive repair work must be understood. Also, the relationship with other technical sections in

regard to the technical processes must be understood. In academic courses, an outline of electric locomotives is given, and for practice, many hours are allocated to general practice.

For the foregoing example, the number of days required for each course is given below.

- (1) Instructors course - About 4 months.
- (2) Leaders course - About 3 months
- (3) Workers course - About 3 months

Appendix 10.3.19 Principal Items of Education and Estimated Hours (Example)

Courses		Outline	Hours of Lesson				
			Educating Instruction	Converting Education of Leaders of Work Team	Converting education of workers		
Academic Courses	General	1. Technique of guidance education	12	4			
		2. Safety of work	20	12	22		
		3. Total	32	16	22		
	Inspection of rolling stock	4. Control of rolling stock	Method of advancing control and maintenance system of rolling stock and improvements of rolling stock	4	4	4	
		5. Control of process	Method of improving process control system	8	8	8	
		6. System of rolling stock inspection	Main points in new rolling stock inspection system and practice.	8	8	6	
		7. Total		20	20	18	
	Inspection facilities	8. Inspection equipment	New inspection equipment and its maintain system	8	6	10	
		9. Inspection data	Effective use of inspection data	10	8	4	
		10. Total		18	14	14	
	Electric locomotive	11. Outline	Overall electric locomotives and construction of main equipment and method of inspection	114	62	60	
		By section	A. Body	Details of construction and method of inspection by special courses	(112)	(102)	(146)
			B. Bogie	"	(112)	(102)	(146)
C. Air Brake equipment			"	(112)	(102)	(146)	
D. Electric equipment			"	(112)	(102)	(146)	
E. Light electrical equipment			"	(112)	(102)	(146)	
F. Total			112	102	146		
12. Electric locomotive total		226	164	206			
13. Academic courses total			296	214	260		
Practice	Electric locomotive	14. Outline	Rough practice of inspection work of overall electric locomotives	112	82	34	
		Special courses	A. Body	Practice by special courses	(184)	(164)	(160)
			B. Bogie	"	(184)	(164)	(160)
			C. Air brake equipment	"	(184)	(164)	(160)
			D. Electric equipment	"	(184)	(164)	(160)
			E. Light electric equipment	"	(184)	(164)	(160)
	F. Total		184	164	160		
16. Practice total			296	246	194		
17. Grand Total			592	460	454		

Note: The "Lesson Hours" are given in the case of the trainee receiving lessons in his country in his own language.

c. Schedule of education and number of persons

The number of persons educated must be planned according to the amount of inspection and repair work for electric locomotives and the period required.

Appendix 10.3.20 gives a plan based on the above. This chart shows the number of electric locomotives allocated each year, the first principal equipment inspection, general inspection and number of men required for the repair of locomotives and the average number of direct workers according to the work load and the amount of rolling stock allocated. And the figures until the first general inspection in 1993 are larger than the actual number required.

Therefore Appendix 10.3.20 shows the relations between the period of education and the number of men.

① At the time of the allocation of the first new electric locomotives, a number of men required for temporary inspection is required. At the time of the 1st principal equipment inspection and overall inspections in 1990~91 and 1993, the number of men must be arranged according to the volume of work.

② At least 5 men are required for each work section at the time of the 1st allocation of new electric locomotives because of the variety of work for each section.

③ The lower part of this chart shows an education plan based on the foregoing. Instructors (3 per special section, total:15) are educated until the 1st allocation of new electric locomotives. Work team leaders are educated until the 1st principal equipment inspection. A total number of workers is educated for each year incrementally. Thus repair of electric locomotives will be carried out smoothly.

Since it is difficult to carry out field practice at the time of training instructors because electric locomotives are not available and the content of the course is sophisticated, it is necessary to consider to dispatch men to locomotive factories or to consider to countries where similar locomotives are in use.

d. Education facilities

Since the number of men educated simultaneously for team leaders and workers for each course is about 10 ~ 25, as shown in Appendix 10.3.20 Education Plan, academic education requires only a small class room, a few text books and audivision equipment.

Practical education must be conducted for the most important items. Since new electric locomotives are not assigned at the time of 1st instruction and generally no electric locomotives enter the workshop on regular basis until the 1st principal equipment inspection, practical learning is difficult.

The following 3 plans are considered as countermeasures. Since learning practical skills is the greatest objective, PJKA's special consideration is desirable.

① Since electrification takes a long period of time and is gradually developed, 1 completed electric locomotive is allocated to the place of practice and used for training the inspection crew of the workshop and depot.

② Reserve electric locomotives assigned to the depot are used as education material so far as it does not interfere with the operation of locomotives.

③ If complete locomotives cannot be used as educational material, reserve equipment purchased at the same time as the new locomotives is used instead.

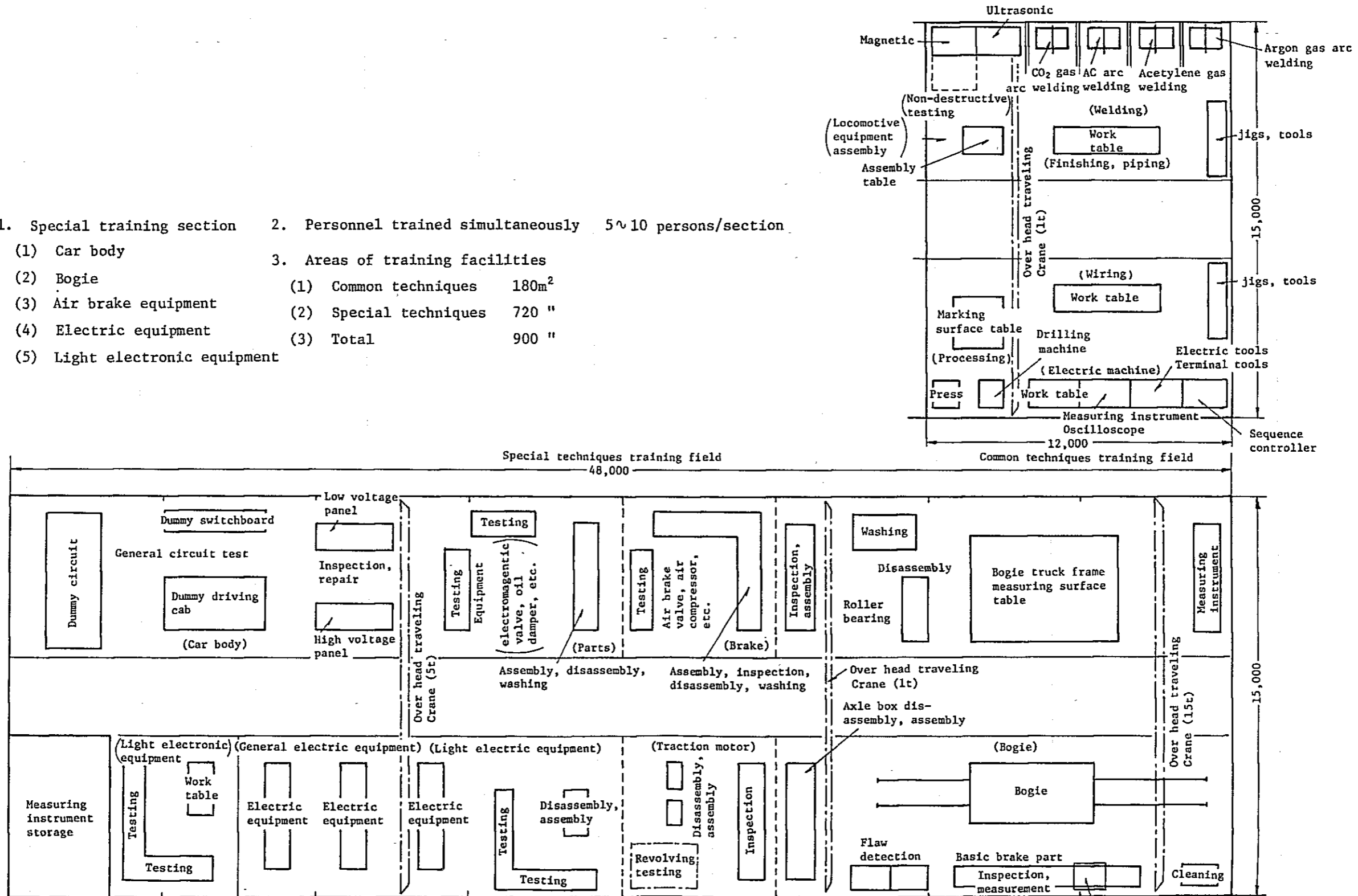
e. Conclusion

The foregoing gives an example of an education and training course. Since conversion from diesel locomotive repair to electric locomotive repair leads to fundamental changes in the workshop work, as mentioned above, education of staff to cope with the situation will bear great importance.

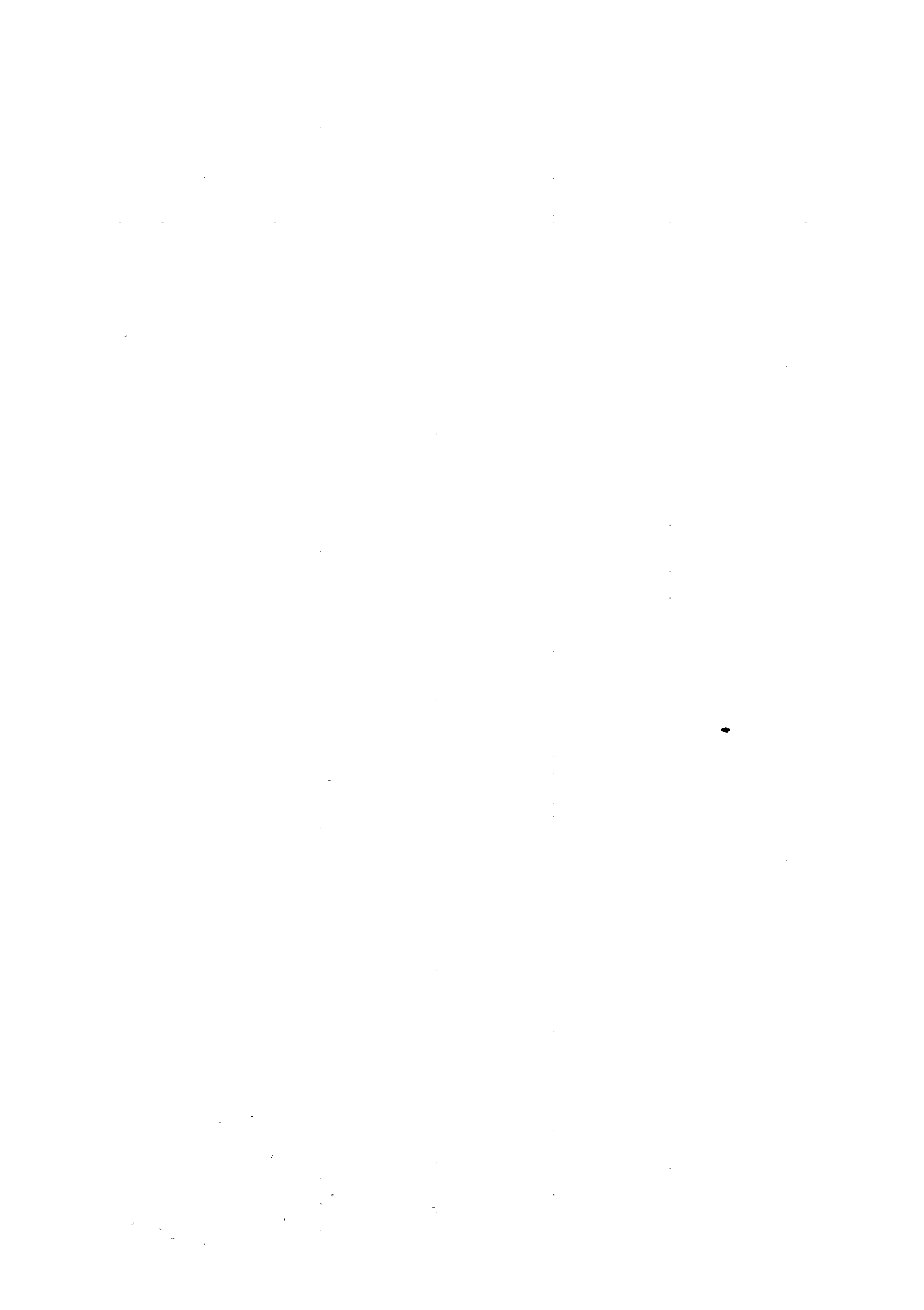
Therefore, further studies are required to establish the most appropriate program of education of PJKA.

1. Special training section
 - (1) Car body
 - (2) Bogie
 - (3) Air brake equipment
 - (4) Electric equipment
 - (5) Light electronic equipment
2. Personnel trained simultaneously 5~10 persons/section
3. Areas of training facilities

(1) Common techniques	180m ²
(2) Special techniques	720 "
(3) Total	900 "



Appendix 10.3.21 Electric Locomotive Maintenance Personnel Training Facility



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