2 CONTRIBUTORS AND THEIR TEST FACILITIES

Following the Call for Test Rig Data distributed among over 100 Potential Test Participants and the next messages issued in 1988 and 1989, 17 labs have declared their participation in the ICET project. The final list of Test Participants is given in Table 7 with a symbolic designation used in the ICET documents.

Table 7 List of Test Participants

No.	*Laboratory*	*Contributor*	*Designation*
1.	China Ship Scientific Research Centre, Wuxi, *China*	Zhiye Ji	CSSRC
2.	Tsinghua University, Beijing, *China*	Jitang Huang	TSING
3.	Technical University of Ostrava, Ostrava, *Czech Republic*	Jaromir Noskievič	VSB
4.	SIGMA Research Institute[1], Olomouc, *Czech Republic*	Alois Koutny	SIGMA
5.	United Power Plants Co. Peitz, Hohenwarte II Pumped Storage Power Plant, Hohenwarte, *Germany*	Klaus Junghanß Erich Dimter	PEITZ
6.	University of Hannover, Hannover, *Germany*	Hartmut Louis	HAN
7.	KSB AG, Frankenthal, *Germany*	Peter Hergt Gerd-Heinz Bauer	KSB
8.	Fluid Control Research Institute, Palghat, *India*	M.S.Konnur	FCRI
9.	CISE S.p.A., Milan, *Italy*	Remo Martinella	CISE
10.	Hiroshima University, Higashi Hiroshima, *Japan*	Masanobu Matsumura	HIRO
11.	Institute of Fluid-Flow Machinery of the Polish Academy of Sciences, Gdańsk, *Poland*	Kazimierz Steller Janusz Steller	IMP
12.	University of Cape Town, Rondebosch, *South Africa*	Anthony Ball	CAP
13.	University of Hull, Hull, *England.*	Robert D. James	HULL
14.	The City University, London, *England*	Peter A. Lush	CITY

Acceptance of Test Rig Identification Cards was completed at the beginning of 1989. Till May 1992 results of experimental tests carried out on 20 rigs in 14 labs were obtained. It is obvious that the number of labs taking part in the project and the scope of the work conducted must have been substantially affected by the lack of any financial support from the side of the Test Co-ordinator. The possibilities of finding own sources for such a support depended essentially on the local economic conditions and it is quite clear that immense ingenuity and personal engagement were needed in some cases to contribute to this project.

It can be easily seen from Tables 8÷11 comprising basic operating parameters[2] of test facilities involved in the ICET project that almost a half of tests has been carried out using

[1] The SIGMA concern was dissolved by the Czechoslovakian government in 1990. According to Dr A.Koutny [9] all the cavitation erosion test facilities have been taken over by the ČKD Blansko Company.

[2] These are standard parameters excerpted from the Test Rig Identification Cards. Their value may slightly differ from that during the erosion test conducted under the ICET programme. The actual values are given in Laboratory results Summarisation Cards and reproduced in Section 4 of this report.

vibratory rigs. The vibration frequency of these rigs is usually close to 20 kHz which corresponds to the ASTM G-32 Standard. An exception is the IMP PAN lab with a facility of 8 kHz vibration frequency. Much wider diversity can be noticed in vibration amplitudes, sizes and mounting methods of test samples.

Counter-samples are applied as a rule in 2 labs (Universities in Cape Town and Hull). Two further labs (University of Hiroshima and the Technical University of Ostrava) use stationary specimens occasionally. As it is generally known, this technique enables testing light and brittle materials. A very special design is applied in Hiroshima. No beaker is applied here. Acoustic cavitation is generated in the liquid flowing on the counter-sample out of a channel in the vibrating horn axis.

Vibrating specimen buttons are usually screwed in the horn (ASTM G-32 Standard). A specimen is screwed on the horn in the Czech Republic (Czech standard CSN-015082-76) whereas a mounting nut (Polish Standard PN-86/H-04427) is applied only in the IMP PAN.

Table 8a Test conditions for vibratory rigs (vibrating specimen)

laboratory	*test conditions*					
	input power	*frequency*	*peak-peak amplitude*	*specimen size*	*working liquid*	*temperature*
	W	Hz	μm	mm		°C
CISE	1000	20	50.8	∅15.8	distilled water	22
CSSRC	250	20	32	∅16	tap water	20
HIRO	100	19.9	24	∅16	distilled water	40
IMP	500	8.1	50	∅12.5	tap water	20
TSING	?	19.8	35	∅19.5	tap water	15÷20
VSB	250	20	40	∅16	distilled water	20

Table 8b Test conditions for vibratory rigs (stationary specimen)

laboratory	*test conditions*						
	input power	*frequency*	*peak-peak amplitude*	*specimen size*	*horn tip/ /sample gap*	*working liquid (water)*	*tempe-rature*
	W	Hz	μm	mm	mm		°C
CAP	500	20	60	∅10	0.35	distilled	30
HIRO	100	19.9	28	∅16	0.4	distilled	40
HULL	200	20	117	∅16.7[1]	0.5	tap	20
VSB	250	20	40	∅16	1.0	distilled	20

[1] maximum erosion area

Cavitation tunnels involved in the ICET programme (Table 9) show a significant differentiation in the test chamber design. Tests have been conducted in 1 tunnel with a cylindrical cavitator (Hohenwarte Pumped Storage Power Plant in Germany), two tunnels with a wedge cavitator (CSSRC and the City University, London) and two tunnels with barricade and counter-barricade systems (Universities of Hiroshima and Hannover). The majority of cavitation tunnels are not used for tests of highly resistant materials.

Table 9 Test conditions for cavitation tunnels

laboratory	*test conditions*						
	pump power	*cavitator*	*specimen area*	*liquid velocity*[1]		*Upstream pressure*	*tempe-rature*
	kW		mm²	v_∞ [m/s]	v_{local} [m/s]	kPa	°C
CITY	22.0	*wedge*	897	21	45	890[2]	40
CSSRC	7.5	*wedge*	3096	14	~28[3]	103[2]	20
HAN	12.0	*barricade system*	1800	40	~670	700[4]	22
HIRO	11.0	*barricade system*	259	30	~300	405.2[4]	40
PEITZ	*none*[5]	*bolt*	986.3	30	~41.5[3]	930[4]	10

From among four rotating disks involved in the ICET project (Table 10) two facilities are of similar design. Both in the CSSRC and the SIGMA Research Institute (Olomouc, Czech Republic) cavitation has been generated by holes drilled in the disk upstream of the test samples. Cavitators in form of cylindrical bolts are applied in the IMP PAN and the KSB laboratory in Frankenthal (Germany). However, the samples are mounted at the disk in the IMP PAN and on the stagnator vanes in the KSB lab.

[1] Subscript ∞ refers to the flow upstream the cavitator. Subscript *local* refers to the specimen surface (CITY, CSSRC, PEITZ) or slot between barricades (HAN, HIRO), respectively.

[2] absolute pressure

[3] Parameter evaluated basing on the blocking factor value

[4] gauge pressure

[5] Operating head of the Pumped Storage Power Plant Hohenwarte is utilised.

Table 10 Test conditions for rotating disk facilities

laboratory	*test conditions*							
	main engine power	*disk dia*	*rotation speed*	*cavitator*		*mean pressure*	*impinged area*	*tempe-rature*
	kW	mm	r.p.m.	*shape*	*velocity* m/s	kPa	mm^2	°C
CSSRC	30	350	2950	*hole*	43	103.0[1]	1256.6	20
IMP	40	330	3000	*bolt*	42.5	155.0[2]	706.5	20
KSB	28	500	1537	*bolt*	29.6	46.4[1]	200.0	40
SIGMA	52.5	275	5000	*hole*	60.2	70.0[2]	2×491.0	40

Cavitating jet tests have been carried out in the FCRI (Palghat, India) and at the University of Hannover. Both rigs follow exactly the design of Dr A. Lichtarowicz of the University of Nottingham [6].

It has been only the SIGMA Research Institute that has offered us tests carried out at a liquid impact device. As it is generally known this kind of a device was widely used in the past to assess the cavitation erosion resistance of materials. Main parameters of cavitating jet (CJ) and liquid jet impact (LJ) devices taking part in the ICET programme are given in Table 11.

Table 11 Test conditions for cavitating jet (CJ) and liquid jet (LJ) facilities

laboratory and facility	*test conditions*							
	pump engine power	*nozzle dia*	*jet velocity*	*specimen*		*pressure*[1]		*tempe-rature*
	kW	µm	m/s	*area* mm^2	*velocity* m/s	*upstream* MPa	*downstream* MPa	°C
FCRI **CJ**	10.3	397÷424	90÷98	113.1	-	≤ 21	0.14	28±2
HAN **CJ**	14.7	400	?	165.1	-	14÷19	0.10	24.5
SIGMA **LJ**	5.5[3]	6000	6.75	299.0	80	~0.126	0.10	?

[1] absolute pressure

[2] gauge pressure

[3] Power of the motor driving the wheel with test specimens