



Proprietary Note:

These procedures are the property of Fläkt Woods Limited and are not to be reproduced without written permission and are to be returned upon request. When loaned, it is with the express agreement that they will not be used except for the limited purpose for which they were loaned. The Quality Assurance Department will determine the degree of proprietary control required and will obtain acknowledgement from the requestor/recipient that they understand the restrictions being imposed.

RADIOSCOPIC PROCEDURE

RQCP/001

TITLE:        **RADIOSCOPIC INSPECTION OF ALUMINIUM CAST ALLOYS  
USING REAL TIME RADIOGRAPHY**

DATE OF ISSUE:    **21 DECEMBER 2004**

PREPARED BY	INSPECTION SUPERVISOR	T MOONEY		
REVIEWED AND APPROVED BY	TWI CERTIFICATION BOARD	I PINSON		
	QUALITY ASSURANCE CO-ORDINATOR	R F BARNETT		
AUTHORISED BY	OPERATIONS MANAGER	N EGNER		
	TITLE	NAME (Print or Type)	SIGNATURE	DATE

DOCUMENT N°	REV
RQCP/001	01



**REV NO: 01    DATE 28.10.2004    MANAGEMENT SYSTEMS PROCEDURE NO: ROCP/001**  
**TITLE:    RADIOSCOPIC INSPECTION OF ALUMINIUM CAST ALLOYS USING REAL TIME**  
**RADIOGRAPHY**

<b>Section</b>	<b>Page</b>
1.0    Scope	04
2.0    References	04
3.0    Definitions	05
4.0    Safety	05
5.0    Personnel	05
6.0    Identification	06
7.0    Surface Preparation	06
8.0    Extent of Inspection	06
9.0    Equipment Specification	06 - 13
10.0    Equipment Calibration	13
11.0    Equipment Checks	14
12.0    Technique	14
13.0    Assessment of Results	14
14.0    Results	14
15.0    Non-Conformance	14

**REV NO: 01    DATE 28.10.2004    MANAGEMENT SYSTEMS PROCEDURE NO: RQCP/001**  
**TITLE:    RADIOSCOPIC INSPECTION OF ALUMINIUM CAST ALLOYS USING REAL TIME**  
**RADIOGRAPHY**

## 1.0    **SCOPE**

This procedure covers the radiographic inspection of both steel and aluminium cast alloys used for the production of fan impeller parts with thickness up to 120 mm. Utilising constant potential X-ray equipment operating below 300kV, which is in accordance with ASTM E1255 (Standard Practice for Radioscopic Real Time Examination) and ASTM E1000-89 (Standard Guide for Radioscopic Real Time Imaging).

The detection medium to be used will be a group 2 X-ray image intensifier as defined in BS 7009.

100% of the component will be covered and the defects to be located will include both volumetric and planar defects located at the surface and sub-surface.

Radiographic inspections will, when specified on the manufacturing instructions, be utilised in conjunction with complementary NDT methods such as magnetic particle, penetrant inspection or ultrasonic inspection to ensure full coverage is achieved.

## 2.0    **REFERENCES**

The following documents are to be utilised in conjunction with this procedure:

BS 2737	Terminology of Internal Defects in Castings (as revealed by radiography).
BS 3683	Glossary of terms used in non-destructive testing Part 3 Radiological Flaw Detection
BS 3971	Specification for Image Quality Indicators for Industrial Radiography.
ASTM E747-97	Controlling the quality of radiographic testing using wire penetrameters,
ASTM E1255-96	Standard Practice for Radioscopy
ASTM E155	Reference Radiographs for inspection of Aluminium and Magnesium Castings
SNT-TC-1A(1996)	Personnel Qualification and Certification in Non-Destructive Testing.
IRR 99	Ionising Radiations Regulations 1999
RQCP/002	Fläkt Woods Limited Radioscopic Calibration Procedure
RQCP/003	Fläkt Woods Limited written practice for the Qualification and Certification of NDT personnel.

**REV NO: 01    DATE 28.10.2004    MANAGEMENT SYSTEMS PROCEDURE NO: RQCP/001**  
**TITLE:    RADIOSCOPIC INSPECTION OF ALUMINIUM CAST ALLOYS USING REAL TIME**  
**RADIOGRAPHY**

### 3.0    **DEFINITIONS**

For the purpose of this procedure the terms and definitions listed in ASTM E1316– 95b Section 07 Terminology for Non-Destructive Examinations shall apply. The following abbreviations are employed in this procedure

kV:            Kilovoltage

mA:           milliamperage

### 4.0    **SAFETY**

Operators shall be trained so that they are familiar with local and company safety requirements, and statutory regulations.

Radiographic procedures shall comply with the requirements of the Ionising Radiation Regulations and associated Local Rules, in addition to the Company's Health and Safety Policy.

All personnel carrying out industrial radiography shall wear personnel monitoring equipment such as film badges so as to accurately measure their received dose levels. Operators will further utilise instantaneous radiation monitoring equipment to prevent excess exposure to radiation.

Operators will have received an annual medical within the previous 12 months at which their general suitability for classification as a classified worker will have been verified. Blood sample measurements will have been carried out to determine if any over exposure has occurred within the previous 12 months.

Radioscopic inspections shall only be performed within the supervised areas as defined in the Ionising Radiations Regulations Local Rules so as to prevent unauthorised access by unclassified workers. Operators will employ practices to ensure that radiation doses are as low as reasonably achievable.

### 5.0    **PERSONNEL**

Personnel applying this procedure shall hold a current qualification to SNT TC 1A Level I or II in radioscopic inspection, supervised by an independently certificated Level III. Colour vision and near vision acuity will be in accordance with the requirements of Fläkt Woods Limited written practice reference RQCP/003

**REV NO: 01    DATE 28.10.2004    MANAGEMENT SYSTEMS PROCEDURE NO: ROCP/001**  
**TITLE:    RADIOSCOPIC INSPECTION OF ALUMINIUM CAST ALLOYS USING REAL TIME**  
**RADIOGRAPHY**

## 6.0    **IDENTIFICATION**

Where specified, all components will be uniquely identified such that radioscopic examination images/records for the component can be traced.

Full material identification and traceability will only be maintained where specifically stated at the order input stage or within the manufacturing instructions (e.g. part drawing).

Items found to be outside of the radiographic acceptance criteria shall be identified as being non-conforming and shall be segregated to prevent further use. The numbers of non-conforming items are recorded for analysis purposes with respect to both internal and external supplier performances. Repairs to non-conforming items shall only be permitted by concession. Internal defects shall not be repaired but surface defects may be made good if agreed by concession.

The control of non-conforming items refers to Quality Control Procedure reference QCP/013. Applications for a concession refer to Quality Control Procedure reference QCP/006.

## 7.0    **SURFACE PREPARATION**

Castings will be free from all traces of loose scale, oil and grease. They will further be in the fully fettled condition. Casting surfaces shall be prepared such as to remove any conditions that could mask or be confused with internal/surface casting discontinuities.

## 8.0    **EXTENT OF INSPECTION**

All sections of the casting shall be tested in accordance with the specific radioscopic inspection component drawing(s).

## 9.0    **EQUIPMENT SPECIFICATION**

Equipment to be utilised shall be in accordance with the requirements of ASTM E1255. The equipment and material to be utilised are:

### 9.1    **768/225 Bay System**

#### 9.1.1    **Product Details**

##### 9.1.1.1    **Product Type and Range** Aluminium castings

**REV NO: 01    DATE 28.10.2004    MANAGEMENT SYSTEMS PROCEDURE NO: ROCP/001**  
**TITLE:    RADIOSCOPIC INSPECTION OF ALUMINIUM CAST ALLOYS USING REAL TIME**  
**RADIOGRAPHY**

9.1.1.2    **Product Maximum Dimensions**

Length 1000 mm (single pass) up to 2000 mm (double Pass)  
Width 710 mm  
Height 150 mm  
Weight 90kg  
Circular component diameter 1000 mm

9.1.1.3    **Maximum Material Thickness Penetration**

120 mm of aluminium

9.1.1.4    **Inspection Standards**

ASTM E155 Reference standards

9.1.2    **Radiographic Parameters**

9.1.2.1    **X-Ray Field of View**

110 mm, 160 mm and 220 mm diameter, remotely selectable from the control panel. Anti-flare sensor eliminating the need for secondary collimation.

9.1.2.2    **Radiographic Image Quality**

Contrast sensitivity better than 2%.  
System resolution 0.25 mm.

9.1.2.3    **Displayed Image Resolution**

X-Ray sensor 768H x 582V pixels.  
Image processor 512H x 512V pixels.  
Image display 800 video lines.

9.1.2.4    **Radiographic Set Up**

X-Ray source to sensor distance 1200 mm maximum

9.1.2.5    **Product Manipulation**

Product rotation	360 degrees at 2 revs/min
Product tilt table	Manual selection of 0 to 45 degrees angular positions, with a 90 degree fixed position available.
Platform vertical travel	1000 mm linear servo-driven positional feedback. Datum reference point. Variable speed to 100 mm/sec max.
X-Ray head linear traverse	200 mm servo-driven positional feedback. Datum reference point. Variable speed to 100 mm/sec max.
X-Ray sensor linear traverse	200 mm servo-driven positional feedback. Datum reference point. Variable speed to 100 mm/sec max.

**REV NO: 01    DATE 28.10.2004    MANAGEMENT SYSTEMS PROCEDURE NO: ROCP/001**  
**TITLE:    RADIOSCOPIC INSPECTION OF ALUMINIUM CAST ALLOYS USING REAL TIME**  
**RADIOGRAPHY**

9.1.2.6    **X-Ray Source Specification**

Source capable of operating at up to 220kV and 13mA.

0 – 220kV variable kV range.

0 – 8.2mA variable mA range for fine focus.

0 – 13mA variable mA range for broad focus.

9.1.2.7    **Calibrated Test Piece**

Test piece to demonstrate image contrast, sensitivity and image resolution and for checking system calibration.

9.1.2.8    **X-Ray Image Archival Unit**

(a) CD Storage

CD    OIS IMPS Software

(b) Data storage

Operator code name.

Date of entry.

Radiograph identification.

Radiograph number.

Disc name.

Archival operator.

(c) Data entry

Qwerty keyboard.

Radiograph identification.

(d) Data viewing

VDU                                    12 inch diagonal.

Viewed information    As storage details and software menu.

9.1.2.9    **Reference X-Ray Image Display and Storage**

(a) Reference image storage    Ability to store a viewed image for reference purposes.

(b) Reference image viewing    Adjustable intensity and contrast control.



**REV NO: 01    DATE 28.10.2004    MANAGEMENT SYSTEMS PROCEDURE NO: ROCP/001**  
**TITLE:    RADIOSCOPIC INSPECTION OF ALUMINIUM CAST ALLOYS USING REAL TIME**  
**RADIOGRAPHY**

9.1.2.10 **Image Processor Hardware and Software**

Real time integration  
Real time subtraction  
Real time shading  
Real time averaging  
Contrast/brightness enhancement  
Image sharpening  
Image zoom and pan  
Density greyscale measurement and display  
Distance and linear measurements  
Image enhancements

X-Ray sensor      X-Ray field of view selection.

Integrated with image processing and X-Ray image archival package.

9.1.2.11 **Product Marking System**

Electronically interfaced to the computer system for image identification verified by screen prompt.

9.1.3 **Operator Control Panel**

The operator control panel consists of:

- 9.1.3.1 X-Ray Sensor Control.
- 9.1.3.2 Image Display Control.
- 9.1.3.3 X-Ray Source Control.
- 9.1.3.4 Manipulation Control.
- 9.1.3.5 X-Ray Image Archival Unit.
- 9.1.3.6 Image Processor Control.

9.1.4 **Image Viewing**

Image display size	14 inch diagonal with adjustable intensity and contrast control.
Image display aspect ratio	4 : 3
Observed radiographic sensitivity	Better than 2%
	System resolution 0.25 mm

**REV NO: 01    DATE 28.10.2004    MANAGEMENT SYSTEMS PROCEDURE NO: ROCP/001**  
**TITLE:    RADIOSCOPIC INSPECTION OF ALUMINIUM CAST ALLOYS USING REAL TIME**  
**RADIOGRAPHY**

9.2    **768/160 Conveyor System.**

9.2.1    **Product Details**

9.2.1.1    **Product Type and Range**

Aluminium castings

9.2.1.2    **Product Maximum Dimensions**

Length 1000 mm

Width 400 mm

Height 90 mm

Weight 15kg

9.2.1.3    **Maximum Material Thickness Penetration**

80 mm of aluminium.

9.2.1.4    **Inspection Standards**

ASTM E155 Reference standards from real time source.

9.2.2    **System Specification**

9.2.2.1    **X-Ray Source Specification**

Constant potential X-Ray energy.

160 kV X-Ray generator.

0 to 160 kV variable kV range.

0 to 4.5mA variable mA range for fine focus.

0 to 10mA variable mA range for broad focus.

Metal ceramic X-Ray head.

9.2.2.2    **X-Ray Shutter**

Shutter for sensor protection which automatically operates during warm up and when there is no product in the x-ray path.

9.2.2.3    **Manipulation and Conveyor**

Conveyor belt mechanism  
(under x-ray beam)

Floor standing.

low density material conveyor belt with  
non-metallic joints.

500 mm width belt.

Fixed speed, reversible under operator  
control.

Product detection and conveyor belt stop  
mechanism.

Reject mechanism

Electrically controlled gating mechanism.

Reject chute for rejected product.

**REV NO: 01    DATE 28.10.2004    MANAGEMENT SYSTEMS PROCEDURE NO: ROCP/001**  
**TITLE:    RADIOSCOPIC INSPECTION OF ALUMINIUM CAST ALLOYS USING REAL TIME**  
**RADIOGRAPHY**

Product unloading	Return conveyor to allow product to be loaded and unloaded by a single operator.
Conveyor bend section	180 degrees powered bend. 500 mm conveyor width.
Product transport section	6000 mm length overall. 500 mm conveyor width. Fixed speed motorised drive. Conveyor sequence control.

9.2.2.4    **X-Ray Sensor**

160 mm, 220 mm and 300 mm diameter, remotely selectable from the control panel.  
Full anti-flare characteristic sensor removing the need for secondary collimation.

9.2.2.5    **Image Processor (Noise Reduction Unit)**

Real time integration.  
Real time averaging.  
Image sharpening control  
Signal gain and back level control  
Signal level display.  
Freeze image and display.

9.2.2.6    **Video Monitor**

14 inch diagonal

9.2.2.7    **CD Storage**

CD                      OIS IMPS Software

9.2.2.8    **System Resolution**

Contrast sensitivity better than 2%.  
X-Ray sensor 768H x 582V pixels.  
Image processor 840H x 582V pixels.  
Resultant resolution 0.25 mm

9.2.2.9    **Product Marking System**

Manual with electronic interface to the computer system for image identification verified by screen prompt.

**REV NO: 01    DATE 28.10.2004    MANAGEMENT SYSTEMS PROCEDURE NO: ROCP/001**  
**TITLE:    RADIOSCOPIC INSPECTION OF ALUMINIUM CAST ALLOYS USING REAL TIME**  
**RADIOGRAPHY**

9.2.3 **Operator Control panel**

9.2.3.1 **X-Ray Source Control**

X-Ray on/off.  
Variable 0 to 160 kV control  
Variable 0 to 4.5mA (fine focus). Variable 0 to 10 mA (broad focus)  
Timer set up/override control.  
Safety interlock indicator  
Warm up override indicator  
X-Ray annunciator control  
Emergency stop.

9.2.3.2 **X-Ray Shutter Control**

Shutter open/closed indication, automatic for warm up and product inspection.

9.2.3.3 **Manipulation Control**

Conveyor operation on/off  
Conveyor forward/reverse switch  
Product accept activation switch  
Product reject activation switch  
Accept/reject casting counter reset

9.2.3.4 **X-Ray Sensor Control**

X-Ray field of view                      160/220/300 mm Diameter  
X-Ray image focus control.            Adjustable for sharp image

9.2.3.5 **Image Process Control (Noise Reduction Unit)**

Selectable integration from 2 to 128  
Selectable averaging from 2 to 128  
Mode selection switch  
Auto/Man/Frame convert  
Adjustable image enhancement  
Adjustable gain and back level  
Live/process/freeze

9.2.3.6 **Image Display Control**

Adjustable brightness and contrast  
Normal/underscan mode

**REV NO: 01    DATE 28.10.2004    MANAGEMENT SYSTEMS PROCEDURE NO: ROCP/001**  
**TITLE:    RADIOSCOPIC INSPECTION OF ALUMINIUM CAST ALLOYS USING REAL TIME**  
**RADIOGRAPHY**

9.2.3.7 **Optical Disc Control**

Archival retrieval and data entry via the key board

9.2.3.8 **Operator Computer VDU and Keyboard Interface**

12 inch VDU  
Computer keyboard  
Digitising unit

9.2.3.9 **X-Ray Image Archival Unit (Software)**

Main Menu:	Log on sequence. Continue/closedown. Product set up procedure. Operator mode. Retrieval mode. Exit.
Sub Menu:	
Product Set up:	Create Procedure and Store. Retrieval procedure.
Operator Mode:	Read number/confirm. Write information on image with date Archive Image. Next sub-image. Continue next image. Review reference images from central computer. Exit.

10 0 **EQUIPMENT CALIBRATION**

All radiographic equipment and materials shall be in accordance with the requirements of ASTM E1255 and where relevant will bear the current status of calibration as appropriate.

<b>Check</b>	<b>Frequency</b>
X-Ray equipment, control panel and meters.	Annually
Radiation safety equipment	Annually
Focal spot size.	Annually

Records shall be maintained of safety checks carried out to all electrical equipment in the previous 12 months.

**REV NO: 01    DATE 28.10.2004    MANAGEMENT SYSTEMS PROCEDURE NO: RQCP/001**  
**TITLE:    RADIOSCOPIC INSPECTION OF ALUMINIUM CAST ALLOYS USING REAL TIME**  
**RADIOGRAPHY**

### 11.0 **EQUIPMENT CHECKS**

#### **Check**

#### **Frequency**

X-ray set will undergo warm up procedure prior to use.

Start up.

Radiation levels in supervised areas.

In accordance with the Ionising Radiations Regulations local rules.

Penetrameter /Calibration Check

At the commencement, during and on completion of each part number batch.

### 12.0 **TECHNIQUE DETAILS**

Radioscopic inspection shall be carried out in accordance with the relevant component technique sheet approved by a level III ASNT or PCN certified person.

### 13.0 **ASSESSMENT OF TEST RESULTS**

All radioscopic images will be examined in the static condition in order to determine the accept/reject decision. The operator shall be suitably qualified in accordance with the recommended practice as defined in accordance with Fläkt Woods Limited document reference RQCP/003.

Unless otherwise stated at the contract-input stage only radioscopic images for the parts specified in the manufacturing instructions issued by Engineering will be stored. Only when clearly stated at the contract-input stage will radioscopic examination records and associated radioscopic images be maintained.

### 14.0 **REPORTING OF TEST RESULTS**

Where requested a report of the test results shall include as a minimum the following:

Component Part number.

Area inspected

Equipment data

Test condition (kV , mA)

System Performance

Operator name and qualification

Date of test

Signature.

Technique details

### 15.0 **NON-COMPLIANCE STATEMENT**

If for any reason the operator is unable to comply with the requirements of this procedure he/she will refer to his/her/any Level II for direction.