CHAPTER-II

FINANCIAL APPRAISAL OF RAILWAY PROJECTS

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201 General Principle. - Investment decisions are among the most interesting and difficult decisions to be made by the Managements. It is fundamental to railway system as a commercial undertaking that expenditure other than that wholly chargeable to Ordinary Revenue incurred on new assets or for improvement of existing assets should be financially justified and sanctioned before it is actually incurred.

202 As an exception to Para 201, while no financial justification as such need be given in the following cases, it should be seen that the scale of expenditure incurred is as economical as possible consistent with the extant orders, if any, on the subject:-

(a) when the expenditure is incurred on a statutory obligation (for example, the fencing of machinery) ;

(b) when the expenditure is unavoidable on considerations of safety;

(c) when the expenditure is incurred on passenger amenity works; and

(d) When the expenditure is incurred on labour welfare works except residential buildings for which special rules are applicable.

Note:--(1) When expenditure on any of the above items forms part of a scheme and is not essential independently of the scheme, the total cost of the scheme, inclusive of the cost of the above works, should be financially justified.

(2) In the case of savings in engine days or wagon days or both by avoidance of or reduction in detentions to stock, etc., the financial justification should be worked out on the basis of increased locomotive or wagon, etc., utilization and consequent postponement of the purchase of new engines or wagons, etc., if such saving can be definitely secured, and not on the basis of the earning capacity of the stock saved.

(3) Savings on a particular railway should not be taken into account if they mean a loss on another railway. In such cases, the interest of railways as a whole should be considered.

(4) No credit should be given to a proposed scheme for a saving which can be achieved regardless of whether the proposed scheme is or is not embarked upon.

(5) If flag stations are included in the new scheme, the cost of operating them should be taken into account as an item of expense in working out the financial justification of the scheme.

(6) Where a number of works required in connection with and/or increasing the line or transhipment capacity have to be carried out on different stations of a section as part of a scheme, the financial justification should be worked out for the section as a whole, as it might be difficult to allocate anticipated savings to individual stations.

(7) Expenditure on works required for meeting statutory obligations or on consideration of safety should be subjected to proper scrutiny to see if the proposal is the result of a fresh development not already covered by the existing rules, or for implementation of a new recommendation of the Standing Safety Committee (accepted by the competent authority) or any Commission of Enquiry set up by Government, as the case may be.

203 Scrutiny by Accounts Officer -The Accounts Officer in his position as the Financial Adviser to the Administration, should carefully scrutinise the justification for proposed expenditure with reference to the principles enunciated in this Chapter and other orders on the subject. Even in cases where the return on the outlay is not the determining factor, it will be incumbent on him to examined and offer his advice on the general merits of the proposal in the spirit of a prudent individual spending his own money.

204 Test of remunerativeness: The net financial gain expected to accrue from a project be either by way of savings in expenditure or increase In net earnings (i.e. gross earnings less working expenses), or a combination of both. Except in case residential buildings, assisted sidings and rolling stock to which special rules are applicable, no proposal for fresh investment will be considered as financially justified unless it can be shown that the net gain expected to be realized as a result of the proposed outlay would after meeting the working expenses or average annual cost of service (see para 217) yield a return of not less than 10 percent under DCF method on the initial estimated cost.

(Authority: F (X)-II/2011/ROR/1 dated 05.10.2017)

Note- (1) Interest during construction should be added to the cost (excluding that chargeable to Revenue) of the projects, the construction of which is likely to last for more than one year.

(2) Depreciation should be calculated on the total cost of the scheme and not only on the portion chargeable to Capital, unless the contrary procedure can be justified in any particular case. However, depreciation as an element of working expense is to be ignored for assessing annual cash flows under the DCF Method (see para 228).

(3) In the case of construction of bridges, maintenance charges should include, besides the maintenance charges on the bridges proper, the maintenance charges of the training works also.

(4) The element of interest charges, vide item (d) of para 215, should be ignored in determining the average annual cost of service in the case of a new project, though it should otherwise be included for the purpose of working out the comparative cost of 2 or more alternative schemes.

205 Following is an illustrative list of the various types of investment proposals which must pass the prescribed test of financial remunerativeness: -

5 New Lines: -

(1) Project oriented or ‘single purpose’.
(2) General purpose.

(b) Line Capacity Works-

(1) Gauge conversions.
(2) Doublings.
(3) Major Signalling Schemes i. e. Tokenless Block Working, Automatic Block Signalling., CTC, Route Relay Interlocking, etc.
(4) Lengthening of loops and/ or provision of additional loops.
(5) Crossing stations.
(6) Strengthening of electric traction distribution system and/or major modifications to electric traction installations.

© Yard Remodellings and Terminal Facilities-

(1) Marshalling yards.
(2) Goods and passenger terminals.
{3) Transhipment points.

(d) Microwave and other Telecommunication Works.

5 Change of Traction (Electrification and Dieselisation) and provision of Loco Sheds 3herefore.

5 Introduction of new services-. Passenger trains, container services, street delivery and collection, out agencies etc.

(g) Workshops---

(1) Production Units.
(2) Repair Units.

206 It may sometimes be necessary to reject a more economical alternative, because of considerations on which it is difficult to put a precise money value. If on the strength of any such factor a proposal is adopted that is less economical than its alternatives, the reasons determining such a choice should be recorded in the report of the estimate containing such proposals. In those cases in which the reasons as recorded are not accepted by the Accounts Officer, the latter should offer his remarks in his certificate of verification of the estimate concerned, so that these remarks may be taken into consideration by the authority sanctioning the proposal.

207 In regard to works proposals estimated to cost Rs.50 lakhs or more, which are intended to increase line capacity, detailed traffic surveys should be conducted by a team consisting of officers of requisite status and experience from the Commercial/Operating Department and the Accounts Department. Where the traffic survey is conducted along with an engineering survey (Reconnaisance, Preliminary Engineering or Final location), the traffic survey report should be prepared under the general guidance of the Leader of the Team who will be an officer of appropriate status from the Civil Engineering Department.

208 **Provision of Rolling Stock –** Investment proposals for purchase/manufacture of additional rolling stock are to be justified on the basis of a general increase in the level of traffic which may or may not require line capacity works being taken up at the same time for the anticipated level of traffic. Where a line capacity work is justified due to anticipated increase in traffic, and also in the case of proposals for new line construction, the initial cost estimate should, for the purpose of Project appraisal, invariably include the cost of the rolling stock and the financial return on the project should be measured with reference to the overall initial cost of the project including the cost of rolling stock.

209 A very substantial part of the capital-at-charge on the Railways is represented by the investment in rolling stock. The assessment of rolling stock required for moving additional traffic is directly related to the targets for movement of freight traffic, commodity-wise as projected by the Planning Directorate of the Railway Board. For additional passenger coaches, the Planning Directorate makes a forecast of the rate of growth of passenger traffic over a specified plan period. This detailed exercise should take into account the existing and projected operating parameters and efficiency indices such as wagon turn-round, provision for 'sickness', requirements for busy season, etc. In all cases where a distinctly new type of rolling stock is proposed to be acquired or manufactured, a detailed financial appraisal should be made of the proposed investment to see that it yields the requisite financial return.

210 **Scheme for change of traction –**Projects connected with the dieselisation and electrification are best formulated on a long term basis after considering the relative claims of the various high density sections of the Railways for better traction. A thorough techno-economic appraisal should be made in respect of each of the various sections proposed to be taken up for change of traction. Wherever possible, priorities for taking up the scheme for change of traction should be determined on the basis of the relative financial return expected from the various alternative schemes.

211 **Earnings estimate –**The earnings expected from additional traffic whether on the existing line or on a new line should be very carefully estimated in the traffic survey report. The estimate of earnings should be worked out for each commodity and for the lead from its origin up to the point of termination of the traffic. It should be ensured, however, that in case line capacity works are required to be undertaken in the contiguous section or Railway system over which the additional traffic is expected to be moved, the initial cost estimate for the scheme takes into account the cost of such additional line capacity works over the entire lead of the traffic.

212 In the case of a 'project-oriented' new line, i. e., when a new railway line is proposed to be built to serve the needs of a specific project or industrial complex, the estimated earnings from the traffic which will move on the line should be assessed realistically in consultation with the authorities

concerned with that specific project. It is, however, essential that the Traffic Survey Team also makes its own independent assessment of the likely traffic which the project is expected to generate, instead of placing complete reliance on the data furnished by the Project Authorities or, in the case of a public sector undertaking, the concerned Department of the Government. The traffic survey officers must deeply probe into the various stages of scheduling of the project; e. g. what commitments have been entered into by the Project Authorities and whether the progress in the execution of the project is adequate to justify any specific claim in respect of the anticipated traffic. While working out the additional earnings from the traffic expected to move on the new line over its entire lead, the Railway Administration should make a careful assessment of the line capacity works required or terminal or any other facilities to be developed on the contiguous section/Railway system to carry this traffic. As stated in Para 211, if additional works are considered necessary, the scope and cost thereof should be defined and included in the main project estimate. In case it is considered that adequate line capacity exists in the contiguous section or Railway system so that the additional traffic on the new line can be carried throughout its lead on the Railway without any hindrance the Railway Administration should confirm that no additional works would be required to be undertaken anywhere on the system to carry this traffic.

213 This approach inevitably involves grouping of a number of works with a common (or complementary) objective, such as for movement of additional traffic by improving line capacity, or for avoidance of detention to trains through yards. 'Group Justification' in such cases should be worked out for the project as a whole in case the individual works cannot stand on their own and must necessarily be taken up as part of a single project. However, where each of the works is self-contained, selection of priorities after consideration of various alternatives should necessarily be done with a view to 'sub-optimization', i.e. to realise the optimum benefit for the project by substituting the less remunerative sub-works by those anticipated to improve the return further.

214 Before proposals are made out for new marshalling yards or major remodelling of existing marshalling yards or mechanisation of marshalling yards, goods terminals and transhipment yards, etc., a work study team should go into the actual working and suggest such improvements in operation as can be achieved even with the existing facilities. Additional facilities should be justified only after all the possibilities of improvement in working by optimum utilisation of the existing assets have been fully explored and evaluated. For line capacity works generally Master Charts should be prepared of the existing (optimum) capacity, the extent to which it is presently utilised, and the capacity expected to be available after the provision of the proposed facilities. The additional traffic beyond the optimum existing capacity of the section should only be reckoned for financial appraisal.

215 **(A) Assessment of Working expenses/Average Annual Cost of Service.–**The average annual cost of service of an asset is the sum of

(a) the average annual cost of operation ;
(b) the average annual cost of maintenance and repairs of the assets ;
© the annual depreciation charges (but see para 228) ; and
(d) annual interest charges on the cost of the asset.

Note. –In computing working expenses in financial evaluation of any capital expenditure proposal under D. C. F. technique, only items (a) and (b) above should be reckoned.

(B) Average cost per unit of service.-- The average cost per unit of service is obtained by dividing the average annual cost of service by the total number of units of service rendered by the asset in a year. In comparing two assets on this basis, care must be taken to see that the number of units of service taken into account in both cases represent the actual number utilised or consumed. Units of service rendered by either of the assets in excess of the actual requirements should be ignored in computing the cost per unit of the asset.

216 For the purpose of assessment of the average annual cost of operation and maintenance, full use should be made of the traffic costing data relevant to the investment proposal under consideration. Correct application of the cost data and, in particular, assessment of the direct/variable and the indirect/fixed or semi-variable costs is very important in arriving at a realistic estimate of the working expenses in respect of the proposed scheme.

217 In applying the unit cost data for working out the cost of moving the additional anticipated traffic, it has to be considered whether it would be reasonable to adopt the 'incremental cost' approach or to take 'fully distributed costs' into account. Logically, it would be realistic to work on the basis of 'incremental costs' for any small increases in traffic and over the short run. In the long run, however, even the so-called fixed costs will vary, and the incremental or marginal costs may fail to cover such semi-variable expenses. On the other hand, it would be equally unreasonable to apply fully distributed costs in all cases while working out the financial implications of a line capacity work. A realistic (though somewhat conservative) approach would, therefore, be to adopt 'long term variable costs' (based on percentages given at the end of Annexure 'A' for each item of cost) which will ensure not only that projects are not thrown out because of the adoption of the 'fully distributed costs' but also that a project is considered as remunerative so long as it yields the requisite return after meeting the 'long term variable costs'.

218 **Provision for depreciation-** Depreciation provision in respect of an asset will be equal to the annual payment to a Sinking Fund which, together with the interest thereon at such rates as may be prescribed by the Railway Board, when compounded annually, will provide the amount required for the replacement of the asset at the end of the normal life. The duration of the Sinking Fund payment will be determined by the 'normal life' of the asset, and the amount of the annual Sinking Fund payment will be ascertained by referring to the table reproduced as Annexure 'B' to this Chapter, which shows the annual amount payable at different rates of interest ranging from 2% to 8% (over periods extending up to 100 years)

219 **Normal lives of assets –**For the purpose of the annual Sinking Fund payment referred to in para 218, the normal life of the various classes of railway assets should be taken as in the table below :-

***(i)* CIVIL ENGINEERING ASSETS**

S.No.	Class of Assets	Average life in years			
		ROUTES			
		A & B	C(Sub)	D	E
1. **RAIL & FASTENTING etc.**					
1.	*Rail & Fastenings*				
(a).	*Rails*	*20*	*15*	*30*	**30*
(b).	*Wooden Sleepers*	*10*	*10*	*10*	**10*
(c.1)	*Metal sleepers (Cast Iron & Steel)*	*20*	*20*	*20*	**20*
(c.2)	*Fittings steel trough*	*10*	*10*	*10*	**10*
(d).	*Concrete sleepers*	*35*	*35*	*40*	**40*
(e).	*Elastic Fastenings*				
(i)	*Elastic Rail clips*	*5-8*	*5-8*	*8-10*	**8-10*
(ii).	*Rubber Pads/ Liners*	*2-4*	*2-4*	*4*	**4-6*
(f).	*Switches*	*4*	*2 / 3*	*5*	**5*
(g).	*Crossings*	*5*	*4/5*	*8*	**8*
2 (A). MAJOR BRIDGES					
(a).	*Bridges work- Steel work*	*60*			

(b).	*Bridge Masonry*	*100*
©.	*Structures Steel*	*60*
(d).	*Structure- masonry and cement concrete*	*65*
(e).	*RCC Bridge Works*	*60*
(f).	*Pre-stressed concrete-Bridge work*	*40*
***(B).* MINOR BRIDGES**		
(a).	*Bridges work-Steel work*	*60*
(b).	*Bridge Masonry*	*100*
©.	*Structures Steel*	*60*
(d).	*Structure- masonry and cement concrete*	*65*
(e).	*RCC Bridge Works*	*60*
(f).	*Pre-stressed concrete-Bridge work*	*40*
3. FOOT OVER BRIDGES		
(a).	*Bridges work-Steel work*	*60*
(b).	*Bridge Masonry*	*100*
©.	*Structures Steel*	*60*
(d).	*Structure- masonry and cement concrete,*	*65*
(e).	*RCC Bridge Works*	*60*
(f).	*Pre-stressed concrete-Bridge work*	*40*
4.TRACK MACHINE (All Categories)		*15*

* The service life as indicated in the table is general life/service life for track components. However renewal/replacement will be subject to various criteria laid down in IRPWM about its condition.

***(ii)* COMPUTERS AND OTHER IT SYSTEMS**

S.No.	Class of assets	Average life in years
1	Active (viz. MIS systems including external storage systems and their connects) & Passive (viz. Network cabling) networking equipments	8 years
2	Small Multi-user systems and power supply equipments (viz. individual office LANs, UPS)	4 years
3	PCs	3 years
4	Secondary systems (Portable Computers/Laptops etc.)	4 years
5	Thin clients/Dumb terminals (for PRS/UTS etc.) (Authority: Board's letter no.2002/AC-II/2/10/Vol.II dated 2 2.08.2012)—acs no.73	5 years (Local administration may approve premature condemnation up to 2 years earlier than the end of average life)
6	Printers (All type) (Authority : Board's letter no. 2002/AC-ll/2/10/Vol.ll dated l5-03-2012)—ACS NO.71 for S.No. 1 to 6	3 years (Local administration may approve premature condemnation up to 1 year earlier than the end of average life)
7.	ATVM (Composite Unit) (Authority: Board's letter no.2002/AC-II/2/10/Vol.II dated 2 2.08.2012)—acs no.73	4 Years

***(iii)* ELECTRICAL ASSETS**

S.No.	Class of assets	***Average life in years***
1.	*Electric Locomotives*	*35*
2.	*EMU/Metro Motor Coaches and EMU/Metro Trailor Coaches*	*25*
3.	*Rail Bus*	*15*
4.	*Over Head Power Lines*	*40*
5.	*Over Head Traction Line excluding contact wire*	*60*
6.	*Electric under ground Cables*	*30*
7 (a)	*Electric contact wire (Alm.)*	*25*

S.No.	Class of assets	***Average life in years***
(b)	*Electric contact wire (Copper)*	*40*
8.	*Electric Power plant excluded oil engine driven*	*25*
9.	*Electric Plant above 25 HP*	*25*
10.	*Electric power plant oil engine driven (diesel)*	*15*
11.	*Overhead traction lines contact wire*	*40*
12.	*Electric Machinery others*	*30*
13.	*Electric Sub Station Building*	*50*
14.	*Water Cooler, Refrigeration, Air Conditioner, hospital and domestic appliance*	*5*
15.	*Internal wiring of building*	*10*
16.	*Switch Gear*	*25*
17.	*Instruments*	*25*
18.	*Electric Pumps*	*20*
19.	*Electric Lifts & Hoist*	*20*
20.	*Ceiling Fans*	*20*
21.	*Electric Battery charging set*	*15*
22.	*Flood Light Projection*	*10*
23.	*Battery lead Acid*	*4*
24.	*Coach wiring*	*12*
25.	*Carriage Fans*	*10*
26.	*Air conditioner Central unit –above 3 tons*	*10*

<u>*B)* Equipments required for replacement through DRF/ Sinking Fund.</u>

S.No.	Class of assets	Average life in years
1	**AC EQUIPMENT**	
(i)	25 KV Inverter	15
(ii)	AC Control Panel (As per F-I codal life is 12 yrs.)	15
(iii)	Inverter Panel	15
2	**TL Power Equipment**	
(i)	4.5/18/22.75/25 KW Alternator (As per F-I codal life of Dynamo is 20 years)	12
(ii)	800 A.H.L.A Battery	4
(iii)	1100 AH VRLA (SMF) Battery	4
(iv)	Diesel Engine for Power Cars	16
(v)	Alternator for Power Car	15
3	**Electric Locomotive Equipments**	
(i)	All Electric rotating machines up to 25 HP used on Electric Locomotives, EMU's Coaches and stationary items	12
(ii)	All Electric rotating machines above 25 HP and upto 750 HP used on Electric Locomotives, EMU's Coaches and for stationary items	12
(iii)	Traction Motor	18
(iv)	Traction Converters	18
(v)	Auxiliary Converters	18
(vi)	Control Electronics	18
(vii)	Tap-Changer	35
(viii)	Rectifier Block	18
(ix)	Traction Gears	12
(x)	Motor Suspension	12
(xi)	Bogies with Wheel	18
(xii)	Armature for Traction Motors	15
(xiii)	Stator for Traction Motor	18
(xiv)	Commutator for Traction Motor	15
(xv)	Locomotive re-cabling	18
4	Microprocessor based control and fault diagnostic system	12
5	Speedometer cum recorder and monitoring system	10
6	BA Panel	18
7	VCB	18
8	DBR (roof mounted)	9
9	DBR (vertical mounted)	9
10	Pantograph	12
11	**TRD Equipments**	

Contd 2-

(i)	Current/Potential/transformer	30
(ii)	Earthling system in sub-station *etc.*	15
(iii)	Lighting arrestor (Gapless type)	15
(iv)	Lighting arrestor (Convertor type)	15
(v)	Buster & Terminal connection	30
(vi)	Battery charger	15
(vii)	Relay (Electromechanical)	15
(viii)	Relay (Electronic)	15
(ix)	Instruments (Electrical)	30
(x)	Instruments (Electronic)	30
(xi)	Relay testing kit & other testing equipment	15
(xii)	**OHE conductors & components - For Normal Zone**	
(a)	OHE fixed structures	
	(i) Mast / Structure / Guy Rod / foundation	80
(b)	**Other than fixed structures**	
	(i) Cantilever assembly and all types of insulators	40
	(ii) Isolators / ATD	30
(c)	**Wires**	
	(i) Catenary / feeder wire / return conductor	60
	(ii) Contact wire	*40 or on the basis of condemning date
(xiii)	**OHE conductors & components - For Polluted Zone**	
	(i) Cantiliver assembly & all types of insulators	On condition basis
	(ii) ATD	On condition basis
(xiv)	**PSI equipments**	
(a)	**Substation's equipments**	
	(i) Power Transformer / Auxiliary Transformers	40
	(ii) All types of cables	30
	(iii) Fixed capacitor bank	15
(b)	**Control equipments**	
	(i) Circuit Breaker, panels, all switchgear and protective circuits	25
	(ii) SCADA system	10
(xv)	**Transmission line equipments & components**	
	(i) 110KV/132 KV, ACSR conductors / Earth wire / insulators / Tower fittings	60
12	38 Tower Wagons (both 4 wheeler, 8 wheeler & all types)	40

(Authority: Railway Board’s letter no 2002/ACII/2/10 Vol II dated 29.11.2019)

C). Equipments required for replacement through Revenue

S.No.	Class of assets	***Average life in years***
1	**Electric Loco Equipment**	
(i)	*Armature for Traction Motor*	*15*
(ii)	*Stator for Traction Motor*	*18*
(iii)	*Commutator for Traction Motor*	*15*
(iv)	*Auxiliary Motor*	*18*
(v)	*Arno Converter*	*18*
(vi)	*Blower Impeller/Casing*	*10*
(vii)	*Locomotive re-cabling*	*18*
(viii)	*Power Cables*	*18*
(ix)	*Control Cables*	*18*
(x)	*Compressor with exhausters complete recondition /replacement*	*10/15*
2	**AC Equipment**	
(i)	*Compressor ACCEL/ CARRIER*	*10*
(ii)	*Sealed Compressor KCL make*	*5*
(iii)	*Sealed Compressor Maneurope make*	*8*
(iv)	*Compressor Motor DC*	*10*

S.No.	Class of assets	Average life in years
(v)	Compressor Motor AC	15
(vi)	Condenser Fan Motor (DC)	8
(vii)	Condenser Fan Motor (AC)	10
(viii)	Condenser Fan Motor (RMPU)	10
(ix)	Evaporater Fan Motor (AC)	10
(x)	Evaporater Fan Motor (DC)	10
(xi)	Evaporater Fan Motor (RMPU)	12
(xii)	Condenser Unit	8
(xiii)	Condenser Unit (RMPU)	10
(xiv)	Evaporater unit	10
(xv)	Evaporater unit (RMPU)	10
(xvi)	Mercury in glass thermostat	5
3	**TL/Power Equipment**	
(i)	4.5/18/22.75/25 KW alternator regulator	12
(ii)	Emergency 90 AH L!A. Battery	3
(iii)	120 AH VRLA (SMF) Batttery	4
(iv)	290 AH starting L.A. Batteries for Power Car	3
(v)	Power Car power panel	15
(vi)	Power panel (AC coaches)	15
(vii)	Pre Cooling cum battery charging transformer rectifier unit	12
(viii)	50 KVA 750/415 V transformer unit	15
(ix)	3 KVA 415/190 V transformer	15
(x)	Water Raising Apparatus (WRA)	5
(xi)	Water Boiler for Pantry	5
(xii)	Hot Case for Pantrv	5
(xiii)	Bottle Cooler cum deep freezer	5
(xiv)	Ventilation Blower Motor for Power Car	12
(xv)	Radiator for Power car	10
(xvi)	Radiator Motor for Power Car	15

(IV) MECHANICAL ASSETS

S.No.	Class of assets	Average life in years
	Machinery & Plant	
1	Machine Tools like Lathes, Planners, Drilling, Boring and Milling machines etc.	15
2	High Precision and special purpose machines like wheel Lathes etc.	15
3	Tool Room and Testing Laboratory equipment	15
4	Foundry and Forge Equipment	15

S.No.	Class of assets	Average life in years
5	Heat Treatment Equipment	15
6	Cranes-EOT /140 B.D Crane	36
7	Power Generation Machinery & Switches	15
8	General purpose light machinery e.g. band saws, floor grinder etc.	10
9	Air Compressors	15
10	Other miscellaneous machines e.g. light cleaning machines, test equipment in diesel sheds, workshops, depots & sick lines	15
11	(i). Construction Machinery	15
	(ii). Track Maintenance equipment	20
12	Station machinery e.g. weighing machines etc.	15
13	Miscellaneous machinery and equipment for hospital, offices etc.	10
14	Mechanical Weigh Bridges	15
15	Electronic in motion Weigh Bridges	08
16	Diesel Pumps	10
17	Welding equipment including diesel welding sets	10
18	Diesel refrigeration equipment	15
19	Material handling equipment like FLT, Lister trucks etc.	10
20	Traversers	25
21	Fuel Station Dispensation Equipment	10
22	Bulldozers and other earth moving equipment	15
23	Motor Boats	10
24	Hydraulic re-railing equipments/Hydraulic Systems	16
	ROAD VEHICLES	
25	Staff Cars including Jeeps	07
26	Light Motor Vehicles	10
27	Heavy Motor Vehicles	10
28	Tractors	10
	ROLLING STOCK	
29	Diesel Electric/ Hydraulic Locomotives	36
30	Diesel Engine	18
31	Shunting Locomotives	36
32	Steam Locomotives	40
33	Boiler and Tender	20
34	Steam Cranes	30
35	Diesel Hydraulic Cranes	25
36	Steel Body Coaches including DMUs / EMUs, Restaurant Cars etc.	25
37	Full Stainless Steel Body Coaches including DMUs/EMUs, Restaurant Cars etc.	30
38	Light utilisation categories of coaches (steel body) like inspection carriages etc.	40

S.No.	Class of assets	***Average life in years***
39	*IRS Coaches*	*30*
40	*Open Bogie wagons with air brakes and Casnub bogies*	*30*
41	*Bogie tank wagons with air brakes and Casnub bogies*	*40*
42	*All other types of Bogie wagons with air brakes and Casnub bogies*	*35*
43	*Open wagons with vacuum brakes and UIC bogies*	*25*
44	*Other wagons with vacuum brakes and UIC bogies*	*30*
45	*4- Wheeler wagons (open and covered)*	*30*
46	*4- Wheeler tank wagons (with plain bearings)*	*35*
47	*4-Wheeler tank wagons (with roller bearings)*	*35*
	Equipment/Sub assemblies of Diesel locos	
48	Engine Block	***18***
49	Crank Shaft	***18***
50	Turbo Super Charger	***12***
51	Governor	***18***
52	ECC assembly with RA Gear Box	***18***
53	Radiator Fan	***16***
54	Heat Exchangers including radiator	***10***
55	Expressor/Compressor	***16***
56	Bogies with wheels	***18***
57	Traction Motor	***18***
58	Traction Generator/Alternator	***18***

S.No.	Class of assets	***Average life in years***
59	All electrical rotating machines above 5 HP on Diesel locos	***18***
60	Rectifiers	***18***
61	Traction Gear	***18***
62	Loco Batteries	***4***
63	Power Cables	***18***
64	Control Cables	***18***
65	Blowers	***10***
66	Armature for Traction Motor	***18***
67	Stator for Traction Motor	***20***
68	Control Equipments	***18***
	Equipment/Sub assemblies of DMUs	
69	Power Pack	**16**
70	Bogies with wheels	**18**
71	Traction Motor	**18**
72	Traction Generator/Alternator	**18**
73	All electrical rotating machines above 5 HP on DMUs/Rail bus/Railcar	**18**
74	Rectifiers	**18**
75	Heat Exchangers	**10**
76	Batteries	**4**
77	Power Cables	**18**

S.No.	Class of assets	**Average life in years**
78	Control Cables	**18**
79	Control Equipments	**18**
80	Hydraulic Transmission Rehabilitation/Replacement	**16**
	(Authority: Board's letter no.2002/AC-II/l/10 dated 12.10.2007)S.No. 48 to 80-**acs no.65.**	

(V) SIGNAL & TELECOMMUNICATION ASSETS

(A) SIGNALLING SYSTEM

S.No.	Class of assets	**Routes**	**Average life in years**
1.	*Electrical/ Mechanical Signalling System*	• *Route-' A'* • *Route-'C'/Sub Urban section* • *Big Yards on all Routes*	*25 Yrs.*
		• *Routes- 'B'* • *Route 'D'* • *Route 'D'-special'*	*25 to 28 Yrs depending upon location & condition*
		• *Routes-'E'* • *Route 'E- Special'*	*30 Yrs*
2.	*Electronic Signalling system like SSI, Axle Counter, AWS, AFTC, IPS etc.*		*15 years or based on obsolescence.*

(B) SIGNALLING EQUIPMENT

S No	Class of assets	***Life in terms of operations***	***Average life in years***				
			Routes				
			A	*B*	***C/ Suburban***	***D & D-Spl***	***E & E-Spl***
1	*Cranks and Compensators*	*50,000*	*2*	*2*	*1*	*4*	*4*
2	*Lock Bar Clips*	*1,00,000*	*3*	*3*	*3*	*5*	*7*
3	*Facing Point Lock with bolt detection*	*3,00,000*	*8*	*8*	*8*	*15*	*15*
4	*Mechanical Detectors*	*5,00,000*	*-*	*15*	*—*	*20*	*25*

S No	Class of assets	Life in terms of operations	Average life in years				
			Routes				
			A	B	C/ Suburban	D & D-Spl	E & E-Spl
5	*Circuit breakers*	*5,00,000*	*15*	*15*	*15*	*25*	*30*
	Lever locks	-	*7*	*7*	*7*	*12*	*15*
6	*EK Transmitter*	-	*10*	*10*	*10*	*15*	*15*
7	*SM's Slide Frame*	-	*30*	*30*	*30*	*30*	*30*
8	*Electric Point Detector & Reversors*	-	*15*	*15*	*15*	*20*	*20*
9	*Signal Machines*	*1,50,000*	-	*10*	-	*20*	*20*
10	*Signal Wire Transmission*	-	*3*	*3*	*3*	*3*	*3*
11	*Point Machine*	*3,00,000*	*12*	*12*	*7*	*15*	*15*
12	*Plug-in and Shelf type Relays*	*10,00,000*	*25*	*28*	*25*	*28*	*30*
13	*Track Feed battery chargers*	-	*10*	*10*	*10*	*10*	*10*
14	*Signal Transformers, Transformers*	-	*12*	*12*	*12*	*12*	*12*
	Battery Chargers, DG Sets, Inverters,	-	*10*	*10*	*10*	*10*	*10*
15	*Batteries*	-	*4*	*4*	*4*	*4*	*4*
16	*Block Instruments*	-	*25*	*25*	*25*	*25*	*25*
17	*Cable* *(Authority : Board's letter no.2002/AC-II/1/10 dated 18.08.2006)-**AC NO.63***	-	***25***	***25 to 28***	***25***	***30***	***30***
18	*Block Instrument Electro Mechanical*	-	*20*	*20*	*20*	*20*	*20*
19.	LED Signals (all aspect types) of specification prior to version 2011	*(Authority : Board's letter no.2002/AC-II/1/10 dated 28.08.2015)-* ***AC NO.78***	**6**	**6**	6	6	6
20.	LED Signals (all aspect types) of specification version 2011 or later	*(Authority : Board's letter no.2002/AC-II/1/10 dated 28.08.2015)-* ***AC NO.78***	**8**	**8**	8	8	8

(C) TELECOMMUNICATION EQUIPMENT

S..No.	*Class of assets*	*Average life in years*
1	*Microwave Equipment*	*12- 15 Years*
2	*Exchange & accessories including*	*12-15 Years*

S..No.	Class of assets	Average life in years
	Telephone equipment	
3	*Under Ground Cables*	*Quad}-20 Years PIJF}*
		OFC -20 Years
4	*Overhead alignment*	*25 Years*
5	*All other electronic/ wireless items including OFC equipment*	*12-15 Years*
6	*Cell Phones*	*5-8 Years*
7	*FAX*	*10 Years*
8	*Walkie-Talkie Sets/VHF*	*5-8 Years*
9	*Datacomm. Equipment, Routers, Modems, PCs etc.*	*5-8 Years*
10.	LED display Board for Passenger Information System, True Colour Video cum Train Information Display System (Authority: Board's letter no.2002/AC-II/2/10(Vol.II)…ACS no.76 dated 25.0.2014	*10 Years*
11.	GPS based Digital Clocks (Authority: Board's letter no.2002/AC-II/2/10(Vol.II)…ACS no.76 dated 25.0.2014	*10 Years*

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(Authority Railway Board letter No.2002/AC-II/1/10 dated 24 /05/06)-acs no. 62

220 Technique of financial appraisal of projects- The following methods of appraisal of capital expenditure proposals are commonly used in industrial and commercial undertakings: -

(a) Accounting rate of return,
(b) Pay back period, and
(c) Discounted Cash Flow.

Of these, methods, (a) & (b) are employed without considering the time value of money. These are also known as the 'Financial statement' methods since the calculation involves data taken from and used essentially in the same form as in financial statements. When time is considered, the method employed for financial appraisal is the Discounted Cash Flow method, also called the 'Present value method', since the time value of money is an explicit consideration.

221 Accounting rate of return method - Under this method, the rate of return is worked out by arriving at a percentage ratio of the net gain (i. e., earnings less working expenses) over the initial anticipated investment of the project. Simply illustrated, it is proposed to construct a masonry building at a cost of Rs.1 1akh to accommodate an office which is now housed in a building at a rental of Rs.15,000 per annum. It will be necessary to ascertain (a) the average annual cost of maintenance and repairs of the proposed building and (b) its scrap value at the end of its normal life. If these are taken to be (say) Rs. 5,000 and Rs. 10,000 respectively, then the average annual cost of the proposed new building will be (a) Rs.5,000 plus (b) Rs. 801 being the annual sinking fund payments (at 3 per cent for 50 years which is equal to 0.0089 multiplied by Rs.1 lakh minus Rs.10,000), or Rs.5,801 in all. This will result in a saving of Rs. 9,199 (Rs.15,000 minus Rs. 5,801) in the annual rental charges that are presently being paid, or a net return of 9.2 percent on the investment of Rs.1 lakh.

222 A minor variant of the above illustration would be to take the average investment over the life of the asset at half the initial cost, viz., Rs.50,000 on the assumption that depreciation is written off in equal instalments over the life of the asset and the amount invested on the asset will decrease each year as funds are released through the effect of the depreciation charge. In that case the return on the average investment will work out to 18.4%.

223 **Pay back period method -**Since recoupment of the original capital invested in a project is an important consideration in appraising a capital investment, the method of working out the pay back period lays emphasis on the calculation of the time it takes to recoup the expenditure incurred on the project. In the table given below, the pay back period is 5 years, as the accumulation of the net cash flow, year by year equals the initial investment at the end of 5 years:

Original Investment-Rs. 1,00,000

Net Cash Flows (i. e., net earnings or reduction in expenditure) : --

Year	Annual	Cumulative
	Rs.	Rs.
1	10,000	10,000
2	12,000	22,000
3	20,000	42,000
4	30,000	72,000
5	28,000	1,00,000

Under this method no attempt is made to assess the return on the capital invested. It only shows the length of time required to recoup the amount invested on the project ,the assumption being that projects with short pay back period are better investment propositions than those with long pay back periods. Bare recoupment of the amount invested under the pay back period method would yield no return unless a suitable rate of interest return on the capital outstanding in each of the years involved is built into the calculation of the net cash flow.

224 The method of ranking projects, or project grading, on the basis of pay back period is of limited application as it can be employed only in situations where there is a strict time limit to the investment before the expiry of the useful life of the project. An example would be of a proposed investment in a project in a foreign country where the political stability can be foreseen only for a limited number of years, or in plant and machinery involving processes or products that are likely to be replaced by technological changes within a few years or a 'single purpose' new line where the known reserves of coal, iron ore, etc., are expected to be depleted/exhausted after a specific number of years. Though presently not in vogue on the Indian Railways, there is no bar to the application of the Pay Back Period method to evaluation of Railway Projects in consultation with the FA & CAO in the special circumstances illustrated in this Para.

225 **Discounted Cash Flow -**The accounting 'Rate of Return' (R.O.R.) Method commonly in use on the Railways does not take into account the time value of money. Also, the return on investment is worked out as at the time of completion of the project or at a single point of time (6^{th} year or 11^{th} year) and not through the entire useful life of the project. The R.O.R. method may, therefore, yield an incorrect result depending on the point of time selected for the purpose of project appraisal. A factor of fundamental importance to investment decisions and one which the R.O.R. method does not take into account is the timing of profits and cash flows that result from an investment and this factor is crucial to the Discounted Cash Flow Method of project appraisal.

226 **Net Present Value (NPV) or Net Present Worth (NPW) -**The concept of the time value of money which is basic to the Discounted Cash Flow Method is illustrated thus :

Rs.100 receivable today is more than Rs.100 receivable a year hence, as Rs. 100 received today will earn interest or profits and shall accumulate to more than Rs. 100 in a year's time. Alternatively, Rs. 100 received today can be used to reduce borrowing thereby avoiding interest payments as well as reducing debts by Rs.100. Assuming that the Railways' cost of finance is its current dividend rate (say 6% per annuam), Rs. 106 received a year hence should be worth Rs.100 today and Rs.100 which may be received in a year's time is worth about Rs. 94 today (actually it is worth Rs.94.34). Likewise, the present value of Rs.100 receivable 2 years hence is about Rs.89, and so on. In this way the cash flow for the project in any future year can be discounted to obtain the present value.

227 The NPV/NPW of a project is sum of the present values of the net cash flows for all the years of the project's economic life. The net cash flow in each year will be the expected net reduction in expenditure or increase in net earnings. The net cash flows are discounted to arrive at the NPV of a project by applying a pre-determined discount rate. Interest formulae & tables commonly used in the Discounted Cash Flow method are given in Annexure 'C'. Present value/worth factors (PWF) of Re. 1 are shown in the Annexure separately for 'single payment', i. e., when cash flows are uneven, and for uniform series, i.e., when cash flows in each year are the same. For example, consider the following excerpts:

	TABLE--A From Col.2 under 'Single payment'		
	Present value of Re. 1		
Year	**12%**	**15%**	**20%**
1	0.893	0.870	0.833
2	0.797	0.756	0.694
3	0.712	0.657	0.579
4	0.635	0.572	0.482
5	0.567	0.498	0.402

TABLE-B From Col. 4 under 'Uniform series'			
Years	Present Value of Re.1 received annually		
	12%	15%	20%
1	0.893	0.870	0.833
2	1.690	1.626	1.528
3	2.402	2.283	2.106
4	3.037	2.855	2.589
5	3.605	3.352	2.991

TABLE -B is derived by adding the data in Table A, **.** At 20% the 0.833 in TABLE-B is the same as the 0.833 in TABLE-A since the time involved is only one year. The 0.833 and the 0.694 for years 1 and 2 under 20% represent the 1.528 under TABLE-B at 20% in year 2. The 0.833, 0.694 and 0.579 in TABLE-A are added to form the 2.106 in TABLE-B. Thus, it can be seen that TABLE-B is essentially a summation of TABLE-A. With TABLE-B, present value calculations can be made more quickly if the cash in flows or out flows are constant. Instead of multiplying the same cash flows by the individual items of TABLE-A, one can multiply

the annual cash flow only once by the sum of the data in TABLE-A which is conveniently arranged in TABLE-B.

228 Annual Cash Flows- It is important that the annual cash flows should be estimated on a realistic basis. By definition, the cash flow will take into account only the realisable earnings and cash expenditure or, in the case of expenditure reducing projects, the net reduction in cash expenditure. Purely accounting adjustments such as depreciation and other provisions are to be completely ignored. The reason is that cash flow is the foundation of the NPV and depreciation is an expense item not involving a flow of cash. It is implicit in the basic arithmetic of the D.C.F. Method of project appraisal that so long as the cash flows are adequate from year to year and the NPV computed at the requisite discount rate equals or exceeds the investment, the capital invested in the Project will remain intact. This is shown by a solved example below :

Basic data-

Initial investment	..	Rs. 4,00,000
Annual Cash Flow	..	Rs. 1,00,000
Life of the Project	..	10 years
DCF rate of return (say)	..	21.4%(See Para 230)

Year	Capital in the beginning of the year	Net surplus the year	Payment of interest @ 21.41 %	Recovery of Capital	Capital at the end of the Year
(1)	(2)	(3)	(4)	(5)	(6)
1	4,00,000	1,00,000	85,652	14,348	3,85,652
2	3,85,652	1,00,000	82,580	17,420	3,68,232
3	3,68,232	1,00,000	78,919	21,081	3,47,151
4	3,47,151	1,00,000	74,335	25,665	3,21,486
5	3,21,486	1,00,000	68,840	31,160	2,90,326
6	2,90,326	1,00,000	62,168	37,832	2,52,494
7	2,52,494	1,00,000	54,067	45,933	2,06,561
8	2,06,561	1,00,000	44,231	55,769	1,50,792
9	1,50,792	1,00,000	32,289	67,711	83,081
10	83,081	1,00,000	17,790	82,210	871
				3,99,129	

The small margin of difference (Rs.871) is accounted by the error in interpolation of the rate of return. It will be seen that at the discount rate of 21.41%, the project has recovered the original cost in full (Col. 5), apart from paying off interest at the same rate.

229 Rate of return under D. C. F.-Two alternative methods can be used for assessing the viability of a project under the D. C. F. technique. For example, assuming an even cash flow of Rs.4,000 per annum over a period of 10 years in respect of a project where the original investment is estimated to be Rs.18,000, it will be observed from the following table that the discount factor of 4.5 (18,000 ÷ 4,000) occurs against the 10th year under the discount rate of 18%;

	Present value of the Re. 1 received annually		
Year	16%	18%	20%

8	4.344	4.078	3.837
9	4.607	4.303	4.031
10	4.833	4.494	4.192
11	5.029	4.656	4.327

In this case the rate of return under the D.C.F method for an even cash flow of Rs.4,000 per annum for an investment of Rs.18,000 will be about 18%. Since the D.C.F. return of 18% is more than the minimum acceptable rate of return (say 10%) , the project would be considered desirable from the financial point of' view. Under an alternative method, the minimum acceptable rate of return (say 10%) would be applied to calculate the **NPV** of the project. If the **NPV** is (zero or) positive, it would be financially acceptable, and if the **NPV** is negative, the project will not be financially acceptable. In judging the ranking of competing projects, under the first method, the D. C. F. rate of return would be used and whichever project gives the higher rate of return would be preferred. Under the second method, the competing projects will be ranked according to their NPV and whichever project gives a higher NPV at the minimum acceptable rate of return would be the preferred project.

230. Another illustration may be given of a case where the initial outlay of (say) Rs. 4,00,000 is incurred in one year and the project starts giving a net cash flow of Rs.1,00,000 per annum over 10 years thereafter. Discounted cash flow at various rates of interest would be as shown below where the cash flows are uniform throughout the project life:

	10%	20%	25%
Factor for 10th year	6.145	4.192	3.571
NPV for even cash flow of Re. 1 lakh per annum	6,14, 500	4,19,200	3,57,100

R. O.R. will be about 21.41%

231 The simple illustrations given above presume that the investment is completed in one year and the project starts yielding a return immediately thereafter. Where the investment is spread over a number of years, it is necessary to work out the value of the investment, by applying the relevant rate of interest, from the inception up to the point when the project is expected to be ready for operation, the rate of interest being the minimum acceptable rate of return of (say) 10%. In the illustration given in the preceding para, if the investment of Rs. 4,00,000 is assumed to have been spread over a period of three years including the year in which the project was completed, the total investment, inclusive of interest, up to the year of completion would be as shown below :----

Year		0% Interest Rs.	10% interest Rs.
	-2	1,00,000	1,21,000
	-1	1,50,000	1,65,000
	0	1,50,000	1,50,000
Total investment		4,00,000	4,36,000

In this case, if the net return over the life of the project of ten years assumed in the earlier illustration is constant amount of Rs.100,000, the return would be about 18% instead of 21.41 % worked out in Para 230.

232 A short write-up on the technique of working out the rate of return under the Discounted Cash Flow Method is at Annexure 'D'. Detailed examples of railway projects showing application of the D. C. F. technique are given in Annexure 'E'.

233 **Residual Value -**Each project will have an estimated life span at the end of which the various assets will be disposed of or put to other uses. The flow of funds created by the sale or disposal of the assets at the end of the life of the project should be estimated so that appropriate credit can be given to the project in the year in which the flow of funds is expected to occur by the sale or disposal of the assets. Since all the assets may not be discarded or sold at the same time, the cash flows resulting from residual values should be allocated to the years in which they are likely to be received. If some of the assets are to be taken out of service and disposed of before the termination of the project, the resultant cash flows must be included in the appropriate years.

234 **Alternative Schemes ---** Equivalent Annual Cost **-** The criterion of choice between alternative schemes, each of which is capable of rendering the required service, is the principle of least cost in the long run. This approach is particularly applicable when the cash outflows under each competing project have sharply different time patterns. To obtain the annual cost, the outlays of the project are summarised into a single present worth amount and then spread over the years of the project life as an equal amount per year, which includes interest at a standard rate. By the same summarization and spreading for an alternate project, the two projects can be compared by reference to the per year figure for each. The comparison is usually of cost only, revenues being assumed as the same under either project. An illustration appears below :

	Year	0	1	2	3	4	Total.
Project A :							
cash inflows		(the same as for Project B)					
cash outflows		(104)	(5)	(1 0)	(1 5)	(20)	(154)
Project B :							
cash inflows		(the same as for Project A)					
cash outflows		(45)	(30)	(30)	(30)	(30)	(165)
10% pre cent : Worth Factors		1.00	.91	.83	.75	.68	....
Present Worth :							
Project A		(104)	(5)	(8)	(11)	(14)	(142)
Project B		(45)	(27)	(25)	(22)	(20)	(139)
***Equivalent Annual Cost** :							
Project A		....	(45)	(45)	(45)	(45)	...
Project B		...	(44)	(44)	(44)	(44)	...

*These annual amounts are determined by dividing the project present worth by the present worth of a four-year Re.1/ - per year annuity. This is the sum of the individual present worth factors .91, .83, .75, .68 which totals Rs 3.17.

The above analysis shows that Project 'B' has the lower uniform annual cost, by a small margin, even though it shows a larger total outlay. The reason for this is that the project outlays take place later under

Project 'B', which reduces its present worth and lowers its annual cost including interest, relative to Project 'A'.

235 Economic Evaluation. -As a commercial undertaking, it is incumbent on the Railways to ensure that a proper financial return is earned from every investment subject to the exceptions given in Para 202. At the same time it has to be borne in mind that the Railways are an important instrument of economic and industrial development of backward areas not connected by a reliable transport network. In the case of major projects such as new line constructions, or change of traction from steam to diesel/electric, the benefits likely to be realised by the economy as a whole are assessed by the Economic Adviser to the Railway Board. The principles on which economic evaluation of Railway investments should be carried out as distinct from working out a financial return to the Railways, are indicated in the note (together with an illustration) at Annexure 'F'.

236 Replacements and Renewals -The proposal for replacement of an existing asset (whether involving improvement or otherwise) should be examined critically with a view to seeing whether it would not be possible to avoid, or, at least, postpone such replacement by suitable repairing or reconditioning the asset at a cost that could be comparatively justified financially. In all cases in which it is considered necessary to replace an asset, instead of reconditioning it, it should be examined whether the estimated average annual cost of service (i. e. cost of operation and maintenance, sinking fund payment to the depreciation fund, and the interest on the cost of the asset), or the estimated average cost per unit of service of the new asset is likely to be less than that of the old asset after reconditioning. Except when renewals or replacements are inevitable, the expenditure chargeable to the Depreciation Reserve Fund, should be financially justified in the same manner as any other expenditure of capital nature.

237 Where a replacement is proposed on grounds of economy in operation and maintenance costs, the estimate therefore should justify the outlay on the proposed replacement by showing that the average annual cost of service or the average cost per unit of service, that will be rendered by the new asset, is less than that of the existing asset.

Note.-The above two paragraphs will not apply to cases of casual or programme renewals, not involving any improvement

238 Reconditioning – When an as asset is repaired at a comparatively high cost in preference to its being replaced, it is referred to as being 'reconditioned'. The cost of such reconditioning is chargeable to Ordinary Repairs and Maintenance, for which no detailed estimates are ordinarily necessary. Nevertheless, for all reconditioning works, the estimated cost of each of which exceeds Rs 20,000 detailed estimates should be prepared.

Note:- Detailed estimates should, however, be prepared in respect of reconditioning works of rolling stock, each costing more than the following limits:-

Locomotives	25,000
Carriages (including rail cars and EMUs)	12,500
Wagons, tenders, boilers and service motor-cars	5,000

239 Scrapping, condemning and abandoning assets - An asset may be scrapped, condemned or abandoned without replacement, when the service rendered by it is no longer required. If the service rendered by it is still necessary and if it is proposed to make other arrangements for such service, it should be definitely established that it is more economical to scrap, condemn or abandon the existing asset and obtain the required service from the new arrangement than to continue to obtain the required service from the existing asset. Here also the relative economics of the two proposals should be assessed on the basis of the average annual cost of service or the average cost per unit of service, as the case may be.

Note : The preparation of financial justification as contemplated in this paragraph is not necessary for condemning rolling stock in the following cases:-

i) Overaged stock due to be replaced by virtue of their age but condemned before replacement.
ii) Under or overage stock involved in accidents and certified to be irrepairable (not included under the category of "beyond economical repairs").
iii) Non I.R.S. type coaches and wagons of inherently weak design proposed to be condemned on condition basis whether under or overage.

240 Example are given in Annexure 'G' illustrating the method of financial justification to be adopted in the case of replacement, reconditioning or abandonment of existing assets. The data used in the illustrations are hypothetical and the methods adopted are not to be regarded as exhaustive or as precluding the use of other methods that may be found to be more appropriate. The D.C.F. method can be conveniently used in some cases as has been shown in Example (1) of Annexure 'G'.

241 Second-hand Value- The second-hand value of an asset is what it is presently worth and has often to be distinguished from its scrap value. For purposes of financial justification of transfer, purchase or sales, the second-hand value of assets may, except in certain cases (e.g. rails, locomotives, boilers, etc.) where separate rules have been prescribed for the determination of the second-hand value, be determined as provided below:-

i) The first cost of an asset (based on which its second-hand value has to be computed) should be taken as the value of a similar asset at present day prices and not the value actually paid for the asset when it was originally purchased.
ii) The second-hand value of an asset that does not depreciate is the same as the first cost.
iii) The second-hand value of a depreciating asset should be so appraised that the average annual cost of service or the average cost per unit of service, as the case may be, of the second-hand asset is equal to that of the same or similar asset while new.

242 Examples illustrating the application of the principles enunciated in the preceding paragraph are given in Annexure 'H'.

243 Post project appraisal - It is important that an investment proposal is subjected to proper financial appraisal not only before it is a sanctioned but also a certain period of time after the project has been in operation. Whether the financial return anticipated from a project at the estimate stage is actually realised in due course or not should be determined by conducting a 'Productivity test' in respect of all major works. For any such comparison to be meaningful and realistic, it is important that the computation of the actual additional earnings and working expenses is done on the same lines as at the project estimate stage. As commercial profitability is liable to be affected by escalation in prices or any other extraneous development, in order to have a more reliable and accurate evaluation wherever relevant, a comparison in terms of physical units of throughput may be carried out. Such a comparison should preferably be done classwise in the case of passenger traffic and commodity-wise in the case of goods traffic.

244 New Lines - In respect of each new line opened for traffic, the railway administration should submit to the Railway Board a statement, showing the financial results of its working in Form No. 244 shown below. The statement should reach the Railway Board not later than the 31st December following the financial year to which it refers and should be accompanied by a covering memorandum in which brief explanations should be given of important variations between the actual realisation and the estimated earnings, together with a Note by the General Manager indicating how the actual net cash flow compares with what was estimated at the project stage. The Note should also bring out the probable traffic prospects of the line in the sixth and the eleventh year of opening.

Statement showing Financial Results of working of New Branch Lines. Form No.F.244

Railway ------------------------------------ Name of branch ---------------------------------
Length in Kilometres--------------------- Gauge --------------Opened on--------------------

Year	Cost on 31st March plus calculated interest during construction.		Earnings of Branch line proper		Actual expenditure of branch assessed on the basis of costing/financial data applied to the traffic over the branch line Working expenses (excluding depreciation & interest)		Net earning of branch proper (Col.3-4)	
	As originally Estimated.	Actuals.	As originally Estimated.	Actuals.	As originally Estimated	Actuals	As originally Estimated.	Actuals
(1)	(2)		(3)		(4)		(5)	
Actuals after opening -- 1st year .. 2nd year .. 3rd year .. 4th year .. 5th year .. 6th year .. 7th year .. 8th year .. 9th year .. 10th year and so on upto 30 years								

Main line				Additional net earnings(Col.6-7).		Total net earnings (Col.5+8)		Return on total cost Col.9x 100 / Col.2	Remarks
Additional earnings minus any loss due to short circuiting or diversion of traffic.		Additional expenses calculated on the basis of costing/ financial data applied to traffic from the existing line to branch line and vice-versa. Working expenses (excluding depreciation & interest)							
As	Actuals.	As	Actuals.	As	Actuals	As	Actuals		

originally Estimated .		originally Estimated.		originally Estimated		originally Estimated .			
6		7		8		9		9A	10

Foot notes to Form No. F. 244.-

1). Actuals will be actuals to end of the year for which accounts have been closed, and fresh estimates for the years thereafter.

2). Special steps taken in the course of the year:-

(a) To develop the traffic earnings-
(i)
(ii)
(iii)
(iv)

(b) To reduce the expenses
(i)
(ii)
(iii)
(iv)

(3). Probable future development of traffic and possibility of the line paying its way (short note)--

Head of Traffic Department.

Head of Account Deportment

Note:- The traffic data required to be maintained vide Para 245 should be used for costing purposes so as to arrive at the expenditure of the Branch proper and of traffic moving from the existing line to the Branch line and vice versa.

245 The following statistics should be maintained from year to year in respect of all new lines opened for traffic and submitted to the Railway Board by l st August of each year :-

(i) (a) Passenger earnings from traffic local to the branch line.

(b) Other coaching earnings from traffic local to the branch line.

(ii) (a) Passenger earnings from traffic from the new line to the existing lines and vice versa.

(b) Other coaching earnings from traffic from the new line to the existing lines and vice versa.

(iii) (a) Tonnage of goods traffic local to the branch line.

(b) Tonnage of goods traffic inter-changed with the existing lines

(iv) (a) Earnings from goods traffic local to the branch line.

(b) Earnings from goods traffic interchanged with the existing lines.

246 The following instructions should be followed in preparing the statement F-244 :-

(i) Column 3 should indicate the earnings of the branch from all traffic originating therein, whether local or foreign (Proportion due to the branch) and all traffic received from the main line.

(ii) Columns 4 & 5 should be worked out on the basis of the costing/financial data under Group 'C'(see Annexure 'A') in respect of the traffic referred to in (i) above.

(iii) The additional or new traffic interchanged to be shown in column 6 should include only that portion of the traffic received by the main line from the new branch and of the traffic from the main line to the branch, which arises solely from the construction of the new branch line. In the absence of actual figures of additional traffic interchanged with the existing lines, a reasonably approximate figure may be adopted. In the case of chord line short-circuiting a previously existing route, figures relating to cross traffic which would have been carried by the previously existing route, if the chord line had not been constructed, may be omitted from this statement and a proportionate reduction in the working expenses on the branch line made. Column 7 should be worked out on the basis of costing financial data under group 'C' (See Annexure 'A'and para 217).

247 The statements vide Paras 244 & 245 should be submitted for every completed financial year after the date of opening of the new line for a period of 11 years. The actuals for the years to end of which accounts have been closed and the cash flows for the remaining years of the assumed project life should be arrived at on the basis of the best possible estimation. The entire series of net cash flows should then be discounted to arrive at the rate of return compared to the originally expected return. In case the actual cash flows shown in statement F.244 indicate a fair degree of proximity to the original estimates, it may be assumed that the cash flows for the remaining years of the project life will also follow the same trend unless definite foreknowledge is available to the contrary. If a review of the annual cash flows for a sufficiently long period (say 5 to 7 years) indicates that the cash flows have settled down, within limits, to a 'uniform' series, the Railway Board may decide that submission of the Statements F. 244 & F. 245 for future years in the case of a particular new line be discontinued.

248 **Open Line Works -** For the purpose of applying the productivity tests to open line works, i. e. works undertaken with the definite object of increasing earnings or reducing expenditure and to which such tests can be applied within five to seven years of their completion, selection will be made out of these works sanctioned (and/or charged to Capital) on grounds of remunerativeness. All such works costing over Rs. 1 crore will invariably be subjected to this test. The result of the test should be reported by the General Managers to the Railway Board. In the case of works costing between Rs. 20 lakhs and Rs.1 crore charged to Capital and sanctioned by the General Manager within his powers 'of sanction, selection for the purpose of productivity test will be made by him in consultation with his Financial Adviser and Chief Accounts Officer. As stated earlier in the preceding para in the case of New Lines, the actual net cash inflow for each year, to end of the $5^{th}/7^{th}$ year from the date of commissioning should be recorded for each open line work to be subjected to the productivity test, and the cash flows for the rest of the project life assessed on the basis of the latest estimate. The whole series of net cash flow should then be discounted to arrive at the rate of return compared to the return originally expected.

249 In addition to productivity test to be conducted as provided in paragraph 248 above, a productivity review should also be undertaken in respect of selected works costing over Rs.10 lakhs which are estimated to fetch some return, even though not the return prescribed for a work being classified as remunerative and as such charged to O. L. W. R. or Development Fund. The methodology to be followed will be the same as prescribed in the preceding para in respect of works costing over Rs.1 crore each. The Railway Board will be selecting works which are sanctioned by them. The selection made by the Railway Board out of such works sanctioned by them will be notified through letters conveying sanction to the estimates for such works. For works costing over Rs. 10 lakhs and upto Rs. 1 crore each, sanctioned by the General Manager within his own powers of sanction, selection for the purpose of productivity review will be made by him in consultation with his Financial Adviser and Chief Accounts officer.

Note.-Justification for works or part of a scheme should show the probable period ,that will elapse between the completion of the works and the time when the productivity review can be made. This note equally applies to paragraph 248.

250 The fact that productivity tests are to be applied to a particular work should be intimated to the authorities entrusted with its execution as also to the Accounts and Audit officers. In respect of all such

selected works, the Financial Adviser and Chief Accounts Officer should keep such statistics as would be necessary for the application of the tests, in addition to those usually available.

251 In order to ensure that a work selected either by the Railway Board or by the General Manager for the application of productivity tests or review is not lost sight of, Railway Administrations and Accounts Officers should maintain a register containing a list showing the following particulars :-

(i) Reference to sanction of the estimate.

(ii) Brief particulars of work selected for the application of productivity tests or review.

(iii) Total estimated expenditure.

(iv) Nature and extent of "productivity" claimed in the estimate.

(v) When the test or review is to be applied.

(vi) Brief remarks about the results of the test or review.

This list should be reviewed half-yearly and timely action taken to apply the test or review to all works due for examination during each half-year.

252 When, in due course, the tests or reviews are actually applied or carried out, the Financial Adviser and Chief Accounts Officer should submit a report embodying the results of the test or review to the General Manager. In the case of works selected by the Railway Board, the General Manager will submit the Financial Adviser and Chief Accounts Officer's report to the Railway Board with his own comments. The object of these reports is not only to furnish information as to the results actually achieved to the authority who sanctioned the expenditure but also to serve as a lesson for the future.

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ANNEXURE 'A'

(Ref. paras 216 *and* 217)

CHECK LIST WITH DETAILED NOTES FOR GUIDANCE OF ZONAL RAILWAYS AND CONCERNED BRANCHES IN RAILWAY BOARD'S OFFICE, IN THE PREPARATION OF PROJECT ESTIMATES

The procedures and methodology to be adopted for a proper financial appraisal of projects are laid down in the Engineering Code and in the Report of the Committee on Technique of Financial Appraisal of Railway Projects as well as the circulars issued by the Railway Board from time to time.

2. Some of the survey reports submitted by the Zonal Railways were scrutinised by the Cost Analysis Cell of the Board's office. It was found that the estimates of working expenses have been substantially understated owing to many important elements such as empty haulage, number of marshallings, tare tonne kilometres, etc., not having been taken into account by the Zonal Railways. In some cases, instead of applying the unit costs the Railways have adopted the operating ratio to estimate the working expenses. The operating ratio is only an end figure and should not, therefore, be used for estimating working expenses. Further, the revenues depend on the product mix, i. e., the proportion of the high-rated, low-rated commodities or short lead or long-lead traffic and the estimate made thereof should be reasonably correct.

3. In order to ensure that no item of cost is excluded and no item of cost is over stated / understated, a check list, together with detailed notes, has been prepared for the guidance of the Zonal Railways and the concerned staff of the Railway Board's office (E.A. Branch F (X) Branch and Planning Branch). The more common mistakes and deficiencies noted in the calculations at present can be avoided if the check list is adhered to.

4. Unit costs are worked out for the broad and metre gauge systems of each of the Zonal Railways under 3 main groups-

Group 'A' – Gives the unit costs applicable for all- traction movement. These unit costs include the direct costs as well as the element of overheads.

Group 'B' - Gives unit costs for particular facets, as cost per shunting engine hour, train engine hour, engine hour etc., for each traction. The unit costs in this group include the element of overheads.

Group 'C'- Gives unit costs traction-wise. The wagon provision costs which include the element of repairs and maintenance, interest and depreciation, are separately shown. The overheads and the central charges are separately indicated.

Unit costs of line haul are worked out separately for through trains and van and shunting trains under both groups 'A' and 'C'.

All the unit costs are furnished separately under 3 heads - Working Expenses, Depreciation and Interest, so that the rate of return can be worked out both under the conventional method or D.C.F. technique.

Group 'A' and Group 'C' costs are more widely used for assessing the costs of specific flows or streams of traffic. If the traction is known, the Group 'C' costs are adopted. If the traction of line haul is not defined or specific, then all-traction figures in Group 'A' are adopted. Group 'C' costs are much more refined and specific and, therefore, by taking note of special characteristics of operation the costs may be estimated with a higher degree of accuracy. Group 'B' costs are generally used for estimating the savings in monetary terms of engine hours, wagon hours and shunting engine hours.

5. A study has been made to estimate broadly the variability of different items of expenditure with appropriate units of performance. The results of the study are summarised at the end of this Annexure.

6. In estimating the expenditure in respect of additional traffic the variability factors mentioned above should be adopted to arrive at the long- term variable costs. In estimating the expenditure in respect of existing traffic, however, the fully distributed cost should be used.

7. **Check list -**The check list and procedures/steps for estimating the costs are detailed below :-

		Existing line		Project line	
		Existing traffic	Additional traffic	Existing traffic	Additional traffic
Freight Traffic-					
(a)	Tonnage loaded under specific commodities				
(b)	Tonnage unloaded under specific commodities				
(c)	Tonnage transhipped				
(d)	Tonnage repacked				
(e)	Tonnage of cross traffic				
(f)	Load of specific traffic				
(g)	Net tonne kilometres				
(h)	Loaded wagon kms.				
(i)	Empty wagon kms.				
(j)	Tare tonne Kilometres				
(k)	Gross tonne Kilometres				
(1)	Engine Kilometres				
(m)	Train Kilometres				
(n)	No. and name of marshalling yards.				
(o)	No. and name of Repacking points.				
(p)	No. and name of Transhipment points				
	Coaching/Passenger traffic-				
	a) No. of Passengers-				
	(i) Originating				
	(ii) incoming				
	b) Train Kilometres				
	c) Engine Kilometres				
	d) Vehicle Kilometres.				

8. The Traffic Survey Report should give in detail the quantum of existing freight traffic (originating, terminating, transhipped, cross, etc.) under Important commodity groups, the pattern of movement (origin and destination of the important flows), the quantum assessed, both in terms of tonnes and in terms of B.G. or M.G.4-wheeler wagons. The additional traffic should also be assessed in a similar fashion. In case any difficulty is experienced in converting the tonnes into wagons, the figures of average starting loads (separately for originating and transhipped traffic) shown in the monthly wagon loading statements may be adopted. Otherwise, the minimum weight condition as per goods tariff may be taken into account.

9. Empty haulage should be carefully calculated taking into account the outward and inward traffic commodity-wise and equipment-wise. The source of empties should also be indicated so that the empty haulage may be reasonably assessed. Otherwise, following norms may be adopted :-

BFRs, Oil tanks, BOBs , BOI and Special types, etc. (B.G. and M.G.)	100%
POL Traffic, iron ore traffic, industrial raw material to steel plants, etc.(B.G. & M.G.)	100%

Coal--Average B. G.	80 %
Other commodities -B.G.	23 %
M. G. (including coal)	33 %

The correct estimate of empty haulage is very essential as this element appears in the calculation of –

(i) Wagon kilometres,
(ii) Gross tonne kilometres,
(iii) Engine kilometres,
(iv) Train kilometres,
(v) Wagon days,
(vi) Engine days, and
(vii) Number of marshalling yards.

10. Marshalling yards. --The survey report should specify the Inward, outward and cross traffic dealt with at different marshalling yards on the project line and the existing main line. This should be separately assessed for the existing traffic and the additional traffic. We should take into account not only the loaded journeys but also the empty journeys of wagons. In case traffic bypasses the marshalling yard, detention to stock for carriage and wagons/train examination for engine changing and crew changing should be taken into account.

There are at least 2 marshalling yards for any movement irrespective of distance. The study reveals frequency of marshalling as indicated below:

	Broad Gauge	Metre Gauge
1-40 Kms.	2.00	2.00
41-120 Kms.	3.00	3.00
121-240 Kms.	3.50	3.50
241-500 Kms.	4.00	4.00
501-800 Kms.	4.50	5.00
801-1300 Kms.	5.00	6.50
1301 and above	5.50	7.50

The above is only for wagons moving in piece-meal. Where the wagons are moving in a specific stream of Traffic, the actual marshalling requirements should be assessed on the concerned route.

11. Terminal:- Documentation charges are calculated on the basis of one invoice per 4-wheeler wagon in the case of wagon load traffic and one invoice for 0.54 tonne of smalls traffic.

In the case of train load movement, one invoice may be adopted for 10 four-wheeler wagons.

There are cases under which one-end terminal documentation is performed by the staff employed by the consignee or the consignor. In those cases, this element of cost for one end may be omitted.

Two terminal costs should be taken, one for the originating end and the other for the destination end.

12. A special study has been made in the case of coal traffic. The coal terminal costs at the originating end for 1970-71 are given below :-

	Cost per wagon			
Railway	Terminal Cost	Trip haul between base yard and collieries	Other costs	Total originating Terminal costs
	Rs.	Rs.	Rs.	Rs.
Central	15.485	8.046	24.649	48.180
Eastern	17.436	8.307	19.870	45.613
South Central	8.605	4.918	17.210	30.733
South Eastern	19.118	11.101	19.514	49.733
Total Indian Railways (B.G.)	17.202	8.803	19.917	45.922

At the destination end, the average unit costs would apply evenin the case of coal traffic.

13. Wagon days. - It is not correct to adopt wagon kilometres per wagon day for assessing the wagon requirements. To illustrate this point, the example of a short distance traffic of lead of 40 kilometres with an empty return ratio of 100% may be considered. The wagon requirement on the basis of wagon kilometres per wagon day would work out to only one wagon day. It is common knowledge that it would take at least 3 days for the wagon to be loaded, unloaded and brought back to the loading point for the subsequent loading, if the detention to stock at the originating end, terminating end, transit time and contiguous marshalling yards were properly taken into account. In the case of fairly long-lead traffic, the wagon user index may be adopted.

14. Engine kilometres - After calculating the train kilometres on the basis of the permissible load (in terms of BOX or 4-wheelers and the gross load) on various sections, the engine kilometres should be assessed on the basis of --

(1) Single engine operation or multiple engine operation,
(ii) Banking engines over gradient sections; and
(iii) Light engines.

Figures of engine kilometres per engine day used for goods traffic are readily available in the Annual Reports and Statistical Pamphlets for each traction. It should be possible to work out engine days required on this basis after giving due allowance for the element of repairs and spares.

For example, 4 million tonnes of iron ore are to be moved over a section 100 kms. in length. The movement will be in BOX wagons with load of 55 tonnes each. The section is heavily graded and the trains will run triple headed (diesel traction) with a load of 40 BOX's plus an additional banking engine over a section of 8 kms. Estimates of engine km/engine days will be as follows :-

(1)	No. of trains each way	1,818
(2)	Train kms. both ways with 100% empty return (1818 x 2 x 100)	3,63,600
(3)	Assisting required and Assisting not required Engine km.	7,27,200
(4)	Banking engine kms. (1818 x 2 x 8)	29,088
(5)	Light engine kms. (say 6% of train kms.)	21,816
		1,41,704

(6)	Bare-engine days required @ say 360 km. per engine day in use (goods).	3172
(7)	Total engine days required (add 16% for POH, spares, etc.)	3680 or 10 engines

The nature of movement should also be taken into account, i. e., whether the traffic is carried by shunting and van train or by through trains. The cost characteristics are different and separate unit costs are available.

15. Fuel and lubrication costs are calculated on the basis of GTKms.

Other operating costs (line haul) are calculated on the basis of train kilometres/engine kilometres.

16. Track and signalling line haul -This is calculated on the basis of GTKms. The average unit costs are not adopted for estimating the cost under track and signalling. A slight refinement is made taking into account the variability of this item of expenditure with reference to GTKms. The variability studies reveal that 50% of this expenditure is variable with GTKms. The average unit costs applicable to B.G. or M. G. systems of an individual Railway are adjusted by taking into account the specific density of traffic on the route or sections involved and the average density of the Zonal Railway system. As an illustration, a section with an average density of 18,000 tonnes per day as against the average density of 12,000 tonnes per day on the gauge may be considered. If the average unit cost for the gauge is Rs. 6.00 per 1000 GTKms., then the average unit cost for the section wi11 be

$$= \text{Rs.}3 + \left[\text{Rs.}3 \times \frac{12000}{18000} \right] \text{ or Rs.5 per 1000G.T.Kms.}$$

Particulars of Service for which unit costs of freight services are worked out on Indian Railways (See para 4 of Annexure A).

Line No.	Particulars
	GROUP A
1. 2.	Terminal Cost per Tonne-Smalls. Terminal Cost per Tonne-Full Loads.
3. 4.	Total Terminal Cost per Wagon-Full Loads. Repacking Cost of smalls per tonne per handling.
5. 6.	Transhipment Cost at Break of Gauge per tonne per transhipment. Marshalling Cost per Wagon per yard handled.
7. 8.	Line Haul Cost -per train kilometre. Line Haul Cost-per Wagon kilometre (Rev.)
9. 10.	Line Haul Cost-per net tonne kilometre (Pay Load). Line Haul Cost-per Wagon kilometre (Carrying Unit). (i) Through Goods Trains.
11. 12.	Line haul Cost per train Km. Line haul Cost per Wagon Km. (Rev.)
13. 14.	Line haul Cost per NTKm (Pay Load). Line haul Cost per Wagon Km. (Carrying units). (ii) Van and Shunting Goods.

15. 16. 17. 18.	Line haul Cost per train Km. Line haul Cost per Wagon Km. (Rev.) Line hau1 Cost per NTKm. (pay load). Line haul Cost per Wagon Km. (Carrying Units).	
	GROUP B	
19.	Cost of Documentation per Invoice.	
20.	Cost of Traction per Engine Hour (Other than Shunting and Siding).	Steam (Total).
21.	,, ,, ,, ,, ,, ,,	Diesel (Total).
22.	,, ,, ,, ,, ,, ,,	Electric (Total).
23. 24.	,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,,	Steam (Fuel, Water, Oi1, Tallow and Stores). Diesel (Fuel and stores)
25.	,, ,, ,, ,, ,,	Electric (Electric current consumed)
26. 27. 28. 29.	Cost of Traction per Train Engine Hour. ,, ,, ,, ,, ,, ,,	Steam (Total). Diesel (Total) Electric (Total). Steam (Fuel, Water, Oil, Tallow and Stores).
30. 31.	,, ,, ,, ,,	Diesel (Fuel and Stores). Electric (Electric current consumed).
32. 33. 34 35.	Cost of Traction per 1000G.T.Kms.. ,, ,, ,, ,, ,, ,,	Steam (Total). Diesel (Total) Electric (Total). Steam (Fuel, Water, Oil, Tallow and Stores).
36. 37.	Cost of Traction per 1000G.T.Kms.. ,, ,,	Diesel (Fuel and Stores). Electric (Electric current consumed).
38. 39. 40. 41.	Cost of Traction per Shunting Hour (Shunting Engines). ,, ,, ,, ,, ,, ,,	Steam (Total). Diesel (Total) Electric (Total). Steam (Fuel, Water, Oil, Tallow and Stores).
42. 43.	Cost of Traction per Shunting Hour (Shunting Engines). ,, ,,	Diesel (Fuel and Stores). Electric (Electric current consumed).
44. 45	Track and Signalling ,, ,,	Provision and Maintenance Cost per train Kilometre Provision and Maintenance Cost per.1000 G.T Kms.

Group C
46. Terminal Services-Cost of Documentation per Invoice. 47. Terminal Services-Cost of Handling per tonne. 48. Terminal Services-Cost of other Terminal Services per tonne-Smalls. 49. Terminal Services-Cost of other Terminal Services per tonne-Full Loads. 50. Terminal Services-Cost of other Terminal Services per wagon (Full Loads). 51. Cost of Repacking of Smalls per tonne per handling. 52. Cost of Transhipment at Break. of Gauge per tonne per Transhipment. 53. Cost of Marshalling per Wagon per yard handled. 54. Carrying Units-Provision and Maintenance per wagon day. 55. Line Haul (Movement) Service-Traction Cost- Steam per 1000 G. T. Kms. 56. ,, ,, ,, ,, ,, ,, ,, Diesel. 57. ,, ,, ,, ,, ,, ,, ,, Electric.
58. Line Haul (Movement) Service-Other Transportation expenses including Train Passing Staff per Train kilometre. 59. Line Haul (Movement) Service-Other Transportation Expenses including Train Passing Staff per 1000 G. T. Kms. 60. Line Haul (Movement) Service-Cost of Track and Signalling per train kilometre. 61. Line Haul (Movement) Service-Cost of Track and signalling per 1000 G. T. Kms. 62. General Overhead Charges-Percentage of Direct Costs.
63. Central Charges (Cost of Railway Board, Audit etc.)- Percentage of the total expenses. (i) Through Goods Trains.
64. Cost of traction per 1000 G. T. Km. (Diesel). 65. Cost of Traction per 1000 G. T. Km. (Steam). 66. Cost of Traction per 1000 G. T. Km. (Electric). 67. Other Transportation Expenses per 1000 G. T. Km. (ii) Van and Shunting Goods.
68. Cost of Traction per 1000 G. T. Km. (Steam). 69. Cost of Traction per 1000 G. T. Km. (Diesel). 70. Cost of Traction per 1000 G. T. Km. (Electric). 71. Other Transportation Expenses per 1000 G.T.Km.

Percentage of 'variable costs' to total costs average-all Railways.									
S. No.	Facets of operation	BROAD GUAGE				METER GAUGE			
		Working exp.	DRF	Interest	Overall	Working exp.	DRF	Inter-est	Over-all
	(i) For cost in group A -								
1.	Terminal	76	75	77	76	75	70	70	74
2.	Marshalling	74	83	85	78	74	80	80	77

3.	Transhipment at break-of-gauge point	80	70	74	79	80	70	74	79
4.	Repacking of Smalls	84	70	74	82	79	70	70	78
5.	Line Haul- (a) Pay load (b) Carrying Unit	 74 72	 46 70	 50 72	 67 72	 73 61	 45 65	 45 70	 67 62
	(ii) For costs in Group 'C -@								
1. 2 3. 4.	Terminal Marshalling Transhipment at break of gauge point Repacking of small	87 88 91 91	50 55 55 54	50 55 57 60	80 80 86 87	85 85 91 90	50 50 55 50	50 60 57 55	80 80 86 85
5.	Line Haul--- (i) Traction :								
	(a) Steam (b) Diesel (c) Electric*	100 100 100	100 100 100	100 100 100	100 100 100	100 100 100	100 100 100	100 100 100	100 100 100
	(ii) Other Transportation	85	45	45	70	85	45	45	77
	(iii) Tracks Signalling	90	45	45	47	48	45	45	47

@-	(1) Variability factors indicated for different facets of operation in Group Care exclusive of costs of provision and maintenance of wagons. The variability for provision and maintenance of wagons is 100% for D.R.F. and interest charge for both B.G. & M. G.
	(2) Variability factors for overhead expenses will be in the ratio of constant and variable expenses as worked out about to the total expenses under these heads.
	(3) For a quick and broad analysis, a variability of 78.5% may be taken as representing working expenses.
	* The variability factor relates to total cost including cost on overhead equipment.

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ANNEXURE 'B'

SINKING FUND PAYMENT TABLE

N-Normal life of assets in years

N	2%	2-1/2%	3%	3-1/4%	3-1/2%	3-3/4%	4%	4-1/4%	4-1/2%	5%	6%	7%	8%
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.4950	0.4938	0.4926	0.4920	0.4914	0.4908	0.4902	0.4896	0.4890	0.4878	0.4854	0.4831	0.4804
3	0.3268	0.3251	0.3235	0.3227	0.3219	0.3211	0.3203	0.3196	0.3188	0.3172	0.3141	0.3111	0.3080
4	0.2426	0.2408	0.2390	0.2381	0.2373	0.2364	0.2355	0.2346	0.2337	0.2320	0.2286	0.2252	0.2219
5	0.1922	0.1902	0.1884	0.1874	0.1865	0.1856	0.1846	0.1837	0.1828	0.1810	0.1774	0.1739	0.1705
6	0.1585	0.1565	0.1546	0.1536	0.1527	0.1517	0.1508	0.1498	0.1489	0.1470	0.1434	0.1398	0.1363
7	0.1345	0.1325	0.1305	0.1295	0.1285	0.1276	0.1266	0.1257	0.1247	0.1228	0.1191	0.1156	0.1121
8	0.1165	0.1145	0.1125	0.1115	0.1105	0.1095	0.1085	0.1076	0.1066	0.1047	0.1010	0.0975	0.0940
9	0.1025	0.1005	0.0984	0.0974	0.0964	0.0955	0.0945	0.0935	0.0926	0.0907	0.0870	0.0835	0.0801

ANNEXURE 'B'

SINKING FUND PAYMENT TABLE

N-Normal life of assets in years

N	2%	2-1/2%	3%	3-1/4%	3-1/2%	3-3/4%	4%	4-1/4%	4-1/2%	5%	6%	7%	8%
10	0.0913	0.0893	0.0872	0.0862	0.0852	0.0843	0.0833	0.0823	0.0814	0.0795	0.0759	0.0724	0.0690
11	0.0822	0.0801	0.0781	0.0771	0.0761	0.0751	0.0410	0.0732	0.0722	0.0704	0.0668	0.0634	0.0601
12	0.0746	0.0725	0.0705	0.0695	0.0685	0.0675	0.0666	0.0656	0.0647	0.0628	0.0593	0.0559	0.0527
13	0.0681	0.0660	0.0640	0.0630	0.0621	0.0611	0.0601	0.0592	0.0583	0.0565	0.0530	0.0497	0.0465
14	0.0626	0.0605	0.0585	0.0575	0.0566	0.0556	0.0547	0.0537	0.0528	0.0510	0.0476	0.0443	0.0413
15	0.0578	0.0558	0.0538	0.0528	0.0518	0.0509	0.0499	0.0490	0.0481	0.0463	0.0430	0.0398	0.0368
16	0.0537	0.0516	0.0496	0.0486	0.0477	0.0467	0.0458	0.0449	0.0410	0.0423	0.0390	0.0359	0.0330
17	0.0500	0.0479	0.0460	0.0450	0.0440	0.0431	0.0422	0.0413	0.0404	0.0387	0.0354	0.0324	0.0296
18	0.0467	0.0447	0.0427	0.0418	0.0408	0.0399	0.0390	0.0381	0.0372	0.0355	0.0324	0.0294	0.0267
19	0.0438	0.0418	0.0398	0.0389	0.0379	0.0370	0.0361	0.0353	0.0344	0.0327	0.0296	0.0268	0.0241
20	0.0412	0.0391	0.0372	0.0363	0.0354	0.0345	0.0336	0.0327	0.0319	0.0302	0.0272	0.0244	0.0219
21	0.0388	0.0368	0.0349	0.0339	0.0330	0.0321	0.0313	0.0304	0.0296	0.0280	0.0250	0.0223	0.0198
22	0.0366	0.0346	0.0327	0.0318	0.0309	0.0301	0.0292	0.0284	0.0275	0.0260	0.0230	0.0204	0.0180
23	0.0347	0.0327	0.0308	0.0299	0.0290	0.0282	0.0273	0.0265	0.0257	0.0241	0.0213	0.0187	0.0164
24	0.0329	0.0309	0.0290	0.0281	0.0273	0.0264	0.0256	0.0248	0.0240	0.0225	0.0197	0.0172	0.0150
25	0.0312	0.0293	0.0274	0.0265	0.0257	0.0248	0.0240	0.0232	0.0224	0.0210	0.0182	0.0158	0.0137
26	0.0297	0.0278	0.0259	0.0251	0.0242	0.0234	0.0226	0.0218	0.0210	0.0196	0.0169	0.0146	0.0125
27	0.0283	0.0264	0.0246	0.0237	0.0229	0.0220	0.0212	0.0205	0.0197	0.0183	0.0157	0.0134	0.0114
28	0.0270	0.0251	0.0233	0.0224	0.0216	0.0208	0.0200	0.0193	0.0185	0.0171	0.0149	0.0124	0.0105
29	0.0258	0.0239	0.0221	0.0213	0.0204	0.0197	0.0189	0.0181	0.0174	0.0600	0.0136	0.0114	0.0096
30	0.0246	0.0228	0.0210	0.0202	0.0194	0.0186	0.0178	0.0171	0.0164	0.0151	0.0126	0.0106	0.0088
31	0.0236	0.0217	0.0200	0.0192	0.0184	0.0176	0.0169	0.0161	0.0154	0.0141	0.0118	0.0098	0.0080
32	0.0226	0.0208	0.0190	0.0182	0.0174	0.0167	0.0159	0.0152	0.0146	0.0133	0.0110	0.0091	0.0075
33	0.0217	0.0199	0.0182	0.0173	0.0166	0.0158	0.0151	0.0144	0.0137	0.0125	0.0103	0.0084	0.0069
34	0.0208	0.0190	0.0173	0.0165	0.0158	0.0150	0.0143	0.0136	0.0130	0.0118	0.0096	0.0078	0.0063
35	0.0200	0.0182	0.0165	0.0158	0.0150	0.0143	0.0136	0.0129	0.0123	0.0111	0.0090	0.0072	0.0058
36	0.0192	0.0175	0.0158	0.0150	0.0143	0.0136	0.0129	0.0122	0.0116	0.0104	0.0084	0.0067	0.0053
37	0.0185	0.0167	0.0151	0.0143	0.0136	0.0129	0.0122	0.0116	0.0110	0.0098	0.0079	0.0062	0.0049
38	0.0178	0.0161	0.0145	0.0137	0.0130	0.0123	0.0116	0.0110	0.0104	0.0093	0.0074	0.0058	0.0045
39	0.0172	0.0154	0.0138	0.0131	0.0124	0.0117	0.0111	0.0104	0.0099	0.0088	0.0069	0.0054	0.0042
40	0.0166	0.0148	0.0133	0.0125	0.0118	0.0112	0.0105	0.0099	0.0093	0.0083	0.0065	0.0050	0.0039
41	0.0160	0.0143	0.0127	0.0120	0.0113	0.0106	0.0100	0.0094	0.0089	0.0078	0.0061	0.0047	0.0036
42	0.0154	0.0137	0.0122	0.0115	0.0108	0.0102	0.0095	0.0090	0.0084	0.0074	0.0057	0.0043	0.0033
43	0.0149	0.0132	0.0117	0.0110	0.0103	0.0097	0.0091	0.0085	0.0080	0.0070	0.0053	0.0040	0.0030
44	0.0144	0.0127	0.0112	0.0105	0.0099	0.0093	0.0087	0.0081	0.0076	0.0066	0.0050	0.0038	0.0028
45	0.0139	0.0123	0.0108	0.0101	0.0095	0.0088	0.0083	0.0077	0.0072	0.0063	0.0047	0.0035	0.0026
46	0.0135	0.0118	0.0104	0.0097	0.0091	0.0084	0.0079	0.0073	0.0068	0.0059	0.0044	0.0033	0.0024
47	0.0130	0.0114	0.0100	0.0093	0.0087	0.0081	0.0075	0.0700	0.0065	0.0056	0.0041	0.0030	0.0022
48	0.0126	0.0110	0.0096	0.0089	0.0083	0.0077	0.0072	0.0067	0.0062	0.0053	0.0039	0.0028	0.0002
49	0.0122	0.0106	0.0092	0.0086	0.0080	0.0074	0.0069	0.0064	0.0059	0.0050	0.0037	0.0026	0.0019
50	0.0118	0.0103	0.0089	0.0082	0.0076	0.0071	0.0066	0.0061	0.0056	0.0048	0.0034	0.0025	0.0017

ANNEXURE 'B'

SINKING FUND PAYMENT TABLE

N-Normal life of assets in years

N	2%	2-1/2%	3%	3-1/4%	3-1/2%	3-3/4%	4%	4-1/4%	4-1/2%	5%	6%	7%	8%
55	0.0101	0.0087	0.0073	0.0068	0.0062	0.0057	0.0052	0.0048	0.0044	0.0037	0.0025	0.0017	0.0001
60	0.0088	0.0074	0.0061	0.0056	0.0051	0.0046	0.0042	0.0039	0.0035	0.0028	0.0019	0.0012	0.0008
65	0.0076	0.0063	0.0051	0.0046	0.0042	0.0038	0.0034	0.0031	0.0027	0.0022	0.0014	0.0009	0.0005
70	0.0067	0.0054	0.0043	0.0039	0.0035	0.0031	0.0027	0.0025	0.0022	0.0017	0.0010	0.0006	0.0004
75	0.0059	0.0047	0.0037	0.0032	0.0029	0.0025	0.0022	0.0020	0.0017	0.0013	0.0008	0.0004	0.0002
80	0.0025	0.0040	0.0031	0.0027	0.0024	0.0021	0.0018	0.0016	0.0014	0.0010	0.0006	0.0003	0.0002
85	0.0046	0.0036	0.0026	0.0023	0.0020	0.0017	0.0015	0.0013	0.0011	0.0008	0.0004	0.0002	0.0001
90	0.0040	0.0030	0.0023	0.0019	0.0017	0.0014	0.0012	0.0011	0.0009	0.0006	0.0003	0.0002	0.0001
95	0.0036	0.0026	0.0019	0.0016	0.0014	0.0012	0.0010	0.0009	0.0007	0.0005	0.0002	0.0001	0.0000
100	0.0032	0.0023	0.0016	0.0014	0.0012	0.0010	0.0008	0.0007	0.0006	0.0004	0.0002	0.0001	0.0000
N	2%	2-1/2%	3%	3-1/4%	3-1/2%	3-3/4%	4%	4-1/4%	4-1/2%	5%	6%	7%	8%
41	0.0160	0.0143	0.0127	0.0120	0.0113	0.0106	0.0100	0.0094	0.0089	0.0078	0.0061	0.0047	0.0036
42	0.0154	0.0137	0.0122	0.0115	0.0108	0.0102	0.0095	0.0090	0.0084	0.0074	0.0057	0.0043	0.0033
43	0.0149	0.0132	0.0117	0.0110	0.0103	0.0097	0.0091	0.0085	0.0080	0.0070	0.0053	0.0040	0.0030
44	0.0144	0.0127	0.0112	0.0105	0.0099	0.0093	0.0087	0.0081	0.0076	0.0066	0.0050	0.0038	0.0028
45	0.0139	0.0123	0.0108	0.0101	0.0095	0.0088	0.0083	0.0077	0.0072	0.0063	0.0047	0.0035	0.0026
46	0.0135	0.0118	0.0104	0.0097	0.0091	0.0084	0.0079	0.0073	0.0068	0.0059	0.0044	0.0033	0.0024
47	0.0130	0.0114	0.0100	0.0093	0.0087	0.0081	0.0075	0.0700	0.0065	0.0056	0.0041	0.0030	0.0022
48	0.0126	0.0110	0.0096	0.0089	0.0083	0.0077	0.0072	0.0067	0.0062	0.0053	0.0039	0.0028	0.0002
49	0.0122	0.0106	0.0092	0.0086	0.0080	0.0074	0.0069	0.0064	0.0059	0.0050	0.0037	0.0026	0.0019
50	0.0118	0.0103	0.0089	0.0082	0.0076	0.0071	0.0066	0.0061	0.0056	0.0048	0.0034	0.0025	0.0017
55	0.0101	0.0087	0.0073	0.0068	0.0062	0.0057	0.0052	0.0048	0.0044	0.0037	0.0025	0.0017	0.0001
60	0.0088	0.0074	0.0061	0.0056	0.0051	0.0046	0.0042	0.0039	0.0035	0.0028	0.0019	0.0012	0.0008
65	0.0076	0.0063	0.0051	0.0046	0.0042	0.0038	0.0034	0.0031	0.0027	0.0022	0.0014	0.0009	0.0005
70	0.0067	0.0054	0.0043	0.0039	0.0035	0.0031	0.0027	0.0025	0.0022	0.0017	0.0010	0.0006	0.0004
75	0.0059	0.0047	0.0037	0.0032	0.0029	0.0025	0.0022	0.0020	0.0017	0.0013	0.0008	0.0004	0.0002
80	0.0025	0.0040	0.0031	0.0027	0.0024	0.0021	0.0018	0.0016	0.0014	0.0010	0.0006	0.0003	0.0002
85	0.0046	0.0036	0.0026	0.0023	0.0020	0.0017	0.0015	0.0013	0.0011	0.0008	0.0004	0.0002	0.0001
90	0.0040	0.0030	0.0023	0.0019	0.0017	0.0014	0.0012	0.0011	0.0009	0.0006	0.0003	0.0002	0.0001
95	0.0036	0.0026	0.0019	0.0016	0.0014	0.0012	0.0010	0.0009	0.0007	0.0005	0.0002	0.0001	0.0000
100	0.0032	0.0023	0.0016	0.0014	0.0012	0.0010	0.0008	0.0007	0.0006	0.0004	0.0002	0.0001	0.0000

The use of the Table – What sum must be paid at the end of each year to Sinking Fund so that the annual payments together with interest therein at 4 per cent compound annually, will at the end of 18 years amount to Rs.2,000/-

Opposite 18 under 4 per cent we find 0.390 which is the annual payment required for Re.1/- so for Rs. 2,000 the annual payment is 2,000 x 0.390 i.e. 78/-

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ANNEXURE 'C'

(See Para 227)

INTEREST FORMULAS AND TABLES FOR DISCOUNTED CASH FLOW TECHNIQUES

Interest Formulas

The interest formula and tables that follow may be found of considerable use in evaluating the financial aspects of Engineering projects.

Symbols:- The symbols used in these formulas and Tables are:

i represent rate of interest per interest period.

n represent number of interest periods

p represent sum of money

S - do - sum of money that is equivalent to p with interest i, at the end of n

R - do - the end of period payments/receipt in a uniform series continuing for the coming n periods, the entire series equivalent to p at interest rate i.

Formulas :- The interest formulas expressing the relationship between P, S and R in terms of i and n are :-

Given P, to find S $S = P \quad (l + i)^n$ (1)

Given S, to find P . $P = S \left[\frac{l}{(l + i)^n} \right]$ (2)

Given S, to find R , $R = S \left[\frac{l}{(l + i)^{n-l}} \right]$ (3)

Given P, to find R , $R= P \left[\frac{i\,(l + i\,)^n}{(l + i\,)^{n-l}} \right]$ (4)

Given R, to find S , $S= R \left[\frac{(l+i)^{n-l}}{i} \right]$ (5)

Given R, to find P , $P= R \left[\frac{(l+i)^{n-l}}{i\,(l+i)^n} \right]$ (6)

In the following explanations of these formulas the interest period is taken as one year; the explanations can be made general by substituting "Period" for "year"

Development of Formulas for Single Payment- If P is invested at interest rate l, the interest for the first year is iP and the total amount at the end of the first year is P(l+i).

The second year the interest on this is ip(l+i), and the amount at the end of this year is P(l+i)+iP(l+i) = $P(l+i)^2$. Similarly at the end of the third year the amount is $P(l+i)^3$; at the end of n years it is $P(l+i)^n$.

This is the formula for the compound amount, S, obtainable in n years from a principal, P.

$S = P \quad (l+i)^n$ (1)

If we express P in terms of S, i and n

$$P = S \left(\frac{1}{(l + i)^{n}} \right) \qquad (2)$$

P may then be thought of as the principal that will give a required amount S in n years; in other words, P is the present worth of a payment S, n years hence.

The expression $(1+i)^{n}$ is called the single payment compound amount actor (denoted as cu’). Its reciprocal $l/(l+i)^{n}$ is called the single payment present worth actor (denoted as pwf.)

Formulas for Uniform Annual Series of End-of Year Payments. - If R is invested at the end of each year for n years, the total amount at the end of n years will be the sum of the compound amounts of the individual investments. The money invested at the end of the first year will earn interest for (n-1) years; its amount will thus be $R\ (l+i)^{n-1}$. The second years payment will amount to $R\ (l+i)^{n-2}$; the third years to $R(l+i)^{n-3}$; and so on until the last payment, made at the end of n years which has earned no interest. The total sum S is then given by the expression-

$$S=R[\ (l+(l+i)+(l+i)^{2} \quad \ldots +(l+i)^{n-2} +(l+i)^{n-1}] \qquad (i)$$

To simplify, multiply both sides of the equation by (l+i),

$$(l+i)S=R[(l+i)+(l+i)^{2}+(l+i)^{3} \quad \ldots \quad +(l+i)^{n-1}+(l+i)^{n}] \qquad (ii)$$

Subtracting (i) from (ii)

$$iS = R[(l+i)^{n-1}]$$

$$\text{or } S = R \left(\frac{(l+i)^{n-1}}{i} \right)$$

$$\text{And } R=S \left(\frac{i}{(l+i)^{n-1}} \right) \qquad (3)$$

A fund established to produce a desired amount at the end of a given period of time by means of a series of payments through out the period is called a sinking fund. The expression—

$$\frac{1}{(1+i)^{n-1}}$$

is called the sinking fund deposit factor (denoted as sff).

To find the uniform end-of year payment, R which can be secured for n years from a present investment P, substitute In equation (3) the value given for S in equation (I)

$$R=S \left(\frac{i}{(l+i)^{n-1}} \right) \quad =P\ (l+i)^{-n} \left(\frac{i}{(l+i)^{n-1}} \right)$$

$$\text{or } R=P \left[\frac{i(l+i)^{n}}{(l+i)^{n-1}} \right] \qquad (4)$$

The expression—

$$\frac{i(l+i)^{n}}{(l+i)^{n-1}}$$

is called the capital recovery factor (denoted as crf).

When multiplied by a present debt (which, from the point of the lender, is a present investment,) it gives the uniform end-of-year payment necessary to repay the debit (the lender's investment) in n years with interest rate i.

Formulas (3) and (4) may be reversed to show S and P in terms of R as follows:

$$S=R \left[\frac{(l+i)^{n-1}}{i} \right] \qquad (5)$$

$$P=R \left[\frac{(l+i)^{n-1}}{i(l+i)^{n}} \right] \qquad (6)$$

The expression— $\left[\frac{(l+i)^{n-1}}{i} \right]$

is called the uniform series compound amount factor (denoted as caf)

The expression $\left[\frac{(l+i)^{n-1}}{i(l+i)^{n}} \right]$

is called the uniform series present worth factor (denoted as pwf).

TABLES 1 TO 19 Give values of the single payment compound amount factor, single payment present worth factor, the sinking fund deposit factor, the capital recovery factor, the uniform series compound amount factor, and the uniform series present worth factor for each value of n from 1 to 35, and for values of n that are multiples of 5 from 40 to 100. Each interest rate has a separate table; the interest rates given are 1%, 1-1/4%, 1-1/2%, 1-3/4%, 2%, 2-1/2%, 3%, 3-1/2%, 4%, 4-1/2%, 5%, 5-1/2%, 6%, 7%, 8%, 10%, 12%, 15%, and 20%. In addition,

TABLES 20 TO 22 give the capital recovery factors, single payment present worth factors, and series present worth factors for interest rates from 25% to 50%.

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Table 1 - 22

Table-1

Table -1

ANNEXURE 'C'—(Contd.)

Interest Tables

1% Compound Interest Factors

	Single Payment		Uniform Series				
	Compound Amount Factor caf'	Present Worth Factor pwf'	Sinking Fund Factor sff	Capital Recovery Factor crf	Compound Amount Factor caf	Present Worth Factor pwf	
	Given P To find S $(1+i)^n$	Given S To find P $\frac{1}{(1+i)^n}$	Given S To find R $\frac{i}{(1+i)^n-1}$	Given P To find R $\frac{i(1+i)^n}{(1+i)^n-1}$	Given R To find S $\frac{(1+i)^n-1}{i}$	Given R To find P $\frac{(1+i)^n-1}{i(1+i)^n}$	
1	1.010	0.9901	1.00000	1.01000	1.000	0.990	1
2	1.020	0.9803	0.49751	0.50751	2.010	1.970	2
3	1.030	0.9706	0.33002	0.34002	3.030	2.941	3
4	1.041	0.9610	0.24628	0.25628	4.060	3.902	4
5	1.051	0.9515	0.19604	0.20604	5.101	4.853	5
6	1.062	0.9420	0.16255	0.17255	6.152	5.795	6
7	1.072	0.9327	0.13863	0.14863	7.214	6.728	7
8	1.083	0.9235	0.12069	0.13069	8.286	7.652	8
9	1.094	0.9143	0.10674	0.11674	9.369	8.566	9
10	1.105	0.9053	0.09558	0.10558	10.462	9.471	10
11	1.116	0.8963	0.08645	0.09645	11.567	10.368	11
12	1.127	0.8874	0.07885	0.08885	12.683	11.255	12
13	1.138	0.8787	0.07241	0.08241	13.809	12.134	13
14	1.149	0.8700	0.06690	0.07690	14.947	13.004	14
15	1.161	0.8613	0.06212	0.07212	16.097	13.865	15
16	1.173	0.8528	0.05794	0.06794	17.258	14.718	16
17	1.184	0.8444	0.05426	0.06426	18.430	15.562	17
18	1.196	0.8360	0.05098	0.06098	19.615	16.398	18
19	1.208	0.8277	0.04805	0.05805	20.811	17.226	19
20	1.220	0.8195	0.04542	0.05542	22.019	18.046	20
21	1.232	0.8114	0.04303	0.05303	23.239	18.857	21
22	1.245	0.8034	0.04086	0.05086	24.472	19.660	22
23	1.257	0.7954	0.03889	0.04889	25.716	20.456	23
24	1.270	0.7876	0.03707	0.04707	26.973	21.243	24
25	1.282	0.7798	0.03541	0.04541	28.243	22.023	25
26	1.295	0.7720	0.03387	0.04387	29.526	22.795	26
27	1.308	0.7644	0.03245	0.04245	30.821	23.560	27
28	1.321	0.7568	0.03112	0.04112	32.129	24.316	28
29	1.335	0.7493	0.02990	0.03990	33.450	25.066	29
30	1.348	0.7419	0.02875	0.03875	34.785	25.808	30
31	1.361	0.7346	0.02768	0.03768	36.133	26.542	31
32	1.375	0.7273	0.02667	0.03667	37.494	27.270	32
33	1.389	0.7201	0.02573	0.03573	38.869	27.990	33
34	1.403	0.7130	0.02484	0.03484	40.258	28.703	34
35	1.417	0.7059	0.02400	0.03400	41.660	29.409	35
40	1.489	0.6717	0.02046	0.03046	48.886	32.835	40
45	1.565	0.6391	0.01771	0.02771	56.481	36.095	45
50	1.645	0.6080	0.01551	0.02551	64.463	39.196	50
55	1.729	0.5785	0.01373	0.02373	72.852	42.147	55
60	1.817	0.5504	0.12224	0.02224	81.670	44.955	60
65	1.909	0.5237	0.01100	0.02100	90.937	47.627	65
70	2.007	0.4983	0.00993	0.01993	100.676	50.169	70
75	2.109	0.4741	0.00902	0.01902	110.913	52.587	75
80	1.217	0.4511	0.00822	0.01822	121.672	54.888	80
85	2.330	0.4292	0.00752	0.01752	132.979	57.078	85
90	2.447	0.4084	0.00690	0.01690	144.863	59.161	90
95	2.574	0.3886	0.00636	0.01636	157.354	61.143	95
100	2.705	0.3697	0.00587	0.01587	170-481	63.029	100

Table – 2

ANNEXURE 'C'—(Contd.)

TABLE 2

$1\frac{1}{4}$% Compound Interest Factors

n	Single Payment		Uniform Series				n
	Compound Amount Factor caf'	Present Worth Factor pwf'	Sinking Fund Factor sff	Capital Recovery Factor crf	Compound Amount Factor caf	Present Worth Factor pwf	
	Given P To find S $(1+i)^n$	Given S To find P $\frac{1}{(1+i)^n}$	Given S To find R $\frac{i}{(1+i)^n-1}$	Given P To find R $\frac{i(1+i)^n}{(1+i)^n-1}$	Given R To find S $\frac{(1+i)^n-1}{i}$	Given R To find P $\frac{(1+i)^n-1}{i(1+i)^n}$	
1	1.012	0.9877	1.00000	1.01250	1.000	0.988	1
2	1.025	0.9755	0.49689	0.50939	2.012	1.963	2
3	1.038	0.9634	0.32920	0.34170	3.038	2.927	3
4	1.051	0.9515	0.24536	0.25786	4.076	3.878	4
5	1.064	0.9398	0.19506	0.20756	5.127	4.818	5
6	1.077	0.9282	0.16153	0.17403	6.191	5.746	6
7	1.091	0.9167	0.13759	0.15009	7.268	6.663	7
8	1.104	0.9054	0.11963	0.13213	8.359	7.568	8
9	1.118	0.8942	0.10567	0.11817	9.463	8.462	9
10	1.132	0.8832	0.09450	0.10700	10.582	9.346	10
11	1.146	0.8723	0.08537	0.09787	11.714	10.218	11
12	1.161	0.8615	0.07776	0.09026	12.860	11.079	12
13	1.175	0.8509	0.07132	0.08382	14.021	11.930	13
14	1.190	0.8404	0.06581	0.07831	15.196	12.771	14
15	1.205	0.8300	0.06103	0.07353	16.386	13.601	15
16	1.220	0.8197	0.05685	0.06935	17.591	14.420	16
17	1.235	0.8096	0.05316	0.06566	10.811	15.230	17
18	1.251	0.7996	0.04988	0.06238	20.046	16.030	18
19	1.266	0.7898	0.04696	0.05946	21.297	16.819	19
20	1.282	0.7800	0.04432	0.05682	22.563	17.599	20
21	1.298	0.7704	0.04194	0.05444	23.845	18.370	21
22	1.314	0.7609	0.03977	0.05227	25.143	19.131	22
23	1.331	0.7515	0.03780	0.05030	26.457	19.882	23
24	1.347	0.7422	0.03599	0.04849	27.788	20.624	24
25	1.364	0.7330	0.03432	0.04682	29.135	21.357	25
26	1.381	0.7240	0.03279	0.04529	30.500	22.081	26
27	1.399	0.7150	0.03137	0.04387	31.881	22.796	27
28	1.416	0.7062	0.03005	0.04255	33.279	23.503	28
29	1.434	0.6975	0.02882	0.04132	34.695	24.203	29
30	1.452	0.6889	0.02768	0.04018	36.129	24.889	30
31	1.470	0.6804	0.02661	0.03911	37.581	25.569	31
32	1.488	0.6720	0.02561	0.03811	39.050	26.241	32
33	1.507	0.6637	0.02467	0.03717	40.539	26.905	33
34	1.526	0.6555	0.02378	0.03628	42.045	27.560	34
35	1.545	0.6474	0.02295	0.03545	43.571	28.208	35
40	1.644	0.6084	0.01942	0.03192	51.490	31.327	40
45	1.749	0.5718	0.01669	0.02919	59.916	34.258	45
50	1.861	0.5373	0.01452	0.02702	68.882	37.013	50
55	1.980	0.5050	0.01275	0.02525	78.422	3g.602	55
60	2.107	0.4746	0.01129	0.02379	88.575	42.035	60
65	2.242	0.4460	0.01006	0.02256	99.377	44.321	65
70	2.386	0.4191	0.00902	0.02152	110.872	46.470	70
75	2.539	0.3939	0.00812	0.02062	123.103	48.489	75
80	2.701	0.3702	0.00735	0.01985	136.119	50.387	80
85	2.875	0.3479	0.00667	0.01917	149.968	52.170	85
90	3.059	0.3269	0.00607	0.01857	164.705	53.846	90
95	3.255	0.3072	0.00554	0.01804	180.386	55.421	95
100	3.463	0.2887	0.00507	0.01757	197.072	56.901	100

Table –3

ANNEXURE 'C'—(*Contd.*)

TABLE 3

$1\frac{1}{2}$% Compound Interest Factors

n	Single Payment		Uniform Series				n
	Compound Amount Factor caf'	Present Worth Factor pwf'	Sinking Fund Factor sff	Capital Recovery Factor crf	Compound Amount Factor caf	Present Worth Factor pwf	
	Given P To find S $(1+i)^n$	Given S To find P $\frac{1}{(1+i)^n}$	Given S To find R $\frac{i}{(1+i)^n-1}$	Given P To find R $\frac{i(1+i)^n}{(1+i)^n-1}$	Given R To find S $\frac{(1+i)^n-1}{i}$	Given R To find P $\frac{(1+i)^n-1}{i(1+i)^n}$	
1	1.015	0.9852	1.00000	1.01500	1.000	0.985	1
2	1.030	0.9707	0.49628	0.51128	2.015	1.956	2
3	1.046	0.9563	0.83283	0.34338	3.045	2.912	3
4	1.061	0.9422	0.24444	0.25944	4.091	3.854	4
5	1.077	0.9283	0.19409	0.20909	5.152	4.783	5
6	1.093	0.9145	0.16053	0.17553	6.230	5.697	6
7	1.110	0.9010	0.13656	0.15156	7.323	6.598	7
8	1.126	0.8877	0.11858	0.13358	8.433	7.486	8
9	1.143	0.8746	0.10461	0.11961	9.559	8.361	9
10	1.161	0.8617	0.09343	0.10843	10.703	9.222	10
11	1.178	0.8489	0.08429	0.09929	11.863	10.071	11
12	1.196	0.8364	0.07668	0.09168	13.041	10.908	12
13	1.214	0.8240	0.07024	0.08524	14.237	11.732	13
14	1.232	0.8118	0.06472	0.07972	15.450	12.543	14
15	1.250	0.7999	0.05994	0.07494	16.682	13.343	15
16	1.269	0.7880	0.05577	0.07077	17.932	14.131	16
17	1.288	0.7764	0.05208	0.06708	19.201	14.908	17
18	1.307	0.7649	0.04881	0.06381	20.489	15.673	18
19	1.327	0.7536	0.04588	0.06088	21.797	16.426	19
20	1.347	0.7425	0.04325	0.05825	23.124	17.169	20
21	1.367	0.7315	0.04087	0.05587	24.471	17.900	21
22	1.388	0.7207	0.03870	0.05370	25.838	18.621	22
23	1.408	0.7100	0.03673	0.05173	27.225	19.331	23
24	1.430	0.6995	0.03492	0.04992	28.634	20.030	24
25	1.451	0.6892	0.03326	0.04826	30.063	20.720	25
26	1.473	0.6790	0.03173	0.04673	31.514	21.399	26
27	1.495	0.6690	0.03032	0.04532	32.987	22.068	27
28	1.517	0.6591	0.02900	0.04400	34.481	22.727	28
29	1.540	0.6494	0.02778	0.04278	35.999	23.376	29
30	1.563	0.6398	0.02664	0.04164	37.539	24.016	30
31	1.587	0.6303	0.02557	0.04057	39.102	24.646	31
32	1.610	0.6210	0.02458	0.03958	40.688	25.267	32
33	1.634	0.6118	0.02364	0.03864	42.299	25.879	33
34	1.659	0.6028	0.02276	0.03776	43.933	26.482	34
35	1.684	0.5939	0.02193	0.03693	45.592	27.076	35
40	1.814	0.5513	0.01843	0.03343	54.268	29.916	40
45	1.954	0.5117	0.01572	0.03072	63.614	32.552	45
50	2.105	0.4750	0.01357	0.02857	73.683	35.000	50
55	2.260	0.4409	0.01183	0.02683	84.530	37.271	55
60	2.443	0.4093	0.01039	0.02539	96.215	39.380	60
65	2.632	0.3799	0.00919	0.02419	108.803	41.338	65
70	2.835	0.3527	0.00817	0.02317	122.364	43.155	70
75	3.055	0.3274	0.00730	0.02230	136.973	44.842	75
80	3.291	0.3039	0.00655	0.02155	152.711	46.407	80
85	3.545	0.2821	0.00589	0.02089	169.665	47.861	85
90	3.819	0.2619	0.00532	0.02032	187.930	49.240	90
95	4.114	0.2431	0.00482	0.01982	207.606	50.462	95
100	4.432	0.2256	0.00437	0.01937	228.803	51.625	100

Table - 4

ANNEXURE 'C'—(*Contd.*)

TABLE 4

1¾% Compound Interest Factors

n	Single Payment: Compound Amount Factor caf' — Given P To find S $(1+i)^n$	Single Payment: Present Worth Factor pwf' — Given S To find P $\frac{1}{(1+i)^n}$	Uniform Series: Sinking Fund Factor sff — Given S To find R $\frac{i}{(1+i)^n-1}$	Uniform Series: Capital Recovery Factor crf — Given P To find R $\frac{i(1+i)^n}{(1+i)^n-1}$	Uniform Series: Compound Amount Factor caf — Given R To find S $\frac{(1+i)^n-1}{i}$	Uniform Series: Present Worth Factor pwf — Given R To find P $\frac{(1+i)^n-1}{i(1+i)^n}$	n
1	1.018	0.9828	1.00000	1.01750	1.000	0.983	1
2	1.035	0.9659	0.49566	0.51316	2.018	1.949	2
3	1.053	0.9493	0.32757	0.34507	3.053	2.898	3
4	1.072	0.9330	0.24353	0.26103	4.106	3.831	4
5	1.091	0.9169	0.19312	0.21062	5.178	4.748	5
6	1.110	0.9011	0.15952	0.17702	6.269	5.649	6
7	1.129	0.8856	0.13553	0.15303	7.378	6.535	7
8	1.149	0.8704	0.11754	0.13504	8.508	7.405	8
9	1.169	0.8554	0.10356	0.12106	9.656	8.260	9
10	1.189	0.8407	0.09238	0.10988	10.825	9.101	10
11	1.210	0.8263	0.08323	0.10073	12.015	9.927	11
12	1.231	0.8121	0.07561	0.09311	13.225	10.740	12
13	1.253	0.7981	0.06917	0.08667	14.457	11.538	13
14	1.275	0.7844	0.06366	0.08116	15.710	12.322	14
15	1.297	0.7709	0.05888	0.07638	16.984	13.093	15
16	1.320	0.7576	0.05470	0.07220	18.282	13.850	16
17	1.343	0.7446	0.05102	0.06852	19.602	14.595	17
18	1.367	0.7318	0.04774	0.06524	20.945	15.327	18
19	1.390	0.7192	0.04482	0.06232	22.311	16.046	19
20	1.415	0.7068	0.04219	0.05969	23.702	16.753	20
21	1.440	0.6947	0.03981	0.05731	25.116	17.448	21
22	1.465	0.6827	0.03766	0.05516	26.556	18.130	22
23	1.490	0.6710	0.03569	0.05319	28.021	18.801	23
24	1.516	0.6594	0.03389	0.05139	29.511	19.461	24
25	1.543	0.6481	0.03223	0.04973	31.027	20.109	25
26	1.570	0.6369	0.03070	0.04820	32.570	20.746	26
27	1.597	0.6260	0.02929	0.04679	34.140	21.372	27
28	1.625	0.6152	0.02798	0.04548	35.738	21.987	28
29	1.654	0.6046	0.02676	0.04426	37.363	22.592	29
30	1.683	0.5942	0.02563	0.04313	39.017	23.186	30
31	1.712	0.5840	0.02457	0.04207	40.700	23.770	31
32	1.742	0.5740	0.02358	0.04108	42.412	24.344	32
33	1.773	0.5641	0.02265	0.04015	44.154	24.908	33
34	1.804	0.5544	0.02177	0.03927	45.927	25.462	34
35	1.835	0.5449	0.02095	0.03845	47.731	26.007	35
40	2.002	0.4996	0.01747	0.03497	57.234	28.594	40
45	2.183	0.4581	0.01479	0.03229	67.599	30.966	45
50	2.381	0.4200	0.01267	0.03017	78.902	33.141	50
55	2.597	0.3851	0.01096	0.02846	91.230	35.135	55
60	2.832	0.3531	0.00955	0.02705	104.675	36.964	60
65	3.088	0.3238	0.00838	0.02588	119.339	38.641	65
70	3.368	0.2969	0.00739	0.02489	135.331	40.178	70
75	3.674	0.2722	0.00655	0.02405	152.772	41.587	75
80	4.006	0.2496	0.00582	0.02332	171.794	42.880	80
85	4.369,	0.2289	0.00519	0.02269	192.539	44.065	85
90	4.765	0.2098	0.00465	0.02215	215.165	45.152	90
95	5.197	0.1924	0.00417	0.02167	239.840	46.148	95
100	5.668	0.1764	0.00375	0.02125	266.752	47.061	100

ANNEXURE 'C'—(*Contd.*)

TABLE 5

2% Compound Interest Factors

n	Single Payment: Compound Amount Factor caf'	Single Payment: Present Worth Factor pwf'	Sinking Fund Factor sff	Uniform Series: Capital Recovery Factor crf	Uniform Series: Compound Amount Factor caf	Uniform Series: Present Worth Factor pwf	n
	Given P To find S $(1+i)^n$	Given S To find P $\frac{1}{(1+i)^n}$	Given S To find R $\frac{i}{(1+i)^n-1}$	Given P To find R $\frac{i(1+i)^n}{(1+i)^n-1}$	Given R To find S $\frac{(1+i)^n-1}{i}$	Given R. To find P $\frac{(1+i)^n-1}{i(1+i)^n}$	
1	1.020	0.9804	1.00000	1.02000	1.000	0.980	1
2	1.040	0.9612	0.49505	0.51505	2.020	1.942	2
3	1.061	0.9423	0.32675	0.34675	3.060	2.884	3
4	1.082	0.9238	0.24262	0.26262	4.122	3.808	4
5	1.104	0.9057	0.19216	0.21216	5.204	4.713	5
6	1.126	0.8880	0.15853	0.17853	6.308	5.601	6
7	1.149	0.8706	0.13451	0.15451	7.434	6.472	7
8	1.172	0.8535	0.11651	0.13651	8.583	7.325	8
9	1.195	0.8368	0.10252	0.12252	9.755	8.162	9
10	1.219	0.8203	0.09133	0.11133	10.950	8.983	10
11	1.243	0.8043	0.08218	0.10218	12.169	9.787	11
12	1.268	0.7885	0.07456	0.09456	13.412	10.575	12
13	1.294	0.7730	0.06812	0.08812	14.680	11.348	13
14	1.319	0.7579	0.06260	0.08260	15.974	12.106	14
15	1.346	0.7430	0.05783	0.07783	17.293	12.849	15
16	1.373	0.7284	0.05365	0.07365	18.639	13.578	16
17	1.400	0.7142	0.04997	0.06997	20.012	14.292	17
18	1.428	0.7002	0.04670	0.06670	21.412	14.992	18
19	1.457	0.6864	0.04378	0.06378	22.841	15.678	19
20	1.486	0.6730	0.04116	0.06116	24.297	16.351	20
21	1.516	0.6598	0.03878	0.05878	25.783	17.011	21
22	1.546	0.6468	0.03663	0.05663	27.299	17.658	22
23	1.577	0.6342	0.03467	0.05467	28.845	18.292	23
24	1.608	0.6217	0.03287	0.05287	30.422	18.914	24
25	1.641	0.6095	0.03122	0.05122	32.030	19.523	25
26	1.673	0.5976	0.02970	0.04970	33.671	20.121	26
27	1.707	0.5859	0.02829	0.04829	35.344	20.707	27
28	1.741	0.5744	0.02699	0.04699	37.051	21.281	28
29	1.776	0.5631	0.02578	0.04578	38.792	21.844	29
30	1.811	0.5521	0.02465	0.04465	40.568	22.396	30
31	1.848	0.5412	0.02360	0.04360	42.379	22.938	31
32	1.885	0.5306	0.02261	0.04261	44.227	23.468	32
33	1.922	0.5202	0.02169	0.04169	46.112	23.989	33
34	1.961	0.5100	0.02082	0.04082	48.034	24.499	34
35	2.000	0.5000	0.02000	0.04000	49.994	24.999	35
40	2.208	0.4529	0.01656	0.03656	60.402	27.355	40
45	2.438	0.4102	0.01391	0.03391	71.893	29.490	45
50	2.692	0.3715	0.01182	0.03182	84.579	31.424	50
55	2.972	0.3365	0.01014	0.03014	98.587	33.175	55
60	3.281	0.3048	0.00877	0.02877	114.052	34.761	60
65	3.623	0.2761	0.00763	0.02763	131.126	36.197	65
70	4.000	0.2500	0.00667	0.02667	149.978	37.499	70
75	4.416	0.2265	0.00586	0.02586	170.792	38.677	75
80	4.875	0.2051	0.00516	0.02516	193.772	39.745	80
85	5.383	0.1858	0.00456	0.02456	219.144	40.711	85
90	5.943	0.1683	0.00405	0.02405	247.157	41.587	90
95	6.562	0.1524	0.00360	0.02360	278.085	42.380	95
100	7.245	0.1380	0.00320	0.02320	312.232	43.098	100

Table- 6

ANNEXURE 'C'—(*Contd.*)

TABLE 6

$2\frac{1}{2}$ % Compound Interest Factors

n	Single Payment		Uniform Series				n
	Compound Amount Factor caf'	Present Worth Factor pwf'	Sinking Fund Factor sff	Capital Recovery Factor crf	Compound Amount Factor caf	Present Worth Factor pwf	
	Given P To find S $(1+i)^n$	Given S To find P $\frac{1}{(1+i)^n}$	Given S To find R $\frac{i}{(1+i)^n-1}$	Given P To find R $\frac{i(1+i)^n}{(1+i)^n-1}$	Given R To find S $\frac{(1+i)^n-1}{i}$	Given R To find P $\frac{(1+i)^n-1}{i(1+i)^n}$	
1	1.025	0.9756	1.00000	1.02500	1.000	0.976	1
2	1.051	0.9518	0.49383	0.51883	2.025	1.927	2
3	1.077	0.9286	0.32514	0.35014	3.076	2.856	3
4	1.104	0.9060	0.24082	0.26582	4.153	3.762	4
5	1.131	0.8839	0.19025	0.21525	5.256	4.646	5
6	1.160	0.8623	0.15655	0.18155	6.388	5.508	6
7	1.189	0.8413	0.13250	0.15750	7.547	6.349	7
8	1.218	0.8207	0.11447	0.13947	8.736	7.170	8
9	1.249	0.8007	0.10046	0.12546	9.955	7.971	9
10	1.280	0.7812	0.08926	0.11426	11.203	8.752	10
11	1.312	0.7621	0.08011	0.10511	12.483	9.514	11
12	1.345	0.7436	0.07249	0.09749	13.796	10.258	12
13	1.379	0.7254	0.06605	0.09105	15.140	10.983	13
14	1.413	0.7077	0.06054	0.08554	16.519	11.691	14
15	1.448	0.6905	0.05577	0.08077	17.932	12.381	15
16	1.485	0.6736	0.05160	0.07660	19.380	13.055	16
17	1.522	0.6572	0.04793	0.07293	20.865	13.712	17
18	1.560	0.6412	0.04467	0.06967	22.386	14.353	18
19	1.599	0.6255	0.04176	0.06676	23.946	14.979	19
20	1.639	0.6103	0.03915	0.06415	25.545	15.589	20
21	1.680	0.5954	0.03679	0.06179	27.183	16.185	21
22	1.722	0.5809	0.03465	0.05965	28.863	16.765	22
23	1.765	0.5667	0.03270	0.05770	30.584	17.332	23
24	1.809	0.5529	0.03091	0.05591	32.349	17.885	24
25	1.854	0.5394	0.02928	0.05428	34.158	18.424	25
26	1.900	0.5262	0.02777	0.05277	36.012	18.951	26
27	1.948	0.5134	0.02638	0.05138	37.912	19.464	27
28	1.996	0.5009	0.02509	0.05009	39.860	19.965	28
29	2.046	0.4887	0.02389	0.04889	41.856	20.454	29
30	2.098	0.4767	0.02278	0.04778	43.903	20.930	30
31	2.150	0.4651	0.02174	0.04674	46.000	21.395	31
32	2.204	0.4538	0.02077	0.04577	48.150	21.849	32
33	2.259	0.4427	0.01986	0.04486	50.354	22.292	33
34	2.315	0.4319	0.01901	0.04401	52.613	22.724	34
35	2.373	0.4214	0.01821	0.04321	54.928	23.145	35
40	2.685	0.3724	0.01484	0.03984	67.403	25.103	40
45	3.038	0.3292	0.01227	0.03727	81.516	26.833	45
50	3.437	0.2909	0.01026	0.03526	97.484	28.362	50
55	3.889	0.2572	0.00865	0.03365	115.551	29.714	55
60	4.400	0.2273	0.00735	0.03235	135.992	30.909	60
65	4.978	0.2009	0.00628	0.03128	159.118	31.965	65
70	5.632	0.1776	0.00540	0.03040	185.284	32.898	70
75	6.372	0.1569	0.00465	0.02965	214.888	33.728	75
80	7.210	0.1387	0.00403	0.02903	248.383	34.452	80
85	8.157	0.1226	0.00349	0.02849	286.279	35.096	85
90	9.229	0.1084	0.00304	0.02804	329.154	35.666	90
95	10.422	0.0958	0.00265	0.02765	377.664	36.169	95
100	11.814	0.0846	0.00231	0.02731	431.549	36.614	100

Table – 7

ANNEXURE 'C'—(Contd.)

TABLE 7

3% Compound Interest Factors

n	Single Payment: Compound Amount Factor caf' — Given P To find S $(1+i)^n$	Single Payment: Present Worth Factor pwf' — Given S To find P $\frac{1}{(1+i)^n}$	Uniform Series: Sinking Fund Factor sff — Given S To find R $\frac{i}{(1+i)^n-1}$	Uniform Series: Capital Recovery Factor crf — Given P To find R $\frac{i(1+i)^n}{(1+i)^n-1}$	Uniform Series: Compound Amount Factor caf — Given R To find S $\frac{(1+i)^n-1}{i}$	Uniform Series: Present Worth Factor pwf — Given R To find P $\frac{(1+i)^n-1}{i(1+i)^n}$	n
1	1.030	0.9709	1.00000	1.03000	1.000	0.971	1
2	1.061	0.9426	0.49261	0.52261	2.030	1.913	2
3	1.093	0.9151	0.32353	0.35353	3.091	2.829	3
4	1.126	0.8885	0.23903	0.26903	4.184	3.717	4
5	1.159	0.8626	0.18835	0.21835	5.309	4.580	5
6	1.194	0.8375	0.15460	0.18460	6.468	5.417	6
7	1.230	0.8131	0.13051	0.16051	7.662	6.230	7
8	1.267	0.7894	0.11246	0.14246	8.892	7.020	8
9	1.305	0.7664	0.09843	0.12843	10.159	7.786	9
10	1.344	0.7441	0.08723	0.11723	11.464	8.530	10
11	1.384	0.7224	0.07808	0.10808	12.808	9.253	11
12	1.426	0.7014	0.07046	0.10046	14.192	9.954	12
13	1.469	0.6810	0.06403	0.09403	15.618	10.635	13
14	1.513	0.6611	0.05853	0.08853	17.086	11.296	14
15	1.558	0.6419	0.05377	0.08377	18.599	11.938	15
16	1.605	0.6232	0.04961	0.07961	20.157	12.561	16
17	1.653	0.6050	0.04595	0.07595	21.762	13.166	17
18	1.702	0.5874	0.04271	0.07271	23.414	13.754	18
19	1.754	0.5703	0.03981	0.06981	25.117	14.324	19
20	1.806	0.5537	0.03722	0.06722	26.870	14.877	20
21	1.860	0.5375	0.03487	0.06487	28.676	15.415	21
22	1.916	0.5219	0.03275	0.06275	30.537	15.937	22
23	1.974	0.5067	0.03081	0.06081	32.453	16.444	23
24	2.033	0.4919	0.02905	0.05905	34.426	16.936	24
25	2.094	0.4776	0.02743	0.05743	36.459	17.413	25
26	2.157	0.4637	0.02594	0.05594	38.553	17.877	26
27	2.221	0.4502	0.02456	0.05456	40.710	18.327	27
28	2.288	0.4371	0.02329	0.05329	42.931	18.764	28
29	2.357	0.4243	0.02211	0.05211	45.219	19.188	29
30	2.427	0.4120	0.02102	0.05102	47.575	19.600	30
31	2.500	0.4000	0.02000	0.05000	50.003	20.000	31
32	2.575	0.3883	0.01905	0.04905	52.503	20.389	32
33	2.652	0.3770	0.01816	0.04816	55.078	20.766	33
34	2.732	0.3660	0.01732	0.04732	57.730	21.132	34
35	2.814	0.3554	0.01654	0.04654	60.462	21.487	35
40	3.262	0.3066	0.01326	0.04326	75.401	23.115	40
45	3.782	0.2644	0.01079	0.04079	92.720	24.519	45
50	4.384	0.2281	0.00887	0.03887	112.797	25.730	50
55	5.082	0.1968	0.00735	0.03735	136.072	26.774	55
60	5.892	0.1697	0.00613	0.03613	163.053	27.676	60
65	6.830	0.1464	0.00515	0.03515	194.333	28.453	65
70	7.918	0.1263	0.00434	0.03434	230.594	29.123	70
75	9.179	0.1089	0.00367	0.03367	272.631	29.702	75
80	10.641	0.0940	0.00311	0.03311	321.363	30.201	80
85	12.336	0.0811	0.00265	0.03265	377.857	30.631	85
90	14.300	0.0699	0.00226	0.03226	443.349	31.002	90
95	16.578	0.0603	0.00193	0.03193	519.272	31.323	95
100	19.219	0.0520	0.00165	0.03165	607.288	31.599	100

Table – 8

ANNEXURE 'C'—(Contd.)

TABLE 8

$3\frac{1}{2}$% Compound Interest Factors

n	Single Payment: Compound Amount Factor caf' — Given P To find S $(1+i)^n$	Single Payment: Present Worth Factor pwf' — Given S To find P $\frac{1}{(1+i)^n}$	Single Payment: Sinking Fund Factor sff — Given S To find R $\frac{i}{(1+i)^n-1}$	Uniform Series: Capital Recovery Factor crf — Given P To find R $\frac{i(1+i)^n}{(1+i)^n-1}$	Uniform Series: Compound Amount Factor caf — Given R To find S $\frac{(1+i)^n-1}{i}$	Uniform Series: Present Worth Factor pwf — Given R To find P $\frac{(1+i)^n-1}{i(1+i)^n}$	n
1	1.035	0.9662	1.00000	1.03500	1.000	0.966	1
2	1.071	0.9335	0.49140	0.52640	2.035	1.900	2
3	1.109	0.9019	0.32193	0.35693	3.106	2.802	3
4	1.148	0.8714	0.23725	0.27225	4.215	3.673	4
5	1.188	0.8420	0.18648	0.22148	5.362	4.515	5
6	1.229	0.8135	0.15267	0.18767	6.550	5.329	6
7	1.272	0.7860	0.12854	0.16354	7.779	6.115	7
8	1.317	0.7594	0.11048	0.14548	9.052	6.874	8
9	1.363	0.7337	0.09645	0.13145	10.368	7.608	9
10	1.411	0.7089	0.08524	0.12024	11.731	8.317	10
11	1.460	0.6849	0.07609	0.11109	13.142	9.002	11
12	1.511	0.6618	0.06848	0.10348	14.602	9.663	12
13	1.564	0.6394	0.06206	0.09706	16.113	10.303	13
14	1.619	0.6178	0.05657	0.09157	17.677	10.921	14
15	1.675	0.5969	0.05183	0.08683	19.296	11.517	15
16	1.734	0.5767	0.04768	0.08268	20.971	12.094	16
17	1.795	0.5572	0.04404	0.07904	22.705	12.651	17
18	1.857	0.5384	0.04082	0.07582	24.500	13.120	18
19	1.923	0.5202	0.03794	0.07294	26.357	13.710	19
20	1.990	0.5026	0.03536	0.07036	28.280	14.212	20
21	2.059	0.4856	0.03304	0.06804	30.269	14.698	21
22	2.132	0.4692	0.03093	0.06593	32.329	15.167	22
23	2.206	0.4533	0.02902	0.06402	34.460	15.620	23
24	2.283	0.4380	0.02727	0.06227	36.667	16.058	24
25	2.363	0.4231	0.02567	0.06067	38.950	16.482	25
26	2.446	0.4088	0.02421	0.05921	41.313	16.890	26
27	2.532	0.3950	0.02285	0.35785	43.759	17.285	27
28	2.620	0.3817	0.02160	0.05660	46.291	17.667	28
29	2.712	0.3687	0.02045	0.05545	48.911	18.036	29
30	2.807	0.3563	0.01937	0.05437	51.623	18.392	30
31	2.905	0.3442	0.01837	0.05337	54.429	18.736	31
32	3.007	0.3326	0.01744	0.05244	57.335	19.069	32
33	3.112	0.3213	0.01657	0.05157	60.341	19.390	33
34	3.221	0.3105	0.01576	0.05076	63.453	19.701	34
35	3.334	0.3000	0.01500	0.05000	66.674	20.001	35
40	3.959	0.2526	0.01183	0.04683	84.550	21.355	40
45	4.702	0.2127	0.00945	0.04445	105.782	22.495	45
50	5.585	0.1791	0.00763	0.04263	130.998	23.456	50
55	6.633	0.1508	0.00621	0.04121	160.947	24.264	55
60	7.878	0.1269	0.00509	0.04009	196.517	24.945	60
65	9.357	0.1069	0.00419	0.03917	238.763	25.518	65
70	11.113	0.0900	0.00346	0.03846	288.938	26.000	70
75	13.199	0.0758	0.00287	0.03787	348.530	26.407	75
80	15.676	0.0638	0.00238	0.03738	419.307	26.749	80
85	18.618	0.0537	0.00199	0.03699	503.367	27.037	85
90	22.112	0.0452	0.00166	0.03666	603.205	27.279	90
95	26.262	0.0381	0.00139	0.03639	721.701	27.484	95
100	31.191	0.0321	0.00116	0.03616	862.612	27.655	100

Table – 9

ANNEXURE 'C'—(*Contd.*)

TABLE 9

4% Compound Interest Factors

n	Single Payment: Compound Amount Factor caf' — Given P To find S $(1+i)^n$	Single Payment: Present Worth Factor pwf' — Given S To find P $\frac{1}{(1+i)^n}$	Single Payment: Sinking Fund Factor sff — Given S To find R $\frac{i}{(1+i)^n-1}$	Uniform Series: Capital Recovery Factor crf — Given P To find R $\frac{i(1+i)^n}{(1+i)^n-1}$	Uniform Series: Compound Amount Factor caf — Given R To find S $\frac{(1+i)^n-1}{i}$	Uniform Series: Present Worth Factor pwf — Given R To find P $\frac{(1+i)^n}{i(1+i)^n-1}$	n
1	1.040	0.9615	1.00000	1.04000	1.000	0.962	1
2	1.082	0.9246	0.49020	0.53020	2.040	1.886	2
3	1.125	0.8890	0.32035	0.36035	3.122	2.775	3
4	1.170	0.8548	0.23549	0.27549	4.246	3.630	4
5	1.217	0.8219	0.18463	0.22463	5.416	4.452	5
6	1.265	0.7903	0.15076	0.19076	6.633	5.242	6
7	1.316	0.7599	0.12661	0.16661	7.898	6.002	7
8	1.369	0.7307	0.10853	0.14853	9.214	6.733	8
9	1.423	0.7026	0.09449	0.13449	10.583	7.435	9
10	1.480	0.6756	0.08329	0.12329	12.006	8.111	10
11	1.539	0.6496	0.07415	0.11415	13.486	8.760	11
12	1.601	0.6246	0.06665	0.10655	15.026	9.385	12
13	1.665	0.6006	0.06014	0.10014	16.627	9.986	13
14	1.732	0.5775	0.05467	0.09467	18.292	10.563	14
15	1.801	0.5553	0.04994	0.08994	20.024	11.118	15
16	1.873	0.5339	0.04582	0.08582	21.825	11.652	16
17	1.948	0.5134	0.04220	0.08220	23.698	12.166	17
18	2.026	0.4936	0.03899	0.07899	25.645	12.659	18
19	2.107	0.4746	0.03614	0.07614	27.671	13.134	19
20	2.191	0.4564	0.03358	0.07358	29.778	13.590	20
21	2.279	0.4388	0.03128	0.07128	31.969	14.029	21
22	2.370	0.4220	0.02920	0.06920	34.248	14.451	22
23	2.465	0.4057	0.02731	0.06731	36.618	14.857	23
24	2.563	0.3901	0.02559	0.06559	39.083	15.247	24
25	2.666	0.3751	0.02401	0.06401	41.646	15.622	25
26	2.772	0.3607	0.02257	0.06257	44.312	15.983	26
27	2.883	0.3468	0.02124	0.06124	47.084	16.330	27
28	2.999	0.3335	0.02001	0.06001	49.968	16.663	28
29	3.119	0.3207	0.01888	0.05888	52.966	16.984	29
30	3.243	0.3083	0.01783	0.05783	56.085	17.292	30
31	3.373	0.2965	0.01686	0.05686	59.328	17.588	31
32	3.508	0.2851	0.01595	0.05595	62.701	17.874	32
33	3.648	0.2741	0.01510	0.05510	66.210	18.148	33
34	3.794	0.2636	0.01431	0.05431	69.858	18.411	34
35	3.946	0.2534	0.01358	0.05358	73.652	18.665	35
40	4.801	0.2083	0.01052	0.05052	95.026	19.793	40
45	5.841	0.1712	0.00826	0.04826	121.029	20.720	45
50	7.107	0.1407	0.00655	0.04655	152.667	21.482	50
55	8.646	0.1157	0.00523	0.04523	191.159	22.109	55
60	10.520	0.0951	0.00420	0.04420	237.991	22.623	60
65	12.799	0.0781	0.00339	0.04339	294.968	23.047	65
70	15.572	0.0642	0.00275	0.04275	364.290	23.395	70
75	18.945	0.0528	0.00223	0.04223	448.631	23.680	75
80	23.050	0.0434	0.00181	0.04181	551.245	23.915	80
85	28.044	0.0357	0.00148	0.04148	676.090	24.109	85
90	34.119	0.0293	0.00121	0.04121	827.983	24.267	90
95	41.511	0.0241	0.00099	0.04099	1012.785	24.398	95
100	50.505	0.0198	0.00081	0.04081	1237.624	24.505	100

Table – 10

ANNEXURE 'C'—(*Contd.*)

TABLE 10

4½% Compound Interest Factors

n	Single Payment: Compound Amount Factor caf' — Given P To find S $(1+i)^n$	Single Payment: Present Worth Factor pwf' — Given S To find P $\frac{1}{(1+i)^n}$	Single Payment: Sinking Fund Factor sff — Given S To find R $\frac{i}{(1+i)^n-1}$	Uniform Series: Capital Recovery Factor crf — Given P To find R $\frac{i(1+i)^n}{(1+i)^n-1}$	Uniform Series: Compound Amount Factor caf — Given R To find S $\frac{(1+i)^n-1}{i}$	Uniform Series: Present Worth Factor pwf — Given R To find P $\frac{(1+i)^n-1}{i(1+i)^n}$	n
1	1.045	0.9569	1.00000	1.04500	1.000	0.957	1
2	1.092	0.9157	0.48900	0.53400	2.045	1.873	2
3	1.141	0.8763	0.31877	0.36377	3.137	2.749	3
4	1.193	0.8386	0.23374	0.27874	4.278	3.588	4
5	1.246	0.8025	0.18279	0.22779	5.471	4.390	5
6	1.302	0.7679	0.14888	0.19388	6.717	5.158	6
7	1.361	0.7348	0.12470	0.16970	8.019	5.893	7
8	1.422	0.7032	0.10661	0.15161	9.380	6.596	8
9	1.486	0.6729	0.09257	0.13757	10.802	7.269	9
10	1.553	0.6439	0.08138	0.12638	12.288	7.913	10
11	1.623	0.6162	0.07225	0.11725	13.841	8.529	11
12	1.696	0.5897	0.06467	0.10967	15.464	9.119	12
13	1.772	0.5643	0.05828	0.10328	17.160	9.683	13
14	1.852	0.5400	0.05282	0.09782	18.932	10.223	14
15	1.935	0.5167	0.04811	0.09311	20.784	10.740	15
16	2.022	0.4945	0.04402	0.08902	22.719	11.234	16
17	2.113	0.4732	0.04042	0.08542	24.742	11.707	17
18	2.208	0.4528	0.03724	0.08224	26.855	12.160	18
19	2.308	0.4333	0.03441	0.07941	29.064	12.593	19
20	2.412	0.4146	0.03188	0.07688	31.371	13.008	20
21	2.520	0.3968	0.02960	0.07460	33.783	13.405	21
22	2.634	0.3797	0.02755	0.07255	36.303	13.784	22
23	2.752	0.3634	0.02568	0.07068	38.937	14.148	23
24	2.876	0.3477	0.02399	0.06899	41.689	14.495	24
25	3.005	0.3327	0.02244	0.06744	44.765	14.828	25
26	3.141	0.3184	0.02102	0.06602	47.571	15.147	26
27	3.282	0.3047	0.01972	0.06472	50.711	15.451	27
28	3.430	0.2916	0.01852	0.06352	53.993	15.743	28
29	3.584	0.2790	0.01741	0.06241	57.423	16.022	29
30	3.745	0.2670	0.01639	0.06139	61.007	16.289	30
31	3.914	0.2555	0.01544	0.06044	64.752	16.544	31
32	4.090	0.2445	0.01456	0.05956	68.666	16.789	32
33	4.274	0.2340	0.01374	0.05874	72.756	17.023	33
34	4.466	0.2239	0.01298	0.05798	77.030	17.247	34
35	4.667	0.2143	0.01227	0.05727	81.497	17.461	35
40	5.816	0.1719	0.00934	0.05434	107.030	18.402	40
45	7.248	0.1380	0.00720	0.05220	138.850	19.156	45
50	9.033	0.1107	0.00560	0.05060	178.503	19.762	50
55	11.256	0.0888	0.00439	0.04939	227.918	20.248	55
60	14.027	0.0713	0.00345	0.04845	289.498	20.638	60
65	17.481	0.0572	0.00273	0.04773	366.238	20.951	65
70	21.784	0.0459	0.00217	0.04717	461.870	21.202	70
75	27.147	0.0368	0.00172	0.04672	581.044	21.404	75
80	33.830	0.0296	0.00137	0.04637	729.558	21.565	80
85	42.158	0.0237	0.00109	0.04609	914.632	21.695	85
90	52.537	0.0190	0.00087	0.04587	1145.269	21.799	90
95	65.471	0.0153	0.00070	0.04570	1432.684	21.883	95
100	81.589	0.0123	0.00056	0.04556	1790.856	21.950	100

Table – 11

ANNEXURE 'C'—(*Contd.*)

TABLE 11

5% Compound Interest Factors

n	Single Payment			Uniform Series			n
	Compound Amount Factor caf'	Present Worth Factor pwf'	Sinking Fund Factor sff	Capital Recovery Factor crf	Compound Amount Factor caf	Present Worth Factor pwf	
	Given P To find S $(1+i)^n$	Given S To find P $\frac{1}{(1+i)^n}$	Given S To find R $\frac{i}{(1+i)^n-1}$	Given P To find R $\frac{i(1+i)^n}{(1+i)^n-1}$	Given R To find S $\frac{(1+i)^n-1}{i}$	Given R To find P $\frac{(1+i)^n-1}{i(1+i)^n}$	
1	1.050	0.9524	1.00000	1.05000	1.000	0.952	1
2	1.103	0.9070	0.48780	0.53780	2.050	1.859	2
3	1.158	0.8638	0.31721	0.36721	3.153	2.723	3
4	1.216	0.8227	0.23201	0.28201	4.310	3.546	4
5	1.276	0.7835	0.18097	0.23097	5.526	4.329	5
6	1.340	0.7462	0.14702	0.19702	6.802	5.076	6
7	1.407	0.7107	0.12282	0.17282	8.142	5.786	7
8	1.477	0.6768	0.10472	0.15472	9.549	6.463	8
9	1.551	0.6446	0.09069	0.14069	11.027	7.108	9
10	1.629	0.6139	0.07950	0.12950	12.578	7.722	10
11	1.710	0.5847	0.07039	0.12039	14.207	8.306	11
12	1.796	0.5568	0.06283	0.11283	15.917	8.863	12
13	1.886	0.5303	0.05646	0.10646	17.713	9.394	13
14	1.980	0.5051	0.05102	0.10102	19.599	9.899	14
15	2.079	0.4810	0.04634	0.09634	21.579	10.380	15
16	2.183	0.4581	0.04227	0.09227	23.657	10.838	16
17	2.292	0.4363	0.03870	0.08870	25.840	11.274	17
18	2.407	0.4155	0.03555	0.08555	28.132	11.690	18
19	2.527	0.3957	0.03275	0.08275	30.539	12.085	19
20	2.653	0.3769	0.03024	0.08024	33.066	12.462	20
21	2.786	0.3589	0.02800	0.07800	35.719	12.821	21
22	2.925	0.3418	0.02597	0.07597	38.505	13.163	22
23	3.072	0.3256	0.02414	0.07414	41.430	13.489	23
24	3.225	0.3101	0.02247	0.07247	44.502	13.799	24
25	3.386	0.2953	[illegible]	0.07095	47.727	14.094	25
26	3.556	0.2812	[illegible]	0.06956	51.113	14.375	26
27	3.733	0.2678	[illegible]	0.06829	54.669	14.643	27
28	3.920	0.2551	0.01712	0.06712	58.403	14.898	28
29	4.116	0.2429	0.01605	0.06605	62.323	15.141	29
30	4.322	0.2314	[illegible]	0.06505	66.439	15.372	30
31	4.538	0.2204	0.01412	0.06413	70.761	15.593	31
32	4.765	0.2099	[illegible]	0.06328	75.299	15.803	32
33	5.003	0.1999	0.01249	0.06249	80.064	16.003	33
34	5.253	0.1904	0.01176	0.06176	85.067	16.193	34
35	5.516	0.1813	0.01107	0.06107	90.320	16.374	35
40	7.040	0.1420	0.00828	0.05828	120.800	17.159	40
45	8.985	0.1113	0.00626	0.05626	159.700	17.774	45
50	11.467	0.0872	0.00478	0.05478	209.348	18.256	50
55	14.636	0.0683	0.00367	0.05367	272.713	18.633	55
60	18.679	0.0535	0.00283	0.05283	353.584	18.929	60
65	23.840	0.0419	0.00219	0.05219	456.798	19.161	65
70	30.426	0.0329	0.00170	0.05170	588.529	19.343	70
75	38.833	0.0258	0.00132	0.05132	756.654	19.485	75
80	49.561	0.0202	0.00103	0.05103	971.229	19.596	80
85	63.254	0.0158	0.00080	0.05080	1245.087	19.684	85
90	80.730	0.0124	0.00063	0.05063	1594.607	19.752	90
95	103.035	0.0097	0.00049	0.05049	2040.694	19.806	95
100	131.501	0.0076	0.00038	0.05038	2610.025	19.848	100

Table – 12

ANNEXURE 'C'—(*Contd.*)

TABLE 12

5½ % Compound Interest Factors

n	Single Payment: Compound Amount Factor caf′ — Given P To find S $(1+i)^n$	Single Payment: Present Worth Factor pwf′ — Given S To find P $\frac{1}{(1+i)^n}$	Uniform Series: Sinking Fund Factor sff — Given S To find R $\frac{i}{(1+i)^n-1}$	Uniform Series: Capital Recovery Factor crf — Given P To find R $\frac{i(1+i)^n}{(1+i)^n-1}$	Uniform Series: Compound Amount Factor caf — Given R To find S $\frac{(1+i)^n-1}{i}$	Uniform Series: Present Worth Factor pwf — Given R To find P $\frac{(1+i)^n-1}{i(1+i)^n}$	n
1	1.055	0.9479	1.00000	1.05500	1.000	0.948	1
2	1.113	0.8985	0.48662	0.54162	2.055	1.845	2
3	1.174	0.8516	0.31565	0.37065	3.168	2.698	3
4	1.239	0.8072	0.23029	0.28529	4.342	3.505	4
5	1.307	0.7651	0.17918	0.23418	5.581	4.270	5
6	1.379	0.7252	0.14518	0.20018	6.888	4.996	6
7	1.455	0.6874	0.12096	0.17596	8.267	5.683	7
8	1.535	0.6516	0.10286	0.15786	9.722	6.335	8
9	1.619	0.6176	0.08884	0.14384	11.256	6.952	9
10	1.708	0.5854	0.07767	0.13267	12.875	7.538	10
11	1.802	0.5549	0.06857	0.12357	14.583	8.093	11
12	1.901	0.5260	0.06103	0.11603	16.386	8.619	12
13	2.006	0.4986	0.05468	0.10968	18.287	9.117	13
14	2.116	0.4726	0.04928	0.10428	20.293	9.590	14
15	2.232	0.4479	0.04463	0.09963	22.409	10.038	15
16	2.355	0.4246	0.04058	0.09558	24.641	10.462	16
17	2.485	0.4024	0.03704	0.09204	26.996	10.865	17
18	2.621	0.3815	0.03392	0.08892	29.481	11.246	18
19	2.766	0.3616	0.03115	0.08615	32.103	11.608	19
20	2.918	0.3427	0.02863	0.08360	34.868	11.950	20
21	3.078	0.3249	0.02646	0.08146	37.786	12.275	21
22	3.248	0.3079	0.02447	0.07947	40.864	12.583	22
23	3.426	0.2919	0.02267	0.07767	44.112	12.875	23
24	3.615	0.2767	0.02104	0.07604	47.538	13.152	24
25	3.813	0.2622	0.01955	0.07455	51.153	13.414	25
26	4.023	0.2486	0.01819	0.07319	54.966	13.662	26
27	4.244	0.2356	0.01695	0.07195	58.989	13.898	27
28	4.478	0.2233	0.01581	0.07081	63.234	14.121	28
29	4.724	0.2117	0.01477	0.06977	67.711	14.333	29
30	4.984	0.2006	0.01381	0.06881	72.435	14.534	30
31	5.258	0.1901	0.01292	0.06792	77.419	14.724	31
32	5.547	0.1803	0.01210	0.06710	82.677	14.904	32
33	5.852	0.1709	0.01133	0.06633	88.225	15.075	33
34	6.174	0.1620	0.01063	0.06563	94.077	15.237	34
35	6.514	0.1535	0.00997	0.06497	100.251	15.391	35
40	8.513	0.1175	0.00733	0.06233	136.606	16.046	40
45	11.127	0.0899	0.00543	0.06043	184.119	16.548	45
50	14.542	0.0688	0.00406	0.05906	246.217	16.932	50
55	19.006	0.0526	0.00305	0.05805	327.377	17.225	55
60	24.840	0.0403	0.00231	0.05731	433.450	17.450	60
65	32.465	0.0308	0.00175	0.05675	572.083	17.622	65
70	42.430	0.0236	0.00133	0.05633	753.271	17.753	70
75	55.454	0.0180	0.00101	0.05601	990.076	17.854	75
80	72.476	0.0138	0.00077	0.05577	1299.571	17.931	80
85	94.724	0.0106	0.00059	0.05559	1704.069	17.990	85
90	123.800	0.0081	0.00045	0.05545	2232.731	18.035	90
95	161.802	0.0062	0.00034	0.05534	2923.671	18.069	95
100	211.469	0.0047	0.00026	0.05526	3826.702	18.096	100

Table – 13

ANNEXURE 'C'—(*Contd.*)

TABLE 13

6% Compound Interest Factors

n	Single Payment		Uniform Series				n
	Compound Amount Factor caf'	Present Worth Factor pwf'	Sinking Fund Factor sff	Capital Recovery Factor crf	Compound Amount Factor caf	Present Worth Factor pwf	
	Given P To find S $(1+i)^n$	Given S To find P $\frac{1}{(1+i)^n}$	Given S To find R $\frac{i}{(1+i)^n-1}$	Given P To find R $\frac{i(1+i)^n}{(1+i)^n-1}$	Given R To find S $\frac{(1+i)^n-1}{i}$	Given R To find P $\frac{(1+i)^n-1}{i(1+i)^n}$	
1	1.060	0.9434	1.00000	1.06000	1.000	0.943	1
2	1.124	0.8900	0.48544	0.54544	2.060	1.833	2
3	1.191	0.8396	0.31411	0.37411	3.184	2.673	3
4	1.262	0.7921	0.22859	0.28859	4.375	3.465	4
5	1.338	0.7473	0.17740	0.23740	5.637	4.212	5
6	1.419	0.7050	0.14336	0.20336	6.975	4.917	6
7	1.504	0.6651	0.11914	0.17914	8.394	5.582	7
8	1.594	0.6274	0.10104	0.16104	9.897	6.210	8
9	1.689	0.5919	0.08702	0.14702	11.491	6.802	9
10	1.791	0.5584	0.07587	0.13587	13.181	7.360	10
11	1.898	0.5268	0.06679	0.12679	14.972	7.887	11
12	2.012	0.4970	0.05928	0.11928	16.870	8.384	12
13	2.133	0.4688	0.05296	0.11296	18.882	8.853	13
14	2.261	0.4423	0.04758	0.10758	21.015	9.295	14
15	2.397	0.4173	0.04296	0.10296	23.276	9.712	15
16	2.540	0.3936	0.03895	0.09895	25.673	10.106	16
17	2.693	0.3714	0.03544	0.09544	28.213	10.477	17
18	2.854	0.3503	0.03236	0.09236	30.906	10.828	18
19	3.026	0.3305	0.02962	0.08962	33.760	11.158	19
20	3.207	0.3118	0.02718	0.08718	36.786	11.470	20
21	3.400	0.2942	0.02500	0.08500	39.993	11.764	21
22	3.604	0.2775	0.02305	0.08305	43.392	12.042	22
23	3.820	0.2618	0.02128	0.08128	46.996	12.303	23
24	4.049	0.2470	0.01968	0.07968	50.816	12.550	24
25	4.292	0.2330	0.01823	0.07823	54.865	12.783	25
26	4.549	0.2198	0.01690	0.07690	59.156	13.003	26
27	4.822	0.2074	0.01570	0.07570	63.706	13.211	27
28	5.112	0.1956	0.01459	0.07459	68.528	13.406	28
29	5.418	0.1846	0.01358	0.07358	73.640	13.591	29
30	5.743	0.1741	0.01265	0.07265	79.058	13.765	30
31	6.088	0.1643	0.01179	0.07179	84.802	13.929	31
32	6.453	0.1550	0.01100	0.07100	90.890	14.084	32
33	6.841	0.1462	0.01027	0.07027	97.343	14.230	33
34	7.251	0.1379	0.00960	0.06960	104.184	14.368	34
35	7.686	0.1301	0.00897	0.06897	111.435	14.498	35
40	10.286	0.0972	0.00646	0.06646	154.762	15.046	40
45	13.765	0.0727	0.00470	0.06470	212.744	15.456	45
50	18.420	0.0543	0.00344	0.06344	290.336	15.762	50
55	24.650	0.0406	0.00254	0.06254	394.172	15.991	55
60	32.988	0.0303	0.00188	0.06188	533.128	16.161	60
65	47.145	0.0227	0.00139	0.06139	719.083	16.289	65
70	59.076	0.0169	0.00103	0.06103	967.932	16.385	70
75	79.057	0.0126	0.00077	0.06077	1300.949	16.456	75
80	105.796	0.0095	0.00057	0.06057	1746.600	16.509	80
85	141.579	0.0071	0.00043	0.06043	2342.982	16.549	85
90	189.465	0.0053	0.00032	0.06032	3141.075	16.579	90
95	253.546	0.0039	0.00024	0.06024	4209.104	16.601	95
100	339.302	0.0029	0.00018	0.06018	5638.368	16.618	100

Table – 14

ANNEXURE C'—(Contd.)

TABLE 14

7% Compound Interest Factors

n	Single Payment: Compound Amount Factor caf' — Given P To find S $(1+i)^n$	Single Payment: Present Worth Factor pwf' — Given S To find P $\frac{1}{(1+i)^n}$	Uniform Series: Sinking Fund Factor sff — Given S To find R $\frac{i}{(1+i)^n-1}$	Uniform Series: Capital Recovery Factor crf — Given P To find R $\frac{i(1+i)^n}{(1+i)^n-1}$	Uniform Series: Compound Amount Factor caf — Given R To find S $\frac{(1+i)^n-1}{i}$	Uniform Series: Present Worth Factor pwf — Given R To find P $\frac{(1+i)^n-1}{i(1+i)^n}$	n
1	1.070	0.9346	1.00000	1.07000	1.000	0.935	1
2	1.145	0.8734	0.48309	0.55309	2.070	1.808	2
3	1.225	0.8163	0.31105	0.38105	3.215	2.624	3
4	1.311	0.7629	0.22523	0.29523	4.440	3.387	4
5	1.403	0.7130	0.17389	0.24389	5.751	4.100	5
6	1.501	0.6663	0.13980	0.20980	7.153	4.767	6
7	1.606	0.6227	0.11555	0.18555	8.654	5.389	7
8	1.718	0.5820	0.09747	0.16747	10.260	5.971	8
9	1.838	0.5439	0.08349	0.15349	11.978	6.515	9
10	1.967	0.5083	0.07238	0.14238	13.816	7.024	10
11	2.105	0.4751	0.06336	0.13336	15.784	7.499	11
12	2.252	0.4440	0.05590	0.12590	17.888	7.943	12
13	2.410	0.4150	0.04965	0.11965	20.141	8.358	13
14	2.579	0.3878	0.04434	0.11434	22.550	8.745	14
15	2.759	0.3624	0.03979	0.10979	25.129	9.108	15
16	2.952	0.3387	0.03586	0.10586	27.888	9.447	16
17	3.159	0.3166	0.03243	0.10243	30.840	9.763	17
18	3.380	0.2959	0.02941	0.09941	33.999	10.059	18
19	3.617	0.2765	0.02675	0.09675	37.379	10.336	19
20	3.870	0.2584	0.02439	0.09439	40.995	10.594	20
21	4.141	0.2415	0.02229	0.09229	44.865	10.836	21
22	4.430	0.2257	0.02041	0.09041	49.006	11.061	22
23	4.741	0.2109	0.01871	0.08871	53.436	11.272	23
24	5.072	0.1971	0.01719	0.08719	58.177	11.469	24
25	5.427	0.1842	0.01581	0.08581	63.249	11.654	25
26	5.807	0.1722	0.01456	0.08456	68.676	11.826	26
27	6.214	0.1609	0.01343	0.08343	74.484	11.987	27
28	6.649	0.1504	0.01239	0.08239	80.698	12.137	28
29	7.114	0.1406	0.01145	0.08145	87.347	12.278	29
30	7.612	0.1314	0.01059	0.08059	94.461	12.409	30
31	8.145	0.1228	0.00980	0.07980	102.073	12.532	31
32	8.715	0.1147	0.00907	0.07907	110.218	12.647	32
33	9.325	0.1072	0.00841	0.07841	118.933	12.754	33
34	9.978	0.1002	0.00780	0.07780	128.259	12.854	34
35	10.677	0.0937	0.00723	0.07723	138.237	12.948	35
40	14.974	0.0668	0.00501	0.07501	199.635	13.332	40
45	21.002	0.0476	0.00350	0.07350	285.749	13.606	45
50	29.457	0.0339	0.00246	0.07246	406.529	13.801	50
55	41.315	0.0242	0.00174	0.07174	575.929	13.940	55
60	57.946	0.0173	0.00123	0.07123	813.520	14.039	60
65	81.273	0.0123	0.00087	0.07087	1146.755	14.110	65
70	113.989	0.0088	0.00062	0.07062	1614.134	14.160	70
75	159.876	0.0063	0.00044	0.07044	2269.657	14.196	75
80	224.234	0.0045	0.00031	0.07031	3189.063	14.222	80
85	314.500	0.0032	0.00022	0.07022	4478.576	14.240	85
90	441.103	0.0023	0.00016	0.07016	6287.185	14.253	90
95	618.670	0.0016	0.00011	0.07011	8823.854	14.263	95
100	867.716	0.0012	0.00008	0.07008	12381.662	14.269	100

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Table – 15

ANNEXURE 'C'—(Contd.)

TABLE 15

8% Compound Interest Factors

n	Single Payment		Uniform Series				n
	Compound Amount Factor caf'	Present Worth Factor pwf'	Sinking Fund Factor sff	Capital Recovery Factor crf	Compound Amount Factor caf	Present Worth Factor pwf	
	Given P To find S $(1+i)^n$	Given S To find P $\frac{1}{(1+i)^n}$	Given S To find R $\frac{i}{(1+i)^n-1}$	Given P To find R $\frac{i(1+i)^n}{(1+i)^n-1}$	Given R To find S $\frac{(1+i)^n-1}{i}$	Given R To find P $\frac{(1+i)^n-1}{i(1+i)^n}$	
1	1.080	0.9259	1.00000	1.08000	1.000	0.926	1
2	1.166	0.8573	0.48077	0.56077	2.080	1.783	2
3	1.260	0.7938	0.30803	0.38803	3.246	2.577	3
4	1.360	0.7350	0.22192	0.30192	4.506	3.312	4
5	1.469	0.6806	0.17046	0.25046	5.867	3.993	5
6	1.587	0.6302	0.13632	0.21632	7.336	4.623	6
7	1.714	0.5835	0.11207	0.19207	8.923	5.206	7
8	1.851	0.5403	0.09401	0.17401	10.637	5.747	8
9	1.999	0.5002	0.08008	0.16008	12.488	6.247	9
10	2.159	0.4632	0.06903	0.14903	14.457	6.710	10
11	2.332	0.4289	0.06008	0.14008	16.645	7.139	11
12	2.518	0.3971	0.05270	0.13270	18.977	7.536	12
13	2.720	0.3677	0.04652	0.12652	21.495	7.904	13
14	2.937	0.3405	0.04130	0.12130	24.215	8.244	14
15	3.172	0.3152	0.03683	0.11683	27.152	8.559	15
16	3.426	0.2919	0.03298	0.11298	30.324	8.851	16
17	3.700	0.2703	0.02963	0.10963	33.750	9.122	17
18	3.996	0.2502	0.02670	0.10670	37.450	9.372	18
19	4.316	0.2317	0.02413	0.10413	41.446	9.604	19
20	4.661	0.2145	0.02185	0.10185	45.762	9.818	20
21	5.034	0.1987	0.01983	0.09983	50.423	10.017	21
22	5.437	0.1839	0.01803	0.09803	55.457	10.201	22
23	5.871	0.1703	0.01642	0.09642	60.893	10.371	23
24	6.341	0.1577	0.01498	0.09498	66.765	10.529	24
25	6.848	0.1460	0.01368	0.09368	73.106	10.675	25
26	7.396	0.1352	0.01251	0.09251	79.954	10.810	26
27	7.988	0.1252	0.01145	0.09145	87.351	10.935	27
28	8.627	0.1159	0.01049	0.09049	95.339	11.051	28
29	9.317	0.1073	0.00962	0.08962	103.966	11.158	29
30	10.063	0.0994	0.00883	0.08883	113.283	11.258	30
31	10.868	0.0920	0.00811	0.08811	123.346	11.350	31
32	11.737	0.0852	0.00745	0.08745	134.214	11.435	32
33	12.676	0.0789	0.00685	0.08685	145.951	11.514	33
34	13.690	0.0730	0.00630	0.08630	158.627	11.587	34
35	14.785	0.0676	0.00580	0.08580	172.317	11.655	35
40	21.725	0.0460	0.00386	0.08386	259.057	11.925	40
45	31.920	0.0313	0.00259	0.08259	386.506	12.108	45
50	46.902	0.0213	0.00174	0.08174	573.770	12.233	50
55	68.914	0.0145	0.00118	0.08118	848.923	12.319	55
60	101.257	0.0099	0.00080	0.08080	1253.213	12.377	60
65	148.780	0.0067	0.00054	0.08054	1847.248	12.416	65
70	218.606	0.0046	0.00037	0.08037	2720.080	12.443	70
75	321.205	0.0031	0.00025	0.08025	4002.557	12.461	75
80	471.955	0.0021	0.00017	0.08017	5886.935	12.474	80
85	693.456	0.0014	0.00012	0.08012	8655.706	12.482	85
90	1018.915	0.0010	0.00008	0.08008	12723.939	12.488	90
95	1497.121	0.0007	0.00005	0.08005	18701.507	12.492	95
100	2199.761	0.0005	0.00004	0.08004	27484.516	12.494	100

Table – 16

ANNEXURE 'C'—(Contd.)

TABLE 16

10% Compound Interest Factors

n	Single Payment			Uniform Series			n
	Compound Amount Factor caf'	Present Worth Factor pwf'	Sinking Fund Factor sff	Capital Recovery Factor crf	Compound Amount Factor caf	Present Worth Factor pwf	
	Given P To find S $(1+i)^n$	Given S To find P $\frac{1}{(1+i)^n}$	Given S To find R $\frac{i}{(1+i)^n-1}$	Given P To find R $\frac{i(1+i)^n}{(1+i)^n-1}$	Given R To find S $\frac{(1+i)^n-1}{i}$	Given R To find P $\frac{(1+i)^n-1}{i(1+i)^n}$	
1	1.100	0.9091	1.00000	1.10000	1.000	0.909	1
2	1.210	0.8264	0.47619	0.57619	2.100	1.736	2
3	1.331	0.7513	0.30211	0.40211	3.310	2.487	3
4	1.464	0.6830	0.21547	0.31547	4.641	3.170	4
5	1.611	0.6209	0.16380	0.26380	6.105	3.791	5
6	1.772	0.5645	0.12961	0.22961	7.716	4.355	6
7	1.949	0.5132	0.10541	0.20541	9.487	4.868	7
8	2.144	0.4665	0.08744	0.18744	11.436	5.335	8
9	2.358	0.4241	0.07364	0.17364	13.579	5.759	9
10	2.594	0.3855	0.06275	0.16275	15.937	6.144	10
11	2.853	0.3505	0.05396	0.15396	18.531	6.495	11
12	3.138	0.3186	0.04676	0.14676	21.384	6.814	12
13	3.452	0.2897	0.04078	0.14078	24.523	7.103	13
14	3.797	0.2633	0.03575	0.13575	27.975	7.367	14
15	4.177	0.2394	0.03147	0.13147	31.772	7.606	15
16	4.595	0.2176	0.02782	0.12782	35.950	7.824	16
17	5.054	0.1978	0.02466	0.12466	40.545	8.022	17
18	5.560	0.1799	0.02193	0.12193	45.599	8.201	18
19	6.116	0.1635	0.01955	0.11955	51.159	8.365	19
20	6.727	0.1486	0.01746	0.11746	57.275	8.514	20
21	7.400	0.1351	0.01562	0.11562	64.002	8.649	21
22	8.140	0.1228	0.01401	0.11401	71.403	8.772	22
23	8.954	0.1117	0.01257	0.11257	79.543	8.883	23
24	9.850	0.1015	0.01130	0.11130	88.497	8.985	24
25	10.835	0.0923	0.01017	0.11017	98.347	9.077	25
26	11.918	0.0839	0.00916	0.10916	109.182	9.161	26
27	13.110	0.0763	0.00826	0.10826	121.100	9.237	27
28	14.421	0.0693	0.00745	0.10745	134.210	9.307	28
29	15.863	0.0630	0.00673	0.10673	148.631	9.370	29
30	17.449	0.0573	0.00608	0.10608	164.494	9.427	30
31	19.194	0.0521	0.00550	0.10550	181.943	9.479	31
32	21.114	0.0474	0.00497	0.10497	201.138	9.526	32
33	23.225	0.0431	0.00450	0.10450	222.252	9.569	33
34	25.548	0.0391	0.00407	0.10407	245.477	9.609	34
35	28.102	0.0356	0.00369	0.10369	271.024	9.644	35
40	45.259	0.0221	0.00226	0.10226	442.593	9.779	40
45	72.890	0.0137	0.00139	0.10139	718.905	9.863	45
50	117.391	0.0085	0.00086	0.10086	1163.909	9.915	50
55	189.059	0.0053	0.00053	0.10053	1880.591	9.947	55
60	304.482	0.0033	0.00033	0.10033	3034.816	9.967	60
65	490.371	0.0020	0.00020	0.10020	4893.707	9.980	65
70	789.747	0.0013	0.00013	0.10013	7887.470	9.987	70
75	127.895	0.0008	0.00008	0.10008	11708.954	9.992	75
80	2048.400	0.0005	0.00005	0.10005	20474.002	9.995	80
85	3299.969	0.0003	0.00003	0.10003	32979.690	9.997	85
90	5313.523	0.0002	0.00002	0.10002	53120.226	9.998	90
95	8556.676	0.0001	0.00001	0.10001	85556.760	9.999	95
100	13780.612	0.0001	0.00001	0.10001	137796.123	9.999	100

Table – 17

ANNEXURE 'C'— (*Contd.*)

TABLE 17

12% Compound Interest Factors

n	Single Payment: Compound Amount Factor caf' — Given P To find S $(1+i)^n$	Single Payment: Present Worth Factor pwf' — Given S To find P $\frac{1}{(1+i)^n}$	Uniform Series: Sinking Fund Factor sff — Given S To find R $\frac{i}{(1+i)^n-1}$	Uniform Series: Capital Recovery Factor crf — Given P To find R $\frac{i(1+i)^n}{(1+i)^n-1}$	Uniform Series: Compound Amount Factor caf — Given R To find S $\frac{(1+i)^n-1}{i}$	Uniform Series: Present Worth Factor pwf — Given R To find P $\frac{(1+i)^n-1}{i(1+i)^n}$	n
1	1.120	0.8929	1.00000	1.12000	1.000	0.893	1
2	1.254	0.7972	0.47170	0.59170	2.120	1.690	2
3	1.405	0.7118	0.29635	0.41635	3.374	2.402	3
4	1.574	0.6355	0.20923	0.32923	4.779	3.037	4
5	1.762	0.5674	0.15741	0.27741	6.353	3.605	5
6	1.974	0.5066	0.12323	0.24323	8.115	4.111	6
7	2.211	0.4523	0.09912	0.21912	10.089	4.564	7
8	2.476	0.4039	0.08130	0.20130	12.300	4.968	8
9	2.773	0.3606	0.06768	0.18768	14.776	5.328	9
10	3.106	0.3220	0.05698	0.17698	17.549	5.650	10
11	3.479	0.2875	0.04842	0.16842	20.655	5.938	11
12	3.896	0.2567	0.04144	0.16144	24.133	6.194	12
13	4.363	0.2292	0.03568	0.15568	28.029	6.424	13
14	4.887	0.2046	0.03087	0.15087	32.393	6.628	14
15	5.474	0.1827	0.02682	0.14682	37.280	6.011	15
16	6.130	0.1631	0.02339	0.14339	42.753	6.974	16
17	6.866	0.1456	0.02046	0.14046	48.884	7.120	17
18	7.690	0.1300	0.01794	0.13794	55.750	7.250	18
19	8.613	0.1161	0.01576	0.13576	63.440	7.366	19
20	9.646	0.1037	0.01388	0.13388	72.052	7.469	20
21	10.804	0.0926	0.01224	0.13224	81.699	7.562	21
22	12.100	0.0826	0.01081	0.13081	92.502	7.645	22
23	13.552	0.0738	0.00956	0.12956	104.603	7.718	23
24	15.179	0.0659	0.00846	0.12846	118.155	7.784	24
25	17.000	0.0588	0.00750	0.12750	133.334	7.843	25
26	19.040	0.0525	0.00665	0.12665	150.334	7.896	26
27	21.325	0.0469	0.00590	0.12590	169.374	7.943	27
28	23.884	0.0419	0.00524	0.12524	190.699	7.984	28
29	26.750	0.0374	0.00466	0.12466	214.582	8.022	29
30	29.960	0.0334	0.00414	0.12414	241.332	8.055	30
31	33.555	0.0298	0.00369	0.12369	271.292	8.085	31
32	37.582	0.0266	0.00328	0.12328	304.847	8.112	32
33	42.091	0.0238	0.00292	0.12292	342.429	8.135	33
34	47.142	0.0212	0.00260	0.12260	384.520	8.157	34
35	52.799	0.0189	0.00232	3.12232	431.663	8.176	35
40	93.051	0.0107	0.00130	0.12130	767.088	8.244	40
45	163.987	0.0061	0.00074	0.12074	1352.224	8.283	45
50	289.001	0.0035	0.00042	0.12042	2400.008	8.305	50
∞				0.12000		8.333	∞

Table – 18

ANNEXURE 'C'—(*Contd.*)

TABLE 18

15% Compound Interest Factors

n	Single Payments: Compound Amount Factor caf'	Single Payments: Present Worth Factor pwf'	Uniform Series: Sinking Fund Factor sff	Uniform Series: Capital Recovery Factor crf	Uniform Series: Compound Amount Factor caf	Uniform Series: Present Worth Factor pwf	n
	Given P To find S $(1+i)^n$	Given S To find P $\frac{1}{(1+i)^n}$	Given S To find R $\frac{i}{(1+i)^n-1}$	Given P To find R $\frac{i(1+i)^n}{(1+i)^n-1}$	Given R To find S $\frac{(1+i)^n-1}{i}$	Given R To find P $\frac{(1+i)^n-1}{i(1+i)^n}$	
1	1.150	0.8696	1.00000	1.15000	1.000	0.870	1
2	1.322	0.7561	0.46512	0.61512	2.150	1.626	2
3	1.521	0.6575	0.28798	0.43798	3.472	2.283	3
4	1.749	0.5718	0.20026	0.35027	4.993	2.855	4
5	2.011	0.4972	0.14832	0.29832	6.742	3.352	5
6	2.313	0.4323	0.11424	0.26424	8.754	3.784	6
7	2.660	0.3759	0.09036	0.24036	11.067	4.160	7
8	3.059	0.3269	0.07285	0.22285	13.727	4.487	8
9	3.518	0.2843	0.05957	0.20957	16.786	4.772	9
10	4.046	0.2472	0.04925	0.19925	20.304	5.019	10
11	4.652	0.2149	0.04107	0.19107	24.249	5.234	11
12	5.350	0.1869	0.03448	0.18448	29.002	5.421	12
13	6.153	0.1625	0.02911	0.17911	34.352	5.583	13
14	7.076	0.1413	0.02469	0.17469	40.505	5.724	14
15	8.137	0.1229	0.02102	0.17102	47.580	5.847	15
16	9.358	0.1069	0.01759	0.16705	55.717	5.954	16
17	10.761	0.0929	0.01537	0.16537	65.075	6.047	17
18	12.375	0.0808	0.01319	0.16319	75.836	6.128	18
19	14.232	0.0703	0.01134	0.16134	88.212	6.198	19
20	16.367	0.0611	0.00976	0.15976	102.443	6.259	20
21	18.821	0.0531	0.00842	0.15842	118.810	6.312	21
22	21.645	0.0462	0.00727	0.15727	137.631	6.359	22
23	24.891	0.0402	0.00628	0.15628	159.276	6.399	23
24	28.625	0.0349	0.00543	0.15543	184.167	6.434	24
25	32.919	0.0304	0.00470	0.15470	212.793	6.464	25
26	37.857	0.0264	0.00407	0.15407	245.711	6.491	26
27	43.536	0.0230	0.00353	0.15353	283.560	6.514	27
28	50.065	0.0200	0.00306	0.15306	327.103	6.534	28
29	57.575	0.0174	0.00265	0.15265	377.169	6.551	29
30	66.212	0.0151	0.00230	0.15230	434.744	6.566	30
31	76.143	0.0131	0.00200	0.15200	500.956	6.579	31
32	87.565	0.0114	0.00173	0.15173	577.099	6.591	32
33	100.700	0.0099	0.00150	0.15150	664.664	6.600	33
34	115.805	0.0086	0.00131	0.15131	765.364	6.609	34
35	133.175	0.0075	0.00113	0.15113	881.168	6.617	35
40	267.863	0.0037	0.00056	0.15056	1779.1	6.642	40
45	538.767	0.0019	0.00028	0.15028	3585.1	6.654	45
50	1083.652	0.0009	0.00014	0.15014	7217.7	6.661	50
∞				0.15000		6.667	∞

Table – 19

ANNEXURE 'C'—(Contd.)

TABLE 19

20% Compound Interest Factors

n	Single Payment: Compound Amount Factor caf' — Given P To find S $(1+i)^n$	Single Payment: Present Worth Factor pwf' — Given S To find P $\frac{1}{(1+i)^n}$	Uniform Series: Sinking Fund Factor sff — Given S To find R $\frac{i}{(1+i)^n-1}$	Uniform Series: Capital Recovery Factor crf — Given P To find R $\frac{i(1+i)^n}{(1+i)^n-1}$	Uniform Series: Compound Amount Factor caf — Given R To find S $\frac{(1+i)^n-1}{i}$	Uniform Series: Present Worth Factor pwf — Given R To find P $\frac{(1+i)^n-1}{i(1+i)^n}$	n
1	1.200	0.8333	1.00000	1.20000	1.000	0.833	1
2	1.440	0.6944	0.45455	0.65455	2.200	1.528	2
3	1.728	0.5787	0.27473	0.47473	3.640	2.106	3
4	2.074	0.4823	0.18629	0.38629	5.368	2.589	4
5	2.488	0.4019	0.13438	0.33438	7.442	2.991	5
6	2.986	0.3349	0.10071	0.30071	9.930	3.326	6
7	3.583	0.2791	0.07742	0.27742	12.916	3.605	7
8	4.300	0.2326	0.06061	0.26061	16.499	3.837	8
9	5.160	0.1938	0.04808	0.24808	20.799	4.031	9
10	6.192	0.1615	0.03852	0.23852	25.959	4.192	10
11	7.430	0.1346	0.03110	0.23110	32.150	4.327	11
12	8.916	0.1122	0.02526	0.22526	39.580	4.439	12
13	10.699	0.0935	0.02062	0.22062	48.497	4.533	13
14	12.839	0.0779	0.01689	0.21689	59.196	4.611	14
15	15.407	0.0649	0.01388	0.21388	72.035	4.675	15
16	18.488	0.0541	0.01144	0.21144	87.442	4.730	16
17	22.186	0.0451	0.00944	0.20944	105.931	4.775	17
18	26.623	0.0376	0.00781	0.20781	128.117	4.812	18
19	31.948	0.0313	0.00646	0.20646	154.740	4.844	19
20	38.338	0.0261	0.00536	0.20536	186.688	4.870	20
21	46.005	0.0217	0.00444	0.20444	225.025	4.891	21
22	55.206	0.0181	0.00369	0.20369	271.031	4.909	22
23	66.247	0.0151	0.00307	0.20307	326.237	4.925	23
24	79.497	0.0126	0.00255	0.20255	392.484	4.937	24
25	95.396	0.0105	0.00212	0.20212	471.981	4.948	25
26	114.475	0.0087	0.00176	0.20176	567.377	4.956	26
27	137.370	0.0073	0.00147	0.20147	681.852	4.964	27
28	164.845	0.0061	0.00122	0.20122	819.223	4.970	28
29	197.813	0.0051	0.00102	0.20102	984.067	4.975	29
30	237.376	0.0042	0.00085	0.20085	1181.881	4.979	30
31	284.851	0.0035	0.00070	0.20070	1419.257	4.982	31
32	341.822	0.0029	0.00059	0.20059	1704.108	4.985	32
33	410.186	0.0024	0.00049	0.20049	2045.930	4.988	33
34	492.223	0.0020	0.00041	0.20041	2456.116	4.990	34
35	590.668	0.0017	0.00034	0.20034	2948.336	4.992	35
40	1469.771	0.0007	0.00014	0.20014	7343.9	4.997	40
45	3657.258	0.0003	0.00005	0.20005	18281.3	4.999	45
50	9100.427	0.0001	0.00002	0.20002	45497.1	4.999	50
∞				0.20000		5.000	∞

Table – 20

ANNEXURE 'C'—(Contd.)

TABLE 20

Capital Recovery Factors for Interest Rate from 25% to 50%

n	25%	30%	35%	40%	45%	50%	n
1	1.25000	1.30000	1.35000	1.40000	1.45000	1.50000	1
2	0.69444	0.73478	0.77553	0.81667	0.85816	0.90000	2
3	0.51230	0.55063	0.58966	0.62936	0.66966	0.71053	3
4	0.42344	0.46163	0.50076	0.54077	0.58156	0.62308	4
5	0.37185	0.41058	0.45046	0.49136	0.53318	0.57583	5
6	0.33882	0.37839	0.41926	0.46126	0.50426	0.54812	6
7	0.31634	0.35687	0.39880	0.44192	0.48607	0.53108	7
8	0.30040	0.34192	0.38489	0.42907	0.47427	0.52030	8
9	0.28876	0.33124	0.37519	0.42034	0.46646	0.51335	9
10	0.28007	0.32346	0.36832	0.41432	0.46123	0.50882	10
11	0.27349	0.31773	0.36339	0.41013	0.45768	0.50585	11
12	0.26845	0.31345	0.35982	0.40718	0.45527	0.50388	12
13	0.26454	0.31024	0.35722	0.40510	0.45362	0.50258	13
14	0.26150	0.30782	0.35532	0.40363	0.45249	0.50172	14
15	0.25912	0.30598	0.35393	0.40259	0.45172	0.50114	15
16	0.25724	0.30458	0.35290	0.40185	0.45118	0.50076	16
17	0.25576	0.30351	0.35214	0.40132	0.45081	0.50051	17
18	0.25459	0.30269	0.35158	0.40094	0.45056	0.50034	18
19	0.25366	0.30207	0.35117	0.40067	0145039	0.50023	19
20	0.25292	0.30159	0.35087	0.40048	0.45027	0.50015	20
21	0.25233	0.30122	0.35064	0.40034	0.45018	0.50010	21
22	0.25186	0.30094	0.35048	0.40024	0.45013	0.50007	22
23	0.25148	0.30072	0.35035	0.40017	0.45009	0.50004	23
24	0.25119	0.30055	0.35026	0.40012	0.45006	0.50003	24
25	0.25095	0.30043	0.35019	0.40009	0.45004	0.50002	25
26	0.25076	0.30033	0.35014	0.40006	0.45003	0.50001	26
27	0.25061	0.30025	0.35011	0.40005	0.45002	0.50001	27
28	0.25048	0.30019	0.35008	0.40003	0.45001	0.50001	28
29	0.25039	0.30015	0.35006	0.40002	0.45001	0.50000	29
30	0.25031	0.30011	0.35004	0.40002	0.45001	0.50000	30
31	0.25025	0.30009	0.35003	0.40001	0.45000	0.50000	31
32	0.25020	0.30007	0.35002	0.40001	0.45000	0.50000	32
33	0.25016	0.30005	0.35002	0.40001	0.45000	0.50000	33
34	0.25013	0.30004	0.35001	0.40000	0.45000	0.50000	34
35	0.25010	0.30003	0.35001	0.40000	0.45000	0.50000	35
∞	0.25000	0.30000	0.35000	0.40000	0.45000	0.50000	∞

Table – 21

ANNEXURE 'C'—(*Contd.*)

TABLE 21

Single Payment Present Worth Factors for Interest Rates from 25% to 50%

n	25%	30%	35%	40%	45%	50%	n
1	0.8000	0.7692	0.7407	0.7143	0.6897	0.6667	1
2	0.6400	0.5917	0.5487	0.5102	0.4756	0.4444	2
3	0.5120	0.4552	0.4064	0.3644	0.3280	0.2963	3
4	0.4096	0.3501	0.3011	0.2603	0.2262	0.1975	4
5	0.3277	0.2693	0.2230	0.1859	0.1560	0.1317	5
6	0.2621	0.2072	0.1652	0.1328	0.1076	0.0878	6
7	0.2097	0.1594	0.1224	0.0949	0.0742	0.0585	7
8	0.1678	0.1226	0.0906	0.0678	0.0512	0.0390	8
9	0.1342	0.0943	0.0671	0.0484	0.0353	0.0260	9
10	0.1074	0.0725	0.0497	0.0346	0.0243	0.0173	10
11	0.0859	0.0558	0.0368	0.0247	0.0168	0.0116	11
12	0.0687	0.0429	0.0273	0.0176	0.0116	0.0077	12
13	0.0550	0.0330	0.0202	0.0126	0.0080	0.0051	13
14	0.0440	0.0254	0.0150	0.0090	0.0055	0.0034	14
15	0.0352	0.0195	0.0111	0.0064	0.0038	0.0023	15
16	0.0281	0.0150	0.0082	0.0046	0.0026	0.0015	16
17	0.0225	0.0116	0.0061	0.0033	0.0018	0.0010	17
18	0.0180	0.0089	0.0045	0.0023	0.0012	0.0007	18
19	0.0144	0.0068	0.0033	0.0017	0.0009	0.0005	19
20	0.0115	0.0053	0.0025	0.0012	0.0006	0.0003	20
21	0.0092	0.0040	0.0018	0.0009	0.0004	0.0002	21
22	0.0074	0.0031	0.0014	0.0006	0.0003	0.0001	22
23	0.0059	0.0024	0.0010	0.0004	0.0002	0.0001	23
24	0.0047	0.0018	0.0007	0.0003	0.0001	0.0001	24
25	0.0038	0.0014	0.0006	0.0002	0.0001	..	25
26	0.0030	0.0011	0.0004	0.0002	0.0001	..	26
27	0.0024	0.0008	0.0003	0.0001	..	..	27
28	0.0019	0.0006	0.0002	0.0001	..	..	28
29	0.0015	0.0005	0.0002	0.0001	..	..	29
30	0.0012	0.0004	0.0001	..	..	..	30
31	0.0010	0.0003	0.0001	..	..	..	31
32	0.0008	0.0002	0.0001	..	..	..	32
33	0.0006	0.0002	0.0001	..	..	..	33
34	0.0005	0.0001	..	..	..	..	34
35	0.0004	0.0001	..	..	..	..	35

Table – 22

ANNEXURE 'C'—(Concld.)

TABLE 22

Series Present Worth Factors for Interest Rates from 25% to 50%

n	25%	30%	35%	40%	45%	50%	n
1	0.800	0.769	0.741	0.714	0.690	0.667	1
2	1.440	1.361	1.289	1.224	1.165	1.111	2
3	1.952	1.816	1.696	1.589	1.493	1.407	3
4	2.362	2.166	1.997	1.849	1.720	1.605	4
5	2.689	2.436	2.220	2.035	1.876	1.737	5
6	2.951	2.643	2.385	2.168	1.983	1.824	6
7	3.161	2.802	2.507	2.263	2.057	1.883	7
8	3.329	2.925	2.598	2.331	2.109	1.922	8
9	3.463	3.019	2.665	2.379	2.144	1.948	9
10	3.571	3.092	2.715	2.414	2.168	1.965	10
11	3.656	3.147	2.752	2.438	2.185	1.977	11
12	3.725	3.190	2.779	2.456	2.196	1.985	12
13	3.780	3.223	2.799	2.469	2.204	1.990	13
14	3.824	3.249	2.814	2.478	2.210	1.993	14
15	3.859	3.268	2.825	2.484	2.214	1.995	15
16	3.887	3.283	2.834	2.489	2.216	1.997	16
17	3.910	3.295	2.840	2.492	2.218	1.998	17
18	3.928	3.304	2.844	2.494	2.219	1.999	18
19	3.942	3.311	2.848	2.496	2.220	1.999	19
20	3.954	3.316	2.850	2.497	2.221	1.999	20
21	3.963	3.320	2.852	2.498	2.221	2.000	21
22	3.970	3.323	2.853	2.498	2.222	2.000	22
23	3.976	3.325	2.854	2.499	2.222	2.000	23
24	3.981	3.327	2.855	2.499	2.222	2.000	24
25	3.985	3.329	2.856	2.499	2.222	2.000	25
26	3.988	3.330	2.856	2.500	2.222	2.000	26
27	3.990	3.331	2.856	2.500	2.222	2.000	27
28	3.992	3.331	2.857	2.500	2.222	2.000	28
29	3.994	3.332	2.857	2.500	2.222	2.000	29
30	3.995	3.332	2.857	2.500	2.222	2.000	30
31	3.996	3.332	2.857	2.500	2.222	2.000	31
32	3.997	3.333	2.857	2.500	2.222	2.000	32
33	3.997	3.333	2.857	2.500	2.222	2.000	33
34	3.998	3.333	2.857	2.500	2.222	2.000	34
35	3.998	3.333	2.857	2.500	2.222	2.000	35
∞	4.000	3.333	2.857	2.500	2.222	2.000	∞

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ANNEXURE 'D'
RATE OF RETURN- USING DISCOUNTED CASH FLOW METHOD

To simplify calculations, a project evaluation sheet (Exhibit I) together with an Interpolation Chart (Exhibit II) has been prepared to obtain rate of return using the discounted cash flow method.

Procedure- Using project evaluation sheet:

(a) In column Trial I enter as disbursements the net estimated investment by years. Enter estimated annual returns for the years in which they will occur, and include terminal salvage value (if any) as a return in the year in which it will be realized.

(b) Total the disbursements and the annual returns for trial I and enter the results in A and B lines respectively.

(c) To obtain the interest rate which equates the present value of the disbursements and annual returns, calculate their present worth in trials 2,3,4 and 5 by multiplying the amounts in trial I by the factors indicated in trials 2 to 5. Add columns to obtain totals A and B.

(d) Calculate the ratio of A to B for each trial by dividing the total present worth of disbursements, Totals (A), by the total present worth of annual returns, Totals (B).

Note .--- Trial 5 should be completed only if trial 4 has a ratio of A to B less than 1

(e) On interpolation chart, plot ratios A/B against the trial rate at which they were calculated.

(f) Join points with a smooth curve and read rate of return on the vertical axis opposite the intersection of the smooth curve with the vertical line representing a ratio of A to B of I. This is the interest rate which equates the present value of investments with the present value of annual returns.

Note. If a smooth curve does not result from joining the four points plotted, an error has been made in calculations or plotting. A minimum of 4 points is, therefore, necessary to check accuracy.

Exhibit I

PROJECT EVALUATION SHEET

Timing	Trial 1 0% Int. Rate	Trial 2 10% Int. Rate		Trial 3 25% Int. Rate		Trial 4 40% Int. Rate		Trial 5 60% Int. Rate	
Period	Disbursement	Factor	Present worth	Factor	Present worth	Factor	Present worth	Factor	Present worth
5th Year	..	1.46		2.44		3.84		6.56	
4th	..	1.33		1.95		2.74		4.10	
3rd	..	1.21		1.56		1.96		2.56	
2nd	..	1.10		1.25		1.40		1.60	
1st	..	1.00		1.00		1.00		1.00	
Totals (A)		…							

ANNEXURE 'D' –(Concld.)

Period	Annual Return	Factor	Pres-ent	Factor	Pres-ent	Factor	Prese-nt	Factor	Pres-ent

			worth		worth		worth		worth
		10% Int. Rate		25% Int. Rate		40% Int. Rate		60% Int. Rate	
1st Year	..	.91		.80		.71		.63	
2nd	..	.83		.64		.51		.39	
3rd	..	.75		.51		.36		.24	
4th	..	.68		.41		.26		.15	
5th	..	.62		.33		.19		.10	
6th	..	.56		.26		.13		.06	
7th	..	.51		.21		.09		.04	
8th	..	.47		.17		.07		.02	
9th	..	.42		.13		.05		.01	
10th	..	.39		.11		.03		.01	
11th	..	.35		.09		.02		.01	
12th	..	.32		.07		.02			
13th	..	.29		.06		.01			
14th	..	.26		.04		.01			
15th	..	.24		.04					
16th	..	.22		.03					
17th	..	.20		.02					
18th	..	.18		.02					
19th	..	.16		.01					
20th	..	.15		.01					
21st	..	.14							
22nd	..	.12							
23rd	..	.11							
24th	..	.10							
25th	..	.09							
26th	..	.08							
27th	..	.08							
28th	..	.07							
29th	..	.06							
30th	..	.06							
Totals (B)									

Exhibit II

INTERPOLATION CHART

RATE OF RETURN	60																
	55																
	50																
	45																
	40																
	35																
	30																
	25																
	20																
	15																
	10																

	5																
	0																
	0	0.5			1.0			1.5		2.0		2.5		3.0		3.5	

RATIO A/B

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ANNEXURE 'F'

ECONOMIC EVALUATION OF RAILWAY INVESTMENTS

A purely financial appraisal of investment proposals does not necessarily lead to the selection of projects which best serve the needs of the community. The inadequacy of financial analysis in this regard derives from the fact that projected cash inflows and outflows associated with feasible investment alternatives do not correctly reflect the actual benefits to the community flowing from them or the costs that they impose on the economy. Financial and economic appraisals, however, need not always lead to conflicting decisions a financially viable project will also be acceptable on economic grounds whenever the economic return on investment is likely to be at least as high as its financial yield. But, there can be instances of financially sound investment proposals which may not turn out to be worthwhile propositions because the relevant cash outflows do not include all the associated costs to the economy. Again, on investment which is not expected to be profitable, may still yield an adequate, or even a fairly high, economic return if the projected cash earnings represent only a part of the benefits or incomes that are likely to be generated by it.

2. Economic benefits attributable to a particular investment can, for a number of reasons, exceed the revenues directly accruing to the Railways in the form of fare and freight receipts. In the first place, most users of a facility may be willing and able to pay somewhat more than what they are actually charged by the Railways. Secondly, there may also be instances where what the consumers are actually able to pay for rail transportation is (because of uneven-income distribution) less than the benefit they derive from it. This, indeed, is the main justification for a preferential fare structure for certain passenger and suburban services. Finally, for economic or social policy reasons freight rates on certain key commodities may be set at levels which do not fully cover rail transportation costs. The entire benefit derived by the users of Railways can never be quantified; however, at least that part of it which consists of the difference between cost of transportation and fares or freight rates actually charged-can be precisely ascertained (Remarks I). The provision of a rail transport facility thus directly adds to the well-being of the community by more than the receipts that accrue thereby to the Railways.

3. Rail transportation, however, can make a substantial indirect contribution as well to general well-being by facilitating economic expansion. A new line, in a backward region not well endowed with alternative modes of transportation, stimulates the growth of output and employment by widening the market for local products as well as by creating a market for some hither to unexploited natural resource. The quantification of such indirect benefits can at best be approximative. For one thing, the expected expansion of regional or local economic activity is difficult to forecast. For another, the quantification of "developmental benefits" poses the problem of allocating expected additions to output and incomes between the Railway project and other complementary investments in industry, agriculture or commerce.

4. Great care should be taken in estimating social benefits for the purpose of economic appraisal of railway investments. Such benefits should, to the extent possible, be quantified with a reasonable degree of accuracy. Thorough investigations at the traffic survey stage would help in identifying the "developmental effects" and in estimating broadly the magnitude of the complementary investments that may be required. Also, the assumptions and reasons underlying any judgement about non-quantifiable benefits. should be clearly spelt out. Fortunately, the assessment of social benefits is necessary only in the case of proposed investments in new rail lines or operations ; as regards investment for modernisation and improvement, which constitute the bulk of the Railways' capital outlay, one need only estimate the social costs entailed by investment alternatives in order to pick out the least cost solution from the point of view of the economy.

5. The expenditure flows associated with Railway projects can, to varying extents, diverge from the cost to the economy of acquiring resources needed for their implementation and operation. The prices at which certain inputs and resources are made available to the Railways, for instance, may understate or exaggerate their real cost to the economy. Thus, the interest rate which is in line with the usual return on new capital

investment in the economy may not be the same as the "dividend" the Railways have to pay on the capital-at-charge. Similarly, the rupee equivalent of direct foreign exchange expenditure may differ from the cost of saying or earning an equivalent amount of foreign exchange. Moreover, the relative prices of various types of equipment and materials purchased by the Railways will be different from the comparative costs of producing them for the reason that the rates of indirect taxes (or subsidies) vary from product to product. Lastly, there are certain types of real costs which do not at all get recorded in the financial cash flows. Environmental damage can, for example, be a major unrecorded element of cost.

6. In selecting investments which impose the least cost on the economy, cash outflows have to be recomputed in such a way as to minimise the distortions caused by the use of prices actually paid for inputs (including the prices of capital and foreign exchange) and by the neglect of other costs which do not figure at all in expenses. Environmental effects of investments are the most difficult to estimate. However, in a number of cases the choice of projects may be influenced much more by the interest and exchange rate, that are utilised than by the correction of distortions introduced by indirect taxes, subsidies and environmental effects. A preliminary sensitivity analysis is useful for picking out the more important. of the factors distorting costs; such factors can then be subjected to a detailed investigation.

7. For economic evaluation of Railway Projects, the interest or discount rate is currently set at 10 percent. This implies that the cost of capital comprises a depreciation or capital recovery factor and interest charged at 10 per cent per annum; a project is thus just acceptable if the expected earnings from it during its lifetime make it possible to recover the investment with a return of 10 per cent per annum, that is, if the DCF rate of return on it is 10 percent.

8. In the cash flows utilised for economic evaluation of high speed diesel oil is not valued at the price actually paid by the Railways for it. Instead, all taxes and duties payable on it are excluded from the price; and, the duty-free price is adjusted upwards so as to allow for the comparative scarcity of crude oil in the Indian economy. At present, this adjustment factor is exactly half the current rate of excise duty on high-speed diesel oi1.

9.There is no direct readjustment of the official exchange rate for the purpose of computing the scarcity value of imported equipments, spares and materials. However, there is an implicit adjustment in as much as the duty paid on imports is retained as a cost item in the cash-flows ideally, other indirect taxes like excise duties, sales taxes, local taxes and other cesses and levies, should be excluded from the cost of domestically procured inputs. But in many cases it has been found, particularly in the analysis of investment for modernisation of traction, that the exclusion of indirect taxes and similar levies does not make any material difference to the ranking of the proposed alternatives.

10. Electric power is valued not at the price at which it is sold to the Railways by the State Electricity Boards but at its estimated cost to the economy. The latter is derived from actual production cost by revaluing its interest component at the rate of 10 per cent per annum and its foreign exchange component at an exchange rate 33 percent-higher than the current official rupee price of foreign currencies.

FINANCIAL AND ECONOMIC EVALUATION OF INVESTMENT ALTERNATIVES

An Example.

A highly simplified hypothetical example of choice between diesel and electric traction is presented here for the purpose of illustrating the essential difference between financial and economic evaluation. This type of choice is basically a problem of minimising the cost of handling a given volume of traffic over specified sections.

The two project alternatives, dieselisation and electrification, are defined as follows-

(i) The project life, which includes the construction period, extends in both cases up to 44 years.
(ii) The level of traffic remains unchanged over the life time of the project.
(iii) Annual operating expenses exclude depreciation and do not vary from one year to another.
(iv) Capital costs exclude interest during construction (Remark II)
(v) Capital outlay on dieselisation is spread over a period of three years; it comprises the expenditure on acquisition of rolling stock and construction of sheds.
(vi) Capital outlay on electrification is phased over four years; it comprises the expenditure on rolling stock and construction of OHE.

Given these assumptions, the financial cost cash-flows associated with the two illustrative traction alternatives can be presented in the following manner :

Financial cost to Railways (Rs. crores).

Year	Diesel	Electric
1	..	3.0
2	0.5	6.0
3	0.5	15.0
4	10.0	6.0
5th to 44th (each year)	4.0	2.5

Discounted Present Worth of Financial Costs.

Interest Rate.	Diesel	Electric
6%	56.5	55.3
7%	49.2	50.3

It would be seen that when discounted at 6 per cent the present worth of the financial cost flow relating to electrification works out to be lower than that of the financial cost flow associated with dieselisation by Rs. 1.2 crores. But the situation is reversed when the cost flows are discounted at 7 per cent, in which case dieselisation turns out to be cheaper by Rs. 1.1 crores. Thus, in this hypothetical case, the depreciation inclusive financial cost of electrification is lower only at rates of interest below 7 per cent. The rate of interest at which the two alternatives will impose identical costs can be found out by linear interpolation. This turns out to be 6.5 percent; at lower rates of interest electrification is the cheaper alternative; but becomes the costlier one at interest rates exceeding 6.5 per cent. This is as it should be; for electrification is the more capital intensive mode of traction.

The estimation of cash-flows relevant for the computation of the cost to the economy is based on the following assumptions :-

(i) The basic price, inflated to the extent of 50 per cent of the excise duty, is taken as the appropriate scarcity value of high-speed diesel oil.

(ii) The cost to the economy of electricity generation and transmission is assumed to be 7 paise per KWH as compared to 10 paise per KWH assumed to be actually paid by the Railways.

(iii) Fuel costs constitute 70 per cent of operating expenses under diesel and 50 per cent of operating expenses under electric traction.

Under these assumptions, the cost to the economy of the uniform annual operating expenses associated with dieselisation and electrification works out to be Rs. 3.00 and Rs. 2.12 crores respectively. But, the cost to the economy of capital outlays continues to be the same as the financial cost. The discounted present worth of the cash flow corresponding to the cost to the economy at 3 and 4 percent interest rates is as follows:

Discounted Present Worth of Costs to the Economy.

Interest Rate	Diesel	Electric
3%	71.4	70.8
4%	60.2	62.4

It will be seen from the above that in this hypothetical case, from the point of view of cost to the economy, electrification turns out to be cheaper than dieselisation only at rates of interest which do not exeed 4 per cent. The break even rate of interest, at which both alternatives involve identical costs, is approximately 3.2 per cent.

Remarks I - Likewise, the difference between the cost to the consumer of rail transportation and that of other modes of transport replaced (partly or wholly) by it is a tangible and measurable social gain.

Remarks II- If the income flows are computed from the date of completion of the project, the capital outlay will be compounded at the desired interest rate.

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ANNEXURE 'E'

EXAMPLE (I) :-

Yard re-modeling and provision of crossing stations on X-Y section of N. Railway.

Estimated capital cost	Rs. 27,56,000
Interest during construction	Rs. 3,93,011
Total	Rs. 31,49,011

Financial Implications-

Earnings in 1976-77-

(i) Additional traffic expected-			
		Wagon per day	
		1976-77	1977-78
Inward	LSHS	28	38
	Coal	20	27
		48	65
Outward		38	50
	G. Total	86	115

(ii)	Lead from X to Y	157 Km.
(iii)	Average load per 4-wheeler LSHS/HSHS Other heavy merchandise	18 tonnes in tank wagons 19.5 tonnes.
	Coal.	21.3 tonnes.
	Over all average load	19.5 tonnes.
(iv) (v)	Tare weight of a wagon Turn round on A Division	10 tonnes. 3.71 days.
(vi)	Earnings per tonne.- Fertillizer Coal LSHS/HSHS	 4.71 3.26 8.33

(vii)	Earnings 1976-77 for entire year	=	Rs(28x18x8.33)+(20x21.3x3.26) + (38x19.5x4.71)
			100 100 100
		=	Rs 41.98 + 13.88 + 34.90
		=	Rs. 157x365x90.76 = Rs. 52,01,001.80

Cost of moving additional traffic-	
(i) Traction (ii) Number of marshalling yard/yards (iii) Number of engine changing points	Diesel

(iv)	Total wagon days		365x86x3.71	=		116457
(v)	Total No. of wagons run loaded trip		365x86	=		31390
(vi)	Total No. of wagons run empty trip		365x66	=		24090
(vii)	Documentation charges @ Rs 1.78 per invoice.	Rs.	31390x1.78	=	Rs.	55874.20

(viii)	Other terminal charges @ Rs. 12.41 per wagon.		Rs.	31390x12.41	=	Rs.	389549.90
(ix)	Provision and maintenance of carrying units @ Rs1.49 per wagon per day		Rs.	116457x1.49	=	Rs.	173520.93
(x)	(a)	GTKM for diesel engines loaded trip	Rs.	31390x29.5x157	=	Rs.	145382785
		Haulage charges @ Rs. 3.73 per 1000 GTKM.	Rs.	145382785x3.73 / 1000	=	Rs.	5,42,277.78
	(b)	GTKM for diesel engines empty trip	Rs.	24090x10x157	=	Rs.	37821300
		Haulage charges @ Rs. 3.73 per 1000 GTKM.	Rs.	37821300x3.73 1000	=	Rs.	141073.45
	(c)	Line haul (movement) service-other than transportation expenses, including train passing staff @ Rs. 1.53 per 1000 GTKM For loaded trip	Rs.	31390x29.5x157x1.53 / 1000	=	Rs.	2,22,453.60
		--do—For empty trip.	Rs.	24090x10x157x1.53 / 1000	=	Rs.	57,866.59
	(d)	Line Haul (movement) services cost of track and signalling @ Rs. 1.33 For loaded Trip	Rs.	31390x29.5x157x1.33 / 1000	=	Rs.	1,93,359.10
		For empty trip	Rs.	24090x10x157x1.33 / 1000	=	Rs.	50,302.33
	(e)	Marshalling yard cost	Nil				
	(f)	Engine changing cost	Nil				
	(g)	Total haulage cost	Rs.	18,26,260.04			
	(h)	Add allowance for 10%	Rs.	20,08,886.04			
	(i)	Marginal cost @ 78%	Rs.	15,66,931.11			

	(i)	Annual maintenance charges per first and subsequent years	Rs.	1,14,564.00			
		Total working expenses	Rs.	16,81,495.11			

Net earnings in 1976-77-			
Earnings Working expenses	(-)	Rs Rs	52,01,001.80 16,81,495.11
Net earnings per year		Rs	35,19,506.69

Earnings in 1977-78 and onwards-					
(i) Earning per year	Rs.	157 x365	$\frac{(38x18x8.33)}{100} + \frac{(27x21.3x3.26)}{100}$	=	$\frac{(50x19.5x4.17}{100}$
	Rs.	157x365x56.98 + 18.74 + 45.92			
	Rs.	157x365x121.64 = Rs. 69,70,580.20			
Cost of moving additional traffic					
(i) Total wagon days (ii) Total No. of wagons run- loaded trip (iii) Total No. of wagons run- empty trip		365x115x3.71 365x115 365x85	= = =	155727 41975 31025	
(iv) Documentation charges @ Rs 1.78 per invoice.	Rs.	41975x1.78	=	Rs.	74715.50
(v) Other terminal charges @ Rs. 12.41 per wagon.	Rs.	41975x12.41	=	Rs.	520902.75
(vi) Provision and maintenance of carrying units @ Rs1.49 per wagon per day.	Rs.	155727x1.49	=	Rs.	232033.23

(vii)	(a)	GTKM for diesel engines- loaded trip	Rs.	41975x29.5x157	=	Rs.	194407212
		Haulage charges @ Rs. 3.73 per 1000/GTKM	Rs.	$\frac{194407212x3.73}{1000}$	=	Rs.	725139
	(b)	GTKM for diesel engine empty trip	Rs.	31025x10x157	=	Rs.	48709250
		Haulage charges @ Rs. 3.73 per 1000/GTKM	Rs.	$\frac{48709250x3.73}{1000}$	=	Rs.	181685.50
	(c)	Line haul (movement) service- other than transportation expenses including train passing staff @ Rs. 1.53 per 1000 GTKM: For loaded trip	Rs.	$\frac{41975x29.5x157x1.53}{1000}$	=	Rs.	297443.00
		For empty trip	Rs.	$\frac{51025x10x157x1.53}{1000}$	=	Rs.	74525.15

	(d)	Line Haul (movement) services: For loaded trip	Rs.	41975x29.5x157x1.33 / 1000	=	Rs.	258561.52
		cost of track and signalling trip @ Rs. 1.33 --do— For empty trip.	Rs.	31025x10x157x1.33 / 1000	=	Rs.	64,783.30

(e) (f)	Marshalling yard cost Engine changing cost	Nil Nil	
(g) (h)	Total haulage cost Add allowance for 10%	Rs Rs.	24,29,798.00 26,72,775.00

(viii)	Marginal cost @ 78%	Rs	20,84,765.00
(ix)	Annual maintenance charges for first and subsequent years	Rs.	1,14,564.00
(x)	Total working expenses Net earnings 1997-98 and onwards- Earnings Working expenses (-)	Rs. Rs Rs	21,99,329.00 69,70,580.00 21,99,329.00
	Net earnings per year	Rs	47,71,251.00

Rolling Stock Requirement in 1977-78 and onwards-			
(1)	Diesel engines (cost Rs. 21,00,000)		
	(a)	Average lead of a diesel engine	65 wagons
	(b)	Lead from C to D	157 Km
	(c)	Total No. of trains per day 100/65	1.5
	(d)	Train Kms. Per day .	1.5x2x157 =471
	(e)	Engine Km. Per day per engine in use (diesel)	387
	(f)	Bare No. of diesel engine required	471/387 = 1.2
	(g)	Add for spares @ 6.96%	1.2 x106.96/100 =1.28 Say 1.3
	(h)	Cost of 1.3 engines @ Rs. 21,00,000	Rs. 27,30,000
(ii)		Covered wagons (Cost Rs.21,014).	
		Wagons required per day for carrying coal for carrying urea	27 (15 to be back loaded) 35
		Total	62

Total bare number of covered wagons required (62x3.71 turn round) 230.02

Add spares @ Rs. 5.32% $\frac{230.02 \times 105.32}{100}$ = 242.25

Say 242

Cost of 248 wagons @ Rs 21,014 ..Rs. 21014x242 = 50,85,388

(iii) Tank wagons (cost bare number of wagons Required)	Rs.	45,696
(38x3.71 turn round)	=	140.98
Add for spares @ 5.32%		$140.98\times\frac{105.32}{100} = 148.43$ Say 148
Cost of 148 wagons @ Rs. 45,696	Rs.	45696x148 = Rs. 67,63,008
Grand total of rolling stock as per items (i), (ii), (iii) above	Rs.	1,45,78,396
Cost of work including interest for 4 years as per details given below	Rs.	31,49,011
Cost of rolling stock		1,45,78,396
Total		**1,77,27,407**

Interest during construction:-

1st Year	10,00,000	$\frac{1000000\times6}{2\times100}$ =	Rs.	30,000
2nd Year	6,00,000	$\left[\frac{600000}{2} + 1030000\right] \times \frac{6}{100}$	Rs.	79,800
3rd Year	6,00,000	$\left[\frac{600000}{2} + 1709800\right] \times \frac{6}{100}$	Rs.	1,20,588
4th Year	5,60,000	$\left[\frac{5,60,000}{2} + 2430388\right] \times \frac{6}{100}$	Rs.	1,62,623
Total	27,60,000		=	3,93,011

Rate of return by DCF method-

(i) Capital cost	Rs.	1,77,27,407
(ii) Life of assets		30 Years
(iii) Salvage value @ 10% (excluding earth work)	Rs.	2,17,413
(iv) Net earnings 1976-77	Rs.	35,19,507
Net earnings 1977-78	Rs.	47,71,251

(v) Present worth calculations-

@ 25% (-177.27) + [(35.20) (0.8)] + [47.71 (3.995-0.8)] + [(2.17x.0012)]
- 177.27 + 28.16 + 152.43 + 0.0026
- 177.27 + 180.59
+ 3.32

ROR is about 25%

Note - in this computation, at 25% discount rate 0.8 is the single payment PWF for the Ist Year, 3.995 is the PWF for uniform cash Flow in the 30th year 0.0012 is the PWF for Single payment in the 30th year.

EXAMPLE (2)

Economics of Dieselisation of the K.V. (N.G.) Railway

A. Basic data—

	Diesel)	Steam	Difference (S-D)
Capital cost (Rs. Lacs)	165.00	52.50	-112.50
Life (years)	30	40	
Salvage value (Rs. Lacs)	16.50	13.35	-3.15
Annual Operating Expenses excluding Depreciation-			
Fuel consumption	17.23	32.18	+14.95
Maintenance expenses	6.32	6.29	-0.03
Running staff	4.71	7.59	+2.88
Annual cost	28.26	46.06	17.80

B. Rate of return on extra capital of diesels-

The extra capital over steam on diesel is Rs 112.5 lacs.
Calculate ROR by taking present worth of difference (S-D)

PW at 12% of difference	=	-112.5 +17.8 (p w f 30 years at 12%)
	=	- 3.15 (p w f 30 years 12% S p)
	=	-112.5+17.8 (8.055) -3.15 (0.0334) = + 30.77
PW at 15% of difference	=	-112.5+17.8 (6.566) -3.15 (0.0151) = + 4.33
PW at 20% of difference	=	-112.5+17.8 (4.979) -3.15 (.0042) = -23.88
Rate of return (by interpolation)	=	$\frac{15+4.33x5}{28.21}$ = 15.8%

C. Conventional method of calculation_

(a)

Annual cost	28.26	46.06	17.80
Depreciation at 3.75%			
Sinking Fund	2.79*	0.53 $	-2.26
Total Annual Costs	31.05	46.59	+15.54

* On capital cost less 10% salvage value.
$ On capital cost of Rs 52.5 lacs less 10% salvage value

(b) Return on Capital:

Net capital outlay (165-52.5) = Rs. 112.5

Annual Recurring Savings = Rs. 15.54 lacs

Return on Capital = $\frac{\text{Rs. } 15.54}{112.5}$ = 13.8%

EXAMPLE (3):-

Financial Benefits as a Result of saving in Detentions to Goods Trains and in Staff with the provision of Tokenless Block instruments on A-B Section

Estimated initial investment Rs.20,80,000

(1) Crossing-

(a) 17 diesel and 1 steam trains are being detained for 3.5 occasions for crossing and TOS per train and the saving in detention would be to the extent of 7 mts. per incidence per train.

(i)	Diesel	:	17x3.5x7	= 6 hrs,56 mts
(ii)	Steam	:	1x3.5x7	= 24 mts
			TOTAL	= 7 hrs. 20 mts

(b) Token lost cases-

0.5 diesel train missed token and suffered detention of 14 mts. per train which will be eliminated:

0.5x14 = 7 mts.

Total	Diesel	a (i) + (b)	= 7 hrs. 3 mts
	Steam	a (ii)	24 mts
Avg. load per Train	Diesel		67 Wagon
	Steam		45 Wagon

(A) (a) Wagon days saved (bare) $\frac{67x7.05}{24} + \frac{45x.4}{24} = 20$

(b) Add for spares @ 5.32% on 20 wagons = 1/21

2.(i)	(a)	Diesel engine hours saved	7.05	
	(b)	Effective engine hours daily	18.8	
	(c)	Therefore bare No. of engine saved daily	$\frac{7.05}{18.8}$	= 0.37
	(d)	Add for spares @ 0.96%	.03	
		Total	0.40	

(ii)	(a)	Steam engine hours saved	.4
	(b)	Effective hours daily	12 hours
	(c)	Bare No. of engine saved	$\frac{.4}{12}$ = .03
	(d)	Add for spare @ 14.6%	.004
		Total	.03

Annual saving per wagon	= Rs. 2418
Annual saving per diesel engine	= Rs.778300
Annual saving on steam engine	= Rs.157166

(a)	Saving in respect of 21 wagons 21x2418	= Rs.50778
(b)	Saving in respect of 40 diesel	= Rs.311320
(c)	Saving in respect of .03 steam	= Rs.4715
	Total	= Rs.366813

	It is presumed that due to various difficulties in the day to day operation, saving at 80% only will be achieved on conservative estimate		= Rs.293450
(2)	Annual maintenance expenses during the 1st and subsequent years		= Rs. 21590
(3)	Net saving	Rs.293450 – 21590)	= Rs. 271860

The work is financially justified as shown below:

Annual rate of return by DCF method-

(i)	Cost of the work including interest		Rs.2267854
(ii)	Salvage value @ 10% (excluding interest)		Rs.208000
(iii)	Life of assets (avg)		25 years
(iv)	Annual saving		Rs.293450
(v)	Annual cost during first and subsequent years (excluding depreciation)		Rs.21590
(vi)	Net annual saving-	Rs.2,93,450-21,590	Rs.2,71,860

	10%	12%
(4) Present worth factor for uniform cash flow over 25 years	9.077	7.843
Present worth factor for single Payment in 25th year	0.0923	0.0588

NPV at 10% = (-22,67,854) + (2,71,860x9.077 + (2,08,000x0.0923) = 2,19,400

NPV at 12% = (-22,67,854) + 2,71,860x7.843 + (2,08,000x0.0588) = 1,21,000

By interpolation: $10\% + \frac{2.19x2}{2.19+1.21} = 10\% + \frac{4.38}{3.40} = 11.13\%$ Which is the ROR under the DCF

		Increase	Decrease
1.	Annual repairs and maintenance charges on Rs.20,80,000/- @ 3%	62,400	-
2.	Annual repairs and maintenance charges on Rs.8,50,000/-@ 3% (Present day cost)	-	25,500
3.	Annual sinking fund on Rs.19,20,000/- less scrap value Rs.192000/- net Rs.17,28,000/- @ 0.0249 (age 25 year)	43,027	-
4.	Annual sinking fund on Rs.1,60,000/- less scrap value Rs.16,000/- net Rs.1,44,000/- @ 0.0676 (age 12 year)	9,734	-
5.	Annual sinking fund on Rs.1,60,000/- less scrap value Rs.16,000/- net Rs.1,44,000/- @ 0.0249 (age 25 years)	-	3,586
6.	Annual sinking fund on Rs.2,65,000/- less scrap value Rs.26,500/- net Rs.2,38,500/- @ 0.0112 (age 40 years)	-	2,671
7.	Saving in terms of wagons and engine detentions	-	3,68,614
8.	Saving in staff :- 2 Block Maintainer Gr.175-240 @ 436.51 = 10476 2 Khalasies Gr.70-85 @ 202.42 P.M.. 4834	-	15,310
		1,15,161	3,40,517

Details of interest @ 6% during 4 years period of construction:-

Year	Outlay	Interest	Amount at the end of the year
1st year	500000	$\frac{(500000)}{2} \times \frac{6}{100}$	15000
2nd year	1000000	$\frac{(1000000)}{2} + 515000 \times \frac{6}{100}$	60900
3rd year	580000	$\frac{(580000)}{2} + 1575900 \times \frac{6}{100}$	111954
	2080000		187854

EXAMPLE (4) :-

Provision of departmental line wires on A-B Section of X Railway.

Estimated initial cost : Rs.25.08 lakhs (including Rs.1.47 lakhs for staff quarters).
Outflow of cash during the Project Construction stage-

Year	0%	6%	10%	15%
- 2	(-) 6,00,000	(-) 6,54,000	--	--
- 1	(-) 12,00,000	(-) 12,72,000	--	--
0	(-) 7,08,000	(-) 7,08,000	--	--
	(-) 25,08,000	(-) 26,34,000	--	--

NPV of the Project, assuming even cash flow of Rs.2,81,184 (details given below), at 10% over a life of 60 years will be 2,81,184 x 9.967 = 28,02,561.

As the NPV is more than the initial investment inclusive of interest during construction, the project is financially justified.

Details of the anticipated annual saving of Rs.2,81,184

Financial Implication:-

		Increase	Decrease
1.	Annual repairs and maintenance charges on Rs.25,08,000 @ 3%	75,240	-
2.	Annual rental savings		
	(a) Iron wire per mile @ Rs.54.23 x4 per conductor (136 miles)	-	29,501
	(b)Copper wire per mile @ Rs.72.27 x 4 per conductor (136miles)	-	39,314
3.	Annual operational savings as per details attached	-	2,83,764
4.	Financial implications arising out of Engg's portion as per details attached	-	3,845
5.	Total	75,240	3,56,424

Net saving during 1st and subsequent years = 3,56,424 –75,240 = 2,81,184

Details of item 4 :-

	Increased by	Decreased by
Annual rent recoverable from type II quarters (7 units) $\frac{7x(110+380)x12}{2}$ @ 10%	...	2,982
Annual rent recoverable from staff of type I quarters (7 units) $\frac{7x(70+110)+47x12}{4}$ @ 7.1/2%	....	863
	....	3,845

Net annual increase during the first and the subsequent year = Rs.3845

Details of items 3

Details of operational savings -It is expected that with the provision of ACSR line wire, the control efficiency will be 90% and above. The efficiency below 90 is primarily due to copper wire thefts. During February, 1970 for 13 days the efficiency was 90% and above and average hours per train is 4 hrs-55 mts. as against 5 hrs-45 mts. per train during the balance of 15 days. The difference in the hours on road is 50 mts or .83 mts per train.

1.	Average number of trains (only Dn trains excluding one works train as per line capacity statement 1968-69)	=		13.1
2.	Total T.G. accounted for	=		370
3.	Number of trains effected below 90% efficiency	=		197
4.	Percentage of trains effected to total trains accounted for	=	$\frac{197 \times 100}{370}$ =	53.24
5.	Percentage of average trains effected to total T.G. running on section i.e. 13.1	=	$\frac{53.24 \times 13.1}{100}$ =	6.97
6.	Average load per train on branch line	=		56

'A' Saving on wagons:-

(a)	No. of hours to be save	=	6.97x56x .83 wagon hrs.
(b)	Converting wagon hours into wagon days	=	$\frac{6.97 \times 56 \times .83}{24}$

(c)	By adding spares @ 3.23%	= $\frac{6.97x56x.83}{24}$ x $\frac{103.23}{100}$ = 13.87
(d)	Saving on one wagon	= Rs. 2229/-
(e)	Annual saving on 13.87	= 2229x13.87 = Rs.30916

'B' Saving on engine :-

(a)	Total detention to be saved	=	6.97 x .83		
(b)	Converting into No. of Diesel Engine @ 19.1 hrs. (Daily effective hourse)	=	$\frac{6.97x.83}{19.1}$		
(c)	By adding spare @ 8.22%	=	$\frac{6.97x83}{19.1}$ x $\frac{108.22}{100}$	=	.32
(d)	Saving on .32 engine @Rs.7,90,152(fraction of an engine W/O interest and depreciation)	=	790152 x .32	=	Rs.2,52,848
(e)	Total saving of 'A' and 'B'	=	30916 + 252848	=	Rs.2,83,764

EXAMPLE (5):-

Provision of line capacity in M.G. section of 'X' Railway.

A section (82 Kms) is partially doubled in two patches over two stretches totalling 52 Kms. On the 30 Kms. long single line section, there are 4 block stations and all these stations have two reception lines at present thereby limiting the capacity of the stations either to crossing of a train or merely to give precedence at the station, both crossing and precedence cannot take place at the same time.

2. The traffic is expected to increase from 20 trains each way on the single line section at present to 24 trains in the course of a year or two. At the end of 5 years, one more passenger train and two goods trains are expected to be introduced, increasing the train density to 27 either way. As against the projected line capacity required at 80% utilization for the above level of traffic at 30 and 34 in the 1st and the 5th the year respectively, the line capacity at present is restricted to 27. All capacity calculations assume diesel traction.

3. The following alternative are being considered for increasing the line capacity to match the progressive traffic requirement :-

Alternative (1) : Doubling of the entire 30 Kms section - Cost Rs.1.90 crores; capacity 44 paths either way.

Alternative (2): Doubling the section in two phases:

- (a) Immediate doubling of 20 Kms section - Cost Rs.1 crore; capacity 32 paths either way.
- (b) Doubling of the remaining 10 Kms length at a cost of Rs.90 lakhs in 5th year - capacity 44 paths each way

Alternative (3):

- (a) Provision of one additional reception line at each of the 4 block stations at an approximate cost of Rs. 10 lakhs straightaway; capacity 30 paths each way.
- (b) Doubling of the entire 30 Kms section in 5th year-cost Rs.1.90 crores; capacity 44 paths each way.

The additional earnings likely to accrue on account of additional traffic worked out, commodity wise, as apportioned to the section in the 1st and the 5th years on the traffic projections for these years assuming the level of traffic to remain constant during this period and 5th year and beyond, are tabulated below :-

Sr. No.	Commodities	1971-72 and onwards	1974-75 to 1975-76	1976-77 and onwards
1.	Cement	56,450	1,25,823	1,95,197
2.	Pulses	19,549	46,149	72,843
3.	Salt	1,28,745	2,37,120	3,45,495
4.	Onions	15,626	38,756	61,887
5.	Rock Phosphate	46,097	1,23,315	2,00,534
6.	Vegetable Oil	89,363	1,69,253	2,49,143
7.	POL	4,84,477	6,01,383	8,38,289
	TOTAL	8,40,307	14,01,799	19,63,288

(a) Plus 1 goods train.
(b) Plus 1 + 1 = 2 goods train.
(c) Plus 2 + 1 = 3 goods train.

4. The financial implications for the three alternatives worked out on the D.C.F. technique are given in the statements annexed. It may be pointed out that only goods earnings have been taken for working out the financial implications and unit cost data with interest has been applied.

Alternative (1)

Full Doubling:-

If doubling is done straightaway, the return comes to 8%. In this case the cash out-flow is Rs.1.90 crores during 1971-72 and 1972-73 while the cash in flow is at the level of 8,40,000 for 1971-72 to 1973-74, Rs.14,01,800 from 1974-75 to 1975-76 and Rs.19,63,000 for the remaining period 1976-77 to 2001-02.

Year	Cash flow	Cumulative discount (8%) factor for 1st Year	Next 2 Years	Remaining 25 years	Present Value
1971-72	1,00,00,000	-	-	-	-100,00,000
1972-73	90,00,000x.85	-	-	-	-76,50,000
1971-72 to 1973-74	8,40,000 each year	2.57	-	-	+21,58,000
1974-75 to 1975-76	14,01,800	-	1.42	-	+19,90,500
1976-77 to 2001-02	19,63,000 each year	-	-	7.26	+142,51,000
				TOTAL	+7,49,000

Note: It is assumed that simultaneously with the doubling work in progress, it will be possible to carry the additional traffic in 1971-72 and 1972-73.

Alternative (2)

Doubling in two Phases:

In case the doubling is taken up in two Phases, the first phase of doubling A-B taken up immediately, i.. e. in 1971-72, and the second phase viz, doubling of B-C taken up in 1976-77, the rate of return would be about 9% as worked out below:-

Cost of first phase	Rs.100,00,000
Cost of second phase	Rs. 90,00,000

Year	Cash flow	Cumulative discount(8%) Factor for 1st 3 years	Next 2 years	For remaining 25 years	Present Value
1971-72	100,00,000	-	-	-	-100,00,000
1971-72 to 1973-74	8,40,000	2.57	-	-	+21,58,000
1974-75 to 1975-76	14,01,800	-	1.42	-	+19,90,500
1976-77	90,00,000	.68	-	-	-61,20,000
1976-77 to 2006-07	19,63,000	-	-	7.26	+142,51,000
				TOTAL	+22,79,00

At 10% the computation will be:

(-100,00,000)+(8,40,000x2.49)+(14,01,800x1.30) - (90,00,000x0.62)+(19,63,000x5.64)
= -100,00,000+20,91,600+18,22,34 - 55,80,000+110,71,320 = - 5,94,740
The return is a little over 9%

Alternative (3)

(Extra reception lines followed by full Doubling: -)

The complete project inclusive of the first phase viz., provision of additional reception line at three stations and the second phase viz., doubling (after 5 years) the total life span being 30 years.

The rate of return works out to slightly above 13% as under :-

Year	Cash flow	Cumulative discount factor in 30 years at 12% 1st 5 year	Remaining 25 years	Present Value
1971-72	10,00,000	-	-	- 10 lakh
1971-72 to 1975-76	8,40,000 each year	3.605	-	+30.28 lakh
1975-76	100,00,000	.5674	-	-56.74 lakh
1976-77	90,00,000	.5066	-	-45.59 lakh
1976-77 to 2001-02	19,63,000 each year		4.45	+87.35 lakh
				5.30 lakh

With this scheme an extra goods train cannot be introduced for two years during (1974 -75 to 1975-76). This entails an annual loss of Rs.1.26 lakh. (Extra wagons Rs.14175, extra locos 1,12,704 because of detentions as capacity utilization over 80%). Discounted to present values, this will reduce the above net figure of Rs.5.30 lakhs by further Rs.1.80 lakh but the rate of return will not be altered significantly.

EXAMPLE (6):-

Providing a Diesel Loco Shed for homing 50 mainline B.G. Diesel Electric Locomotives 'X' Railway

(A) Capital costs (estimated) and phasing of expenditure (Rs. lakhs)

(1) Diesel		Total	Loco Shed	Loco Motives	
	1974-75	295	25	270	(10 WDM 2 Locos at Rs.27 lakhs each)
	1975-76	320	50	270	- do -
	1976-77	311	41	270	- do -

1977-78	270	-	270	- do -
1978-79	270	-	270	- do -
		116	1350	
Scrap value of locos (at Rs.1,00,000 per loco)			(-)50	
			1300	

			Loco Shed	Loco Motives	
(II)	Steam (replacement of existing locos):-	1974-75		145	2.5 steam taken as equivalent to one WDM2 Cost per Steam Loco assumed at Rs.5.8 lakhs.
		1975-76		145	
		1976-77		145	
		1977-78		145	
		1978-79		145	
				725	
Estimated scrap value (at Rs.23000 per loco)				(-)29	
				696	

Estimated economic life : Even though 40 years per steam and 30 years per diesel, the life is assumed to be 30 years in both cases. (Discount factor after 30 years is negligible).

(B) Operating and Maintenance costs:-

(i) Basic Data:-

		Steam	Diesel
(a)	Km. per day for goods services(for steam and all Railway B.G. for diesel loco)	83	323
(b)	Average gross load per train (excluding loco)	1329 t	1591 t
(c)	Locos in use daily (with 17.6% repairs allowance for steam, or 15% of total holding and 12.1/2% for diesels)	...	43.75 WDM2
(d)	Steam locos on line equivalent to 50 WDM2 Locos- vide (a) to (c) above. (This gives a ratio of 4.68 steam equal to one diesel however in the computations for this appraisal, the conservative and generally accepted ratio of 2.5 steam to one diesel has been adopted.)	234	$\frac{43.75 \times 323 \times 1591}{85 \times 1329} \times \frac{100}{85}$
(e)	Km per loco per annum (derived from diesel loco operation).	$\frac{103.158 \times 1591}{1329 \times 2.5}$ = 49.398	$\frac{323 \times 365 \times 7}{8}$ = 103.158
(f)	Cost of fuel per 1000 GTKM	Rs.2.94	Rs. 2.31
(g)	Cost of repairs and maintenance per engine Km.	Rs.0.71	Rs. 0.45
(h)	Consumption of lubricating oil per 100 engine Km.	4.50 litres	11.2 litres
(i)	Cost of lubricant per litre (in terms of latest purchase rate etc.)	Rs.1.71	Rs.2.42

(ii) Cost Data

(a)	Repairs and maintenance per annum	0.71x49,398 =Rs. 35,073	0.45x103,158 Rs.46,421
(b)	Cost of fuel per annum	1329x49398 x2.94x.001 =Rs. 1,93,011	1,591x103.158 x2.31x.001 = Rs. 379,127
(c)	Cost of lubricating oil per annum	49,398x4.5x1.71 100 = Rs. 3801	103,158x11.2x2.42 100 = Rs. 27,960
(d)	Wages of running staff per annum (estimated for staff requirement)	Rs.23,493	Rs.28,458
(e)	Kilometrage allowance per annum	Rs.8,052	Rs.13,411
(f)	Total cost per locomotive per annum	Rs.2,63,430	Rs.4,95,377
(g)	Equivalent cost at 2.5 steam : 1 diesel	Rs.6,58,575	Rs.4,95,377
(h)	Saving in diesel operation per loco per annum	Rs.1,63,198 (say) Rs.1.63 lakh	.....

(C) Financial Analysis (DCF) (Cash outflows) Rs. lakhs

Year	Index	Interest/ Discount factor @ 10%	Steam	Diesel	Saving (+) Additional (-)	
					Absolute	Discounted
1974 -75	-2	1.21	(145+66)*	(295+49)*	-133	-161
1975 -76	-1	1.10	(145+132)	(320+98)	-141	-155
1976 -77	0	1.0	(145+198)	(311+147)	-115	-115
1977 -78	1	0.91	(145+263)	(270+198)	-50	-45
1978 -79	2	0.83	(145+329)	(270+245)	-41	-34
1979 - 80 to 2009-10	3 to 30	6.93	329	245	+84	+582
Residual value	30	0.057	+29	+50	+21	+1
						+23

* Capital and Revenue cash outflows are shown separately for easy reference.

This analysis shows that the proposed diesel shed to home 50 WDM2's is financially justified, the return under DCF being a little over 10%

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ANNEXURE 'F'

ECONOMIC EVALUATION OF RAILWAY INVESTMENTS

A purely financial appraisal of investment proposals does not necessarily lead to the selection of projects which best serve the needs of the community. The inadequacy of. financial analysis in this regard derives from the fact that projected cash inflows and outflows associated with feasible investment alternatives do not correctly reflect the actual benefits to the community flowing from them or the costs that they impose on the economy. Financial and economic appraisals, however, need not always lead to conflicting decisions a financially viable project will also be acceptable on economic grounds whenever the economic return on investment is likely to be at least as high as its financial yield. But, there can be instances of financially sound investment proposals which may not turn out to be worthwhile propositions because the relevant cash outflows do not include all the associated costs to the economy. Again, on investment which is not expected to be profitable, may still yield an adequate, or even a fairly high, economic return if the projected cash. earnings represent only a part of the benefits or incomes that are likely to be generated by it.

2. Economic benefits attributable to a particular investment can, for a number of reasons, exceed the revenues directly accruing to the Railways in the form of fare and freight receipts. In the first place, most users of a facility may be willing and able to pay somewhat more than what they are actually charged by the Railways. Secondly, there may also be instances where what the consumers are actually able to pay for rail transportation is (because of uneven-income distribution) less than the benefit they derive from it. This, indeed, is the main justification for a preferential fare structure for certain passenger and suburban services. Finally, for economic or social policy reasons freight rates on certain key commodities may be set at levels which do not fully cover rail transportation costs. The entire benefit derived by the users of Railways can never be qualified; however, at least that part of it which consists of the difference between cost of transportation and fares or freight rates actually charged-can be precisely ascertain. *The provision of a rail transport facility thus directly adds to the well-being of the community by more than the receipts that accrue thereby to the Railways.

*Likewise, the difference between the cost to the consumer of rail transportation and that of other modes of transport replaced (partly or wholly) by it is a tangible and measurable social gain.

3. Rail transportation, however, can make a substantial indirect contribution as well to general well-being by facilitating economic expansion. A new line, in a backward region not well endowed with alternative modes of transportation, stimulates the growth of output and employment by widening the market for local products as well as by creating a market for some hitherto unexploited natural resource. The quantification of such indirect benefits can at best be approximative. For one thing, the expected expansion of regional or local economic activity is difficult to forecast. For another, the quantification of "developmental benefits" poses the problem of allocating expected additions to output and incomes between the Railway project and other complementary investments in industry, agriculture or commerce.

4. Great care should be taken in estimating social benefits for the purpose of economic appraisal of railway investments. Such benefits should, to the extent possible, be quantified with a reasonable degree of accuracy. Thorough investigations at the traffic survey stage would help in identifying the "developmental effects" and in estimating broadly the magnitude the complementary investments that may be required. Also, the assumptions and reasons underlying any judgement about non-quantifiable benefits. should be clearly spelt out. Fortunately, the assessment of social benefits is necessary only in the case of proposed investments in new rail lines or operations ; as regards investment for modernisation and improvement, which constitute the bulk of the Railways' capital outlay, one need only estimate the social costs entailed by investment alternatives In order to pick out the least cost solution from the point of view of the economy.

5. The expenditure flows associated with Railway projects can, to varying extents, diverge from the cost to the economy of acquiring resources needed for their implementation and operation. The prices at which certain inputs and resources are made available to the Railways, for instance, may understate or exaggerate their, real cost to the economy. Thus the interest rate which is in line with the usual return on new capital investment in the economy may not be the same as the "dividend" the Railways have to pay on the capital-at-charge. Similarly ,the rupee equivalent of direct foreign exchange expenditure may differ from the cost of saying or earning an equivalent amount of foreign exchange. Moreover, the relative prices of various types of equipment and materials purchased by the railways will be different from the comparative costs of producing them for the reason that the rates of indirect taxes (or subsidies) vary from product to product. Lastly, there are certain types of real costs which do not at all get recorded in the financial cash flows. Environmental damage can, for example, be a major unrecorded element of cost.

6. In selecting investments which impose the least cost on the economy, cash out flows have to be recomputed in such a way as to minimise the distortions caused by the use of prices actually paid for inputs (including the prices of capital and foreign exchange) and by the neglect of other costs which do not figure at all in expenses. Environmental effects of investments are the most difficult to estimate However in a number of cases the choice of projects may be influenced much more by the interest and exchange rate, that are utilised than by the correction of distortions introduced by indirect taxes, subsidies and environmental effects. A preliminary sensitivity analysis is useful for picking out the more important, of the factors distorting costs; such factors can then be subjected to a detailed investigation.

7. For economic evaluation of Railway Projects, the interest or discount rate is currently set at 10 percent. This implies that the cost of capital comprises a depreciation or capital recovery factor and interest charged at 10 per cent per annum; a project is thus just acceptable if the expected earnings from it during its lifetime make it possible to recover the investment with a return if 10 per cent per annum, that is, if the DCF rate of return on it is 10 percent.

8. In the cash flows utilised for economic, evaluation of high speed diesel oil is not valued at the price actually paid by the Railways for it. Instead, all taxes and duties payable on it are excluded from the price; and, the duty-free price is adjusted upwards so as to allow for the comparative scarcity of crude oil in the Indian economy. At present this adjustment factor is exactly half the current rate of excise duty on high-speed diesel oi1.

9. There is no direct readjustment of the official exchange rate for the purpose of computing the scarcity value of imported. equipment, spares and materials. However, there is an implicit adjustment in as much as the duty paid on imports is retained as a cost item in the cash-flows ideally, other indirect taxes like excise duties, sales taxes, local taxes and other cesses and levies, should be excluded from the cost of domestically procured inputs. But in many cases it has been found, particularly in the analysis of investment for modernisation of traction, that the exclusion of indirect taxes and similar levies does not make any material difference to the ranking of the proposed alternatives.

10. Electric power is valued not at the price at which it is sold to the Railways by the State Electricity Boards but at its estimated cost to the economy. The latter is derived from actual production cost by revaluing its interest component at the rate of 10 per cent per annum and its foreign exchange component at an exchange rate 33 per cent-higher than the current official rupee price of foreign currencies.

FINANCIAL AND ECONOMIC EVALUATION OF-
NVESTMENT ALTERNATIVES

An Example.

A highly simplified hypothetical example of choice between diesel and electric traction is presented here for the purpose of illustrating the essential difference between financial and economic evaluation. This type of choice is basically a problem of minimising the cost of handling a given volume of traffic over specified sections.

The two project alternatives, dieselisation and electrification, are defined as follows-

(ii) The project life, which includes the construction period, extends in both cases up to 44 years.
(ii) The level of traffic remains unchanged over the life time of the project.
(iii) Annual operating expenses exclude depreciation and do not vary from one year to another.
(iv) Capital costs exclude interest during construction**
(v) Capital outlay on dieselisation is spread over a period of three years; it comprises the expenditure on acquisition of rolling stock and construction of sheds.
(vi) Capital outlay on electrification is phased over four years; it comprises the expenditure on rolling stock and construction of OHE.

**If the income flows are computed from the date of completion of the project, the capital outlay will be compounded at the desired interest rate.

Given these assumptions, the financial cost cash-flows associated with the two illustrative traction alternatives can be presented in the following manner :

Financial cost to Railways (Rs. crores).

Year	Diesel	Electric
1	..	3.0
2	0.5	6.0
3	0.5	15.0
4	10.0	6.0
5^{th} to 44^{th} (each year)	4.0	2.5

Discounted Present Worth of Financial Costs.

Interest Rate.	Diesel	Electric
6%	56.5	55.3
7%	49.2	50.3

It would be seen that when discounted at 6 per cent the present worth of the financial cost flow relating to electrification works out to be lower than that of the financial cost flow associated with dieselisation by Rs. 1.2 crores. But the situation is reversed when the cost flows are discounted at 7 per cent, in which case dieselisation turns out to be cheaper by Rs. 1.1 crores. Thus, in this hypothetical case, the depreciation inclusive financial cost of electrification is lower only at rates of interest below 7 per cent. The rate of interest at which the two alternatives will impose identical costs can be found out by linear interpolation. This turns out to be 6.5 percent; at lower rates of interest electrification is the cheaper alternative; but becomes the costlier one at interest rates exceeding 6.5 per cent. This is as it should be; for electrification is the more capital intensive mode of traction.

The estimation of cash-flows relevant for the computation of the cost to the economy is based on the following assumptions :-

(i) The basic price, inflated to the extent of 50 per cent of the excise duty, is taken as the appropriate scarcity value of high-speed diesel oil.

(ii) The cost to the economy of electricity generation and transmission is assumed to be 7 paise per KWH as compared to 10 paise per KWH assumed to be actually paid by the railways.

(iii) Fuel costs constitute 70 per cent of operating expenses under diesel and 50 per cent of operating expenses under electric traction.

Under these assumptions, the cost to the economy of the uniform annual operating expenses associated with dieselisation and electrification works out to be Rs. 3.00 and Rs. 2.12 crores respectively. But, the cost to the economy of capital outlays continues to be the same as the financial cost. The discounted present worth of the cash flow corresponding to the cost to the economy at 3 and 4 percent interest rates is as follows:

Discounted Present Worth of Costs to the Economy.

Interest Rate	Diesel	Electric
3%	71.4	70.8
4%	60.2	62.4

It will be seen from the above that in this hypothetical case, from the point of view of cost to the economy, electrification turns out to be cheaper than dieselisation only at rates of interest which do not exeed 4 per cent. The break even rate of interest, at which both alternatives involve identical costs, is approximately 3.2 per cent.

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ANNEXURE 'G'

(See Paragraph 240)

The examples given below are intended to illustrate the principles set out in paragraph 238 et seq. The data assumed are hypothetical and the conclusions arrived at in these examples are purely illustrative. The methods adopted are not to be regarded as exhaustive or as precluding the use of alternative methods which may be found to be more appropriate.

1. Renewal of a Locomotive.-(i) Whether to recondition or to renew a locomotive, given the following data :-

Particulars.	Old Locomotive.	New Locomotive
Cost of the locomotive	Rs. 50,000 (Second-hand cost).	Rs. 5,00,000 (New cost).
Cost of reconditioning	Rs. 50.000	....
Rate of interest	6 percent.	6 percent.
Life	10 years	40 years
Scrap Value	Rs. 10,000	Rs. 20,000
Maintenance Operation and Repair Charges	Rs. 50,000 a year.	Rs. 40,000 a year

(ii) The average annual cost of the existing locomotive after reconditioning would be Rs.62,831made up of the following :-

	Rs.
(a) Cost of maintenance, operation, repairs, etc.	50,000
(b) Interest at 6 per cent on Rs. 1,00,000 (Rs. 50,000 Plus Rs. 50,000)	6,000
(c) Sinking Fund Payment at 6 per cent (90,000x0.0759)	6,831
Total	62,831

(iii*)* The average annual cost of the new locomotive would be Rs.75,520 made up of the following:-

		Rs,
(a)	Cost of maintenance, operation, repairs, etc.	40,000
(b)	Interest at 6 per cent on Rs.5,40,000 (i.e., new cost Rs.5,00,000+ the second hand cost of the old locomotive, Rs.50,000- the scrap value of old locornotive Rs. 1 0,000).	32,400
(c)	Sinking Fund Payment at 6 per cent (4,80,000x0.0065).	3,120
	Total	75,520

(iv) It follows from the above figures that, with the data assumed, it is cheaper to recondition the old locomotive than to replace it by a new one.

(v) Applying the DCF method also, it is observed that for an initial investment of Rs. 5 lakhs, the NPV for 40 years on the basis of the saving of Rs.10,000/- reckoned at 10 per cent p.a. adds up to Rs.1,02,210 only (10,000x9.779)+(20,000x0.0221). The purchase of new locomotive is, therefore, not justified.

2. Renewal of a Bridge.- (i) Whether to recondition or to renew a bridge, given the following data:-

Particulars.		Old Locomotive.	New Locomotive.
Cost		10,000	40,000
Scrap Value		2,000	4,000
Scrap Value	(after reconditioning)	4,000	....
Interest		6 per cent	6 per cent
Life		30 years	60 years
Reconditioning Cost		10,000	…..

Note.-Maintenance cost is the same for both the reconditioned and new bridge

(ii) The annual cost of service of the reconditioned unit will be Rs. 1,402 vide details given below:-

	Rs.
(a) Interest at 6 percent on Rs.20,000 (i.e. Rs:10,000+10,000)	1,200
(b) Sinking Fund Payment at 6 percent on Rs16,000 (i.e. 16,000x0.0126)	202
Total	1,402

(iii) The annual cost of service of the new girders ,will be Rs.2,948 vide details below.-

	Rs.
(a) Interest at 6 per cent on Rs.48,000, i. e., on cost of new girders + second hand value of old girders-scrap, value of old girders) Rs. 40,000+ Rs. 1 0,000-Rs.2,000).	2,880
(b) Sinking Fund Payment at 6 per cent on Rs.36,000 (Rs,40,000-Rs.4,000) 36,000x0.0019)	68
Total	2,948

(iv) It follows that reconditioning is cheaper.

3. Renewal of Permanent Way.--(i) To determine whether a line of 85 lb. B. H. rails should be fitted with 2 additional sleepers, one, Duplex joint sleeper and new fish-plates and bolts, or replaced with 90 lb. F. F. rails, given the following data :-

For providing additional fittings.	Fitting new 901b.rails
Cost of two additional sleepers including fittings Rs 60	Cost of 2 new 90 lbs. rails Rs.550
Cost of Duplex joint sleepers including fittings 64	Including carriage and laying.....

Cost of fish-bolts and plates	10	Life	60 years.
Cost of fitting these in each	7	Scrap value	Rs. 207
Life of 85 lb. rails Scrap value of rails 36 ft. long	30 years Rs. 100	Rate of interest	6 per cent.
Scrap value of fittings	5		
Second-hand cost of two 85 lb. rails, 36 ft. long. Rate of interest	243 6 per cent		

Note -(1) Maintenance and repair cost are considered to be the same in both cases.
(2) Steel scrap has a very high price in the market and new rails are comparatively cheap from indigenous sources.
(3) The old rails cannot be used elsewhere.

(ii) The average annual cost of service of the existing 85 lb. track after additional fittings are made will be Rs. 26.27 vide calculations below:-

(a) Interest at 6 per cent on the—

	Rs.
Cost of 2 sleepers	60
Cost of Duplex Joint sleepers new	64
Cost of fish-plates and bolts	10
Cost of fitting	7
Second-hand value of old rail	243
	384
Less scrap value of fish- plates and bolts	5
	379 =22.74
(b) Sinking Fund Payment at 6 percent on Rs. (60+64+10+7+ 243) - (100+5) or Rs.279=0.0126x279)	3.53
Total	26.27

(iii) The average annual cost of service of new rails will be Rs.41.93, vide calculations below.-

	Rs.
(a) interest at 6 percent on-	
Cost of new rails and fittings, etc.	550
Plus second-hand cost of old rails.	243
Less scrap value of old rails and fittings.	793
	105
	688=41.28
(b) Sinking Fund Payment at 6 per cent on Rs.500-207 =(343xO.OOl9)	=0.65
Total	41.93

(iv) With the data assumed it is cheaper to provide 2 extra sleepers 1 Duplex Point sleepers and new fish-plates and bolts to the existing track than to replace it with 90 lb. F. F. rails. If, however, it were possible to use the B. H. rails elsewhere on the line, it might be cheaper to provide new rails than to provide these additional fittings.

4. Re-alignment of Line.-(i) To determine whether the re-alignment of a track by abandoning the arc and following the chord, is justifiable, given the following data :-

Length of arc		15 miles
Length of chord		10 miles
Cost of chord	Rs.	5,00,000
Scrap value of items recoverable from the arc	Rs.	50,000
Scrap value of items recoverable from the chord	Rs.	40,000
Second-hand value of all assets of the arc	Rs.	3,00,000
Savings in operation and maintenance costs	Rs.	70,000
Loss on tickets owing to reduction of mileage	Rs.	10,000
Extra traffic expected.	Rs.	15,000
Rate of interest.		6 per cent

Note.-There is keen bus competition on the section running along the arc and the chord will cut this competition as the road runs along the arc and not the chord, and it is very unlikely another road will be built along the chord.

(ii) The net saving due to re-alignment is Rs. (70,000-10,000+ 15,000) or Rs. 75,000.

(iii) The average annual cost excluding the cost of operation and maintenance of the realigned track will be Rs.49,140 vide calculations below.-

	Rs.
(a) Interest on Rs. 7,50,000 (i.e. Rs. 5,00,000+ Rs. 3,00,000-Rs. 50,000) at 6 per cent.	45,000
(b) Sinking Fund Payment at 6 percent required to provide Rs.4,60,000(i. e. 5,00,000-Rs.40,000) at the end of 35 years-(0.0090x4,60,000).	4,140
Total	49,140

Note.-There are many assets on the track having varying normal lives. For the purpose of this calculation, a life of 35 years has been taken as a fair average for all the assets involved.

(iv) Hence it may be seen that realignment is justified since, it will yield a net saving of about Rs.26,000 p. a.

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ANNEXURE-'H'

(See Paragraph 242)

The examples given below are intended to illustrate the principle set out in paragraph 241 The data assumed are hypothetical and the results arrived at in these examples are purely illustrative.

1. If, in the case of an asset where the average annual cost of service is the basis on which the second hand value has to be fixed.-

the normal life is	N years.
the first cost is	Rs. C
the scrap value is	Rs. S
life as second-hand asset is	n years.
the annual cost of operation and maintenance, repairs, etc. of the asset while new is.	Rs. 0
the annual cost of operation and maintenance, repairs, etc. in the second-hand condition r is the annual rate of interest.	Rs. 01

dN is the sinking fund Payment required to be paid annually so that at the end of N years, the sinking fund provides Re. 1.

dn is the sinking fund Payment required to be paid annually so that at the end of n years the sinking fund provides Re. 1.

then, 'X', the second-hand value of the asset is such that the average annual cost of the second hand asset is equal to the average annual cost of the new asset, or Xr + (X-S) dn+01 = Cr + (C-S) dN+O. Simplifying the equation, we have .-

$$Xr+X\,dn-Sdn+01=Cr+(C-S)\,dN+0.$$
$$X\,(r+dn)=Cr+(C-S)\,dN+0+Sdn-01.$$
$$X=\frac{Cr+(C-S)\,dN+0+Sdn-01}{r+dn}$$

Illustration. - If Rs. 10,000 be the first cost of an asset with 60 years of normal life and a scrap value of Rs.2,500, the rate of interest is 3 percent or .03 per rupee and the average maintenance and repair cost for the first 20 years is Rs.250 and for the next 40 years Rs.35O, then applying the above formula, the second-hand value at the end of 20 years will be.

$$\text{Rs. }\frac{10{,}000 \times .03+(10{,}000-2{,}500).0061^{*}+250+2{,}500 \times .0133^{*}-350}{.03+.0133}$$

Or $\frac{279}{.0433}$ i.e., Rs.6,443.

* These are obtained from the Table in Annexure B.

2. In the case of an asset the second-hand value of which is to be determined on the basis of 'the average cost per unit of service; if the same notation as in Example (1) were used and.-

if u is the average number of annual units of service rendered by the asset while new, and u1 the average number of units of service rendered by the asset while second-hand, then, X the second-hand value of the asset is such that-

$$\frac{Xr+(X-S)\ dn+01}{U1} = \frac{Cr+(C-S)\ dN+0}{u}$$

$$\text{There fore,}\quad X= \frac{u1\ /u\ [\ Cr+(C-S)\ dN+0]-01\ Sdn}{r+dn}$$

Illustration.- If Rs. 1,00,000 be the cost of an asset with a normal life of 35 years and a scrap value of Rs.10,000; if the rate of interest is assumed to be 3 percent or .03, the average operation, maintenance and repairs costs while new, Rs. 1,20,000 per annum and the average operation, maintenance and repairs costs in the second-hand condition Rs. 1,03,000 per annum; and if, the average serviceability of the asset while new be 1,20,000 units per annum and 1,00,000 units in the second-hand condition, then applying the formula above, the second-hand value of the asset at the end of 20 years will be.-

$$\frac{1,00,000}{Rs.\ 1,20,000} - [\ 1,00,000x03+(1,00,000-10,000).0165+1,20,000]--1,03,000+10,000x\ .0538$$

$$.03+.0538$$

$$\text{or}\quad \frac{2551}{2} \times \frac{1}{.0838} \qquad \text{i.e,}\quad \text{Rs. } 15,221 \text{ nearly.}$$

END