EDS NUCLEAR INC.

PROJECT INSTRUCTIONS

TITLE: 5.0 Engineering Criteria/Procedure for the Application of the Blume Curves Crite:

CLIENT / PROJECT: Commonwealth-Edison JOB NO.: 0590-003

REVISION: 0

PREPARED: [signature] 10/19/79
DATE

APPROVED: John McCarthy 10/19/79
DATE

REVISION RECORD

Revision	Date	Prepared	Approved
1	3/7/80	[signature]	T.K. [signature]

1.0 INTRODUCTION

1.1 Purpose

This document provides the engineering criteria for the application of the Blume Curves as shown in Attachment A. The first set of Blume Curves applies to Dresden Unit 2 and 3, and the second set applies to Quad Cities Unit 1 and 2.

1.2 Applicability of the Blume Curves Criteria:

a) Dresden Units 2 and 3: diameter 10" or less piping
b) Quad Cities Units 1 and 2: diameter 8" or less piping for lateral seismic spans spacing.

2.0 INPUT INFORMATION REQUIRED FOR APPLYING THE BLUME CURVES

2.1 Piping Data

- Pipe Size
- Schedule
- Pipe Weight
- Contents
- Insulation

2.2 Piping Isometric with Field Information from Bechtel Walkdown

- Dimensions of piping
- Locations of supports - type and direction
- Weights of valves/flanges
- Piping Class - breaks
- Highest elevation of piping system is required for flexible spans (Attachment A)

3.0 A mathematical model should be drawn for each problem using input information described in 2.2. All support points, branch points, concentrated weight locations, elevations, line number, valve number, and orientation of piping system (N direction) should be properly identified on the Blume mathematical model.

⚠1

4.0 ANALYSIS FOR OBE

4.1 The evaluation of seismic restraints should be performed for all directions; effects of concentrated weight and change in line size should be considered.

4.1.1 Horizontal Direction

The adequacy of seismic restraints of the two perpendicular horizontal directions for OBE can be evaluated directly from the Blume Curves. Both rigid and flexible spans should be considered. In addition to avoiding the resonant range, the seismic stress for Quad Cities 1 and 2 piping should be less than 3700 psi, and the deflection should be less than 2 inches.

For Dresden 2 and 3 piping, the deflection criteria $\frac{L}{480}$ plotted on the Deflection Curves limits the allowable span.

Building amplification is considered in the Quad Cities Blume Criteria by multiplying restraint loads, stresses, and deflections by 3 for piping located at elevation 579 feet and above. This amplification is included in the Blume Curves for Dresden , so that the multiplication factor for higher elevations does not apply. △1

4.1.2 Vertical Direction

The Blume Criteria states that the Y-direction seismic restraints provide sufficient support when the piping system is adequately supported for gravity. However, when the piping is principally supported by spring hangers, additional vertical supports may be required to assure that seismic bending stresses do not exceed 3700 psi.

Table 1 gives the maximum spans for vertical rigid supports as a function of pipe size. These spans are based on a vertical deflection of 1 inch and vertical ground acceleration of .1g. The stresses for the given spans are limited to the level established by Quad Cities Blume Curve Criteria (3700 psi), based on S.I.F. of 2.4.

4.2 When the as-built restraints on the piping system have been evaluated to be inadequate, additional supports would be designed such that the Blume Curve Criteria is met. The thermal criteria as provided in Project Instruction 10.0 should be applied while adding seismic restraint to the piping system. △1

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5.0 Support Location Requests for new supports are transmitted to EDD after approval by the Project Engineer.

6.0 The deflection, seismic stress (for Quad Cities piping only), and frequency corresponding to the new span lengths should be documented. The attached summary should be used to document support loads and displacements.

7.0 Calculation of Restraint Design Loads for X, Y, and Z direction should include the concentrated weights contributions. Support loads due to vertical seismic response can be calculated by taking 10% of the loads due to deadweight. 1

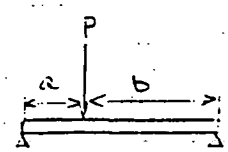
8.0 Analysis for DBE is similar to that of OBE. DBE deflection and restraint loads are twice those read from the design curves and all concentrated weights are doubled.

TABLE 1 REV. 1

VERTICAL SEISMIC SPAN
FOR BLUME PIPING

Pipe Size	Pipe Schedule	Maximum Seismic Span* (ft.)
$2\frac{1}{2}$	80	40
4	80	49
6	80	60
8	80	68
10	80	75
$2\frac{1}{2}$	40	39
4	40	48
6	40	58
8	40	65
10	40	72

* SEISMIC SPAN w/ CONCENTRATED WEIGHT CAN BE CALCULATED BY THE FOLLOWING EQN:



1. $\Delta = \frac{[illegible] L^3}{EI} (P + .625 wL) \leq 1$ in.

2. Check of stress is $\leq$ 2700 psi $\Rightarrow \sigma_i = \left(\frac{6wa(L-a)}{Z} + \frac{12Pab}{LZ} \right)$

units: a, b, L = ft. Δ = in. σ = psi w = lb/ft P = lb. E = psi I = in^4 Z = in^3

ITEM Engineering Criteria [illegible] for the Application of [illegible] Curve Criteria	CLIENT CECO
	PROJECT QUAD CITIES & DRESDEN
	JOB NO. 0590-003
BY KWJ DATE 3/11/80 CKD. A/I DATE 3/11/80	ITEM NO. SHT. 5 OF 5

eds nuclear

Reanalysis of Blume Piping

Seismic Span Evaluation For Added Support

Blume Criteria: ____________ pipe, schedule ______

Span length ____ ft. RIGID
Span length ____ ft. FLEXIBLE

* With concentrated weights,

Span length required _____ ft. RIGID

Piping From	Piping To New Restraint	Excitation Direction	Period (Sec.)	Span Length (ft.)	Deflection (in.)	Stress (psi)

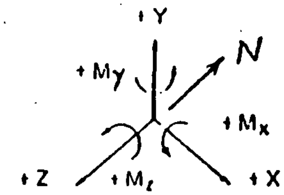
Math Model No.: ____________ Reference Sketch: __________
Line No.: ____________

ITEM Project instructions S.O Attachment 1 Page 1	CLIENT
	PROJECT
	JOB NO.
BY / DATE / CKD. / DATE	ITEM NO. / SHT. OF

SUMMARY OF LOADS AND MOVEMENTS AT PIPE SUPPORTS

NOTE. All loads act *on* the pipe at data points; positive directions are shown at right.

References:



Data Point Number	Support Type (See Code Below)	LOADS (Lbs. or Ft. - Lbs.) Component	Thermal	Seismic	Gravity							DISPLACEMENTS (In.) Component	Thermal	Seismic		
		F_x										Δx				
		F_y										Δy				
		F_z										Δz				
		M_x														
		M_y														
		M_z														

Remarks

		F_x										Δx				
		F_y										Δy				
		F_z										Δz				
		M_x														
		M_y														
		M_z														

Remarks

SH (Spring Hanger), X/Y/Z STOP (Rigid Restraint), X/Y/Z SNUBBER (Seismic Restraint), ANCHOR, FICTITIOUS ANCHOR

DATE	REVISION	BY	CKD
0			

CLIENT CECo
PROJECT Dresden Unit 2
Project Instruction 5.0 Attachment
JOB NO. 0590-003
PROB. NO.
Rev 1.

EDS NUCLEAR: 220 MONTGOMERY STREET • SAN FRANCISCO, CALIFORNIA 94104

(4) New field [illegible] during walkdown	3	11	[illegible]3	[illegible]1
(5) Number of inoperable supports (number requiring repair)	5 (0)	3 (0)	52 (16)	37 (9)
(6) Number of missing supports identified	6	2	1	0

b. <u>EDS Evaluation</u>

(1) Estimated number of calculations:				
• Dynamic analysis	27	27	9	9
• Static coefficient analysis	0	0	23	23
• Blume curve analysis	48	48	34	34
(2) Number Evaluated:				
• Dynamic analysis	8	0	0	0
• Static coefficient analysis	0	0	7	0
• Blume curve analysis	23	13	9	3

ENG. FILE 016192

cc: J. E. Love
R. S. Cile
E. O. Swain
LB (KGH)
File 06.89

July 17, 1968

R. P. Barr
Requisition Engineering
MC 377

Subject: DRESDEN 2 & 3 SEISMIC EVALUATION OF CLASS I PIPING SYSTEMS

Lateral deflection and force evaluation curves for piping systems have been developed by John A. Blume and Associates for Class I piping. The curves provide approximate guidelines for the evaluation of the lateral supports in a piping system. The pipes are considered filled with water and the wall thickness or schedule number is shown on the graph. The modulus of elasticity is 29×10^6 psi. The curves are based on a single span with pinned-pinned end conditions.

The use of the piping curves are as follows:

1. Knowing the period of the supporting building or structure we can establish the period of the piping as to when it is rigid, flexible or resonant.

2. We can establish the maximum spans for various diameters of piping to carry a load of 0.5 g (table I) and not be stressed more than 1500 psi. (See Table 121.4 in Power Piping USAS B31.1.0 1967.)

3. We establish the resonant limits for various diameters of piping by using Blume's curves giving natural periods as a function of pipe size and span. (Plate I and I-A.)

4. After the span has been selected, plates 2 and 3 can be used to determine the deflection and the reaction on the support.

The displacement and support reactions should be increased by a factor three (3) due to magnification of the equipment over ground acceleration.

Spans should be reduced by a factor of two to account for valves or branch lines. For 90-degree bends, either leg shall not be more than L/2 where L is the sum of the spans for both legs.

Supports should be located in a manner so as to be out of the resonant range. From the table of spans for various size pipes which limits the stress to 1500 psi, an estimate of the stress for the above acceleration values can be made.

Classification of Piping by Natural Period

Rigid System: $\frac{Tb}{Tp} \geq 2.0$ (Tb = 0.17 sec) — for both turb & reactor bldg. conc. portion

$$Tp \leq \frac{0.17}{2.0} = 0.085 \text{ sec}$$

Resonant System: $0.085 \text{ sec} \leq Tp \leq \frac{0.17}{.7} \text{ sec} = 0.24 \text{ sec}$

Flexible System: $Tp \geq \frac{0.17}{.7} \text{ sec} = 0.24 \text{ sec}$

Tp = .085 sec   Tp = 0.24 sec

Rigid ←|→ Resonant ←|→ Flexible

TABLE I

SPANS FOR VARIOUS DIAMETERS OF PIPING

Nominal Pipe Size	1	1 1/2	2	2 1/2	3	3 1/2	4	5	6	8	10	12	14	16	18	20	24
1.0g Span	7	9	10	11	12	13	14	16	17	19	22	23	25	27	28	30	32
0.5g Span	10	13	14	15	17	18	20	23	24	28	31	33	35	38	40	42	45

Stress = 1500 psi
Seismic Loading: 1.0g and 0.5g

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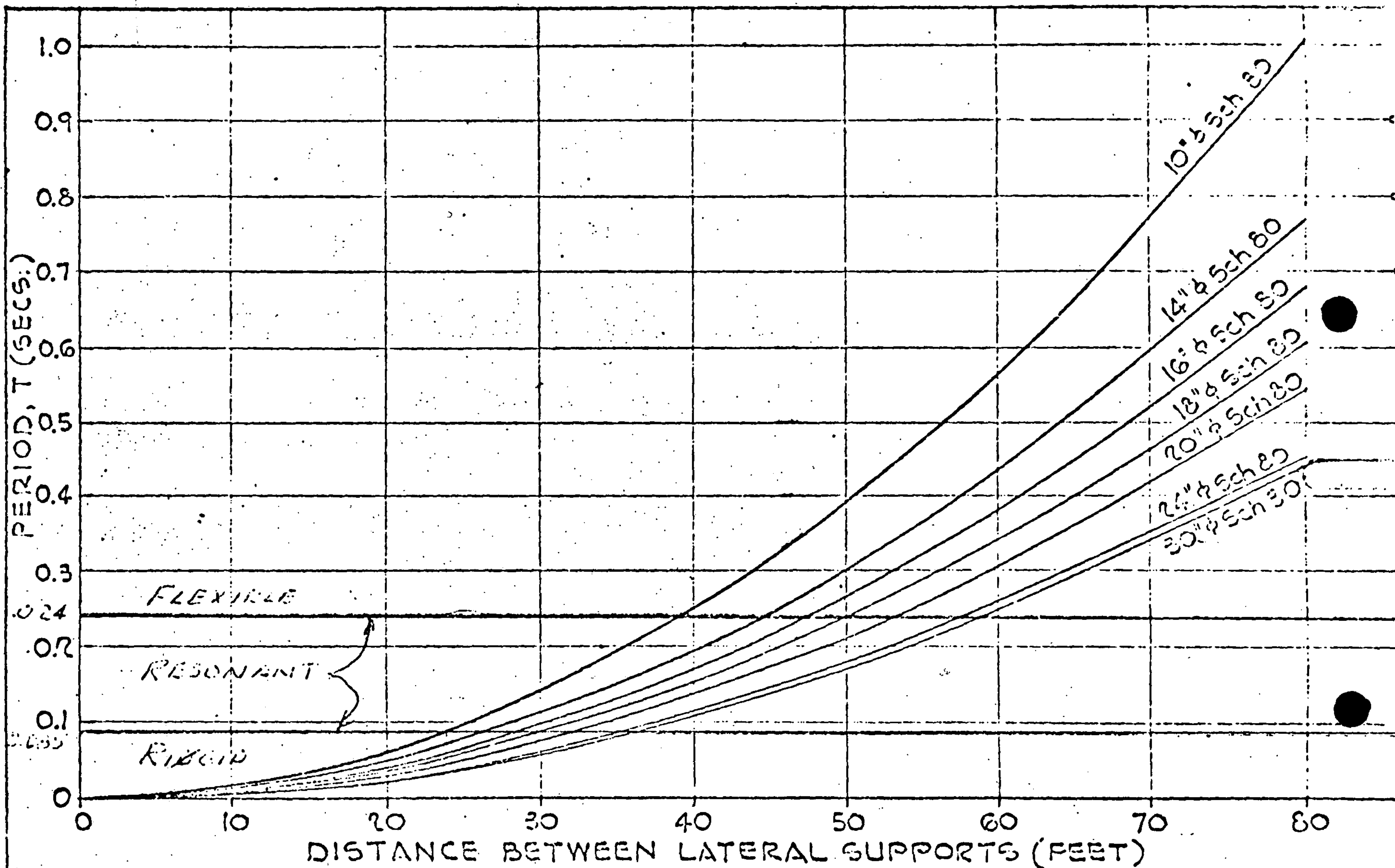
Piping & Structural Design
MC 761 - ext. 3744

DRESDEN 2 AND 3
REACTOR - TURBINE BLDG



NATURAL PERIOD AS A FUNCTION OF PIPE SIZE AND SPAN

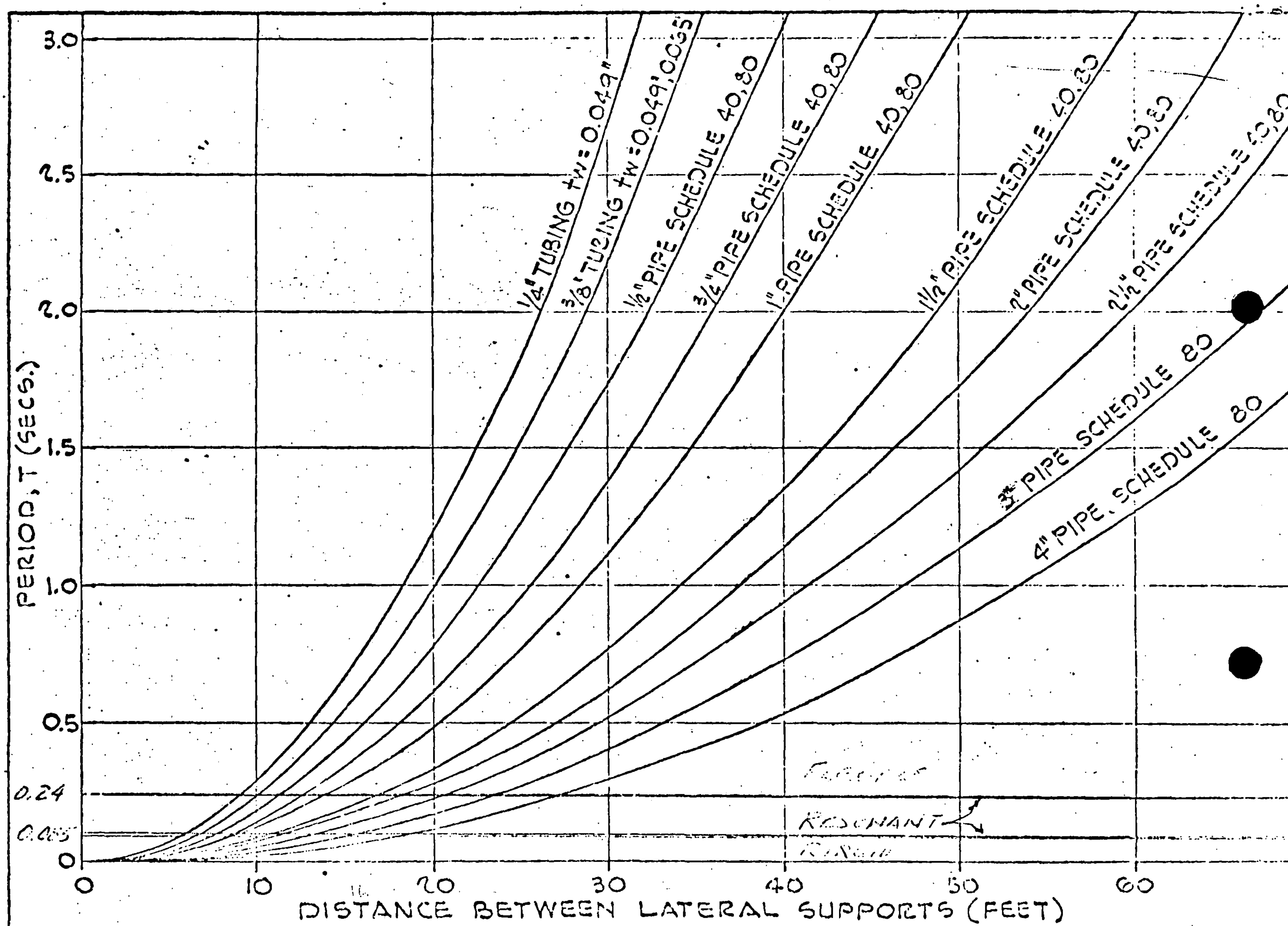
PLATE 1

JOHN A. BLUME AND ASSOCIATES, ENGINEERS
612 HOWARD STREET SAN FRANCISCO

Dresden 2 & 3
Reactor-Turbine Bldg

JOHN A. BLUME AND ASSOCIATES, ENGINEERS

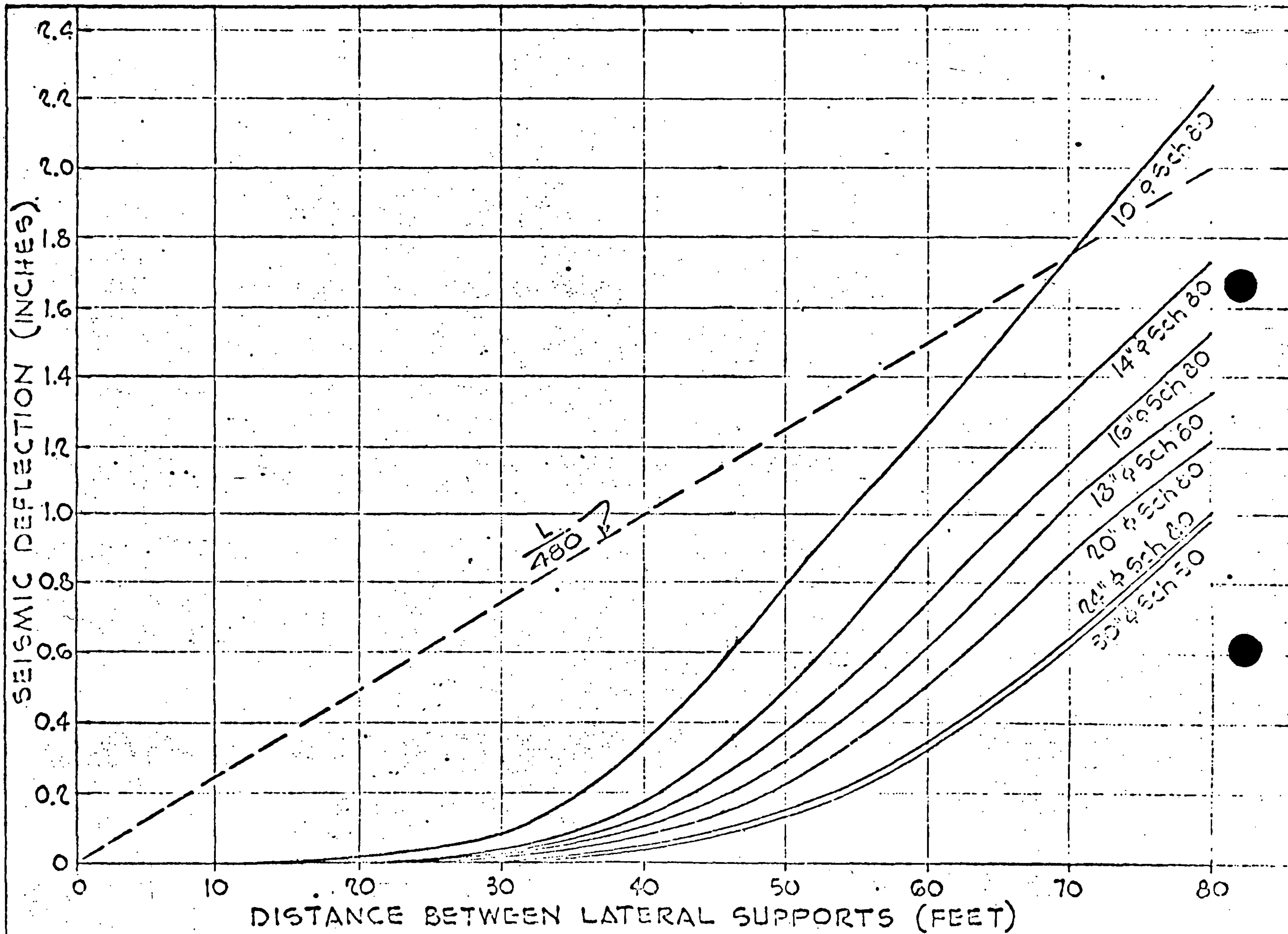
PLATE 1-A



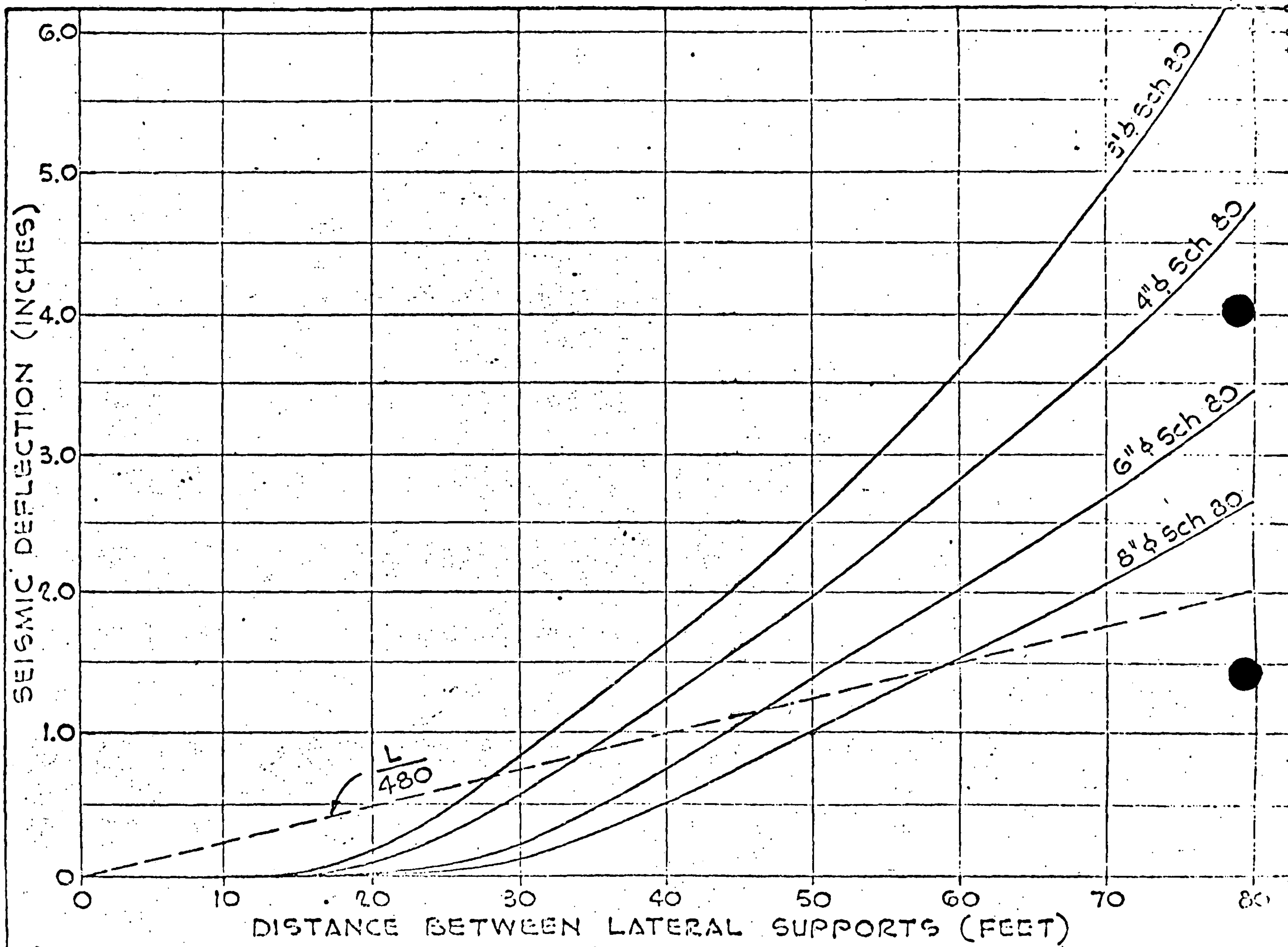
NATURAL PERIOD AS A FUNCTION OF PIPE SIZE AND SPAN

JOHN A. BLUME AND ASSOCIATES, ENGINEERS
612 HOWARD STREET SAN FRANCISCO

PLATE 2



DEFLECTION AS A FUNCTION OF PIPE SIZE AND SPAN



DEFLECTION AS A FUNCTION OF PIPE SIZE AND SPAN

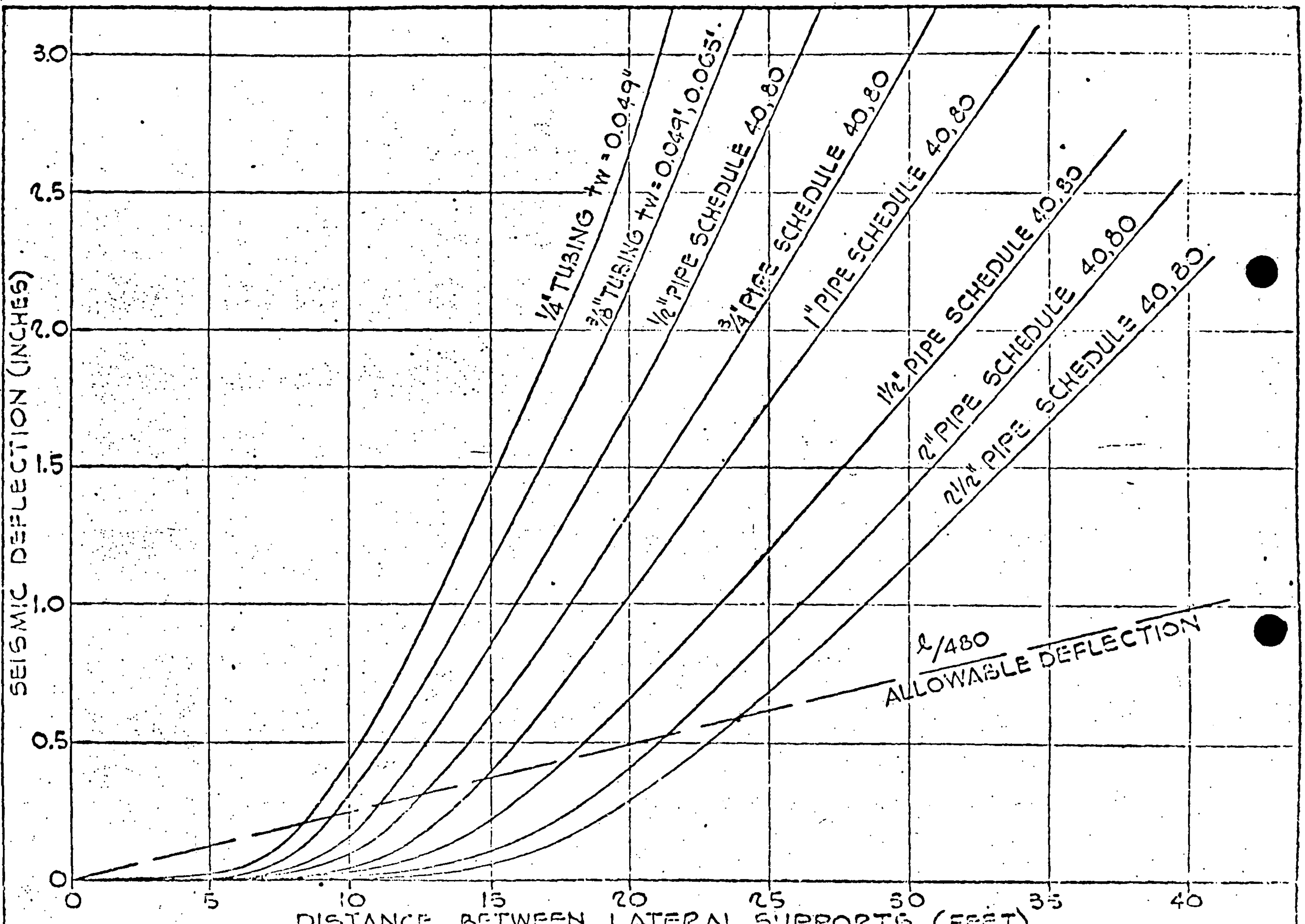
PLATE 2-A

JOHN A. BLUME AND ASSOCIATES, ENGINEERS
612 HOWARD STREET SAN FRANCISCO

JOHN A. BLUME AND ASSOCIATES, ENGINEERS

612 HOWARD STREET

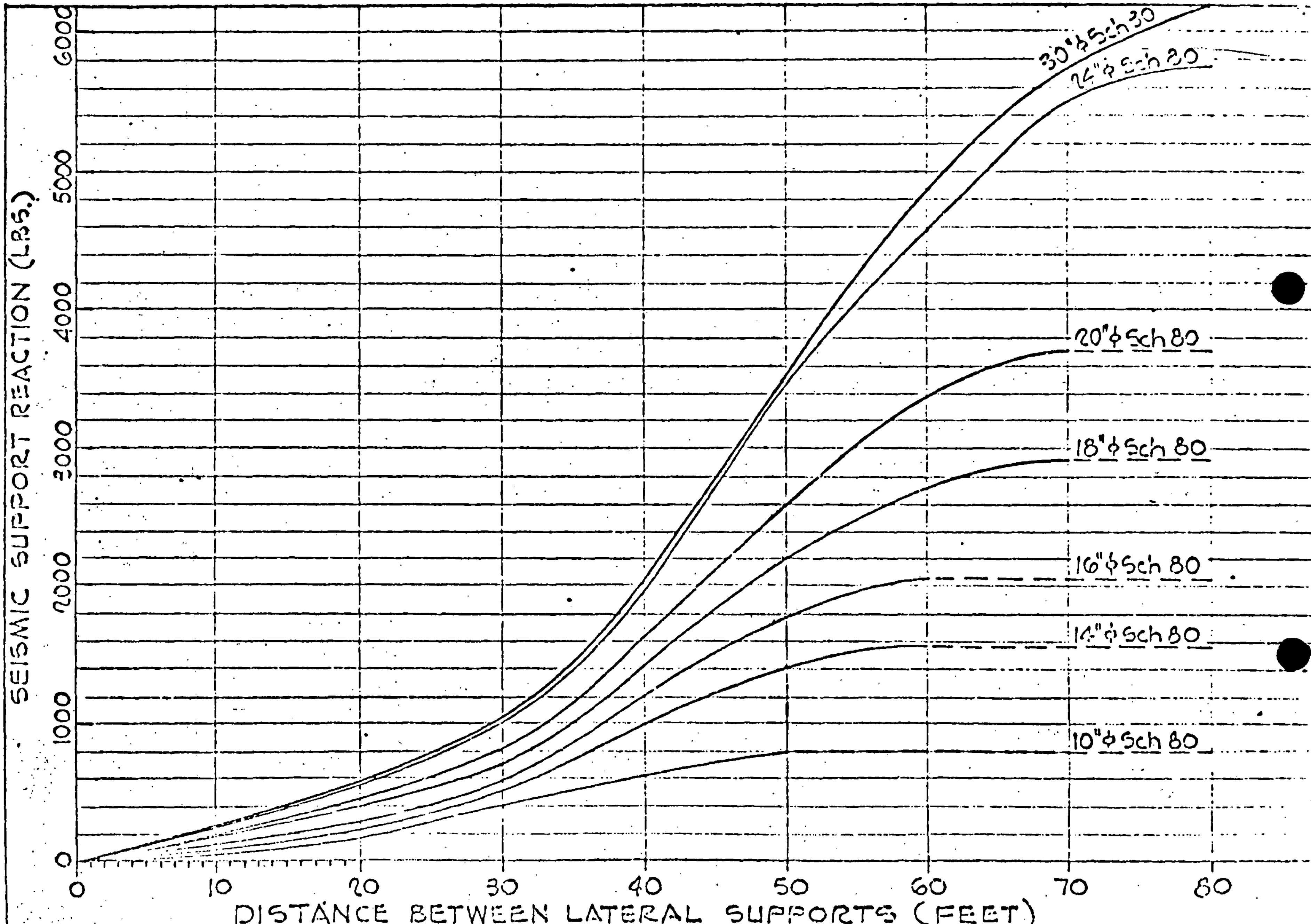
PLATE 2-3



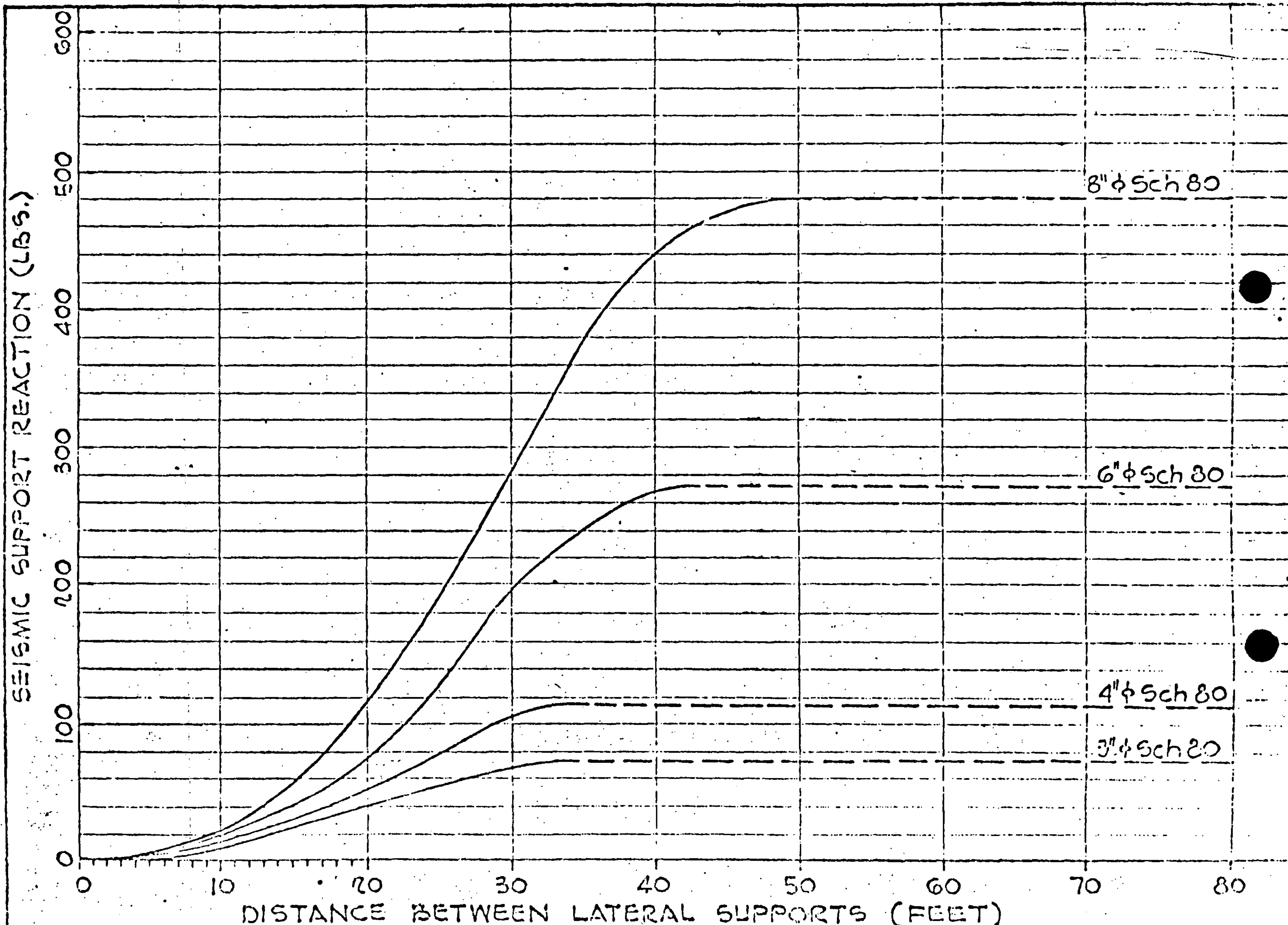
DEFLECTION AS A FUNCTION OF PIPE SIZE AND SPAN

JOHN A. BLUME AND ASSOCIATES, ENGINEERS

PLATE 3



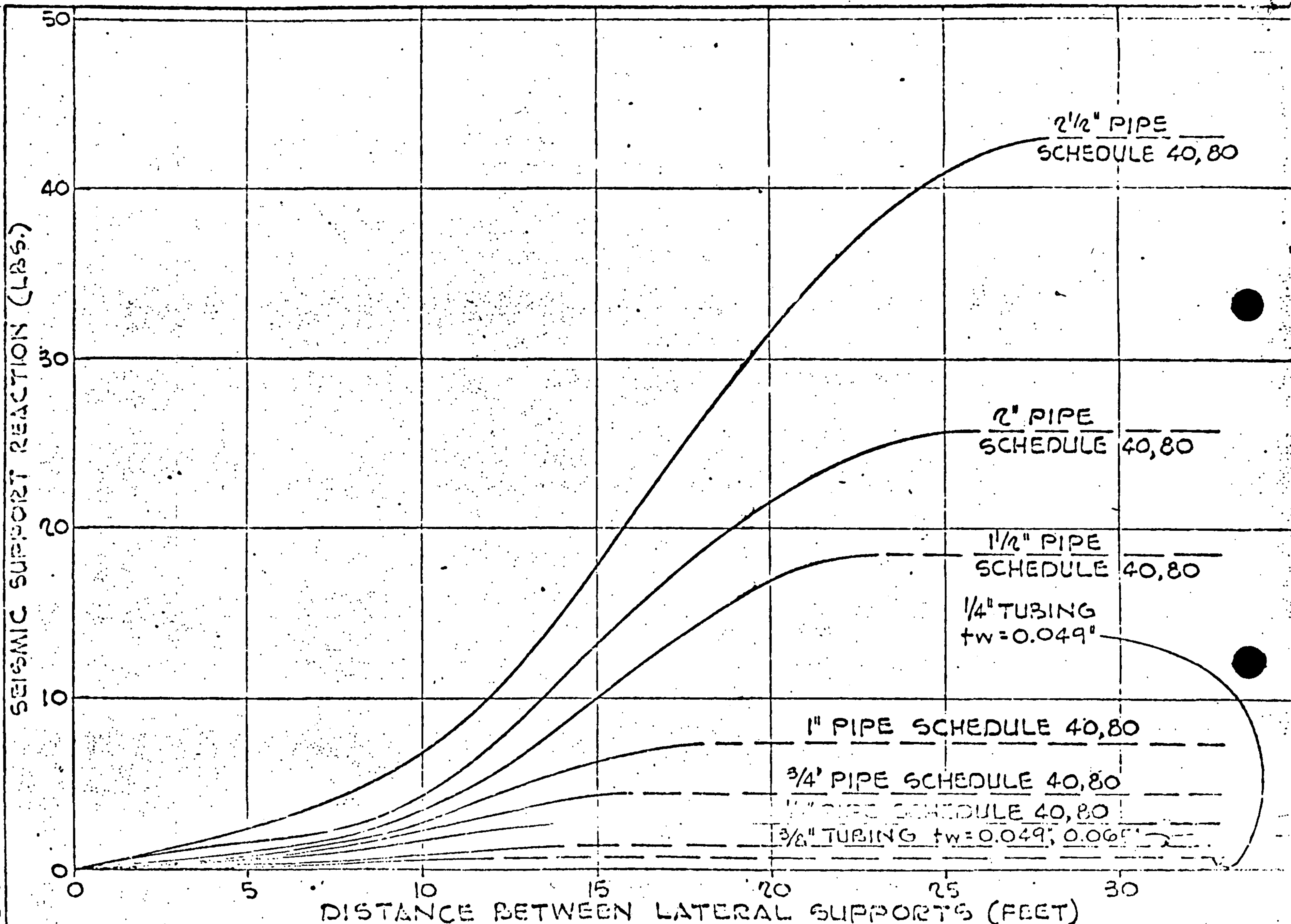
SUPPORT REACTION AS A FUNCTION OF PIPE SIZE AND SPAN



SUPPORT REACTION AS A FUNCTION OF PIPE SIZE AND SPAN

PLATE 3-A

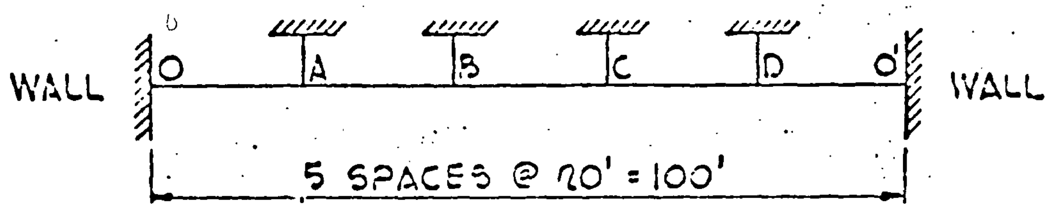
JOHN A. BLUME AND ASSOCIATES, ENGINEERS
612 HOWARD STREET SAN FRANCISCO

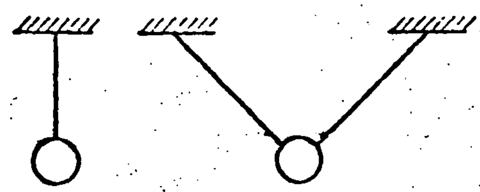


SUPPORT REACTION AS A FUNCTION OF PIPE SIZE AND SPAN

PLATE 3.5

JOHN A. BLUME AND ASSOCIATES, ENGINEERS
612 HOWARD STREET SAN FRANCISCO





SCHEMATIC DIAGRAM OF SUPPORTS

GIVEN: PIPING SYSTEM AS SHOWN.

REQUIRED: EVALUATION OF MAXIMUM SPAN, OF NATURAL PERIOD, OF DEFLECTION, AND OF SUPPORT REACTIONS OF PIPING UNDER LATERAL LOAD.

SOLUTION:

LATERAL SUPPORTS: SUPPORTS A & C PROVIDE NO LATERAL RESTRAINT HENCE ARE NOT PERTINENT TO THIS ANALYSIS. LATERAL RESTRAINT IS PROVIDED AT SUPPORTS B & D

DEFLECTION: ENTER PLATE 2 WITH $\ell = 40'$, AND THE CURVE FOR A 14" SCHEDULE 80 PIPE. THIS GIVES A DEFLECTION OF 0.17 INCHES.

PERIOD: ENTER PLATE 1 WITH $\ell = 40'$, AND THE 14" SCHEDULE 80 PIPE CURVE. THIS GIVES T = 0.19 SECONDS.

REACTIONS: ENTER PLATE 3 WITH $\ell = 40'$, AND THE 14" SCHEDULE 80 PIPE CURVE. THIS GIVES A SIMPLY SUPPORTED REACTION OF ABOUT 1000 POUNDS.

FOR THE REACTION AT B, MULTIPLY 1000 POUNDS BY TWO.

$$R_B = 2000 \text{ LBS.}$$

FOR THE REACTION AT D, ENTER PLATE 5 WITH $\ell = 20'$ (SPAN DO') AND THE CURVE FOR A 14" SCHEDULE 80 PIPE, AND OBTAIN A VALUE OF 240 POUNDS. ADD TO THIS THE REACTION FROM SPAN BD TO GET R_D.

$$R_D = 240 + 1000 = 1240 \text{ LBS.}$$

THE SUPPORTS SHOULD BE DESIGNED FOR THESE FORCES.

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