CRIEPI's Research Activities on

Fluid-Structure interaction

- Current Status and Future Plan -

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Abstract

This report summarizes the studies of fluid-structure interaction, which have been performed as a part of LMFBR-related research program in CRIEPI. Future program plan starting from FY1987 is also described.

(1) Current Status

(a) Flow-induced vibration of FBR piping system

High velocity of sodium flow (4 ~ 5m/s) is required in the FBR coolant system. The flow-induced vibration behaviors of the complicated piping with high velocity flow inside are made clear by a series of water tests with various numbers and radii of bends.

(b) Flow-induced vibration of IHX tubes

The zigzag flow pattern including cross flow component in tube bundle is expected to improve the heat transfer efficiency of IHX. However, it may develop flow-induced vibration of tubes.
The water vibration test of tubes subjected to the flow including cross flow component have been performed.

(c) Fluid-structure interaction in pool-type reactor vessel

Large free surface of pool-type reactor has a possibility to enlarge seismic sloshing. To examine this,1/40 ~ 1/10-scale tests have been performed. As a result design concept with fluid between reactor vessel and safety vessel is effective for suppression of seismic response. And floating nuclear plant evaluation which aims to spread available site have been examining.

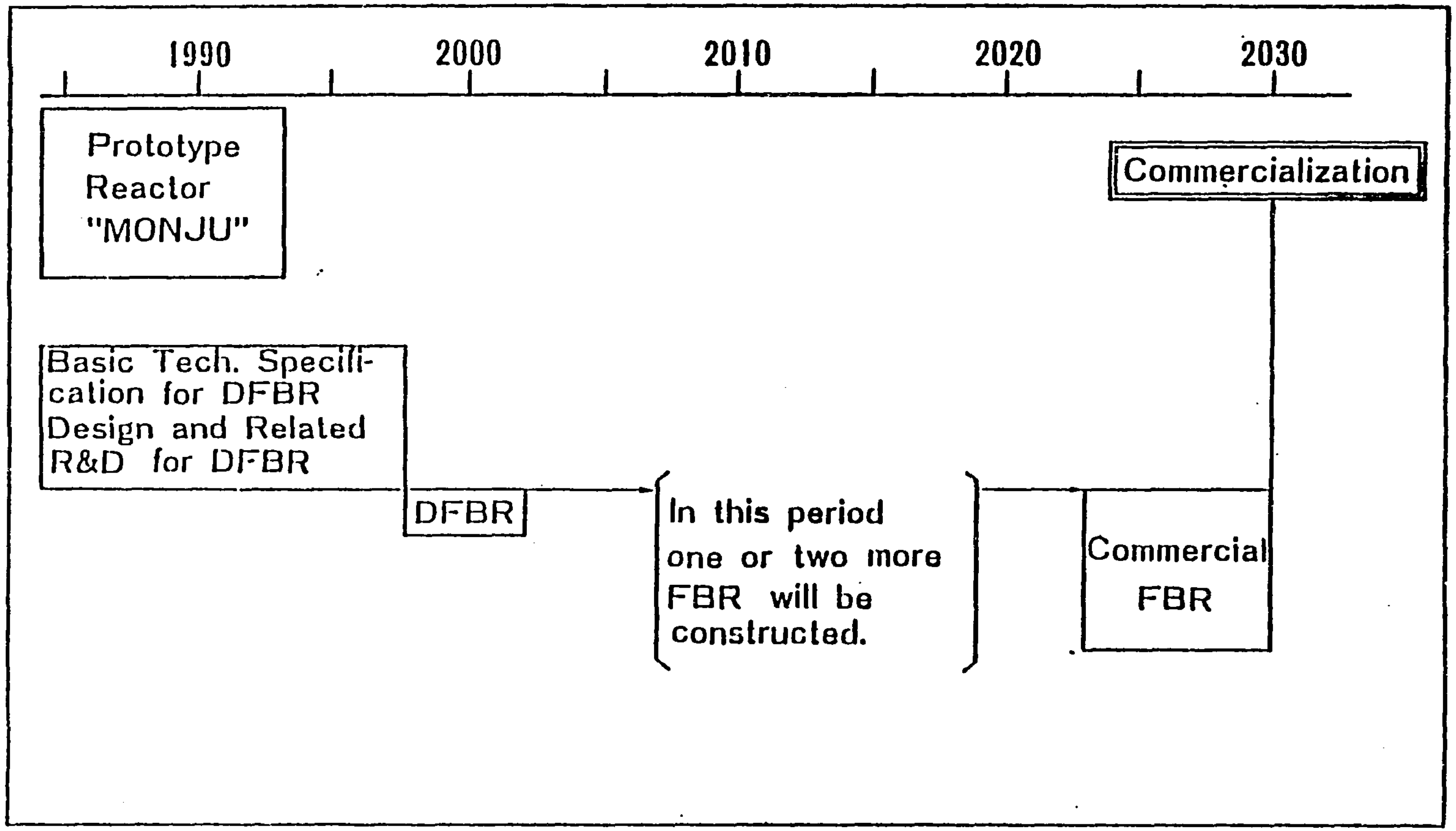
(d) Free surface sloshing and cover gas entrainment

Scaled model thermal hydraulic tests have been performed and there observed large sloshing accompanied with breaking of waves in the large scale test while there did not in the small and middle scale tests.
Similar behavior was observed for the stratified surface. Those results are due to scale effect and interaction with structure.

(2) Future plan

Large scale thermal hydraulic tests and development of analysis code capable of dealing with free surface are scheduled for future research activities.

Position of DFBR on Scenario of FBR Commercialization



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Target for FBR Commercialization

1. Reduction of Construction Cost for Economical Competitor with LWR

2. Concrete Target for FBR Commercialization
   (1) Electricity Cost : Less than LWR
   (2) Construction Cost : Less than 1.1 Times of LWR
   (3) Burn up : More than 150,000MWD/T

3. Target of DFBR
   (1) Construction Cost : Less than 1.5 Times of LWR
   (2) Safety : Same Level as LWR
   (3) Operability & Maintenability : Same Level as LWR

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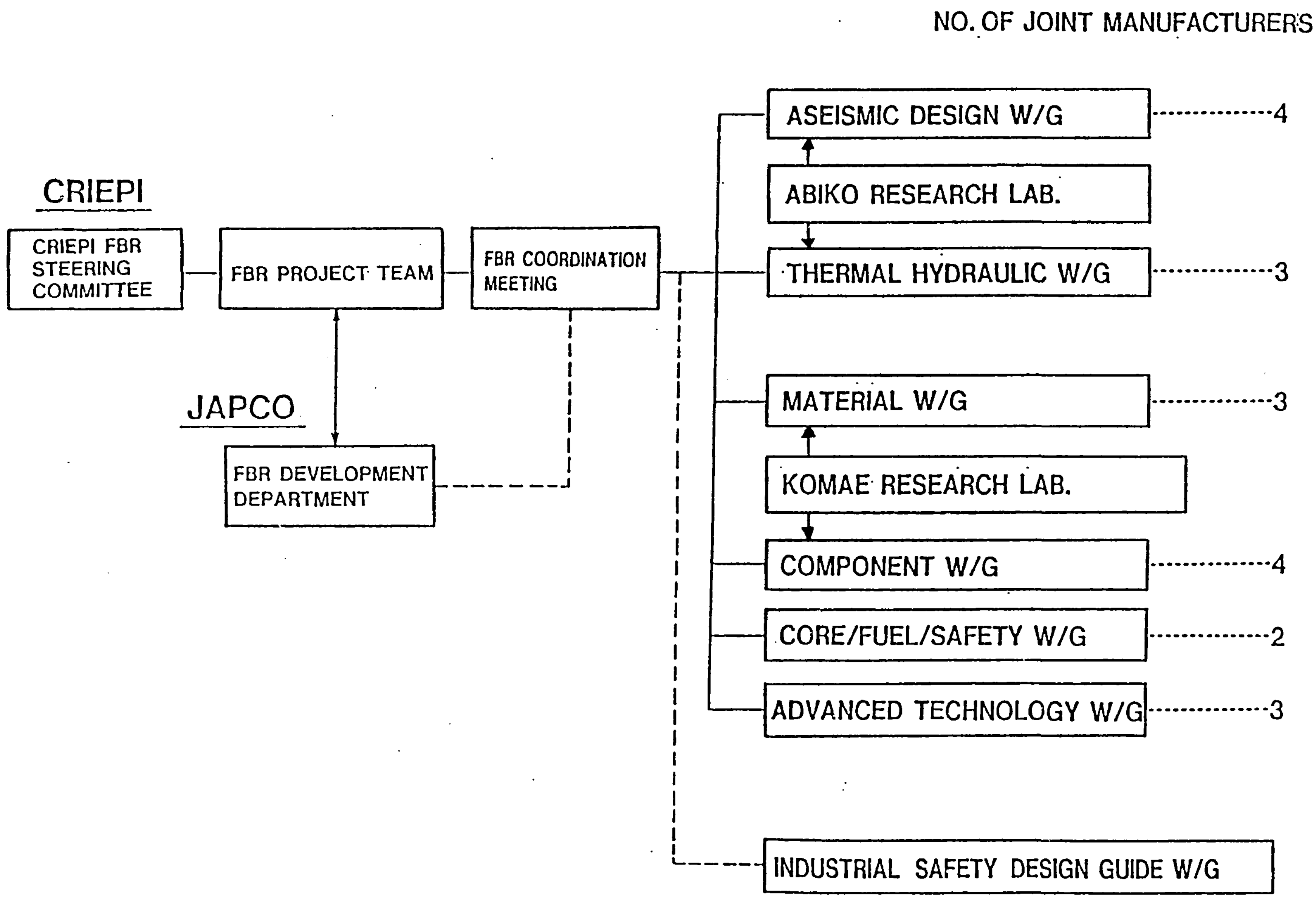
CRIEPI STRUCTURE FOR LMFBR WORKS

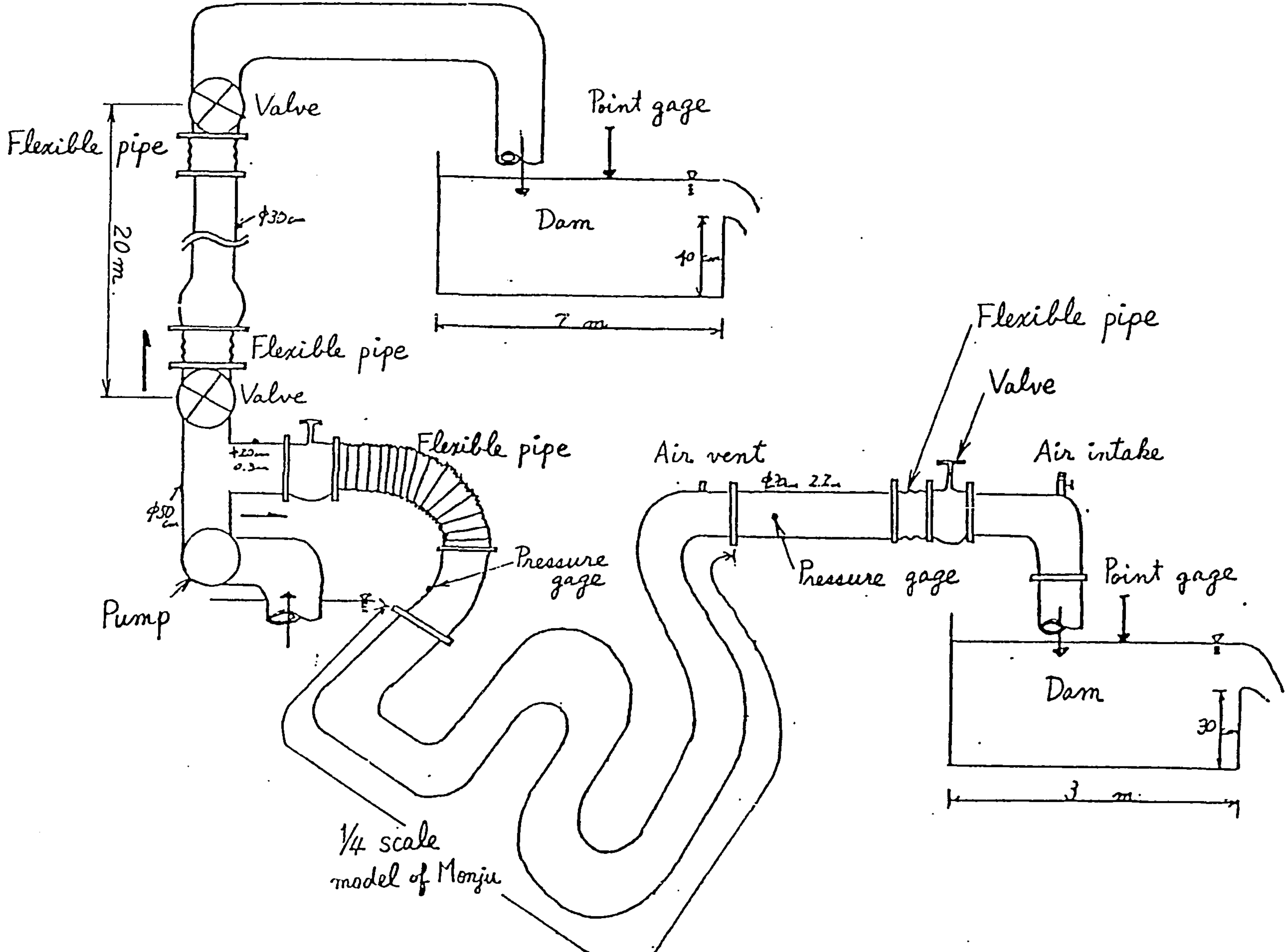


BUDGET FOR CRIEPI LMFBR WORKS

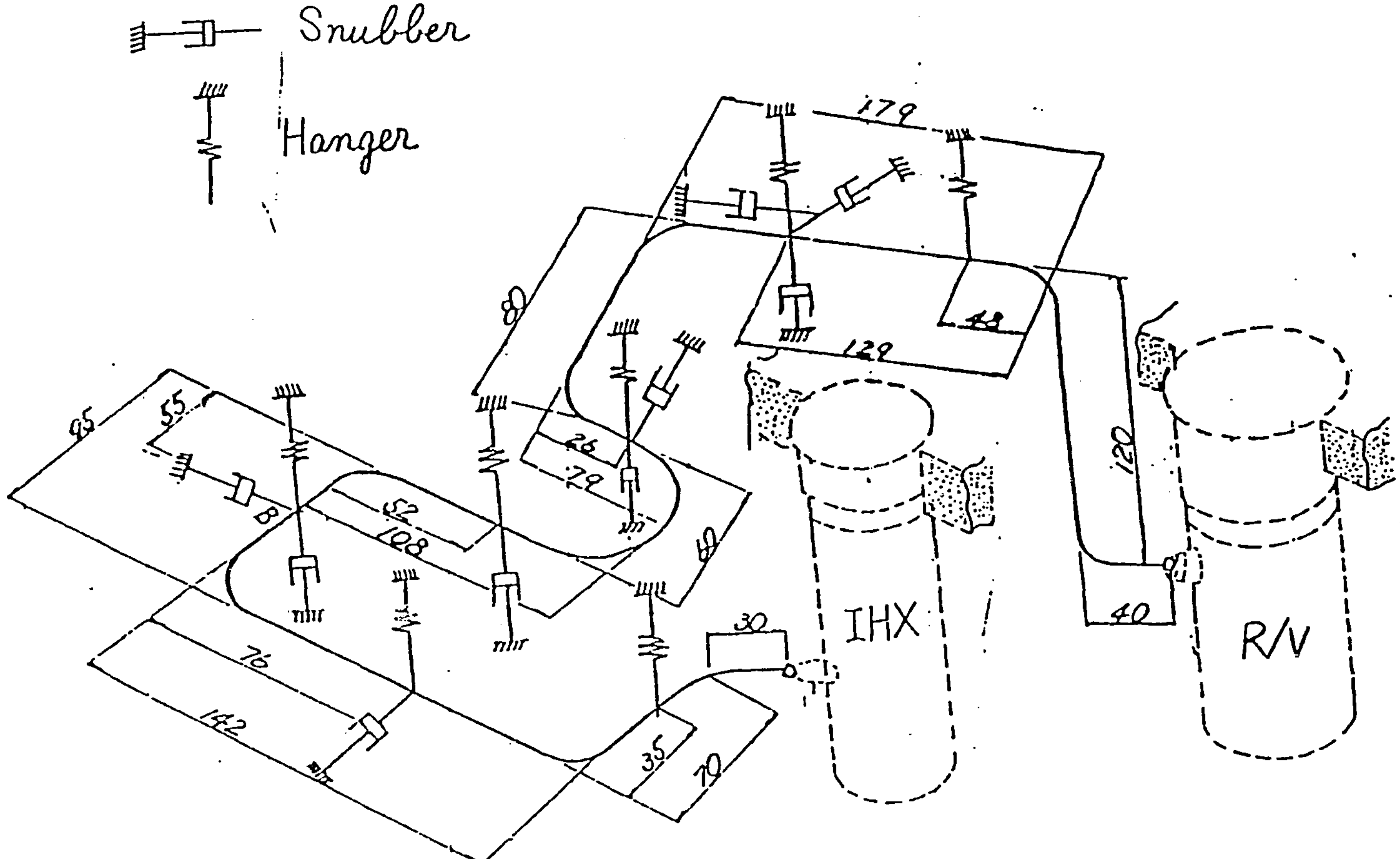
(JFY-'84~-'86)

UNIT : M¥

ITEMS	'84	'85	'86	SUM
CRIEPI FUND	1,600	2,100	2,200	5,900
JOINT MANUFACTURERS FUND	1,100	1,600	1,600	4,300
TOTAL	2,700	3,700	3,800	10,200

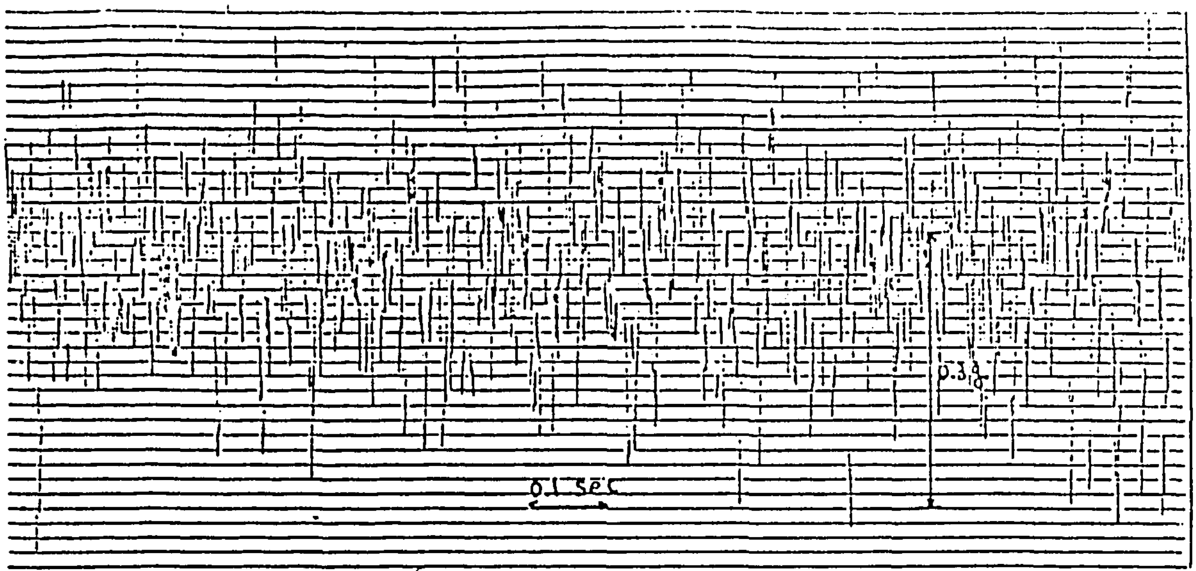


Outline of test apparatus

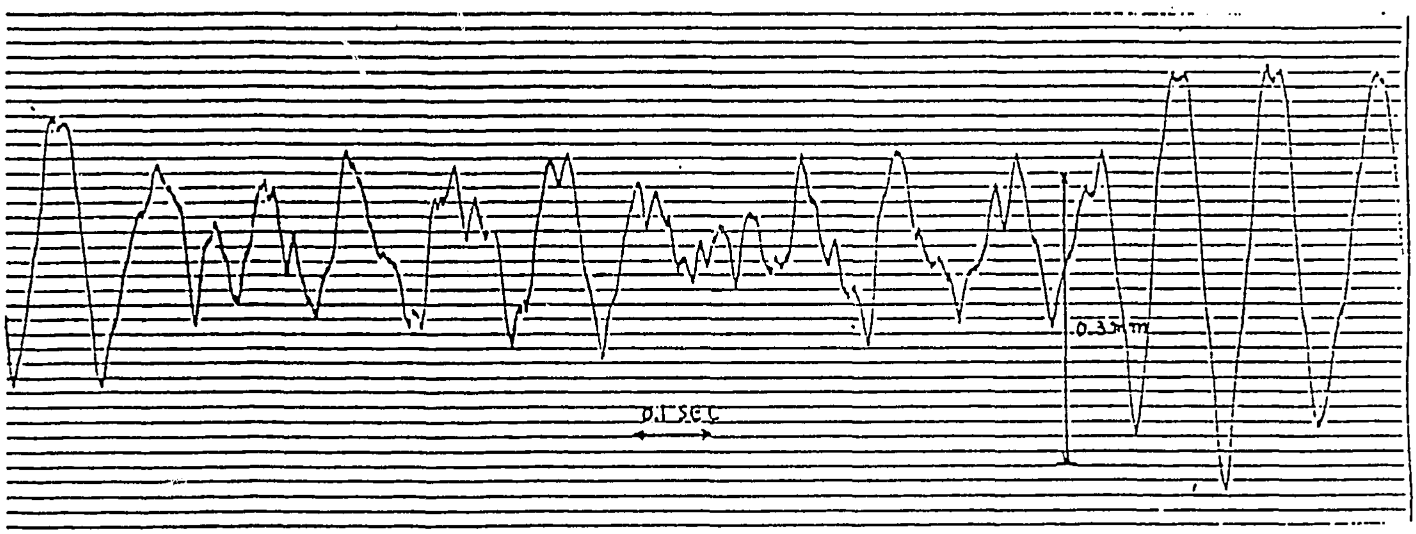


Unit : cm

Primary Piping (Hot Leg)

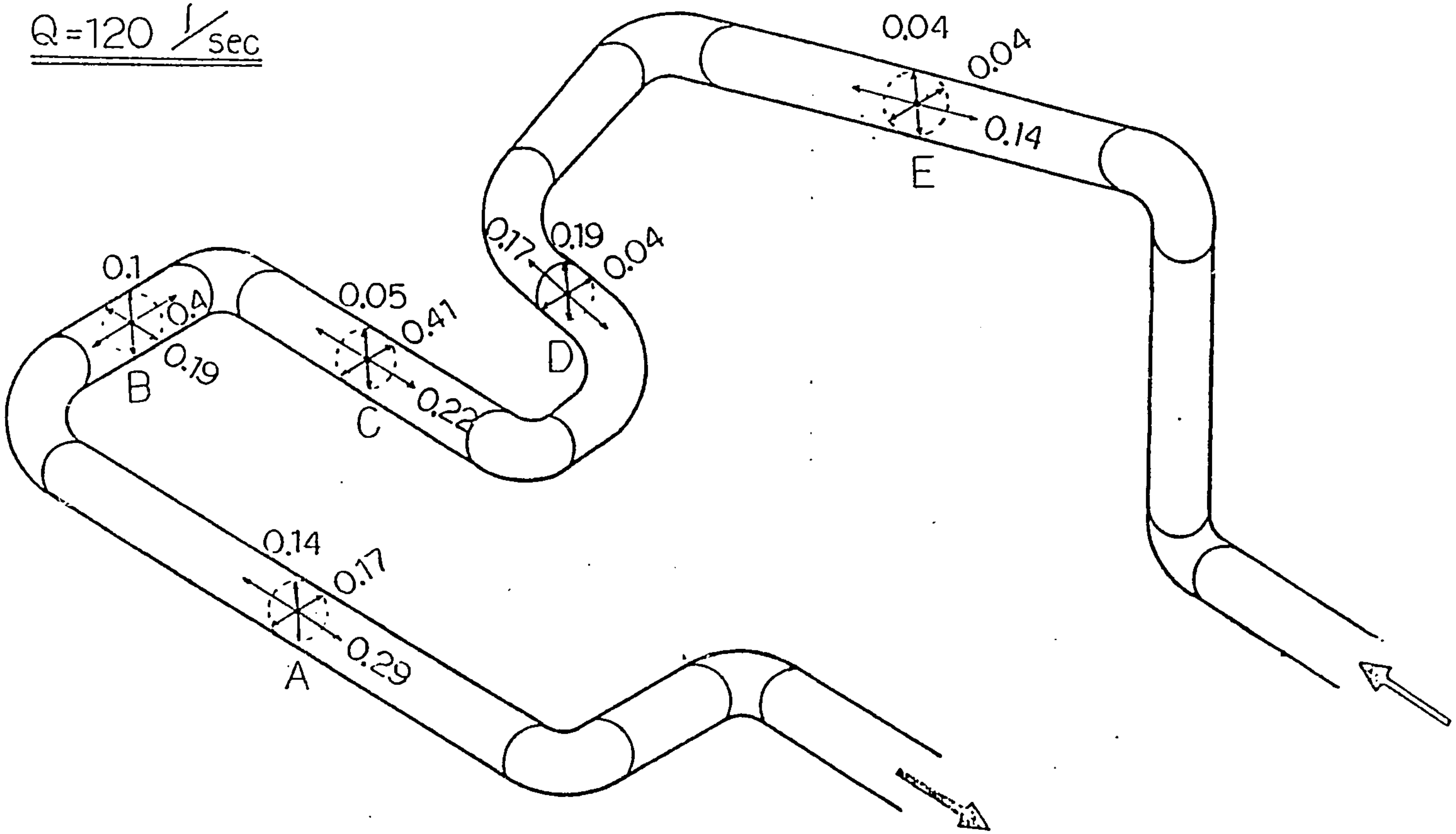


a) Accerelation



b) Displacement

		Flow Direction			
Flow %/x	Location	Max. Accel. g	Frequency Hz	Max. Disp. mm	Frequency Hz
1.00	B	0.57	10	0.14	8



(Velocity : 3.8m/see)

unit (mm)

Vibration Characteristics on piping wall

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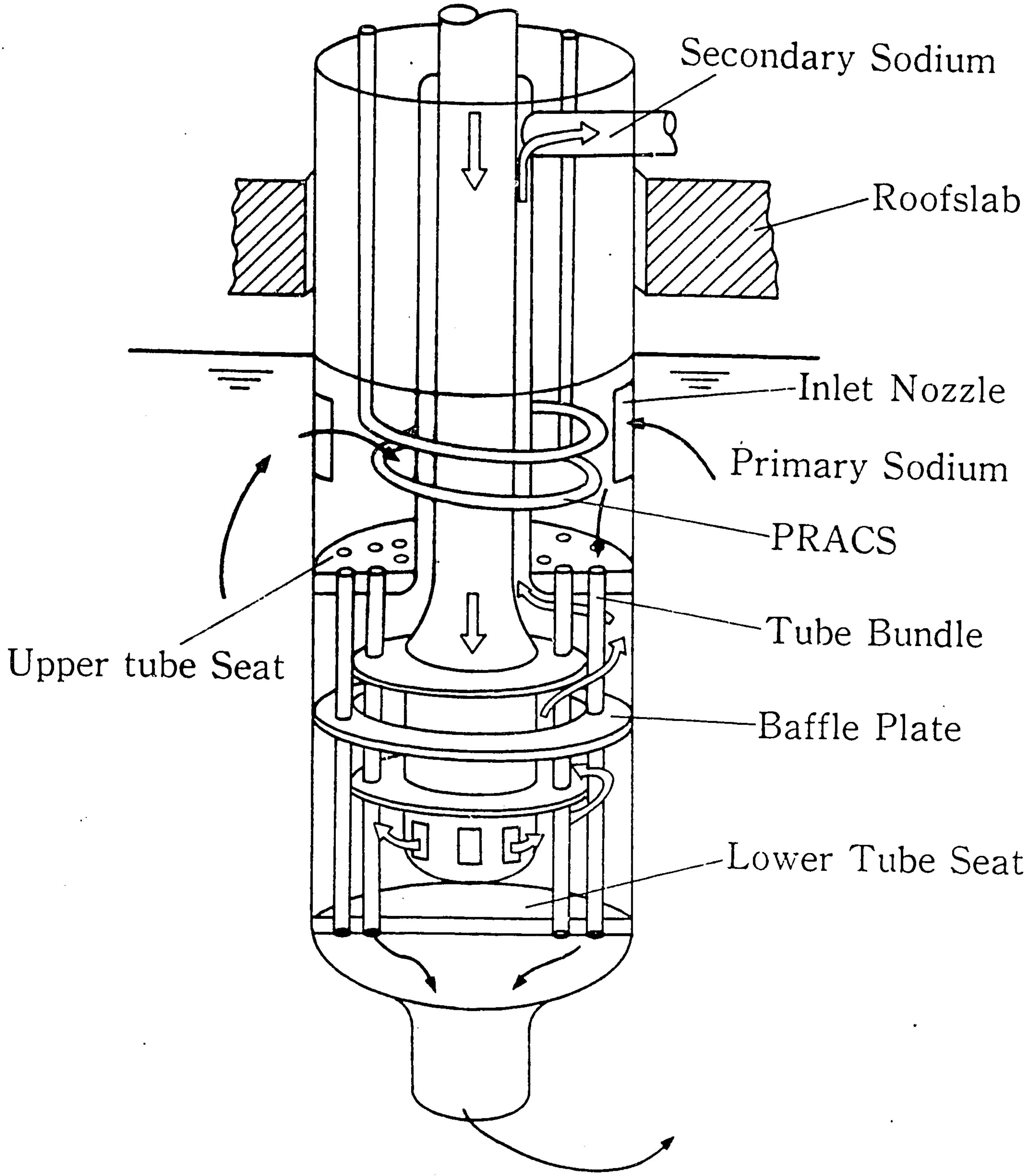
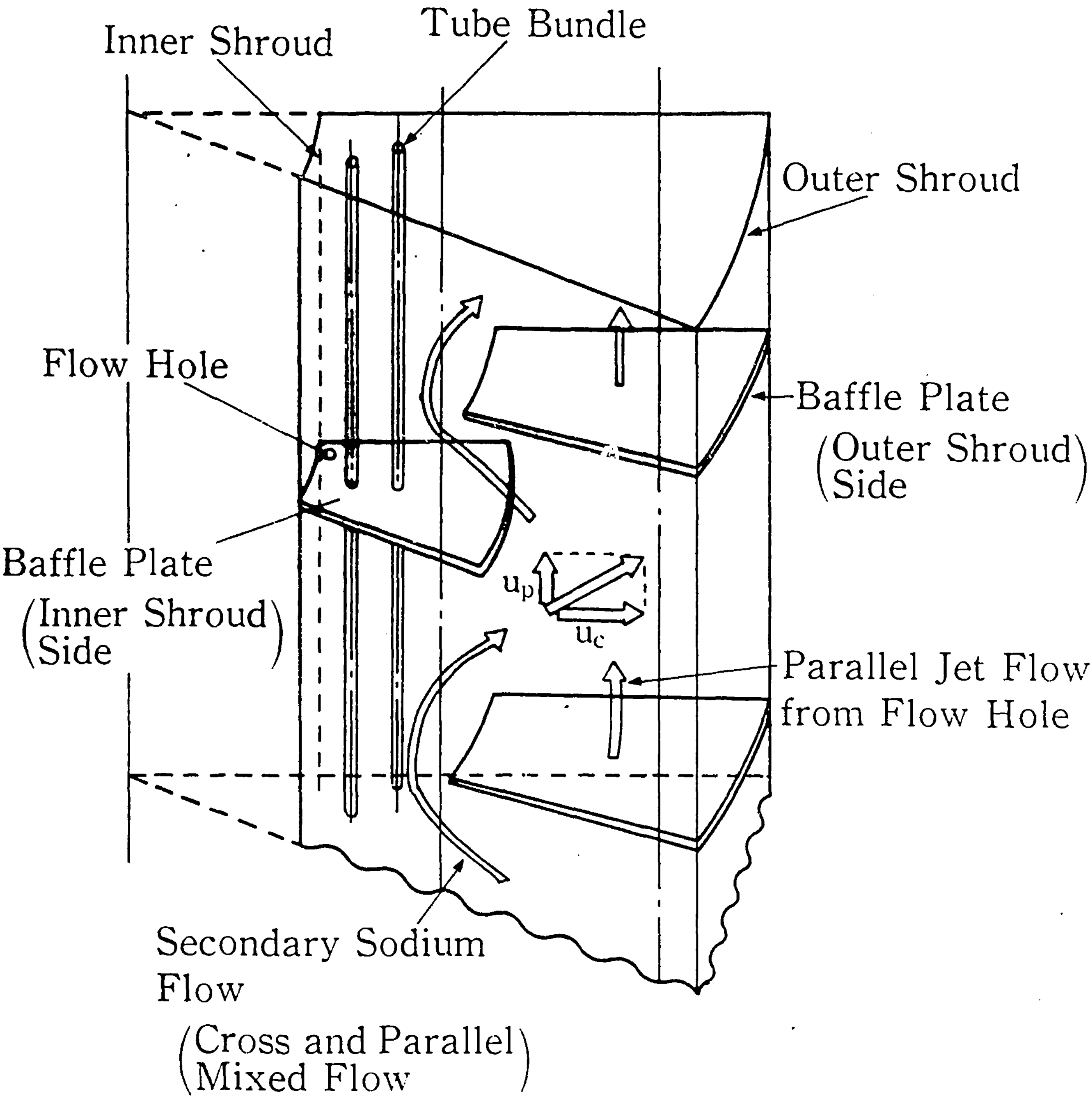
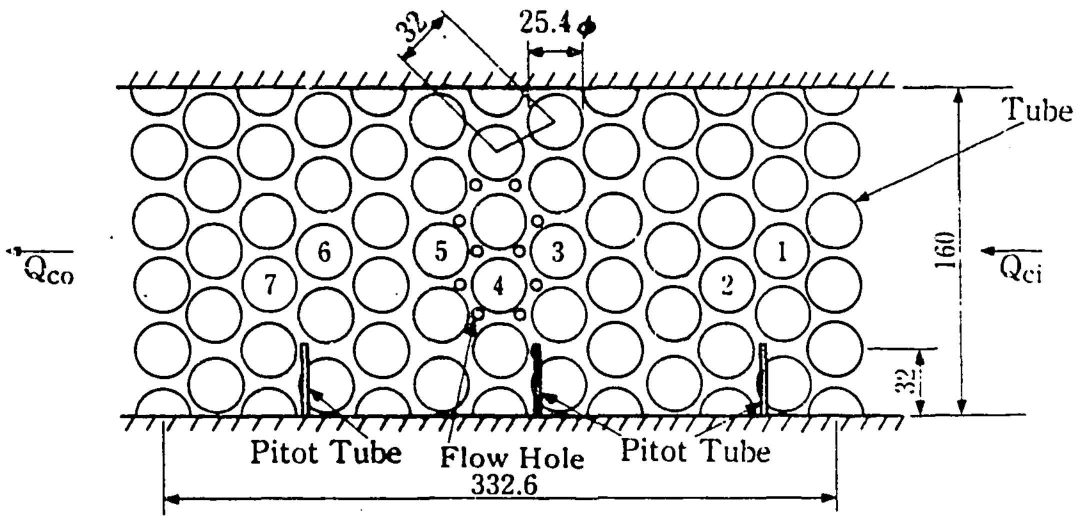


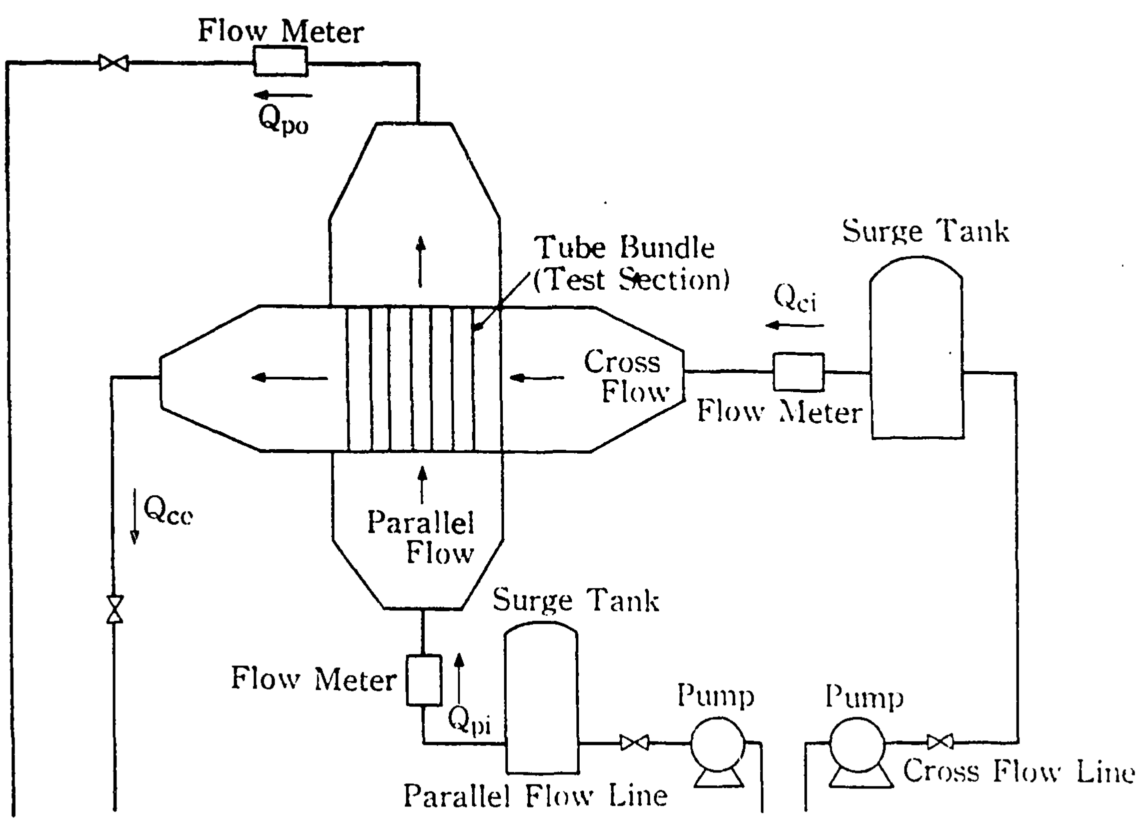
Intermediate Heat Exchanger (IHX)



Secondary Sodium Flow Pattern in Tube Bundle of IHX

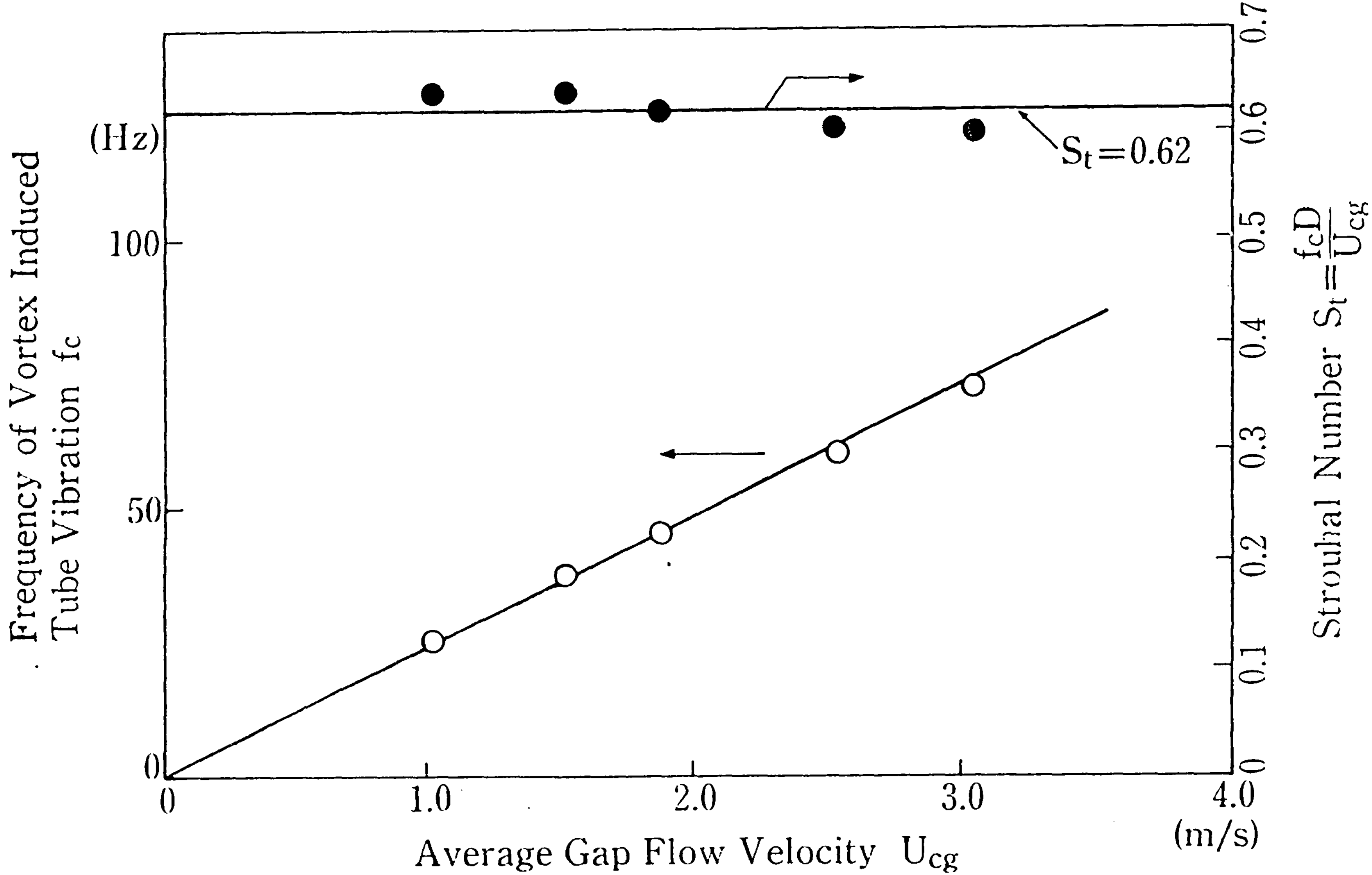


Test Section

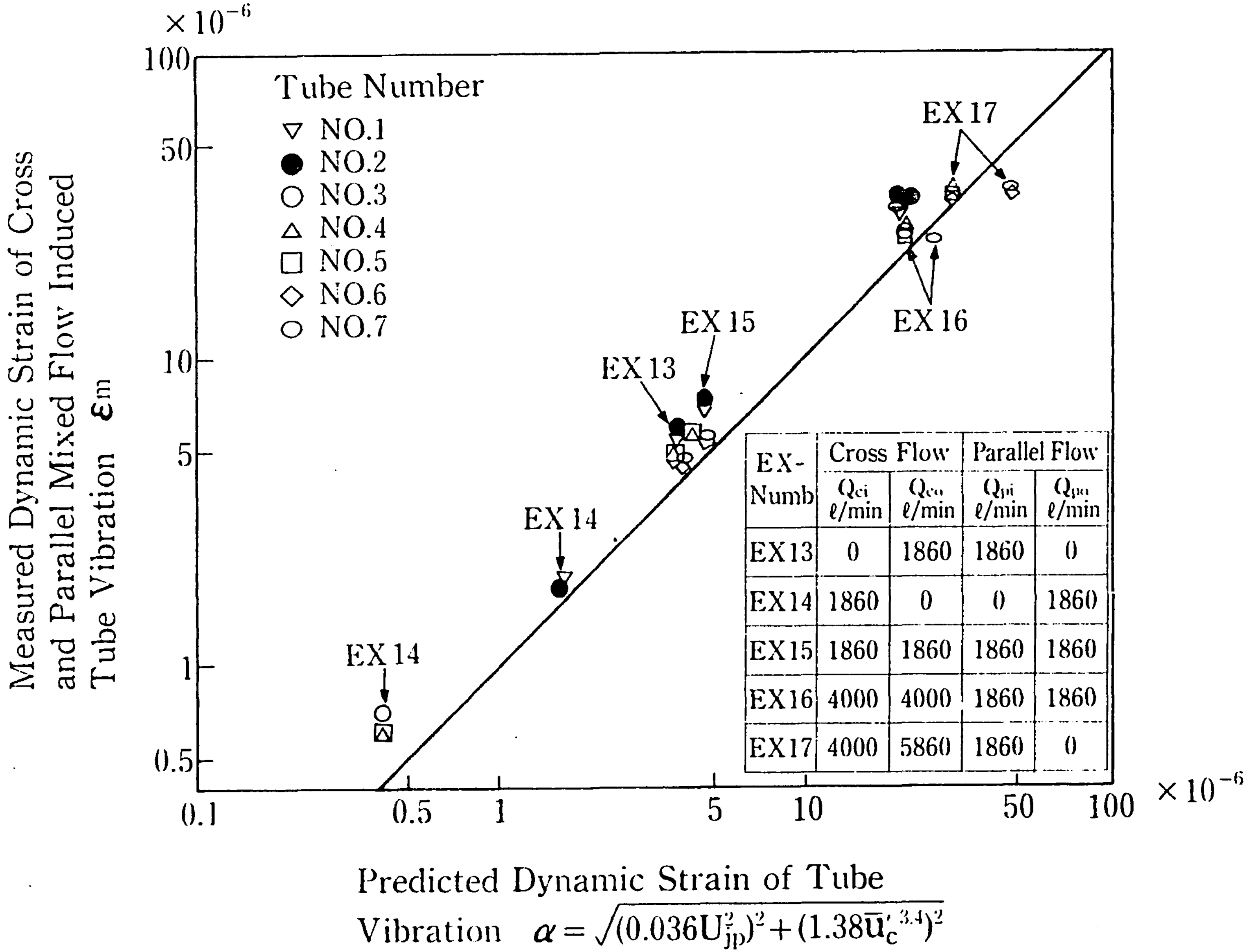


Schematic Diagram

Single Span Tube Vibration Experimental Apparatus

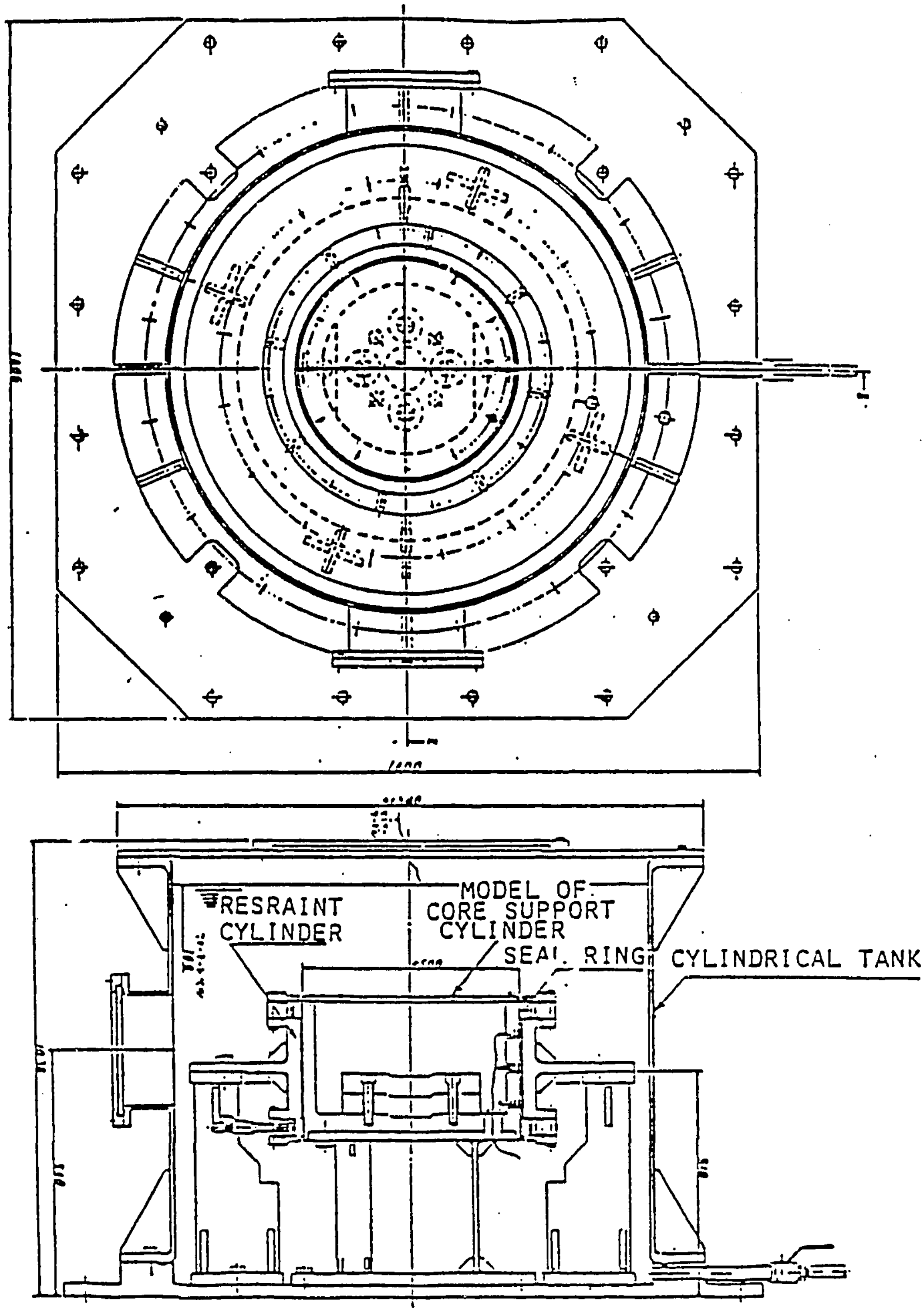


Relationship between Strouhal Number and Average Gap Flow Velocity

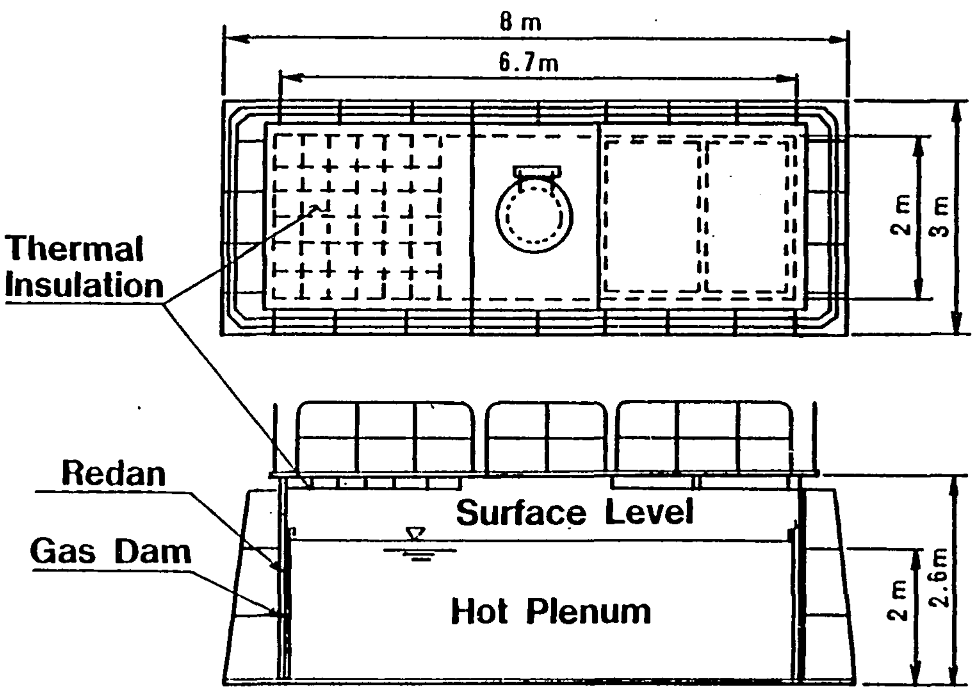


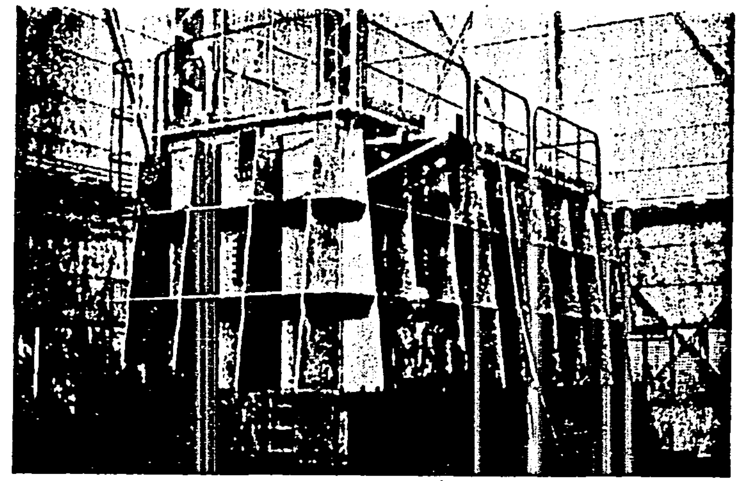
EX-Numb	Cross Flow		Parallel Flow	
	Q_{ci} ℓ/min	Q_{co} ℓ/min	Q_{pi} ℓ/min	Q_{po} ℓ/min
EX13	0	1860	1860	0
EX14	1860	0	0	1860
EX15	1860	1860	1860	1860
EX16	4000	4000	1860	1860
EX17	4000	5860	1860	0

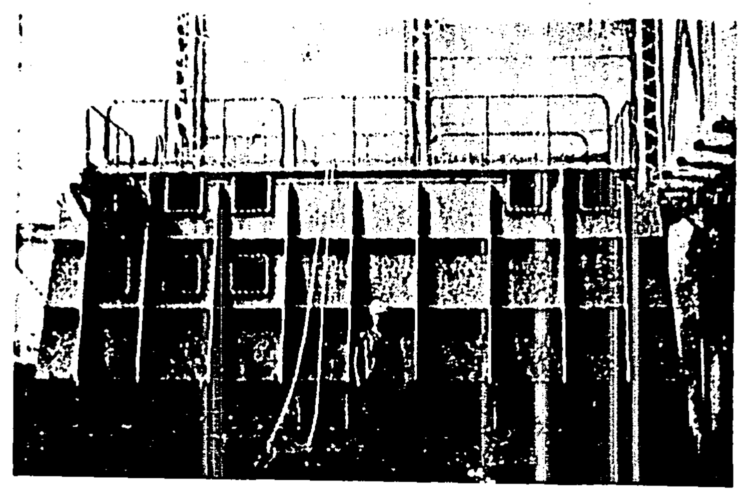
Comparison between Mixed Flow Induced Vibration and Evaluation Equation



TESTING MODEL







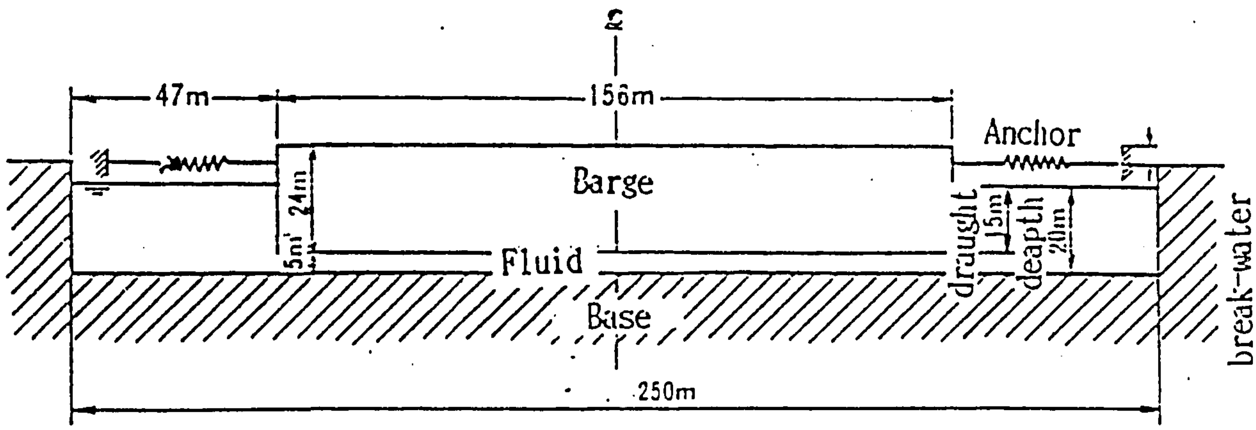
Specification	(1)Scale ; 1/3 of real plant (2)Dimension ; Hot Plenum 2.6mH 7.0mL (3)Weight ; 50Ton (with 28Ton Water)

Sloshing in 2D Reactor Plenum Model (Video①—b)

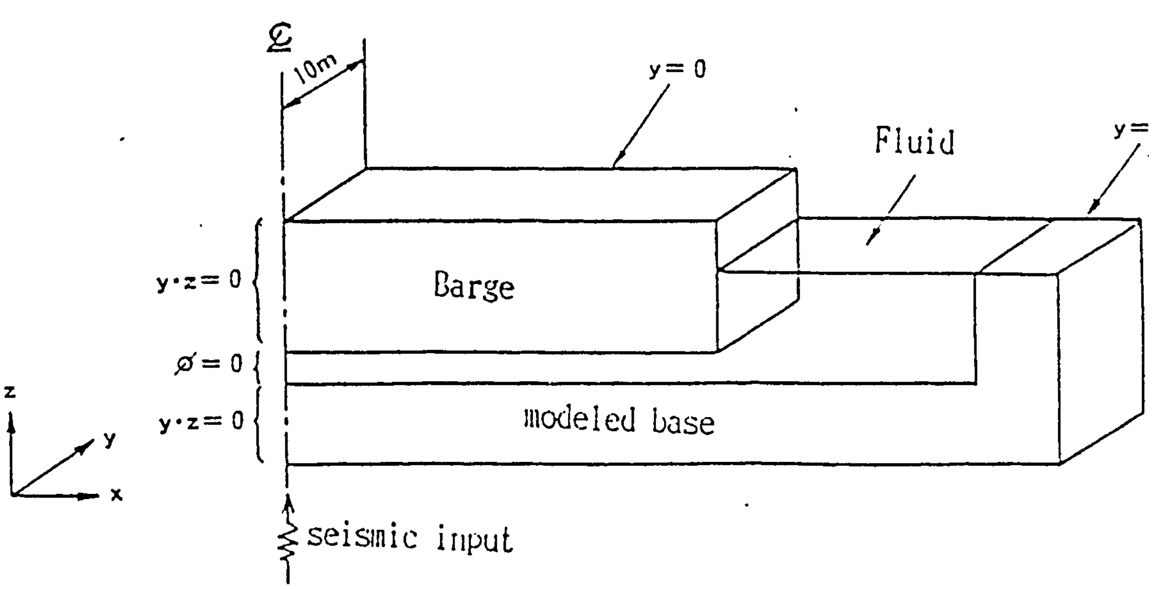
Seismic analysis of barge

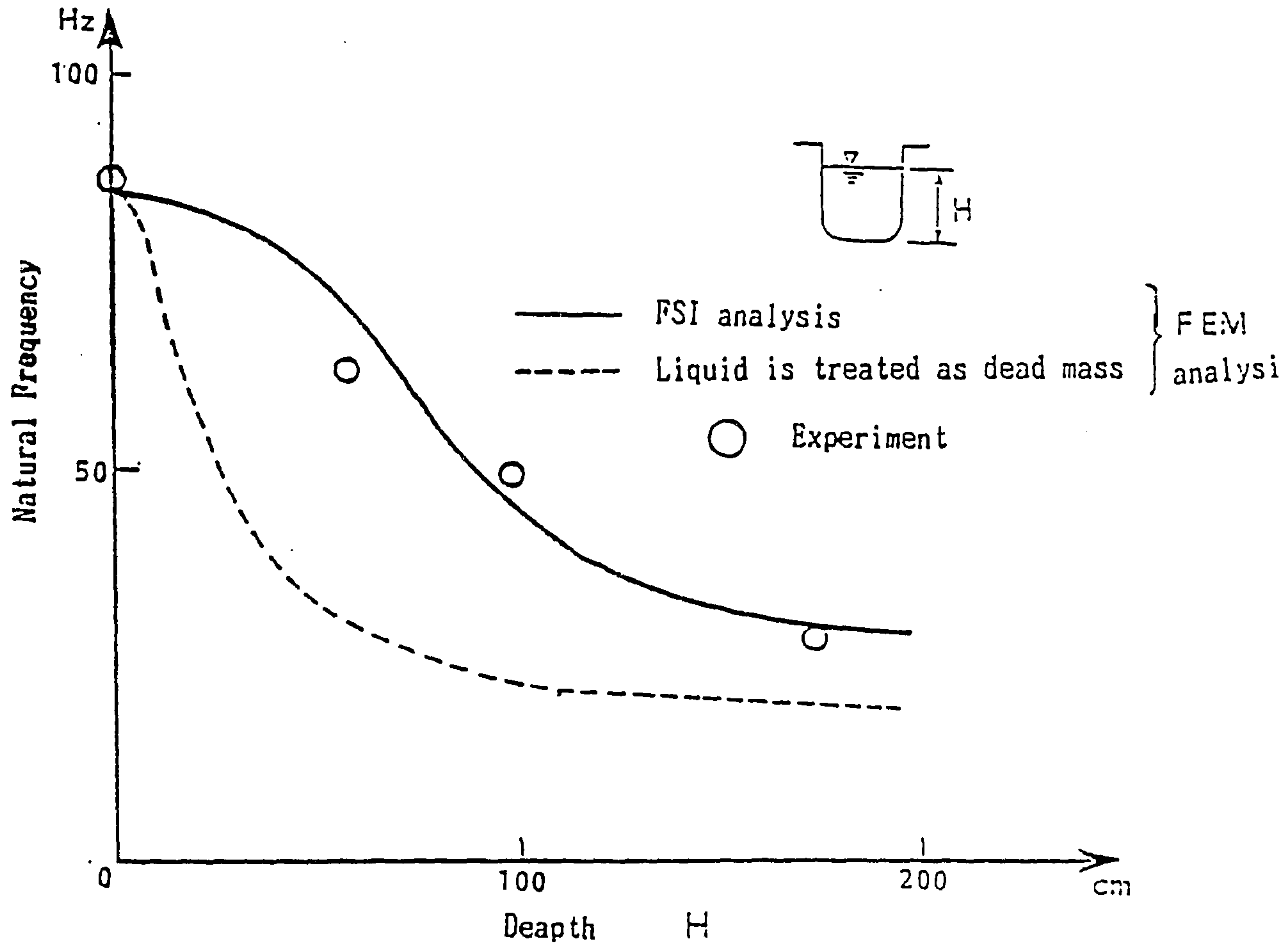
Analysis model

. 3-D FEM analysis



2-D model scheme





Natural frequency of R/V influenced by the deapth, H (N = 1, K = 1)

Inner liquid works as additional mass (Horizontal movement)