Examination Bank Structure for Radiographic Testing (RT) – An Example

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Abstract: In the normative references PN-EN ISO/IEC 17024 standard [1] and the IAF Guidance FG17024 [2] there are the requirements of a "secure storage of the examination bank" and "the controls for rotation of examination or revision in order to maintain their objectivity and confidentiality".
Referring to these requirements an example of the examination bank for Radiographic Testing, consisting of the following items, has been presented in the paper:

- bank of **questions**, classified according to syllabus CEN ISO/TR 25107:2006[3] and ICNDT edition 2004 [4],
- **test specimens** bank**,**
- bank of examination **radiographs** and their master interpretations,
- examination **instructions** bank for level 1(to follow) and for level 2 (to prepare),
- examination **procedures** bank for Level 3, with master copies.

The RT examination bank concept presented in the paper is still developed as a one of the possible solutions to the problem.

Introduction

Examination bank for non destructive testing (NDT) consists of examination questions, test specimens, test procedures (for Level 3) and test instructions. In Radiographic Testing (RT) the examination radiographs are also included.

A tentative structure of the NDT examination bank has been proposed in the paper, with detailed presentation of the RT examination bank as an example. The normative requirements concerning examination banks specified in the PN-EN ISO/IEC 17024 standard [1] and the IAF Guidance FG17024 [2] (a "secure storage of the examination bank" and "the controls for rotation of examination or revision in order to maintain their objectivity and confidentiality") have been taken into consideration during development of the examination bank structure in the Polish Body Certifying Persons "JCO UDT-CERT".

1. Examination bank structure

Fig. 1 shows the examination bank structure developed in the JCO UDT-CERT and applied for qualification examination in Visual Testing (VT), Magnetic Particle Testing (MT), Penetrant Testing (PT), Radiography Testing (RT) and Interpretation of Radiographs (RTI), Ultrasonic Testing (UT) and Ultrasonic Thickness Measurements (UTT), and in Magnetic Testing of Steel Ropes (MTR).

The part of the examination bank covering Radiography Testing has been presented in details.

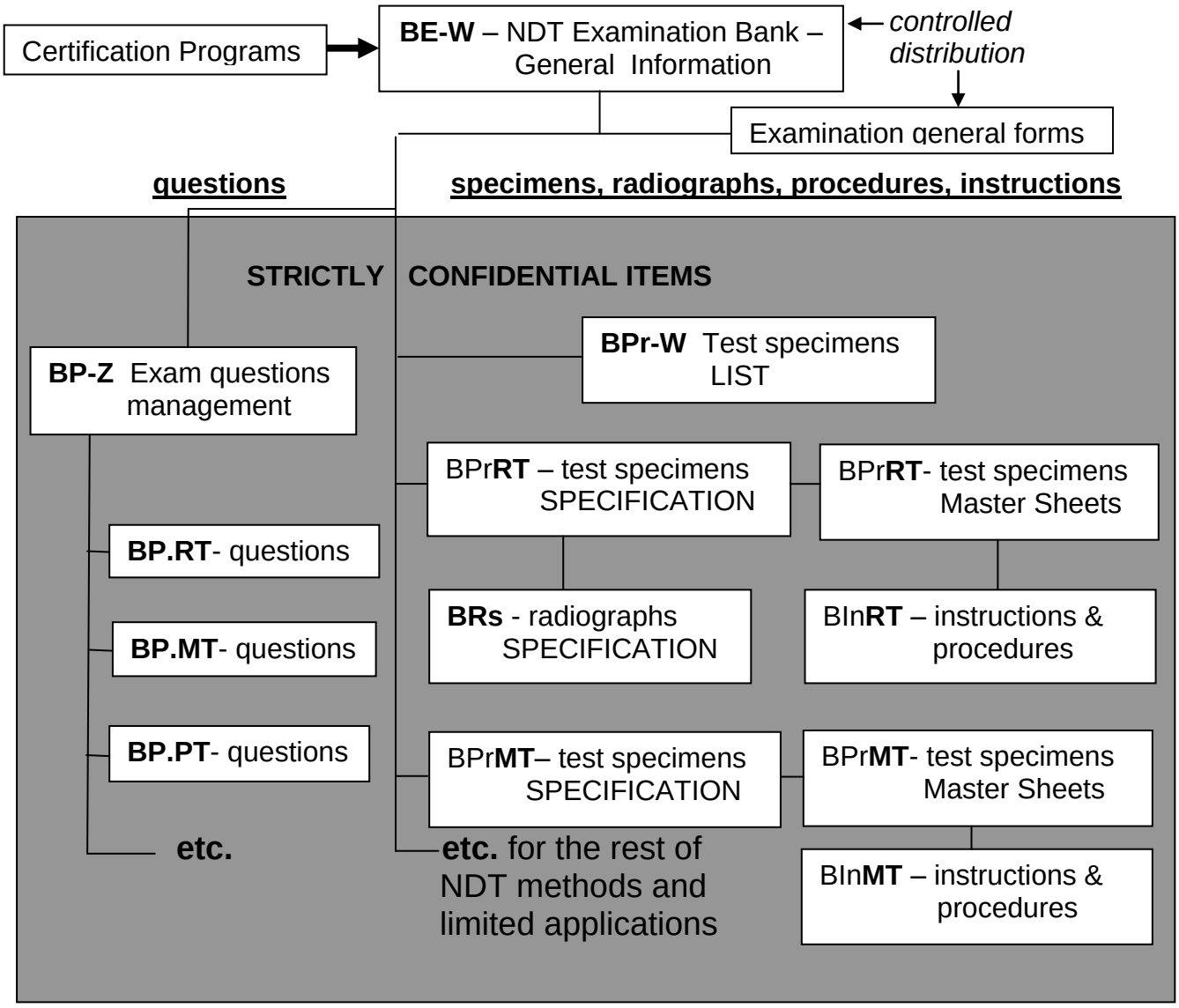


Fig. 1. The structure of the examination bank

2. BE-W - NDT Examination bank – General Information (controlled distribution)

2.1 Contents

General information about the NDT examination bank comprises the following chapters:

1. Objective, scope and field of application
2. Reference documents
3. Confidentiality
4. Examination bank contents
5. Examination bank structure
6. Classification of test specimens
7. Identification of test specimens, radiographs, test instructions and procedures
8. Identification of examination questions

9. Management of examination bank – general principles; development of examination bank
10. Bank VT – Visual Testing
11. Bank PT – Penetrant Testing
12. Bank MT – Magnetic Particle Testing
13. **Bank RT – Radiographic Testing**
14. Bank UT – Ultrasonic Testing
15. Bank UTT – Ultrasonic Thickness Measurement
16. Bank RTI – Review and interpretation of radiographs
17. Bank MTR – Magnetic Testing of Steel Ropes

*2.2 **BE-W – NDT e**xamination bank – General information. Chapter 13: Bank RT – Radiographic Testing (controlled distribution)*

2.2.1. RT test specimens – general information (fragment)

Table. 1. General information about RT test specimens and radiographs available in the document BW-E under controlled distributions (fragment)

Set nr	Sup-plier	Sectors & number of specimens ; form[(1)], material[(2)]				Cert. Nr	To-tal Num-ber	Loca-lisa-tion
		1 (c) casting	2 (f) forging	3 (w) welded products	others			
RTzb1	Sona-spec-tion			**7 PL, cs** **1 T, cs** **2 P, cs**			**10**	Exam Center Wa-wa
RTzb2				**4 PL, cs** **2 PL, Al** (6x1=6r) **4 P,cs** (4x5=20r)		306a	**10** (26r)[(*)]	Exam Center Poznań

[(1)] – **PL**-plate, **T**- T joint, **P**- pipe, **N**-nozzle [(2)] – **cs**-carbon steel, **ss**-stainless steel, **Al**-aluminium, **Fe**-iron, steel casting; (*) – **r** radiographs

2.2.2 RT examination questions, instructions, procedures – general information

Table. 2. General information about RT questions, test procedures and instructions available in the document BW-E under controlled distributions

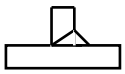
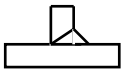
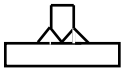
Type of examination	Number of questions	Number of instructions (procedures for C3 examinations)
RT-1	NNN (including N PED and NN Radiation Safety)	NN
RT-2	NNN (including N PED and NN Radiation Safety)	NN
G3[(1)], A1, A2, A3	NN (the same for all methods)	
RT3m[(2)], C1, C2	NN	
RT3m, C3 (procedures)		N

[(1)]G3 – Basic examination; [(2)] RT3m – Main method examination

3. BPr-W - Test specimens LIST (confidential)

Full list of the test specimens is presented in the confidential document "BPr-W Test specimens LIST". A fragment of this document concerning RT test specimens is shown in the Table 3 below.

Table 3. LIST (fragment) of the RT test specimens (confidential)

Set **RTzb3**		**Examination test specimens (RT)** 03/05/02 **Weld Test Specimen (RT)** **Certificat: Sonaspection Nr 306b**					
No.	**Scheme**	**Dimen-sions**	**METHOD** *(fitness)*			**Localisation**	**NUMBER**
			RT	**VT?(1)**	**PT?(1)**	**Exam. Centre**	**material (2) remarks**
1		300 x 5	+			CLDT Poznań	***T nnnn*(3), *cs*** 2 rdg (D7)
2		300 x 10	+			CLDT Poznań	***T nnnn,** cs* 3 rdg (D7)
3		300 x 5	+			CLDT Poznań	***T nnnn,** Al* 2 rdg (D7)
4		300 x 25	+			CLDT Poznań	***T nnnn,** Al* 4 rdg (D7)
5		ϕ100x10 x12/13 450x450	+			CLDT Poznań	***N nnnn,** cs* 8 rdg: 0-5, 5, 10, 15, 15-20, 20-25, 25-30, 30-0
6		ϕ100x5 x12/13 450x450	+			CLDT Poznań	***N nnnn,** cs* 9 rdg: 0-5, 5-10, 10, 10-15, 15-20, 20-25, 25-30, 25-30, 30-0

(1) – eventual fitness for VT, PT, MT and UT to be verified

(2) – designations: **PL**- plate, **T**- T-joint, **P**-pipe, **N** - nozzle;
Material: **cs**-carbon steel, **ss**-stainless steel, **Al** – aluminium;

(3) – all numbers of the test specimens are visible on radiographs

4. BPrRT - RT test specimens SPECIFICATION (cofidential)

Specification of the RT examination specimens and area to be tested under particular examination tasks (fragment) is shown in the Table 4.

5. BRs - Examination radiographs SPECIFICATION (cofidential)

Specification of the RT examination radiographs (fragment) is shown in Table 5.

Table 4. **BPrRT** – RT test specimens specification (confidential, fragment)

SET No.	No. of specimen in the SET	DESIGNATION OF TEST SPECIMEN(1)	TYPE, DIMENSIONS	Technique of test (2); Arrangement – Fig. No accord. to EN 1435	VT characterisation [mm] : b – face width, ndl – reinforcement height Imperfections [mm] (*) : kind of imperfection / h or d – depth, height or diameter / l – length / Σl - accum. length, x - coordinate		SUPPLIER Cert. Number Master Sheet Number (WKO)	LOCALISATION			REMARKS Dates of examination, etc.
					VT	RT		Specimen	Master sheet (WKO)	Instruction for Level 1	
RT zb2	1	PL NNNN, cs, 1 rdg	weld 300x5	RX, Fig.1	b = ? ndl = ?	1011(*), l = 6, x= 37 4021(*), l=17, x=163 1013(*), l=17, x=228	Sonaspection 306 a	CLDT	JCO, Wa-wa		

(1) T – T joints, **PL-** plate, **P –** pipe, **N –** nozzle, **s** – steel; **cs** – carbon steel; **ss –** stainless steel; **Al** or **A**– aluminium, **Z -** iron, steel casting
(2) RX- roentgen, **RГ –** gamma
(*) – imperfections obligatory to report by examinee

Table 5. **BRs** - Examination radiographs specification (confidential, fragment)

SET No. of SPECIMENS / RADIOGRAPHS	No. of specimen in the SET	JOINT TYPE(1) DESIGNATION OF RADIOGRAPH	THICKNESS penetrated / evaluated [mm]	JOINT TYPE, MATERIAL(1); WELDING METHOD acc. to ISO4063 (1); TESTING TECHNIQUE (2) - arrangement Fig. No. acc. to EN PN 1435 ; Film size [cm]	IMAGE QUALITY No. TEST CLASS (A,B)	DENSITY D	Results of preliminary VT: face (width. – b) , reinforcement (heigth – h) Indications - ISO EN 6520-1 [mm] (*)				ACCEPTANCE LEVEL EN-12517 (**)	QUALITY LEVEL ISO EN-5817 (**)	Supplier, certificat number	LOCALISATION			REMARKS Dates of examination, etc.
							designation EN ISO 6520 -1	l, Σl length, accum. length	h = height, d = diametre b=width	x = coordinate				Radiograph	Master sheet WKO	Instruction for Level 1	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
RT zb2r	1	PL NNNN	5 / 5	Butt joint, PL, cs Meth. 111 V- weld RX, Fig.1 Rdg.10x40cm	W16 B		Face Reinforcrmrnt 1011(*) 4021(*) 1013(*) root	6 17 17	b = ? h = ?	37 163 228	>3	>D	Sonaspection 306a	JCO, Wa-wa	JCO, Wa-wa		ExamSetNo.RTI(3)1/1 ExamSetNo.RT(6,7)1/1

Film interpretation examination report – „MASTER"

(1) T – T joints, **PL-** plate, **P –** pipe, **N –** nozzle, **s** – steel; **cs** – carbon steel; **ss –** stainless steel; **Al** or **A**– aluminium, **Z –** iron, steel casting; Welding method **: 111**(arc), **311**(acet.), **141**(TIG), **31**(MIG),
(2) RX- rentgen, **RГ –** gamma; **(*) –** imperfections obligatory to report by examinee; **(**)** >3, >D – below acceptance level 3 and quality level D

6. Questions

6.1 Level 1 and Level 2 questions

Individual groups of questions are developed in particular method and level, ex. **RT2.** Identification number of each question is composed of the group designation and successive number of question in a given group; ex. **RT2.01.**

Additionally, the question may be marked with letter "g" (general) or "s" (specific), number of sector, kind of syllabus plus subject number in this syllabus and successive number of question in a given subject; ex.: **RT2.63s(3) CEN 8/5,** which means: 63rd question in RT level 2, specialised in sector 3 (welding), 5th question dealing with interpretation of the test results (subject no 8 in the syllabus CEN).

The distribution of the examination questions RT2, classified according to ISO/TR 25107:2005 and ICNDT:2004 is presented in the Tables 6 and 7.

6.2. Level 3 questions and procedures

According to PN EN 473 [5] the Level 3 examination questions have been grouped in following manner:

a) **G3 -** basic examination :

- **A1** – material science and process technology questions,
- **A2** – EN 473 , certification scheme JCO UDT-CERT, DGZfP, ASTM, etc
- **A3** – Level 2 general questions in 5 methods: MT, PT, RT, UT and VT

b) Main methods, ex. **RT3m**:

- **C1 –** level 3 knowledge questions, relating to the main method (RT)
- **C2 –** application of main method in the sector concerned: in the industrial sectors 6 - "metal manufacturing" and 7 - "pre and in-service testing of equipment, plant and structure", combining five product sectors (casting, forging, welded products, tubes & pipes, wrought products)
- **C3** – drafting procedures in the relevant sector, mostly In-Service Inspection of equipment composed of different products.

Designation of the Level 3 question and procedure comprises: type of examination and successive number of question in the particular group of Level 3 questions. Ex.: **G3.A1-23** indicates 23rd question in the part A1 of basic examination. Additional symbols indicate sector(s) and subject of question according to given syllabus.

7. Examination forms

General examination forms, like examination reports, list of participants, examination plan, lottery of the test specimens and tasks, testing reports, typical form for test procedures and instructions, typical form for standard evaluation of the examination results and grading,

are integral part of the detailed certification programmes for individual testing methods and limited application.

Table 6. Addenda 2006.11.21 to the RT2 group of questions classified according to syllabus **CEN ISO/TR25107**

SUBJECT (short) acc. to CEN ISO/TR25107		Currently in the group of questions RT2			Numbers of current and new questions		Will be in the group of questions RT2		
		QUAN-TITY OF QUES-TIONS	[%] CUR-REN-TLY	[%] Acc. to TR 25107	Cur-rent	NEW, In the AD-DENDA	QUAN-TITY OF QUES-TIONS	[%] Will be	[%] Acc. to TR 25107
1	**Intr. Term. History**	--	--	1		X	N	2,2	1
	1.1. Purpose	--					--		
	1.2. NDT task	--					--		
	1.3. NDT history	--				X	N		
	1.4. NDT terminology	--					--		
	1.5. Gen. Safety consider.	--					--		
	1.6. History of RT	--					--		
	1.7. RT Terminology	--					--		
2	**Physical principles**	N	41,5	15		X	N	38,6	15
	2.1. Properties of X & gam.	N	2,9	1,3	X		N		1,3
	2.2. Generation of X-Rays	N	1,4	1,8	X	X	N		1,8
	2.3. Generation of Γ rays	N	2,9	1,8	X	X	N		1,8
	2.4. Interaction with matter	N	14,3	3,8	X	X	N		3,8
	2.5.Film systems properties	N	20	2,5	X	X	N		2,5
	2.6.Geometry for RT expos.	--	--	3,8			--		3,8
3	**Product knowledge**	N	1,4	10		X	N	4,3	10
	3.1. Weld imperfections	--	--	3,8		X	N		3,8
	3.2. Casting imperfections	--	--	3,8		X	N		3,8
	3.3. Influence to detectibility	N	1,4	2,4	X		N		2,4
4	**Equipment**	N	11,4	5		X	N	10,8	5
	4.1. Design & oper. X-Ray	N	11,4	2,5	X	X	N		2,5
	4.2. Design & oper. Γ rays	--	--	2,5			--		2,5
5	**Inf. prior to test**	N	1,6	2,5			N	1,1	2,5
	5.1. Inf. about test object		1,6	2,5	X		N		2,5
6	**Testing**	N	27,1	39		X	N	23,6	39
	6.1. Develop. process	N	4,3	4	X		N		4
	6.2. Weld exam. EN 1435	N	15,7	10	X				10
	6.3. Cast exam. EN 12681	N	1,4	7,5	X		N		7,5
	6.4. Special techniques	N	1,4	7,5	X	X	N		7,5
	6.5.IQI EN 462-1,-2,-3,-4,-5	N	4,3	2,5	X		N		2,5
	6.6.Instr. for weld & casting	--	--	7,5		X	N		7,5
7	**Eval. & reporting**	N	8,6	12			N	8,6	12
	7.1. Basic of evaluation	N	8,6	2,5	X		N		2,5
	7.2. Eval. of radiographs	--	--	4,5			--		4,5
	7.3. Check of test report	--	--	5		X	N		5
8	**Assessment**	N	8,6	15			N	9,7	15
	8.1.Classif. of imperfections	N	8,6	15	X	X	N		15
9	**Quality aspects**	N	1,4	-	X		N		-
10	**Developments**	--	--	0,5			--	--	0,5
			100%	100%				100%	100%

Table 7. Addenda 2006.11.21 to the RT2 group of questions classified according to syllabus **ICNDT:2004**

SUBJECT (short) acc. to ICNDT:2004		Currently in the group of questions RT2			Numbers of current and new questions		Will be in the group of questions RT2		
		QUANTITY OF QUESTIONS	[%] CURRENTLY	[%] Acc. to ICNDT:2004	Current	NEW, in the ADDENDA	QUANTITY OF QUESTIONS	[%] Will be	[%] Acc. to ICNDT:2004
1	**Physics**	N	**15,5**	**15**			N	**15,4**	**15**
	1.1. Waves	N			X	X	N		
	1.2. Atomic physics	N			X		N		
	1.3. Interaction with mat.	N			X	X	N		
	1.4. Electricity	-			-		-		
	1.5. Laws	N			X		N		
	1.6. SI units & measure	-			-	X	N		
2	**Equipment**		**33,8**	**30**			N	**31,8**	**30**
	2.1. X-Ray	N			X	X	N		
	2.2. Neutr.RT (Level 3)	-			-		-		
	2.3. Gamma ray equip.	N			X	X	N		
	2.4. Films	N			X		N		
	2.5. Film processing	N			X		N		
	2.6. Film viewing	N			X	X	N		
	2.7. Radioscopy	-			-		-		
	2.8. Screen & filters	N			X		N		
	2.9. IQI	N			X		N		
	2.10. Miscellaneous	-			-	X	N		
3	**RT techniques**	N	**23,9**	**20**			N	**20,9**	**20**
	3.1 Geometric principles	N			X		N		
	3.2. Exposure	N			X	X	N		
4	**Report.&interpr**	N	**18,3**	**20**			N	**19,8**	**20**
	4.1. Interpretation	N			X		N		
	4.2. Codes & standards	N			X		N		
5	**Gen.knowledge**	N	**8,5**	**15**			N	**12,1**	**15**
	5.1. Product	-			-	X	N		
	5.2. Indications	N			X		N		
	5.3. Other methods	-			-	X	N		
	Total		**100%**	**100%**		**Total**		**100%**	**100%**
6	**Pesonal safety**								
	6.1. Mains								
	6.2. Monitoring								
	6.3. Effect of radiation								

References.

[1] PN-EN ISO/IEC 17024 – Conformity assessment – General requirements for bodies operation certification of persons
[2] FG17024 – IAF Guidance on the Application of ISO/IEC 17024:2003
[3] CEN ISO/TR 25107:2006 – Non-destructive testing – Guidelines for NDT training syllabuses
[4] ICNDT recommended guidelines for qualification and certification of NDT personnel according to ISO 9712 – 2004 Edition
[5] PN-EN 473:2000 – Non destructive testing – Qualification and certification of NDT personnel – General principles