Junction Network

Case Studies

Mr. T. Fried, ITU

UNION INTERNATIONALE DES TELECOMMUNICATIONS
INTERNATIONAL TELECOMMUNICATION UNION
UNION INTERNACIONAL DE TELECOMUNICACIONES

Case Study 1 : Route Optimisation

For given values of

A = traffic offered to the direct route

C_D = cost per circuit on the direct route

C_T = cost per erlang on the overflow path

B = required grade of service for the traffic case

find the optimal number of circuits, N, to be installed on the direct route, as well as the resulting

B_R = congestion on the direct route

m = overflow traffic mean

v = overflow traffic variance.

Note : Finding the optimal number of circuits, N, on the direct route corresponds to find the N-value for which the cost function,

$$C(N) = N * C_D + m * C_T$$

has a minimum.

The value of m for given A and N can be found from an Erlang-table, or from the attached diagram.

A C_D C_T B ➔ N B_R m v Cost

A	**C_D**	**C_T**	**B**		**N**	**B_R**	**m**	**v**	**Cost**
20.	1.	2.	0.10	➔					
20.	1.	2.	0.05	➔					
20.	1.	2.	0.01	➔					
20.	1.	1.2	0.01	➔					

Case Study 2 : Optimisation and Dimensioning of Junction Network

Consider a network with 6 exchanges. The tables below give the traffic interest between all exchanges, and the cost per circuit for each pair of exchanges. Find the number of circuits between all pairs of exchanges, calculate the total network cost for the 3 cases described below, and decide on the most economic way of realizing the network.

Case 1 : all traffic between any exchange pair (i,j) is carried on a direct, low-loss route.

Case 2 : all traffic between any exchange pair (i,j) is routed through a transit exchange, T.

Case 3 : optimize the number of circuits on each route i to j. The optimal number of circuits, N(i,j), depends on

- the cost of a circuit on the direct route;
- the traffic offered:
- the cost per erlang on the overflow routes, which in turn depends on the cost per circuit and the efficiency of the route; as this efficiency, F, can be approximately expressed as the ratio between circuits and offered traffic, it is in turn dependent on the traffic offered, which is not known before the lower-level routes have been optimised; therefore an iterative procedure has to be established:

Step 1 : use Rapp's approximation, and the attached diagram, to find the optimal number of circuits on all high-usage routes;

Step 2 : find the corresponding parameters of the overflow traffic, m(i,j) and v(i,j);

Step 3 : find the traffics offered to/from the tandem exchange by summing up the relevant individual overflow traffics;

Step 4 : find the required circuits on the tandem routes, and calculate the total network cost.

Note : For cases 2 and 3 the following should be observed :

- you will have to decide which of the exchanges should be the **tandem exchange**, T;
- the grade of service used for routes to/from T should be adjusted to give the same overall grade of service as Case 1;
- calculate overflow traffics, and routes to/from T, using the attached diagrams, and Wilkinson's method.

Traffic interest matrix (in Erlang) :

	1	2	3	4	5	6
1	-	10	15	5	2	20
2	9	-	25	6	8	10
3	20	23	-	18	20	30
4	6	6	20	-	10	12
5	3	7	22	10	-	11
6	15	12	40	10	13	-

Cost-per-circuit matrix

	1	2	3	4	5	6
1	-	100	150	120	130	200
2	110	-	100	100	110	150
3	130	110	-	120	110	130
4	100	90	110	-	100	130
5	120	100	110	120	-	150
6	180	150	130	130	150	-

Required grade of service : 0.01

You should use the following page to tabulate your results.

Case 1 : *All traffic on low-loss routes*

Circuit matrix :

	1	2	3	4	5	6
1						
2						
3						
4						
5						
6						

Total cost =

Case 2 : *All traffic through a transit exchange, T*

Selected tandem :

Traffics and circuits :

	To Tandem T		From Tandem T	
	Traffic	Circuits	Traffic	Circuits
1				
2				
3				
4				
5				
6				

Total cost =

Case 3 : *Optimization of Alternative Routing Network*

Selected tandem :

Calculate cost relations :

$$\varepsilon = C_D / C_T$$

	1	2	3	4	5	6
1						
2						
3						
4						
5						
6						

Calculate improvement factors :

$$F_N(A) = \varepsilon \times (0.7 + 0.3 \times \varepsilon^2)$$

	1	2	3	4	5	6
1						
2						
3						
4						
5						
6						

Optimize circuits on High-usage routes :

	1	2	3	4	5	6
1						
2						
3						
4						
5						
6						

Use attached diagrams to determine circuits and overflow traffics!

Overflow Traffic Mean :

	1	2	3	4	5	6
1						
2						
3						
4						
5						
6						

Overflow Traffic Variance :

	1	2	3	4	5	6
1						
2						
3						
4						
5						
6						

Calculate traffics (mean and variance) offered to tandem routes, and find required number of circuits :

Traffics and circuits :

To Tandem

	Mean	Variance	V/M	Circuits
1				
2				
3				
4				
5				
6				

From Tandem

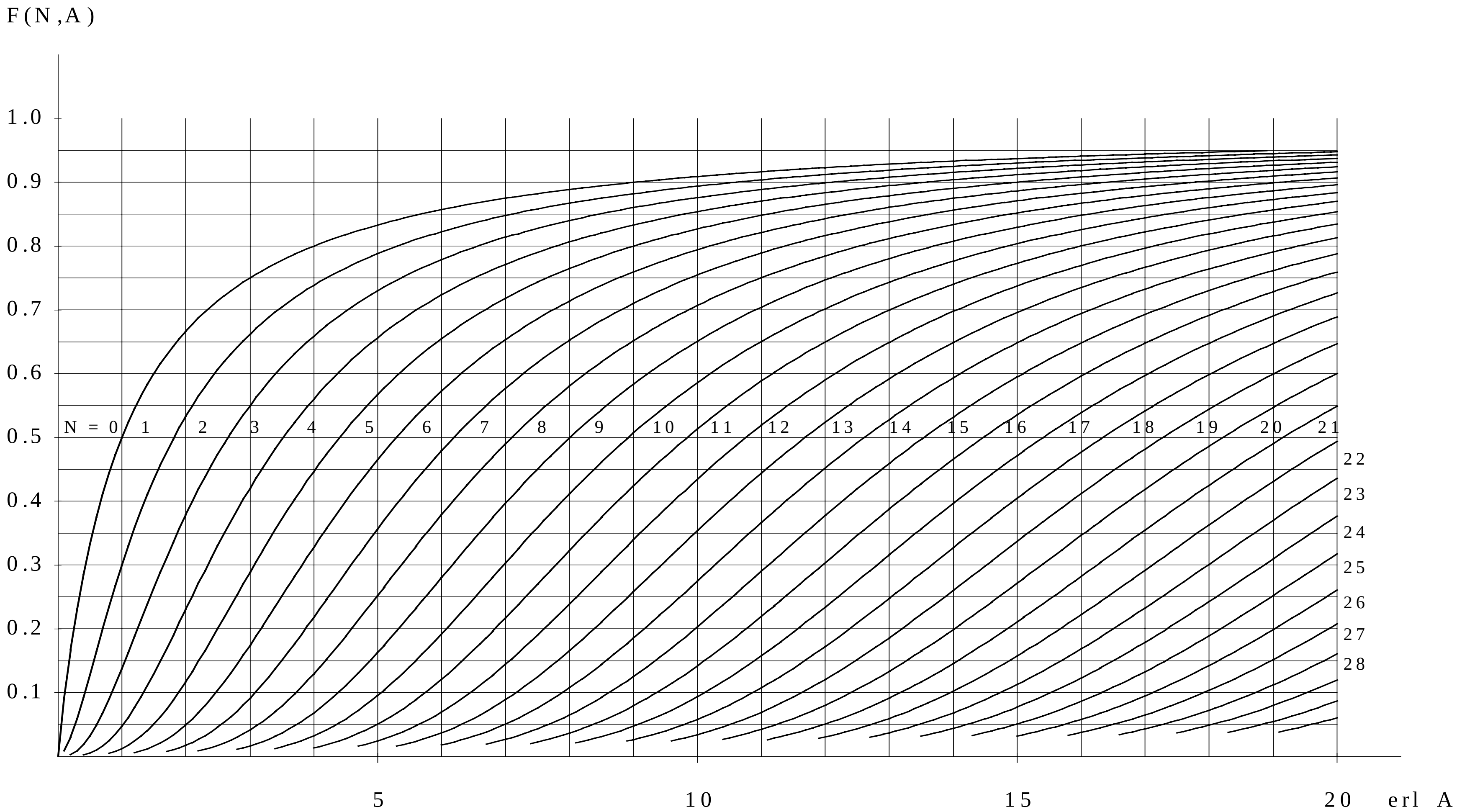
	Mean	Variance	V/M	Circuits
1				
2				
3				
4				
5				
6				

Total cost = | |
|---|

N = Number of lines in direct route

A = Traffic offered to direct route

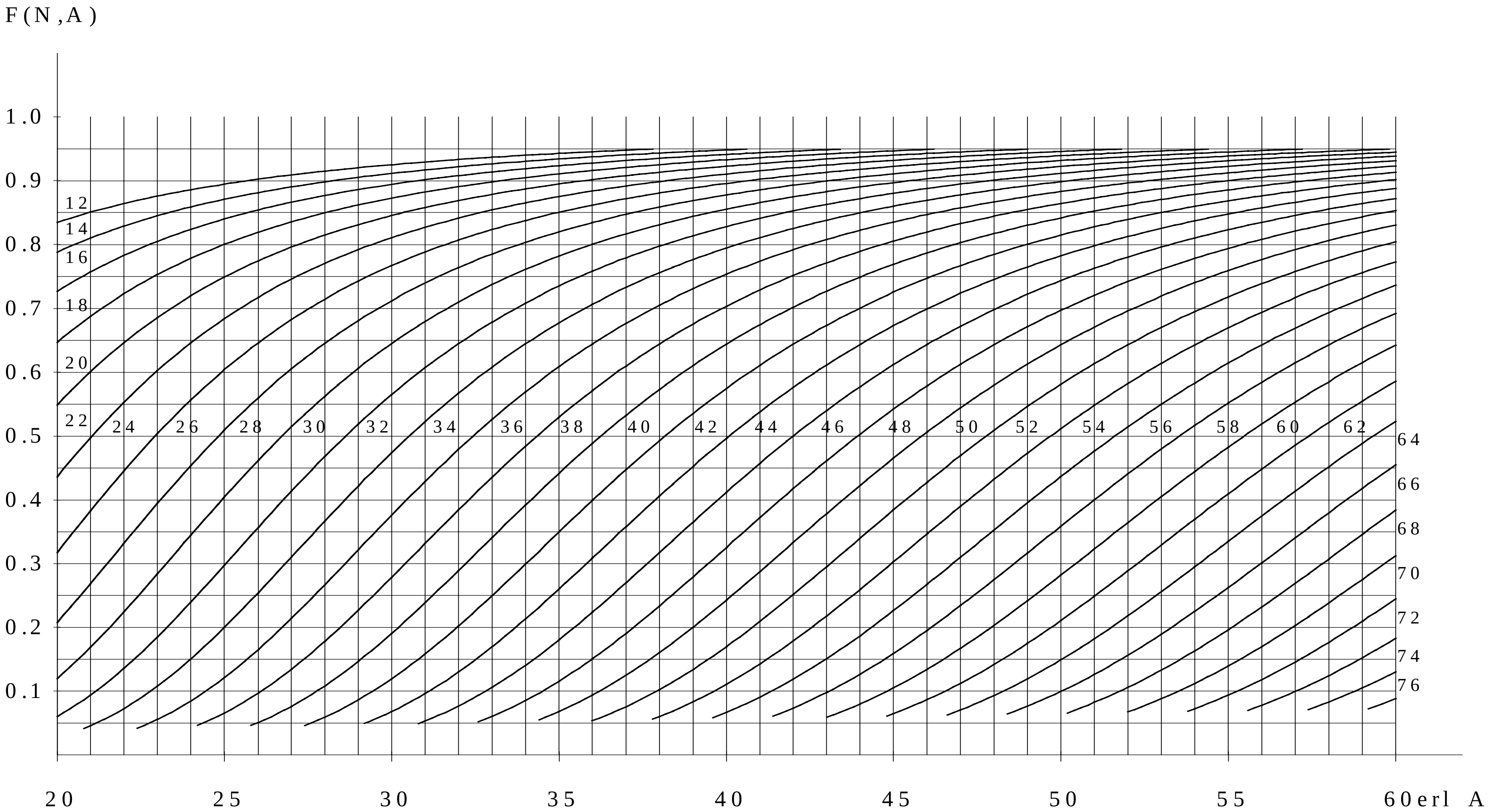
F(N,A) = Improvement factor = CD/CT



N = Number of lines in direct route

A = Traffic offered to direct route

F(N,A) = Improvement factor = CD/CT

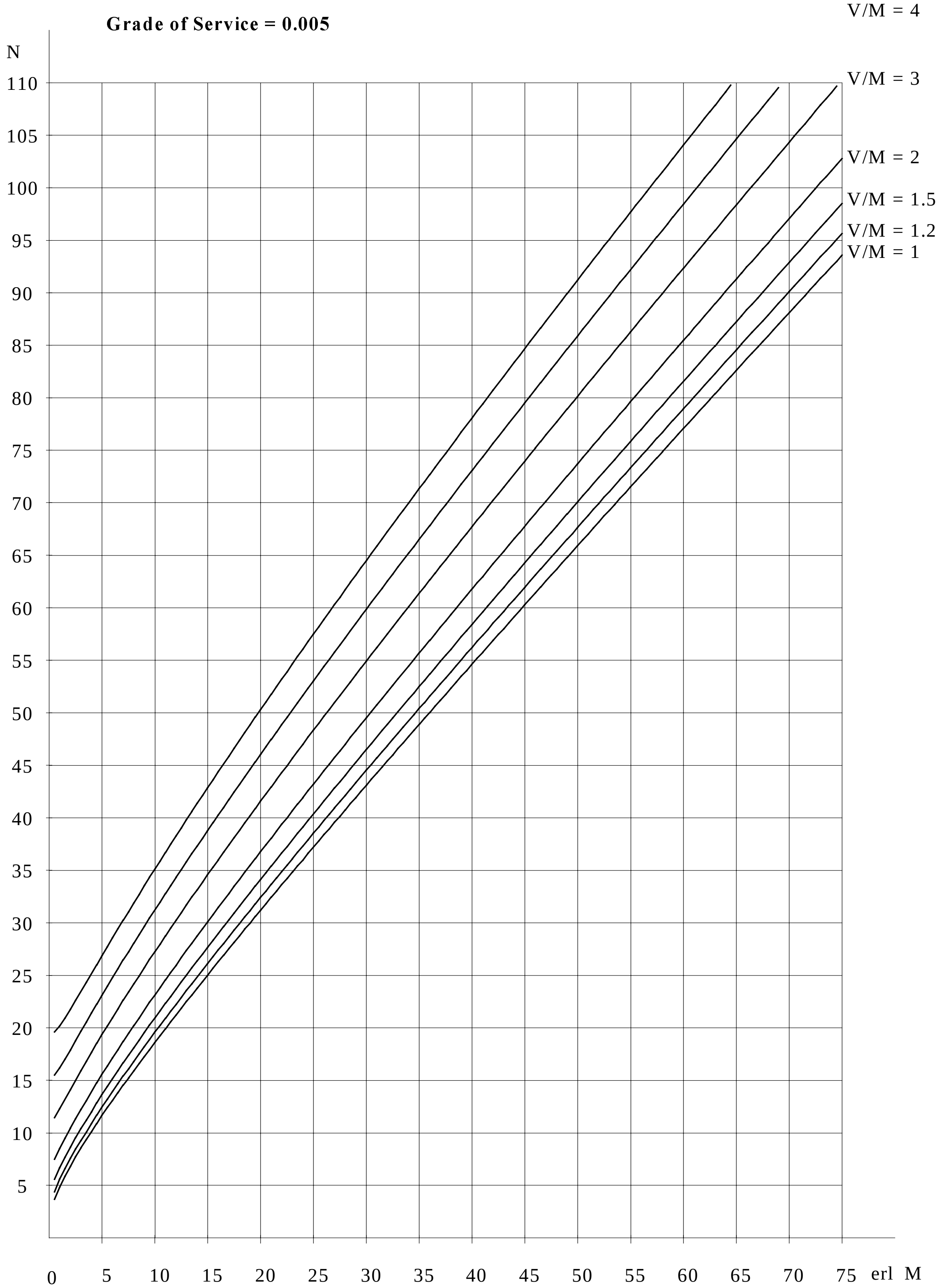


N = Number of lines in final route

M = Mean of Traffic offered

V = Variance of Traffic offered

Grade of Service = 0.005

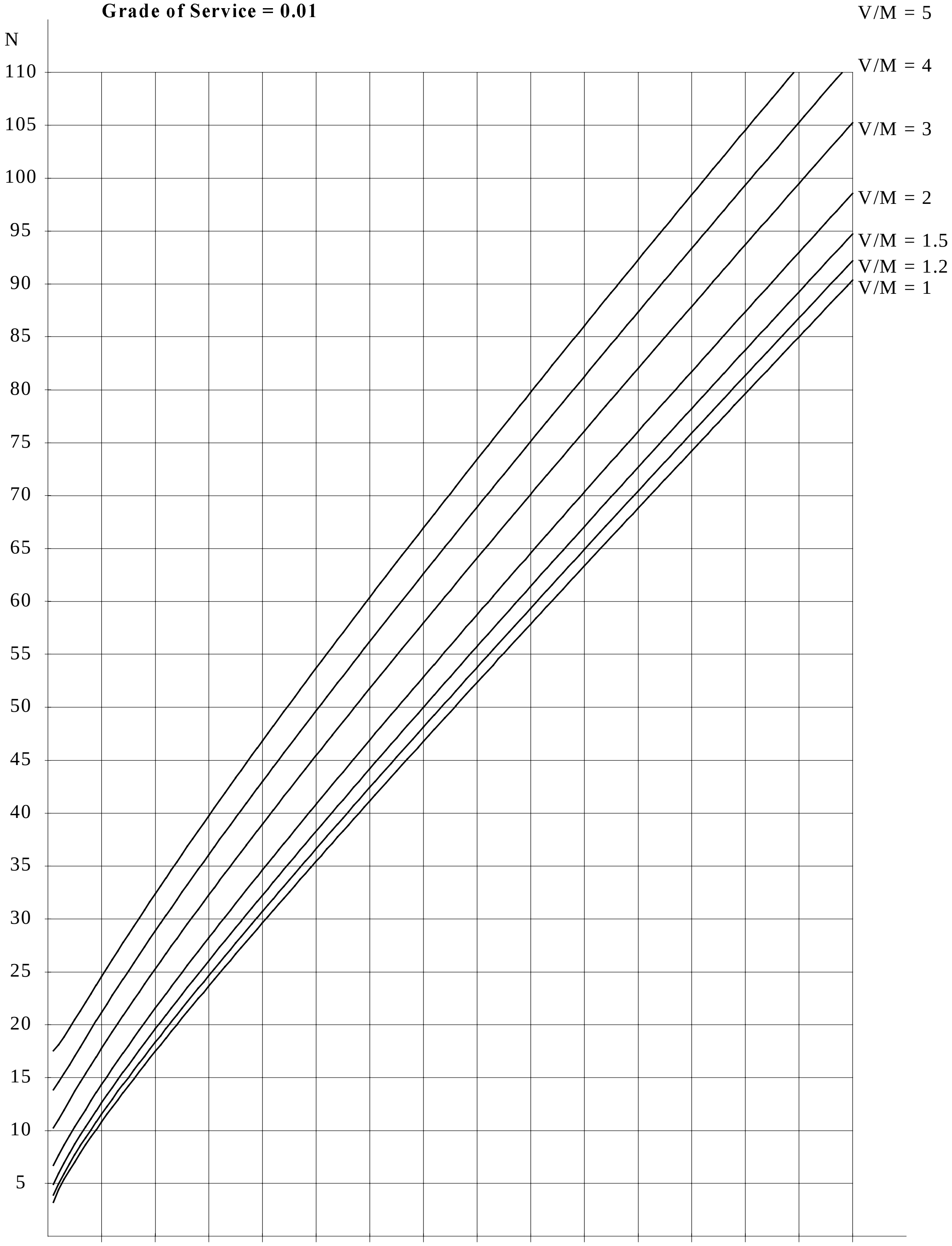


N = Number of lines in final route

M = Mean of Traffic offered

V = Variance of Traffic offered

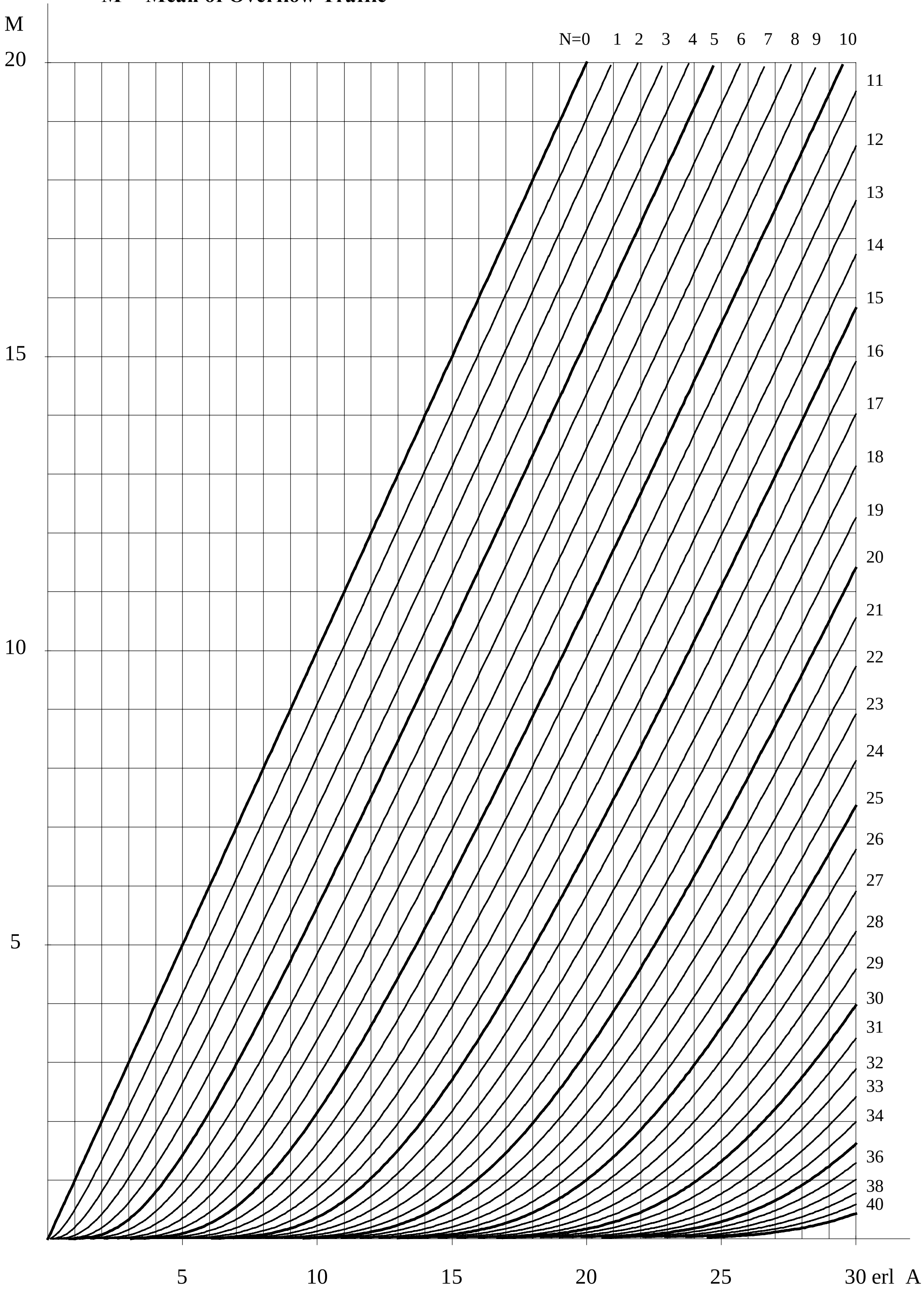
Grade of Service = 0.01



N = Number of lines in direct route

A = Traffic offered to direct route

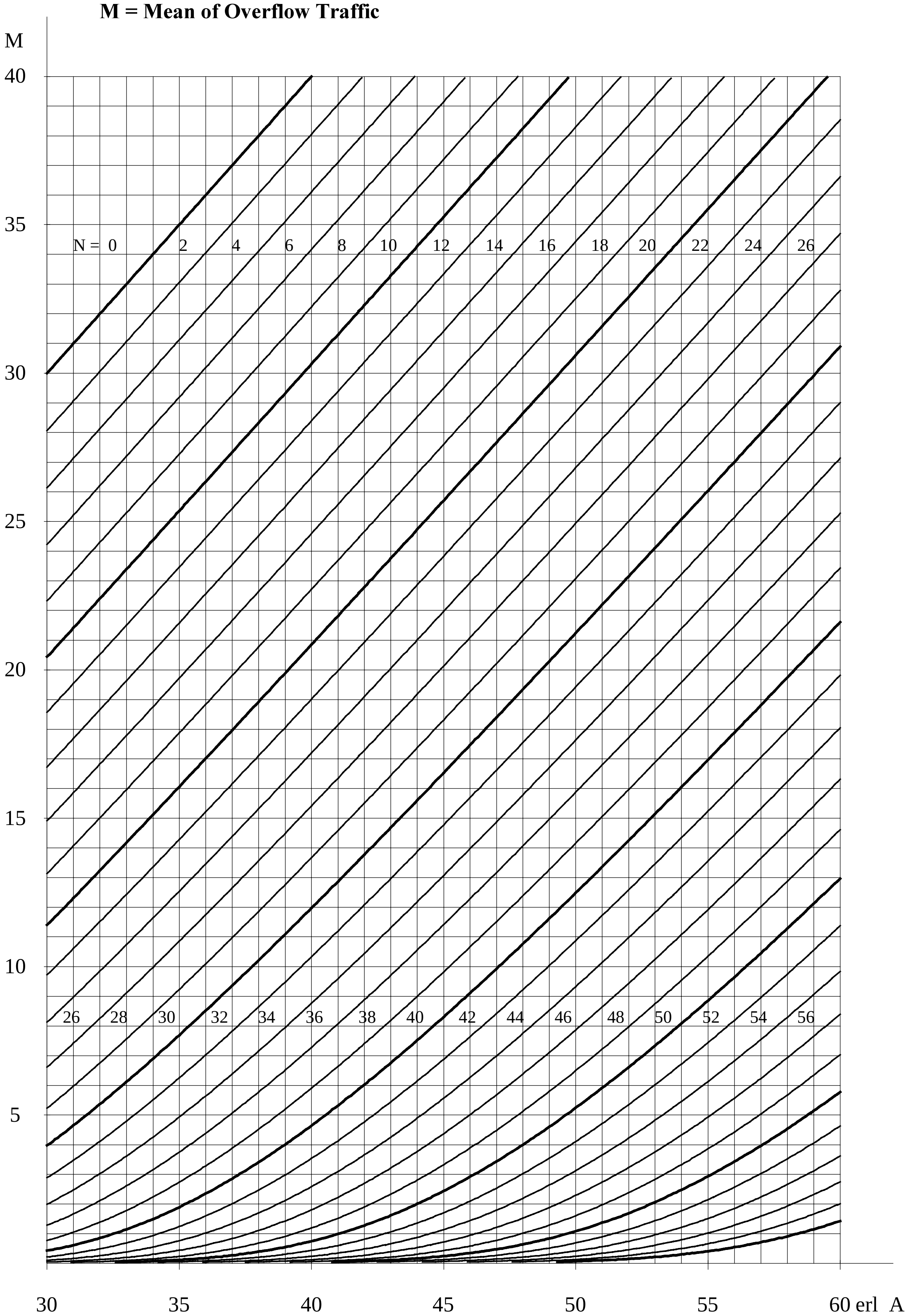
M = Mean of Overflow Traffic



N = Number of lines in direct route

A = Traffic offered to direct route

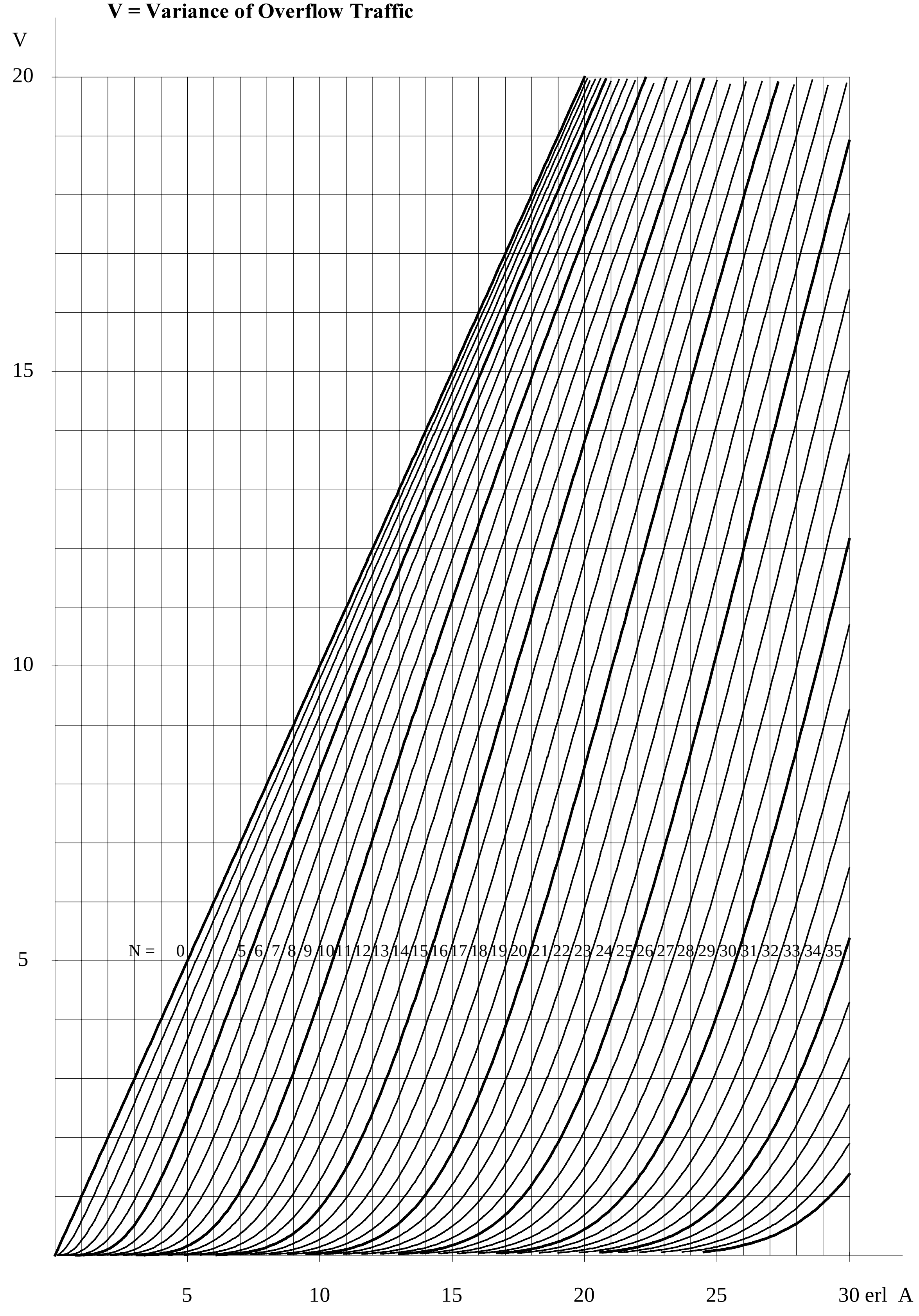
M = Mean of Overflow Traffic



N = Number of lines in direct route

A = Traffic offered to direct route

V = Variance of Overflow Traffic



N = Number of lines in direct route

A = Traffic offered to direct route

V = Variance of Overflow Traffic