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U.S.NRC/LLL LIAISON WITH THE FEDERAL REPUBLIC OF GERMANY FOR THE GKSS-PSS
STEAM CONDENSATION TESTS - PROGRESS REPORT NO. 1

Edward W. McCauley

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the GKSS-PSS Steam Condensation Tests

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ABSTRACT

This progress report for the USNRC/LLL Liaison program with the Federal Republic of Germany regarding boiling water reactor containment multivent steam condensation tests being conducted by GKSS (Gesellschaft für Kernenergieverwertung in Schiffbau und Schifffahrt) address program activity during the period of May-June 1979. During this period the program scope was defined, initial contacts between LLL and GKSS were established, and the first trip by an LLL representative to the GKSS test facility was taken.

25

CONTENTS

Abstract	iii
Introduction and Background.	1
Work Statement - FY79.	2
Objective	2
Scope.	2
GKSS-PSS Program	4
Discussion of Test Results	58
Conclusions and Recommendations.	71
References	72

INTRODUCTION AND BACKGROUND

At the combined Containment Review Meeting of December 9-10, 1976, in Cologne, FRG, the USNRC was asked by the German Ministry for recommendations as to future pressure suppression testing in the GKSS facility in Hamburg, FRG. Additional planning activities between the USNRC (RSR & NRR) and the German Minister for Research and Technology have resulted in a GKSS directed research program of significant importance to both the USNRC and FRG.

Specific measurements are desired for pressure oscillations (and pressure spikes) during the condensation of relatively air-free steam discharging from multiple, large scale vents. These measurements will include determination of the lateral vent loads in the multiple vent configuration. In general, this experimental research program addresses the response of a BWR pressure suppression system to the late time, steam condensation phase of a hypothetical loss-of-coolant accident (LOCA). Such systems are an integral part of both the FRG and U.S. boiling water reactor primary safety systems.

The GKSS Pressure Suppression Test (GKSS-PST) program is now in progress with all facility hardware modifications completed [1], three multivent pre-tests conducted, and a final pre-test scheduled for early July, 1979. A 15 test matrix with additional wetwell floor & wall pressure transducers, is planned to investigate steam chugging in a full-scale three vent arrangement. The main tests are to begin about September, 1979 and it is anticipated that one test will be performed every six weeks.

From the viewpoint of the USNRC, the general objective of this program is to provide confirmatory data for the General Electric Mark II BWR containment. The Mark II pressure suppression design is based on full scale, single vent (unit cell) experiemnts that simulate a LOCA transient. Of primary interest in the design are the dynamic loads during steam condensation. In addition, the magnitude of the lateral loads on the structure connecting the vents needs confirmation. The particular objective of the planned GKSS tests is to obtain

comparable data on a multiple vent test configuration. Past experiments indicate that the amplitude of pressure oscillations and therefore induced loads, are dependent on the number of vents used. This needs to be understood. In addition, the relative simultaneity of load inducing pressure oscillations from adjacent vents requires investigation.

In order to derive maximum benefit to the USNRC in assuring the safety of U.S. nuclear reactors, it is required that a principle U.S. contact be established for receipt and evaluation of all GKSS steam condensation test data.

WORK STATEMENT - FY79

OBJECTIVE

The Contractor is acting as the Nuclear Regulatory Commission's principle liaison for the full scale steam condensation tests to be performed at the GKSS Test Facility in the Federal Republic of Germany. The work is performed as a continuation of the Pressure Suppression Test & Analysis Program whereby the Contractor provided large scale Confirmatory BWR Pressure Suppression Research for the USNRC.

SCOPE

The Contractor is the designated U.S. recipient of data generated by the GKSS-PST program and will establish close liaison with FRG personnel and participate in the GKSS tests. Specifically, the work tasks are to:

- 1) Determine an appropriate selection and format of data for reporting that reflects the steam chugging phenomenon under investigation.
- 2) Provide the necessary data processing services to convert the test data to the format described under 1 above.
- 3) Generate data reports for each test according to the format in 1 above and disseminate to designated organizations per NRC instruction.

- 4) Provide technical evaluation of the test data for guidance in the performance of successive tests and to develop a more fundamental understanding of the chugging phenomenon.
- 5) Perform other liaison activities with the GKSS test program per NRC instruction.
- 6) Data reports to be provided for each test. Progress reports will be provided to the NRC on a monthly basis.

The Contractor began liaison activities in June 1979. Based on the revised test schedule, (see Table 1) the tests themselves will extend through the second quarter of FY81 with the FRG-US liaison activity extending through the fourth quarter of FY81.

During this initial period, primary emphasis is placed on items 1 and 2 of the overall work scope in order to provide timely and effective generation of data reports (item 3) and technical evaluations (item 4). Initial efforts have established the logistics involved in delivery of data tapes, video tapes^a, cinematic records (16mm)^b, and the preliminary test evaluations from GKSS to the Contractor and the extent of required format conversions by the Contractor. Based on discussions between BMFT, GKSS, and NRC, reporting protocol will be established including both Contractor generated documents as well as those provided by GKSS personnel. In order to provide timely reporting, all related translation and publication services are included in this work scope. Following each Contractor trip to the GKSS facility for consultation and/or test participation, the Contractor will provide to the NRC staff, at NRC headquarters, a briefing and overview on the results of the trip.

^a two each on each of the pre-tests; three are planned for the main tests.

^b the first high speed film is expected from pre-test VM-4.

GKSS-PSS PROGRAM

I visited the GKSS facility on June 11-15, 1979 for purposes of establishing a detailed understanding of the overall test program, the instrumentation system, and the data processing system. The trip was quite successful due to the strong cooperation of the GKSS-PSS personnel. In Table 1 is given an organization chart for the PSS multivent test personnel. Included as Table 2 is my agenda while at GKSS.

At the present time three so called pre-tests have been conducted with general operating conditions as shown in Table 3. The fourth such test (VM-4) is planned for early July, 1979 at a break flow rate of ~80kg/sec. Data assessment has been completed on VM-1^[2] and is in progress for data from pre-tests VM-2 and 3. Based on the GKSS discussions, I have drafted a new version of the test matrix which include the 4 pre-tests. This is shown in Table 4.

Basic characteristics of the GKSS test stand are shown in Figures 1 through 4 and Table 5. In general, the facility consists of a pressure vessel, drywell, wetwell, and wetwell ullage expansion chamber. This latter feature derives from the earlier ship development program where ullage volume was minimized in the wetwell to avoid exposing the vent pipe exits to air during maximum keeling of the ship.

The pre-tests have all been conducted with 3 vents as will be the majority of the main tests. The primary difference between pre-tests and main tests lies in the completeness of instrumentation, particularly pressure transducers, in the wetwell and vent pipes.

An intercomparison of the GKSS-PSS facility design with Mk II plants and the JAERI facility is provided in Table 6. The primary difference between GKSS and Mk II lies in the small drywell volume which is effectively sized for a single vent pipe rather than 3. Compared to plant average the pool volume is ~ 40% low, primarily due to the relative shallowness of the pool. However, key

items such as vent diameter, submergence, and the pool to vent area ratio are representative of the Mk II plants. Since the important data to be obtained from these tests lies in late time steam condensation oscillations, the above differences are not considered to be of significant importance.

TABLE 1

List of persons involved in PSS multi vent tests

Dr. Schafstall	responsible for	underwater technology	)	directors of the
Dr. Schultheiß	responsible for	reactor safety research	)	Institut für Anlagentechnik

Sesliger	Dipl.-Ing.	head of the department reactor safety
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Aust	Dipl.-Ing.	project leader
Ehrst	Ing. (grad.)	video and high speed photography
Niemann	Ing. (grad.)	experiment supervision
Schwan	Dipl.-Ing.	pre-test analysis
Vollbrandt	Dipl.-Ing.	instrumentation

6

Additional for operation, maintenance and repair from the department technical experiments

Peters	Ing.-(grad.)	head of this department
Groß	Ing.-(grad.)	
Ottersbach	Ing.-(grad.)	
mechanicians		

TABLE 2

INFORMATION MEETING ON 11.6. to 15.6.1979
AT GEESTHACHT ABOUT GKSS AND LLL, Mr. McCauley,
PRESSURE SUPPRESSION CONTAINMENT RESEARCH

working and time schedule

<u>Monday, 11.6.</u>	11 ³⁰	arrival at GKSS welcome, discussion of the schedule
	12 ³⁰	lunch
	13 ³⁰	- general discussion on goals of the experimental program - objectives of multiple vent tests at USNRC(LLL)
	16 ¹⁵	departure to hotel
<u>Tuesday, 12.6.</u>	8 ³⁰	pick up at hotel
	9 ¹⁵	visit of the pressure suppression test facility - arrangement - construction - measuring technique - video tapes, high speed film equipment
	12 ³⁰	lunch
	13 ³⁰	discussion on different technical items of the test facility, on video and high speed technique and corresponding experience at LLL
	16 ¹⁵	departure to hotel (H. Wümburg w/ Mr. Schaefer)
<u>Wednesday, 13.6.</u>	8 ³⁰	pick up at hotel in room 2018, 2019, 2020, 2021, 2022, 2023
	9 ¹⁵	experience of the three operational tests - measurement technique - data recording and processing - planned application of data at USNRC(LLL) codes, documentation, feedback

TABLE 2 - Cont.

	12 ³⁰	lunch
	13 ³⁰	data transfer, presentation of test results in quick look reports code application and development of GKSS
	16 ¹⁵	departure to hotel
<u>thursday, 14.6.</u>	8 ³⁰	pick up at hotel
	9 ¹⁵	detailed discussion on the GKSS-program - open questions in test arrangement, parameters and measurement technique - further cooperation with ILL - time schedule
	12 ³⁰	lunch
	13 ³⁰	summary, recommendations and conclusion
	16 ¹⁵	departure to hotel
<u>friday, 15.6.</u>	8⁴⁵	if desired participation on a bicycle tour of the institut to the surroundings of Geesthacht
	15 ¹⁵	
	16 ⁰⁰	departure to hotel and back to USA
	8 ³⁰	pickup @ hotel
	9 ⁴⁵	detailed study of transducers & use to NRC
	12 ³⁰	lunch
	13 ³⁰	discussion of data transfer details + reports

TABLE 3. Test Matrix for Multivalent Pre-Test

Parameter	Pre-Test Number			
	VM 1	VM 2	VM 3	VM 4
<u>Pressure Vessel</u>				
Water Mass (kg)	9×10^3	9×10^3	9×10^3	9×10^3
Initial Pressure (bar)	40	65	85	N/A
Initial Temperature (°C)	250	280	299	N/A
Steam Flow Rate Peak (kg/s)	~25	~41	~58	~80
<u>Drywell</u>				
Initial Pressure (bar)	~1	~1	~1	1
Initial Temperature	25	25	25	25
Height of Ullage (m)	3.	3.	3.	3.
<u>Wetwell</u>				
Initial Pressure (bar)	~1	~1	~1	~1
Initial Temperature over Water (°C)	~25	~25	~25	~25
Initial Water Temperature (°C)	25	25	25	25
Water mass (kg)	64×10^3	64×10^3	64×10^3	64×10^3
Initial Ullage Overpressure (bar)	1	1	1	1
Transient mass flow rate peak (kg/m ² s)	~25	~40	~55	~75
Pool Depth (m)	2.8	2.8	2.8	2.8
<u>Vent Pipes</u>				
Number of Vents	3	3	3	3
Inside Diameter (mm)	610	610	610	610
Submergence (m)	3.8	3.8	3.8	3.8
Clearance from Wetwell Floor (m)	0.98	0.98	0.98	0.98

TABLE 4: TEST MATRIX: COMPILATION OF MULTI-PIPE EXPERIMENTS FOR PRESSURE SUPPRESSION SYSTEMS OF LAND-BASED PLANTS. STATUS: June 1979

TEST BLOCK	a		b			c		d		e		f		g		h					
PARAMETER	Pre-Tests					Main Tests												Additional Tests			
	WM 1	WM 2	WM 3	WM 4	WM 5	1	2	3	4	5	6	7	8	9	10 ⁽¹⁾	11 ⁽¹⁾	12 ⁽¹⁾				
Number of Vent Pipes	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3				
Draywell Volume m ³	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10				
Pool Area-net m ²	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100				
Pipe Inside Diameter mm	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50				
Submergence m	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0				
Distance from Bottom m	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0				
Water Level in Pool m	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0				
Water Level in Pool m	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0				
Draywell volume to Vent	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10				
Pipe Area m ²	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10				
Net Pool Area to Vent	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100				
Pipe Area m ²	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10				
Transient Mass Flow Rate, Initial Value, kg ms ⁻¹	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10				
Temperature Range to be Covered in Pool °C	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10				
Backpressure via Water Pool, Bar abs.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				
	a	b	c	d	e	f	g	h													

1. Variant Test

2. Repeat Test Under Max.

3. Qualifier Test Under Max. Load Conditions

GKSS	Druckabbau-Versuchsstand (PRESSURE SUPPRESSION TEST STAND) Grundriß (Plan View)	Stand. 12.78
		FIG. 1 Abb. 1

GKSS	Druckabbau-Versuchsstand (PRESSURE SUPPRESSION TEST STAND) Aufriß (Elevation)	Stand: 1278 (Fig.) Abb. 2
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GKSS	ANORDNUNG DER KONDENSATIONSROHRE (ARRANGEMENT OF THE CONDENSATION PIPES)	STAND 12. 78
		ABB. 3 (FIG.)

GKSS

Druckabbau-Versuchsstand
Kreislauflsystem

Stand: 12.78

FIG. 4
APP.

TABLE 5. CHARACTERISTICS OF THE PRESSURE SUPPRESSION TEST STAND
(Pre-Test VM-1)

<u>Dampfkessel (Steam generator)</u>	
Wassermenge (water mass)	$8,1 \cdot 10^3$ kg
Abblasdruck (blow-off pressure)	41 bar
Abblastemperatur (blow-off temperature)	250 °C
<u>Druckkammer (Chamber)</u>	
freies Behälter-Volumen (free container volume)	55,5
plus Luft-Volumen der Kond.-Röhre (plus air volume of the cond. pipes)	+ 4,3
	} 59,8 m ³
Anfangsdruck (initial pressure)	1 bar
Aufangstemperatur (initial temperature)	22,5 °C
<u>Kondensationskammer (Condensation chamber)</u>	
gesamtes Behälter-Volumen (total container volume)	114,6 m ³
davon: Wasserfüllung bei einem Wasser- stand von 3,785 m (water volume to a water-stand of 3,785 m)	64,3 m ³
Luft-Volumen (air volume)	50,3
minus anteiliges Luft-Volumen (minus the portion of air volume) in den Kondensationsröhren (displaced by the cond. pipes)	- 2,4
	} 47,9 m ³
zusätzliches freies Volumen in Expan- sionsraum und Luftüberschleus- leitung (additional free volume in expan- sion room and connecting air- duct)	25,4 m ³

TABLE 5. CHARACTERISTICS OF THE PRESSURE SUPPRESSION TEST STAND
(Cont.)

übertragende wasserbenetzte Innen- fläche (3,785 m wasserstand)	79 m ²
Höhe des Luftraumes über Wasser (height of air space over the water)	2,965 m
Poolfläche (total pool area)	16,99 m ²
Poolfläche* = Poolfläche - Rohrquer- schnittsfläche (net pool area = total area - cross-sectional area of vents)	16,08 m ²
Anfangsdruck (Initial Pressure)	1 bar
Anfangstemperatur über Wasser (Initial temperature over the water)	25 °C
Wassermenge (water mass)	64,1 · 10 ³ kg
<u>Kondensationsrohre (Vent pipes)</u>	
Anzahl der Kondensationsrohre (number of vent pipes)	3
Innendurchmesser der Kondensationsrohre (inside diameter of vent pipe)	610 mm
Kondensationsrohre	610 mm
Eintauchtiefe der Kondensationsrohre (submergence depth of vent pipe)	2,805 m
Bodenabstand (clearance between vent exit and pool bottom)	0,98 m
<u>Kennwerte (Associated values)</u>	
Druckkammer-Volumen/Kondensationsrohr (Drumwell volume / vent pipe)	20,0 m ³
Wasserfüllung/Kondensationsrohr (water volume / vent pipe)	21,5 m ³
Poolfläche*/Kondensationsrohr (net pool area / vent pipe)	5,36 m ²
Poolfläche*/Kondensationsrohrfläche (net pool area / vent exit area)	18,33

TABLE 6. INTERCOMPARISON OF MK II PLANT AND MULTIVENT, FULL SCALE TEST FACILITY DESIGN

FACILITY NAME	TYPE	No. of Vents	Vent Dia(mm)	Vol.D.W. Vent Pipe (m ³)	Vol.D.W. Vol.Pool	Vol.Pool Vent Pipe (m ³)	Pool Area Vent Area	Vent. Length (m)	Vent Subm. (m)	Bottom Clear. (m)
GKSS	Test	3	610	20.0	0.93	21.5	18.3	5.8	2.8	1.0
JAERI	Test	7	610	50.3	1.59	31.7	14.4	14.0	3.5	3.5
WPPSS2	Plant	84/18	50/711	55.7	1.78	31.1	13.6	13.7	3.7	5.8
LaSalle	"	98	600	64.0	1.56	41.1	14.9	15.0	3.9	4.2
9 Mi.Pt.	"	100	590	65.1	1.44	45.3	N/A	N/A	3.4	4.0
Shoreham	"	88	590	61.9	2.36	26.2	15.4	13.8	2.7	2.7
Susquehanna	"	87	610	78.0	1.89	41.3	19.5	13.1	3.4	3.6
Zimmer	"	88	610	57.9	1.76	32.8	15.1	11.4	3.0	3.8
Bailey	"	60	N/A	75.9	2.19	34.7	N/A	N/A	3.4	N/A
Limerick	"	85	610	78.2	1.81	43.2	21.6	13.6	3.4	3.6
Plant Average		88	605	67	1.85	37.0	16.7	13.4	3.4	4.0

The GKSS-PSS experiments produce substantial optically and electronically recorded data. In addition to the two TV cameras (above and below water pool) and the subpool high speed camera, the measurement system consists of up to 215 channels and provides transducing of pressure, differential pressure, temperature, force, acceleration, strain, water levels, density, and mass flow rate. There are four electronic measurement systems in use at the GKSS-PSS facility:

- a) One-point pressures - 24 Channels @ .04 Hz
- b) digital recorder - 128 channels @ 25 Hz
- c) digital/PCM recorder - 56 Channels @ 1.7 kHz
- d) analog/mag. tape - 7 Channels @ 40kHz

As shown in Figure 5, these data are recorded on mag. tape, by measurement system, channel for channel and preceded by necessary test identification and calibration data. Originally recorded in binary format, a change to BCD has been incorporated along with improved processing software which, in context with the GKSS Cal-Comp plotting hardware allows for fast search and co-plotting of up to 12 selected transducer outputs over specified time intervals.

After extensive discussion with GKSS staff, it is suggested that a data set from a test consist of both optically and electronically recorded test results. We will establish the transfer procedure with pre-test VM-1 and expect to receive, within a few days:

- a) both video records on a single cassette (a total of 10 minutes of film);
- b) one digital tape (25 Hz) containing 125 channels of data (MEA)
- c) detailed description of the format and contents of the digital tape;
- d) partial listing of the digital tape contents;
- e) listing of GKSS processing software for production of engineering units calibration of each transducer file and fast search for desired files;
- f) related calibration reports.

Based on the GKSS approach to data tape treatment we will establish unblocking procedures and software revisions using the above tape to arrive at a LISS compatible methodology for rapid processing so as to minimize future effort in obtaining usable data for analysis. In procedure, data application details will be developed with NRC (RSR & DSS) so as to define the extent of further pre-test data tapes to be transmitted and analyzed. The reason that all data tapes were not to be sent immediately is due to the prodigious amount of data available from the PCM and analog systems. In the BCD form, GKSS staff has indicated they require 56 tapes per test. Since the data contained in these fast channels is of primary importance to the NRC purposes, a compromise must be struck. The most reasonable one would seem to be development of defined time intervals for transmission of data from most of the fast channels with only a few channels being identified for complete transmittal.

G K S S

(MEASUREMENT SYSTEM - OVERVIEW)
MESSSYSTEM (ÜBERSICHT)

Stand: Okt. 78

FIG. 5

Of the 215 channels listed on the previous page, 165 were used in the pre-tests. In the following pages are given details of the present transducer locations and types as arranged in the various facility systems. In addition, the locations of future maintest pressure transducers as developed during my meetings with GKSS staff, are indicated in Figures 7, 10, & 13. Table 7 is provided as a guide to the makeup of the details regarding transducer location and type. In general, each major section of the PSS facility is treated separately, in order - pressure vessel, drywell, vent pipes, and wetwell. For each of these sections figures show the physical location of each transducer. They are followed by a tabulation listing each transducer by number, type, and data collection system.

TABLE 7. GUIDE TO TRANSDUCER LOCATION & TYPE

<u>FACILITY SECTION</u>	<u>FIGURE NO.</u>	<u>TABLE NO.</u>
Pressure Vessel	6	8
Drywell	7-8	9
Vent Pipes	9-12A	10
Wetwell	13-15	11
Camera Positions	16	-

In the figures I have identified the PCM channels by a star (*) next to the transducer I.D. number. Some 40 such channels were in use with each "column" of water level gages multiplexed. It will be noted from the tables that several transducers were not recorded due to various reasons. In general, all of the water level gages have now become inoperative. A new "spark plug" design has been developed by GKSS staff and will be in place for pre-test VM-4.

It was recognized early-on that the LLL experience in PSS experimental work might be of benefit to the GKSS test program, particularly in the areas of protection of high sensitivity pressure gages from steam induced thermal transients and high speed underwater photography of two-component (air/water), two-phase (steam/water) flow. Much beneficial discussion ensued with the GKSS staff on these subjects with the result that a GKSS study will be made of the effectiveness (in the GKSS environment) of the LLL pressure transducer protection

methods. I would note that this area was pioneered by Wm. Shay and his colleagues in 1976-77 [3]. Its effectiveness was confirmed by independent work of the National Bureau of Standards in 1978 [4]. In the underwater photography area I made reference to the work of D. Dixon and his colleagues in L-Division [5]. The newly acquired Hi Cam camera at GKSS has, to date, produced rather under-exposed film. A concern that the internal limitation of light collection system of the Hi Cam camera had been overlooked proved groundless. The difficulty seems to lie in the inexact nature of predicting the available light for underwater bubbly flow photography at framing rates of 1000 fps and greater. A separate study using the GKSS wetwell and varying the position of available underwater 300 w spot lights and 2kw tube lights, possibly incorporating diffuser screens, is now underway to provide the necessary empirical data base prior to the fourth pretest (VM-4). In addition, the GKSS staff were very interested in the LLL capability for obtaining detailed subpool video records. This was based on the Storz lens probe as developed by D. Lord and associates [5] earlier and applied recently by G. Carter of MED in a steam-flow measurements Spool in support the the PKL portion of the 3D Program for NRC(RSR).[6]

^aMaterials Engineering Division

G K S S	MEASUREMENTS in the PRESSURE VESSEL and the DELIVERY LINE	Stand: Okt. 78 (Fig) ABB, 6
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TABLE 8a
TABELLE NR. 8a

MESS-STELLEN UND MESSWERTAUFNEMER: DAMPFKESSEL

STAND: 19.2.79 (Versuch VM 01)

Meß- stelle	Meßgröße	Meßwertaufnehmer	Meß- prinzip	Meßbereich der Kette	Regi- strier- art	Bemerkungen/ Störungen
DK-PD 00	(Δp) Differenzdruck	STATHAM PH 8052	DMS	1 bar	MEA	
DK-PD 01	Differenzdruck	STATHAM PH 8052	DMS	1 bar	MEA	
DK-PA 02	(Static pressure) stat. Druck L	HBM P3M/200	DMS	0 - 130 bar	MEA + TV	nach ca. 150 s Signalausfall wegen Fehler in der TV-Anpassung
DK-PA 03	stat. Druck L	HBM P3M/200	DMS	0 - 130 bar	PDR	(dropout after 150 s because of defect in the TV adaptation)
DK-PA 05	stat. Druck L	HBM P3M/200	DMS	0 - 130 bar	MEA	
DK-FV 01	(Force) Kraft (Gewicht)	KIAG 909 B	piezo- elektr.	0 - 50 000 N	MEA	unbefriedigendes Verhältnis von Stör- zu Nutzsignal
DK-FV 02	Kraft (Gewicht)	KIAG 909 B	piezo- elektr.	0 - 50 000 N	MEA	unbefriedigendes Verhältnis von Stör- zu Nutzsignal (unsatisfactory ratio of force to useful signal)
DK-AV 01	(acceleration) Beschleunigung	EMDEVCO 7701-100	piezo- elektr.	50 g	MEA	falsche Empfindlichkeit (false sensitivity)
DK-AV 02	Beschleunigung	EMDEVCO 7701-100	piezo- elektr.	50 g	MEA	falsche Empfindlichkeit
DK-PW 03	Heizleistung	Siemens A 13	3- Ω	5 A / 500 V	LIS	
PL-PW 01	Pumpenleistung	Siemens A 13	ARON		Pult	
PL-PW 02	Pumpenleistung	Siemens A 13	ARON		Pult	

MEA: digitale Meßwertfassung
ANA: analoge Registrierung
PCM: schnelle digitale Meßwertfassung

PDR: Punktedrucker
LIS: Linienschreiber
L: langsame Transiente

ü.B.: über dem Boden

TABLE 8b

TABELLE NR. 8b

MESS-STELLEN UND MESSWERTAUFNEMER: DAMPKESSEL

Meß- stelle	Meßgröße	Meßwertaufnehmer	Meß- prinzip	Meßbereich der Kette	Regi- strier- art	Bemerkungen/ Störungen
DK-TM 01	Temperatur	MMT NiCrNi Ø 2	TE	0 - 400 °C	PDR	Temperatursignal konstant um ca. 5 °C zu hoch, Ursache bisher ungeklärt
DK-TM 02	Temperatur	MMT NiCrNi Ø 0,5/0,25	TE	0 - 350 °C	MEA	
DK-TM 03	Temperatur	MMT NiCrNi Ø 0,5/0,25	TE	0 - 350 °C	(not installed), kein Einsatz	
DK-TM 04	Temperatur	MMT NiCrNi Ø 0,5	TE	0 - 350 °C	MEA	markierender Signalverlauf ab ca. 400 s (Signal off after 400s)
DK-TM 05	Temperatur	MMT NiCrNi Ø 0,5	TE	0 - 350 °C	MEA	
DK-TM 06	Temperatur	MMT NiCrNi Ø 0,5/0,25	TE	0 - 400 °C	PDR	Temperatursignal konstant um ca. 10 °C zu hoch, Ursache bisher nicht geklärt (Temp. signal about 10°C too high - reason not clear)
(Heizkammerzone)						
DK-TW 80	Wandtemperatur	MMT NiCrNi Ø 1	TE	0 - 350 °C	MEA	
DK-TW 81	Wandtemperatur	MMT NiCrNi Ø 1	TE	0 - 350 °C	MEA	
DK-TW 82	Wandtemperatur	MMT NiCrNi Ø 1/0,5	TE	0 - 350 °C	MEA	
DK-TW 83	Wandtemperatur	MMT NiCrNi Ø 1/0,5	TE	0 - 350 °C	MEA	

MEA: digitale Meßwerterfassung
 ANA: analoge Registrierung
 PCM: schnelle digitale Meßwerterfassung

PDR: Punktedrucker
 LIS: Linienschreiber

Ü.B.: Über dem Boden

Table 8c

TABELLE NR. 1-2

MESS-STELLEN UND MESSWERTAUFNEMER: ABLASELEITUNG

Meß- stelle	Meßgröße	Meßwertaufnehmer	Meß- prinzip	Meßbereich der Kette	Regi- strier- art	Bemerkungen/ Störungen
ES-PG 07	stat. Druck S	KIAG 6001	piezo- elektr.	0 - 130 bar	PCM	Signalausfall
ES-PA 08	stat. Druck L	HBM P3M/200	DMS	0 - 130 bar	PCM	unerklärlicher Signalverlauf von ca. 250 bis 320 s
ES-TM 07	Temperatur	NiCrNi 0,25 Ø	TE	0 - 350 °C	PCM	unerklärlicher Signalverlauf, besonders ab 100 s
ES-TM 08	Temperatur	NiCrNi 0,5 Ø	TE	0 - 350 °C	MEA	
ES-TM 09	Temperatur	NiCrNi 0,5 Ø	TE	0 - 350 °C	MEA	
ES-TW 84	Wandtemperatur	NiCrNi 2 Ø	TE	0 - 400 °C	PDR	
ES-TW 85	Wandtemperatur	NiCrNi 2 Ø	TE	0 - 400 °C	PDR	
ES-DE 01	Strömungskraft	drag body (Battelle)	DMS	0 - 100 kg/s	PCM	Dragbody erreicht nach Versuchsstart u.i.d.Zeit v.ca.40-90s d.mech.MB-Anschl
ES-DE 02	Wanddehnung	Alltech SG 125-01HP-24	DMS	0 - 1200 µm/m	MEA	falsche Empfindlichkeitseinstellung

MEA: digitale Meßwerterfassung
 ANA: analoge Registrierung
 PCM: schnelle digitale Meßwerterfassung

PDR: Punktedrucker
 LIS: Linienschreiber
 L : langsame Transiente
 S : schnelle Transiente

Ü.B.: über dem Boden

M 1 : 50

G K S S	PRESSURE MEASUREMENTS in the DRYWELL and VENT PIPE INLETS	stand: Okt. 78 Fig. ABB. 7
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M 1 : 50

G K S S	TEMPERATURE MEASUREMENTS IN THE DRYWELL AND VENT PIPE INLETS	Stand: Okt. 78
		Fig. ABB. 8

TABLE 9a

TABELLE NR. 9a

MESS-STELLEN UND MESSWERTAUFNEMER: DRYWELL (Druckkammer)

Meß- stelle	Meßgröße	Meßwertaufnehmer	Meß- prinzip	Meßbereich der Kette	Regi- strier- art	Bemerkungen/ Störungen
DY-PA 60	stat. Druck L	STATHAM PA 822	DMS	4 bar	MEA + PDR	Meßwert defekt shortly after test start
DY-PA 61	stat. Druck S	STATHAM PA 856	DMS	4 bar	PCM, ANA	Aufnehmer defekt kurz nach Versuchs- start
DY-PD 62	Differenzdruck ΔP	STATHAM PM 8052	DMS	1 bar	MEA	falsche Empfindlichkeitseinstellung
DY-TM P1	Temperatur	MNT NiCrNi Ø 1	TE	0 - 150 °C	PDR	
DY-TM P2	Temperatur	MNT NiCrNi Ø 0,5/0,4	TE	0 - 200 °C	MEA	
DY-TM P3	Temperatur	MNT NiCrNi Ø 1	TE	0 - 150 °C	PDR	
DY-TM P4	Temperatur	MNT NiCrNi Ø 0,5/0,4	TE	0 - 200 °C	MEA	
DY-TM P5	Temperatur	MNT NiCrNi Ø 1	TE	0 - 150 °C	PDR	
DY-TM P6	Temperatur	MNT NiCrNi Ø 0,5/0,4	TE	0 - 200 °C	MEA	
DY-TM 60	Temperatur	MNT NiCrNi Ø 1	TE	0 - 150 °C	PDR	
DY-TM 61	Temperatur	MNT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
DY-TW 62	Wandtemperatur	MNT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
DY-TW 63	Wandtemperatur	MNT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	

MEA: digitale Meßwerterfassung
 ANA: analoge Registrierung
 PCM: schnelle digitale Meßwerterfassung

PDR: Punktedrucker
 LIS: Linienschreiber
 L: langsame Transiente
 S: schnelle Transiente

Ü.B.: über dem Boden

TABLE 9b

TABELLE NR. 1-d

MESS-STELLEN UND MESSWERTAUFGNEHMER: DRYWELL (Druckkammer)

Meß- stelle	Meßgröße	Meßwertaufnehmer	Meß- prinzip	Meßbereich der Kette	Regi- strier- art	Bemerkungen/ Störungen
DY-PA 60	stat. Druck L	STATHAM PA 822	DMS	4 bar	MEA + PDR	
DY-PA 61	stat. Druck S	STATHAM PA 856	DMS	4 bar	PCM, ANA	Aufnehmer defekt kurz nach Versuchs- start
DY-PD 62	Differenzdruck	STATHAM PM 8052	DMS	1 bar	MEA	falsche Empfindlichkeitseinstellung
DY-TM P1	Temperatur	MNT NiCrNi Ø 1	TE	0 - 150 °C	PDR	
DY-TM P2	Temperatur	MNT NiCrNi Ø 0,5/0,4	TE	0 - 200 °C	MEA	
DY-TM P3	Temperatur	MNT NiCrNi Ø 1	TE	0 - 150 °C	PDR	
DY-TM P4	Temperatur	MNT NiCrNi Ø 0,5/0,4	TE	0 - 200 °C	MEA	
DY-TM P5	Temperatur	MNT NiCrNi Ø 1	TE	0 - 150 °C	PDR	
DY-TM P6	Temperatur	MNT NiCrNi Ø 0,5/0,4	TE	0 - 200 °C	MEA	
DY-TM 60	Temperatur	MNT NiCrNi Ø 1	TE	0 - 150 °C	PDR	
DY-TM 61	Temperatur	MNT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
DY-TM 62	Wandtemperatur	MNT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
DY-TM 63	Wandtemperatur	MNT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	

MEA: digitale Meßwerterfassung
 ANA: analoge Registrierung
 PCM: schnelle digitale Meßwerterfassung

PDR: Punktedrucker
 LIS: Linienschreiber
 L : langsame Transiente
 S : schnelle Transiente

Ü.B.: Über dem Boden

TABELLE NR. 44

MESS-STELLEN UND MESSWERTAUFNEMER:

DRYWELL (Druckkammer)

[illegible]

MEA: digitale Meßwerterfassung
ANA: analoge Registrierung
PCM: schnelle digitale Meßwerterfassung

PDR: Punktedrucker
LIS: Linienschreiber

ü.B.: über dem Boden

M. 1:50

G K S S

DENSITY MEASUREMENT IN VENT PIPE A

Stand: Okt. 78

Fig
ABB. 9

M 1 : 50

PRESSURE MEASUREMENTS
INSIDE THE VENT PIPES

G K S S

Stand: Okt. 78

Abb. 10

M. 1:50

TEMPERATURE MEASUREMENTS
INSIDE THE VENT PIPES

KOND. TOWER

G K S S

Stand: Okt. 78

Fig.
ABB 11

GKSS

PRESSURE & TEMPERATURE
MEASUREMENTS AT THE
VENT PIPE EXITS - DETAIL...

~~MEASUREMENTS~~
~~MEASUREMENTS~~

Stand: Okt. 78

Fig.
Abb. 12

[illegible]

Stand: Okt. 78

TABLE 10a

TABELLE NR. ~~10~~

MESS-STELLEN UND MESSWERTAUFNEMER:

KONDENSATIONSROHR A

Meß- stelle	Meßgröße	Meßwertaufnehmer	Meß- prinzip	Meßbereich der Kette	Regi- strier- art	Bemerkungen/ Störungen
KA-PA 10	Pitotdruck	SIATHAM PA 856	DMS	0 - 4 bar	PCM	Ausfall der PCM-Registrierung durch fehlerhafte Synchronisation
KA-PA 11	stat. Druck S	SIATHAM PA 856	DMS	0 - 4 bar	PCM	Ausfall der PCM-Registrierung durch fehlerhafte Synchronisation
KA-PA 12	stat. Druck S	SIATHAM PA 856	DMS	0 - 4 bar		kein Einsatz
KA-PA 13	stat. Druck S	SIATHAM PA 856	DMS	0 - 4 bar	PCM, ANA	Drucksignal um ca. 0,2 bar zu hoch, vermutlich durch Temperatureinfluß
KA-PA 14	stat. Druck S	SIATHAM PA 856	DMS	0 - 4 bar	PCM	
KA-PA 15	stat. Druck S	SIATHAM PA 856	DMS	0 - 4 bar		kein Einsatz
-37-						
KA-TM 14	Temperatur	MWT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
KA-TM 15	Temperatur	MWT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
KA-TM 16	Temperatur	MWT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
KA-TM 17	Temperatur	MWT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
KA-TM 18	Temperatur	MWT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
KA-TM F0	Temperatur	MWT NiCrNi Ø 0,5/0,4	TE	0 - 200 °C	MEA	
KA-TM F1	Temperatur	MWT NiCrNi Ø 0,5/0,4	TE	0 - 200 °C	MEA	
KA-TM F2	Temperatur	MWT NiCrNi Ø 0,5/0,4	TE	0 - 200 °C	MEA	

MEA: digitale Meßwerterfassung
 ANA: analoge Registrierung
 PCM: schnelle digitale Meßwerterfassung

PDR: Punktedrucker
 LIS: Linienschreiber
 S : schnelle Transiente

ü.B.: über dem Boden

TABLE 10b

TABELLE NR. 10b MESS-STELLEN UND MESSWERTAUFNEMER: KONDENSATIONSROHR A

Meß- stelle	Meßgröße	Meßwertaufnehmer	Meß- prinzip	Meßbereich der Kette	Regi- strier- art	Bemerkungen/ Störungen
KA-TM F3	Temperatur	MNT NiCrNi Ø 0,5/0,4	TE	0 - 200 °C	MEA	
KA-TM F4	Temperatur	MNT NiCrNi Ø 0,5/0,4	TE	0 - 200 °C	MEA	
KA-TM F5	Temperatur	MNT NiCrNi Ø 0,5/0,4	TE	0 - 200 °C	MEA	
KA-TM F6	Temperatur	MNT NiCrNi Ø 0,5/0,4	TE	0 - 200 °C	MEA	
KA-TM F7	Temperatur	MNT NiCrNi Ø 0,5/0,4	TE	0 - 200 °C	MEA	
KA-TM F8	Temperatur	MNT NiCrNi Ø 0,5/0,4	TE	0 - 200 °C	MEA	
KA-DE 10	Dehnung (Kraft)	Alltech SG 325-01HF-24	DMS	0 - 1000 µm/m	PCM	fehlerhafte Brückenschaltung
KA-DE 11	Dehnung (Kraft)	Alltech SG 325-01HF-24	DMS	0 - 1000 µm/m	PCM	fehlerhafte Brückenschaltung
KA-AH 10	Beschleunigung	offen	piezo- elektr.	0 - 200 g/2 kHz	kein Einsatz	
KA-AH 11	Beschleunigung	offen	piezo- elektr.	0 - 200 g	kein Einsatz	

-38-

MEA: digitale Meßwertverarbeitung
 ANA: analoge Registrierung
 PCM: schnelle digitale Meßwertverarbeitung

PDR: Punktedrucker
 LIS: Linienschreiber

ü.B.: über dem Boden

Tabelle 10c

TABELLE NR. 10c

MESS-STELLEN UND MESSWERTAUFNEMER:

KONDENSA. NEROHR A

Meß- stelle	Meßgröße	Meßwertaufnehmer	Meß- prinzip	Meßbereich der Kette	Regi- strier- art	Bemerkungen/ Störungen
KA-WS 10	Wasserstand	Sparkplug-Sonde	Leit- fähigkeit		PCM	Ausfall durch Leckage in der Sonde und Leitungsbruch
KA-WS 11	Wasserstand	Sparkplug-Sonde	Leit- fähigkeit		PCM	Ausfall durch Leckage in der Sonde und Leitungsbruch
KA-WS 12	Wasserstand	Sparkplug-Sonde	Leit- fähigkeit		PCM	Ausfall durch Leckage in der Sonde und Leitungsbruch
KA-WS 13	Wasserstand	Sparkplug-Sonde	Leit- fähigkeit		PCM	Ausfall durch Leckage in der Sonde und Leitungsbruch
KA-WS 14	Wasserstand	Sparkplug-Sonde	Leit- fähigkeit		PCM	Ausfall durch Leckage in der Sonde und Leitungsbruch
KA-WS 15	Wasserstand	Sparkplug-Sonde	Leit- fähigkeit		PCM	Ausfall durch Leckage in der Sonde und Leitungsbruch
KA-WS 16	Wasserstand	Sparkplug-Sonde	Leit- fähigkeit		PCM	Ausfall durch Leckage in der Sonde und Leitungsbruch
KA-IR 10	Luftdichte	Marviken-IR-Sonde	IR-Absorpt.	0 - 2 kg/m ³		kein Einsatz
KA-IR 11	Dampfdichte	Marviken-IR-Sonde	IR-Absorpt.	0 - 2 kg/m ³		kein Einsatz
KA-IR 12	Wasserkonzentr.	Marviken-IR-Sonde	IR-Absorpt.	0 - 2 kg/m ²		kein Einsatz

MEA: digitale Meßwertaufzeichnung
 ANA: analoge Registrierung
 PCM: schnelle digitale Meßwertaufzeichnung

PDR: Punktedrucker
 LIS: Linienschreiber

G.B.: über dem Boden

TABLE 10d

TABELLE NR. 10d

MESS-STELLEN UND MESSWERTAUFNEMER: KONDENSATIONSROHR B

Meß- stelle	Meßgröße	Meßwertaufnehmer	Meß- prinzip	Meßbereich der Kette	Regi- strier- art	Bemerkungen/ Störungen
KB-PA 20	Pitotsonde	STATHAM PA 856	DMS	0 - 4 bar	PCM	Ausfall der PCM-Regist. durch fehlerhafte Synchronisation
KB-PA 21	stat. Druck S	STATHAM PA 856	DMS	0 - 4 bar	PCM	Ausfall der PCM-Regist. durch fehlerhafte Synchronisation
KB-TM 24	Temperatur	MMT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
KB-TM 25	Temperatur	MMT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
KB-TM 26	Temperatur	MMT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
KB-TM 27	Temperatur	MMT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
KB-TW 20	Wandtemperatur	MMT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
KB-TW 21	Wandtemperatur	MMT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
KB-TW 22	Wandtemperatur	MMT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
KB-TW 23	Wandtemperatur	MMT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	

MEA: digitale Meßwerterfassung
 ANA: analoge Registrierung
 PCM: schnelle digitale Meßwerterfassung

PDR: Punktedrucker
 LIS: Linienschreiber
 S: schnelle Transiente

ü.B.: über dem Boden

TABLE 10e

TABELLE NR. 10e

MESS-STELLEN UND MESSWERTAUFNEMER:

KONDENSATIONSROHR B

Meß- stelle	Meßgröße	Meßwertaufnehmer	Meß- prinzip	Meßbereich der Kette	Regi- strier- art	Bemerkungen/ Störungen
KB-TM K0	Temperatur	MNT NiCrNi Ø 0,5/0,4	TE	0 - 200 °C	MEA	Ausfall durch TE-Bruch
KB-TM K1	Temperatur	MNT NiCrNi Ø 0,5/0,4	TE	0 - 200 °C	MEA	
KB-TM K2	Temperatur	MNT NiCrNi Ø 0,5/0,4	TE	0 - 200 °C	MEA	
KB-TM K3	Temperatur	MNT-NiCrNi Ø 0,5/0,4	TE	0 - 200 °C	MEA	
KB-TM K4	Temperatur	MNT NiCrNi Ø 0,5/0,4	TE	0 - 200 °C	MEA	
KB-TM K5	Temperatur	MNT NiCrNi Ø 0,5/0,4	TE	0 - 200 °C	MEA	
KB-TM K6	Temperatur	MNT NiCrNi Ø 0,5/0,4	TE	0 - 200 °C	MEA	Ausfall durch TE-Bruch
KB-TM K7	Temperatur	MNT NiCrNi Ø 0,5/0,4	TE	0 - 200 °C	MEA	
KB-TM K8	Temperatur	MNT NiCrNi Ø 0,5/0,4	TE	0 - 200 °C	MEA	
KB-TM H0	Temperatur	MNT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
KB-TM H1	Temperatur	MNT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
KB-TM H2	Temperatur	MNT-NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
KB-TM H3	Temperatur	MNT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
KB-TM H4	Temperatur	MNT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	

MEA: digitale Meßwerterfassung
 ANA: analoge Registrierung
 PCM: schnelle digitale Meßwerterfassung

PDR: Punktedrucker
 LIS: Linienschreiber

G.B.: über dem Boden

Tabelle 10f

Tabelle Nr. 10f

MESS-STELLEN UND MESSWERTAUFNEMER:

KONDENSATIONSROHR B

Meß- stelle	Meßgröße	Meßwertaufnehmer	Meß- prinzip	Meßbereich der Kette	Regi- strier- art	Bemerkungen/ Störungen
KB-DE 20	Dehnung (Kraft)	Ailtech SG 325-01HF-20	DMS	0 - 1000 $\mu\text{m/m}$	PCM	fehlerhafte Brückenschaltung
KB-DE 21	Dehnung (Kraft)	Ailtech SG 325-01HF-20	DMS	0 - 1000 $\mu\text{m/m}$	PCM	fehlerhafte Brückenschaltung
KB-AH 20	Beschleunigung		piezo- elektrisch	$\pm 200 \text{ g/2 kHz}$	kein Einsatz	
KB-AH 21	Beschleunigung		piezo- elektrisch	$\pm 200 \text{ g/2 kHz}$	kein Einsatz	
KB-WS 20	Wasserstand	Sparkplug-Sonde	Leit- fähigkeit		PCM	Ausfall durch Leckage in der Sonde und Leitungsbruch
KB-WS 21	"	Sparkplug-Sonde	Leit- fähigkeit		PCM	Ausfall durch Leckage in der Sonde und Leitungsbruch
KB-WS 22	"	Sparkplug-Sonde	Leit- fähigkeit		PCM	Ausfall durch Leckage in der Sonde und Leitungsbruch
KB-WS 23	"	Sparkplug-Sonde	Leit- fähigkeit		PCM	Ausfall durch Leckage in der Sonde und Leitungsbruch
KB-WS 24	"	Sparkplug-Sonde	Leit- fähigkeit		PCM	Ausfall durch Leckage in der Sonde und Leitungsbruch
KB-WS 25	"	Sparkplug-Sonde	Leit- fähigkeit		PCM	Ausfall durch Leckage in der Sonde und Leitungsbruch
KB-WS 26	"	Sparkplug-Sonde	Leit- fähigkeit		PCM	Ausfall durch Leckage in der Sonde und Leitungsbruch

MEA: digitale Meßwerterfassung
 ANA: analoge Registrierung
 PCM: schnelle digitale Meßwerterfassung

PDR: Punktedrucker
 LIS: Linienschreiber

G.B.: über dem Boden

TABLE 109

TABELLE NR. 109

MESS-STELLEN UND MESSWERTAUFNEHMER:

KONDENSATIONSROHR C

Meß- stelle	Meßgröße	Meßwertaufnehmer	Meß- prinzip	Meßbereich der Kette	Regi- strier- art	Bemerkungen/ Störungen
KC-PA 30	Pitotdruck	STATHAM PA 856	DMS	0 - 4 bar	PCM	Ausfall der PCM-Regist. durch fehlerhafte Synchronisation
KC-PA 31	stat. Druck S	STATHAM PA 856	DMS	0 - 4 bar	PCM	Ausfall der PCM-Regist. durch fehlerhafte Synchronisation
KC-TM 34	Temperatur	MMT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
KC-TM 35	Temperatur	MMT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	Temperatursignal um ca. 18 °C zu hoch
KC-TM 36	Temperatur	MMT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	Temperatursignal um ca. 3 °C zu niedrig
KC-TM 37	Temperatur	MMT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
KC-TM G0	Temperatur	MMT NiCrNi Ø 0,5/0,4	TE	0 - 200 °C	MEA	
KC-TM G1	Temperatur	MMT NiCrNi Ø 0,5/0,4	TE	0 - 200 °C	MEA	
KC-TM G2	Temperatur	MMT NiCrNi Ø 0,5/0,4	TE	0 - 200 °C	MEA	
KC-TM G3	Temperatur	MMT NiCrNi Ø 0,5/0,4	TE	0 - 200 °C	MEA	
KC-TM G4	Temperatur	MMT NiCrNi Ø 0,5/0,4	TE	0 - 200 °C	MEA	Ausfall durch Te-Bruch

MEA: digitale Meßwerterfassung
 ANA: analoge Registrierung
 PCM: schnelle digitale Meßwerterfassung

PDR: Punktedrucker
 LIS: Linienschreiber
 S : schnelle Transiente

u.B.: über dem Boden

TABLE 10h

TABELLE NR. 4-m)

MESS-STELLEN UND MESSWERTAUFNEMER:

KONDENSATIONSROHR C

Meß- stelle	Meßgröße	Meßwertaufnehmer	Meß- prinzip	Meßbereich der Kette	Regi- strier- art	Bemerkungen/ Störungen
KC-TM G5	Temperatur	MNT NiCrNi $\emptyset$ C,5/0,4	TE	0 - 200 °C	MEA	Ausfall durch TE-Bruch
KC-TM G6	Temperatur	MNT NiCrNi	TE	0 - 200 °C	MEA	
KC-TM G7	Temperatur	MNT NiCrNi	TE	0 - 200 °C	MEA	
KC-TM G8	Temperatur	MNT NiCrNi	TE	0 - 200 °C	MEA	
KC-DE 30	Dehnung (Kraft)	Alltech SG 325-01HF-22	DMS	0 - 1000 μ m/m	PCM	fehlerhafte Brückenschaltung
KC-DE 31	Dehnung (Kraft)	Alltech SG 325-01HF-22	DMS	0 - 1000 μ m/m	PCM	fehlerhafte Brückenschaltung
KC-AH 30	Beschleunigung		piezo- elektrisch	$\pm$ 200 g/2 kHz	kein Einsatz	
KC-AH 31	Beschleunigung		piezo- elektrisch	$\pm$ 200 g/2 kHz	kein Einsatz	

MEA: digitale Meßwertfassung
 ANA: analoge Registrierung
 PCM: schnelle digitale Meßwertfassung

PDR: Punktedrucker
 LIS: Linienschreiber

Ü.B.: über dem Boden

TABELLE NR. ~~1-A~~

KONDENSATIONSACHE C.

MEA: digitale Meßwerterfassung
ANA: analoge Registrierung
PCM: schnelle digitale Meßwerterfassung

PDR: Punktedrucker
LIS: Linienschreiber

Ü.B.: über dem Boden

M 1 : 50

G K S S

PRESSURE MEASUREMENT
in the WETWELL

Stand: Okt. 78

Fig. 13
ABB 13

M 1 : 50

STRAIN MEASUREMENT
in the WETWELL

100000

Stand: Okt. 78

G K S S

TABLE IIa

TABELLE NR. 101 MESS-STELLEN UND MESSWERTAUFNEMER: WETWELL (Kondensationskammer)

Meß- stelle	Meßgröße	Meßwertaufnehmer	Meß- prinzip	Meßbereich der Kette	Regi- strier- art	Bemerkungen/ Störungen
WW-PA 40	stat. Druck S	STATHAM PA 856	DMS	0 - 4 bar	PCM, ANA	
WW-PA 41	stat. Druck S	STATHAM PA 856	DMS	0 - 4 bar	PCM	
WW-PA 42	stat. Druck S	STATHAM PA 856	DMS	0 - 4 bar	PCM	
WW-PA 43	stat. Druck S	STATHAM PA 856	DMS	0 - 4 bar	PCM	Ausfall vor Versuch
WW-PA 44	stat. Druck S	STATHAM PA 856	DMS	0 - 4 bar	PCM	Ausfall während des Versuchs
WW-PA 45	stat. Druck S	STATHAM PA 856	DMS	0 - 4 bar	PCM, ANA	
WW-PA 46	stat. Druck S	STATHAM PA 856	DMS	0 - 4 bar	PCM	Ausfall während des Versuchs
WW-PA 47	stat. Druck S	STATHAM PA 856	DMS	0 - 4 bar	PCM	Ausfall während des Versuchs
WW-PA 48	stat. Druck S	STATHAM PA 856	DMS	0 - 4 bar	PCM, ANA	
WW-PA 49	stat. Druck S	STATHAM PA 856	DMS	0 - 4 bar	PCM	
WW-PA 50	stat. Druck S	STATHAM PA 856	DMS	0 - 4 bar	PCM	
WW-PA 51	stat. Druck S	STATHAM PA 856	DMS	0 - 4 bar	PCM	
WW-PA 52	stat. Druck L	STATHAM PA 822	DMS	0 - 4 bar	MEA	
WW-PA 53	stat. Druck L	STATHAM PA 822	DMS	0 - 4 bar	MEA	
WW-PA 54	stat. Druck L	HW P3M/10	DMS	0 - 4 bar	MEA + PDR	kein Signal wegen falscher Ventil- stellung

MEA: digitale Meßwerterfassung
 ANA: analoge Registrierung
 PCM: schnelle digitale Meßwerterfassung

PDR: Punktedrucker
 LIS: Linienschreiber
 S: schnelle Transiente
 L: langsame Transiente

S.B.: über dem Boden

TABLE 11b

TABELLE NR. 11b

MESS-STELLEN UND MESSWERTAUFNEMER:

WETWELL (Kondensationskammer)

Meß- stelle	Meßgröße	Meßwertaufnehmer	Meß- prinzip	Meßbereich der Kette	Regi- strier- art	Bemerkungen/ Störungen
WW-TM A1	Temperatur	MMT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
WW-TM A2	Temperatur	MMT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
WW-TM A3	Temperatur	MMT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
WW-TM A4	Tempera	MMT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
WW-TM A5	Temperatur	MMT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
WW-TM A6	Temperatur	MMT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
WW-TM B1	Temperatur	MMT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
WW-TM B2	Temperatur	MMT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
WW-TM B3	Temperatur	MMT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
WW-TM B4	Temperatur	MMT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
WW-TM B5	Temperatur	MMT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
WW-TM B6			TE	0 - 200 °C	kein Einsatz	
WW-TM C1	Temperatur	MMT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	

MEA: digitale Meßwerterfassung
 ANA: analoge Registrierung
 PCM: schnelle digitale Meßwerterfassung

PDR: Punktedrucker
 LIS: Linienschreiber

Ü.B.: über dem Boden

TABLE 11c

TABELLE NR. 11c

MESS-STELLEN UND MESSWERTAUFNEMMER:

NETWELL (Kondensationskammer)

Meß- stelle	Meßgröße	Meßwertaufnehmer	Meß- prinzip	Meßbereich der Kette	Regi- strier- art	Bemerkungen/ Störungen
WW-TM C2	Temperatur	MMT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
WW-TM C3	Temperatur	MMT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
WW-TM C4	Temperatur	MMT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
WW-TM C5	Temperatur	MMT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
WW-TM C6	Temperatur	MMT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
WW-TM D1	Temperatur	MMT NiCrNi Ø 0,5	TE	0 - 200 °C	kein Einsatz	
WW-TM D2	Temperatur	MMT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
WW-TM D3	Temperatur	MMT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
WW-TM D4	Temperatur	MMT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
WW-TM D5	Temperatur	MMT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
WW-TM D6	Temperatur	MMT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
WW-TM D7	Temperatur	MMT NiCrNi Ø 0,5	TE	0 - 200 °C	PDR	
WW-TM D8	Temperatur	MMT NiCrNi Ø 0,5	TE	0 - 200 °C	PDR	
WW-TM E1	Temperatur	MMT NiCrNi Ø 0,5	TE	0 - 200 °C	kein Einsatz	
WW-TM E2	Temperatur	MMT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	

MEA: digitale Meßwerterfassung (25 kHz)
 ANA: analoge Registrierung (40 kHz)
 PCM: schnelle digitale Meßwerterfassung (1,7 kHz)

PDR: Punktedrucker
 LIS: Linienschreiber

Ü.B.: über dem Boden
 (on the bottom)

TABLE II d

TABELLE NR. 1 →

MESS-STELLEN UND MESSWERTAUFNEMER:

WETWELL (Kondensationskammer)

Meß- stelle	Meßgröße	Meßwertaufnehmer	Meß- prinzip	Meßbereich der Kette	Regi- strier- art	Bemerkungen/ Störungen
WW-TM E3	Temperatur	MNT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
WW-TM E4	Temperatur	MNT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
WW-TM E5	Temperatur	MNT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
WW-TW 40	Wandtemperatur	MNT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
WW-TW 41	Wandtemperatur	MNT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
WW-TM 43	Temperatur	NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
WW-TW 44	Wandtemperatur	NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
WW-TW 45	Wandtemperatur	NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	

MEA: digitale Meßwertfassung
 ANA: analoge Registrierung
 PCN: schnelle digitale Meßwertfassung

PDR: Punktedrucker
 LIS: Linienschreiber

ü.B.: über dem Boden

TABLE IIc

TABELLE NR. 4-2

MESS-STELLEN UND MESSWERTAUFNEMER:

WETWELL (Kondensationskammer)

Meß- stelle	Meßgröße	Meßwertaufnehmer	Meß- prinzip	Meßbereich der Kette	Regi- strier- art	Bemerkungen/ Störungen
WW-AH 40	Beschleunigung	HBM B 12/2000	induktiv	250 g/200 Hz	PCM	
WW-AH 41	Beschleunigung	HBM B 12/2000	induktiv	250 g/200 Hz	PCM	
WW-AH 42	Beschleunigung	HBM B 12/2000	induktiv	250 g/200 Hz	PCM	
WW-AH 43	Beschleunigung	HBM B 12/2000	induktiv	250 g/200 Hz	PCM	Defekt im Stecker
WW-AH 44	Beschleunigung	HBM B 12/2000	induktiv	250 g/200 Hz	PCM	
WW-AH 45	Beschleunigung	HBM B 12/2000	induktiv	250 g/200 Hz	PCM	
WW-DE 40	Dehnung	HBM 10/120 LY11	DMS	0 - 500 $\mu\text{m/m}$	MEA	
WW-DE 41	Dehnung	HBM 10/120 LY11	DMS	0 - 500 $\mu\text{m/m}$	MEA	Ausfall der Brücke vor Versuch
WW-DE 42	Dehnung	HBM 10/120 LY11	DMS	0 - 500 $\mu\text{m/m}$	MEA	
WW-DE 43	Dehnung	HBM 10/120 LY11	DMS	0 - 500 $\mu\text{m/m}$	MEA	
WW-DE 44	Dehnung	HBM 10/120 LY11	DMS	0 - 500 $\mu\text{m/m}$	MEA	
WW-DE 45	Dehnung	HBM 10/120 LY11	DMS	0 - 500 $\mu\text{m/m}$	MEA	

MEA: digitale Meßwerterfassung
 ANA: analoge Registrierung
 PCM: schnelle digitale Meßwerterfassung

PDR: Punktedrucker
 LIS: Linienschreiber

Ü.B.: über dem Boden

Tabelle 119

TABELLE NR. 119

MESS-STELLEN UND MESSWERTAUFNEMER:

WETWELL (Kondensationskammer)

Meß- stelle	Meßgröße	Meßwertaufnehmer	Meß- prinzip	Meßbereich der Kette	Regi- strier- art	Bemerkungen/ Störungen
WN-PD 68	(Differential press.) Differenzdruck	STATHAM PM 8052	DMS	1 bar	MEA	
WN-PD 69	Differenzdruck	STATHAM PM 8052	DMS	0,2 bar	MEA	falsche Empfindlichkeitseinstellung
WN-WS 40	(Water level) Wasserstand	Sparkplug-Sonde	Leit- fähigkeit		PCM	
WN-WS 41	Wasserstand	Sparkplug-Sonde	Leit- fähigkeit		PCM	
WN-WS 42	Wasserstand	Sparkplug-Sonde	Leit- fähigkeit		PCM	
WN-WS 43	Wasserstand	Sparkplug-Sonde	Leit- fähigkeit		PCM	
WN-WS 44	Wasserstand	Sparkplug-Sonde	Leit- fähigkeit		PCM	
WN-WS 45	Wasserstand	Sparkplug-Sonde	Leit- fähigkeit		PCM	
WN-WS 46	Wasserstand	Sparkplug-Sonde	Leit- fähigkeit		PCM	

MEA: digitale Meßwerterfassung
 ANA: analoge Registrierung
 PCM: schnelle digitale Meßwerterfassung

PDR: Punktedrucker
 LIS: Linienschreiber

ü.B.: über dem Boden

TABLE III
TABELLE NR. 11

MESS-STELLEN UND MESSWERTAUFNEMER: EXPANSIONSRAUM
HALLE

Meß- stelle	Meßgröße	Meßwertaufnehmer	Meß- prinzip	Meßbereich der Kette	Regi- strier- art	Bemerkungen/ Störungen
EX-PA 70	stat. Druck L	STATHAM PA 822	DMS	0 - 4 bar	MEA+ PDR	
EX-TM 70	Temperatur	MNT NiCrNi Ø 0,5/0,25	TE	0 - 200 °C	MEA	
EX-TM 71	Temperatur	MNT NiCrNi Ø 1	TE	0 - 150 °C	PDR	
EX-TM 72	Temperatur	MNT NiCrNi Ø 0,5/0,25	TE	0 - 200 °C	kein Eins.	
EX-TM L1	Temperatur	MNT NiCrNi Ø 0,5	TE	0 - 200 °C	kein Eins.	
EX-TM L2	Temperatur	MNT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
EX-TM L3	Temperatur	MNT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
EX-TM L4	Temperatur	MNT NiCrNi Ø 0,5	TE	0 - 200 °C	MEA	
HA-PA 75	Atmosphären- druck	Pell + Howell 4 - 461	Kapazitiv	890-1060 mbar	--- (MEA)	
HA-TM 75	Temperatur	MNT NiCrNi Ø 1,0	TE	0 - 150 °C	PDR	
HA-TM 76	Temperatur	MNT NiCrNi Ø 1,0	TE	0 - 150 °C	PDR	
HA-TM 77	Temperatur	MNT NiCrNi Ø 1,0	TE	0 - 150 °C	PDR	

MEA: digitale Meßwerterfassung
ANA: analoge Registrierung
PCM: schnelle digitale Meßwerterfassung

PDR: Punktedrucker
LIS: Linienschreiber

G.B.: über dem Boden

GKSS

Kamerapositionen IN PRETEST VM 1

Stand: 15.3.79

Fig.
Abb. 1/6

DISCUSSION OF TEST RESULTS

As mentioned earlier, 3 pretests (VM-1, -2, & -3) have been conducted on the 3-vent pressure suppression test stand. All data has been processed by GKSS for VM-1 and a sampling of results are included here as drawn from Ref. 2. Results from VM-2 & -3 are expected in the near future. Table 12 provides a reference to the included figures.

TABLE 12. SAMPLING OF PRETEST VM 1 RESULTS

<u>Figure No.</u>	<u>Transducer</u>	<u>Contents</u>	<u>Time Interval-sec.</u>
17	DY-PA60	Drywell pressure history	0 - 5
18	(Calculated)	Mass flow rate to Drywell	0 - 250
19	WW-PA40,45,48	Vent exit pressure (Vents A, B, & C)	65 - 85
20	WW-PA40,45,48	Vent exit pressure (Vents A, B, & C)	65 - 67
21	WW-DE 47	Above-surface impact gage	65 - 67.5
22	WW-DE 46	Sub-surface impact gage	65 - 67.5
23	WW-DE 40	Wetwell wall strain history	65 - 67.5
24	WW-AH 45	Wetwell wall accelerometer history	65 - 67.5
25	DK-PA05	Steam Boiler Pressure History	0 - 250

The drywell pressurization rate for VM 1 was 11.2 psi/sec. as indicated on Fig. 17. This was due to an initial break flow rate of ~25 kg/sec as shown in Fig. 18. A sequence of 5 chugging events are identified in Fig. 19. Chug event -1, as observed at the exit of the 3 vents A, B, & C is shown in Fig. 20. From these results a strong simultaneity of pool response is observed. I have chosen to characterize this pressure pulse form, as shown in Fig. 20 and the sketch on the following page, by 5 separate peaks. The approximate timing of these peaks is given in Table 13 relative to peak 1 of vent pipe B.

GKSS

DAS - VERSUCH NR. VM 01
DRYWELL Pressure History - Measured

ABB.17

GKSS

DAS-VERSUCH VM 01

ABB. 19

CHUG EVENT - TRAIN

-62-

GKSS	DAS-Versuch VM 1 CHUG EVENT -DETAIL (CHUG#1)	Stand: 4. 79
		Abb. 20

In general, the pulse form is the same from all 3 vents although the amplitudes vary significantly.

TABLE 12. TIME CHARACTERIZATION OF CHUG PULSE NO. 1
(relative to peak 1- vent pipe B-ms)

Vent Pipe	Peak No.				
	1	2	3	4	5
A	+15	+27	+42	+135	+146
B	0	+12	+42	+138	+165
C	0	+15	+42	+138	+162

Characterizations of Chug Pulse Peaks

With regard timing of the peaks and within the accuracy of this preliminary characterization,

- the peak (1) rarefaction is simultaneous at vents B & C and delayed ~15 ms at vent A.
- the peak (2) compression is simultaneous at vents B & C and delayed ~15 ms at vent A in a much weaker state.
- the peak (3) compression is simultaneous at all 3 vents.
- the peak (4) rarefaction is nearly simultaneous at all 3 vents.
- the peak (5) compression is nearly simultaneous at vents B & C; it arrives ~20 ms earlier at vent A.

Note that no vent inlet baffle plates are used in these tests.

Figures 21 through 24 are included here to provide a visual indication of data quality as well as event timing for representative transducer types (pool impact gauges, wetwell wall strain, and wetwell wall acceleration. On each of these figures the time of peak 1 as seen at vent B (Ref. Fig. 20) is indicated by a vertical arrow. The pressure vessel pressure history for the first 250 seconds of the test is shown in Figure 25. Again the time of chug peak 1 is shown by a vertical arrow. The GKSS-PSS facility is apparently very effective in producing the desired chugging phenomena since it occurs only ~66 seconds into an approximately 400 second transient.

Figure 26 provides a coplot of several related pressures during the vent clearing time period (0-5 sec). This is included to provide a Mark II correlation to phenomena observed earlier in the Mark I vent system.^a Shown in Figure 26 are the drywell pressure, ullage pressure, vent C exit pressure, and pool bottom pressure. The characteristic MK I dual peaks at vent exit and pool bottom (PA48 & PA50) following vent clearing, as well as near equal late time pressurization histories of drywell, and pool pressures (PA60, 48 and 50), are clearly evident. The exceptional behavior of ullage pressure (PA53) at late times is due to the special expansion room of the GKSS-PSS facility which prevents the ullage pressure from increasing times beyond 1.7 seconds. The degree to which this atypical behavior decreases the expected MK II ullage transient and influences subsequent condensation will be a subject for further study.

^aSee Fig. 40, UCRL-52371

GKSS

DAS - VERSUCH NR. VM 01.

ABB. 21

ABOVE-SURFACE IMPACT GAGE RESPONSE - WETWELL

GKSS

DAS - VERSUCH NR. VM 01

ABB. 22

SUB-SURFACE IMPACT CHARGE RESPONSE - WETWELL

GKSS

DAS - VERSUCH NR. VM. 01

ABB. 23

WALL STRAIN HISTORY - WETWELL

GKSS

DAS - VERSUCH NR. VM 01

ABB. 24

-70-

GKSS

DAS - VERSUCH NR. VM 01

ABB. 26

PRESSURE SUPPRESSION PRETEST No. VMI

CONCLUSIONS AND RECOMMENDATIONS

Study of the GKSS-DAS facility and discussion of the planned test matrix with the GKSS staff indicates this multivalent pressure suppression test program is well suited to aid the U.S.NRC in improved understanding of the dynamic loads induced in a Mk II containment during a hypothetical LOCA. Preliminary tests to date in the 3 vent configuration have produced good quality data. Additional pressure transducers will be added for direct wetwell floor and wall measurements, to enhance the usefulness of each test. As a result of the visit to the facility, efforts are underway to resolve pressure transducer sensitivity to temperature transients as well as preliminary difficulties experienced in high speed photography of vent effluent.

Initial results of the first multivalent test show that significant steam chugging events occur early in the blowdown and persist throughout the test. These events are seen to occur with a high degree of simultaneity and to produce significant lateral loading on the free hanging vent pipes.

Data transfer to the U.S. appears to be straight forward and no difficulties are anticipated. It is recommended that only selected-time digital data be obtained from each test in order to gain needed information while minimizing mag tape storage requirements. Further, it is recommended that the video records and high speed cine records be considered as part of the test data base and thus obtained for each test.

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