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Besse, J.; Cattiaux, G.; Clicques, J.; Landez, J.P.; Birac, A.M.

Intercontrole, 94-Rungis (France)

Benaist, P.; Viard, J.

CEA CEN Saclay, 91-Gif-sur-Yvette (France). IRDI, Dept. de Technologie

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DIVISION DE METALLURGIE ET D'ETUDES DES COMBUSTIBLES NUCLEAIRES

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SERVICE DES TECHNIQUES AVANCEES

NEW GENERATION OF FRENCH ISIM

J. BESSE - G. CATTIAUX - J. CLICQUES - J.P. LANDEZ - AM. BIRAC
INTERCONTROLE / RUNGIS / FRANCE

P.BENOIST - J. VIARD
IRDI-STA-SCND - CEN SACLAY / GIF SUR YVETTE / FRANCE

ABSTRACT

Up to now, 110 pre- or inservice inspections have been performed both in France and aboard by the mean of the first generation of french ISIM named MIS.

Due to the increase of the number inspections which have to be realized in the next years, a new generation of ISIM have been developped. The first one is named MIS 5.

This new generation makes profit of the recent developments of technology, in particulary in the field of electronics, computers ... and so on.

The general structure of the mechanical part of MIS has not been changed, some improvements have been introduced to take in account the experience and facilitate maintenance, mounting, dismounting and transportation.

The main changes lie in the control system and data acquisition and analysis equipment.

The versatility of computers is widely used.

A parametrizing unit allows to set all the parameters both for the tools and for the ultrasonic equipment and the data acquisition system.

The ultrasonic equipment is able of managing 32 channels. Data are recorded simultaneously on Winchester disk, bulk memory and cassette of a HP 1000 computer (serial 900) and cassette.

SOFTWARES have been developped by INTERCONTROLE (IC) for acquisition and analysis, which allow to exhibit results automatically on screen printer or/and plotter.

All the electronics and computer equipment are set in a shelter outside of the containement, linked to the MIS by 2 cables, (120m long).

1. INTRODUCTION

Since July 1976 (first pre-service inspection realized in France on FESSENHEIM plant 1), with an automatic tool and up to now, CEA and IC have completed about 120 inspections of PWR vessels (60 PSI, 60 ISI), using the first generation of french ISIM called MIS.

The table below shows some of the capacities of the first generation.

EQUIPMENT	FIRST USE		ADAPTATION AVAILABLE				NUMBER OF INSPECTIONS from 07.76 to 10.86		REMARK
	FIRST PRE SERVICE	FIRST IN SERVICE	300 MWe	900 MWe	1300 MWe	MBT (1)	PRE SERVICE	IN SERVICE	
MIS 1	07.76			yes			13		(2)
MIS 2		11.76	yes	yes	yes	yes		33	
MIS 3	02.80			yes	yes		38		
MIS 4	04.82	07.82	no	yes	yes	yes	1	17	
MIS 5		07.86	no	yes	yes	yes		2	
MIS 8	08.81	03.86	yes (4)	yes		yes	5	3	(3)

REMARKS

(1) MBT : Underclading cracks detection and sizing tool

(2) Used since end of 1981 for methods qualification and international progams such as PWS , PISC , ...

(3) WESTINGHOUSE or FRAMATOME design

(4) Manufactured in 1987

These machines are able to complete examinations using the following technics :

- ultrasonic focused probes, used in immersion [1]. Those transducers have been choised formerly, because of their good detection capability through cladding and aptitude to give accurate informations for sizing [2] [3] [4] [5].
- gammaray examination of safe end welds ;
- televisual examination of the cladding surface.

In the middle of 1985, due to the increase of plants in operation in France, E.D.F. asked IC to built a new MIS, in order to have 3 ISIM available for inservice inspections.

2. MAIN CHARACTERISTICS

Figure 1 gives a block diagram of the whole equipment.

In comparison with previous ISIM, main differencies lie in :

- a parameterizing unit which allows to set all values of position scanning speed, increment angle, ultrasonic sequences, gain, gates, ... and so on ;
- a computerized ultrasonic equipment able of 32 channels ;
- data acquisition and analysis specific softwares are implanted on a HEWLETT PACKARD computer 1000 serial 900.

The mechanical device has been modified, although the main technical choices remain the same, to take in account the experience and facilitate maintenance mounting, dismounting and transport operations.

2.1. PARAMETERIZING UNIT

This unit is used in the preparation phasis to record all the parameters necessary for the setting of the UT and control command systems.

Before starting the examination of one part of the vessel, all the values are transferred to the active elements simply by calling the sequence of control identification number. Set of parameters :

ultrasonic equipment
Sequence transmitter/receiver
Gain
Position and duration of gates
Type of synchronisation : echo start, emission ...

control command equipment
Scanning speed
Length of movements
Incremental value

For all the examination sequences, all the values are stored on 720 kilo bytes. A printer is available for the print out of data stored.

2.2. CONTROL COMMAND UNIT

On this unit, all the movements can be manually obtained ; their speeds are easily adjustable. This unit is programmable by the mean of the parameterizing unit (IEEE 488 link).

A microprocessor manages all the movements and safeties. Automatic sequences of examination are programmed and are called by codes on a key board.

The status, position and movements of the tools are displayed on an illuminated mimic diagram. A daily log is print out.

2.3. ULTRASONIC UNIT AND DATA ACQUISITION SYSTEM

The ultrasonic unit has been developped by IC in order to met the following requirements :

- programmable by computer, by the mean of a IEEE 488 link ;
- pass band 1000Hz to 40MHz, -6dB ;
- 32 multiplexed transmission and/or reception channels ;
- addressable HF filter for each reception channel ;
- addressable envelope filter for each reception channel ;
- A.Scan display : logarithmic presentation / dynamic range : 68dB ;
- generation of validation gates for each reception channel : position adjustable from 1 to 999µs (accuracy : 20µs) / duration adjustable from 1 to 999µs (accuracy : 20µs) / programmable synchronisation : transmission, echo start digitised out put of data (amplitude, time of flight on 16 bits).

The data acquisition system of ultrasonic data is based on a 16 bit computer. The characteristics of the information which are recorded have been described formerly [6]. Each event recorded is composed of channel number amplitude, time of flight, position along the scanning direction, angle position. All the events are recorded on a 55 megabyte Winchester disk with saving on 60 megabyte cassette.

Softwares are available which allow to display on screen real time B, C and D.Scan images, as the examination is on the way.

In order to give to the operators watching the examination the maximum easily interpretable information, areal time B.Scan analog display is presented on five memory screen [7].

2.4. DATA ANALYSIS AND PROCESSING

Data analysis and processing softwares are implanted on a "16 bit" computer associated with a 132 megabyte Winchester disk (see figure 2).

On the basis of raw data, first it calculates the actual position of each event in regard with the vessel coordinates (see figure 3).

Then according to proximity rules (3D space) the events are grouped. The limits of the volume envelops are calculated automatically. A, B, C and D.Scan of the envelops are displayed on colour screen and may be reproduced on printer or plotter on request. Zoom fonctions are avaible.

An imagery software gives to the operator the opportunity to obtain on coulour screen A, B, C and D.Scan presentations. Those images might be reproduce on paper (plotter) (see figures 4 and 5).

Using the information obtained from event grouping software and imagery software, and knowing the geometry of the zone inspected, the list of flaw indications is obtained (see figure 6). All the results are stored in cassette.

2.5. MECHANICAL ASPECTS

The MIS is stainless steel welded assembly. Its total weight, when assembled, is 10 tonnes, the heaviest component is 3 tonnes. The MIS has to be handled by the reactor containement crane. When laying on the flange crane hook is removed.

MIS is watertight under 20m of water. Movements are either, electrical ones using DC low voltage motors or hydraulic ones by demineralised water actuators.

During examination phasis, the scanning speed is adjustable up to 300 mm/s. When MIS is dismounted, it is stored in 6 tight containers and may travel by road or air plane.

2.6. ACQUISITION AND ANALYSIS SHELTERS

Two air conditionned shelters are used. The first one containing the control command and parametrizing units ; the ultrasonic unit and data acquisition system is linked by 2 cables 120m long to the MIS. The second one contains the data analysis and processing. Those two shelters are set close by the reactor containement.

3. CONCLUSION

The first ISIM of this new generation of machines has been studied manufactured, mounted and entierly tested within 10 months.

The first inservice inspection, using it, have been conducted with in July 1986 ; the examination ended 10 hours before the contract duration.

The inspection covering testing of all the welds by UT, examination of all the nozzle area affected by under cladding cracking phenomena, televisual examination of the whole cladded surface of the vessel and gammaray exposition of the 12 safe end welds (bi-metallic and homogenous) lasted 14 days. The team was working day and night in 4 shifts ; it was composed of 20 persons, only 2 UT level 3, are required to manage such an examination.

INTERCONTROLE is now currently examining the possibilities of transferring some of the improvements of this new ISIM to the first generation machine.

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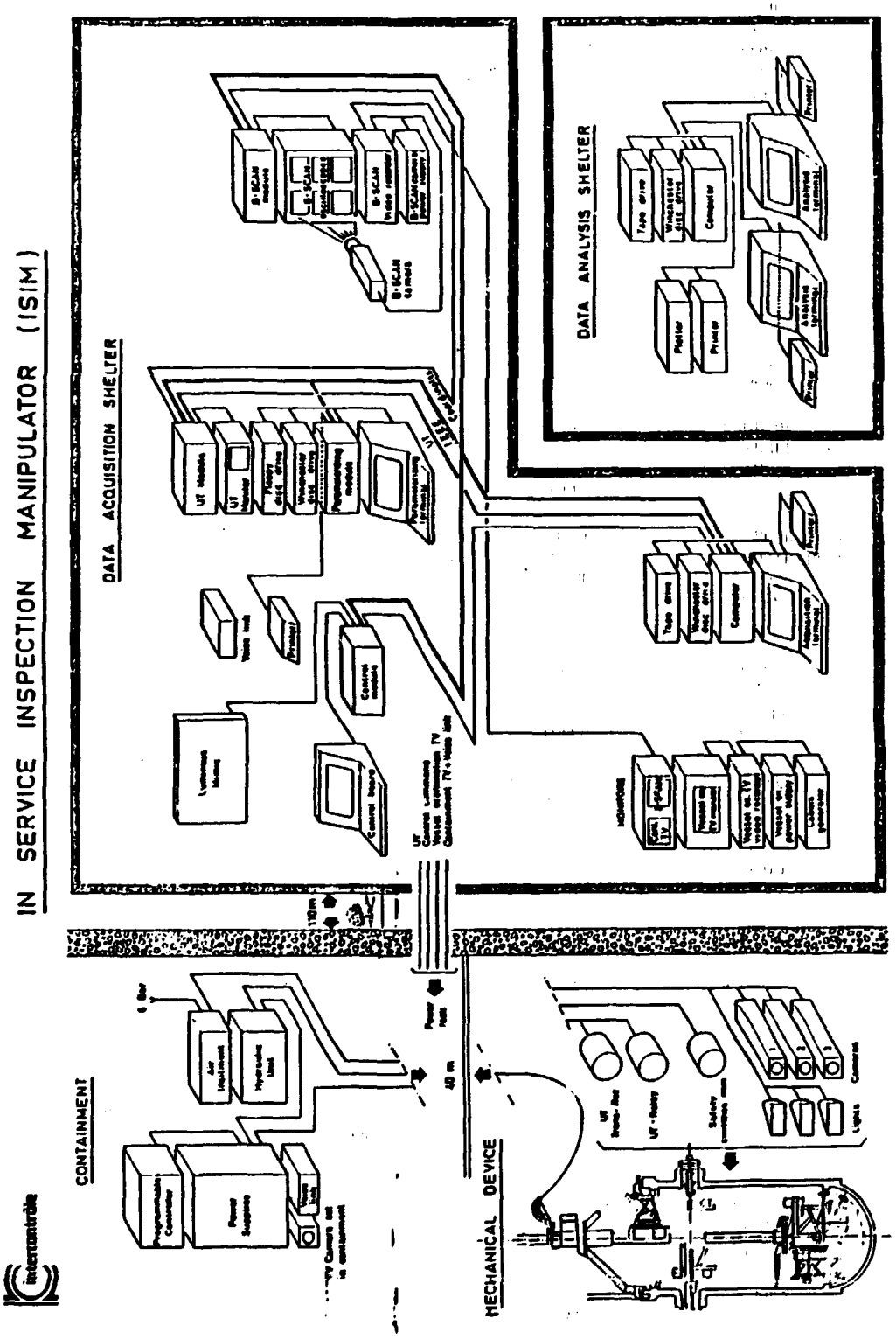
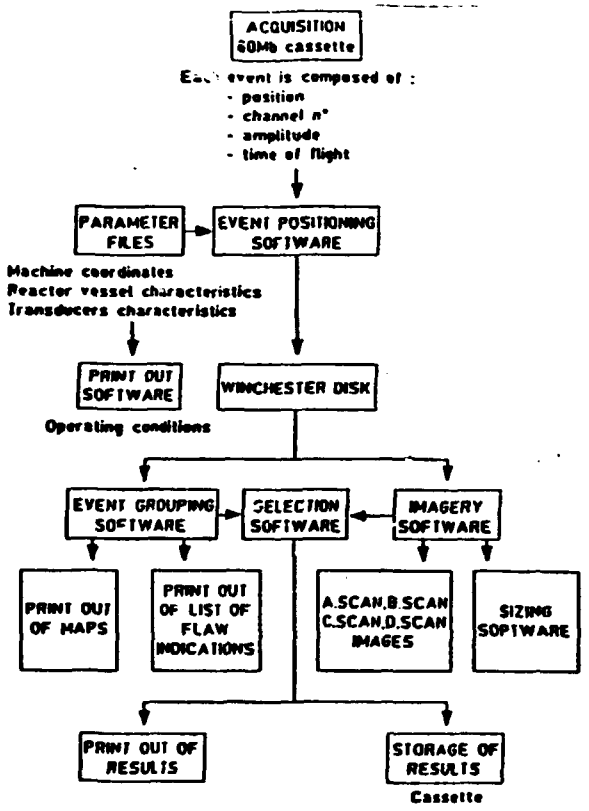


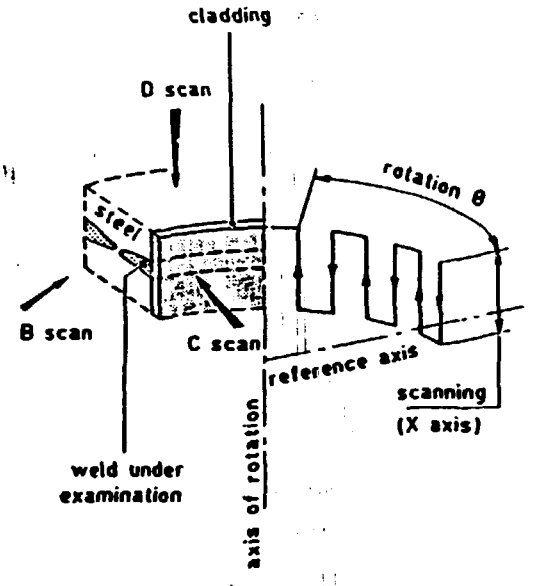
BLOCK DIAGRAM OF ISIM

FIGURE 1



DATA ANALYSIS

FIGURE 2

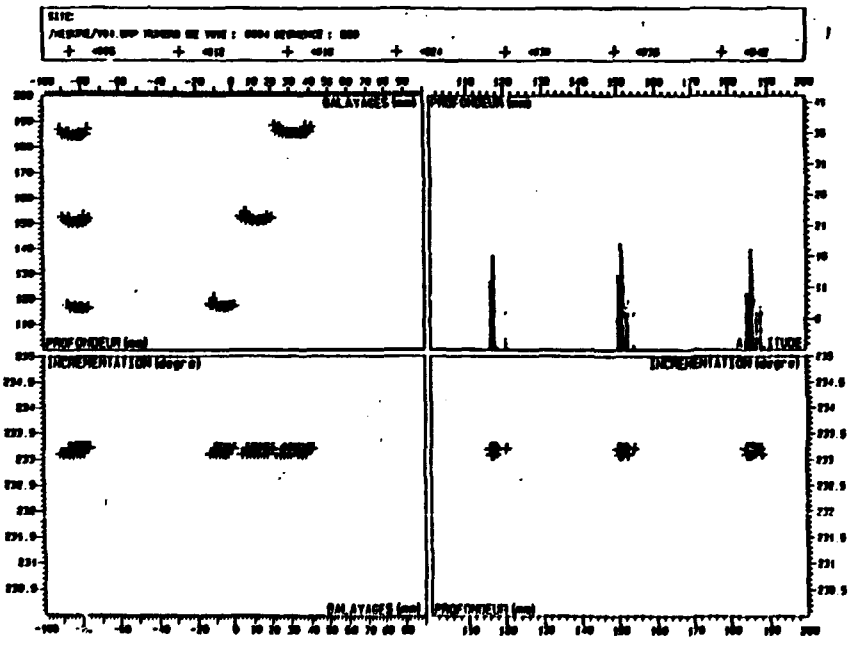


IMAGERY REPRESENTATION

FIGURE 3

A, B, C and D.Scan images of a test block including side drilled hole 2mm in diameter

FIGURE 4



KEY WORDS :

- BALAYAGE = SCANNING
- PROFONDEUR = DEPTH
- INCREMENT = INCREMENT

LABEL	
D.SCAN	A.SCAN
C.SCAN	B.SCAN

FIGURE 5a

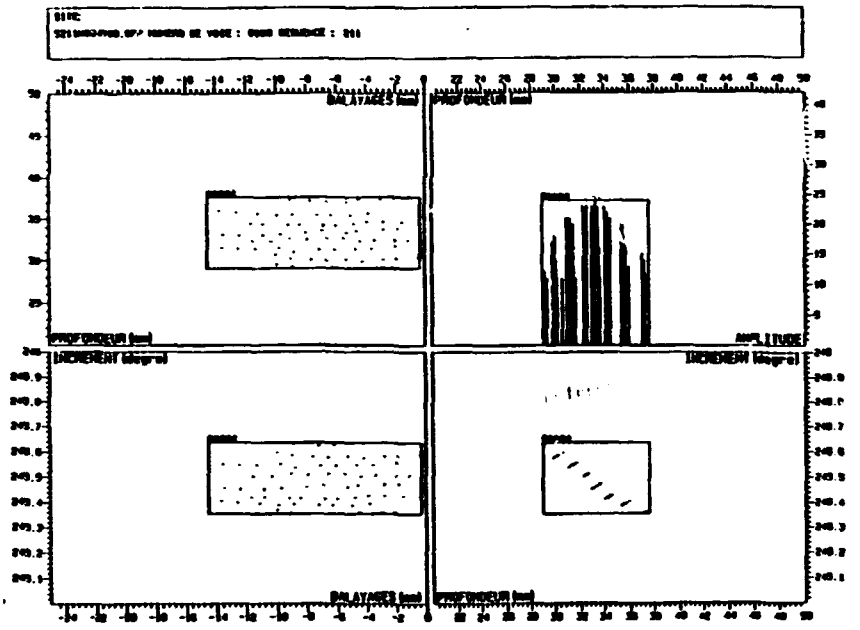


FIGURE 5b

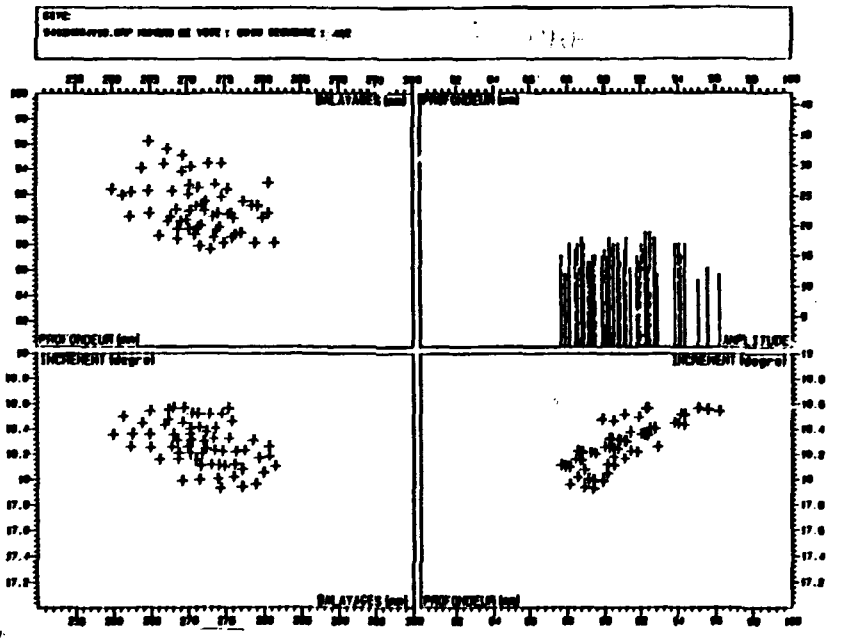


FIGURE 5c

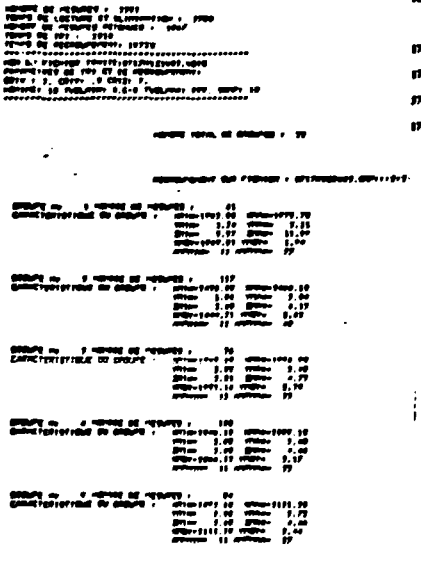


FIGURE 5a : EXAMPLE OF IMAGERY POINTING OUT THE GROUP ENVELOPS

FIGURE 5b : AN OTHER EXAMPLE OF IMAGERY

FIGURE 5c : EXAMPLE OF PRINT OUT

FIGURE 5

Case :	Niveau de lecture 5 = -15 dB					Date :	Niveau de lecture 5 = -15 dB					Page :
Numéro indication	P Sommet (en mm)	P Fond (en mm)	Tete hub. (en deg.)	Ø/axe cuve (en mm)	Lx (en mm)	Numéro indication	P Sommet (en mm)	P Fond (en mm)	Tete hub. (en deg.)	Ø/axe cuve (en mm)	Lx (en mm)	Observations
14	8	12	7.5	2211	12	14	11	15	7.8	2212	13	N = 4
21	8	12	16.8	1951	24	21	11	15	17.1	1953	23	N = 4
45	8	12	175.8	1949	23	45	12	15	174.8	1950	23	N = 4
******						*******						
******						*******						
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******						*******						
******						*******						
******						*******						
		R = Cc + 613 +1.000 x P		Alfa =0 deg. CIRC Alfa=1.00		Cc = 1273mm		CS = 590 mm CS = 629 mm		*******	Date :	Nom :	Visa :
Numéro de R.E. :		Site :		Tranche :		Type de visite :		Contrôle de: ZONE A		I.C.			

EXAMPLE OF FINAL RESULTS PRINT OUT

FIGURE 6