ОПИС НА ДОКУМЕНТИТЕ, СЪДЪРЖАЩИ СЕ В ОФЕРТАТА

за участие в процедура за възлагане на обществена поръчка с предмет:
„Модернизация (ретрофит) на електрически уредби 110/20 (10) kV и въвеждането им в режим на телемеханика"

№	**Наименование на документа**	**Форма на документа** (оригинал или заверено копие) **/Страница №** (от .... до ...)
1.	Опис на представените документи	Оригинал Стр.1 – 2
2.	Единен европейски документ за обществени поръчки (ЕЕДОП)	Оригинал Стр. 3 – 16
3.	Предложение за изпълнение на поръчката за обособена позиция № 2	Оригинал Стр. 17 – 18
	Приложение № 1 – Срокове за изпълнение на ретрофита	Оригинал Стр. 19 – 20
	Приложение № 2	Оригинал Стр. 21 – 25
	Приложение 1.1 – каталожна информация за разединител	Заверено копие Стр. 26 – 30
	Приложение 1.2 – техническо описание, инструкции за разединител	Заверено копие Стр. 31 – 38
	Приложение 1.3 – Протоколи от типови изпитания на разединител	Заверено копие Стр. 39 – 59
	Приложение 1.4. – Сертификат на независимата лаборатория, провела типовите изпитания	Заверено копие Стр. 60 – 66
	Приложение 2.1 – Каталожна информация за токов измервателен трансформатор	Заверено копие Стр. 67 – 70
	Приложение 2.2. – Удостоверение за одобрен тип средство за измерване	Заверено копие Стр. 71 – 72
	Приложение 2.3. – Техническо описание на токовите измервателни трансформатори, инструкции и др	Заверено копие Стр. 73 – 74
	Приложение 2.4. – Протоколи от типови изпитания на токовите измервателни трансформатори	Заверено копие Стр. 75 – 159
	Приложение 2.5 – Акредитация на независимата изпитателна лаборатория, провела типовите изпитания	Заверено копие Стр. 160 – 163
	Приложение 2.6 – Информация за провежданите рутинни изпитания	Заверено копие Стр. 164 – 175
	Приложение 3 – Каталожна информация за цифрови защити	Заверено копие Стр. 176 – 340
	Приложение 4 – каталожна информация за цифров локален контролер	Заверено копие Стр. 341 – 351
	Приложение 5.1 – Каталожна информация за вакуумни прекъсвачи	Заверено копие Стр. 352 – 404
	Приложение 5.2 – Протоколи от типови изпитания на вакуумни прекъсвачи	Заверено копие Стр. 405 – 426
	Приложение 5.3 – Акредитация на независимата изпитателна лаборатория, провела типовите изпитания	Заверено копие Стр. 427 – 440

	Приложение 6.1. – Техническа информация за токови трансформатори 20 kV за монтиране на закрито, фиксиран	Заверено копие Стр. 441 – 445
	Приложение 6.2 – Удостоверение за одобрен тип средство за измерване	Заверено копие Стр. 446 – 459
	Приложение 6.3 – Протоколи от типови изпитания на токови измервателни трансформатори	Заверено копие Стр. 460 – 482
	Приложение 6.4 – Акредитация на независимата изпитателна лаборатория, провела типовите изпитания	Заверено копие Стр. 483 – 485
	Приложение 7.1 – Техническа информация за Напреженов измервателен трансформатор 20 kV, еднополюсен, с две вторични намотки, за монтиране на закрито	Заверено копие Стр. 486 – 490
	Приложение 7.2 – Удостоверение за одобрен тип средство за измерване	Заверено копие Стр. 491 – 498
	Приложение 7.3. – Протокол от първоначална метрологична проверка	Заверено копие Стр. 499 – 521
	Приложение 7.4. – Акредитация на независимата изпитателна лаборатория, провела типовите изпитания	Заверено копие Стр. 522 – 524
	Приложение № 3 – Комуникация на цифрови устройства за RTU	Оригинал Стр. 525
4.	Декларация за конфиденциалност и извършен оглед на обект по предмета на поръчката Декларация за конфиденциалност във връзка с посещение на обект	Оригинал Стр. 526 – 527
5.	Декларация за приемане на условията в проекта на договор	Оригинал Стр. 528
6.	Декларация за срока на валидност на офертата на участника	Оригинал Стр. 529
7.	Ценово предложение за обособена позиция № 2 Представено в отделен непрозрачен и запечатан плик с надпис „Предлагани ценови параметри	Оригинал 1 бр

Дата 24.07.2017 г.

ПОДПИС и ПЕЧАТ:

Петър Терев
(име и фамилия)
Управител
(длъжност на представляващия участника)

ПРИЛОЖЕНИЕ № 1

СРОКОВЕ ЗА ИЗПЪЛНЕНИЕ НА РЕТРОФИТА ПО ОБОСОБЕНА ПОЗИЦИЯ № 2:

Проектирането, доставката на цялостното оборудване и изпълнението на всички необходими дейности за цялостната реализация на реконструкцията на ОРУ 110 кV и на модернизацията (ретрофита) на ЗРУ 20 кV (като демонтаж на съществуващо оборудване, строителни работи /включително доставка на необходимите строителни материали/ по подготовка на площадките в енергийния обект за извършване на монтажа на новото оборудване, монтажни работи по отношение на доставеното ново енергийно оборудване, единични функционални проби на монтираните машини и съоръжения и въвеждането им в работен режим на телемеханика, както и провеждане на обучение на персонал на възложителя за работа с новото оборудване) и настоящото техническо задание следва да се изпълнят в срок до 18 (осемнадесет) месеца, считано от датата на подписване на договора за изпълнение на поръчката.

1. Срок за изготвяне на програмата с линейния план-график за цялостно изпълнение на модернизацията (ретрофита) и представянето й на Възложителя:

Срокът за изготвяне на програмата с линейния план-график и представянето й на Възложителя за одобрение е до 14 (четиринадесет) дни, считано от датата на подписване на договора. Срокът за одобрение на предложената програма с линеен план-график от Възложителя е до 3 (три) дни, считано от датата на представяне на изработената програмата с линейния план-график на Възложителя.

2. Изготвяне на работен проект:

Срокът за проектирането на реконструкцията на ОРУ 110 кV и на модернизацията (ретрофита) на ЗРУ 20 кV в пълен обем е до 20 (двадесет) дни след датата на подписване на Договора с конкретния Изпълнител.

3. Съгласуване на работния проект с „ЧЕЗ Разпределение България“ АД:

Срокът за съгласуване на работния проект е до 10 (десет) дни след датата на предаването му на Възложителя.

4. Доставка на цялостно оборудване, съгласно утвърдения работен проект:

Срокът за доставка на цялостното оборудване за изпълнение на предмета на поръчката съобразно предвижданията на съгласувания работен проект, както и на всички необходими резервни части, включително и за изработката и доставката на необходимите за модернизацията (ретрофита) врати и детайли в заводски условия, е до 50 (петдесет) дни от датата на одобрена от Възложителя заявка до съответен доставчик, по количествено – стойностни сметки към договора.

В допълнение, доставките на цялостното оборудване, апарати и помощни съоръжения, съответстващи на утвърдения линеен график следва да се изпълнява планово на работната площадка.

5. Срок за изпълнение на реконструкцията на ОРУ 110 кV и на модернизацията (ретрофита) на ЗРУ 20 кV:

Изпълнението на реконструкцията на ОРУ 110 кV и на модернизацията (ретрофита) на ЗРУ 20 кV, включително и въвеждане на вериги за телемеханика, е до 30 (тридесет) дни от датата на първия подписан възлагателен протокол за изпълнение на реконструкцията на ОРУ 110 кV или на модернизацията (ретрофита) на ЗРУ 20 кV.

Срокът за изпълнение на дейности по реконструкцията на ОРУ 110 кV и на модернизацията (ретрофита) на ЗРУ 20 кV, като демонтаж на съществуващо оборудване, строителни работи /включително доставка на необходимите строителни материали/ по подготовка на площадките в енергийния обект за извършване на монтажа на новото оборудване и монтажни работи по отношение на доставеното ново енергийно оборудване, единични функционални проби на монтираните машини и съоръжения и въвеждането им в работен режим на телемеханика е до 30 (тридесет) дни, считано от датата на първия възлагателен протокол.

6.Обучение на специалисти на Възложителя:

- Срокът за изготвяне от страна на избрания Изпълнител на програма за обучение на 6-ма служители на Възложителя и предаването й за одобрение на Възложителя е до 10 (десет) дни, считано от датата на съгласуване на работния проект от Възложителя и предаването му на Изпълнителя;
- Срокът за одобрение на програмата за обучение от страна на Възложителя е до 2 (два) дни, след датата на предаването й на Възложителя.

- Срокът за провеждане на обучението и сертифицирането на 6-ма служители на Възложителя, за работа и поддръжка на доставеното и монтирано оборудване, включително цифрови защити и др. е до 10 (десет) дни, след датата на одобрение на програмата за обучение от страна на Възложителя.

7. Изработване и предоставяне на екзекутивна документация:

Срокът за изработване и предоставяне от Изпълнителя на Възложителя на екзекутивни чертежи (документация) с нанесени всички изменения в работния проект, настъпили в процеса на изпълнение на реконструкцията на ОРУ 110 kV и на модернизацията (ретрофита) на ЗРУ 20 kV, е до 15 (петнадесет) работни дни, считано от датата на последния подписан възлагателен протокол за изпълнение на ретрофит на присъединение 20 kV, с който приключва целия обем дейности в обекта, но не по-късно от датата на провеждане на 72 часовите проби под напрежение и товар.

8.Провеждане на 72-часови проби под напрежение и товар:

Срокът за провеждане на 72-часови проби под напрежение и товар и въвеждане на енергийния обект 110/20 kV и свързаните с нормалната му експлоатация апарати и съоръжения в работен режим е до 10 (десет) работни дни, считано от датата на протокола на приемателната комисия за приемане на цялостното изпълнение на реконструкцията на ОРУ 110 kV и на модернизацията (ретрофита) на ЗРУ 20 kVв пълен обем за целия обект.

Дата 21.07.2017 г.

ПОДПИС и ПЕЧАТ:

Петър Терев

(име и фамилия)

управител

(длъжност на представителя на участника)

ПРИЛОЖЕНИЕ №2

ТАБЛИЦА 1 КЪМ ОБОСОБЕНА ПОЗИЦИЯ № 2
СТАНДАРТ НА МАТЕРИАЛА ЗА РАЗЕДИНИТЕЛ С ЦЕНТРАЛНО РАЗДЕЛЯНЕ И С ДВА ЗАЗЕМИТЕЛНИ НОЖА 110 KV, 1250 КА

Изисквания към документацията и изпитванията:

№	Документи за участие	Приложение № или текст
1.	Точно обозначение на типа, производителя и страната на производство (произход) и последно издание на каталога на производителя	Разединител тип SDF123 .Приложение 1.1
2.	Техническо описание на изделието, в т.ч. гарантирани параметри и съоръжаване	Приложение 1.2
3.	Протоколи от типови изпитвания на английски или български език съгл. съответните стандарти от серията БДС EN 62271 или еквивалентно/и, проведени от независима акредитирана изпитателна лаборатория– заверени копия (и допълнителни изпитвания, ако са проведени),	Приложение 1.3
4.	Сертификат/акредитация на независимата изпитателна лаборатория, провела типовите изпитвания – заверено копие	Приложение 1.4

Технически параметри на разединители с централно разделяне и с два заземителни ножа 110 kV, за монтаж на открито, които се попълват от Участника в графа „Гарантирано предложение":

Наименование на материала		Разединител с централно разделяне и с два заземителни ножа 110 kV, за монтиране на открито	
Съкратено наименование на материала		РДЗН 110 kV, ОМ	
№	Параметър	Изискване	Гарантирано предложение
1.	Тип/референтен номер съгласно каталога на производителя	Да се посочи	SDF123/1600E2
2.	Производител	Да се посочи	АББ България ЕООД, България

ТАБЛИЦА 2 КЪМ ОБОСОБЕНА ПОЗИЦИЯ № 2
СТАНДАРТ НА МАТЕРИАЛА ЗА ТОКОВ ИЗМЕРВАТЕЛЕН ТРАНСФОРМАТОР 110 KV, 150/300/600/5/5/5/5 А

Изисквания към документацията и изпитванията:

№	Документи при участие	Приложение № (или текст)
1.	Точно обозначение на типа на токовите измервателни трансформатори, производителя и страната на произход и последно издание на каталога на производителя	Токови измервателни трансформатори тип PA123a Производител: ABB Sp. z o.o. Произход: Полша. Приложение 2.1
2.	Удостоверение за одобряване на типа на токовите измервателни трансформатори, издадено по реда и при условията на Закона за измерванията	Приложение 2.2
3.	Техническо описание на токовите измервателни трансформатори, гарантирани параметри и характеристики, тегло и др.	Приложение 2.3
4.	Протоколи от типови изпитвания на токовите измервателни трансформатори на английски или български език, проведени от независима изпитателна лаборатория с приложени резултати от изпитванията	Приложение 2.4
5.	Сертификат/акредитация на независимата изпитателна лаборатория, провела типовите изпитвания – заверено копие	Приложение 2.5
6.	Информация за провежданите от производителя контролни (рутинни) изпитвания	Приложение 2.6

Технически параметри на токови измервателни трансформатори 110 kV, за монтаж на открито, които се попълват от Участника в графа „Гарантирано предложение“:

Наименование на материала		Токов измервателен трансформатор 110 kV, 150/300/600/5/5/5/5 A за монтиране на открито	
Съкратено наименование на материала		ТИТ 110 kV, 150/300/600//5/5/5/5 A, ОМ	
№	Параметър	Изискване	Гарантирано предложение
1.	Тип/референтен номер съгласно каталога на производителя	Да се посочи	PA123a
2.	Производител	Да се посочи	ABB Sp. z o.o., Полша

ТАБЛИЦА 3 КЪМ ОБОСОБЕНА ПОЗИЦИЯ № 2
СТАНДАРТ НА МАТЕРИАЛА ЗА ЦИФРОВИ ЗАЩИТИ ЗА СИЛОВ ДВУНАМОТЪЧНИ ТРАНСФОРМАТОРИ 110/20 (НАДЛЪЖНО – ДИФЕРЕНЦИАЛНА ЗАЩИТА И РЕЗЕРВНА МАКСИМАЛНО ТОКОВА ЗАЩИТА)

Технически данни за основна цифрова надлъжна диференциална защита на силов двунамотъчен трансформатор, които се попълват от Участника в графа „Гарантирано предложение“:

Название на материала		Основна цифрова надлъжна диференциална защита на силов двунамотъчен трансформатор	
Съкратено название на материала		Основна ЦНДЗ СДТ	
№	Технически параметър	Изискване	Гарантирано предложение
1.	Тип	Да се посочи	MICOM P633
2.	Производител	Да се посочи	Шнайдер

Технически данни за резервна цифрова максималнотокова защита на силов двунамотъчен трансформатор, които се попълват от Участника в графа „Гарантирано предложение“:

Название на материала		Резервна цифрова максималнотокова защита на силов двунамотъчен трансформатор	
Съкратено название на материала		Резервна ЦМТЗ СДТ	
№	Технически параметър	Изискване	Гарантирано предложение
1.	Тип	Да се посочи	MICOM P132
2.	Производител	Да се посочи	Шнайдер

ТАБЛИЦА 4 КЪМ ОБОСОБЕНА ПОЗИЦИЯ № 2
ЦИФРОВ ЛОКАЛЕН КОНТРОЛЕР ЗА БЛОК ЛИНИЯ - ТРАНСФОРМАТОР 110 KV

Технически данни, които се попълват от Участника в графа „Гарантирано предложение“:

№	Технически характеристики	Изискване	Гарантирано предложение
1.	Тип	Да се посочи	MiCOM C264
2.	Производител	Да се посочи	Шнайдер

ТАБЛИЦА 5 ЗА ОБОСОБЕНА ПОЗИЦИЯ № 2
СТАНДАРТ НА МАТЕРИАЛА ЗА ТРИПОЛЮСНИ ВАКУУМНИ ПРЕКЪСВАЧИ, 24 KV, ЗА МОНТИРАНЕ НА ЗАКРИТО, ФИКСИРАНИ

Изисквания към документацията и изпитванията:

№	Документ при участие	Приложение № (или текст)
1.	Техническо описание на прекъсвача, в т.ч. гарантирани параметри и съоръжаване	Вакуумен прекъсвач, 24 kV Приложение №5.1
2.	Протоколи от типови изпитвания на английски или български език, проведени от независима акредитирана изпитвателна лаборатория– заверени копия (и допълнителни изпитвания, ако са проведени), с приложен списък на отделните изпитвания на български език.	Приложение №5.2
3.	Сертификат/акредитация на независимата изпитвателна лаборатория, провела типовите изпитвания – заверено копие	Приложение №5.3

Технически данни за триполюсен вакуумен прекъсвач 24 kV/1250 A/20 kA, за монтиране на закрито, фиксиран, които се попълват от Участника в графа „Гарантирано предложение“:

Наименование на материала		Триполюсен вакуумен прекъсвач, 24 kV/800 A/20 kA, за монтиране на закрито, фиксиран	
Съкратено наименование на материала		Трип. вак. прек., 24 kV/1250 A/20 kA, 3M, Ф	
№	Технически параметър	Изискване	Гарантирано предложение
1.	Тип/референтен номер съгласно каталога на производителя	Да се посочи	3AH5283-2
2.	Производител	Да се посочи	SIEMENS AG
3.	Обявен нормален ток, Ir	≥ 1250 A	1250 A

Технически данни за триполюсен вакуумен прекъсвач 24 kV/630 A/20 kA, за монтиране на закрито, фиксиран, които се попълват от Участника в графа „Гарантирано предложение“:

Наименование на материала		Триполюсен вакуумен прекъсвач, 24 kV/630 A/20 kA, за монтиране на закрито, фиксиран	
Съкратено наименование на материала		Трип. вак. прек., 24 kV/630 A/20 kA, 3M, Ф	
№	Технически параметър	Изискване	Гарантирано предложение
1.	Тип/референтен номер съгласно каталога на производителя	Да се посочи	3AH5283-2
2.	Производител	Да се посочи	SIEMENS AG
3.	Обявен нормален ток, Ir	≥ 630 A	1250 A

ТАБЛИЦА № 6 ЗА ОБОСОБЕНА ПОЗИЦИЯ № 2
СТАНДАРТ НА МАТЕРИАЛА ЗА ТОКОВИ ТРАНСФОРМАТОРИ 20 KV ЗА МОНТИРАНЕ НА ЗАКРИТО, ФИКСИРАН

Изисквания към документацията и изпитванията:

№	Документ за участие	Приложение № (или текст)
1.	Точно обозначение на типа на токовите измервателни трансформатори, производителя и страната на произход и последно издание на каталога на производителя	Тип: ATB 20-BS Производител: ESITAS ELEKTRIKSAN. VE TIC. A.S. Страна на произход: Турция Приложение 6.1.
2.	Удостоверение за одобряване на типа на токовите измервателни трансформатори, издадено по реда и при условията на Закона за измерванията	Приложение 6.2.
3.	Протоколи от типови изпитвания на токовите измервателни трансформатори на английски или български език, проведени от независима изпитателна лаборатория с приложени резултати от изпитванията, представени при доставка	Приложение 6.3.
4.	Сертификат/акредитация на независимата изпитателна лаборатория, провела типовите изпитвания – заверено копие	Приложение 6.4.

Технически параметри на токови измервателни трансформатори 20 kV, 800/5/5 A, подпорен тип, за монтиране на закрито, които се попълват от Участника в графа „Гарантирано предложение“:

Наименование на материала		Токов измервателен трансформатор 10 kV, 800/5/5 A за монтиране на закрито	
Съкратено наименование на материала		ТИТ 10 kV, 800/5/5 A, 3M	
№	Параметър	Изискване	Гарантирано предложение
1.	Тип/референтен номер съгласно каталога на производителя	Да се посочи	ATB 20-BS

2.	Производител	Да се посочи	ESITAS ELEKTRIKSAN. VE TIC. A.S.

Технически параметри на токови измервателни трансформатори 20 kV, 300/5/5 A, подпорен тип, за монтиране на закрито, които се попълват от Участника в графа „Гарантирано предложение“:

Наименование на материала		Токов измервателен трансформатор 10 kV, 300/5/5 A за монтиране на закрито	
Съкратено наименование на материала		ТИТ 10 kV, 300/5/5 A, ЗМ	
№	Параметър	Изискване	Гарантирано предложение
1.	Тип/референтен номер съгласно каталога на производителя	Да се посочи	ATB 20-BS
2.	Производител	Да се посочи	ESITAS ELEKTRIKSAN. VE TIC. A.S.

ТАБЛИЦА № 7 ЗА ОБОСОБЕНА ПОЗИЦИЯ № 2
СТАНДАРТ НА МАТЕРИАЛА ЗА НАПРЕЖЕНОВИ ТРАНСФОРМАТОРИ 20 KV, ЕДНОПОЛЮСЕН, С ДВЕ ВТОРИЧНИ НАМОТКИ, ЗА МОНТИРАНЕ НА ЗАКРИТО

Изисквания към документацията и изпитванията:

№	Документ за участие	Приложение № (или текст)
1.	Точно обозначение на типа на напреженовия трансформатор (НИТ), производителя и страна на произход и последно издание на каталога на производителя	Тип: VTB 20-K Производител: ESITAS ELEKTRIKSAN. VE TIC. A.S. Страна на произход: Турция Приложение 7.1.
2.	Удостоверение за одобряване на типа на НИТ, издадено по реда и при условията на Закона за измерванията	Приложение 7.2.
3.	Протокол от първоначална метрологична проверка, проведена от оправомощена лаборатория, съгласно действащото в Република България законодателство в областта на измерванията (представя се при доставка за всеки НИТ)	Приложение 7.3.
4.	Сертификат/акредитация на независимата изпитателна лаборатория, провела типовите изпитвания – заверено копие	Приложение 7.4.

Технически параметри на напреженови измервателни трансформатори 20 kV, еднополюсен, с две вторични намотки, за монтиране на закрито, които се попълват от Участника в графа „Гарантирано предложение“:

Наименование на материала		Напреженов измервателен трансформатор 20 kV, еднополюсен, с две вторични намотки, за монтиране на закрито	
Съкратено наименование на материала		НИТ 20 kV, 1P, с две вторични намотки, ЗМ	
№	Параметър	Изискване	Гарантирано предложение
1.	Тип/референтен номер съгласно каталога на производителя	Да се посочи	VTB 20-K
2.	Производител	Да се посочи	ESITAS ELEKTRIKSAN. VE TIC. A.S.

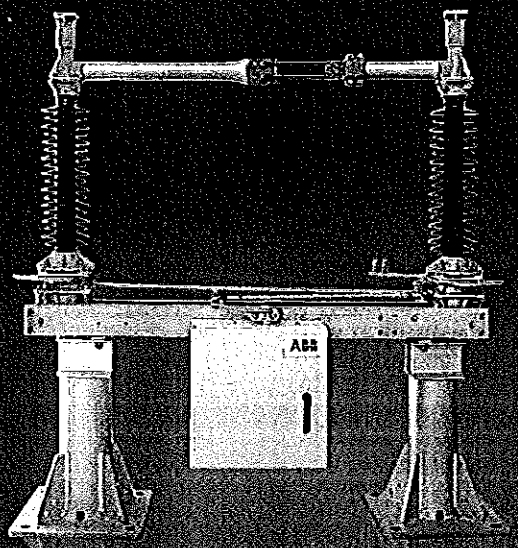
ТАБЛИЦА 8 КЪМ ОБОСОБЕНА ПОЗИЦИЯ № 2
СТАНДАРТ НА МАТЕРИАЛА ЗА ЦИФРОВИ ЗАЩИТИ ЗА ВЪЗДУШНИ И КАБЕЛНИ ЕЛЕКТРОПРОВОДНИ ЛИНИИ СР.Н.

Технически данни за непосочна цифрова защита за въздушни и кабелни електропроводни линии Ср.Н., които се попълват от Участника в графа „Гарантирано предложение“:

Название на материала		Непосочна цифрова защита за въздушни и кабелни електропроводни линии СрН	
Съкратено название на материала		Непосочна ЦЗ ВКЕЛ СрН	
№	Технически параметър	Изискване	Гарантирано предложение
1.	Тип	Да се посочи	VAMP 57
2.	Производител	Да се посочи	Шнайдер

Дата 21.07.2017 г.

ПОДПИС и ПЕЧАТ:
Петър Терев
(име и фамилия)
управител
(длъжност на представителя на участника)



Horizontal center break disconnector Type SDF, up to 550 kV Maximum reliability and minimal maintenance

Power and productivity
for a better world™

Horizontal centre break disconnector – Type SDF

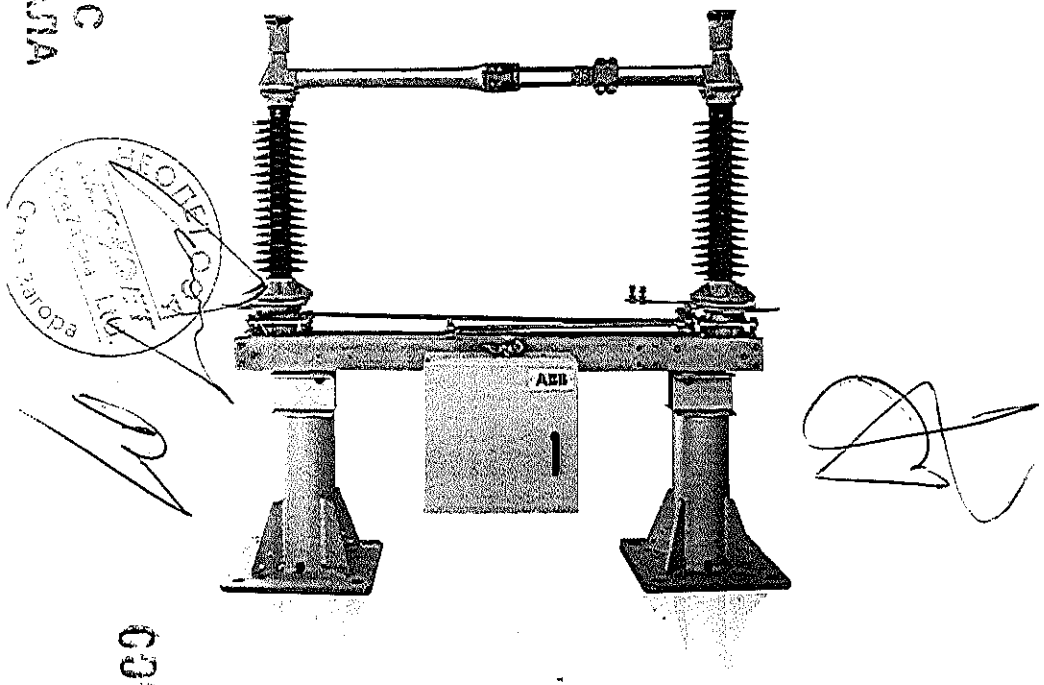
Horizontal Centre Break Disconnector – Type SDF
ABB disconnectors have been in service across the world for over two decades providing maintenance-free service with the highest records of operational reliability. The worldwide experience, often under severe climatic conditions, is applied for continual product improvement.

A mechanical device for providing isolation of power equipment from the network, a disconnector is suitable for switching very small currents or where no significant change in voltage occurs across the terminals. The option of earthing sections of power systems can be made available by providing each disconnector pole with one or two earthing switches.

The horizontal center break disconnectors type SDF are available for rated voltages up to 550kV.

Regulations
The SDF disconnectors are designed as per IEC 62271-102 and IEC 62271-1 standards. Other international regulations can be met on request.

Type tests on the disconnectors are carried out by accredited testing laboratories in accordance with the latest regulations. Comprehensive electrical and mechanical routine tests are carried out on the poles and operating mechanism of each disconnector ensuring world class quality.



72.5 kV SDF disconnector

Maximum reliability and minimal maintenance

Minimized contact resistance
The current carrying aluminum conductors are welded to minimize joint resistance.

No external springs in contact fingers for maximum reliability
The contact fingers of the moving contacts of disconnector type SDF are designed from special conducting material and without external springs for increased reliability.

Easy and quick erection
The current carrying conductors and rotary pedestals are designed for easy adjusting and alignment.

Low friction design for smooth operation Maintenance-free linkages with stainless steel rod-end bearings require less drive power for operation and provide smooth motion transmission without any disturbance in the setings.

Dead center interlocking for reliability under extreme conditions
The dead center interlocking of operating mechanisms ensures there are no inadvertent changes in the open or close switching position even under extreme external conditions such as storms, earthquakes etc. or close switching position even under extreme external conditions such as storms, earthquakes etc.

Superior design of mechanical interlock
The mechanical interlock between the earth switch and main blade is designed such that there is no scope for malfunction.

Ice breaking capacity
The disconnectors are capable of operating under severe ice conditions.

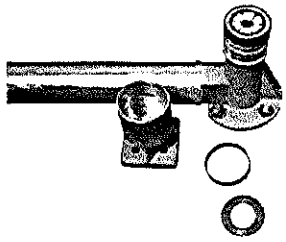
Strong rotary pedestals
This ensures that the deflection remains unchanged at high static mechanical loads.

Suitable for wide range of environmental conditions
The disconnectors can operate in a wide range of temperatures as well as under polluted environmental conditions.

Minimal maintenance
Superior material and lubricant used in the encapsulation of the pedestals and rotary terminal pads makes the disconnectors practically maintenance-free.

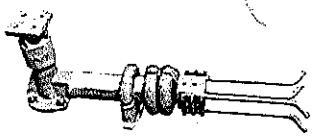
Design based on cuting-edge technology and experience
The horizontal center break disconnectors type SDF consist of a steel base frame with two rotary pedestals, insulators, current carrying conductors (current path) and driving mechanisms. Steel components are hot dip galvanized to protect against atmospheric influences.

Each of the three phases of the disconnector consists of two insulators mounted on maintenance free, sealed rotary pedestals which are carried by the steel base frame. The support post insulators carry the current paths consisting of two halves, with finger contacts and fist contacts. The current transfer takes place at the rotary heads of the two current paths via tulip-type contact fingers. The rotary heads can be turned 360° and therefore the installation of a pipe connection or the straining of connection cable is possible in any direction. Flat terminal plates can be provided as per DIN standard 46203, NEMA or any other standards.



Tulip contacts of 1600 A current path terminal head

Fist side current path rated for 1600 A



Finger side path rated for 1600 A with earthing fixed contact mounted.

Technical data

Voltage		72.5 kV *	123 kV	145 kV	170 kV	245 kV	300 kV	362 kV	420 kV	550 kV
Type designation		SDF72.5	SDF123	SDF145	SDF170	SDF245	SDF300	SDF362	SDF420	SDF550
Rated voltage (U_r)	kV	72.5	123	145	170	245	300	362	420	550
Rated frequency (f_r)	Hz	50/60								
Rated normal current (I_r)	A	1600, 2500, 3150, 4000 **								
Rated short-withstand current, rated duration of short circuit (I_k,t_k)	kA, s	40/50/63, 1***								
Rated peak withstand current (I_p)	kAp	2.5x I_k (for 50 Hz) / 2.6x I_k (for 60 Hz)								
Basic insulation level										
Power frequency withstand voltage for 1 minute										
To earth and between poles	kV	140	230	275	325*	460	380	450	520	27
Across the isolatting distance	kV	160	265	315	375	530	435	520	610	315
Lightning impulse withstand voltage										
To earth and between poles	kVp	325	550	650	750	1050	1050	1175	1425	650
Across the isolating distance	kVp	375	650	750	860	1200	1050(+170)	1175(+205)	1425(+240)	750
Switching impulse withstand voltage										
To earth and between poles	kVp	-	-	-	-	-	850	950	1050	1175
Across the isolating distance	kVp	-	-	-	-	-	700(+245)	800(+295)	900(+325)	900(+450)

* 36 kV on demand
** Higher currents on demand
*** 3s for 40 kA

ВЯРНО С ОРИГИНАЛА

C00023

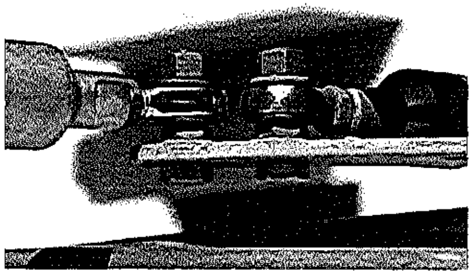
Mode of operatio.

The disconnector and earthing switch are operated via independent operating mechanisms.

The operating energy from the operating mechanism of the disconnectoris transmitted to one of the rotary pedestals of one phase. A diagonal rod connects both the rotary pedestals of each column ensuring simultaneous operation of both columns. The three phases of the disconnector are connected by gang operating linkages for three phase operation. During opening and closing operation both the current paths rotate through an angle of 900. The current paths will be at right angles to the base frame in open position.

Operating mechanism
All disconnectors can be supplied by manual or motor operated mechanism, as required by the customer. Each three-pole disconnector or earthing switch group requires only one operating mechanism. The coupling rods between the individual poles can be continuously adapted.

Operating mechanisms contain auxiliary switches for control and signaling as well as provisions for electrical interlocks.

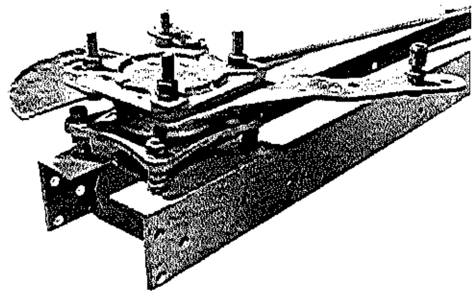


Linkages with spherical bearings

Three phase operation is conducted via mechanical or electrical gang operation.

For maximum reliability the main contacts of the disconnector and earthing switch pass through the dead center positions shortly before they reach the end positions. This prevents accidental opening or closing of the units due to external influences (e.g. short-circuits, storm, earthquake).

Interlocks
The disconnector and earthing switch (when supplied) are mechanically interlocked. In operating mechanisms a blocking magnet can be installed as an additional interlocking facility, which in disconnected condition, makes operation of the operating mechanism impossible.



Bearing on frame assembly

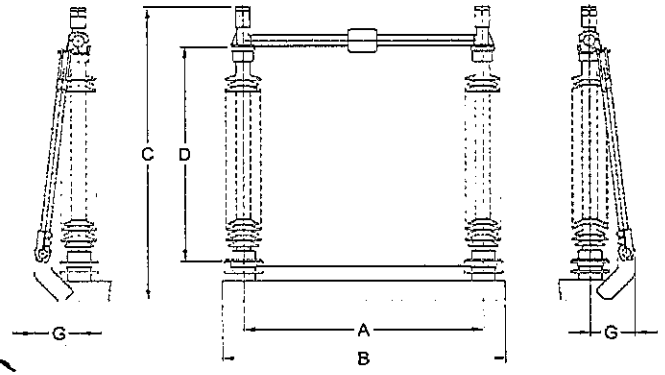
Earthing switch unit
The earthing switch unit, an optional assembly, consists of a hingedtype earthing switch fixed at the base frame. The unit can be mounted on either of the contact sides or on both sides as required.

In case of the earthing switch, the operating energy is transmitted to the earthing switch shaft. The tubular contact arm swings upwards when the unit is closing.

Easy installation

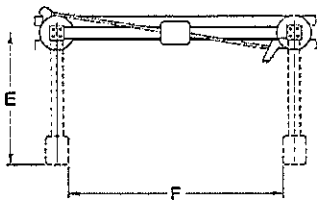
The disconnectors are delivered in following assemblies - lower part with rotary pedestals and diagonal rod, current path halves, support insulators and operarting mechanism. As all mechanical adjustments are carried out in the factory, only mounting of the assemblies, installation of the coupling rods between the poles, connection of the high-tension leads and the electrical connection leading to the operating mechanisms is required at the site.

Stud bolts are provided to compensate rapidly and exactly any inaccuracies in insulator position caused due to tensile forces.



Earthing switch contact side

Earthing switch finger side

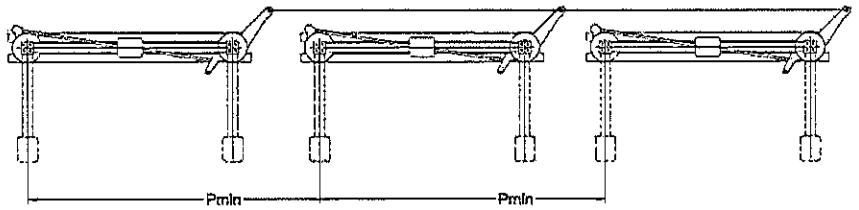


Main dimensions as in drawing (mm)

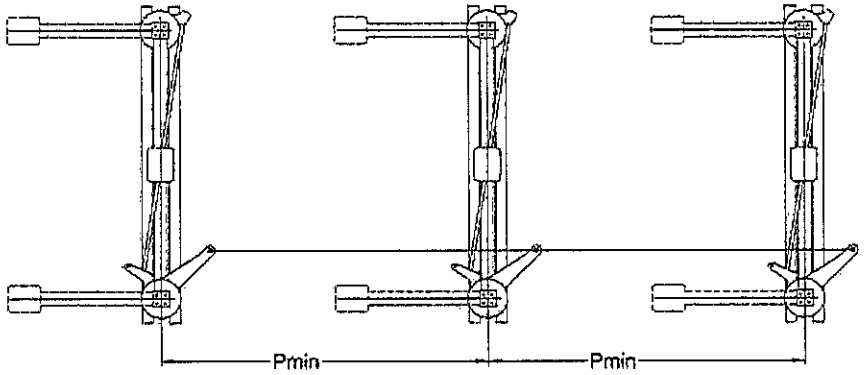
			SDF72.5	SDF123	SDF145	SDF170	SDF245	SDF300	SDF362	SDF420	SDF550
A	Support insulator distance		1000	1400	1650	1830	2620	2620	3200	3800	4200
B	Base frame length		1300	1300	1950	2130	2920	2920	3500	4066	4466
C	Disconnector height	1600 A	1325	1775	2055	2255	2855	3205	3255	-	-
		2500 A	1375	1825	2105	2305	2905	3255	3255	4090	-
		3150 A	1425	1875	2155	2355	2955	3305	3305	4140	4790
		4000 A	1425	1875	2155	2355	2955	3305	3305	4140	4790
D	Support insulator height		770	1220	1500	1700	2300	2650	2650	3350	4000
E	Disconnector width (open)		560	760	925	1030	1370	1370	1725	2100	2380
F	Isolating distance		800	1200	1450	1630	2420	2300	2700	3385	3810
G	Length of earthing switch attachment		450	450	450	450	450	450	450	1050	1050

Type	Installation (with or without earthing switch)	
	In series Pmin(mm)	In parallel Pmin(mm)
SDF72.5	1790	1270
SDF123	2700	1970
SDF145	3150	2330
SDF170	3530	2640
SDF245	4920	3520
SDF300	5350	4070
SDF360	6925	4755
SDF420	On request	
SDF550	On request	

Series installation



Parallel installation



Contact us

ABB Bulgaria
High Voltage products
32, Nikola Petkov Str, 5400,
Sevlievo, Bulgaria
Phone: +359-675-33630
Email: office@bg.abb.com

www.abb.com/highvoltage

Note: ABB is working continuously to improve the products. We therefore reserve the right to change designs, dimensions and data without prior notice.

Publicon1HYD800045, Rev.B 2012-12 Horizontal center break disconnector Type SDF up to 550

Power and productivity
for a better world™

Техническо описание на разединител с централно разделяне и един заземителен нож 110kV, за монтиране на открито тип SDF123 E1 производство на АББ България ЕООД – бранч Севлиево.

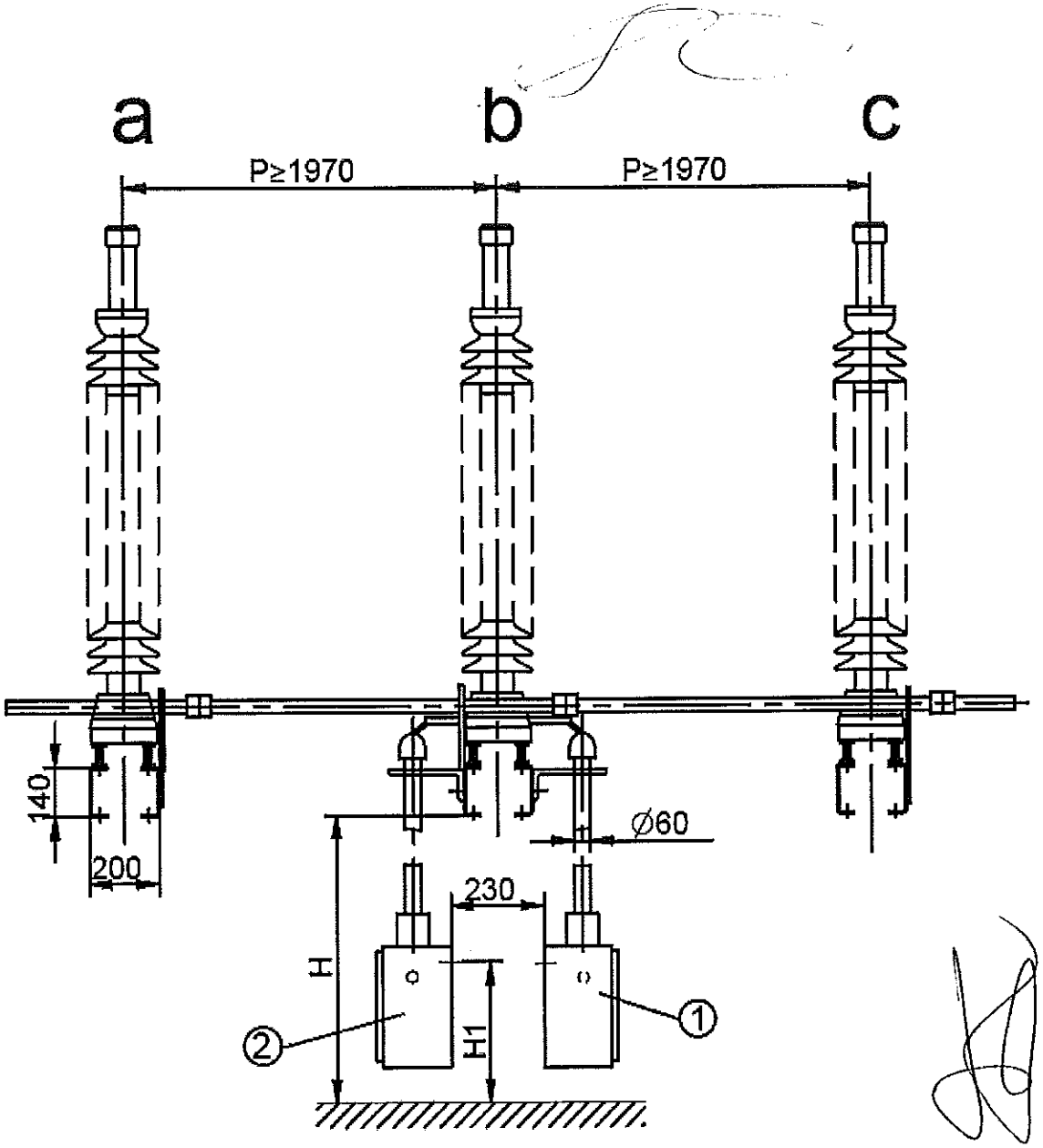
	Характеристика	Минимални технически изисквания	
1.	Брой на полюсите (фазите)	3	3
2.	Място на експлоатация	За монтиране на открито	За монтиране на открито
3.	Обявени изолационни разстояния:		
-	между осите на полюсите (фазите)	≥ 1000 mm	≥ 1000 mm
4.	Главна контактна система:		
-	тип	С централно разединяване	≥ 1000 mm
-	материал на клемовите съединения за свързване към външната верига	Мед или алуминий с подходящо покритие непредизвикващо електрохимична корозия	Cu+Ag – main contacts; Cu- ES contacts
-	време за (включване/изключване)	≤ (10/10) s	≤ 7 s
5.	Заземителни ножове:	един комплект	един комплект
-	движение	Вертикално	Вертикално
-	оцветяване	Тип зебра – бяло (RAL 9016) и червено (RAL 3020) или еквивалентно/и (през 100 mm)	Тип зебра – бяло (RAL 9016) и червено (RAL 3020) или еквивалентно/и (през 100 mm)
6.	Тип на изолаторите	Порцелан/полимер	Порцелан С6
7.	Блокировки	Механична, електрическа	Механична, електрическа
8.	Задвижване		
-	вид	Моторно	Моторно
-	номинално напрежение на електродвигателя	220 V DC ± 20 %	220 V DC -20/+20% according to IEC
9.	Статични натоварвания		
-	хоризонтално	≥ 500 N	≥ 500 N
-	вертикално	≥ 1000 N	≥ 1000 N
-	комбинирано	≥ 750 N	≥ 750 N
10.	Динамично натоварване	≥ 2000 N	≥ 2000 N
11.	Клас на механична комутационна възможност	≥ M1	
12.	Сеизмична устойчивост	≥ 0,3 g	≥ 0,3 g
13.	Оцветяване	RAL 6021 или еквивалентно/и	RAL 6021
14.	Период на необслужваемост на повърхностите на всички метални части	≥ 15 год.	≥ 15 год.
15.	Табелка за техническите характеристики и надписи	Съгласно БДС EN 62271-102 или еквивалентно/и на български език	Съгласно БДС EN 62271-102 на български език
16.	Допълнителни аксесоари		
17.	Манивела за ръчно включване/изключване	≥ 2 бр.	2 бр.

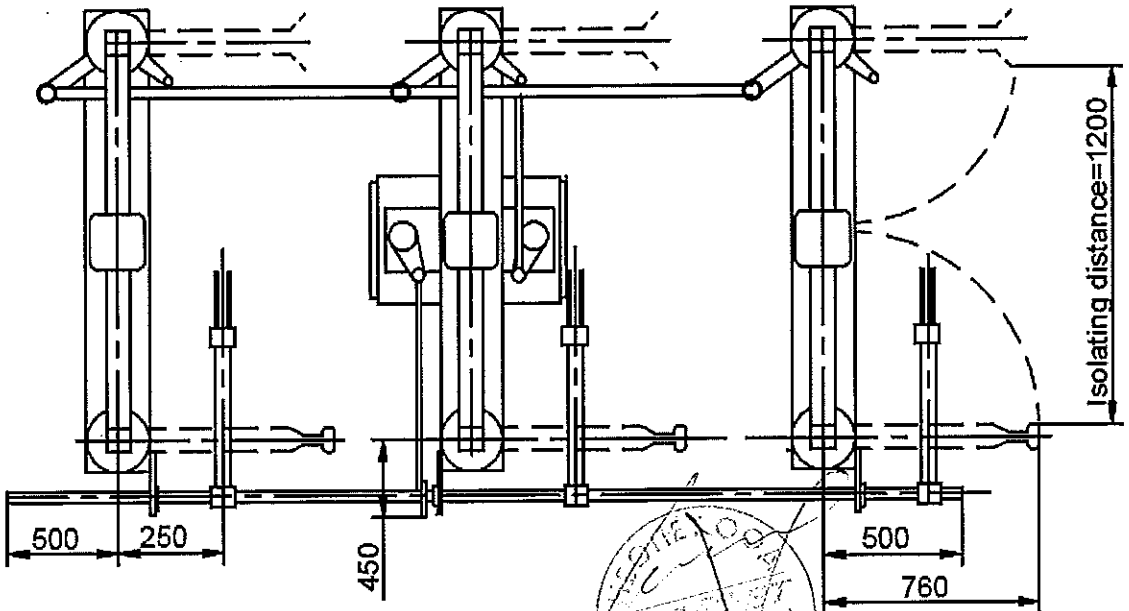
ВЯРНО С ОРИГИНАЛА

№	Параметър	Минимални технически изисквания	
1.	Обявено напрежение *(U_r)*	123 kV	123 kV
2.	Обявено изолационно ниво между части под напрежение и земя		
-	Обявено издържано мълниево импулсно напрежение *(U_p)* (върхова стойност): спрямо земя, между полюси и между отворени контакти	550 kV	550 kV
-	Обявено краткотрайно (1 min) издържано напрежение с промишлена честота (50 Hz) *(U_d)* (ефективна стойност): спрямо земя, между полюси и между отворени контакти	230 kV	230 kV
3.	Обявено изолационно ниво между разделящо разстояние		
-	Обявено издържано мълниево импулсно напрежение *(U_p)* (върхова стойност): спрямо земя, между полюси и между отворени контакти	550 kV	550 kV
-	Обявено краткотрайно (1 min) издържано напрежение с промишлена честота (50 Hz) *(U_d)* (ефективна стойност): спрямо земя, между полюси и между отворени контакти	230 kV	230 kV
4.	Обявена честота *(f_r)*	50 Hz	50 Hz
5.	Обявени стойности на тока		
-	Обявен номинален ток	1250 A	1250 A (up to 1600A)
-	Обявен краткотраен издържан ток *(I_k)*	≥ 31.5 kA	≥ 31.5 kA up to 40kA)
-	Обявен върхов издържан ток *(I_p)*	≥ 78.8 kA	≥ 78.8 kA (up to 100kA)
6.	Обявена продължителност на късо съединение*(t_k)*	≥ 1 s	≥ 1 s (up to 3s)
7.	Способност за изключване на:	-	
-	Индуктивен ток	≥ 3 A	3 A
-	Капацитивен ток	≥ 1 A	2 A
8.	Ниво на радио смущения	≤ 2500 μV	≤ 2500 μV
9.	Път на пропълзяване по повърхността на изолатора	≥ 31 mm/kV	31 mm/kV

ВЯРНО С ОРИГИНАЛА

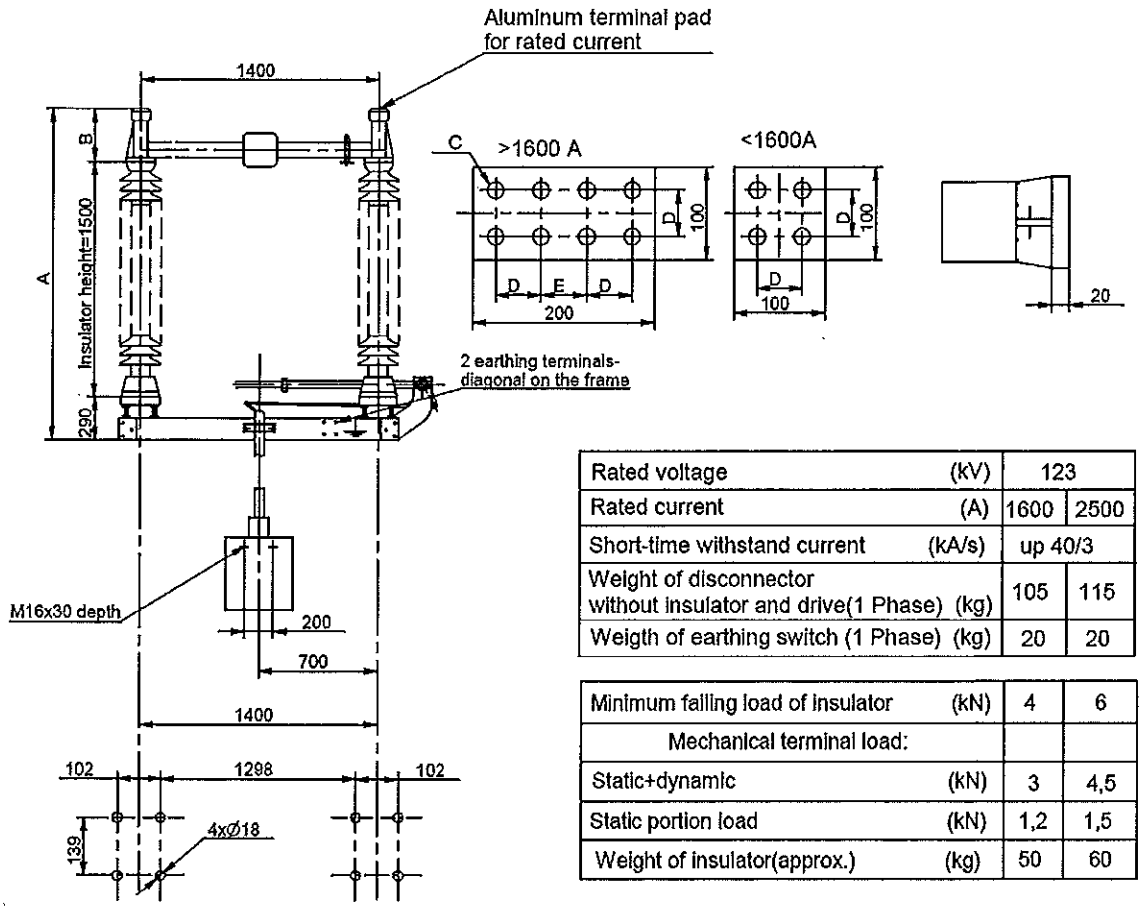
000032





ВЯРНО С ОРИГИНАЛА

C00033



Mounting Dimensions 1 phase

① Operating mechanism of Disconnector
② Operating mechanism of Earthing switch

Operating mechanism is to be mounted at either phase a, b or c

Rated voltage	(kV)	123	
Rated current	(A)	1600	2500
Short-time withstand current	(kA/s)	up 40/3	
Weight of disconnector without insulator and drive(1 Phase)	(kg)	105	115
Weigth of earthing switch (1 Phase)	(kg)	20	20

Minimum failing load of insulator	(kN)	4	6
Mechanical terminal load:			
Static+dynamic	(kN)	3	4,5
Static portion load	(kN)	1,2	1,5
Weight of insulator(approx.)	(kg)	50	60

Rated Current	Terminal pad	A	B	C	D	E
1600A	DIN	1790	280	14	50	-
	NEMA			14.3	44.4	-
	GOST			14	45	-
2500A	DIN	1840	330	14	50	50
	NEMA			14.3	44.4	55.6

Техническо описание на разединител с централно разделяне и два заземителни ножа 110kV, за монтиране на открито тип SDF123 E2 производство на АББ България ЕООД – бранч Севлиево.

	Характеристика	Минимални технически изисквания	
18.	Брой на полюсите (фазите)	3	3
19.	Място на експлоатация	За монтиране на открито	За монтиране на открито
20.	Обявени изолационни разстояния:		
-	между осите на полюсите (фазите)	≥ 1000 mm	≥ 1000 mm

ВЯРНО С ОРИГИНАЛА

Стара Загора

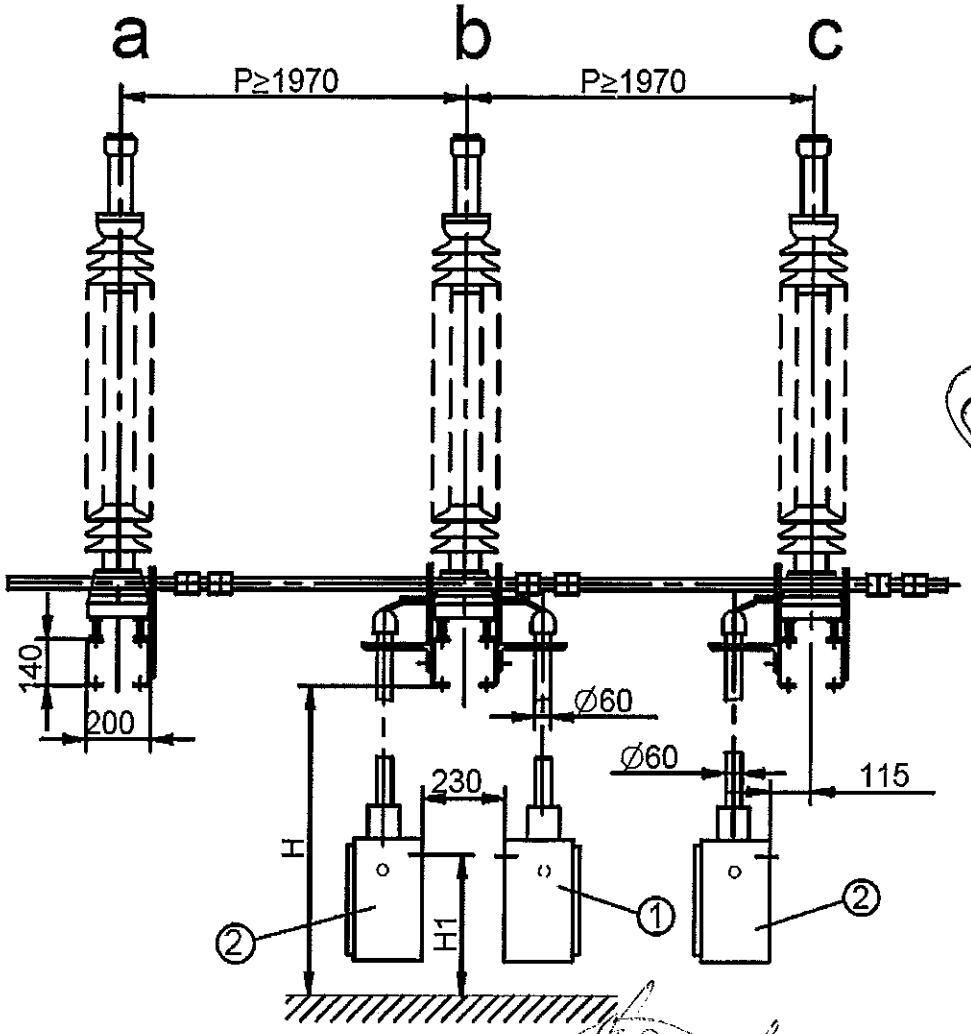
G00031

	Характеристика	Минимални технически изисквания	
21.	Главна контактна система:		
-	тип	С централно разединяване	≥ 1000 mm
-	материал на клемовите съединения за свързване към външната верига	Мед или алуминий с подходящо покритие непредизвикващо електрохимична корозия	Cu+Ag – main contacts; Cu- ES contacts
-	време за (включване/изключване)	≤ (10/10) s	≤ 7 s
22.	Заземителни ножове:	два комплект	два комплект
-	движение	Вертикално	Вертикално
-	оцветяване	Тип зебра – бяло (RAL 9016) и червено (RAL 3020) или еквивалентно/и (през 100 mm)	Тип зебра – бяло (RAL 9016) и червено (RAL 3020) или еквивалентно/и (през 100 mm)
23.	Тип на изолаторите	Порцелан/полимер	Порцелан С6
24.	Блокировки	Механична, електрическа	Механична, електрическа
25.	Задвижване		
-	вид	Моторно	Моторно
-	номинално напрежение на електродвигателя	220 V DC ± 20 %	220 V DC -20/+20% according to IEC
26.	Статични натоварвания		
-	хоризонтално	≥ 500 N	≥ 500 N
-	вертикално	≥ 1000 N	≥ 1000 N
-	комбинирано	≥ 750 N	≥ 750 N
27.	Динамично натоварване	≥ 2000 N	≥ 2000 N
28.	Клас на механична комутационна възможност	≥ M1	
29.	Сеизмична устойчивост	≥ 0,3 g	≥ 0,3 g
30.	Оцветяване	RAL 6021 или еквивалентно/и	RAL 6021
31.	Период на необслужваемост на повърхностите на всички метални части	≥ 15 год.	≥ 15 год.
32.	Табелка за техническите характеристики и надписи	Съгласно БДС EN 62271-102 или еквивалентно/и на български език	Съгласно БДС EN 62271-102 на български език
33.	Допълнителни аксесоари		
34.	Манивела за ръчно включване/изключване	≥ 2 бр.	2 бр.

№	Параметър	Минимални технически изисквания	
10.	Обявено напрежение (U_r)	123 kV	123 kV
11.	Обявено изолационно ниво между части под напрежение и земя		
-	Обявено издържано мълниево импулсно напрежение (U_p) (върхова стойност): спрямо земя, между полюси и между отворени контакти	550 kV	550 kV
-	Обявено краткотрайно (1 min) издържано напрежение с промишлена честота (50 Hz) (U_d) (ефективна стойност): спрямо земя, между полюси и между отворени контакти	230 kV	230 kV
12.	Обявено изолационно ниво между разделящо разстояние		
-	Обявено издържано мълниево импулсно напрежение (U_p) (върхова стойност): спрямо земя, между полюси и между отворени контакти	550 kV	550 kV

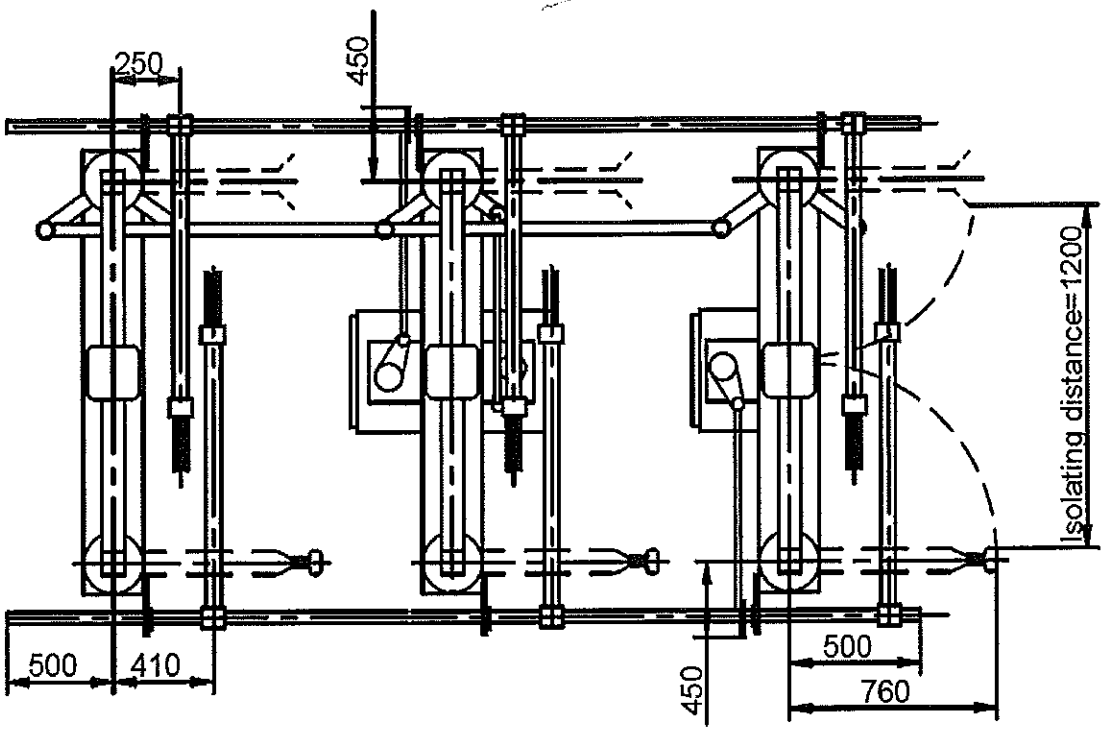
ВЯРНО С ОРИГИНАЛА

№	Параметър	Минимални технически изисквания	
-	Обявено краткотрайно (1 min) издържано напрежение с промишлена честота (50 Hz) *(U_d)* (ефективна стойност): спрямо земя, между полюси и между отворени контакти	230 kV	230 kV
13.	Обявена честота *(f_r)*	50 Hz	50 Hz
14.	Обявени стойности на тока		
-	Обявен номинален ток	1250 A	1250 A (up to 1600A)
-	Обявен краткотраен издържан ток *(I_k)*	≥ 31.5 kA	≥ 31.5 kA up to 40kA)
-	Обявен върхов издържан ток *(I_p)*	≥ 78.8 kA	≥ 78.8 kA (up to 100kA)
15.	Обявена продължителност на късо съединение*(t_k)*	≥ 1 s	≥ 1 s (up to 3s)
16.	Способност за изключване на:	-	
-	Индуктивен ток	≥ 3 A	3 A
-	Капацитивен ток	≥ 1 A	2 A
17.	Ниво на радио смущения	≤ 2500 μV	≤ 2500 μV
18.	Път на пропълзяване по повърхността на изолатора	≥ 31 mm/kV	31 mm/kV

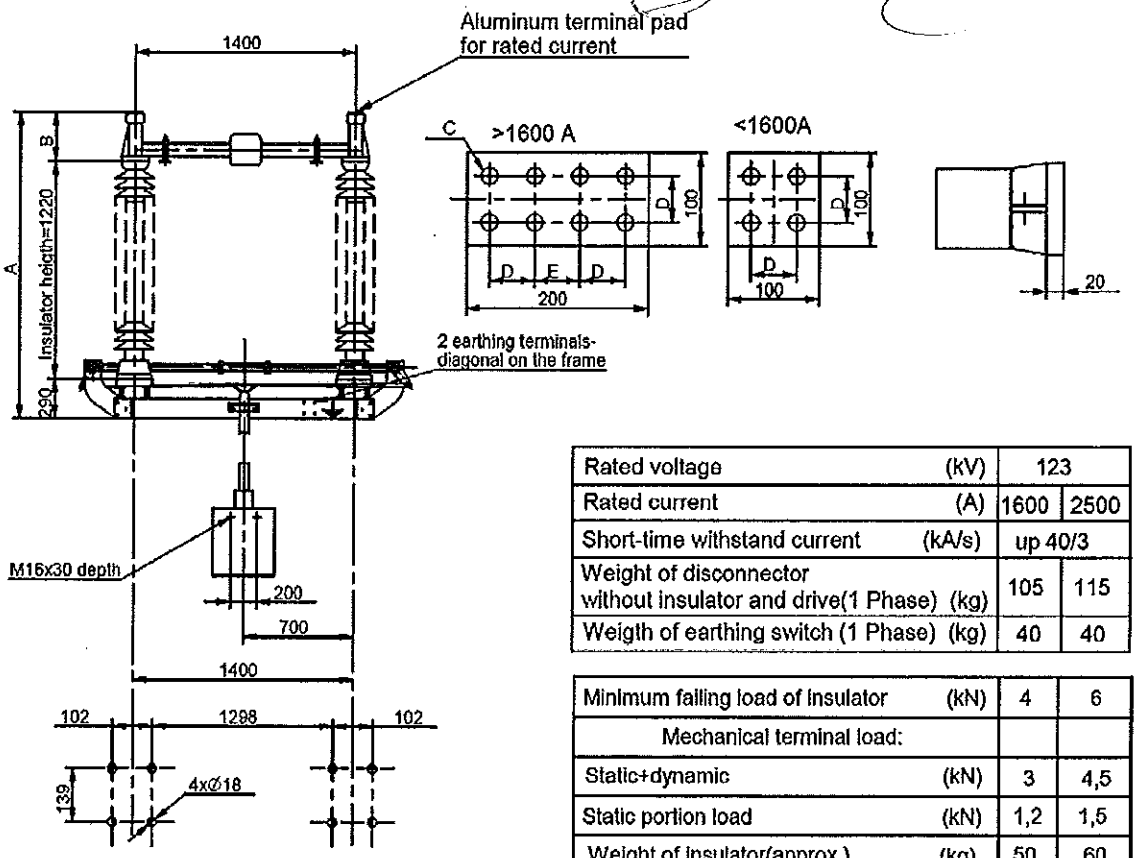


ВЕРНО С ОРИГИНАЛА

С30036



ВЯРНО С
ОРИГИНАЛА



Mounting Dimensions 1 phase

Rated voltage (kV)	123	
Rated current (A)	1600	2500
Short-time withstand current (kA/s)	up 40/3	
Weight of disconnector without insulator and drive(1 Phase) (kg)	105	115
Weigth of earthing switch (1 Phase) (kg)	40	40

Minimum falling load of insulator (kN)	4	6
Mechanical terminal load:		
Static+dynamic (kN)	3	4,5
Static portion load (kN)	1,2	1,5
Weight of insulator(approx.) (kg)	50	60

Rated Current	Terminal pad	A	B	C	D	E
1600A	DIN	1790	280	14	50	-
	NEMA			14.3	44.4	-
	GOST			14	45	-
2500A	DIN	1840	330	14	50	50
	NEMA			14.3	44.4	55.6

① Operating mechanism of Disconnector
② Operating mechanism of Earthing switch

Operating mechanism is to be mounted at either phase a, b or c

H - vary with structure height - (Hmin=2400 mm)
H1 - standard height 1350 mm.

ВЕРНО С ОРИГИНАЛА

ГЕОПЕТРОЛ Stara Zagora Стара Загора

C000038

Обобщение на типови изпитания за разединител тип SDF 123kV

Производител: АББ България, клон Севлиево
Разединител тип: Разединител, тип Централно отваряне SDF 123 kV 1600 A EI

Спецификация:

Номинално напрежение:	123	kV
Номинално импулсно напрежение:		
-фаза към земя и между фазите;	550	kV peak
-през изолационното разстояние.	630	kV peak
Номинално напрежение с промишлена честота:		
-фаза към земя и между фазите;	230	kV r.m.s.
-през изолационното разстояние;	265	kV r.m.s.
-в най-неблагоприятната позиция на земния нож.	142	kV r.m.s.
Номинален ток:	1600	A
Номинална честота:	50/60	Hz
Номинален ток на късо съединение - главен нож:		
-върхова стойност;	104	kA
-ефективна стойност;	40	kA
-продължителност на късото съединение.	3	sec
Номинален ток на късо съединение – земен нож:		
-върхова стойност;	104	kA
- ефективна стойност;	40	kA
-продължителност на късото съединение.	3	sec
Ниво на радио-смущения	<2500	μV
Максимална температура на околната среда	+50	°C

Приложените протоколи от изпитването, документират типови изпитания, извършени съгласно посочените по-долу стандарти:

Проведени тестове	Проведен тест съгласно:	Тестови протоколи	
		No.	Издател:
Измерване на съпротивление	IEC 62271-102 clause 6.4	12329	ICMET-Craiova
Типово изпитание - нагрев	IEC 62271-102 clause 6.5	12329	ICMET-Craiova
Номинален ток на късо съединение, максимален ток на късо съединение	IEC 62271-102 clause 6.6	12329	ICMET-Craiova
Импулсно напрежение	IEC 62271-102 clause 6.2	45229	ICMET-Craiova
Напрежение с промишлена честота	IEC 62271-102 clause 6.2.6	45229	ICMET-Craiova
Напрежение с промишлена честота, в най-неблагоприятната позиция на земния нож	IEC 62271-102 clause 4.2	45229	ICMET-Craiova
Ниво на радио-смущения	IEC 62271-102 clause 6.3	45229	ICMET-Craiova
Работа при максимална температура на околната среда	IEC 62271-102 clause 6.104.2	NR31-805T-1	URBAN-INCERC

ABB Bulgaria EOOD
Main office:
9 Hristofor Kolumb Blvd, fl.3
1592 Sofia, Bulgaria
Tel.:(+359 2) 8075500, 8075600, 8075700
Fax: (+359 2) 8075599 (8,7,6)
Web: www.abb.bg

UIC:831133152
VAT Nr.: BG 831133152
Bank details:
ING Bank, branch Sofia
IBAN:BG13INGB91451000027317 (BGN)
IBAN: EUR: BG60INGB91451400027311 (EUR)
BIC: INGBBGSF

Branch Sevlievo
Production and office
32, Nikola Petkov Str.
5400 Sevlievo, Bulgaria
Tel.: (+359 675) 39222
Fax: (+359 675) 30043
e-mail: abb.sevlievo-branch@bg.abb.com

ВЯРНО С ОРИГИНАЛА

URBAN INCD INCERC
Ministry of Education and Scientific Research
National Authority for Scientific Research and Innovation
National Institute for Research and Development in Construction, Urban Planning and Sustainable Spatial Development "URBAN-INCERC"
Bd-ul Pantelimon 266, 023982, Sector 2, Bucuresti, Tel: 021 527 27 40; Fax: 021 255 15 52; e-mail:urban-incerc@incd.ro, www.incd.ro

Iasi Branch
Laboratory for Climatic – Hygrothermal, Mechanical and Seismic Tests for Buildings, Installations and Equipment (IHS)
Address: Str. Prof. Anton Sesan, nr. 37, Iasi
1st degree laboratory certification no. 2972 /18.12.2014 issued by I.S.C

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SR EN ISO/CEI 17025:2005
CERTIFICAT DE ACREDITARE LI 320

APPROVED BY GENERAL MANAGER
INCD „URBAN - INCERC"
Associate Professors dr. arch. Sabin Mateș

Director General V.M.

TEST REPORT NR 31- 805T - 1 / 15.03.2016
FOR CLIMATIC TEST ACCORDING TO EN 62271-102, CLAUSE 6.104.2 - OPERATION AT MAXIMUM AMBIENT AIR TEMPERATURE (+50°C)

1. **Customer order/contract:** 81/17.02.2016/ contract no.805T/2016
2. **Name of test object:**

Three pole disconnector SDF 123kV 40kA 1600A with earthing switch operated by Motor Drive MD 60

3. **Customer name : NATIONAL INSTITUTE for RESEARCH, DEVELOPMENT and TESTING in ELECTRICAL ENGINEERING - ICMET Craiova**

Customer address: B-dul Decebal no. 118A,Craiova, Calea Bucuresti no. 144 Tel. 0351 404888 , 0351 404 889, Fax: 0351 404 890, 0251 415 482

4. **Manufacturer: ABB BULGARIA BRANCH SEVLIEVO BULGARIA**

Manufacturer address: 32 N. PETROV STR. 5400 SEVLIEVO, Bulgaria

5. **Identification of the test specification or procedure:**
   - **EN 62271-102:2002 - High-voltage switchgear and controlgear. Part 102: High-voltage alternating current disconnectors and earthing switches, clause 6.104.2- Operation at maximum ambient air temperature**
   - **PTE IHS - 19 / 12.08 - URBAN INCERC Iasi**
6. **Description and identification of tested object:**
Three pole Disconnector SDF 123/1600 with one Erthing Switch serial number 2GPA45040000654, operated by Motor Drive MD 60 serial number 2GPA45010023372, 2GPA45010023376
7. **Date when tested object was received:** PVPP no. 24IHS from 22.02.2016 and expedition note ABB Bulgaria Branch Sevlievo /19.02.2016 Laboratory code IHS 486/E1-02.16
8. **Test date: 22.02.2016 – 26.02.2016**

9. **Description of sampling procedure:** Sampling of the test object was performed by the customer at their own risk.
10. **Obtained results:**

Equipment and materials used: climatic room with thermal adjustment, 600m³

10.1. The resistance of the circuit:

Resistance of the circuit (μΩ) – measurement at 100A			
Resistance of the main circuit (μΩ)			
Moment of measurements	Pole A	Pole B	Pole C
initial	50.7	51.1	50.3
final	54.5	53.7	51.3
Percentage Increase	4.97 %	4.84 %	1.95 %
Resistance of the earthing switch circuit (μΩ)			
initial	64.3	60.9	62.8
final	67.9	64.5	68.7
Percentage Increase	5.30%	5.58%	8.59%

10.2. The drive time cycles of closing and opening of the contact of main circuit:

	Initial drive time of cycles Minimum Voltage - Normal temperature (s)	Drive time of cycles Maximum Voltage (s)	Drive time of cycles Minimum Voltage (s)	Final drive time of cycles Minimum Voltage - Normal temperature (s)
		extreme positive + 50°C temperature		
Cycles Open - Close	4.459	4.321	4.335	4.697
	4.461	4.330	4.334	4.559
	4.456	4.321	4.340	4.478
	4.453	Medium value – 4.324	Medium value – 4.336	4.504
	4.459			4.573
Medium value	4.460			4.642
Percentage increase:				1.8%
		extreme positive + 50°C temperature		
Cycles Close – open	4.378	4.253	4.319	4.380
	4.363	4.250	4.348	4.426
	4.371	4.252	4.364	4.406
	4.391	Medium value 4.452	Medium value 4.344	4.516
	4.376			4.512
Medium value	4.380			4.448
Percentage increase				1.63%

10.3. The drive time cycles of closing and opening of the contact of earthing switch circuit:

	Initial drive time of cycles Minimum Voltage - Normal temperature (s)	Drive time of cycles Maximum Voltage (s)	Drive time of cycles Minimum Voltage (s)	Final drive time of cycles Minimum Voltage - Normal temperature (s)
		Extreme positive + 50°C temperature		
Cycles Open - Close	4.487	4.404	4.395	4.913
	4.484	4.386	4.382	4.908
	4.476	4.399	4.389	4.815
	4.483	Medium value – 4.398	Medium value – 4.389	4.857
	4.469			4.905
Medium value	4.480			4.882
Percentage increase:				1.11%
		Extreme positive + 50°C temperature		
Cycles Close – open	4.059	3.958	3.942	4.049
	4.047	3.961	3.955	4.129
	4.051	3.959	3.957	4.131
	4.050	Medium value 3.959	Medium value 3.951	4.128
	4.039			4.120
Medium value	4.049			4.111
Percentage increase				1.76%

11. **Uncertainty of measurement:** Was not requested by the customer.
12. *** Opinions and Interpretations:** * Item 12 is not covered by the RENAR accreditation

Three pole Disconnector SDF 123/1600 with one Erthing Switch serial number 2GPA45040000654, operated by Motor Drive MD 60 serial number 2GPA45010023372, 2GPA45010023376
HAS FULFILLED THE TECHNICAL CONDITIONS REQUIRED FOR:

- **functioning to AT MAXIMUM AMBIENT AIR TEMPERATURE +50°C, according to EN 62271-102, clause 6.104.2. The equipment (the main circuits and earthing switch) may be maneuvered, performing the closed-open drive cycles imposed by the standard (three cycles close-open), by means of the motor drive mechanism. No malfunctions of the contact and drive elements, and support insulators, were detected, as well as no deformations or permanent blocking that might hinder the mechanical or electrical performance of the disconnector with earthing switch.**

NOTES:

- *The result of the test refers only to the tested object.*
- *The test report cannot be partially reproduced without the approval of the laboratory which performed the test.*
- *The test report is accompanied by Annex to TEST REPORT No. 31-805T-1/15.03.2016, 8 pages.*

Verified by Branch Manager eng. Constantin Mircea, PhD

Verified by Head of HT Laboratory eng. Livia Miron, PhD

Prepared by Contract handler eng. Adrian Clobanu, PhD

ВЯРНО С ОРИГИНАЛА

ANNEX TO TEST REPORT No. 31-805T –1/ 15.03.2016

1. PRODUCT PRESENTATION

Three pole Disconnector SDF 123/1600 with one Erthing Switch serial number 2GPA45040000654, operated by Motor Drive MD 60 serial number 2GPA45010023372, 2GPA45010023376 has been assembled in the climatic chamber of the Research and Hygrothermal, Climatic, Mechanical and Seismic Testing for Constructions, Instalations and Equipment Laboratory of the National Institute for Research and Development in Constructions, Urban Planning And Sustainable Territorial Development "URBAN - INCERC", Iași Branch and has been verified by experimental means, through tests on its functional behavior when subjected to severe climatic conditions:

- **at maximum ambient air temperature + 50°C temperature, according to EN 62271-102, clause 6.104.2,**

1.1 Product identification (components)
1) Three pole Disconnector with Erthing Switch SDF 123/1600, operated by Motor Drive MD 60
2) supporting metalic frame.

Producer: ABB BULGARIA BRANCH SEVLIEVO BULGARIA, 32 N. PETROV STR. 5400 SEVLIEVO, Bulgaria

1.2 Installation in the climatic chamber of the Research and Hygrothermal, Climatic, Mechanical and Seismic Testing for Constructions, Instalations and Equipment Laboratory of URBAN - INCERC Iași Branch

Three pole Disconnector SDF 123/1600 with one Erthing Switch serial number 2GPA45040000654, operated by Motor Drive MD 60 serial number 2GPA46010023372, 2GPA45010023376 has been assembled for tests in the climatic chamber of the Research and Hygrothermal, Climatic, Mechanical and Seismic Testing for Constructions, Instalations and Equipment Laboratory of the "URBAN - INCERC", Iași Branch, according to the reference technical documentation.

During installation, the following has been verified:

- Overall dimensions;
- dimensions and types of the component subsystems;
- elevations at which the subsystems may be mounted;
- product subassemblies;
- product integrity and recording of possible fissures, deformations or other damages caused by transportation, manipulation, and installation, in order to differentiate between original defects and the ones that have appeared following tests.

The installation and mounting of the Three pole Disconnector SDF 123/1600 with one Erthing Switch serial number 2GPA45040000654, operated by Motor Drive MD 60 serial number 2GPA45010023372, 2GPA45010023376 in the climatic chamber has been performed according to the normal installation procedures specified by the producers (according to 10142), and electrical connection diagram for Motor drive MD 60(2GPA543235-FM), fig. 1.1, 1.2 and picture no.1).
The pictures no. 2 through 5 show Three pole Disconnector SDF 123/1600 with one Erthing Switch serial number 2GPA45040000654, operated by Motor Drive MD 60 serial number 2GPA45010023372, 2GPA45010023376 assembled in the climatic chamber and during various stages of the test performed.

000040

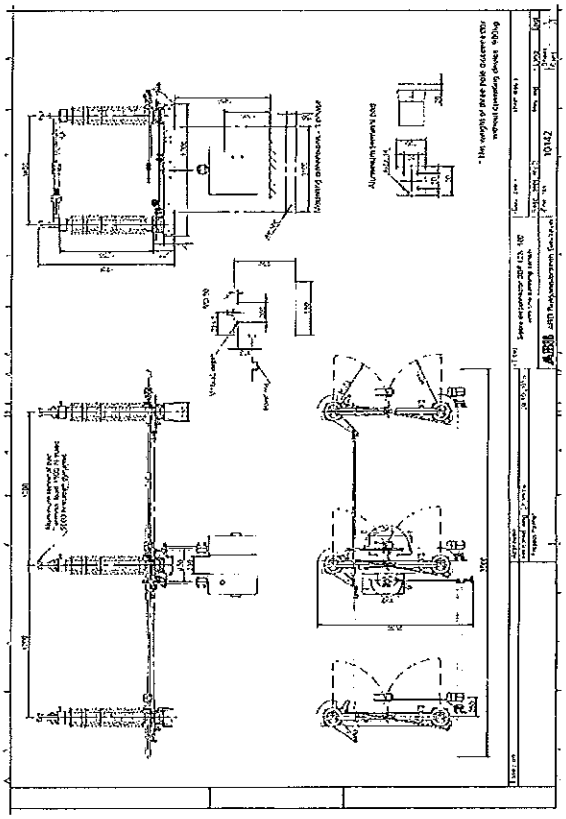


Fig. 1.1 - Three pole Disconnector with one Earthing Switch SDF 123/1600, operated by Motor Drive MD 50

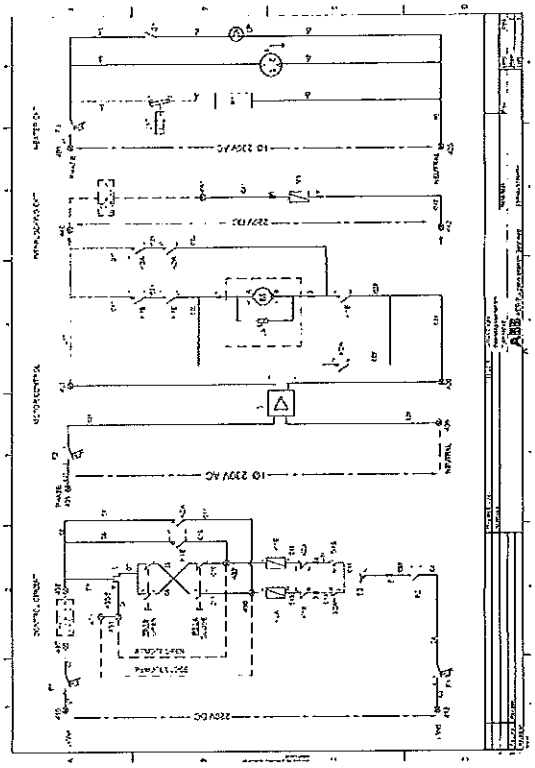
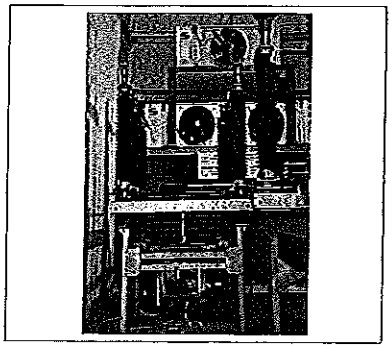
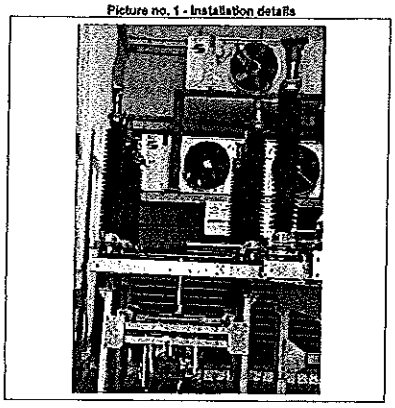


Fig. 1.2– Electrical connection diagram - Motor drive MD 50

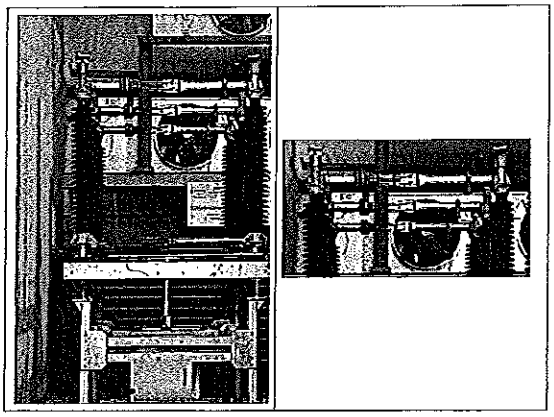


Picture no. 1 - Installation details

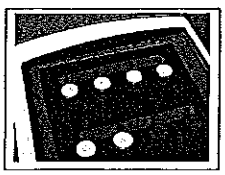


Picture no. 2 – The disconnector in open position at +50°C

ВЕРНО С ОРИГИНАЛА



Picture no. 3,4 – The disconnector in close position at +50°C



Picture 5 – The controle of close position of circuit of the disconnector.

2. Installation conditions:

The device has been assembled according to the details from draw no. 10142, and electrical connection diagram for Motor drive MD 50(2GPA543235-FM), fig. 1.1,...1.2 and picture no.1, in climatic chamber of the Research and Hygrothermal, Climatic, Mechanical and Seismic Testing for Constructions, Instalations and Equipment Laboratory of "URBAN - INCERC", Iaşi Branch, which has the following characteristics:

- chamber volume 600 m³;
- cooling capacity 11500 W;
- attainable temperatures: - 50°C....+70°C;
- ice layer of 0 ... 20 mm measured on a witness tube.

The device has been connected to its own drive mechanism.

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3. Measuring equipment and technical means:

The climatic parameters have been measured in the following way:

- Digital thermohygrograph KIMO Instruments, CE METROMAT no. 2372 – 09.14/18.09.2014;
- Digital thermometer Thermo Loger R DigiSense - 50... +100°C, CE report INM BC-308-1165/2013
- Micro – ohmetru RMO 500; 20μΩ /1mΩ /10mΩ /100mΩ/200mΩ, CE report INM 02-01-368/2013
- Programmable counter PTE-30-CH, 0 + 99 999 s, CE BC -304-2965/2012
- Regulation of the temperature in the climatic chamber – automatically by means of Dixell temperature and humidity regulators, Bitzer compressor group and Dixell system for the monitoring and automatic recording of parameters XWEB 500, Calibration Report INM BC – 308-1045/2011;

4. Functional requirements during and after the climatic test. Acceptance criteria

Throughout the climatic test, the disconnector with earthing switch has been fulfilling the conditions in fig.1.1 as well as the specifications at point 2, with no voltage applied to its terminals.

The disconnector with earthing switch fulfill the acceptance criteria of the climatic sequence imposed for maximum ambient air temperature **+50°C, according to EN 62271-102, clause 6.104.2, if:**

1) prior to the operation under extreme positive + 50°C temperature conditions, the disconnector and the earthing switch fulfill the routine mechanical operating test according to EN 62271-102, clause 6.103.3 – g;
2) it is possible to perform the complete drive cycles of closing and opening of the disconnector and the earthing switch, imposed by the standard (complete three operating cycles, at a minimum and maximum supply energy), using the equipment's own drive mechanism powered by maximum and minimum voltage, respectively;
3) no sudden maneuvers are performed on the disconnector's and the earthing switch's contacts and the continuity of the circuit is maintained during the test, in the closed and open positions of the disconnector and the earthing switch;
4) no damages are inflicted which can hinder the mechanical or electrical performance of the disconnector and the earthing switch;
5) the position of the contacts is maintained – closed/open;
6) the functioning of the kinematic system is maintained;
7) the dielectric properties of the components of the drive mechanism's electric diagram are maintained

5. Conditioning of the equipment

- The device has been kept at the parameters of the environment in the climatic chamber (cca 20°C) for a minimum of 24 hours. During this period, the routine mechanical operating test has been performed.

6. Test phases

Test phases for severe climatic conditions to extreme positive + 50°C temperature, according to EN 62271-102, clause 6.104.2– according to the table and the diagram no. 2 below

Phases	Initial	Heating	Maintenance	Steady-state regime	C-O Maneuvers	Reversion	Final
Nr.	1	2	3	4	5	6	7
$T_{a\,cnd}$	+17,5		+ 50	+51	+ 50		+22
ΔT_{as}	±1,4		± 2,1	± 2,1	± 2,1		
$\delta T_a/\Delta t$		+5,7				8,7	
φ_r	62		31	31	31		55
Δt		7	3	4	1	4	

Legend:
$T_{a\,cnd}$ – average temperature in the climatic chamber
ΔT_{as} – maximum deviation of temperature on the chamber's height
$\delta T_a/\Delta t$ – speed of temperature variation (°C/h)
φ_r – relative humidity of the air (%)
Δt – phase duration (h)

Diagram of the climatic test under the circumstances of the extreme positive +50°C temperature, according to EN 62271-102, clause 6.104.2.

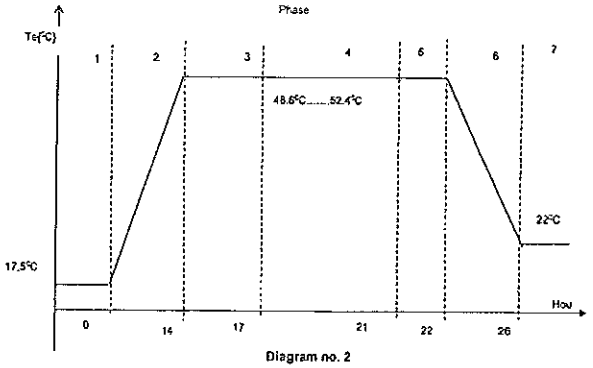


Diagram no. 2

Phase 1 - initial phase of maintaining the equipment at a temperature of 18 °C ± 1°C, for cca 6 hours During this period, the routine mechanical operating test has been performed.
Phase 2,3 - heating the climatic chamber up to + 50 °C ± 2,1°C cca 7 hours and keeping of the equipment inside for at least of 2 hours.
Phase 4 - steady-state regime at an extreme positive temperature of + 50°C according to EN 62271-102, clause 6.104.2, cca 4 hours
Phase 5

a. Performing the complete drive cycles of closing and opening of the main circuit of disconnector and the earthing switch, imposed by the standard, using the equipment's own drive mechanism powered by maximum and minimum voltage, respectively, at the same extreme positive temperature of +50°C ± 2,1°C, cca 1 hour;
b. Verifying the values of the drive time.

Phase 6 – Reversion of the chamber temperature to 22 °C for cca 4 hours and verification the contact resistance of main circuit and the values of the drive time

Three pole Disconnector SDF 123/1600 with one Erthing Switch serial number 2GPA45040000854, operated by Motor Drive MD 50 serial number 2GPA45010023372, 2GPA45010023376.

Experimental results

In order to verify the integrity of the equipments before the beginning of the climatic test, we have performed a general inspection to confirm that the equipment had been assembled according to the requirements of the company standard (positions, dimensions, connections, gauging) and that no damage had been caused during assembling (insulator breaking, remaining deformations), and to ensure a complete maneuvering Closed - Open cycle.

Throughout the experimental program, we have observed the general state, structural integrity and functional behavior of the products in order to be able to identify possible defects or malfunctions. Consequently, at the end of each experimental phase, we have inspected the equipment's state and we have performed the necessary maneuvers according to the verification procedures.

Our observations of the general state, structural integrity and functional behavior of the products

during the program of **experimental testing under extreme positive temperature of + 50°C, prove that the device fulfils the acceptance criteria according to EN 62271-102, clause 6.104.2,** as follows:

1) we have been able to perform the complete three drive cycles of closing and opening of the disconnector with earthing switch imposed by the standard, using the equipment's own drive mechanism powered by maximum and minimum voltage, respectively;
   Unominal =110VDC,
   Umax= Unom+15%=127VDC,
   Umin= Unom -20%=88VDC
2) the drive time is within the limits value 4.3 – 4.8 s;
3) no sudden maneuvers were performed on the earthing switch's contacts and the continuity of the circuit was maintained during the test, in the closed and open positions of the disconnector with earthing switch;
4) no damages were inflicted which could have hindered the mechanical or electrical performance of the disconnector with earthing switch;
5) the position of the contacts was maintained – closed/open;
6) the functioning of the kinematic system was maintained;
7) the dielectric properties of the components of the drive mechanism's electric diagram were maintained.
8) The value of contact resistance - The increased resistance after the environmental test is in keeping with the max limit of 20% imposed by SR EN 62271-102, clause 6.102.3.2.

All test phases have been carried out in the presence and with the technical assistance of the producer ABB BULGARIA Branch Sevlievo and ICMET Craiova.

Laboratory for Research and Hygrothermal, Climatic, Mechanical and Seismic Testing for Constructions, Instalations and Equipment, Iasi Branch, Romania

Head of laboratory: eng Livia Miron, PhD

Test responsible person: eng. Adrian Alexandru Ciobanu, PhD

Chief of test division: eng Livia Miron, PhD

Laboratory A-Q responsible person: eng Alina Cobzaru

ВЕРНО С ОРИГИНАЛА

NATIONAL INSTITUTE FOR RESEARCH-DEVELOPMENT AND TESTING IN ELECTRICAL ENGINEERING
ICMET CRAIOVA
HIGH POWER DIVISION
HIGH POWER TESTING LABORATORY FOR ELECTRICAL EQUIPMENT (HPL)
"Ovidiu Rarinca"
200746 CRAIOVA, Blvd. DECEBAL, No.118A, ROMANIA
Matriculation certificate J16/312/1999, VAT number RO387 1599
Phone: (351) 402 427; Fax: (351) 404 890;
www.icmet.ro; E-mail: [illegible]

TEST REPORT
No. 12329

CUSTOMER: **ABB Bulgaria EOOD – Branch Sevlivo**
32, Nikola Petkov Str., 5400 Sevlievo - Bulgaria

MANUFACTURER: **ABB Bulgaria EOOD – Branch Sevlivo**
32, Nikola Petkov Str., 5400 Sevlievo - Bulgaria

TESTED PRODUCT: 123 kV, 1600 A, 40 kA/3 s Three-pole disconnector type SDF with earthing switch

REFERENCE STANDARD: IEC 62271-102:2013

TEST PERFORMED: Measurement of the resistance
Temperature-rise test
Short-time withstand current and peak withstand current test

TEST DATE: 01-02.03.2016

TEST RESULT: **Passed the tests**

Test Report has 15 pages and it is edited in 4 copies from which copy 1 for laboratory and copies 2, 3 and 4 for customer.

TECHNICAL MANAGER OF HIGH POWER LABORATORY:
Eng. Ilie Sbora

HEAD OF HIGH POWER LABORATORY:
Phys. Daniel Truta

ICMET LABORATORUL DE MARE PUTERE "OVIDIU RARINCA" CRAIOVA

DATE OF ISSUE: 26.04.2016

Content

1. IDENTIFICATION OF APPARATUS

	Disconnector	Main mechanism	ES mechanism
Type	SDF 123/1600	MD 50	MD 50
Serial number/Year	2GPA45040000654	2GPA45010023375	2GPA45010023372
Contract No.	705.2 / 682 / 22.01.2016		
Product receiving date	01.03.2016		
Product condition at receiving	New		
Drawings	See page 11		

The manufacturer confirms that the test object has been manufactured in compliance with these drawings that were retained in HPL archive.
This test report contains only representative drawings chosen by HPL.

2. TECHNICAL CHARACTERISTICS ESTABLISHED BY PRODUCER

	Disconnector	Earthing switch
Rated voltage:	123 kV	123 kV
Rated normal current:	1600 A	-
Rated frequency:	50 Hz	50 Hz
Rated short - time withstand current:		
- peak value:	104 kA	104 kA
- r.m.s. value:	40 kA	40 kA
Rated duration of short-circuit:	3 s	3 s

3. TESTS PROGRAM

3.1. Measurement of the resistance according to clause 6.4.
3.2. Temperature-rise test at I = 1600 A, f = 50 Hz on one pole of the disconnector, according to clause 6.5.
3.3. Short-time withstand current and peak withstand current test:
3.3.1. Single-phase short-time withstand current and peak withstand current test on main circuit at parameters: Ip = 104 kA, Ik = 40 kA, tk = 3 s, according to clause 6.6.
Supply was made with 80x10 mm cross section aluminium tube and short-circuit was made with 80 mm diameter aluminium tube and disconnector in close position.
The test circuit is presented in figure 3.
3.3.2. Single-phase short-time withstand current and peak withstand current test on earthing switch at the parameters Ip = 104 kA, Ik = 40 kA, tk = 3 s, according to clause 6.6.
Supply was made with 80x10 mm cross section aluminium tube and by 2x240 mm^2 copper cables with earthing switch in close position as in test circuit presented in figure 4.

NOTE: Short-time withstand current and peak withstand current tests are performed with a current factor of 2.6.

4. RESPONSIBLE FOR TESTS: Eng. Catalin Dobrea

5. PRESENT AT THE TESTS: Eng. Delyan Stoev and Eng. Plamen Sharkov from ABB Bulgaria

6. TEST REPORT DOCUMENTATION: Oscillograms 4; Tables 4; Photos 6; Drawings 1.

7. MEASUREMENT OF THE RESISTANCE

The resistance of the main circuit before and after test was measured with digital micro ohmmeter type OMICRON CPM500. The results are presented in table 1.

Table 1

	Before test (R1)	After test (R2)	Remarks
R [μΩ]	71.4	70.2	Temperature-rise test
ΔR % = (R2-R1)/R1x100	-	-1.7	
R [μΩ]	69.1	68.8	Short-time withstand current and peak withstand current test
ΔR % = (R2-R1)/R1x100	-	- 0.4	

Measurements were performed with extended uncertainty of 2.2% for resistances and the confidence level P = 95%.

8. TEMPERATURE-RISE TEST

8.1. Data of testing and measuring circuit
Data of testing and measuring circuit are presented in fig. 1.

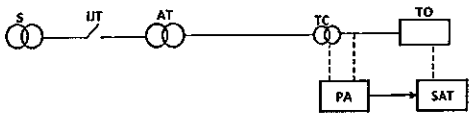


Fig. 1 – Test diagram for current paths temperature-rise test

S - Power supply
IJT - Low voltage circuit-breaker
AT - Single-phase autotransformer 230 V; 70 kVA.
TC - Current transformer
PA - Power analyzer
SAT - Automatic system type Keithley for temperatures measurements with thermocouples
TO - Tested object

8.2. Values obtained at test
Temperature-rise test was performed by passing a current of 1600 A / 50 Hz through the main circuit until the temperature variation did not exceed 1°K per hour.
Supply was made with flexible copper cables of 1000 mm^2 cross-section.
Temperatures were measured using the temperatures measurement computerized system Keithley Multimeter Integra 2700 with type J thermocouple.
Environment temperature was measured in three points equally distributed around Disconnector, at half height and approximately 1 m distance of it.

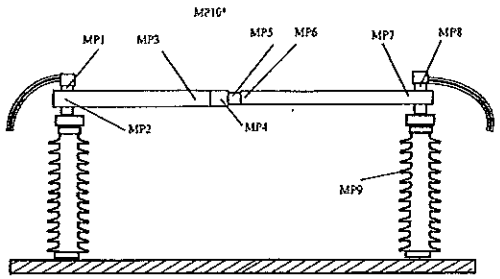


Fig. 2 – Location of the temperature-rise test measuring points

Values of the measured temperatures are presented in table 2.

Table 2

No. of MP	Location of the measuring points MP	Nature of the part	Material	Maxim value of temperature rise [°C]	Final temperature [°C]	Temperature rise [K]
MP1	Input terminal	Connection	Cu/Al	50	52.97	38.02
MP2	Male arm	Connection	Al/Al	50	51.46	36.51
MP3	Male arm	Connection	Al/Cu-Ag	75	52.33	37.38
MP4	Male arm	Contact	Cu-Ag/Cu-Ag	65	54.29	39.34
MP5	Female arm	Contact	Cu-Ag/Cu-Ag	65	53.68	38.73
MP6	Female arm	Connection	Cu-Ag/Al	75	52.49	37.54
MP7	Female arm	Connection	Al /Al	50	51.83	36.88
MP8	Output terminal	Connection	Al/Cu	50	53.02	38.07
MP9	Insulated support	Insulator	Porcelain	140	17.57	2.62
MP10	Environment	Environment	-	-	14.95[1)]	-

Measurements were performed with expanded uncertainty of: 1.1% for temperature and 2.1% for current the confidence level P = 95%. Measurement points are presented in fig. 2.

1) Average value of 3 measurement points

The temperature-rise on supply bars at 1m distance from terminals was 36.29 K, 36.80 K.

Note: Aspect of the Disconnector during temperature-rise test is presented in photo 1.

9. SHORT-TIME WITHSTAND CURRENT AND PEAK WITHSTAND CURRENT TEST

9.1. Data of testing and measuring circuit

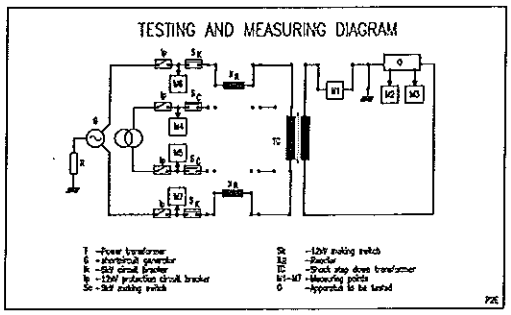
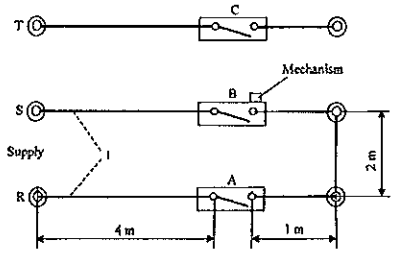


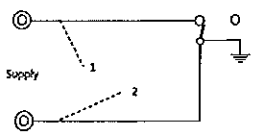
Table 3

Number of phases		2
Powe supply / Connection		Ø3 /Y
Transformer / Ratio		TC 7, 8, 9 / 6.67
Earthing	Power supply	600 Ω
	Apparatus	Net earthing connection
Reactor [Ω]		0.4
Power factor		<0.15
M1 - Test current – Shunt 70 kA / 1.75 V		
M4 - Power supply voltage - Voltage transformer 15000 V/100 V		
M8 - Data acquisition system TRAS 2 - 16 bit, 16 channels		



1 - Aluminium tube 80x10 mm

Fig. 3 - Testing circuit for main circuit



1 - Aluminium tube 80x10 mm
2 - Copper cable 2x240 mm²

Fig. 4 – Testing circuit for earthing switch

9.2. Values obtained at tests

Table 4

Oscillogram No.	I_p [kA]	I_t [kA]	t_t [s]	$I_{t.equiv.tk}$ [kA]	ΔU [V]	Remarks
91579/2016	105.7	-	0.24	-	19.3	Dynamic test on main circuit
91580/2016	-	40.8	2.9	40.1	19	Thermal test on main circuit
91582/2016	104.8	-	0.23	-	-	Dynamic test on earthing switch
91583/2016	-	40.3	3	-	-	Thermal test on earthing switch

Measurements were performed with extended uncertainty of: 1.5% for voltages; 2.5% for currents; 0.2% for time and the confidence level P = 95%.

Symbols used in tables and oscillograms

I = Short-circuit current
I_p = Peak values of short-time withstand currents on the phases R, S, T.
I_t = R.m.s. values of short - time withstand currents on the phases R, S, T.
ΔU = Voltage drop on the main circuit
t_t = Duration of short - circuit
$I_{t.med.equiv.t_k}$ = Equivalent value of short-time withstand current on t_k = 3 s calculated as follows:

$$I_{t.med.equiv.t_k} = I_{t.med} * \sqrt{\frac{t_t}{t_k}}$$

Notes:

- The environment temperature was 14°C.
- Aspect of the disconnector and earthing switch in the test circuit and of their contacts after tests are presented in photos 2 to 6.

10. TEST RESULT

- The specified limits of temperature-rise according to IEC standard were not exceeded in all the measuring points.
- After short-time withstand current and peak withstand current tests Disconnector and Earthing Switch opened at first attempt and presented no visible damages.
- The resistance of the disconnector measured after tests did not exceed with more than -0.4 % from the resistance measured before tests.

123 kV, 1600 A, 40 kA/3 s Three-pole disconnector type SDF with earthing switch passed the tests.

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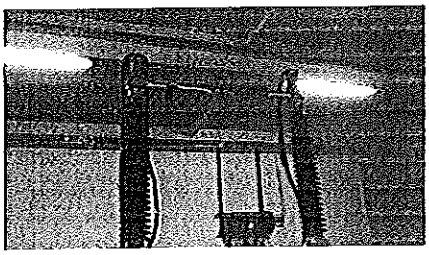


Photo 1 - Aspect of three-pole disconnector type SDF with earthing switch during the temperature-rise test

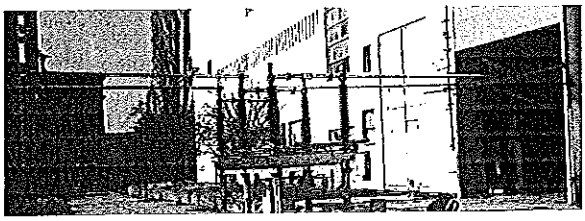


Photo 2 - Aspect of three-pole disconnector type SDF with earthing switch at test on main circuit

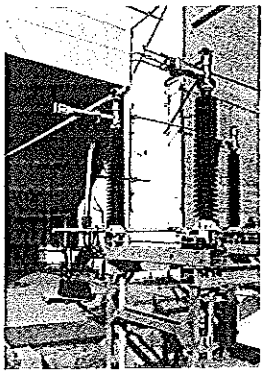
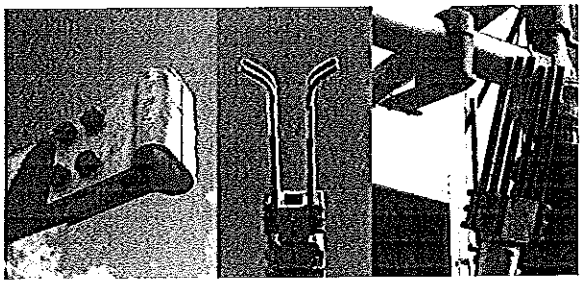
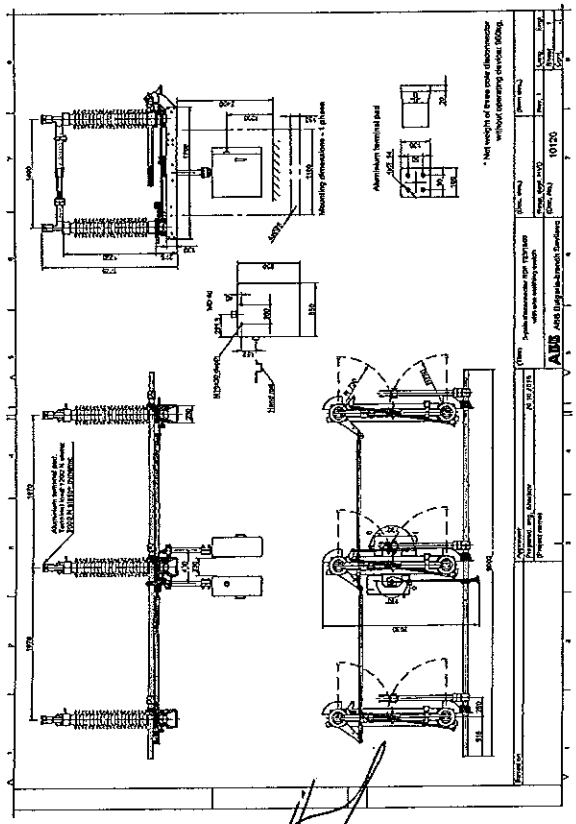
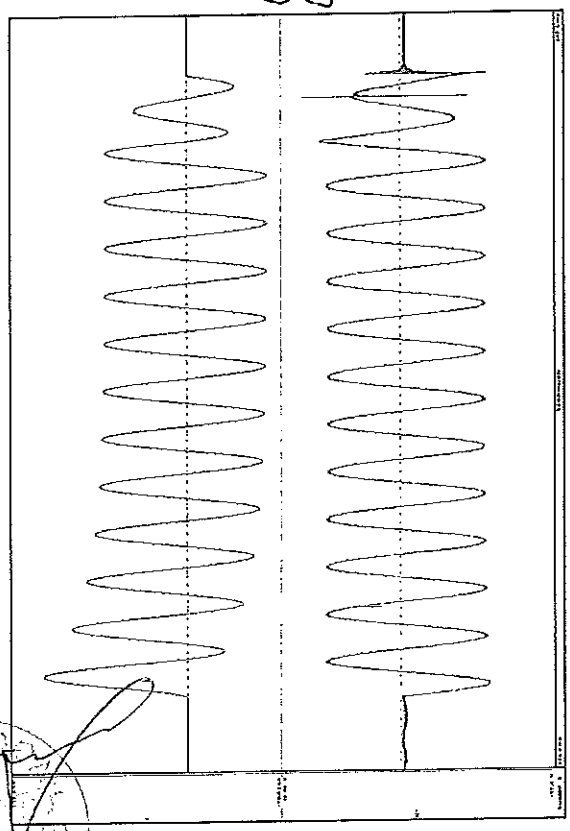


Photo 3 - Aspect three-pole disconnector type SDF with earthing switch at test on earthing switch



Photos 4, 5, 6 - Aspect of the main contacts and the earthing switch contact after tests





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TEST REPORT No. 12329

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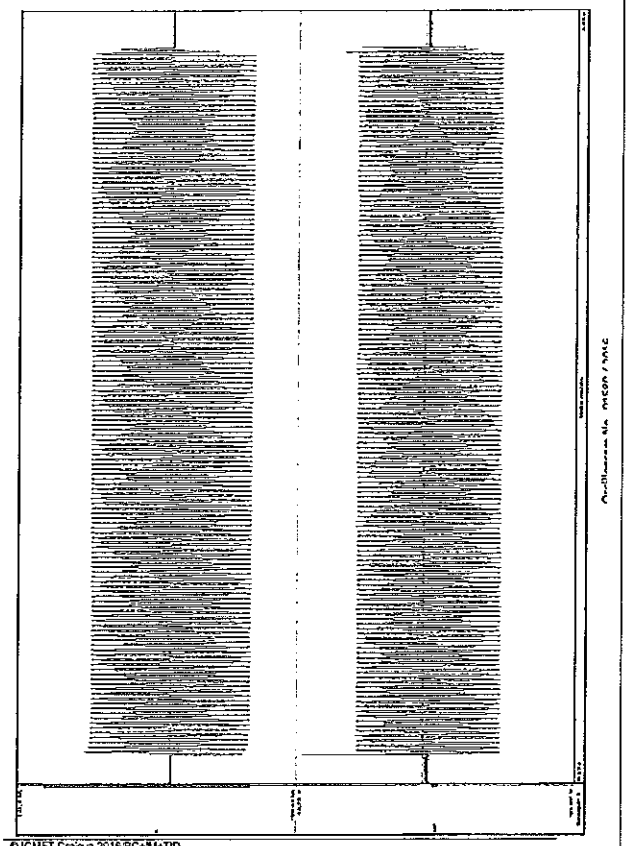

TEST REPORT No. 12329

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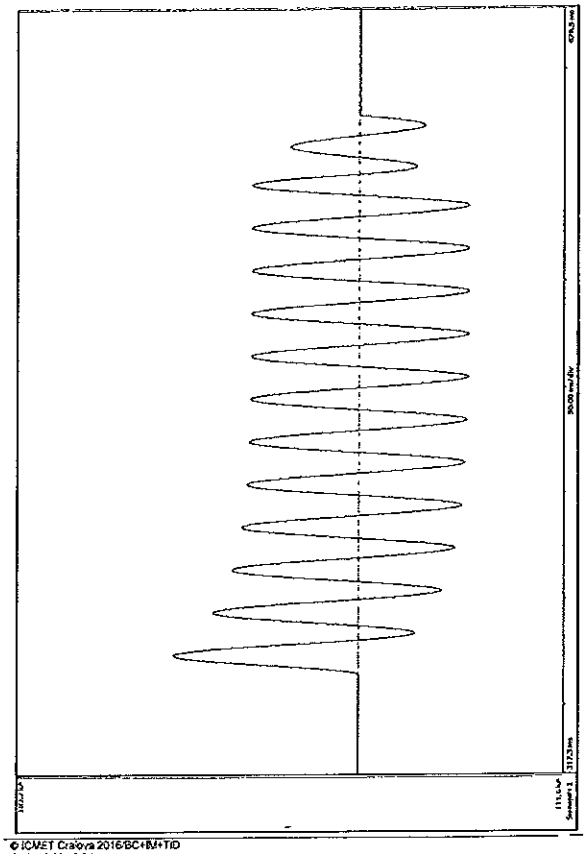

Oscillogram No. 91582 / 2016

TEST REPORT No. 12329

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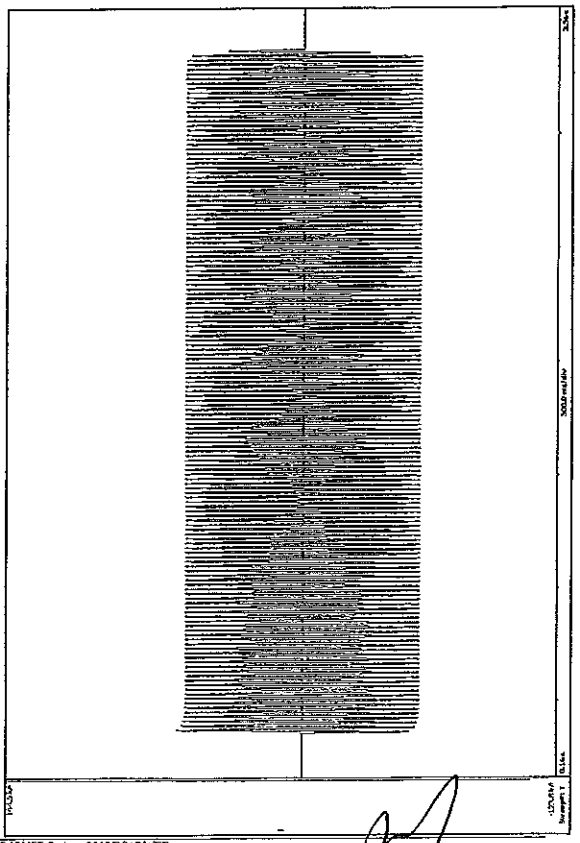


Oscillogram No. 91583 / 2016

ВЯРНО С ОРИГИНАЛА

NATIONAL INSTITUTE FOR RESEARCH, DEVELOPMENT AND TESTING IN ELECTRICAL ENGINEERING
ICMET CRAIOVA
HIGH VOLTAGE DIVISION
Low and High Voltage Testing Laboratory
200746 CRAIOVA, Blvd. DECEBAL, No.118A, ROMANIA
Matriculation certificate: J16/312/1999, VAT number RO3871599
Phone. + 40 0351 402425, 404888; Fax: + 40 0351 404890
www.icmet.ro ; E-mail: market@icmet.ro

accredited for TESTING
RE 141
SR EN ISO/IEC 17025:2005
ACCREDITATION CERTIFICATE LI 654

TEST REPORT
No. 45229 / 09.03.2016

1. CUSTOMER: **ABB Bulgaria EOOD – Branch Sevlievo**
Address: 32, Nikola Petkov Str., 5400 Sevlievo - BULGARIA

2. MANUFACTURER: **ABB Bulgaria EOOD – Branch Sevlievo**
Address: 32, Nikola Petkov Str., 5400 Sevlievo - BULGARIA

3. TESTED PRODUCT: **3-pole disconnector SDF 123 / 1600 with one earthing switch**
Serial no. 2GPA45040000654

4. REFERENCE STANDARDS: IEC 62271-102:2013; IEC 62271-1:2011; IEC 60060-1:2010

5. PERFORMED TESTS:
I – Radio interference voltage (RIV) test
II – Dry lightning impulse withstand voltage test
III – Dry power frequency withstand voltage test
IV – Wet power frequency withstand voltage test
V – Dry power frequency withstand voltage test in the most unfavourable position of the earthing blade
VI – Wet power frequency withstand voltage test in the most unfavourable position of the earthing blade

6. TESTS DATE: (04 ÷ 08).03.2016

7. TESTS RESULTS: The product passed the tests.

The test report contains 23 pages and is edited in 4 copies, copy no.1 remain in laboratory and copies 2÷ 4 are sent to the customer.

HEAD OF HVD – TECHNICAL MANAGER,
Dipl. Eng. BURCIU Ion

HEAD OF TESTING TEAM,
Dipl. Eng. BADEA Ion

Warnings:
a. *The results refer only to the tested product.*
b. *Publication and reproduction of the contents of this report in any other form unless its complete photocopying is not allowed without writing approval of Division to which laboratory belongs.*
c. *All signatures of the present report are original ones.*

Content

1. IDENTIFICATION OF THE TEST PRODUCT: 3-pole disconnector SDF 123 / 1600 with one earthing switch

Type: SDF 123 / 1600

Serial / year: 2GPA45040000654 / 2016

Technical Specification / Drawing: - / see page 22

Client test order: 705.2 / 682 / 22.01.2016

Internal test order: 22936 / 18.02.2016

Product receiving date: 02.03.2016

Product condition at receiving: New

2. THE MAIN TECHNICAL CHARACTERISTICS ESTABLISHED BY MANUFACTURER:
Rated voltage: 123 kV
Rated normal current: 1600 A
Rated frequency: 50 Hz
Rated lightning impulse withstand voltage:
a). Phase – to – earth and between phases.....550 kV_{peak}
b). Across the isolating distance.....630 kV_{peak}
Rated power frequency withstand voltage:
a). Phase – to – earth and between phases.....230 $kV_{r.m.s}$
b). Across the isolating distance.....265 $kV_{r.m.s}$
In the most unfavourable position of earthing blade.....142 $kV_{r.m.s}$
Note: For solidly earthed neutral systems.

Max. radio interference level.....< 2500 µV

Note. During the tests, the disconnector was mounted above earth on an insulated base.

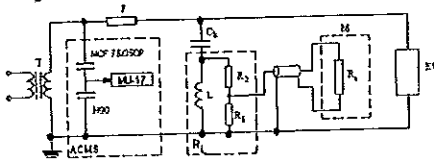
3. TESTS PROGRAM:
I – Radio interference voltage (RIV) test
II – Dry lightning impulse withstand voltage test
III – Dry power frequency withstand voltage test
IV – Wet power frequency withstand voltage test
V – Dry power frequency withstand voltage test in the most unfavourable position of the earthing blade
VI – Wet power frequency withstand voltage test in the most unfavourable position of the earthing blade

4. RESPONSIBLE FOR TESTS: Eng. T. Nicoară (I)
Eng. L.Vlădoi (II)
Eng. V.Tetea (III, IV, V, VI)

5. PRESENT AT THE TESTS: Dipl.Eng. Delyan Stoev – ABB Bulgaria
Dipl.Eng. Plamen Sharkov – ABB Bulgaria
Dipl.Eng.Yavor Yankov – ABB Bulgaria

I – RADIO INTERFERENCE VOLTAGE TEST

1. **Test date:** 07.03.2016
2. **Test standard:** IEC 62271 – 102: 2013, clause 6.3; IEC 62271 – 1 : 2011, clause 6.3; 6.9.1.1; TR CISPR 18-2 : 2010, clause 4.5.
3. **Atmospheric conditions:** p = 990 mbar; t = 11.5°C, h_r = 74.8 %.
4. **Equipment used (see also the test circuit diagram from the point 5):**
– Test transformer 350 kVA / 350 kV, no.3 - 1993
Measuring systems:
– AC measuring system 350 kV consists of: high voltage compressed gas capacitor type MCF 75/350P, no.853889 and low voltage arm type H90, no.858939 + digital peak voltmeter type MU-17, no. 910396.
(Calibration Certificate no. 41 / 04.2015).
Measuring uncertainty is 1.6 %.
The uncertainty stated is expanded uncertainty obtained by multiplying the standard uncertainty by the coverage factor k = 2 providing a level of confidence of approximately 95 %.
– RIV measuring system:
– Measuring impedance:
– coupling capacitor C_x (1nF / 600 kV), no.73H297;
– resistance R_1: resistor R_2 (275Ω), matching resistor R_1 (50Ω);
– Measuring instrument – electromagnetic interference receiver type SMV-42 (M), no.007 with internal resistor R_i (50Ω).
(Calibration Certificate no. A020477/P804 / 10.2014).
5. **Test circuit diagram:**



Legend: F – rejection filter;
EUT – equipment under test.

Fig. 1

6. **Measuring results:**
Note: The presented results were obtained during the last series of voltage reductions.
Pol Aa - Closed Position (see photo 1, page 8)

Measuring voltage	RIV level		
	V_m	V^0	V^a
[kV]	[dB/1µV/50Ω]	[dB/1µV/300Ω]	[µV]
1.1 x 123 / √3 = 78	28.6	57.1	716
71	25.1	53.7	484
64	20.3	48.8	279
57	12.7	41.3	116
50	0	28.6	27
43	0	28.6	27
35	0	28.6	27
28	0	28.6	27
21	0	28.6	27

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Open Position
Voltage applied to "a" the female contact (contact without earthing blade)
(see photo 2, page 8)

Measuring voltage	RIV level		
[kV]	V_m [dB/1µV/50Ω]	V^{0} [dB/1µV/300Ω]	V^{0} [µV]
1.1 x 123 / √3 ≈ 78	35.6	64.2	1622
71	33.5	62.1	1274
64	26.9	55.5	596
57	0	28.6	27
50	0	28.6	27
43	0	28.6	27
36	0	28.6	27
28	0	28.6	27
21	0	28.6	27

Open Position
Voltage applied to "A" the male contact (contact with earthing blade)
(see photo 3, page 8)

Measuring voltage	RIV level		
[kV]	V_m [dB/1µV/50Ω]	V^{0} [dB/1µV/300Ω]	V^{0} [µV]
1.1 x 123 / √3 ≈ 78	22.6	51.2	363
71	13.8	42.5	132
64	7.6	36.2	65
57	3.9	32.5	42
50	3.7	32.3	41
43	3.5	32.1	40
36	3.2	31.8	39
28	3	31.6	38
21	2.5	31.1	36

Pol Bb - Closed Position (see photo 4, page 8)

Measuring voltage	RIV level		
[kV]	V_m [dB/1µV/50Ω]	V^{0} [dB/1µV/300Ω]	V^{0} [µV]
1.1 x 123 / √3 ≈ 78	29.2	57.8	776
71	27.3	55.9	624
64	24.2	52.8	437
57	4.3	32.9	44
50	0	28.6	27
43	0	28.6	27
36	0	28.6	27
28	0	28.6	27
21	0	28.6	27

Open Position
Voltage applied to "b" the female contact (contact without earthing blade)
(see photo 5, page 8)

Measuring voltage	RIV level		
[kV]	V_m [dB/1µV/50Ω]	V^{0} [dB/1µV/300Ω]	V^{0} [µV]
1.1 x 123 / √3 ≈ 78	39	67.6	2399
71	33.6	62.2	1288
64	30	58.6	851
57	8	36.6	68
50	7	35.6	60
43	3.5	32.1	40
36	0	28.6	27
28	0	28.6	27
21	0	28.6	27

Open Position
Voltage applied to "B" the male contact (contact with earthing blade)
(see photo 6, page 9)

Measuring voltage	RIV level		
[kV]	V_m [dB/1µV/50Ω]	V^{0} [dB/1µV/300Ω]	V^{0} [µV]
1.1 x 123 / √3 ≈ 78	22.8	51.4	372
71	8.5	35.1	57
64	2.4	31	35
57	2.2	30.8	35
50	1.6	30.2	32
43	1.2	29.8	31
36	0	28.6	27
28	0	28.6	27
21	0	28.6	27

Pol Cc - Closed Position (see photo 7, page 9)

Measuring voltage	RIV level		
[kV]	V_m [dB/1µV/50Ω]	V^{0} [dB/1µV/300Ω]	V^{0} [µV]
1.1 x 123 / √3 ≈ 78	28.5	57.1	716
71	24.8	53.4	468
64	18.7	47.3	232
57	10.2	38.8	87
50	8.7	37.8	73
43	8.5	37.1	72
36	8.5	37.1	72
28	8.2	36.8	69
21	7.4	36	63

Open Position
Voltage applied to "c" the female contact (contact without earthing blade)
(see photo 8, page 9)

Measuring voltage	RIV level		
[kV]	V_m [dB/1µV/50Ω]	V^{0} [dB/1µV/300Ω]	V^{0} [µV]
1.1 x 123 / √3 ≈ 78	38.6	67.2	2291
71	34	62.6	1349
64	31	59.6	955
57	9	37.6	76
50	8	36.6	68
43	7.4	36	63
36	7.3	35.9	62
28	7.3	35.9	62
21	7.1	35.7	61

Open Position
Voltage applied to "C" the male contact (contact with earthing blade)
(see photo 9, page 9)

Measuring voltage	RIV level		
[kV]	V_m [dB/1µV/50Ω]	V^{0} [dB/1µV/300Ω]	V^{0} [µV]
1.1 x 123 / √3 ≈ 78	18.7	47.3	232
71	13.1	41.7	122
64	9.2	37.8	78
57	3.9	32.5	42
50	1.8	30.4	33
43	0	28.6	27
36	0	28.6	27
28	0	28.6	27
21	0	28.6	27

General notes for to the tables:

[1] The corrected value of the instrument reading:
$V = V_m + A + R$, where:
V_m – instrument reading;
A – attenuation of the measuring circuit determined at the calibration of the test circuit with $1V_{r.m.s.}$, 1MHz sine wave voltage:
$A = A_2 - A_1 = 67.6\ dB - 60.6\ dB = 7\ dB$;
A_1 - attenuation of the complete measuring circuit = 60.6 dB;
A_2 - attenuation of the test object = 67.6 dB;
R – resistance network factor;
$R = 20\ lg\ (600/50) \approx 21.6\ dB$.

[2] The reported value of the RIV level expressed in µV.

The radio interference voltage level don't exceed 2500µV at $1.1 \times 123/\sqrt{3} \approx 78$ kV.
The product passed the test.

Pol Aa

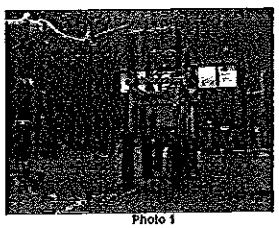
Photo 1

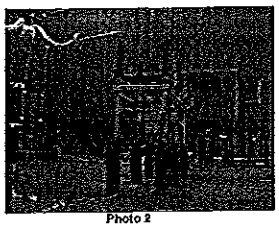
Photo 2

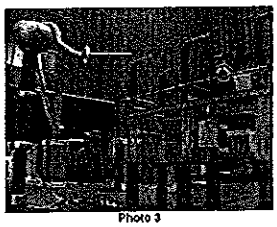
Photo 3

Pol Bb

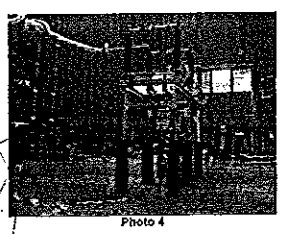
Photo 4

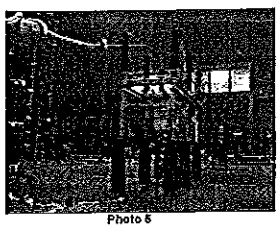
Photo 5

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Photo 6

Pol Cc

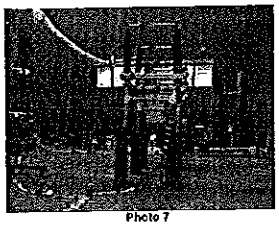


Photo 7

Photo 8

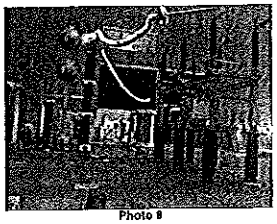


Photo 8

II – DRY LIGHTNING IMPULSE WITHSTAND VOLTAGE TEST

1. **Test date:** 04.03.2016
2. **Test standard:** IEC 62271-102 : 2013, subclause 6.2; IEC 62271 - 1 : 2011, subclause 6.2
3. Atmospheric conditions: p = 987 mbar; t = 11 °C; h_t = 65 %
4. Equipments used:
   - Impulse generator 4.2 MV, no. 5 – 1187; connection 1 5 x 1;
   - C_s = 0.115 [μF]; R_s = 176.25 [Ω]; R_p = 575[Ω].

Addends: C_s – equivalent capacity of impulse generator; R_s – equivalent serial resistance of impulse generator; R_p – equivalent parallel resistance of impulse generator;

HV measuring systems:

- for lightning impulse voltage:
  - Capacitive voltage divider serial no.5 – 1197, k_{nr} = 1731.8
  - Digital measuring system type TR- AS-RC 100 – 10/4, serial no. 241, channel 2 for recorded lightning impulse voltage test. (Calibration Certificate OKD-K- 18701, no. 292 / 12.2011)

The uncertainty stated is expanded uncertainty obtained by multiplying the standard uncertainty by the coverage factor k = 2. The value of measurand lies within the assigned range of values with probability of 95 % equal with 1.8 % for peak value, 8.4 % and 4.2 % for front and tail times.

6. **Test procedure / Test set-up:**

	Tested insulation	
	phase to earth and between phases (acc. to IEC 62271-1, sct.6.2.5.1 and sct.6.2.6.2)	across the isolating distance (acc. to IEC 62271-1, sct.6.2.5.2, method (b) and 6.2.6.2)
	C & O	O
Arcing distance [mm]:	1110	1260
Correction factors: k_1	1.0052	1.0052
k_2	0.9548	0.9497
$k_t = k_1 \cdot k_2$	0.9596	0.9547
$U_{rw}(p_0,t_0,h_0)$ (-) and (+) [kV_{peak}]	650	630
$U_{test}(p,t,h) = k_t \cdot U_{rw}(p_0,t_0,h_0)$	627.8	601.6

Symbols used: - U_{rw} (p_0, t_0, h_0) – rated withstand voltage value; U_{test} (p, t, h) – test voltage corrected to atmospheric conditions
- O; C – open and respectively closed position of disconnector.

Note: The test was performed with standard lightning impulse wave: 1.2 / 50 μs.
For wave parameters see oscillograms 302544 and 302649 from page13 for testing the insulation phase- to-earth and oscillograms 302733 and 302755 from page 14 for testing across the isolating distance.

Lightning impulse voltage withstand test – phase – to – earth and between phases

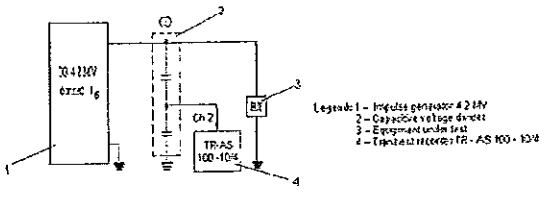
Disconnector position	Voltage applied to	Earthed to	Free terminals	$U_{test}(p_0,t_0,h_0)$ [kV]	Pol	Number of impulses / disruptive discharges
Closed	A, a	B, b, C, c, F	–	650	(+)	15 / 0
				650	(-)	15 / 0
	B, b	A, a, C, c, F	–	650	(+)	15 / 0
				650	(-)	15 / 0
	C, c	A, a, B, b, F	–	650	(+)	15 / 0
				650	(-)	15 / 0
Open	A	a,b, c, B, C,F	–	650	(+)	15 / 0
				650	(-)	15 / 0
	a	A,B,C,b,c, F	–	650	(+)	15 / 0
				650	(-)	15 / 0
	B	A,C,a,b,c,F	–	650	(+)	15 / 0
				650	(-)	15 / 0
	b	A,B,C,a,c,F	–	650	(+)	15 / 0
				650	(-)	15 / 0
	C	A,B,a,b,c,F	–	650	(+)	15 / 0
				650	(-)	15 / 0
	c	A,B,C,a,b,F	–	650	(+)	15 / 0
				650	(-)	15 / 0

Lightning impulse across isolating distance

Disconnector position	Voltage applied to	Earthed to	Free terminals	$U_{test}(p_0,t_0,h_0)$ [kV]	Pol	Number of impulses / disruptive discharges
open	A	a	B, b, C, c, F	630	(+)	15 / 0
				630	(-)	15 / 0
	a	A	B, b, C, c, F	630	(+)	15 / 0
				630	(-)	15 / 0
	B	b	A, a, C, c, F	630	(+)	15 / 0
				630	(-)	15 / 0
	b	B	A, a, C, c, F	630	(+)	15 / 0
				630	(-)	15 / 0
	C	c	A, a, B, b, F	630	(+)	15 / 0
				630	(-)	15 / 0
	c	C	A, a, B, b, F	630	(+)	15 / 0
				630	(-)	15 / 0

Notes: 1. A – male contact (contact without earthing blade); a – female contact (contact with earthing blade); F– frame.
2. The standard 1.2 / 50μs lightning impulse withstand test was carried out in accordance with IEC 60060 – 1: 2010, Procedure B by applying 15 consecutive impulses for each polarity.

Impulse test circuit



Legend: 1 – Impulse generator 4.2 MV
2 – Capacitive voltage divider
3 – Equipment under test
4 – Transient recorder TR - AS 100 - 10/4

Fig. 2

Legend: 1 – Impulse generator 4.2 MV
2 – Capacitive voltage divider
3 – Equipment under test
4 – Transient recorder TR – AS 100 – 10 / 4

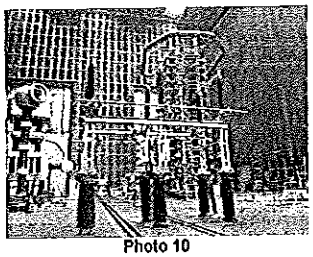


Photo 10

6. **Test result:** The product passed the test.

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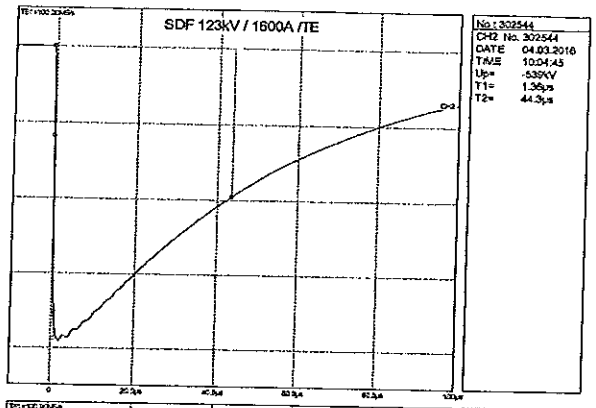

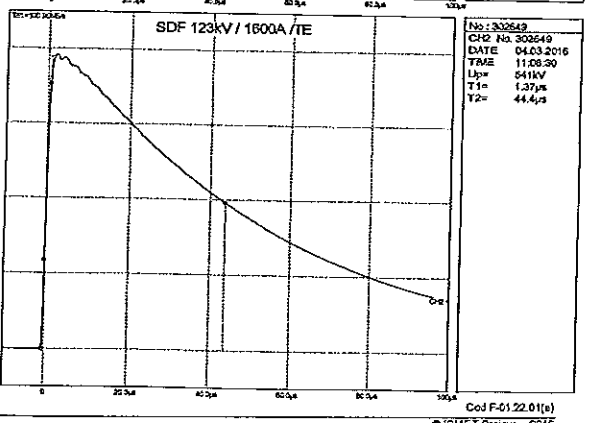

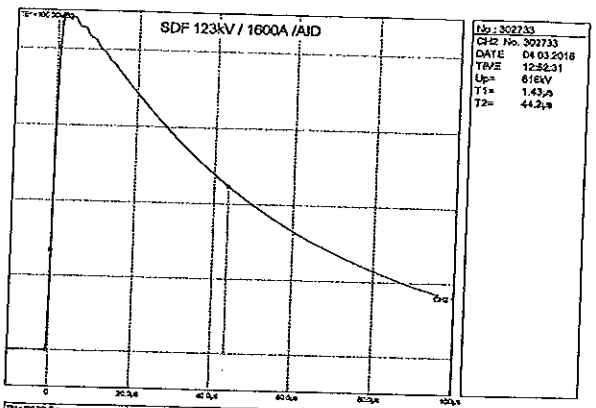

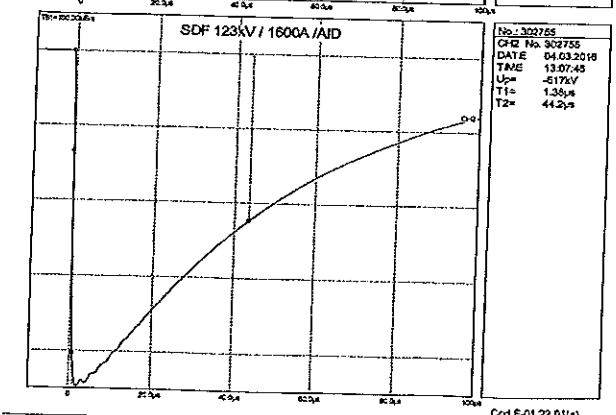

III – DRY POWER FREQUENCY WITHSTAND VOLTAGE TEST

1. Test date: 04.03.2016
2. Test standards: IEC 62271–102:2013, subclause 6.2.6; IEC 62271–1:2011, sct. 6.2.
3. Atmospheric conditions: p = 987 mbar; t = 11 °C; h = 64.5 %
4. Equipment used:

– Test transformer: 350 kVA / 350 kV, no. 3 – 1963.

Measuring systems used:

– AC measuring system 350 kV consists of: high voltage compressed gas capacitor type MCF 75/350P, no. 853889 and low voltage arm type H90, no.898939 + digital peak voltmeter type MU-17, no. 910396.

(Calibration Certificate no. 41 / 04.2015).

Measuring uncertainty is ± 1.6 %.
The reported uncertainty is an expanded uncertainty, based on a standard uncertainty multiplied by a coverage factor k = 2, providing a level of confidence of approximately 95 %.

5. Test procedure:

Description		Tested insulation: phase-to-earth and between phases (acc. to IEC 62271-1: 2011, sct.6.2.6.1 and IEC 62271-102:2013, sct.6.2.6.1)	Tested insulation: across the isolating distance (acc. to IEC 62271-1: 2011, sct.6.2.5.2 method b) and IEC 62271-102:2013, sct.6.2.6.1)
		C & O	O
Arcing distance [mm]:		1110	1260
Correction factors:	k_1	1.0023	1.0023
	k_2	0.9767	0.9759
	$k_3 = k_1 \cdot k_2$	0.9789	0.9782
$U_{sw}(p_0,t_0,h_0)$ [kV$_{rms}$]:		230	265
$U_{test}(p, t, h) = k_3 \cdot U_{sw}(p_0,t_0,h_0)$ [kV$_{rms}$]:		225.14	259.22
Frequency [Hz]:		50	50
Time [s]:		60	60

Symbols used: – $U_{test}(p_0,t_0,h_0)$ – rated withstand voltage value;
– $U_{test}(p, t, h)$ – test voltage corrected to atmospheric conditions;
– O,C – open or respectively closed position of disconnector.

Dry power frequency withstand voltage test: phase – to – earth and between phases

Disconnector position	Voltage applied to	Earthed to	Free terminals	$U_{sw}(p_0,t_0,h_0)$ [kV]	Time [s]
Closed	A, a	B, b, C, c, F	–	230	60
	B, b	A, a, C, c, F	–	230	60
	C, c	A, a, B, b, F	–	230	60
Open	A	a,b, c, B, C,F	–	230	60
	a	A,B,C,b,c, F	–	230	60
	B	A,C,a,b,c,F	–	230	60
	b	A,B,C,a,c,F	–	230	60
	C	A,B,a,b,c,F	–	230	60
	c	A,B,C,a,b,F	–	230	60

Dry power frequency withstand voltage test: across isolating distance

Disconnector position	Voltage applied to	Earthed to	Free terminals	$U_{sw}(p_0,t_0,h_0)$ [kV]	Time [s]
Open	A	a	B,b,C,c,F	265	60
	a	A	B,b,C,c,F	265	60
	B	b	A,a,C,c,F	265	60
	b	B	A,a,C,c,F	265	60
	C	c	A,a,B,b,F	265	60
	c	C	A,a,B,b,F	265	60

Symbols used: A – male contact (contact with earthing blade); a – female contact (contact without earthing blade).
F – frame.

6. Test set-up:

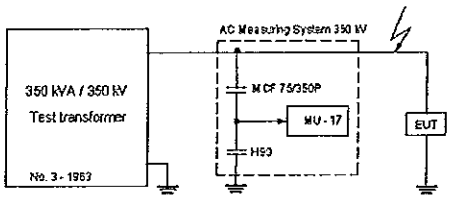

Fig. 3

Legend: EUT – Equipment under test

7. Test result: During the test no flashover or disruptive discharge occurred.
The product passed the test.

IV. WET POWER - FREQUENCY VOLTAGE TEST

1. Test date: 04.03.2016
2. Test standards: IEC 62271–102:2013, subclause 6.2.6; IEC 62271–1:2011, scl. 6.2.
3. Atmospheric conditions: p = 987 mbar; t = 11 °C; h = 64.5 %
4. Equipment used:
   - for power frequency voltage:
     – Test transformer: 350 kVA / 350 kV, no. 3 – 1963.
   - for rain:
     – Artificial rain installation, serial no. 3 – 29.

Measuring systems used:
- for power frequency voltage:
  – AC measuring system 350 kV consists of: high voltage compressed gas capacitor type MCF 75/350P, no. 853889 and low voltage arm type H90, no.898939 + digital peak voltmeter type MU-17, no. 910396. (Calibration Certificate no. 41 / 04.2015).

The uncertainty stated is expanded uncertainty obtained by multiplying the standard uncertainty by the coverage factor k = 2. The value of measurand lies within the assigned range of values with probability of 95 % equal with 1.6 %.

- for measuring the parameters of the water have been used:
  – liquid glass thermometer series 41;
  (Calibrate Certificate no. DJ 013.141 – 652 / 2012 – BRML Craiova)

The uncertainty stated is expanded uncertainty obtained by multiplying the standard uncertainty by the coverage factor k = 2. The value of measurand lies within the assigned range of values with probability of 95 % equal with 0.4 % / °C.
  – conductometer type 3210 serial no. 15440615 encompassing conductivity cell type TetraCon 325, series 15440175;
  (Calibrate Certificate no. 132.05 – 03.2016)

The uncertainty stated is expanded uncertainty obtained by multiplying the standard uncertainty by the coverage factor k = 2. The value of measurand lies within the assigned range of values with probability of 95 % equal with 3.5 µS/cm.

5.Test procedure:

Description		Tested insulation	
		phase-to-earth and between phases (acc. to IEC 62271-1: 2011, scl.6.2.5.1 and IEC 62271-102:2013, scl.6.2.6.1)	across the isolating distance (acc. to IEC 62271-1: 2011, scl.6.2.5.2 method b) and IEC 62271-102:2013, scl.6.2.6.1)
		C & O	O
Arcing distance [mm]:		1110	1260
Correction factors:	k_1	1.0023	1.0023
	k_2	1	1
	$k = k_1 \cdot k_2$	1.0023	1.0023
Precipitation conditions:	Temp. [°C]	16	16
	Aparent [mm/min]	1.5	1.5
	Apar.hc [mm/min]	1.5	1.5
	Water conductivity [µS/cm]	66	66
$U_{test}(p_0,t_0,h_0)$ [kV_{rms}]:		230	265
$U_{test}(p,t,h) = k \cdot U_{test}(p_0,t_0,h_0)$ [kV_{rms}]:		230.52	265.6

Symbols used: – $U_{test}(p_0,t_0,h_0)$ – rated withstand voltage value;
– $U_{test}(p,t,h)$ – test voltage corrected to atmospheric conditions;
– O;C – open or respectively closed position of disconnector.

Wet power-frequency withstand voltage test: phase – to – earth and between phases

Disconnector position	Voltage applied to	Earthed to	Free terminals	$U_{test}(p_0,t_0,h_0)$ [kV]	Time [s]
Closed	A, a	B, b, C, c, F	–	230	60
	B, b	A, a, C, c, F	–	230	60
	C, c	A, a, B, b, F	–	230	60
Open	A	a,b, c, B, C,F	–	230	60
	a	A,B,C,b,c, F	–	230	60
	B	A,C,a,b,c,F	–	230	60
	b	A,B,C,a,c,F	–	230	60
	C	A,B,a,b,c,F	–	230	60
	c	A,B,C,a,b,F	–	230	60

Wet power-frequency withstand voltage test: across isolating distance

Disconnector position	Voltage applied to	Earthed to	Free terminals	$U_{test}(p_0,t_0,h_0)$ [kV]	Time [s]
Open	A	a	B,b,C,c,F	265	60
	a	A	B,b,C,c,F	265	60
	B	b	A,a,C,c,F	265	60
	b	B	A,a,C,c,F	265	60
	C	c	A,a,B,b,F	265	60
	c	C	A,a,B,b,F	265	60

Symbols used: A – male contact (contact with earthing blade); a – female contact (contact without earthing blade); F – frame.

6. Test set-up:

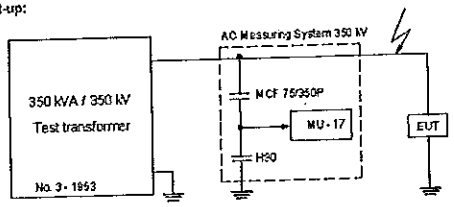

Fig. 4
Legend: EUT – Equipment under test

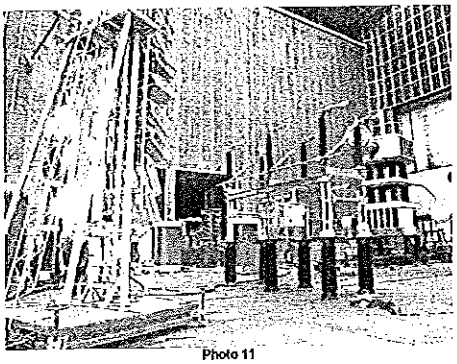

Photo 11

7. Test result: During the test no flashover or disruptive discharge occurred.
The product passed the test.

V – DRY POWER FREQUENCY WITHSTAND VOLTAGE TEST IN THE MOST UNFAVOURABLE POSITION OF THE EARTHING BLADE

1. Test date: 04.03.2016
2.Test standard: IEC 62271–102 : 2013, subclause 4.2; 6.2.5 and Table 5.
3. Atmospheric conditions: p = 987 mbar; t = 11 °C; h = 64.5 %
4. Equipment used:
   – Test transformer: 350 kVA / 350 kV, no. 3 – 1963.

Measuring systems used:
   – AC measuring system 350 kV consists of: high voltage compressed gas capacitor type MCF 75/350P, no. 853889 and low voltage arm type H90, no.898939 + digital peak voltmeter type MU-17, no. 910396.
   (Calibration Certificate no. 41 / 04.2015).

The uncertainty stated is expanded uncertainty obtained by multiplying the standard uncertainty by the coverage factor k = 2. The value of measurand lies within the assigned range of values with probability of 95 % equal with 1.6 %.

5. Test procedure:

	Earthing blade in the most unfavourable position
Arcing distance measured [mm]	780
Correction factors:	
k_1	1.0016
k_2	0.9832
$k = k_1 \cdot k_2$	0.9848
$U_{test}(p_0,t_0,h_0)$ [kV_{rms}]:	142
Frequency [Hz]:	50
Time [s]:	60

Symbols used: $U_{test}(p_0,t_0,h_0)$ – rated withstand voltage value.
O;C – open or respectively closed position of disconnector.

Dry power frequency withstand voltage test in the most unfavourable position of the earthing blade – earthing blade in the most unfavourable position

Condition	Voltage applied to	Earthed to	Free terminals	Voltage test [kV]	Time [s]
Disconnector open	A	a, B, b,C,c, F	-	142	60
	B	b, A, a,C,c, F	-	142	60
	C	c, A, a,B,b, F	-	142	60

Symbols used: A–male contact (contact with earthing blade); a–female contact (contact without earthing blade); F – frame.

6. Test set-up:

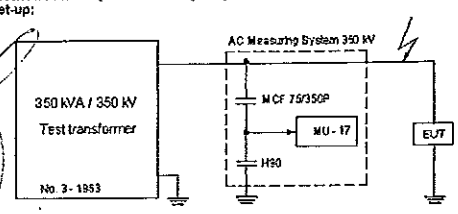

Fig. 5

7. Test result: The product passed the test.

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VI – WET POWER FREQUENCY WITHSTAND VOLTAGE TEST IN THE MOST UNFAVOURABLE POSITION OF THE EARTHING BLADE

1. Test date: 04.03.2016
2. Test standard: IEC 62271-102 : 2013, subclause 4.2; 6.2.5 and Table 5.
3. Atmospheric conditions: p = 987 mbar; t = 11 °C; h_t = 64.5 %
4. Equipment used:
   - for power frequency voltage:
     - Test transformer: 350 kVA / 350 kV, no. 3 – 1963.
   - for rain:
     - Artificial rain installation, serial no. 3 – 29.

Measuring systems used:

- for power frequency voltage:
  - AC measuring system 350 kV consists of: high voltage compressed gas capacitor type MCF 75/350P, no. 853889 and low voltage arm type H90, no.896939 + digital peak voltmeter type MU-17, no. 910396. (Calibration Certificate no. 41 / 04.2015).

The uncertainty stated is expanded uncertainty obtained by multiplying the standard uncertainty by the coverage factor k = 2. The value of measurand lies within the assigned range of values with probability of 95 % equal with 1.6 %.

- for measuring the parameters of the water have been used:
  - liquid glass thermometer series 41;
    (Calibrate Certificate no. DJ 013.141 – 552 / 2012 – BRML Craiova)

The uncertainty stated is expanded uncertainty obtained by multiplying the standard uncertainty by the coverage factor k = 2. The value of measurand lies within the assigned range of values with probability of 95 % equal with 0.4 % / °C.

  - conductometer type 3210 serial no. 15440815 encompassing conductivity cell type TetraCon 325, series 15440175;
    (Calibrate Certificate no. 152.05 – 03.2016)

The uncertainty stated is expanded uncertainty obtained by multiplying the standard uncertainty by the coverage factor k = 2. The value of measurand lies within the assigned range of values with probability of 95 % equal with 3.5 pS/cm.

5. Test procedure:

		Earthing blade in the most unfavourable position
Arcing distance measured [mm]		780
Correction factors:		
	k_1	1.0016
	k_2	1
	$k_t = k_1 \cdot k_2$	1.0016
$U_{rw}(p_0/t_0/h_0)$	[$kV_{r.m.s.}$]:	142
Frequency	[Hz]:	50
Time	[s]:	60

Symbols used: - U_{rw} ($p_0/t_0/h_0$) – rated withstand voltage value.
- O;C – open or respectively closed position of disconnector.

Wet power frequency withstand voltage test in the most unfavourable position of the earthing blade – earthing blade in the most unfavourable position

Condition	Voltage applied to	Earthed to	Free terminals	Voltage test [kV]	Time [s]
Disconnector open	A	a, B, b,C,c, F	-	142	60
	B	b, A, a,C,c, F	-	142	60
	C	c, A, a,B,b, F	-	142	60

Symbols used: A – male contact (contact with earthing blade), a – female contact (contact without earthing blade), F–frame.

6. Test set-up:

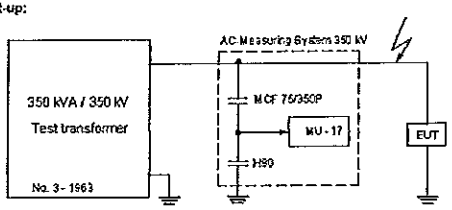
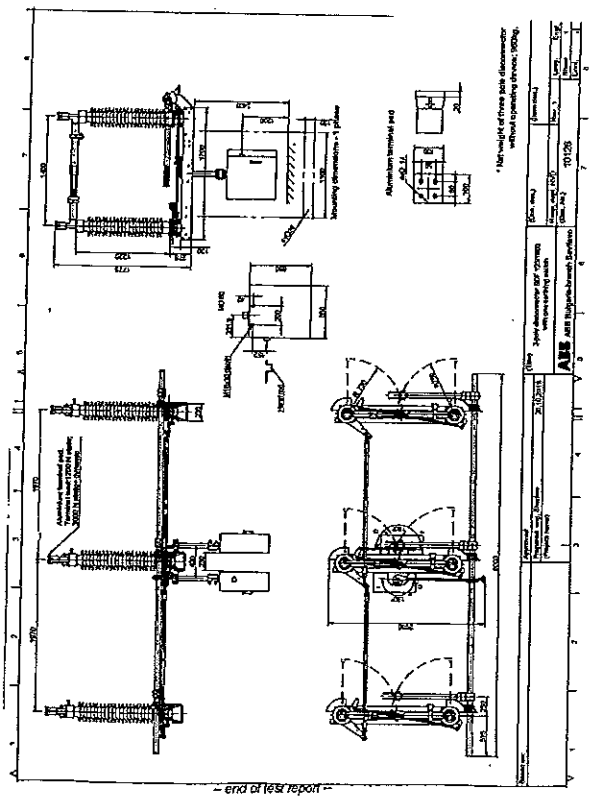


Fig. 6

7. Test result: The product passed the test.



– end of test report –

ВЯРНО С ОРИГИНАЛА

ICMET CO Craiova Ltd.

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NATIONAL INSTITUTE FOR RESEARCH, DEVELOPMENT AND TESTING IN ELECTRICAL ENGINEERING
ICMET CRAIOVA
HIGH VOLTAGE DIVISION
Low and High Voltage Testing Laboratory
200746 CRAIOVA, Blvd. DECEBAL, No.118A, ROMANIA
Matriculation certificate: J16/312/1999, VAT number RO3871599
Phone: + 40 0351 402425, 404838; Fax: + 40 0351 404890
www.icmet.ro ; E-mail: market@icmet.ro

TEST REPORT
No. 45326 / 22.04.2016

1. CUSTOMER: **ABB Bulgaria EOOD – Branch Sevlievo**
Address: 32, Nikola Petkov Str., 5400 Sevlievo - BULGARIA

2. MANUFACTURER: **ABB Bulgaria EOOD – Branch Sevlievo**
Address: 32, Nikola Petkov Str., 5400 Sevlievo - BULGARIA

3. TESTED PRODUCT: **Operating mechanism box type MD 50**
Serial no. 500022570 – 150 - 015

4. REFERENCE STANDARDS: IEC 60529 : 2013; IEC 62271-202:2014

5. PERFORMED TESTS:
I – Verification of the protection degree IP – 55
II – Mechanical impact test (IK CODE)

6. TESTS DATE: (08 + 09).04.2016

7. TESTS RESULTS: The product passed the tests.

The test report contains 7 pages and is edited in 4 copies, copy no.1 remain in laboratory and copies 2+ 4 are sent to the customer.

HEAD OF HVD – TECHNICAL MANAGER,
Dipl. Eng. BURCIU Ion

HEAD OF TESTING TEAM,
Dipl. Eng. DINU Ion

Warnings:
a. *The results refer only to the tested product.*
b. *Publication and reproduction of the contents of this report in any other form unless its complete photocopying is not allowed without writing approval of Division to which laboratory belongs.*
c. *All signatures of the present report are original ones.*

Content

1. IDENTIFICATION OF THE TEST PRODUCT: Operating mechanism box
Type: MD 50
Serial / year: 500022570 – 150 - 015 / 2016
Technical Specification / Drawing: - / -
Client test order: 705.2 / 682 / 22.01.2016 + Additional Act No.3 / 22.01.2016
Internal test order: 22936 / 18.02.2016
Product receiving date: 09.04.2016
Product condition at receiving: New

2. THE MAIN TECHNICAL CHARACTERISTICS ESTABLISHED BY MANUFACTURER:
- IP of Protection Degree : IP 55.

3. TESTS PROGRAM:
I – Verification of the protection degree IP – 55
II – Mechanical impact test (IK CODE)

4. RESPONSIBLE FOR TEST: Dipl. Eng. V. Tetea (I)
Dipl. Eng. R. Georgescu (II)

5. PRESENT AT THE TEST: Dipl.Eng. Delyan Stoev – ABB Bulgaria
Dipl.Eng. Plamen Sharkov – ABB Bulgaria
Dipl.Eng.Yavor Yankov – ABB Bulgaria

I. VERIFICATION PROTECTION DEGREE IP – 55

1. Test date: (08 + 09).04.2016
2. Test standard: IEC 60529 : 2013, clauses 12; 13 and 14
3. Atmospheric conditions: 08.04.2016 p = 1007 mbar; t = 12.5 °C; h_r = 59 %
09.04.2016 p = 1005 mbar; t = 11.7 °C; h_r = 62 %
4. Test procedure / Test set-up:
a. Verification of the first characteristic numeral "5"
a.1. Protection against access to hazardous parts
a.2. Protection against the penetration of solid foreign objects

For a.1. it was used the access probe with a diameter of 1 mm and a length of 100 mm.
(Calibration Certificate 01.01 1425 / 2015 INM Bucharest)
Measuring uncertainty is ± 0.010.
The reported uncertainty is an expanded uncertainty, based on a standard uncertainty multiplied by a coverage factor k = 2, providing a level of confidence of approximately 95 %.
Result: The access caliber not penetrated the object tested.

For a.2. It was used dust chamber according to fig.2 of IEC 60529 : 2013.
Test object is of the category 2. (Enclosures where no pressure difference relative to the surrounding air is present – see subclause 13.4 of IEC 60529 : 2013).
The enclosure under test is supported in its normal operating position in side the test chamber, but was not connected to a vaccum pomp. The test duration is 8 hours.
Result: No any dust ingresses inside of tested enclosure.

b. Verification of the second characteristic numeral "6", against splashing water
It was used the spray nozzle compliant with fig.6 of IEC 60529 : 2013
Internal diameter of the nozzle: 6.3 mm
Total area A_T = 1.32 m²
Delivery rate: 12.5 [l / min ± 5 %]
Distance from nozzle to enclosure surface 2.5 – 3 m
Minimum test duration: 3 min.
Measuring uncertainty is ± 3 %.
The reported uncertainty is an expanded uncertainty, based on a standard uncertainty multiplied by a coverage factor k = 2, providing a level of confidence of approximately 95 %.
Result: There was no ingress of water into the test object.
Pictures of the test product are presented on the page 5.

5. Test result: The product passed the test.

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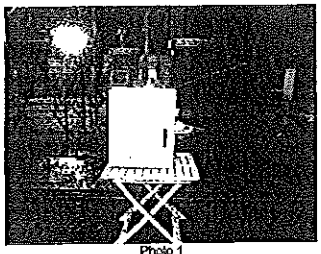

Photo 1

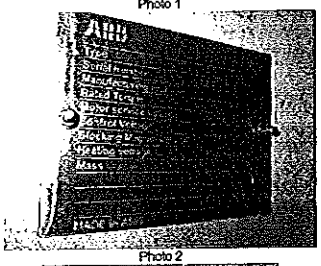

Photo 2

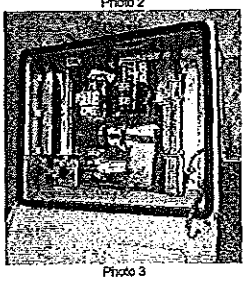

Photo 3

II. MECHANICAL IMPACT TEST (IK CODE)

1. **Test date:** 09.04.2016
2. **Test standard:** IEC 62271-202:2014, clause 6.101.3
3. **Environmental conditions:** temperature: 11.7°C
   relative humidity: 62 %
4. **Equipment used:**

- Pendulum hammer 5-50J, ICMET Craiova,
  Calibration Certificate no. AG – 10 - 1339 / 07.12.2011, SJML Pitesti

5. Testing procedure:

The enclosure was mounted on a rigid support, according to the manufacturer's instructions for use (photo 4.).

The test was performed on the weak points of the exposed parts of the enclosure of the substation.

The impact energy was 20 J.

Five impacts were applied on each exposed side, using the pendulum hammer.

The impacts were distributed on the faces of the enclosure under test; there were no more than three impacts applied in the surroundings of the same point of the enclosure.

Only one impact was applied at the same point.

After the application of the impacts, the enclosure was inspected.

The paint was not removed; just 1 small deppresion were observed.

6. Test Results:

Clearence and creepage distances remained the same.

The protection degree of the enclosure was maintained.

Operation of control means, handles, was not impaired.

The product passed the test according to IEC 62271-202:2014, clause 6.101.3.

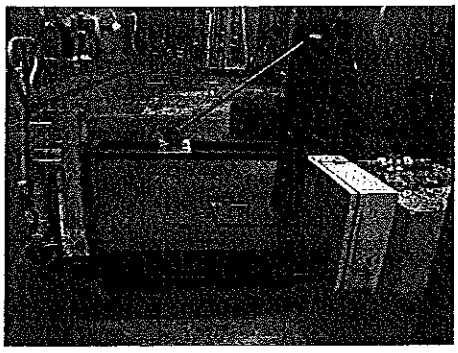

Photo 4. Test set-up for Mechanical Impact Test

– end of test report –

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NATIONAL INSTITUTE for RESEARCH and DEVELOPMENT IN CONSTRUCTIONS, URBAN PLANNING AND SUSTAINABLE TERRITORIAL DEVELOPMENT
"URBAN - INCERC"
Branch IAŞI
Laboratory for Research and Hygrothermal, Climatic, Mechanical and Seismic Testing for Constructions, Instalations and Equipment – SHT
Address: Str. Prof. Anton Şesan nr. 37 Testing Station B - ob. 101, Str. Gh. Asachi nr.13, Iasi – Testing Station A
Authorization Laboratory of I[st] degree no. 2101/2. 08. 2010 issued by I.S.C.

APPROVED BY GENERAL MANAGER
INCD "URBAN - INCERC"
Associate Professor Ec. arch. Vasile Meiță
Director General
V.M.

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SR EN ISO/CEI 17025:2005
CERTIFICAT DE ACREDITARE
LI 320

TEST REPORT NR. 659T - 1 / 30.07.2014

FOR CLIMATIC TEST ACCORDING TO EN 62271-102, CLAUSE 6.103 - CLIMATIC TEST UNDER SEVERE ICE CONDITIONS - CLASS 20 mm CLAUSE 6.104 - CLIMATIC TEST TO EXTREME NEGATIVE TEMPERATURE (-50°C)

1. **Order/contract: 101/19.02.2014/ contract no.659T/2014**
2. **Designation of tested object:**

Three phase Horizontal Centre Break Disconnector with one Earthing Switch SDF 145 operated by Motor Drive MD 50

3. **Customer name : RESEARCH DEVELOPMENT AND TESTING NATIONAL INSTITUTE FOR ELECTRICAL ENGINEERING - ICMET Craiova**

Customer address: B-dul Decebal no. 118A,Craiova, Calea Bucuresti no. 144 Tel. 0351 404888 , 0351 404 889, Fax: 0351 404 890, 0251 415 482

4. **Manufacturer: ABB BULGARIA BRANCH SEVLIEVO BULGARIA**

Manufacturer address: 32 N. PETROV STR. 5400 SEVLIEVO, Bulgaria

5. **Identification of the test specification or procedure:**
   - **Climatic test under severe ice conditions class 20 mm, according to: EN 62271-102, clause 6.103 (SR EN 62271-102:2003, clause 6.103) - PTE IH- 19 / 12.01 - URBAN INCERC Iaşi**
   - **Climatic test to extreme negative – 50°C temperature, according to EN 62271-102, clause 6.104.1, EN 68-2:1990+A1:1993+A2:1994 (SR EN 62271-102:2003, clause 6.104.1, SR EN 60068 - 2 – 1:2007 and SR EN 60068 - 1:1995) - PTE IH - 19 / 12.08 - URBAN INCERC Iaşi**
6. **Description and identification of tested object:**
Three phase Horizontal Centre Break Disconnector with one Earthing Switch SDF 145 serial number 2GPA45040000087, operated by Motor Drive MD 60 serial number 2GPA45010021882, 2GPA45010021881
7. **Date when tested object was received:** according to proceedings (F- PG-5.8-01) - PVPP no. 1221HS from 14.07.2014 and expedition note ABB Bulgaria Branch Sevlievo /11.07.2014 Laboratory code IHS 324/E1-07.14
8. **Test date: 15.07.2014 – 25.07.2014**

9. **Description of sampling procedure:** Sampling of the test object was performed by the customer at their own risk.
10. **Obtained results:**

Equipment and materials used: climatic room with thermal adjustment, 600m³, artificial rain equipment.

10.1. The resistance of the circuit:

Resistance of the circuit (μΩ) – measurement at 100A			
Resistance of the main circuit (μΩ)			
Moment of measurements	Pole A	Pole B	Pole C
Initial	71.2	73.5	70.9
final	75.6	79.4	78.8
Percentage increase	6.18 %	8.03 %	8.32 %
Resistance of the earthing switch circuit (μΩ)			
Initial	62.4	58.9	61.4
final	69.8	65.7	71.2
Percentage increase	11.86%	11.54%	15.96%

10.2. The drive time cycles of closing and opening of the contact of main circuit:

	Initial drive time of cycles Nominal Voltage - Normal temperature (s)	Drive time of cycles Maximum Voltage (s)	Drive time of cycles Minimum Voltage (s)	Final drive time of cycles Nominal Voltage - Normal temperature (s)
		extreme negative – 50°C temperature		
Cycles Open - Close	4.329	4.468	4.539	4.351
	4.208	4.498	4.698	4.322
	4.224	4.563	4.486	4.335
	4.212	Medium value – 4.510	Medium value – 4.574	4.228
	4.377			4.412
Medium value	4.27			4.331
Percentage increase:				1.42%
		extreme negative – 50°C temperature		
Cycles Close – open	4.261	4.475	4.571	4.268
	4.222	4.386	4.502	4.451
	4.219	4.435	4.603	4.328
	4.267	Medium value: 4.432	Medium value:4.559	4.317
	4.217			4.263
Medium value	4.237			4.331
Percentage increase				2.21%

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10.3. The drive time cycles of closing and opening of the contact of earthing switch circuit:

	Initial drive time of cycles Nominal Voltage - Normal temperature (s)	Drive time of cycles Maximum Voltage (s)	Drive time of cycles Minimum Voltage (s)	Final drive time of cycles Nominal Voltage - Normal temperature (s)
		extreme negative – 50°C temperature		
Cycles Open - Close	4.819	4.926	5.034	4.913
	4.828	4.964	5.104	4.908
	4.794	5.012	4.937	4.815
	4.832	Medium value – 4.987	Medium value – 5.042	4.867
	4.867			4.905
Medium value	4.828			4.882
Percentage increase:				1.11%
		extreme negative – 50°C temperature		
Cycles Close – open	4.651	4.976	5.112	4.954
	4.672	4.954	5.099	4.999
	4.599	4.998	5.018	4.923
	4.674	Medium value:4.976	Medium value:5.076	4.913
	4.827			4.699
Medium value	4.871			4.938
Percentage increase				1.33%

11. **Uncertainty of measurement:** Was not requested by the customer.
12. *** Opinions and interpretations:** * Item 12 is not covered by the RENAR accreditation

Three phase Horizontal Centre Break Disconnector with one Earthing Switch SDF 145 serial number 2GPA45040000087, operated by Motor Drive MD 50 serial number 2GPA45010021881, 2GPA4501D021882

HAS FULFILLED THE TECHNICAL CONDITIONS REQUIRED FOR:

- **functioning in the presence of a layer of transparent ice of 20mm, according to EN 62271-102, clause 6.103 (SR EN 62271-102:2003, clause 6.103). The equipment (the main circuits and earthing switch) may be maneuvered on first operation by means of the motor drive mechanism. No malfunctions of the contact, drive elements and support insulators were detected, as well as no deformations or permanent blocking that might hinder the mechanical or electrical performance of the disconnector with earthing switch.**
- **functioning to extreme negative – 50°C temperature, according to EN 62271-102, clause 6.104.1, EN 68-2:1990+A1:1993+A2:1994 (SR EN 62271-102:2003, clause 6.104.1, SR EN 60068 - 2 – 1:2007 and SR EN 60068 - 1: 1995). The equipment (the main circuits and earthing switch) may be maneuvered, performing the closed-open drive cycles imposed by the standard (three cycles close-open), by means of the motor drive mechanism. No malfunctions of the contact and drive elements, and support insulators, were detected, as well as no deformations or permanent blocking that might hinder the mechanical or electrical performance of the disconnector with earthing switch.**

NOTES:

- *The result of the test refers only to the tested object.*
- *The test report cannot be partially reproduced without the approval of the laboratory which performed the test.*
- *The test report is accompanied by Annex to Test Report no. 659T-1/30.07.2014, 16 pages.*

Certified by Branch Manager
eng. Constantin Miron, PhD

Verified by Head of HT Laboratory
eng. Livia Miron, PhD

Prepared by Contract handler
eng. Constantin Miron, PhD

ANNEX TO TEST REPORT No. 659T –1/ 30.07.2014

1. PRODUCT PRESENTATION

Three phase Horizontal Centre Break Disconnector with one Earthing Switch SDF 145 serial number 2GPA45040000087, operated by Motor Drive MD 60 serial number 2GPA45010021881, 2GPA45010021882 has been assembled in the climatic chamber of the Research and Hygrothermal, Climatic, Mechanical and Seismic Testing for Constructions, Instalations and Equipment Laboratory of the National Institute for Research and Development in Constructions, Urban Planning And Sustainable Territorial Development "URBAN - INCERC", Iaşi Branch and has been verified by experimental means, through tests on its functional behavior when subjected to severe climatic conditions:

- **such as the forming of an ice layer of 20 mm, according to EN 62271-102, clause 6.103 (SR EN 62271-102:2003, clause 6.103).**
- **to extreme negative – 50°C temperature, according to EN 62271-102, clause 6.104.1, EN 68-2:1990+A1:1993+A2:1994 (SR EN 62271-102:2003, clause 6.104.1, SR EN 60068 - 2 – 1:2007 and SR EN 60068 - 1:1995).**

1.1 Product identification (components)
1) Three phase Horizontal Centre Break Disconnector with one Earthing Switch SDF 145, operated by Motor Drive MD 50
3) supporting metallic frame.

Producer: ABB BULGARIA BRANCH SEVLIEVO BULGARIA, 32 N. PETROV STR. 5400 SEVLIEVO, Bulgaria

1.2 Installation in the climatic chamber of the Research and Hygrothermal, Climatic, Mechanical and Seismic Testing for Constructions, Instalations and Equipment Laboratory of URBAN - INCERC Iaşi Branch

Three phase Horizontal Centre Break Disconnector with one Earthing Switch SDF 145 serial number 2GPA45040000087, operated by Motor Drive MD 50 serial number 2GPA45010021881, 2GPA45010021882 has been assembled for tests in the climatic chamber of the Research and Hygrothermal, Climatic, Mechanical and Seismic Testing for Constructions, Instalations and Equipment Laboratory of the "URBAN - INCERC", Iaşi Branch, according to the reference technical documentation.

During installation, the following has been verified:

- Overall dimensions;
- dimensions and types of the component subsystems;
- elevations at which the subsystems may be mounted;
- product subassemblies;
- product integrity and recording of possible fissures, deformations or other damages caused by transportation, manipulation, and installation, in order to differentiate between original defects and the ones that have appeared following tests.

The installation and mounting of the Three phase Horizontal Centre Break Disconnector with one Earthing Switch SDF 145 serial number 2GPA45040000087, operated by Motor Drive MD 50 serial number 2GPA45010021881, 2GPA45010021882 in the climatic chamber has been performed according to the normal installation procedures specified by the producers (according to 1HYD930321-011-zp specification 1HYD300777-B, 1HYD300777-D, drawings 1HYD300777-001, and electrical connection diagram for Motor drive MD 50, fig. 1.1,... 1.5 and picture no.1,2).
The pictures no. 5 through 9 show Three phase Horizontal Centre Break Disconnector with one Earthing Switch SDF 145 serial number 2GPA45040000087, operated by Motor Drive MD 50 serial number 2GPA45010021881, 2GPA45010021882 assembled in the climatic chamber and during various stages of the test performed to determine its behavior when subjected to the pressure of an ice layer of 20 mm.

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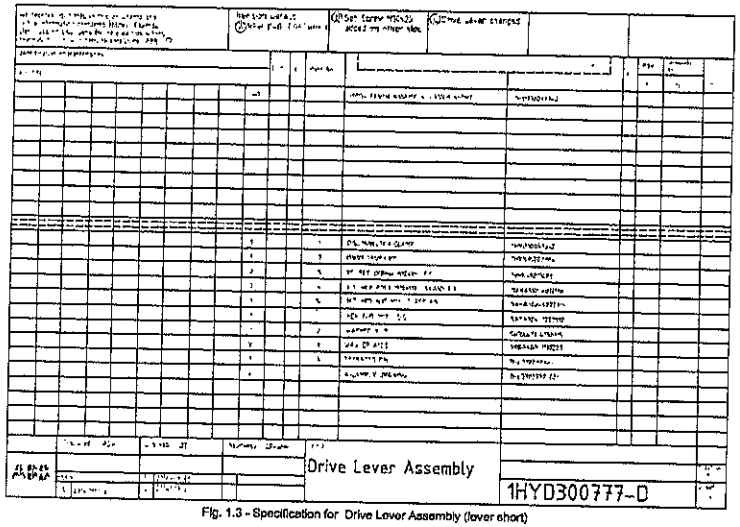


Fig. 1.3 - Specification for Drive Lever Assembly (lever short)

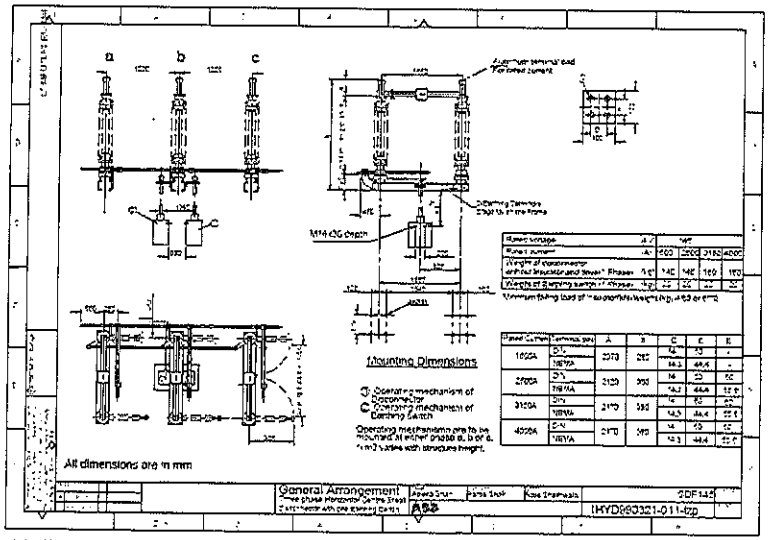


Fig. 1.1 - Three phase Horizontal Centre Break Disconnector with one Earthing Switch SDF 145, operated by Motor Drive MD 50

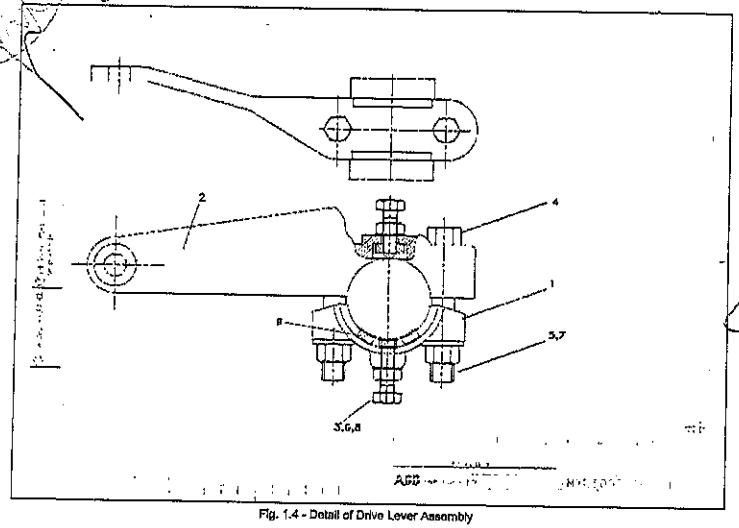


Fig. 1.4 - Detail of Drive Lever Assembly

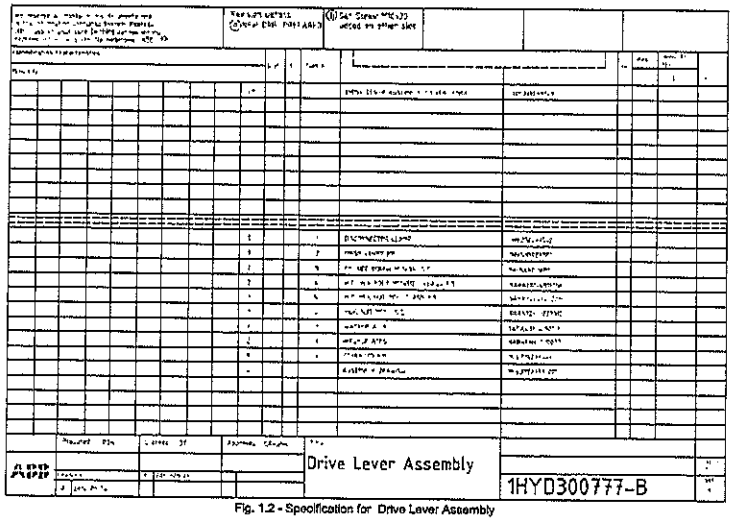


Fig. 1.2 - Specification for Drive Lever Assembly

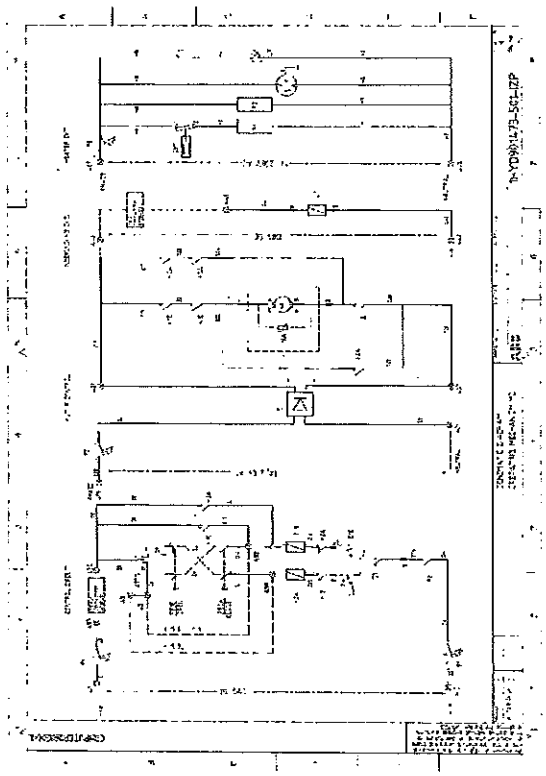
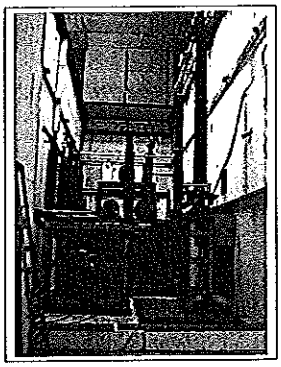
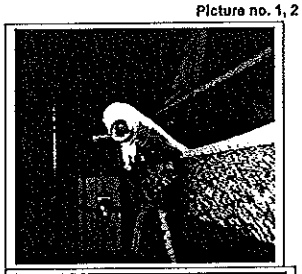


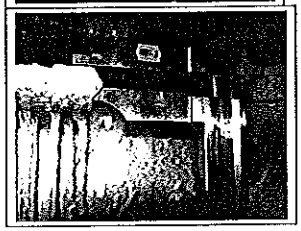
Fig. 1.5 – Electrical connection diagram - Motor drive MD 50



Picture no. 1, 2 - Installation details

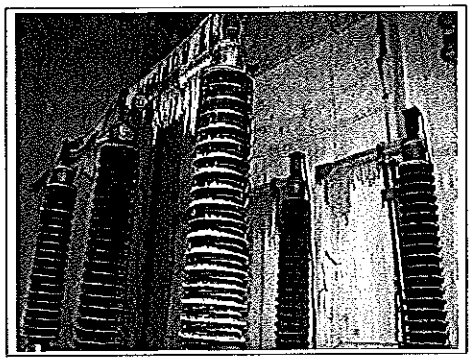


Picture no. 3a Picture no. 3b

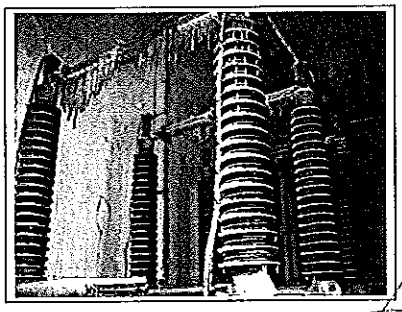


Picture no. 4

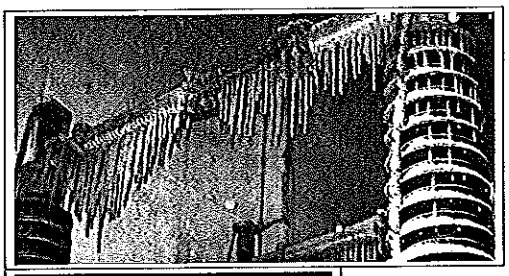
Pictures no. 3a, 3b, 4 – Witness tube



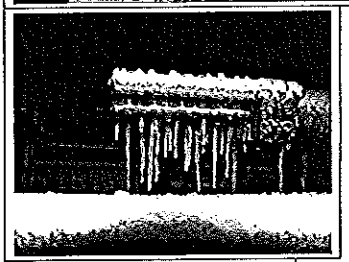
Picture no. 5 – The disconnector in open position



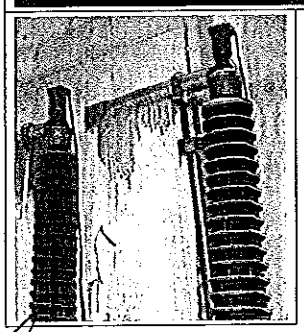
Picture no. 6 – The disconnector in close position



Picture no. 7

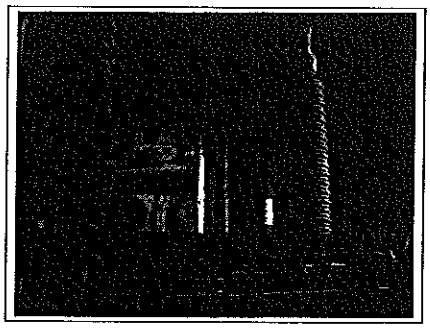


Picture no. 8



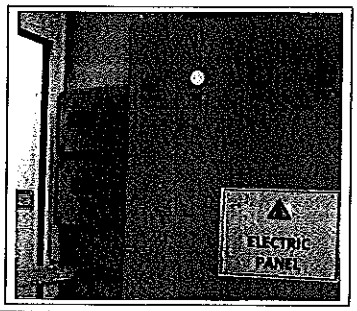
Picture no. 9

Picture no. 7, 8, 9 – Details of the disconnector

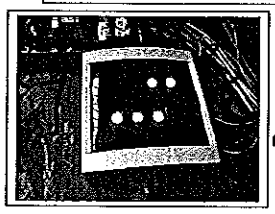


Picture no. 10

Picture no. 10 – The disconnector to extreme negative – 50°C temperature



Picture no. 11 - Dixell system for the monitoring and automatic recording of parameters XWEB 500



Picture 12 – The controle of close position of circuit of the disconnector.

2. Installation conditions:

The device has been assembled according to the details in figure no. 1HYD990321-011-izp,specification 1HYD300777-B, 1HYD300777-D, drawings 1HYD300777-001, climatic chamber of the Research and Hygrothermal, Climatic, Mechanical and Seismic Testing for Constructions, Instalations and Equipment Laboratory of "URBAN - INCERC", Iaşi Branch, which has the following characteristics:

- chamber volume 600 m³;
- cooling capacity 11500 W;
- attainable temperatures: - 50°C.....+70°C;
- ice layer of 0 ... 20 mm measured on a witness tube.

The device has been connected to its own drive mechanism.

3. Measuring equipment and technical means:

The climatic parameters have been measured in the following way:

- Digital thermohygrograph KIMO Instruments, CE nr. 4.8 -12-09-005/2009;
- Digital thermometer Thermo Loger R DigiSense - 50... +100°C, Calibration Report BC – 308 - 1165/8.10.2013;
- Micro – ohmetru RMO 500; 20μΩ /1mΩ /10mΩ /100mΩ/200mΩ, Calibration Report INM 03.01-476/2009
- Programmable counter PTE-30-CH, 0 + 99 999 s, Calibration Report FACV M 01/23.11.2009
- Regulation of the temperature in the climatic chamber – automatically by means of Dixell temperature and humidity regulators, Bitzer compressor group and Dixell system for the monitoring and automatic recording of parameters XWEB 500, Calibration Report INM BC – 308-1045/2011;

4. Functional requirements during and after the climatic test. Acceptance criteria

Throughout the climatic test, the disconnector with earthing switch has been fulfilling the conditions in fig.1.1 as well as the specifications at point 2, with no voltage applied to its terminals.

The disconnector with earthing switch fulfill the acceptance criteria of the climatic sequence imposed if:

4 A- For severe climatic conditions such as the forming of an ice layer of 20 mm, according to EN 62271-102, clause 6.103 (SR EN 62271-102:2003, clause 6.103):

1) prior to the operation under severe ice conditions, the disconnector with earthing switch fulfil the routine mechanical operating test according to EN 62271-102, clause 6.103.3 – g;
2) on first operation, the disconnector with earthing switch performed the complete opening and closing of contacts
3) no sudden maneuvers are performed on the disconnector with earthing switch's contacts and the continuity of the circuit is maintained during the test, in the closed and open positions of the disconnecor switch;
4) no damages are inflicted which can hinder the mechanical or electrical performance of the disconnector with earthing switch;
5) the position of the contacts is maintained – closed/open;
6) the functioning of the kinematic system is maintained;
7) the dielectric properties of the components of the drive mechanism's electric diagram are maintained

4B- For severe climatic conditions to extreme negative – 50°C temperature, according to EN 62271-102, clause 6.104.1, EN 68-2:1990+A1:1993+A2:1994 (SR EN 62271-102:2003, clause 6.104.1, SR EN 60068 - 2 – 1:2007 and SR EN 60068 - 1: 1995):

1) prior to the operation under extreme negative – 50°C temperature conditions, the disconnector with earthing switch fulfil the routine mechanical operating test according to EN 62271-102, clause 6.103.3 – g;
2) it is possible to perform the complete drive cycles of closing and opening of the disconnector with earthing switch, imposed by the standard (complete three operating cycles, at a minimum and maximum supply energy), using the equipment's own drive mechanism powered by maximum and minimum voltage, respectively;
3) no sudden maneuvers are performed on the disconnector with earthing switch's contacts and the continuity of the circuit is maintained during the test, in the closed and open positions of the the disconnector with earthing switch;
4) no damages are inflicted which can hinder the mechanical or electrical performance of the the disconnector with earthing switch;
5) the position of the contacts is maintained – closed/open;
6) the functioning of the kinematic system is maintained;

7) the dielectric properties of the components of the drive mechanism's electric diagram are maintained

5. Conditioning of the equipment

- The device has been kept at the parameters of the environment in the climatic chamber (cca 20°C) for a minimum of 24 hours. During this period, the routine mechanical operating test has been performed.

6. Test phases

6. A Test phases for severe climatic conditions such as the forming of an ice layer of 20 mm, according to EN 62271-102, clause 6.103– according to the diagram no.1

Phase no. 1 – Three phase Horizontal Centre Break Disconnector with one Earthing Switch SDF 145 serial number 2GPA45040000087, operated by Motor Drive MD 60 serial number 2GPA45010021881, 2GPA45010021882 in open position

- Cooling of the climatic chamber down to +2°C ± 1°C and keeping of the device inside for at least 5 hours.
- Ice formation according to EN 62271-102, clause 6.103 (SR EN 62271-102:2003, clause 6.103), at a temperature of +2°C ... -7°C for cca 8 hours.
- Maintaining at a temperature of -7°C ± 1°C for cca 5 hours.
- Performing of the closing maneuver using the device's own drive mechanism of circuits and the opening maneuver using the device's own drive mechanism for the disconnector with earthing switch.

Phase no. 2 – Three phase Horizontal Centre Break Disconnector with one Earthing Switch SDF 145 serial number 2GPA45040000087, operated by Motor Drive MD 60 serial number 2GPA45010021881, 2GPA45010021882 in closed position.

- Cooling of the climatic chamber down to +2°C ± 1°C and keeping of the device inside for at least 5 hours.
- Ice formation according to EN 62271-102, clause 6.103 (SR EN 62271-102:2003, clause 6.103), at a temperature of +2°C ... -7°C for cca 8 hours.
- Maintaining at a temperature of -7°C ± 1°C for cca 5 hours.
- Performing of the opening maneuver using the device's own drive mechanism of circuits and the closing maneuver using the device's own drive mechanism for the disconnector with earthing switch.

Phase no.3 – Restoring of the normal environment conditions and verification the values of the drive time and of the contact resistance of the circuit.

OBSERVATIONS – the thickness of the ice layers formed was an average of 20 ... 25 mm, as measured on a witness tube.

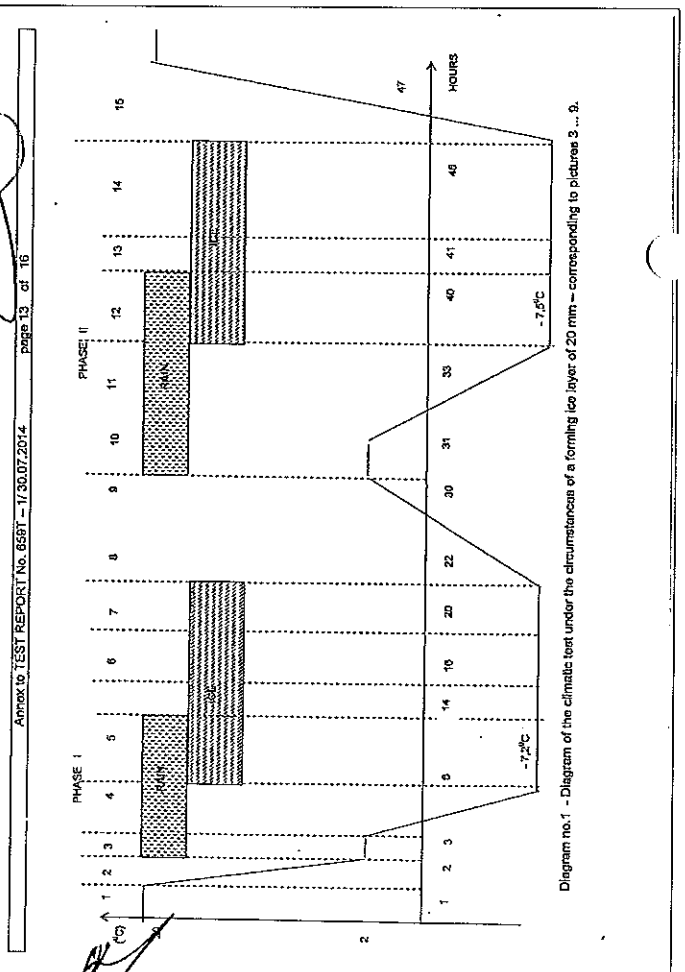


Diagram no.1 - Diagram of the climatic test under the circumstances of a forming ice layer of 20 mm – corresponding to pictures 3 ... 9.

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Experimental results

In order to verify the integrity of the equipments before the beginning of the climatic test, we have performed a general inspection to confirm that the equipment had been assembled according to the requirements of the company standard (positions, dimensions, connections, gauging) and that no damage had been caused during assembling (insulator breaking, remaining deformations), and to ensure a complete maneuvering Closed – Open cycle.

Throughout the experimental program, we have observed the general state, structural integrity and functional behavior of the products in order to be able to identify possible defects or malfunctions. Consequently, at the end of each experimental phase, we have inspected the equipment's state and we have performed the necessary maneuvers according to the verification procedures.

Our observations of the general state, structural integrity and functional behavior of the products during the program of experimental testing under severe ice conditions (forming ice layer of 20 mm) prove that the device fulfils the acceptance criteria according to EN 62271-102, clause 6.103 (SR EN 62271-102:2003, clause 6.103), as follows:

1) on first operation, the disconnector with earthing switch performed the complete opening and closing of contacts;
2) the drive time is within the limits 4,2 – 5,2 s.
3) no sudden maneuvers were performed on the earthing switch's contacts and the continuity of the circuit was maintained during the test, in the closed and open positions of the disconnector with earthing switch;
4) no damages were inflicted which could have hindered the mechanical or electrical performance of the disconnector with earthing switch;
5) the position of the contacts was maintained – closed/open;
6) the functioning of the kinematic system was maintained;
7) the dielectric properties of the components of the drive mechanism's electric diagram were maintained.
8) The value of contact resistance - The increased resistance after the environmental test is in keeping with the max limit of 20% imposed by SR EN 62271-102, clause 6.102.3 2.

6B - Test phases for severe climatic conditions to extreme negative – 50°C temperature, according to EN 62271-102, clause 6.104.1 – according to the table and the diagram no 2.
Diagram of the climatic test under the circumstances of the extreme negative – 50°C temperature, according to EN 62271-102, clause 6.104.1.

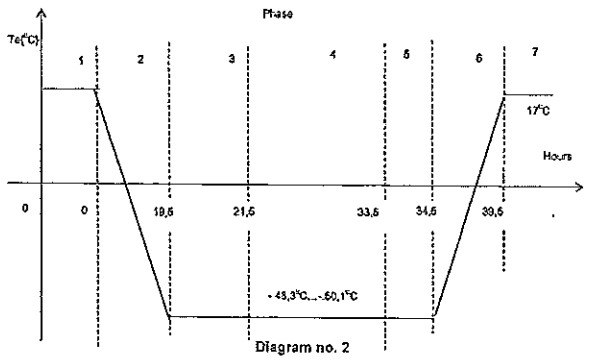

Diagram no. 2

Phases	Initial	Cooling	Maintenance	Steady-state regime	C-O Maneuvers	Reversion	Final
Nr.	1	2	3	4	5	6	7
$T_{a\,med}$	+18,5		-50,1	-50,1	-50,1		+17
ΔT_{as}	±1,6		± 1,8	± 1,8	± 1,8		±1,2
$\delta T_a / \Delta t$		-3				11,4	
φ_r	65		42	42	42		61
Δt		19,5	2	12	1	5	

Legend:
$T_{a\,med}$ – average temperature in the climatic chamber
ΔT_{as} – maximum deviation of temperature on the chamber's height
$\delta T_a / \Delta t$ – speed of temperature variation (°C/h)
φ_r – relative humidity of the air (%)
Δt – phase duration (h)

Phase 1 - Initial phase of maintaining the equipment at a temperature of 18 °C ± 1,5°C, for cca 5 hours During this period, the routine mechanical operating test has been performed.

Phase 2,3 - cooling of the climatic chamber down to - 50°C ± 1,8°C cca 20 hours and keeping of the equipment inside for at least of 2 hours.

Phase 4 - steady-state regime at an extreme negative temperature of – 50°C, according to EN 62271-102, clause 6.104.1 EN 68-2:1990+A1:1993+A2:1994 (SR EN 62271-102:2003, clause 6.104.1, SR EN 60068-2-1:2007, SR EN 60068-1:1995), for cca 12 hours

Phase 5

a. Performing the complete drive cycles of closing and opening of the disconnector with earthing switch, imposed by the standard, using the equipment's own drive mechanism powered by maximum and minimum voltage, respectively, at the same extreme negative temperature of - 50°C ± 1,8°C, cca 1 hour
b. Verifying the values of the drive time.

Phase 6 – Reversion of the chamber temperature to 17°C for cca 5 hours and verification of the contact resistance of main circuit and the values of the drive time.

Three phase Horizontal Centre Break Disconnector with one Earthing Switch SDF 145 serial number 2GPA45040000087, operated by Motor Drive MD 50 serial number 2GPA45010021881, 2GPA45010021882 has been assembled in the climatic chamber according to the details in fig. 1.1, in a closed position.

Experimental results

In order to verify the integrity of the equipments before the beginning of the climatic test, we have performed a general inspection to confirm that the equipment had been assembled according to the requirements of the company standard (positions, dimensions, connections, gauging) and that no damage had been caused during assembling (insulator breaking, remaining deformations), and to ensure a complete maneuvering Closed - Open cycle.

Throughout the experimental program, we have observed the general state, structural integrity and functional behavior of the products in order to be able to identify possible defects or malfunctions. Consequently, at the end of each experimental phase, we have inspected the equipment's state and we have performed the necessary maneuvers according to the verification procedures.
Our observations of the general state, structural integrity and functional behavior of the products

during the program of **experimental testing under the extreme negative - 50°C temperature**, prove that the device fulfils the acceptance criteria according **EN 62271-102, clause 6.104.1 (SR EN 62271-102:2003, clause 6.104.1, SR EN 60068-2-1:2007, SR EN 60068-1:1995)**, as follows:

1) we have been able to perform the complete three drive cycles of closing and opening of the disconnector with earthing switch imposed by the standard, using the equipment's own drive mechanism powered by maximum and minimum voltage, respectively;
   Unominal =110VDC,
   Umax= Unom+15%=127VDC,
   Umin= Unom -20%=88VDC
2) the drive time is within the limits value 4,2 – 4.8 s;
3) no sudden maneuvers were performed on the earthing switch's contacts and the continuity of the circuit was maintained during the test, in the closed and open positions of the disconnector with earthing switch;
4) no damages were inflicted which could have hindered the mechanical or electrical performance of the disconnector with earthing switch;
5) the position of the contacts was maintained – closed/open;
6) the functioning of the kinematic system was maintained;
7) the dielectric properties of the components of the drive mechanism's electric diagram were maintained.
8) The value of contact resistance - The increased resistance after the environmental test is in keeping with the max limit of 20% imposed by SR EN 62271-102, clause 6.102.3.2.

All test phases have been carried out in the presence and with the technical assistance of the producer ABB BULGARIA Branch Sevlievo and ICMET Craiova.

Laboratory for Research and Hygrothermal, Climatic, Mechanical and Seismic Testing for Constructions, Installations and Equipment, Iasi Branch, Romania

Head of laboratory: eng. Livia Miron, PhD
Test responsible person: eng. Constantin Miron, PhD
Chief of test division: eng Livia Miron, PhD
Laboratory A-Q responsible person: eng Alina Cobzaru

ROMÂNIA

Stația Iași Ltd.

000659

ASOCIAȚIA DE ACREDITARE DIN ROMÂNIA - RENAR

București, Calea Văcărești nr. 242, sector 3, cod 031301
CIF RO 4311680

RENAR este semnatar al EA-MLA pentru încercări.

CERTIFICAT DE ACREDITARE
Nr. LI 320

Asociația de Acreditare din România – RENAR, fiind recunoscută ca Organism Național de Acreditare prin OG 23/2009, prin prezentul certificat atestă că organizația:

Institutul Național de Cercetare Dezvoltare în Construcții, Urbanism și Dezvoltare Teritorială Durabilă "URBAN-INCERC"

București, Șos. Pantelimon nr. 266, sector 2
prin
LABORATOARE "URBAN- INCERC"

1. Laborator de Cercetare și Încercări Materiale și Elemente de Construcții - IME
2. Laborator de Cercetare și Încercări Structuri, Materiale și Echipamente - LE
3. Laborator de Cercetare și Încercări pentru Materiale, Elemente și Structuri de Construcții - ESC
4. Laborator de Cercetare și Încercări pentru Protecția la Coroziune și Degradare Biochimică a Construcțiilor - PCC
5. Laborator de Cercetare și Încercări Produse Polimerice și Finisaje - LPPF
6. Laborator de Cercetare și Încercări Higrotermică-Climatice, Mecanice și Balistice pentru Construcții, Instalații și Echipamente - IHS
7. Laborator de Cercetare și Încercări Acustica Construcțiilor - AC
8. Laborator de Cercetare și Încercări "Securitatea la Foc a Construcțiilor" - FOC

Îndeplinește cerințele SR EN ISO/CEI 17025:2005 și este competentă să efectueze activități de ÎNCERCĂRI, așa cum se detaliază în Anexele la prezentul certificat de acreditare.

Această acreditare este menținută cu condiția îndeplinirii în mod continuu a criteriilor de acreditare stabilite de Asociația de Acreditare din România - RENAR.

Prezentul certificat este însoțit de Anexele nr. 1 și nr. 6 (câte 3 pagini fiecare), nr. 2, nr. 3, nr. 4, nr. 5, nr. 7 și nr. 8 (câte1 pagină fiecare), parte integrantă a acestuia.

Pentru verificarea validității certificatului de acreditare, inclusiv a Anexelor, se consultă website-ul RENAR, www.renar.ro.

Data acreditării inițiale: 20.12.2004
Data reînnoirii acreditării: 18.12.2014
Data expirării acreditării: 17.12.2018

DIRECTOR GENERAL
Cătălina Viorica NEAGU

PREȘEDINTE AL CONSILIULUI DE ACREDITARE
dr. ing. Dumitru DINU

Anexa nr. 1 la Certificatul de Acreditare nr. LI 320
Data emiterii Anexei nr. 1: 18.12.2014

Laborator de Cercetare și Încercări Materiale și Elemente de Construcții - IME

Cluj-Napoca, Calea Florești nr. 117, județul Cluj

aparținând de Institutul Național de Cercetare-Dezvoltare în Construcții, Urbanism și Dezvoltare Teritorială Durabilă „URBAN – INCERC"- Sucursala Cluj-Napoca

Nr. crt.	Tipul / Denumirea încercării	Material / produs	Documentul de referință
	Încercări dimensionale		
1	Determinarea granulozității. Analiza granulometrică prin cernere	Agregate	SR EN 933-1:2012 PTE-IME-33/02.01
2	Determinarea formei granulelor. Coeficient de aplatizare.	Agregate	SR EN 933-3:2012 PTE-IME-33/02.02
3	Determinarea formei particulelor. Coeficient de formă	Agregate	SR EN 933-4:2008 PTE-IME-33/02.15
4	Evaluarea pământ fine. Determinarea echivalentului de nisip	Agregate	SR EN 933-8:2012 PTE-IME-33/02.04
5	Evaluarea pământ fine.Încercare cu albastru de metilen	Agregate	SR EN 933-9+A1:2013 PTE-IME-33/02.16
6	Determinarea lungimii și lățimii	Produse termoizolante	SR EN 822:2013 PTE-IME-13/05.01
7	Determinarea grosimii	Produse termoizolante destinate utilizării la clădiri	SR EN 823:2013 PTE-IME-13/05.13
		Produse termoizolante pentru pardoseli flotante	SR EN 12431:2013 PTE-IME-13/05.12
8	Determinarea perpendicularității	Produse termoizolante	SR EN 824:2013 PTE-IME-13/05.14
9	Determinarea planității	Produse termoizolante	SR EN 825:2013 PTE-IME-13/05.15
10	Determinarea stabilității dimensionale în condiții normale și constante de laborator (23 grade C și 50% umiditate relativă)	Produse termoizolante	SR EN 1603:2013 PTE-IME-13/05.04
11	Determinarea stabilității dimensionale în condiții specificate de temperatura și umiditate	Produse termoizolante	SR EN 1604:2013 PTE-IME-13/05.05
	Încercări fizice		
12	Determinarea conținutului de elemente cochiliere. Procent de cochilii în agregate	Agregate	SR EN 933-7:2001 PTE-IME-33/02.03
13	Determinarea masei volumice în vrac și a porozității intergranulare	Agregate	SR EN 1097-3:2002 PTE-IME- 33/02.06
14	Determinarea masei reale și a coeficientului de absorbție a apei	Agregate	SR EN 1097-6:2013 PTE-IME- 33/02.07
15	Determinarea procentului de suprafețe concasate și sfărmate din agregate grosiere	Agregate	SR EN 933-5:2001 SR EN 933-5:2001/A1:2005 PT- IME-02/01.01
16	Determinarea alunecării	Adezivi pentru plăci ceramice	SR EN 1308:2008 PTE-IME-10/17.02
17	Determinarea absorbției apei : - de scurtă durată prin imersie parțială - de lungă durată prin imersie	Produse termoizolante	SR EN 1609:2013 PTE-IME-13/05.09 SR EN 12087:2013 PTE-IME-13/05.16
18	Determinarea deformației în condiții specifice de încercare la compresiune și de temperatură	Produse termoizolante	SR EN 1605:2013 PTE-IME-13/05.06
19	Determinarea permeabilității la aer	Ferestre și uși	SR EN 1026:2001 PTE- IME-10/01.06

Anexa nr. 1 la Certificatul de Acreditare nr. LI 320
Data emiterii Anexei nr. 1: 18.12.2014

Nr. crt.	Tipul / Denumirea încercării	Material / produs	Documentul de referință
20	Determinarea etanșeității la apă	Ferestre și uși	SR EN 1027:2001 PTE-IME-10/01.07
21	Încercarea de tasare	Beton proaspăt	SR EN 12350-2:2009 PTE- IME-04/01.02
22	Determinarea densității	Beton proaspăt	SR EN 12350-6:2009 PTE- IME-04/01.03
		Beton întărit	SR EN 12390-7:2009 PTE-IME-04/02.07
23	Determinarea contracției axiale a betonului întărit	Betoane	SR 2833:2009 PTE-IME-04/02.05
24	Determinarea permeabilității la vapori de apă a sistemelor compozite de izolare termică la exterior (ETICS)	Produse termoizolante	SR EN ISO 7783:2012 PTE-IME-47/01.10
25	Determinarea rezistenței termice prin metoda termoflumetrică la produse cu rezistență termică mare și medie	Produse termoizolante	SR EN 12667:2002, pct.7.3.5.2 PTE-IME-57/01.04
26	Determinarea permeabilității la apă lichidă a suprafeței sistemului - ETICS	Produse termoizolante	SR EN 1062-3:2008 PTE-IME-20/05.06
	Încercări mecanice		
27	Determinarea rezistenței la sfărâmare. Metoda Los Angeles	Agregate	SR EN 1097-2:2010 PTE-IME-33/02.05
28	Determinarea rezistenței la uzura (micro-Deval)	Agregate	SR EN 1097-1:2011 PTE-IME- 33/02.11
29	Determinarea timpului deschis (operativ)	Adezivi pentru plăci ceramice	SR EN 1346:2008 PTE-IME-10/17.01
30	Determinarea aderenței prin încercare pentru adezivi pe bază de lianți minerali	Adezivi pentru plăci ceramice	SR EN 1348:2008 PTE-IME-10/17.04
31	Determinarea deformației la încovoiere prin încovoiere pentru adezivi pe bază de lianți minerali și chituri	Adezivi pentru plăci ceramice	SR EN 12002:2009 PTE-IME-10/17.05
32	Determinarea comportării la compresiune	Produse termoizolante	SR EN 826:2013 PTE-IME-13/05.02
33	Determinarea rezistenței la tracțiune perpendicular pe fețe	Produse termoizolante	SR EN 1607:2013 PTE- IME-13/05.07
34	Determinarea comportării la încovoiere	Produse termoizolante	SR EN 12089:2013 PTE-IME-13/05.10
35	Determinarea rezistenței la efectul de îngheț-dezgheț	Produse termoizolante	SR EN 12091:2013 PTE-IME-13/05.11
36	Rezistența la încărcare din vânt	Ferestre și uși	SR EN 12211:2001 PTE-IME-10/01.08
37	Determinarea rezistenței la încovoiere statică	Uși batante sau pivotante	SR EN 948:2002 PTE-IME-10/01.12
38	Determinarea rezistenței la răsucire statică	Ferestre	SR EN 14609:2004 PTE-IME-10/01.13
39	Determinarea rezistenței la compresiune	Beton întărit	SR EN 12390-3:2009 SR EN 12390-3:2009/AC:2011 PTE-IME-04/02.02
		Ciment	SR EN 196-1:2006 PTE-IME- 33/01.01
40	Determinarea rezistenței la încovoiere	Beton întărit	SR EN 12390-5:2009 PTE-IME-04/02.15
		Ciment	SR EN 196-1:2006 PTE-IME-33/01.01

Anexa nr. 1 la Certificatul de Acreditare nr. LI 320
Data emiterii Anexei nr. 1: 18.12.2014

Nr. crt.	Tipul / Denumirea încercării	Material / produs	Documentul de referință
41	Rezistența la înfândere prin despicare a epruvetelor	Beton întărit	SR EN 12390-6:2010 PTE- IME-04/02.16
42	Determinarea adâncimii de pătrundere a apei sub presiune	Beton întărit	SR EN 12390-8: 2009 PTE-IME-04/02.08
43	Determinarea rezistenței la îngheț-dezgheț prin măsurarea rezistenței la compresiune	Betoane	SR 3518:2009 PTE-IME-04/02.04
44	Determinarea timpului de priză	Ciment	SR EN 196-3+A1:2009 PTE-IME-33/01.02
45	Determinarea stabilității	Ciment	SR EN 196-3+A1:2009 PTE-IME-33/01.03
46	Determinarea rezistenței la impact a sistemelor compozite de izolare termică la exterior (ETICS)	Produse termoizolante	SR EN 13497:2004 PTE-IME-20/05.03
47	Determinarea rezistenței la smulgere a sistemelor compozite de izolare termică la exterior (ETICS)	Produse termoizolante	SR EN 13495:2003 PTE- IME-20/05.04
48	Determinarea caracteristicilor mecanice ale plaselor de fibre de sticlă	Produse termoizolante	SR EN 13496:2013 PTE- IME-20/05.05
49	Determinarea rezistenței la penetrare a sistemelor compozite de izolare termică la exterior (ETICS)	Produse termoizolante	SR EN 13498:2004 PTE-IME-20/05.07
50	Determinarea aderenței prin tracțiune a adezivilor și a straturilor de bază la materialul termoizolant	Produse termoizolante	SR EN 13494:2003 PTE-IME 47/01.05
51	Încercarea la tracțiune. Metoda de încercare la temperatura ambiantă	Materiale metalice(oțel-beton, benzi, profile, table, țevi, sârmă trasă, alte materiale metalice)	SR EN ISO 6892-1:2010 PTE-IME-04/01.04
	Încercări chimice		
52	Determinarea eficacității ignifugării	Lemn	SR 652:2009 PTE-IME-39/01.01
53	Determinarea caracteristicilor termice și de stabilitate a agregatelor încercarea cu șoc de magneziu	Agregate	SR EN 1367-2:2010 PTE-IME-33/02.08
54	Determinarea clorurilor solubile în apă. Metoda Volhard	Agregate	SR EN 1744-1+A1:2013 PTE-IME-33/02.09

Sfârșit document

DIRECTOR GENERAL
Cătălina Viorica NEAGU

Anexa nr. 2 la Certificatul de Acreditare nr. LI 320
Data emiterii Anexei nr. 2: 18.12.2014

Laborator de Cercetare şi Încercări Instalaţii, Materiale şi Echipamente - LII

Bucureşti, Şos. Pantelimon nr. 266, sector 2

aparţinând de Institutul Naţional de Cercetare-Dezvoltare în Construcţii, Urbanism şi Dezvoltare Teritorială Durabilă „URBAN – INCERC" - Sucursala INCERC Bucureşti

Nr. crt.	Tipul / Denumirea încercării	Material / produs	Documentul de referinţă
	Încercări termice		
1	Determinarea puterii termice şi temperaturii medii a suprafeţei	Radiatoare şi convectoare	SR EN 442-2:2002 SR EN 442-2:2002/ A1:2002 SR EN 442-2:2002/ A2:2004 SR EN 442-2:2002/C91:2007 PTE-LII-21.7.a
		Panouri radiante de plafon	SR EN 14037-2:2004 PTE-LII-21.8.a SR EN 14037-3:2004 PTE-LII-21.8.b
	Încercări mecanice		
2	Verificarea rezistenţei (etanşeităţii) la presiune	Radiatoare şi convectoare	SR EN 442-1:2000 SR EN 442-1:2000/ A1:2004 PTE-LII-21.3.a
		Panouri radiante de plafon	SR EN 14037-1:2004 PTE4.9-LII-21.8.c
	Încercări fizice		
3	Determinarea proprietăţilor de transmisie a vaporilor de apă	Produse termoizolante, folii	SR EN 12086:2013 PTE -LII- 23.1.a
4	Determinarea densităţii aparente	Produse termoizolante	SR EN 1602:2013 PTE-LII-23.1.b
5	Determinarea dimensiunilor liniare a epruvetelor de încercat	Produse termoizolante	SR EN 12085:2013 PTE-LII-23.1.b
6	Determinarea rezistenţei termice cu metoda, plăcii calde gardate	Produse termoizolante plane cu rezistenţă termică mare şi medie	SR EN 12667:2002 PTE-LII-23.1.b
		Produse termoizolante plane groase cu rezistenţă termică mare şi medie	SR EN 12939:2002 PTE-LII-23.1.b
		Produse plane uscate cu rezistenţă termică medie şi mică	SR EN 12664:2002 PTE-LII-23.1.b

Sfârşit document

DIRECTOR GENERAL
Cătălina Viorica NEAGUE

Anexa nr. 3 la Certificatul de Acreditare nr. LI 320
Data emiterii Anexei nr. 3: 18.12.2014

Laborator de Cercetare şi Încercări pentru Materiale, Elemente şi Structuri de Construcţii – ESC

Bucureşti, Şos. Pantelimon nr. 266, sector 2

aparţinând de Institutul Naţional de Cercetare-Dezvoltare în Construcţii, Urbanism şi Dezvoltare Teritorială Durabilă „URBAN – INCERC" – Sucursala INCERC Bucureşti

Nr. crt.	Tipul / Denumirea încercării	Material / produs	Documentul de referinţă
	Încercări dimensionale		
1	Determinarea dimensiunilor	Elemente pentru zidărie	SR EN 772-16:2011 PTE-ESC-01
	Încercări fizice		
2	Determinarea densităţii aparente	Cărămizi, blocuri ceramice	SR EN 772-13:2001 PTE-ESC-02
3	Determinarea permeabilităţii la aer	Ferestre şi uşi	SR EN 1026:2001 PTE-ESC-23
4	Determinarea etanşeităţii la apă	Ferestre şi uşi	SR EN 1027:2001 PTE-ESC-24
	Încercări mecanice		
5	Determinarea rezistenţei la compresiune	Elemente pentru zidărie	SR EN 772-1:2011 PTE-ESC-04
		Zidărie	SR EN 1052-1:2001 PTE-ESC-05
6	Determinarea rezistenţei la încărcare din vânt	Ferestre şi uşi	SR EN 12211:2001 PTE-ESC-25
7	Încercarea la tracţiune	Bare, sârme laminate şi sârme pentru armarea betonului	PTE-ESC-20 SR EN ISO 15630-1:2011
8	Încercarea la încovoiere	Bare, sârme laminate şi sârme pentru armarea betonului	SR EN ISO 15630-1:2011 PTE-ESC-21

Sfârşit document

DIRECTOR GENERAL
Cătălina Viorica NEAGUE

Anexa nr. 4 la Certificatul de Acreditare nr. LI 320
Data emiterii Anexei nr. 4: 18.12.2014

Laborator de Cercetare şi Încercări pentru Protecţia la Coroziune şi Degradare Biochimică a Construcţiilor - PCC

Bucureşti, Şos. Pantelimon nr. 266, sector 2

aparţinând de Institutul Naţional de Cercetare-Dezvoltare în Construcţii, Urbanism şi Dezvoltare Teritorială Durabilă „URBAN – INCERC" – Sucursala INCERC Bucureşti

Nr. crt.	Tipul/Denumirea încercării	Material / produs	Documentul de referinţă
	Încercări fizice		
1	Determinarea densităţii	Vopsele, lacuri şi produse similare	SR EN ISO 2811-1:2011 PTE-PCC-01
2	Determinarea conţinutului de substanţe nevolatile	Vopsele, lacuri şi produse similare	SR EN ISO 3251:2008 PTE-PCC-02
3	Determinarea rezistenţei la umiditate. Condensarea continuă	Vopsele, lacuri şi produse similare	SR EN ISO 6270-1:2002 PTE-PCC-09
	Încercări chimice		
4	Determinarea rezistenţei la lichide a) Metoda prin imersiune b) Metoda petei	Vopsele, lacuri şi produse similare	SR EN ISO 2812-1:2007 SR EN ISO 2812-4:2007 PTE-PCC-10
5	Încercari la coroziune în atmosfere artificiale. Determinarea rezistenţei la ceaţă salină neutră	Metale şi aliaje, acoperiri metalice (anodice şi catodice), acoperiri obţinute prin oxidare anodică, acoperiri organice pe materiale metalice	SR EN ISO 9227:2012 PTE-PCC-07
	Încercări dimensionale		
6	Determinarea grosimii peliculei. Metoda magnetică	Vopsele, lacuri şi produse similare	SR EN ISO 2808:2007 PTE-PCC-03
	Încercări mecanice		
7	Determinarea durităţii peliculei. Încercarea de amortizare a pendulului Persoz	Vopsele, lacuri şi produse similare	SR EN ISO 1522:2007 PTE-PCC-04
8	Încercarea la cenuşă	Vopsele, lacuri şi produse similare	SR EN ISO 2409:2013 PTE-PCC-05

Sfârşit document

DIRECTOR GENERAL
Cătălina Viorica NEAGUE

Anexa nr. 5 la Certificatul de Acreditare nr. LI 320
Data emiterii Anexei nr. 5: 18.12.2014

Laborator de Cercetare şi Încercări Produse Polimerice şi Finisaje – LPPF

Bucureşti, Şos. Pantelimon nr. 266, sector 2

aparţinând de Institutul Naţional de Cercetare-Dezvoltare în Construcţii, Urbanism şi Dezvoltare Teritorială Durabilă „URBAN – INCERC" – Sucursala INCERC Bucureşti

Nr. crt.	Tipul / Denumirea încercării	Material / produs	Documentul de referinţă
	Încercari mecanice		
1	Determinarea proprietăţilor de tracţiune	Materiale plastice	SR EN ISO 527-1:2012 SR EN ISO 527-2:2012 SR EN ISO 527-3:2000 SR EN ISO 527-3:2000/AC:2006 SR EN ISO 527-4:2000 PTE-LPPF-09
2	Determinarea proprietăţilor de încovoiere	Materiale plastice	SR EN ISO 178:2011, Metoda A SR EN ISO 178:2011/A1:2013 PTE-LPPF-10
		Produse termoizolante (polistiren expandat, spumă poliuretanică)	SR EN 12089:2013 PTE-LPPF-10
		Mortare pentru zidărie	SR EN 1015-11:2002 SR EN 1015-11:2002/A1:2007 PTE-LPPF-10
		Lemn lamelat încleiat	SR EN 408+A1:2012, poz. 19 PTE-LPPF-10
3	Determinarea comportării la compresiune	Produse termoizolante (polistiren expandat, spumă poliuretanică)	SR EN 826:2013 PTE-LPPF-11
		Piatră naturală	SR EN 1926:2007 PTE-LPPF-11
		Mortare pentru zidărie	SR EN 1015-11:2002 SR EN 1015-11:2002/A1:2007 PTE-LPPF-11
4	Determinarea aderenţei	Chituri de etanşare	SR EN 1279-4:2003 PTE-LPPF-16
		Adezivi pentru plăci ceramice	SR EN 1348:2008 PTE-LPPF-16
5	Încercarea la cenuşă	Lacuri şi vopsele	SR EN ISO 2409:2013 PTE-LPPF-19
6	Determinarea rezistenţei la îngheţ sub sarcină concentrată	Piatră naturală	SR EN 12372:2007 PTE-LPPF-20
7	Încercarea de perforare statică (CBR)	Geotextile şi produse înrudite	SR EN ISO 12236:2007 PTE-LPPF-23
	Încercări fizice		
8	Determinarea absorbţiei de apă : - de scurtă durată prin imersie parţială - de lungă durată prin imersie	Produse termoizolante	SR EN 1609:2013 SR EN 12087:2013 PTE-LPPF-25
9	Determinarea etanşeităţii la apă	Foi flexibile hidroizolante	SR EN 1928:2008 PTE-LPPF-26

Sfârşit document

DIRECTOR GENERAL
Cătălina Viorica NEAGUE

Anexa nr. 6 la Certificatul de Acreditare nr. LI 320
Data emiterii Anexei nr. 6: 18.12.2014

Laborator de Cercetare şi Încercări Higrotermice-Climatice, Mecanice şi Seismice pentru Construcţii, Instalaţii şi Echipamente - IHS

Iaşi, Str. Prof. Anton Sesan nr. 37, judeţul Iaşi

aparţinând de Institutul Naţional de Cercetare-Dezvoltare în Construcţii, Urbanism şi Dezvoltare Teritorială Durabilă „URBAN – INCERC" - Sucursala Iaşi

Nr. crt.	Tip/Denumirea încercării	Material / produs	Documentul de referinţă
	Încercări dimensionale		
1	Determinarea lungimii, lăţimii şi înălţimii	Foi flexibile hidroizolante. Foi hidroizolante bituminoase pentru acoperiş	SR EN 1848-1:2003 PTE-IHS-8/01.12
2	Determinarea dimensiunilor	Elemente pentru zidărie	SR EN 772-16:2011 PTE IHS-8/01.01
		Elemente metalice ale cadrului pentru sisteme de pereţi de ghips-carton	SR EN 14195:2005, pct. 5.2 SR EN 14195:2005/A C:2006 PTE IH-10/04.02
	Încercări fizice		
3	Determinarea densităţii	Elemente pentru zidărie din ceramică arsă	SR EN 772-13:2001 PTE IH-8/01.02
		Beton întărit	SR EN 12390-7:2009 PTE IHS-02/07
4	Determinarea rezistenţei termice cu ajutorul metodei plăcii calde gardată şi al metodei termoflumetrice	Produse cu rezistenţă termică mare şi medie/ Produse termoizolante destinate utilizării la clădiri	SR EN 12667:2002 PTE IH-8/04.01
5	Determinarea conductivităţii termice	Materiale de construcţie omogene	STAS 6912-89 PTE IH-8/03.09
6	Determinarea indicelui de pătrundere a umidităţii şi măsurarea temperaturii punctului de rouă	Elemente de vitraje izolante	SR EN 1279-2:2004, pct. 5 şi Anexa A PTE IH-8/14.05 PTE IH-8/14.01
7	Caracteristicile fizice ale ansamblurilor etanşate	Elemente de vitraje izolante	SR EN 1279-4:2003, pct.5 PTE IH- 8/14.06
8	Determinarea grosimii peliculei. Metoda prin cântărire	Vopsele şi lacuri	SR EN ISO 2808:2007 PTE IH- 8/02.01-02
9	Determinarea absorbţiei de apă - de lungă durată prin imersie - de scurtă durată prin imersie parţială	Produse termoizolante destinate utilizării la clădiri	SR EN 12087:2013 PTE IH- 8/09.05
			SR EN 1609:2013 PTE IHS-9/09.05.01
10	Funcţionarea în condiţii severe de formare a gheţii a) Condiţionare b) Testare (înainte, în timpul condiţionării şi după condiţionare)	Aparataj de înaltă tensiune / Separatoare şi separatoare de legare la pământ de înaltă tensiune şi de curent alternativ	SR EN 62271-102:2003, pct. 6.103 SR EN 62271-102:2003/A1:2012 SR EN 62271-102:2003/A2:2013 SR EN 62271-102:2003/AC:2014 SR EN 62271-102:2003/ AC(2005):2014 SR EN 62271-1: 2009, pct. 6.4.1;7.3 SR EN 62271-1: 2009/A1:2012 PTE IH-19/12.01
11	Funcţionarea la limita de temperatură a) Condiţionare b) Testare (înainte, în timpul condiţionării şi după condiţionare)	Aparataj de înaltă tensiune / Separatoare şi separatoare de legare la pământ de înaltă tensiune şi de curent alternativ	SR EN 62271-102: 2003, pct. 6.104 SR EN 62271-102: 2003/ A1:2012 SR EN 62271-102: 2003/ A2:2014 SR EN 62271-102:2003/AC:2014 SR EN 62271-102:2003/ AC(2005):2014

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Anexa nr. 6 la Certificatul de Acreditare nr. LI 320
Data emiterii Anexei nr. 6: 18.12.2014

Nr. crt.	Tip/Denumirea încercării	Material / produs	Documentul de referinţă
			SR EN 62271-1: 2009, pct. 6.4.1;7.3 SR EN 62271-1: 2009/A1:2012 PTE IH-19/12.03
12	Încercări de mediu. Încercarea A la frig a) Condiţionare b) Testare (înainte, în timpul condiţionării şi după condiţionare)	Ansambluri de aparataj de joasă tensiune - dulapuri şi cofrete (Structuri mecanice pentru echipamente electronice-carcase pentru utilizare în exterior)	SR EN 60068-2-1: 2007 SR EN 61439-1:2012, pct. 11.9 PTE IH-19/12.02
13	Încercări de mediu. Încercarea B: Căldură uscată a) Condiţionare b) Testare (înainte, în timpul condiţionării şi după condiţionare)	Ansambluri de aparataj de joasă tensiune-dulapuri şi cofrete (Structuri mecanice pentru echipamente electronice -carcase pentru utilizare în exterior)	SR EN 60068-2-2:2008 SR EN 61439-1:2012, pct. 11.9 PTE IH-19/12.03
14	Încercări de mediu. Încercarea N - variaţii de temperatură a) Condiţionare b) Testare (înainte, în timpul condiţionării şi după condiţionare)	Ansambluri de aparataj de joasă tensiune - dulapuri şi cofrete (Structuri mecanice pentru echipamente electronice-carcase pentru utilizare în exterior)	SR EN 60068-2-14: 2010 SR EN 61439-1:2012, pct. 11.9 PTE IH-19/12.06
15	Încercări de mediu. Încercarea Dd Căldură dolică umedă a) Condiţionare b) Testare (înainte, în timpul condiţionării şi după condiţionare)	Ansambluri de aparataj de joasă tensiune - dulapuri şi cofrete (Structuri mecanice pentru echipamente electronice-carcase pentru utilizare în exterior)	SR EN 60068-2-30:2006 SR EN 60068-3-4:2003 SR EN 61439-1:2012, pct. 11.9 PTE IH-19 /12.04
16	Încercări de mediu.Încercarea Sa: Radiaţie solară simulată la nivelul solului a) Condiţionare b) Testare (înainte, în timpul condiţionării şi după condiţionare)	Ansambluri de aparataj de joasă tensiune - dulapuri şi cofrete (Structuri mecanice pentru echipamente electronice-carcase pentru utilizare în exterior)	SR EN 60068-2-5:2011 SR EN 61439-1:2012, pct. 11.9 PTE IH-19/12.07
17	Permeabilitate la aer	Ferestre şi Uşi	SR EN 1026:2001 PTE IH-8/01.06
		Faţade cortină	SR EN 12153:2002 PTE IH-8/01.06.01
18	Etanşeitate la apă	Ferestre şi Uşi	SR EN 1027:2001 PTE IH-8/01.07
		Faţade cortină	SR EN 12155:2002 PTE IH-8/01.07.01
19	Rezistenţa la încărcare din vânt	Ferestre şi Uşi	SR EN 12211: 2001 PTE IH-8/01.17
		Faţade cortină	SR EN 12179:2002 PTE IH-8/01.17
	Încercări mecanice		
20	Determinarea rezistenţei la îngheţ-dezgheţ	Elemente pentru zidărie	SR EN 772-18:2011 PTE IH-8/01.07-01
21	Determinarea rezistenţei la suport. Încercarea la carlaj	Vopsele şi lacuri	SR EN ISO 2409:2013 PTE IH-8/02.05
22	Determinarea comportării la compresiune	Produse termoizolante destinate utilizării la clădiri	SR EN 826:2013 PTE IH-8/09.14-01
23	Rezistenţa la compresiune	Cuburi beton întărit	SR EN 12390-3:2009 SR EN 12390-3:2009/AC:2011

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Anexa nr. 6 la Certificatul de Acreditare nr. LI 320
Data emiterii Anexei nr. 6: 18.12.2014

Nr. crt.	Tip/Denumirea încercării	Material / produs	Documentul de referinţă
			PTE IHS-02/04
		Elemente pentru zidărie	SR EN 772-1:2011 PTE IHS-05/02
24	Rezistenţa la încovoiere şi a încărcării de rupere	Beton întărit	SR EN 12390-5:2009 PTE IHS-02/06
25	Rezistenţa la întindere prin despicare	Beton întărit	SR EN 12390-6:2010 PTE IHS-02/05
26	Rezistenţa la tracţiune (limita de curgere, alungirea)	Bare, sârme laminate şi sârme pentru armarea betonului	SR EN ISO 15630-1:2011 SR EN ISO 6892-1:2010 PTE IHS-06/02
		Plase sudate	SR EN ISO 15630-2:2011 SR EN ISO 6892-1:2010 PTE IHS-06/03
27	Încercarea la îndoire	Bare	SR EN ISO 15630-1:2011 SR EN ISO 7438:2006 PTE IHS-06/01
28	Determinarea capacităţii de rezistenţă a dispozitivelor de siguranţă. Determinarea rezistenţei la răsucire statică şi încovoiere statică.	Ferestre	SR EN 1809:2004 PTE IHS-08/01.27
		Uşi	SR EN 948:2002 PTE IHS-08/01.27

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DIRECTOR GENERAL
Cătălina Viorica NEAGUE

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Anexa nr. 7 la Certificatul de Acreditare nr. LI 320
Data emiterii Anexei nr. 7: 18.12.2014

Laborator de Cercetare şi Încercări Acustica Construcţiilor - AC

Bucureşti, Şos. Pantelimon nr. 266, Sector 2

aparţinând de Institutul Naţional de Cercetare-Dezvoltare în Construcţii, Urbanism şi Dezvoltare Teritorială Durabilă „URBAN – INCERC" Sucursala INCERC Bucureşti

Nr. crt.	Tipul / Denumirea încercării	Material / produs	Documentul de referinţă
	Metode fizice		
1	Determinarea coeficientului de absorbţie acustică în câmp difuz	Materiale fonoabsorbante Structuri fonoabsorbante Obiecte distincte fonoabsorbante	SR EN ISO 354:2004 SR EN ISO 11654:2002 PTE-AC/01.02
2	Determinarea în laborator a izolării acustice la zgomot aerian	Pereţi, planşee, uşi şi elemente similare, ferestre, jaluzele, elemente de faţadă, faţade, vitraje, elemente tehnice mici; plăcări acustice pentru pereţi sau planşee, tavane suspendate şi pardoseli	SR EN ISO 10140-1:2011 SR EN ISO 10140-1:2011/A1:2012 SR EN ISO 10140-1:2011/A2:2014 SR EN ISO 10140-2:2011 SR EN ISO 10140-4:2011 SR EN ISO 10140-5:2011 SR EN ISO 10140-5:2011/A1:2014 SR EN ISO 717-1:2013 PTE-AC/02.01.a
3	Determinarea în laborator a izolării acustice la zgomot de impact	Planşee brute, planşee cu pardoseli, planşee cu tavane executate la intradosul planşeului	SR EN ISO 10140-1:2011 SR EN ISO 10140-1:2011/A1:2012 SR EN ISO 10140-1:2011/A2:2014 SR EN ISO 10140-3:2011 SR EN ISO 10140-4:2011 SR EN ISO 10140-5:2011 SR EN ISO 10140-5:2011/A1:2014 SR EN ISO 717-2:2013 PTE-AC/02.02.a

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DIRECTOR GENERAL
Cătălina Viorica NEAGUE

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Anexa nr. 8 la Certificatul de Acreditare nr. LI 320
Data emiterii Anexei nr. 8: 18.12.2014

Laborator de Cercetare şi Încercări "Securitatea la Foc a Construcţiilor" – FOC

Bucureşti, Şos. Pantelimon nr. 266, Sector 2

aparţinând de Institutul Naţional de Cercetare-Dezvoltare în Construcţii, Urbanism şi Dezvoltare Teritorială Durabilă „URBAN – INCERC" - Sucursala INCERC Bucureşti

Nr. crt.	Tipul / Denumirea încercării	Material / produs	Documentul de referinţă
	Încercări la foc		
1	Determinarea rezistenţei la foc	Uşi, obloane şi ferestre	SR EN 1634-1:2014 SR EN 1363-1:2012 SR EN 1363-2:2001 PTE-FOC-01.01
		Elemente de construcţii reportate - Pereţi	SR EN 1364-1:2002 SR EN 1364-1:2002/C91:2007 SR EN 1363-1:2012 SR EN 1363-2:2001 PTE-FOC-01.02
		Elemente de construcţii reportante - Planşee	SR EN 1364-2:2002 SR EN 1363-1:2012 PTE-FOC-01.03
		Elemente de construcţii portante - Planşee şi acoperişuri	SR EN 1365-2:2002 SR EN 1363-1:2012 PTE-FOC-01.06

Strânt document

DIRECTOR GENERAL
Cătălina Viorica NEAGUE

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Bucharest, Calea Vitan no. 242, sector 3, zip code 031301
CIF RO 4311880

RENAR is EA-MLA signatory for Testing.

ACCREDITATION CERTIFICATE
No. LI 004

Romanian Accreditation Association – RENAR, being recognized as National Accreditation Body by OG 23/2009, herewith attests that the organization:

NATIONAL INSTITUTE FOR RESEARCH-DEVELOPMENT AND TESTING IN ELECTRICAL ENGINEERING – ICMET CRAIOVA
Decebal Avenue no. 118A, Craiova, county Dolj

through

HIGH POWER TESTING LABORATORY FOR ELECTRICAL EQUIPMENT (HPTL)

fulfils the requirements of **SR EN ISO/CEI 17025:2005** and is competent to carry on **TESTING** activities, as it is detailed in the Annex of the present accreditation certificate.

This accreditation is maintained provided that the accreditation criteria established by the Romanian Accreditation Association – RENAR are met continuously.

The present certificate includes Annex no. 1/21.03.2016 (11 pages), which is an integrated part of this certificate.

In order to check the validity of the accreditation certificate, including the Annex, the website of RENAR shall be consulted: www.renar.ro.

Date of initial accreditation: 22.11.2010
Date of accreditation renewal: 21.11.2014
Updated on: 21.03.2016
The accreditation is valid until: 20.11.2018

GENERAL DIRECTOR
Cătălina Viorica NEAGUE

PRESIDENT OF THE ACCREDITATION COUNCIL
PhD. Eng. Dumitru DINU

The translation of this certificate was issued today, 03.05.2016.

The Accreditation Certificate does not relieve/exempt CAB the obligation to obtain all permits and authorizations required for its operation under the law.

Partial reproduction of this certificate is forbidden.

Annex no. 1 to Accreditation Certificate no. LI 004
Annex no. 1 Issue Date: 21.03.2016

HIGH POWER TESTING LABORATORY FOR ELECTRICAL EQUIPMENT (HPTL)

Decebal Avenue no. 118A, Craiova, county Dolj

belonging to **NATIONAL INSTITUTE FOR RESEARCH-DEVELOPMENT AND TESTING IN ELECTRICAL ENGINEERING – ICMET CRAIOVA**

No.	Activity area/ Measurement technique / Name of the test	Material / product/ test object	Reference document
	A. SWITCHING CAPACITY VERIFICATION (MAKING AND BREAKING OPERATIONS)		
1.	Basic short-circuit switching test. Basic sequences: T10,T30,T60, T100s,T100a	a) Alternating current circuit-breakers for voltages above 1 kV	SR EN 62271-100:2009, SR EN 62271-100:2009/A1:2013, clause 6.102+6.106 IEC 62271-100:2012, clause 6.102-6.106 SR EN 62271-1:2009, SR EN 62271-1:2009/A1:2012 clause 6 IEC 62271-1:2011 clause 6 PT-03.01, Ed. 4
		b) Single-pole alternating current circuit-breakers for voltages above 1 kV - railway applications	IEC 62505-1:2009 clause 7.8 ÷ 7.12 SR EN 62271-1:2009, clause 6 IEC 62271-1:2011, clause 6 PT-03.01, Ed. 4
2.	Critical current switching test	a) Alternating current circuit-breakers for voltages above 1 kV	SR EN 62271-100:2009, SR EN 62271-100:2009/A1:2013, clause 6.107 IEC 62271-100:2012, clause 6.107 SR EN 62271-1:2009, SR EN 62271-1:2009/A1:2012 clause 6 IEC 62271-1:2011, clause 6 PT-03.01, Ed. 4
		b) Single-pole alternating current circuit-breakers for voltages above 1 kV - railway applications	IEC 62505-1:2009 clause 7.13 SR EN 62271-1:2009, SR EN 62271-1:2009/A1:2012 clause 6 IEC 62271-1:2011, clause 6 PT-03.01, Ed. 4
3.	Single-phase and double-earth fault switching test	Alternating current circuit-breakers for voltages above 1 kV	SR EN 62271-100:2009, SR EN 62271-100:2009 / A1:2013 , clause 6.103 IEC 62271-100:2012, clause 6.103 PT-03.01, Ed. 4
4.	Out-of-phase making and breaking switching test (OP1, OP2)	a) Alternating current circuit-breakers for voltages above 1 kV	SR EN 62271-100:2009, SR EN 62271-100:2009 / A1:2013, clause 6.110 IEC 62271-100:2012, clause 6.110 SR EN 62271-1:2009, SR EN 62271-1:2009 /A1:2012 clause 6 IEC 62271-1/2011 clause 6 PT-03.01, Ed. 4
		b) Single-pole alternating current circuit-breakers for voltages above 1 kV - railway applications	IEC 62505-1:2009 clause 7.14 SR EN 62271-1:2009, SR EN 62271-1:2009 /A1:2012 clause 6 IEC 62271-1:2011, clause 6 PT-03.01, Ed. 4
5.	Capacitive current switching test (LC1, LC2), (CC1, CC2), (BC1, BC2)	a) Alternating current circuit-breakers for voltages above 1 kV	SR EN 62271-100:2009, SR EN 62271-100:2009/A1:2013, clause 6.111 IEC 62271-100:2012, clause 6.111 SR EN 62271-1:2009, SR EN 62271-1:2009 /A1:2012 clause 6 IEC 62271-1:2011 clause 6 PT-03.01, Ed. 4

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Annex no. 1 to Accreditation Certificate no. LI 004
Annex no. 1 Issue Date: 21.03.2016

No.	Activity area/ Measurement technique / Name of the test	Material / product/ test object	Reference document
		b) Single-pole alternating current circuit-breakers for voltages above 1 kV - railway applications	IEC 62505-1:2009 clause 7.15 SR EN 62271-1:2009, SR EN 62271-1:2009 /A1:2012 clause 6 IEC 62271-1:2011, clause 6 PT-03.01, Ed. 4
6.	Electrical usage test (electrical endurance)	Alternating current circuit-breakers for voltages above 1 kV	SR EN 62271-100:2009,SR EN 62271-100:2009/ A1:2013, clause 6.102+6.106 and 6.112 IEC 62271-100:2012, clause 6.102+6.106 and 6.112 PT-03.01, Ed. 4
7.	Bus transfer current switching test	Alternating current disconnectors	SR EN 62271-102:2003, SR EN 62271-102:2009 / A1:20012, SR EN 62271-100:2009 /A2:2013, clause 6.106 IEC 62271-102:2013, clause 6.106 PT-03.02, Ed. 4
8.	Induced current switching test	Alternating current disconnectors earthing switches	SR EN 62271-102:2003, SR EN 62271-102:2009 / A1:20012, clause 6.107 IEC 62271-102:2013, clause 6.107 PT-03.02, Ed. 4
9.	Verification of rated making and breaking capacity	High-voltage alternating current contactors	SR EN 62271-106:2012, clause 6.102 IEC 62271-106:2011, IEC 62271-106:2011 /Corr.1:2014, clause 6.102 PT-03.02, Ed. 4
10.	Overload ability test	High-voltage alternating current contactors	SR EN 62271-106:2012, clause 6.103 IEC 62271-106:2011, IEC 62271-106:2011 /Corr.1:2014, clause 6.103 PT-03.02, Ed. 4
11.	Short-circuit current making and breaking test	High-voltage alternating current contactors	SR EN 62271-106:2012, clause 6.104 IEC 62271-106:2011, IEC 62271-106:2011 /Corr.1 /2014, clause 6.104 PT-03.02, Ed. 4
12.	Verification of making and breaking capacities	AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV up to and including 52 kV	SR EN 62271-200:2012, clause 6.101 IEC 62271-200:2011, clause 6.101 PT-03.01, Ed. 4
13.	Short-circuit making current test	High voltage alternating current disconnectors and earthing switches	SR EN 62271-102:2003, SR EN 62271-102:2003/A1:20012, SR EN 62271-102:2003 /A2:20013, clause 6.101 IEC 62271-102:2013, clause 6.101 PT-03.02, Ed. 4
14.	Mainly active load switching test	a) Switches for rated voltages above 1 kV up to and including 52 kV (Mechanical disconnectors for rated voltage above 1 kV up to and including 52 kV)	SR EN 62271-103:2012, clause 6.101 IEC 62271-103:2011, IEC 62271-103:2011 /Corr.1:2013, clause 6.101 PT-03.02, Ed.4
		b) Single-pole disconnectors, earthing switches and switches for rated voltages above 1 kV for railway application	IEC 62505-2:2009, clause 7 SR EN 62271-103:2012, clause 6.101 IEC 62271-103:2011, IEC 62271-103:2011 /Corr.1:2013 clause 6.101 PT-03.02, Ed.3
15.	Closed loop switching test	a) Alternating current switches for rated voltages above 1 kV up to and including 52 kV	SR EN 62271-103:2012, clause 6.101 IEC 62271-103:2011, IEC 62271-103:2011 /

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No.	Activity area/ Measurement technique / Name of the test	Material / product/ test object	Reference document
		(Mechanical disconnectors for rated voltage above 1 kV up to and including 52 kV)	Corr.1:2013, clause 6.101 PT-03.02, Ed.3
		b) Single-pole disconnectors, earthing switches and switches for rated voltages above 1 kV - railway application	IEC 62505-2:2009, clause 7 SR EN 62271-103:2012, clause 6.101 IEC 62271-103:2011, IEC 62271-103:2011/Corr. 1:2013, clause 6.101 PT-03.02, Ed.4
16.	Capacitive current switching test (no-load cables and lines)	a) Alternating current switches for rated voltages above 1 kV up to and including 52 kV (Mechanical disconnectors for rated voltage above 1 kV up to and including 52 kV)	SR EN 62271-103:2012, clause 6.101 IEC 62271-103:2011, Corr. 1:2013 clause 6.101 PT-03.02, Ed.4
		b) Single-pole disconnectors, earthing switches and switches for rated voltages above 1 kV - railway application	IEC 62505-2:2009, clause 7 SR EN 62271-103:2012, clause 6.101 IEC 62271-103:2011, IEC 62271-103:2011/Corr. 1:2013 clause 6.101 PT-03.02, Ed.4
17.	Short-circuit making current test	a) Alternating current switches for rated voltages above 1 kV up to and including 52 kV (Mechanical disconnectors for rated voltage above 1 kV up to and including 52 kV)	SR EN 62271-102:2003, SR EN 62271-102:2003/A1:2012, SR EN 62271-102:2003/A2:2013, clause 6.101 IEC 62271-102:2013, clause 6.101 SR EN 62271-103:2012, clause 6.101 IEC 62271-103:2011, IEC 62271-103:2011/Corr. 1:2013 clause 6.101 PT-03.02, Ed.4
		b) Single-pole disconnectors, earthing switches and switches for rated voltages above 1 kV for railway application	IEC 62505-2:2009, clause 7 SR EN 62271-103:2012, clause 6.101 IEC 62271-103:2011, IEC 62271-103:2011/Corr. 1:2013 clause 6.101 PT-03.02, Ed.4
18.	Switching test on earthing fault current	Alternating current switches for rated voltages above 1 kV up to and including 52 kV (Mechanical disconnectors for rated voltage above 1 kV up to and including 52 kV)	SR EN 62271-103: 2012, clause 6.101 IEC 62271-103:2011, IEC 62271-103:2011/Corr. 1:2013 clause 6.101 PT-03.02, Ed.4
19.	No-load cables and lines switching current test under earth fault conditions	Alternating current switches for rated voltages above 1 kV up to and including 52 kV (Mechanical disconnectors for rated voltage above 1 kV up to and including 52 kV)	SR EN 62271-103:2012, clause 6.101 IEC 62271-103:2011, IEC 62271-103:2011/Corr. 1:2013 clause 6.101 PT-03.02, Ed.4
20.	Making and breaking test at the rated short-circuit current (ID_{sc})	Alternating current mechanical switch-fuse combinations	SR EN 62271-105:2013, clause 6.101. IEC 62271-105:2012, clause 6.101 PT-03.02, Ed.4
21.	Making and breaking test at the maximum breaking (TD_{max})	Alternating current mechanical switch-fuse combinations	SR EN 62271-105:2013, clause 6.101. IEC 62271-105:2012, clause 6.101 PT-03.02, Ed.4
22.	Breaking test at the rated transfer current ($TD_{transfer}$)	Alternating current mechanical switch-fuse combinations	SR EN 62271-105:2013, clause 6.101. IEC 62271-105:2012, clause 6.101 PT-03.02, Ed.4

No.	Activity area/ Measurement technique / Name of the test	Material / product/ test object	Reference document
23.	Verification of the breaking capacity	a) High-voltage current limiting exceeding 1kV fuses	SR EN 60282-1:2010, clause 6.6 IEC 60282-1:2009, clause 6.6 IEC 60282-2:2008, clause 8.6 PT-03.03, Ed. 4
		b) High-voltage expulsion fuses	
		c) Low-voltage fuses	SR EN 60269-1:2006, SR EN 60269-1:2006/A1:2010, clause 8.5 IEC 60269-1:2009, clause 8.5 PT-03.03, Ed.4
24.	Test for verifying time - current characteristics	High-voltage current limiting exceeding 1kV fuses	SR EN 60282-1:2010, SR EN 60282-1:2010 /A1:2015, clause 6.7 IEC 60282-1:2014, clause 6.7 PT-03.06, Ed. 4
	B. TYPE TESTS FOR LOW VOLTAGE CIRCUIT-BREAKERS	PT-03.18, Ed.4	
25	General performance characteristics (test sequence 1)	All circuit-breakers categories	SR EN 60947-2:2007,SR EN 60947-2:2007/A1:2010, SR EN 60947-2:2007/A2.2013, clause 8.3.3 IEC 60947-2: 2013, clause 8.3.3
26	Rated service short-circuit breaking capacity (test sequence 2)	All circuit-breakers categories	SR EN 60947-2:2007,SR EN 60947-2:2007/A1:2010, SR EN 60947-2:2007/A2:2013, clause 8.3.4 IEC 60947-2: 2013, clause 8.3.4
27	Rated ultimate short-circuit breaking capacity (test sequence 3)	Circuit-breakers category A Circuit-breakers category B integrally fused	SR EN 60947-2:2007,SR EN 60947-2:2007/A1:2010, SR EN 60947-2:2007/A2.2013, clause 8.3.5 IEC 60947-2: 2013, clause 8.3.5
28	Rated short-time withstand current (test sequence 4)	Circuit-breakers category B	SR EN 60947-2:2007,SR EN 60947-2:2007/A1:2010, SR EN 60947-2:2007/A2:2013, clause 8.3.6 IEC 60947-2: 2013, clause 8.3.6
29	Performance of integrally fused circuit-breakers (test sequence 5)	Integrally fused circuit-breakers	SR EN 60947-2:2007,SR EN 60947-2:2007/A1:2010, SR EN 60947-2:2007/A2:2013, clause 8.3.7 IEC 60947-2: 2013, clause 8.3.7
30	Combined test sequence (test sequence 6)	Circuit-breakers category B	SR EN 60947-2:2007,SR EN 60947-2:2007/A1:2010, SR EN 60947-2:2007/A2:2013, clause 8.3.8 IEC 60947-2: 2013, clause 8.3.8
	C. SHORT-TIME WITHSTAND CURRENT BEHAVIOR (SHORT-CIRCUIT)		
31	Short-time withstand current test and peak withstand current tests	a) Alternating- current circuit-breakers exceeding 1 kV	SR EN 62271-100:2009, SR EN 62271-100:2009/A1:2013, clause 6.6 IEC 62271-100:2012, clause 6.6 SR EN 62271-1:2009, SR EN 62271-1:2009/A1:2012 clause 6.6 IEC 62271-1:2011clause 6.6 PT-03.04, Ed.4
		b) Single-pole alternating current circuit-breakers with nominal voltage above 1 kV - railway applications	SR EN 62271-1:2009, SR EN 62271-1:2009/A1:2012 clause 6.6 IEC 62271-1:2011 clause 6.6

No.	Activity area/ Measurement technique / Name of the test	Material / product/ test object	Reference document
			IEC 62505-1:2009 clause 7.6 PT-03.04, Ed.4
		c) Alternating current switches for rated voltages above 1 kV up to and including 52 kV (Mechanical disconnectors for rated voltage above 1 kV up to and including 52 kV)	SR EN 62271-1:2009, SR EN 62271-1:2009/A1:2012 clause 6.6 IEC 62271-1:2011, clause 6.6 SR EN 62271-103:2012, clause 6.6 IEC 62271-103:2011, IEC 62271-103:2011/Corr.1:2013 clause 6.6 PT-03.04, Ed. 4
		d) High voltage alternating current disconnectors and earthing switches	SR EN 62271-1:2009, clause 6.6 IEC 62271-1:2011, clause 6.6 SR EN 62271-102:2003, A1/2012, A2/2013, clause 6.6 IEC 62271-102:2012, clause 6.6 PT-03.04, Ed. 4
		e) Single-pole switches, earthing switches, and switches with nominal voltage above 1 kV - railway applications	IEC 62505-2:2009, clause 7 SR EN 62271-1:2009, SR EN 62271-1:2009/A1:2012 clause 6.6 IEC 62271-1:2011, clause 6.6 PT-03.04, Ed. 4
		f) AC metal enclosed switchgear and controlgear for rated voltages above 1 kV up to and including 52 kV	SR EN 62271-200:2012, clause 6.6 IEC 62271-200:2011, clause6.6 PT-03.04, Ed. 4
		g) Low voltage switchgear and controlgear: switches, circuit-breakers, disconnectors,	SR EN 60947-2:2007, SR EN 60947-2:2007/A1:2010, SR EN 60947-2:2007/A2:2013, clause. 8.3.6 IEC 60947-2:2013, 8.3.6 SR EN 60947-3:2009, SR EN 60947-3:2009/A1:2012, clause 8.3.5.1 IEC 60947-3:2012, IEC 60947-3:2012/A1:2013, clause 8.3.5.1 PT-03.18, Ed.4 PT-03.19, Ed. 4
		h) Current switches and fuse switch combination units	SR EN 62271-105:2013, clause 6.6 IEC 62271-105:2012, clause 6.6 PT-03.04, Ed. 4
		i) Bushars and low-voltage switchgear and controlgear assemblies (distributing boxes, measuring and protection units)	SR EN 61439-1:2012, clause 10.10 IEC 61439-1:2011, clause 10.10 PT-03.04, Ed.4
		j) Bushings	SR EN 60137:2008, SR EN 60137:2008/C91/2012, clause 8.6 IEC 60137:2008, clause 8.6 PT 03.04, Ed.4
		k) Prefabricated substations	SR EN 62271-202:2007, clause 6.4 IEC 62271-202:2014, clause 6.4 PT 03.04, Ed.4
		l) Current transformers	SR EN 61869-2:2013, clause 7.2.201 IEC 61869-2:2012, clause 7.2.201 PT 03.04, Ed. 4
		m) Busbar trunking systems (busways)	SR EN 61439-6:2013, clause 10.11.1 IEC 61439-6:2012, clause 10.11.1 PT-03.04, Ed.4

No.	Activity area/ Measurement technique / Name of the test	Material / product/ test object	Reference document
32	Inter-turn overvoltage test	Current transformers	SR EN 61869-2:2013, clause 7.3.204 IEC 61869-2:2012, clause 7.3.204 PT-03.17, Ed. 4
33	Short-circuit withstand capability test	a) Inductive voltage transformers	SR EN 61869-3:2012, clause 7.2.301 IEC 61869-3:2011, clause 7.2.301 PT 03.11, Ed.3
		b) Capacitive voltage transformers	SR EN 61869-5:2012, clause 7.2.502 IEC 61869-5:2011, clause 7.2.502 PT-03.04, Ed. 4
34	Short-circuit current test	Tap changers	SR EN 60214-1:2004, clause 7.2.3 IEC 60214-1:2014, clause 7.2.3 PT-03.21, Ed. 1
35	Short-circuit current test (temperature and dynamic stability)	Portable equipment for earthing or earthing and short-circuiting	SR EN 61230:2009, clause 6.6 IEC 61230:2008, clause 6.6 PT-03.12, Ed.4
36	Ability to withstand short-circuit	a) Power transformers: • oil immersed • dry	SR EN 60076-5:2006, clause 4.2 IEC 60076-5:2006, clause 4.2 SR EN 60076-11:2005, clause 25 IEC 60076-11:2004, clause 25 PT-03.05, Ed. 4
		b) Current limiting reactors	SR EN 60076-6:2009, clause 8.9.13 IEC 60076-6:2007, clause 8.9.13 PT-03.14, Ed. 4
		c) Line traps for alternating current power systems	IEC 60353:1989, IEC 60353:1989/A1:2002, clause 19.4 PT-03.14, Ed. 4
		d) Filter, damping and discharge reactors associated with capacitors	SR EN 60076-6:2009, clause 9.5 IEC 60076-6:2007 clause 9.5 PT-03.06, Ed. 4
		e) Earthing transformers (neutral couplers)	SR EN 60076-6:2009, clause 10.5 IEC 60076-6:2007, clause 10.5 PT-03.06, Ed. 4
37	Short-circuit tests	Metal-oxide surge arresters without gaps for a.c. systems	SR EN 60099-1:2002, SR EN 60099-1:2002/A1:2003, clause 8.7 IEC 60099-1:1999, clause 8.7 SR EN 60099-4:2005, SR EN 60099-4:2005/A1:2007, SR EN 60099-4:2005/A2:2009, clause 8.7 IEC 60099-4:2009, clause 8.7 PT-03.09, Ed. 4
	D. INTERNAL ARC TEST		
38	Internal arc fault test	a) AC metal enclosed switchgear and controlgear for rated voltages above 1 kV up to and including 52 kV	SR EN 62271-200:2012, clause 6.106 IEC 62271-200:2011, clause 6.106 PT-03.08, Ed. 4
		b) Prefabricated substations	SR EN 62271-202:2007, 6.8 IEC 62271-202:2014, 6.102 PT-03.08, Ed. 4
		c) Current transformers	SR EN 61869-1:2010 clause 7.4.6 IEC 61869-1:2007 clause 7.4.6 SR EN 61869-2:2013, clause 7.4.6

No.	Activity area/ Measurement technique / Name of the test	Material / product/ test object	Reference document
			IEC 61869-2:2012, clause 7.4.6 PT-03.08, Ed. 4
		d)) Voltage transformers	SR EN 61869-1:2010 clause 7.4.6 IEC 61869-1:2007 clause 7.4.6 SR EN 61869-3:2012, clause 7.4.6 IEC 61869-3:2011, clause 7.4.6 PT-03.08, Ed. 4
		e) Low-voltage switchgear and controlgear assemblies	IEC 61641:2014, clause 8 PT-03.08, Ed. 4
39	AC power arc tests	Insulators for overhead lines with a nominal voltage above 1000 V	SR EN 61467:2009, clause 8 IEC 61467:2008, clause 8 PT-03.15, Ed. 4
40	Tests using a constrained and directed arc	Protective clothing against the thermal hazards of an electric arc	SR EN 61482-1-1:2010 IEC 61482-1-1: 2009 SR EN 61482-1-2: 2007 IEC 61482-1-2: 2007 IEC 61482-2: 2009 PT-03.22, Ed. 1
	E. TEMPERATURE-RISE TESTS		
41	Temperature-rise test	a) Circuit-breakers for rated voltages above 1 kV	SR EN 62271-1:2009, SR EN 62271-1:2009/A1:2012 clause 6.5 IEC 62271-1:2011 clause 6.5 SR EN 62271-100:2009, SR EN 62271-100:2009/A1:2013, clause 6.5 IEC 62271-100:2012, clause 6.5 PT-03.06, Ed. 4
		b) Single-pole alternating current circuit-breakers with nominal voltage above 1 kV - railway applications	SR EN 62271-1:2009, SR EN 62271-1:2009/A1:2012 clause 6.5 IEC 62271-1:2011clause 6.5 IEC 62505-1:2009 clause 7.4 PT-03.06, Ed. 4
		c) Switches for rated voltages above 1 kV up to and including 52 kV (Mechanical disconnectors for rated voltage above 1 kV up to and including 52 kV)	SR EN 62271-103:2012, clause 6.5 IEC 62271-103:2011,IEC 62271-103:2011/Cor.1:2013, clause 6.5 SR EN 62271-102:2003, SR EN 62271-102:2003/A1:2012,SR EN 62271-102:2003/A2:2013, clause 6.5 IEC 62271-102:2013, clause 6.5 PT-03.06, Ed. 4
		d) Switches and earthing switches, single-pole switches with nominal voltage above 1 kV - railway applications	SR EN 62271-102:2003, SR EN 62271-102:2003/A1:2012, SR EN 62271-102:2003/A2:2013, clause 6.5 IEC 62271-102:2013, clause 6.5 SR EN 62271-103:2012, clause 6.5 IEC 62271-103:2011, IEC 62271-103:2011/Cor.1:2013, clause 6.5 IEC 62505-2:2009, clause 7 PT-03.06, Ed. 4
		e) High-voltage current-limiting fuses	SR EN 60282-1:2010, clause 6.5 IEC 60282-1:2009, clause 6.5 IEC 60282-2:2008, clause 8.5 PT-03.06, Ed. 4

No.	Activity area/ Measurement technique / Name of the test	Material / product/ test object	Reference document
		f) Low voltage fuses	SR EN 60269-1:2008, SR EN 60269-1:2008/A1:2010, clause 8.3 IEC 60269-1:2009, clause 8.3 SR HD 60269-2:2011, clause 8.3 IEC 60269-2:2013, clause 8.3 PT-03.06, Ed.3
		g) Disconnectors for rated voltages above 1 kV	SR EN 62271-102:2003, SR EN 62271-102:2003/A1:2012, SR EN 62271-102:2003/A2:2013, clause 6.5 IEC 62271-102:2013, clause 6.5 PT-03.06, Ed. 4
		h) Bushings	SR EN 60137:2008, clause 25 IEC 60137:2008, clause 25 PT-03.05, Ed. 4
		i) High voltage alternating current contactors	SR EN 62271-106:2012, clause 6.5 IEC 62271-106:2011, IEC 62271-106:2011/Corr.1:2014, clause 6.5 PT-03.06, Ed. 4
		j) Current transformers	SR EN 61869-1:2010, clause7.2.2 IEC 61869-1:2007, clause 7.2.2 SR EN 61869-2:2013, clause 7.2.2 IEC 61869-2:2012, clause 7.2.2 PT-03.16, Ed. 4
		k) Tap changers	SR EN 60214-1:2004, clause 7.2.2 IEC 60214-1:2014, clause 7.2.2 PT-03.09, Ed. 4
		l) Inductive voltage transformers	SR EN 61869-1:2010 clause 7.2.2 IEC 61869-1:2007 clause 7.2.2 SR EN 61869-3:2012, clause 7.2.7 IEC 61869-3:2011, clause 7.2.7 PT-03.16, Ed. 4
		m) Capacitive voltage transformers	SR EN 61869-5:2012, clause 7.2.2 IEC 61869-5:2011, clause7.2.2 PT-03.16, Ed.3
		n) Power transformers • oil immersed • dry	SR EN 60076-2:2011, clause 7 IEC 60076-2:2011, clause 7 IEC 60076-7:2005, clause 8 SR EN 60076-11:2005, clause 23 IEC 60076-11:2004, clause 23 PT-03.10, Ed. 4
		o) Prefabricated substations	SR EN 62271-202:2007, clause 6.3 IEC 62271-202:2014, clause 6.3 PT-03.10, Ed. 4
		p) Alternating current switch-fuse combinations	SR EN 62271-105:2013, clause 6.5 IEC 62271-105:2012, clause 6.6 PT-03.06, Ed. 6
		r) AC metal enclosed switchgear and controlgear for rated voltages above 1 kV up to and including 52 kV	SR EN 62271-200:2012, clause 6.5 IEC 62271-200:2011, clause 6.5 PT-03.06, Ed. 4
		s) Low voltage switchgear and controlgear. switches, disconnectors, switch-disconnectors and fuse-combination units	SR EN 60947-1:2008, SR EN 60947-1:2008/A1:2011, clause 8.3.3.3 IEC 60947-1:2011, clause 8.3.3.3

No.	Activity area/ Measurement technique / Name of the test	Material / product/ test object	Reference document
			SR EN 60947-3:2009, SR EN 60947-3:2009/A1:2012, clause 8.3.3.6 IEC 60947-3:2012, IEC 60947-3:2012/A1:2013, clause 8.3.3.6 PT-03.19, Ed. 4
		s) Low voltage switchgear and controlgear. Circuit-breakers	SR EN 60947-2:2007, SR EN 60947-2:2007/A1:2010, SR EN 60947-2:2007/A2:2013, clause 8.3.3.6, clause 8.3.4.4, clause 8.3.6.3, clause 8.3.7.2 IEC 60947-2:2013, clause 8.3.3.6, clause 8.3.4.4, clause 8.3.6.3, clause 8.3.7.2 PT-03.18, Ed.3
		t) Busbars and low-voltage switchgear and controlgear assemblies (distributing boxes, measuring and protection units)	SR EN 61439-1:2012, clause 9.2 IEC 61439-1:2011, clause 9.2 PT-03.06, Ed.4
		u) Neutral Grounding Resistors	ANSI/IEEE 32:1972, Amendment 1974,clause 14.4 PT-03.23, Ed. 4
		v) Busbar trunking systems (busways)	SR EN 61439-6 : 2013, clause 10.10 IEC 61439-6:2012, clause 10.10 PT-03.06, Ed. 4
		x) Earthing transformers (neutral couplers)	SR EN 60076-6:2009, clause 10.6 IEC 60076-6:2007, clause 10.6 PT-03.06, Ed. 4
	F. MECHANICAL TESTS		
42	Mechanical endurance tests	a) Circuit-breakers for a.c voltages above 1 kV	SR EN 62271-100:2009, SR EN 62271-100:2009/A1:2013, clause 6.101 IEC 62271-100:2012, clause 6.101 PT-03.07, Ed. 4
		b) Alternating current disconnectors above 1 kV	SR EN 62271-103:2012, clause 6.102 IEC 62271-103:2011, IEC 62271-103:2011/Corr.1:2013 clause 6.102 SE EN 62271-102:2003, SE EN 62271-102:2003/A1:2012, SR EN 62271-102:2003/A2:2013, clause 6.102 IEC 62271-102:2013, clause 6.102 PT-03.07, Ed. 4
		c) Alternating current switches for rated voltages above 1 kV	SR EN 62271-102:2003, SR EN 62271-102:2003/A1:20012, SR EN 62271-102:2003/A2:2013, clause 6.102 IEC 62271-102:2013, clause 6.102 SR EN 62271-103:2012, clause 6.102 IEC 62271-103:2011, IEC 62271-103:2011/Corr.1:2013 clause 6.102 PT-03.07, Ed.4
		d) Switches and earthing switches, single-pole switches with nominal voltage above 1 kV - railway applications	SR EN 62271-102:2003, SR EN 62271-102:2003 / A1:20012, A2/2013, clause 6.102 IEC 62271-102:2013, clause 6.102 SR EN 62271-103:2012, clause 6.102 IEC 62271-103:2011, IEC 62271-103:2011/Corr.1:2013 clause 6.102 IEC 62505-2:2009, clause 7.3 PT-03.07, Ed.4

No.	Activity area/ Measurement technique / Name of the test	Material / product/ test object	Reference document
		e) High-voltage alternating current contactors	SR EN 62271-106:2012, clause 6.101 IEC 62271-106:2011, IEC 62271-106:2011/Corr.1:2014, clause 6.101 PT-03.07, Ed. 4
43	Switching devices and removable parts verification	AC metal enclosed switchgear and controlgear for rated voltages above 1 kV up to and including 52 kV	SR EN 62271-200:2012, clause 6.102.1 IEC 62271-200:2011, clause 6.102 PT-03.07, Ed. 4
44	Interlocks verification	AC metal enclosed switchgear and controlgear for rated voltages above 1 kV up to and including 52 kV	SR EN 62271-200:2012, clause 6.102.2 IEC 62271-200:2011, clause 6.102 PT-03.07, Ed. 4
	G. SOUND LEVEL DETERMINATION		
45	Sound levels determination	a) Power transformers • oil immersed • dry	SR EN 60076-10:2003 IEC 60076-10:2001 IEC 60076-10-1:2005 PT-03.13, Ed. 3
		b) Prefabricated substations	SR EN 62271-202:2007, Annex BB IEC 62271-202:2014, Annex BB SR EN 60076-10:2003; IEC 60076-10:2001 IEC 60076-10-1:2005 PT-03.13, Ed. 3
	H. MAIN AND AUXILIARY CIRCUIT RESISTANCE MEASURING		
46	Main and auxiliary circuit resistance measuring	a) Alternating current circuit-breaker for rated voltages above 1 kV	SR EN 62271-100:2009, SR EN 62271-100:2009/ A1:2013, clause 6.4 IEC 62271-100:2012, clause 6.4 SR EN 62271-1:2009, SR EN 62271-1:2009/A1:2012, clause 6.4 IEC 62271-1:2011, clause 6.4 PT-03.20, Ed. 3
		b) AC metal enclosed switchgear and controlgear for rated voltages above 1 kV up to and including 52 kV	SR EN 62271-200:2012, clause 6.4 IEC 62271-200:2011, clause 6.4 PT-03.20, Ed. 3
		c) Alternating current switches for rated voltages above 1 kV up to and including 52 kV, mechanical disconnectors (switches) for rated voltage above 1 kV up to and including 52 kV	SR EN 62271-103:2012, clause 6.4 IEC 62271-103:2011, IEC 62271-103:2011/Corr.1:2013, clause 6.4 SR EN 62271-102:2003, SR EN 62271-102:2003/A1:20012, SR EN 62271-102:2003/A2:2013, clause 6.4 IEC 62271-102:2013, clause 6.4 PT-03.20, Ed. 3
		d) Switches and earthing switches, single-pole switches with nominal voltage above 1 kV for railway applications	SR EN 62271-103:2012, clause 6.4 IEC 62271-103:2011, IEC 62271-103:2011/Corr.1:2013, clause 6.4 IEC 62505-2:2009, PT-03.20, Ed. 3
		e) Single-pole alternating current (AC) circuit-breakers with nominal voltage above 1 kV for railway applications	SR EN 62271-1:2009, SR EN 62271-1:2009/A1:2012, clause 7.5 IEC 62271-1:2011clause 7.5 IEC 62505-1:2009 clause 7.5 PT-03.20, Ed. 3
		f) Alternating current switch-fuse combinations	SR EN 62271-105:2013, clause 6.4 IEC 62271-105:2012, clause 6.4 PT-03.20, Ed. 4

Annex no. 1 to Accreditation Certificate no. LI 004
Annex no. 1 Issue Date: 21.03.2016

No.	Activity area/ Measurement technique / Name of the test	Material / product/ test object	Reference document
	I. INDIVIDUAL TESTS		
47	Measurement of winding resistance	Power transformers	SR EN 60076-1:2012,clause 11.2 IEC 60076-1:2012, clause 11.2 PT-03.10, Ed. 4
48	Measurement of voltage ratio and check of phase displacement	Power transformers	SR EN 60076-1:2012,clause 11.3 IEC 60076-1:2012, clause 11.3 PT-03.10, Ed. 4
49	Measurement of short-circuit impedance and load loss	Power transformers	SR EN 60076-1:2012, clause 11.4 IEC 60076-1:2012, clause 11.4 PT-03.10, Ed. 4
50	Measurement of no-load loss and current	Power transformers	SR EN 60076-1:2012, clause 11.5 IEC 60076-1:2012, clause 11.5 PT-03.10, Ed. 4

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GENERAL DIRECTOR
Cătălina Viorica NEAGU

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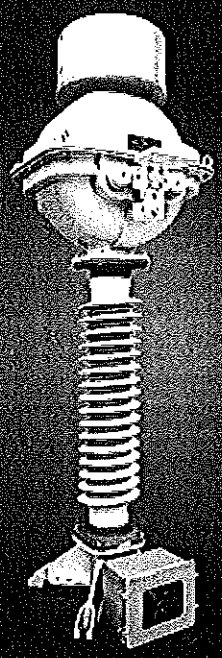

High Voltage Products

Current transformers PA 123a and PA 145a

Power and productivity
for a better world™

ABB

Product description

The PVA 123a and PVA 145a current transformers are used for feeding measurement and protection systems in electric power grids with the highest system voltage of 123 kV or 145 kV, respectively, and frequency of 50 Hz. They are designed to operate in grids with effectively earthed or insulated neutral points as well as in compensated earthed systems. The transformers are suitable to operate in outdoor conditions with ambient temperature from 233 K (-40°C) to 313 K (+40°C) and at relative humidity of up to 100% at 303 K (+30°C), at an altitude not exceeding 1000 m above sea level. Two designs are available: with composite or porcelain insulator.

Current transformers type PA 123a and PA 145a feature a top core design; active parts are placed in a tight enclosure filled with PCB-free transformer oil.
The covered transformer's stainless steel compensation bellows in casing is fixed to the head. The compensation bellows compensates for thermal changes in oil volume.

Top core construction

The use of the top core design in the current transformer makes it possible to achieve high values of thermal and dynamic short--circuit currents as well as a broad range of rated primary currents and burdens of secondary windings.

Primary and secondary windings and accuracy classes

The primary and secondary windings are made of electrical copper and aluminum. For clients requiring high transformation accuracy with low values of selected rated primary currents, we are able to deliver a solution comprising the use of special classes 0.2S and 0.5S. We guarantee very high transformation accuracy in the special classes, from 1% to 120%, 150% and even to 200% of the value of selected primary current for both secondary currents of 1 A and 5 A.
Secondary windings for protection purposes are offered in all accuracy classes, namely: 5P, 10P, 5PR, 10PR, TPX, TPY, TPZ, PX, PXR.
Our laboratory for measurements of accuracy classes of instrument transformers is one of the most advanced and well-equipped research facilities in the country. We are accredited by the Polish Central Office of Measures.

Current range switching

The transformer can be switched on the primary side as well as on the secondary side. A metal jumper is used for current range switching on the primary side. It shall be placed in appropriate location in accordance with the terminal board. This solution does not require performance of additional operations related to change of location of line connections.

Main insulation

The main insulation is made of insulation paper impregnated with transformer oil. We utilize high quality oil conforming to IEC 60296 Standard requirements. This oil does not contain PCBs or any other highly toxic substances and has low environmental impact.

Hollow insulator

The standard insulator is made of brown porcelain with creepage distance required for the 3rd pollution zone. A grey composite insulator with creepage distance required for the 4th pollution zone is available upon request. All materials used in the production of our insulators conform to relevant IEC Standards.

Enclosure

All external parts are robust and made of corrosion resistant materials. All enclosure joints are leak proof due to O-ring sealing system. Each completely assembled unit is subject to stringent leakage checks during routine testing. The expansion bellows is equipped with a large oil level indicator that enables observations of changes in oil volume even from a large distance.

Primary terminals

The standard primary terminals are flat, made of aluminum, and their width is 100 mm or 200 mm. Upon request we can offer pin type primary terminals, made of copper or aluminum, with a diameter of 30 mm or 40 mm.

Terminal box

The terminal box is made of aluminum and fixed to the transformer's bottom tank. Tightness – according to IP55. Secondary terminals are available for connection of conductors with cross--section of up to 10 mm². Sealing of current measurement terminals is also possible upon request. The standard terminal box is equipped with two M40 cable glands (for cables from Ø 19 mm to Ø 28 mm). We offer terminal boxes with different number of cable glands upon request. IT's with two secondary boxes are available upon request (possibility of splitting into measuring and protective part).

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Technical specifications

General information

Parameter	Value	
Type	PA 123a	PA 145a
Compliance with standards	IEC 61869-2; PN-EN 61869-2	
Highest system voltage	123 kV	145 kV
Power-frequency withstand test voltage	50 Hz 230 kV	50 Hz 275 kV
Rated lighting-impulse withstand voltage	1,2/50 µs 550 kV	1,2/50 µs 650 kV
Minimum creepage distance	16; 20; 25; 31 mm/kV	
Rated frequency	50 Hz	
Total weight [max.]	420; 360* kg	

*Composite insulator.

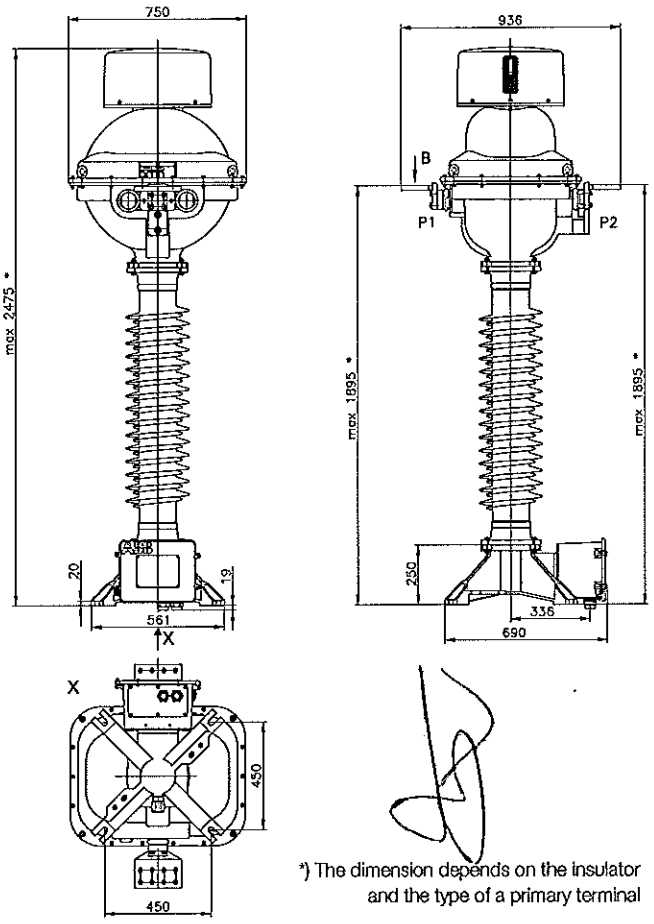
Current module

Rated current [A]	Short-circuit thermal current 1 s [kA]	Dynamic short-circuit current [kA]
50–3000	up to 63	up to 157

Switched design 1:2 or 1:2:4 on request.

Parameter	Value
Rated secondary current	1 A; 5 A
Extended current range	120%; 150%; 200%
Number of cores	1–6
Measuring cores parameters:	
– total rated output	1–200 VA
– accuracy class	0,1; 0,2; 0,2S; 0,5; 0,5S; 1; 3; 5
Protection cores parameters:	
– total rated output	1–200 VA
– accuracy class	5P, 10P, 5PR, 10PR, TPX, TPY, TPZ, PX, PXR

Dimensional drawing



*) The dimension depends on the insulator and the type of a primary terminal

More information

ABB Contact Center
ph.: +48 22 22 37 777
e-mail: kontakt@pl.abb.com

ABB Sp. z o.o.
Branch Office in Przasnysz
ul. Leszno 59
06-300 Przasnysz
ph.: +48 22 22 38 931, +48 22 22 39 255
fax: +48 22 22 38 958

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Power and productivity
for a better world™

РЕПУБЛИКА БЪЛГАРИЯ
Български институт по метрология

REPUBLIC OF BULGARIA
Bulgarian Institute of Metrology

УДОСТОВЕРЕНИЕ ЗА ОДОБРЕН ТИП СРЕДСТВО ЗА ИЗМЕРВАНЕ

Measuring Instrument Type-approval Certificate

№ 16.05.5104

Издадено на производител: ABB Sp. zo. o., Poland
Issued to manufacturer: 06-300 Przasnysz, ul. Leszno 59

На основание на: чл. 32, ал. 1 от Закона за измерванията (ДВ, бр. 46 от 2002 г., изм. бр. 88 от 05 г., изм. и доп. бр. 95 от 2005 г.)
In Accordance with:

Относно: измервателни токови трансформатори тип PA 123a, PA 145a
In Respect of:

Знак за одобрен тип:
Type Approval Mark:

BG 16
5104

Технически и метрологични характеристики: приложение, неразделна част от настоящото удостоверение за одобрен тип средство за измерване
Technical and metrological characteristics:

Срок на валидност: 12.05.2026 г.
Valid until:

Вписва се в регистъра на одобрените за използване типове средства за измерване под №: 5104
Reference №:

ВЯРНО С ОРИГИНАЛА

Дата на издаване на удостоверението за одобрен тип: 12.05.2016 г.
Date:

И. Д. ПРЕДСЕДАТЕЛ:
Пауп Илчев

000871

Приложение към удостоверение за одобрен тип № 16.05.5104

Издадено на производител: ABB Sp. zo. o., Poland, 06-300 Przasnysz, ul. Leszno 59

Относно: измервателни токови трансформатори тип PA 123a, PA 145a

1. Описание на типа:

Измервателните токови трансформатори тип PA 123a и PA 145a се използват за измерване и защита на електрически мрежи с максимално допустимо работно напрежение до 123 kV и 145 kV и честота 50 Hz. Те са проектирани да работят в системи с ефективно заземен или изолиран звезден център, както и в компенсирани системи. Предназначени са за външен монтаж.

Активната част на токовите трансформатори се състои от първична намотка, вторични намотки и ядро, разположени в херметичен корпус запълнен с трансформаторно масло, не съдържащо полихлорирани бифинили PCB. Ядрата са разположени в горната част на токовия трансформатор.

Първичната и вторичната намотки са направени от висококачествена електротехническа мед, позволяваща висок клас на точност започващ от 0,1 при ниски стойности на номиналния първичен ток. При измервателните токови трансформатори тип PA 123a и PA 145a има възможност за превключване на първичната намотка.

Изолаторът може да бъде направен от порцелан с път на утечка 25 mm/kV или 31 mm/kV. Възможно е той да бъде изработен и от полимерен композитен материал с път на утечка 31 mm/kV.

Токовите трансформатори тип PA 123a и PA 145a са подходящи за работа в условия на открито с температура на околната среда от –40 °C до +40 °C при относителна влажност на въздуха до 100% при 30 °C и надморска височина до 1000 m. Трансформаторите са изработени за общо механично натоварване от скоростта на вятъра до 34 m/s, поледица с дебелина до 20 mm и до опъване на проводника не повече от 500 N.

Вторичните клеми са обозначени със стандартни маркировки на изводите. Всички външни метални части са изработени от корозоустойчиви материали.

2. Технически и метрологични характеристики:

Характеристика	Трансформатори тип PA 123a	Трансформатори тип PA 145a
Максимално работно напрежение, kV	123	145
Честота, Hz	50	
Номинален първичен ток, A	от 50 до 3000	
Клас на точност: - измервателна намотка: - защитна намотка:	0,1; 0,2S; 0,2; 0,5S; 0,5; 1; 3; 5 5P; 10P; 5PR; 10PR; PX; PXR; TPX; TPY; TPZ;	
Коефициент на сигурност, FS	FS5; FS10	
Номинален вторичен ток, A	1; 5	
Мощност, VA	до 200	

3. **Типово означение:** PA 123a, PA 145a.

4. **Описание на местата, предназначени за поставяне на знаци от метрологичен контрол:**
   - Знакът за одобрен тип (марка за залепване) се поставя на табелката с технически данни;
   - Знакът за първоначална проверка (марка за залепване) се поставя до знака за одобрен тип.

ВЕРНО С ОРИГИНАЛА

000072

ABB

Data Schedule : Current Transformer

Date :	**2017-07-05**	**Name :**	**bozena.trajer@pl.abb.com**
CCP Number:	**-**		
Our ref :	**KU 657/17**	**Revision :**	**A**
Project :	**CEZ**		

General data

Quantity	6
Type	PA 123a
Standards	IEC 61869-2
Design	Outdoor
Insulation	Oil / paper hermetic
Manufacturer, country	ABB, Poland

Service conditions

Highest voltage of a system (phase-to-phase) U_{sys}	kV r.m.s.	123
Rated frequency f_R	Hz	50
Ambient air temperature (Temperature category)	°C	-40/ +40
Average ambient air temp. (period 24h)	°C ≤	35
Altitude	m	1000
Seismic activity acc. to IEC 62271-300		AF3

Rated insulation level

Highest voltage for equipment (phase-to-phase) U_m	kV r.m.s.	123
Rated lightning impulse withstand voltage 1,2/50 µs	kV peak	550
Rated power-frequency withstand voltage, dry	kV r.m.s.	230
Rated power-frequency withstand voltage, wet	kV r.m.s.	230

Current ratings

Rated primary current I_{pr}	A r.m.s.	150 - 300 - 600
Rated continuous thermal current I_{cth}	A r.m.s.	180-360-720
Rated short-time thermal current I_{th} / time	kA r.m.s./s	31,5-31,5-31,5/1
Rated dynamic current I_{dyn}	kA peak	80 - 80 - 80
Reconnection		Primary 1:2:4

Accuracy ratings

Core No.	Terminals	Ratio A / A	Accuracy	Rct75	No. of terminal box	Cover for sealing
1, 2	[x]S1-[x]S2	150-300-600/5	1-15VA 0,2S ext.120% FS5	-	1	-
3, 4	[x]S1-[x]S2	150-300-600/5	30VA 10P20	-	1	-

[x] – means given number of the core

Product data

Dimension drawing		2GKA614717A0657;rev.A
Rating plate language		Bulgarian
Insulator type / colour		Composite / grey
Minimum creepage distance	mm	4411
Minimum arcing distance	mm	1174
Primary terminal type		Al flat pad 100x120 T=20 mm; 4xD=14/50x50mm
Earthing terminals type		2 x ø14 / 45-60mm
Secondary terminal type		Phoenix rail terminal blocks; spring connection, type ST 10 without cable glands;
Cable glands – terminal box No. 1		

000073

Withstand test load on primary terminal FR	(Static/Dyn)N	3600/5000
Painting (colour)		
- Housing above insulator		Not painted
- Housing below insulator		Not painted
Total weight	kg	330
Weight of oil	kg	130
Insulating oil type		Nynas Nytro 10XN – Inhibited mineral insulating oil acc. to IEC 60296
Packing		Vertical -3-pack wooden crate
Shipping weight	kg/3unit	1160
Shipping dimensions	cm x cm x cm/3unit	242x106x263
Shipping volume	m3/3unit	6,4

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http://www.ien.com.pl/eur

TEST REPORT No. EUR/34/E/14-1 E

TEST OBJECT: Current transformer type PA 145a with spiral composite insulator
Serial No. 2GKP014A1287155

MANUFACTURER: ABB Sp. z o.o. Division in Przasnysz, ul. Leszno 59, 06-300 Przasnysz

TESTS ORDERED BY: ABB Sp. z o.o., ul. Żegańska 1, 04-713 Warszawa
order No. 4500574872 dated 22.07.2014

TYPE OF TESTS: Mechanical tests

TESTS PROCEDURE: According to IEC 61869-1:2007 p. 7.4.5

DATE OF TESTS: 21.08.2014

TESTS RESULT: Positive for
F_R = 3600 N

Tests result refers only to the test object

THE TESTS WERE WITNESSED BY: -

Test engineer

Tomasz Kaczmarczyk

HEAD OF LABORATORY

Lidia Gruza

Warsaw, 05.09.2014

Contents **Page**

Report contents:

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1. TEST OBJECT

1.1 Description

Current transformer type PA 145a is used for supplying of measuring and protection circuits in the network of maximum operating voltage 145 kV and frequency 50 Hz. The transformer consists of current transformer mounted housing with spiral composite insulator immersed with transformer oil.

1.2 Technical data

The Manufacturer attributed the following construction data to the test object.

Maximum operating voltage	145 kV
Rated frequency	50 Hz
Rated static load	3600 N

1.3 Technical documentation

For the purpose of tests the orderer delivered the following technical documentation:
- dimensional drawing current instrument transformer PA 145, No. 2GKA612004, 01.08.2014,
- rating plate,
- instrument transformer electrical diagram

prepared by ABB Sp. z o.o. (Annex 2).

The laboratory proceeded the identification of test object on the base of above documentation and the rating plate.

1.4 Preparation for tests

The test object was prepared for test by factory.

2. SCOPE OF TESTS

Test program, agreed with orderer, comprised the following tests according to requirements of IEC 61869-1:2007:
- mechanical tests acc. to item 7.4.5 of above standard for F_R = 3600 N of P1 and P2 3000 A terminals.

During the tests deflection of the transformer shall be recorded.

3. TEST AND MEASURING CIRCUITS

For the tests the transformer was fixed to the rigid construction of the test stand. Mechanical tests were performed applying the load consecutively to the transformer's P1 and P2 3000 A terminals as shown on photographs in Annex 1.

4. TESTS AND THEIRS DETAILED RESULTS

Tests results presents table 1. The load was increased and released smoothly (30 – 90 s) and was maintained 60 s. During the tests deflection of the transformer was recorded by laser displacement sensor (accuracy of measurement ± 0,1 mm).

During the tests the following records were made:
- phot. 1 to 6 - current transformer during mechanical tests.

(Annex 1 presents the photographs)

Table 1. Results of static load withstand tests at F = 3620 N

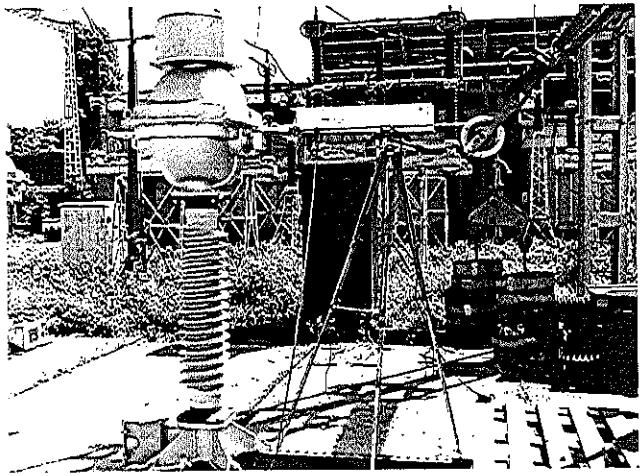
Test No.	Terminal	Load direction	Test time	Observations
-	-	-	s	-
1	P1	longitudinal	60	During the static load deflection was 16,9 mm. Residual deflection was 0,2 mm. After tests no damage nor oil leak was stated.
2	P1	transverse	60	During the static load deflection was 21,4 mm. Residual deflection was 1,3 mm. After tests no damage nor oil leak was stated.
3	P1	vertical	60	During the static load deflection was 4,9 mm. Residual deflection was 0,2 mm. After tests no damage nor oil leak was stated.
4	P2 3000 A	longitudinal	60	During the static load deflection was 16,3 mm. Residual deflection was 1,3 mm. After tests no damage nor oil leak was stated.
5	P2 3000 A	transverse	60	During the static load deflection was 20,9 mm. Residual deflection was 0,3 mm. After tests no damage nor oil leak was stated.
6	P2 3000 A	vertical	60	During the static load deflection was 3,9 mm. Residual deflection was 0,1 mm. After tests no damage nor oil leak was stated.

5. TESTS RESULTS EVALUATION

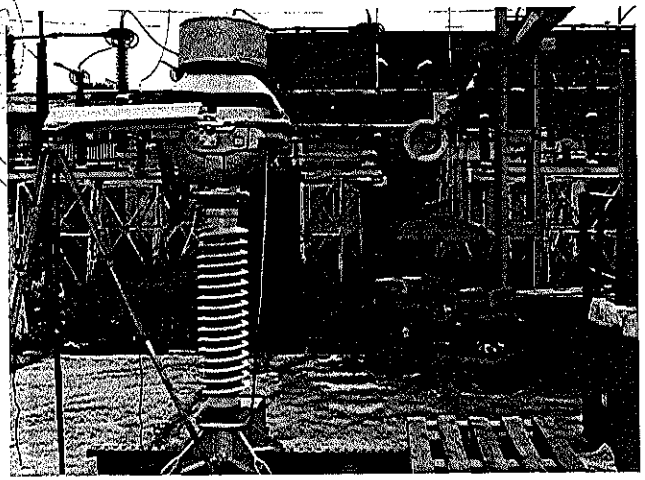
According to criteria given in IEC 61869-1:2007 p. 7.4.5 the results of tests of tested current transformer is positive for:

F_R = 3600 N.

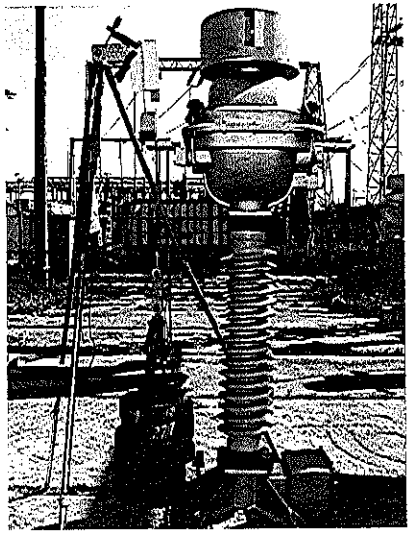
ANNEX 1 **Photographs taken during the tests**



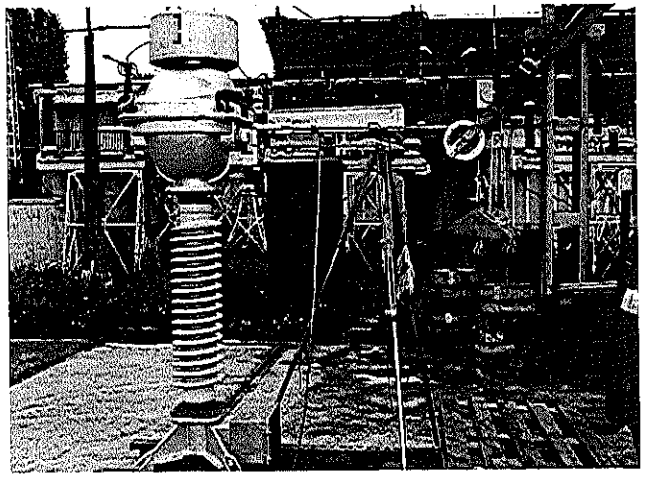
Phot. 1. Longitudinal load of terminal P1



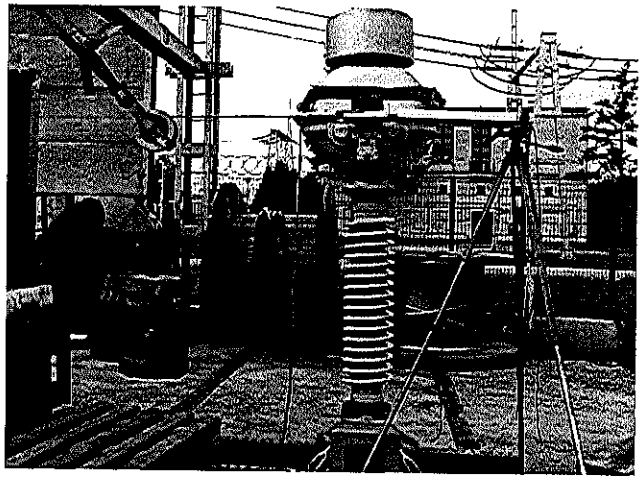
Phot. 2. Transverse load of terminal P1



Phot. 3. Vertical load of terminal P1



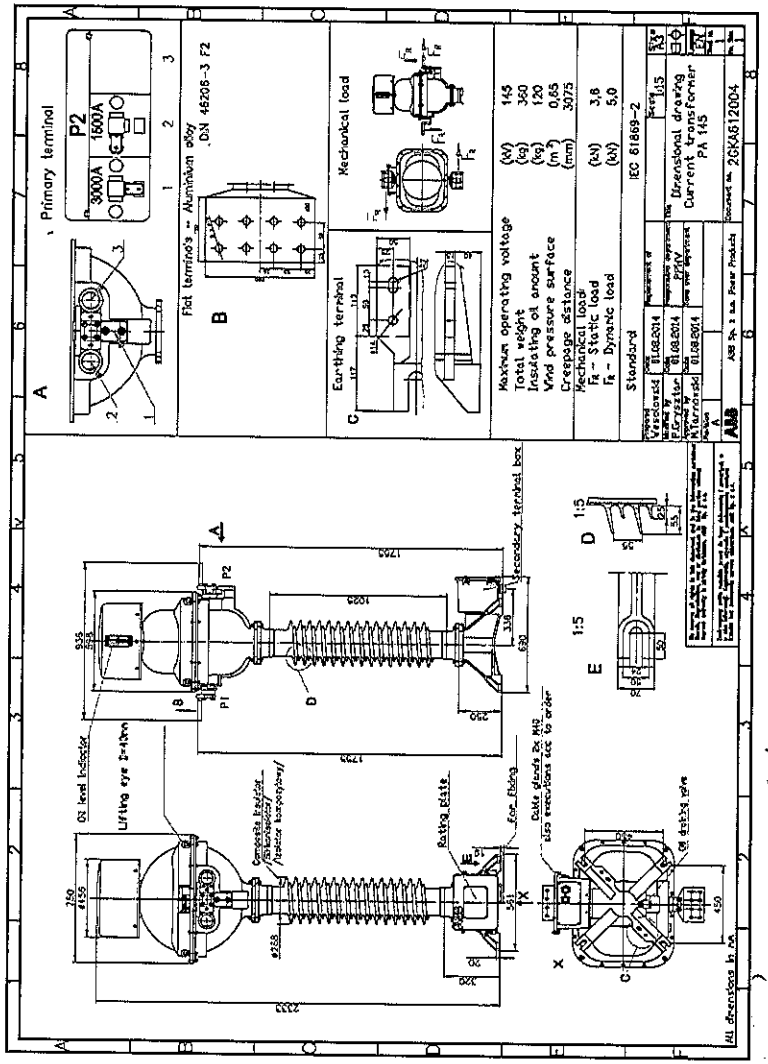
Phot. 4. Longitudinal load of terminal P2 3000 A



Phot. 5. Transverse load of terminal P2 3000 A

Phot. 6. Vertical load of terminal P2 3000 A

ANNEX 2 **Documentations delivered by orderer**



ABB

Current Transformer

				Type	PA 145a
Insulation level	145/275/650 kV	Standard	PN-EN 61869-2	fn	50 Hz
Oil type	Nytro Libra	Weight / Oil weight	360 / 120 kg	Temp. range	-40°C→ +40°C
S/N	2GKP014A1287155				

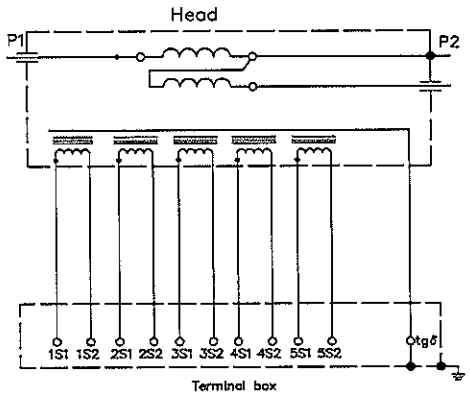
K_n 1500-3000/5-1-5-1-1 A/A

I_{th}/1s 63-63 kA I_{dyn} 158-158 kA

I_{cth} 1800-3600 A

	A	VA	Class	FS/ALF	Ext.%
1S1-1S2	5	200	0,2	10	120
2S1-2S2	1	100	0,1	5	120
3S1-3S2	5	20	5P	60	
4S1-4S2	1	35	10P	40	
5S1-5S2	1	40	10P	20	
6S1-6S2					

Transportation Vertical / Horizontal



Instrument transformer electrical diagram

ATTENTION!
1. HIGH VOLTAGE AT OPEN CURRENT SECONDARY TERMINALS XS1 – XS2
2. DURING INSTRUMENT TRANSFORMER OPERATION TERMINAL tgδ MUST BE EARTHED

643003

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tel. +48 22 345-13-86
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TEST REPORT No. EUR/34/E/14-2 E

TEST OBJECT: Current transformer type PA 145a with composite insulator
Serial No. 2GKP014A1287180

MANUFACTURER: ABB Sp. z o.o. Division in Przasnysz, ul. Leszno 59, 06-300 Przasnysz

TESTS ORDERED BY: ABB Sp. z o.o., ul. Żegańska 1, 04-713 Warszawa
order No. 4500574872 dated 22.07.2014

TYPE OF TESTS: Mechanical tests

TESTS PROCEDURE: According to IEC 61869-1:2007 p. 7.4.5

DATE OF TESTS: 22.08.2014

TESTS RESULT: Positive for
$F_R = 3600$ N

Tests result refers only to the test object

THE TESTS WERE WITNESSED BY: -

Test engineer

Tomasz Kaczmarczyk

HEAD OF LABORATORY

Lidia Gruza

Warsaw, 23.09.2014

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1. TEST OBJECT

1.1 Description

Current transformer type PA 145a is used for supplying of measuring and protection circuits in the network of maximum operating voltage 145 kV and frequency 50 Hz. The transformer consists of current transformer mounted housing with composite insulator immersed with transformer oil.

1.2 Technical data

The Manufacturer attributed the following construction data to the test object.

Maximum operating voltage	145 kV
Rated frequency	50 Hz
Rated static load	3600 N

1.3 Technical documentation

For the purpose of tests the orderer delivered the following technical documentation:
- dimensional drawing current instrument transformer PA 145a, No. 2GKK612002, 11.09.2014,
- rating plate,
- instrument transformer electrical diagram

prepared by ABB Sp. z o.o. (Annex 2).

The laboratory proceeded the identification of test object on the base of above documentation and the rating plate.

1.4 Preparation for tests

The test object was prepared for test by factory.

2. SCOPE OF TESTS

Test program, agreed with orderer, comprised the following tests according to requirements of IEC 61869-1:2007:
- mechanical tests acc. to item 7.4.5 of above standard for F_R = 3600 N of P1 and P2 2000 A terminals.

During the tests deflection of the transformer shall be recorded.

3. TEST AND MEASURING CIRCUITS

For the tests the transformer was fixed to the rigid construction of the test stand.
Mechanical tests were performed applying the load consecutively to the transformer's P1 and P2 2000 A terminals as shown on photographs in Annex 1.

4. TESTS AND THEIRS DETAILED RESULTS

Tests results presents table 1. The load was increased and released smoothly (30 – 90 s) and was maintained 60 s.

During the tests the following records were made:
- phot. 1 to 6 - current transformer during mechanical tests.

(Annex 1 presents the photographs)

Table 1. Results of static load withstand tests at F = 3620 N

Test No.	Terminal	Load direction	Test time	Observations
-	-	-	s	-
1	P1	longitudinal	60	During the static load deflection was 32,5 mm. Residual deflection was 0,8 mm. After tests no damage nor oil leak was stated.
2	P1	transverse	60	During the static load deflection was 42,5 mm. Residual deflection was 0,5 mm. After tests no damage nor oil leak was stated.
3	P1	vertical	60	During the static load deflection was 4,5 mm. Residual deflection was 0,2 mm. After tests no damage nor oil leak was stated.
4	P2 2000 A	longitudinal	60	During the static load deflection was 36,3 mm. Residual deflection was 1,1 mm. After tests no damage nor oil leak was stated.
5	P2 2000 A	transverse	60	During the static load deflection was 39,8 mm. Residual deflection was 0,4 mm. After tests no damage nor oil leak was stated.
6	P2 2000 A	vertical	60	During the static load deflection was 7,0 mm. Residual deflection was 0,1 mm. After tests no damage nor oil leak was stated.

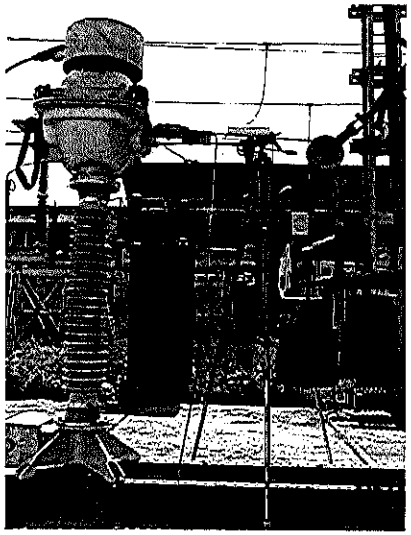
5. TESTS RESULTS EVALUATION

According to criteria given in IEC 61869-1:2007 p. 7.4.5 the results of tests of tested current transformer is positive for:

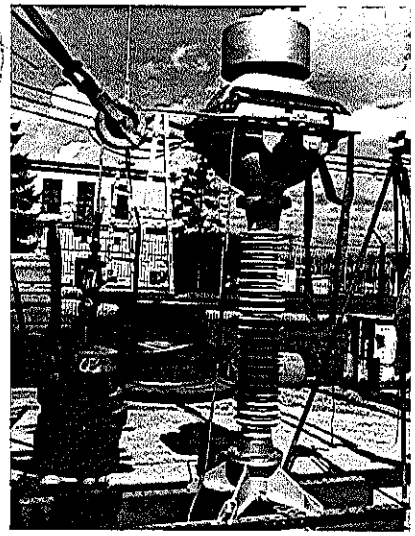
F_R = 3600 N.

ANNEX 1

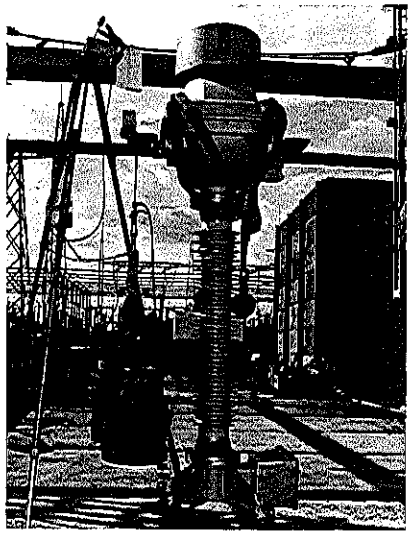
Photographs taken during the tests



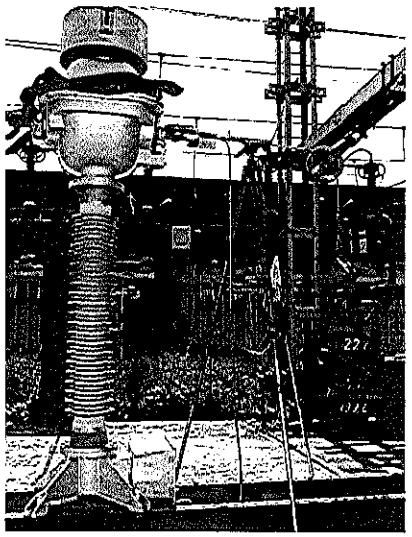
Phot. 1. Longitudinal load of terminal P1



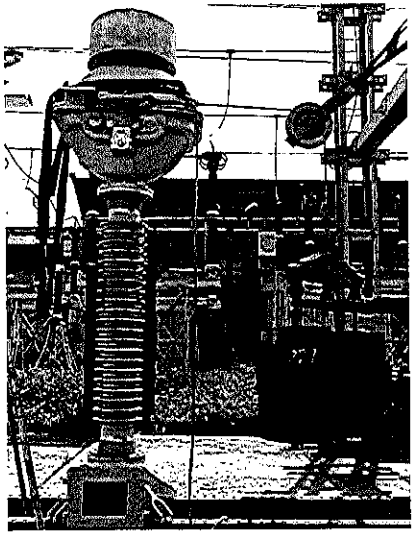
Phot. 2. Transverse load of terminal P1



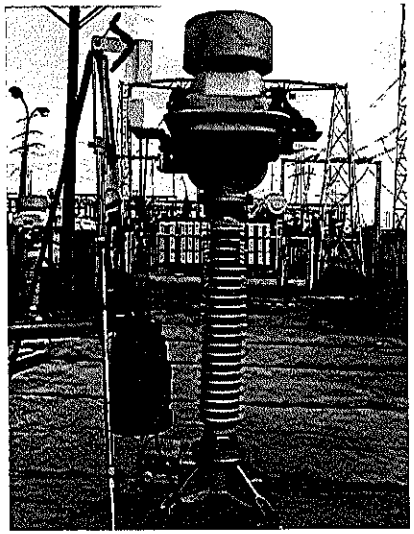
Phot. 3. Vertical load of terminal P1



Phot. 4. Longitudinal load of terminal P2 2000 A

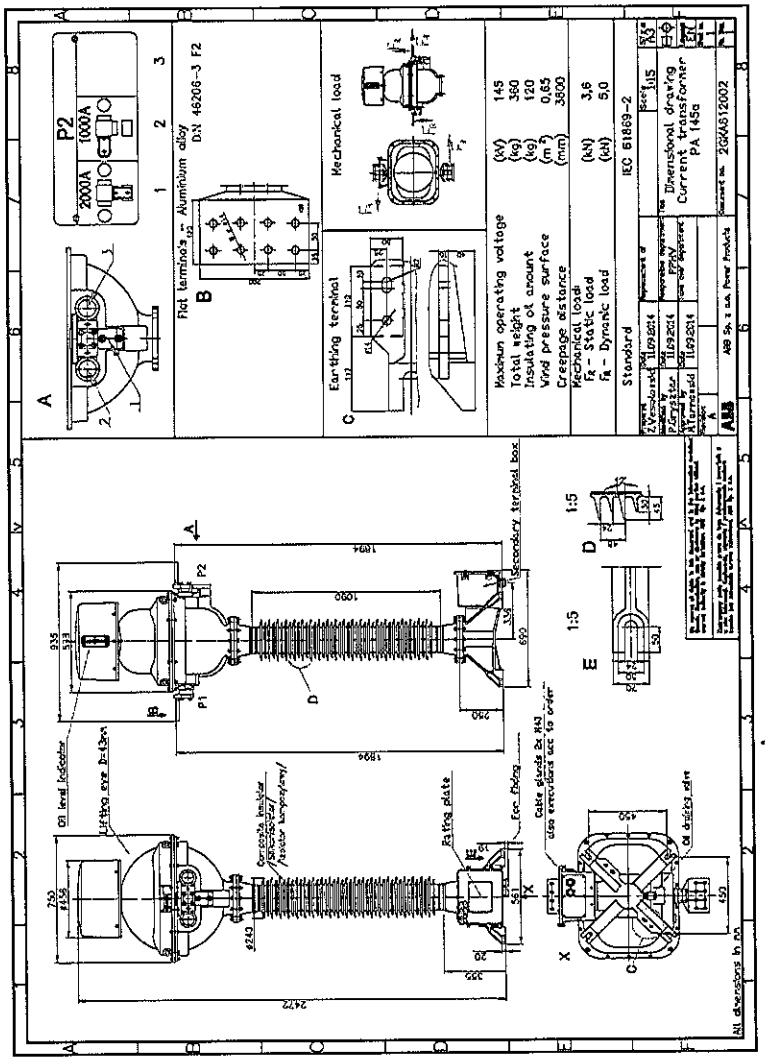


Phot. 5. Transverse load of terminal P2 2000 A



Phot. 6. Vertical load of terminal P2 2000 A

ANNEX 2 **Documentations delivered by orderer**



ABB

Current Transformer

				Type	PA 145a
Insulation level	145/275/650 kV	Standard	PN-EN 61869-2	fn	50 Hz
Oil type	Nytro Libra	Weight / Oil weight	360 / 120 kg	Temp. range	-40°C÷ +40°C
S/N	2GKP014A1287180				

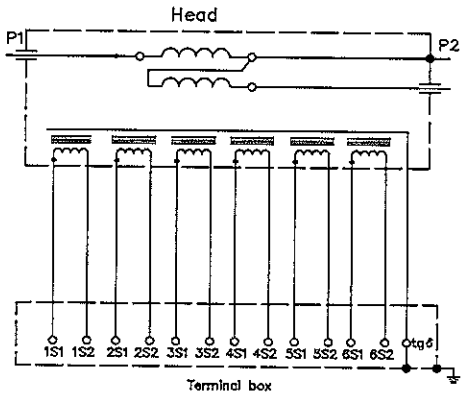
K_n 1000-2000/5-1-1-5-1-1 A/A

I_{th}/1s 63-63 kA I_{dyn} 158-158 kA

I_{cth} 1200-2400 A

	A	VA	Class	FS/ALF	Ext.%
1S1-1S2	5	100	0,2	10	120
2S1-2S2	1	70	0,1	5	120
3S1-3S2	1	35	5P	20	
4S1-4S2	5	15	5P	60	
5S1-5S2	1	30	5P	30	
6S1-6S2	1	10	5P	20	

Transportation Vertical / Horizontal



Instrument transformer electrical diagram

ATTENTION!
1. HIGH VOLTAGE AT OPEN CURRENT SECONDARY TERMINALS XS1 – XS2
2. DURING INSTRUMENT TRANSFORMER OPERATION TERMINAL tgδ MUST BE EARTHED

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tel. +48 22 345-13-86
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TEST REPORT No. EUR/34/E/14-3 E

TEST OBJECT: Current transformer type PA 145a with porcelain insulator
Serial No. 2GKP014A1287182

MANUFACTURER: ABB Sp. z o.o. Division in Przasnysz, ul. Leszno 59, 06-300 Przasnysz

TESTS ORDERED BY: ABB Sp. z o.o., ul. Żegańska 1, 04-713 Warszawa
order No. 4500574872 dated 22.07.2014

TYPE OF TESTS: Mechanical tests

TESTS PROCEDURE: According to IEC 61869-1:2007 p. 7.4.5

DATE OF TESTS: 22.08.2014

TESTS RESULT: Positive for
F_R = 3600 N

Tests result refers only to the test object

THE TESTS WERE WITNESSED BY: -

Test engineer

Tomasz Kaczmarczyk

HEAD OF LABORATORY

Lidia Gruza

Warsaw, 23.09.2014

Contents

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tables	1
photographs	6

1. TEST OBJECT

1.1 Description

Current transformer type PA 145a is used for supplying of measuring and protection circuits in the network of maximum operating voltage 145 kV and frequency 50 Hz. The transformer consists of current transformer mounted housing with porcelain insulator immersed with transformer oil.

1.2 Technical data

The Manufacturer attributed the following construction data to the test object.

Maximum operating voltage	145 kV
Rated frequency	50 Hz
Rated static load	3600 N

1.3 Technical documentation

For the purpose of tests the orderer delivered the following technical documentation:
- dimensional drawing current instrument transformer PA 145a, No. 2GKK612001, 11.09.2014,
- rating plate,
- instrument transformer electrical diagram

prepared by ABB Sp. z o.o. (Annex 2).

The laboratory proceeded the identification of test object on the base of above documentation and the rating plate.

1.4 Preparation for tests

The test object was prepared for test by factory.

2. SCOPE OF TESTS

Test program, agreed with orderer, comprised the following tests according to requirements of IEC 61869-1:2007:
- mechanical tests acc. to item 7.4.5 of above standard for F_R = 3600 N of P1 and P2 150 A terminals.

During the tests deflection of the transformer shall be recorded.

3. TEST AND MEASURING CIRCUITS

For the tests the transformer was fixed to the rigid construction of the test stand. Mechanical tests were performed applying the load consecutively to the transformer's P1 and P2 150 A terminals as shown on photographs in Annex 1.

4. TESTS AND THEIRS DETAILED RESULTS

Tests results presents table 1. The load was increased and released smoothly (30 – 90 s) and was maintained 60 s.

During the tests the following records were made:
- phot. 1 to 6 - current transformer during mechanical tests.

(Annex 1 presents the photographs)

Table 1. Results of static load withstand tests at F = 3620 N

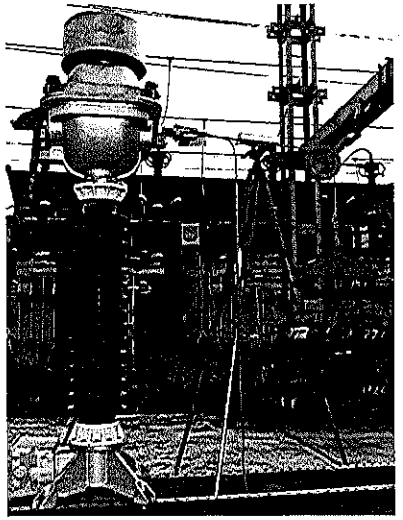
Test No.	Terminal	Load direction	Test time	Observations
-	-	-	s	-
1	P1	longitudinal	60	During the static load deflection was 9,0 mm. Residual deflection was 1,5 mm. After tests no damage nor oil leak was stated.
2	P1	transverse	60	During the static load deflection was 9,7 mm. Residual deflection was 1,6 mm. After tests no damage nor oil leak was stated.
3	P1	vertical	60	During the static load deflection was 3,2 mm. Residual deflection was 0,1 mm. After tests no damage nor oil leak was stated.
4	P2 150 A	longitudinal	60	During the static load deflection was 7,8 mm. Residual deflection was 1,1 mm. After tests no damage nor oil leak was stated.
5	P2 150 A	transverse	60	During the static load deflection was 9,0 mm. Residual deflection was 1,4 mm. After tests no damage nor oil leak was stated.
6	P2 150 A	vertical	60	During the static load deflection was 3,0 mm. Residual deflection was 0,2 mm. After tests no damage nor oil leak was stated.

5. TESTS RESULTS EVALUATION

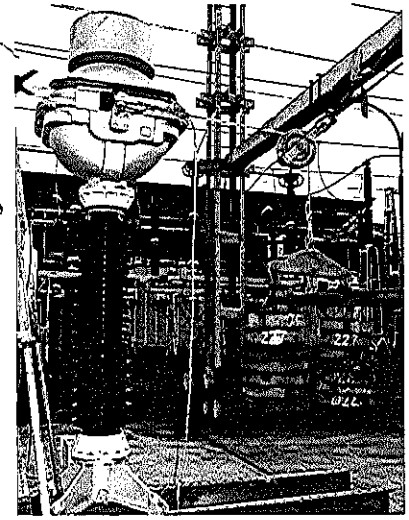
According to criteria given in IEC 61869-1:2007 p. 7.4.5 the results of tests of tested current transformer is positive for:

F_R = 3600 N.

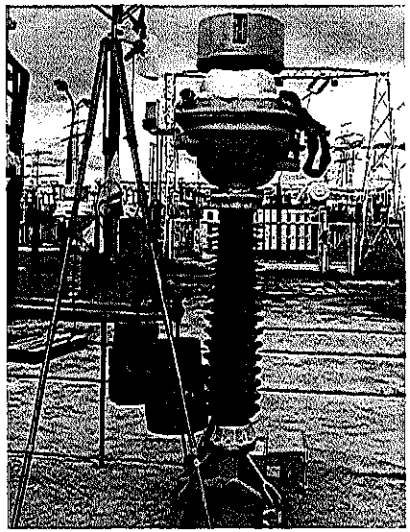
ANNEX 1 **Photographs taken during the tests**



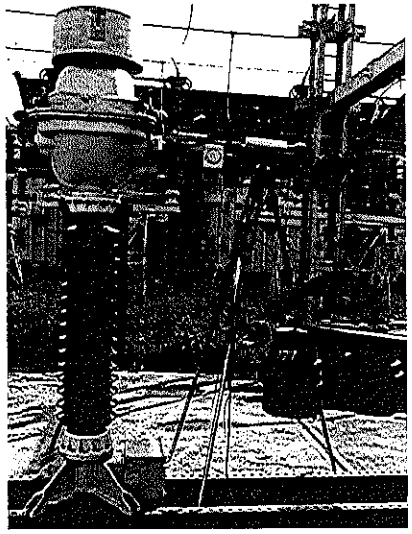
Phot. 1. Longitudinal load of terminal P1



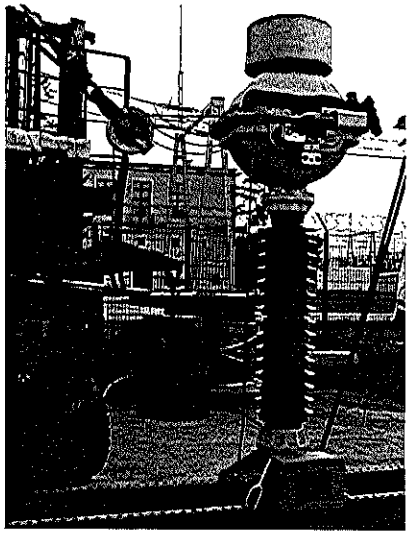
Phot. 2. Transverse load of terminal P1



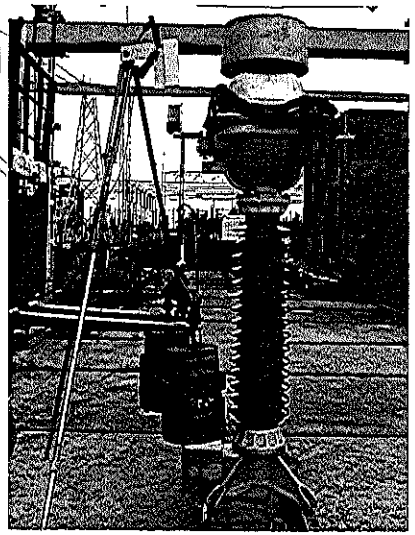
Phot. 3. Vertical load of terminal P1



Phot. 4. Longitudinal load of terminal P2 150 A

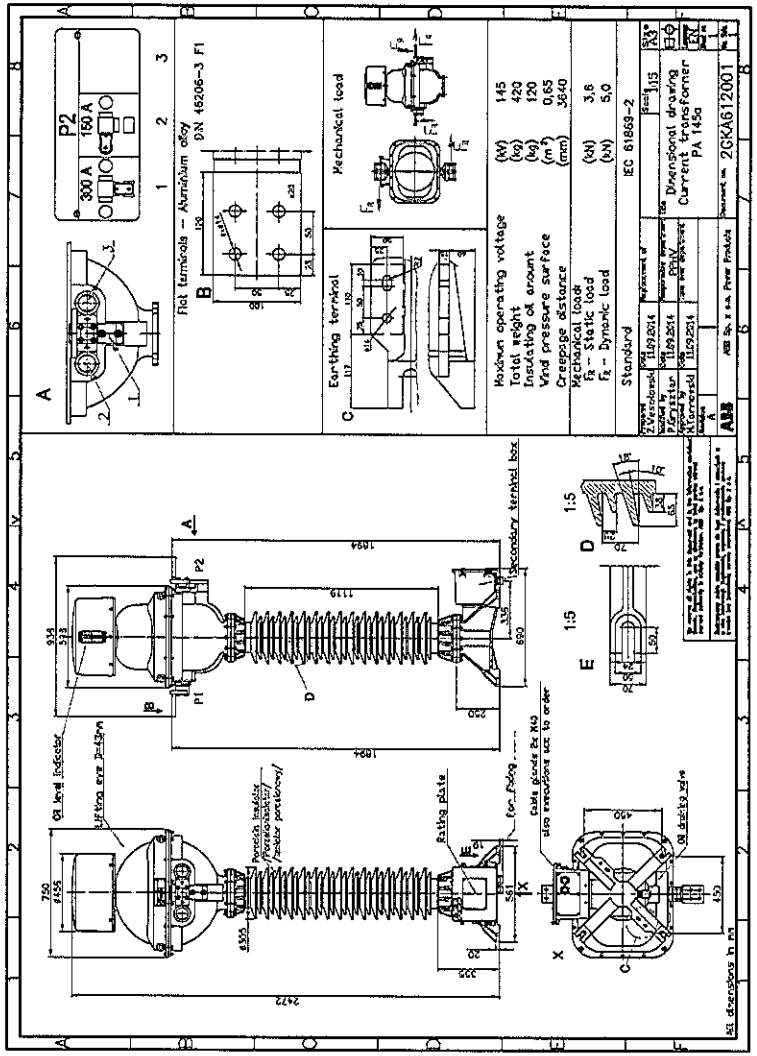


Phot. 5. Transverse load of terminal P2 150 A



Phot. 6. Vertical load of terminal P2 150 A

ANNEX 2 **Documentations delivered by orderer**



ABB

Current Transformer

Type: PA 145a

Insulation level	145/275/650 kV	Standard	PN-EN 61869-2	fn	50 Hz
Oil type	Nytro Libra	Weight / Oil weight	420 / 120 kg	Temp. range	-40°C — +40°C
S/N	2GKP014A1287182				

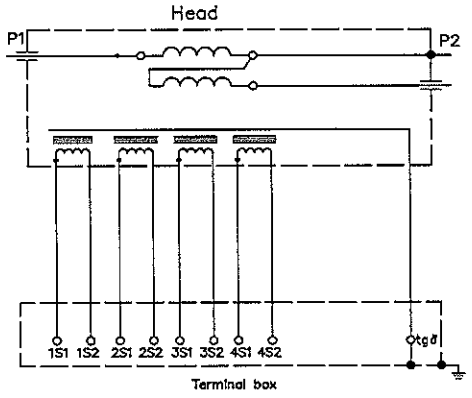
K_n 150-300/5-1-5-1 A/A

I_{th}/1s 20-20 kA I_{dyn} 50-50 kA

I_{cth} 180-360 A

	A	VA	Class	FS/ALF	Ext.%
1S1-1S2	5	30	0,2	5	120
2S1-2S2	1	40	5P	20	
3S1-3S2	5	60	5P	20	
4S1-4S2	1	60	5P	20	
5S1-5S2					
6S1-6S2					

Transportation: Vertical / Horizontal



Instrument transformer electrical diagram

ATTENTION!
1. HIGH VOLTAGE AT OPEN CURRENT SECONDARY TERMINALS XS1 – XS2
2. DURING INSTRUMENT TRANSFORMER OPERATION TERMINAL tgδ MUST BE EARTHED

INSTITUTE OF POWER ENGINEERING
DISTRIBUTION EQUIPMENT LABORATORY

01-330 Warsaw, ul Mory 8
tel.fax. +48 22 836-73-35
tel. +48 22 345-13-86
http://www.ien.com.pl/eur

TEST REPORT No. EUR/34/E/14-4 E

TEST OBJECT: Current transformer type PA 145a with porcclain insulator
Serial No. 2GKP014A1287181

MANUFACTURER: ABB Sp. z o.o. Division in Przasnysz, ul. Leszno 59, 06-300 Przasnysz

TESTS ORDERED BY: ABB Sp. z o.o., ul. Żegańska 1, 04-713 Warszawa
order No. 4500574872 dated 22.07.2014

TYPE OF TESTS: Mechanical tests

TESTS PROCEDURE: According to IEC 61869-1:2007 p. 7.4.5

DATE OF TESTS: 27.08.2014

TESTS RESULT: Positive for
F_R = 3600 N

Tests result refers only to the test object

THE TESTS WERE WITNESSED BY: -

Test engineer

Tomasz Kaczmarczyk

HEAD OF LABORATORY

Lidia Gruza

Warsaw, 23.09.2014

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1. TEST OBJECT

1.1 Description

Current transformer type PA 145a is used for supplying of measuring and protection circuits in the network of maximum operating voltage 145 kV and frequency 50 Hz. The transformer consists of current transformer mounted housing with porcelain insulator immersed with transformer oil.

1.2 Technical data

The Manufacturer attributed the following construction data to the test object.

Maximum operating voltage	145 kV
Rated frequency	50 Hz
Rated static load	3600 N

1.3 Technical documentation

For the purpose of tests the orderer delivered the following technical documentation:
- dimensional drawing current instrument transformer PA 145a, No. 2GKK612003, 11.09.2019,
- rating plate,
- instrument transformer electrical diagram

prepared by ABB Sp. z o.o. (Annex 2).

The laboratory proceeded the identification of test object on the base of above documentation and the rating plate.

1.4 Preparation for tests

The test object was prepared for test by factory.

2. SCOPE OF TESTS

Test program, agreed with orderer, comprised the following tests according to requirements of IEC 61869-1:2007:
- mechanical tests acc. to item 7.4.5 of above standard for F_R = 3600 N of P1 and P2 600 A terminals.

During the tests deflection of the transformer shall be recorded.

3. TEST AND MEASURING CIRCUITS

For the tests the transformer was fixed to the rigid construction of the test stand. Mechanical tests were performed applying the load consecutively to the transformer's P1 and P2 600 A terminals as shown on photographs in Annex 1.

C00091

4. TESTS AND THEIRS DETAILED RESULTS

Tests results presents table 1. The load was increased and released smoothly (30 – 90 s) and was maintained 60 s.

During the tests the following records were made:
- phot. 1 to 6 - current transformer during mechanical tests.

(Annex 1 presents the photographs)

Table 1. Results of static load withstand tests at F = 3620 N

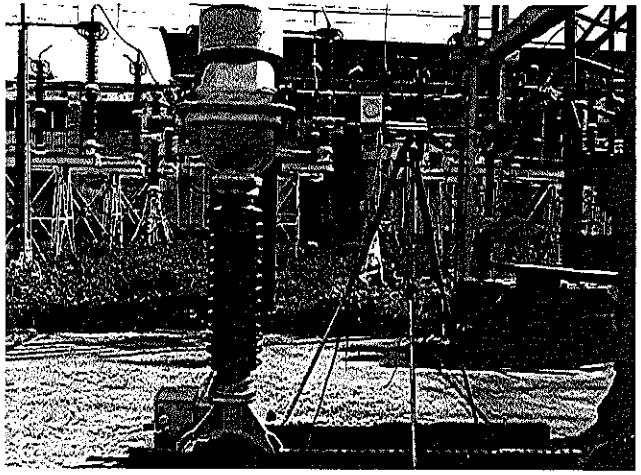
Test No.	Terminal	Load direction	Test time	Observations
-	-	-	s	-
1	P1	longitudinal	60	During the static load deflection was 7,5 mm. Residual deflection was 0,3 mm. After tests no damage nor oil leak was stated.
2	P1	transverse	60	During the static load deflection was 4,3 mm. Residual deflection was 0,8 mm. After tests no damage nor oil leak was stated.
3	P1	vertical	60	During the static load deflection was 3,1 mm. Residual deflection was 0,2 mm. After tests no damage nor oil leak was stated.
4	P2 600 A	longitudinal	60	During the static load deflection was 8,4 mm. Residual deflection was 0,7 mm. After tests no damage nor oil leak was stated.
5	P2 600 A	transverse	60	During the static load deflection was 9,2 mm. Residual deflection was 0,5 mm. After tests no damage nor oil leak was stated.
6	P2 600 A	vertical	60	During the static load deflection was 2,7 mm. Residual deflection was 0,2 mm. After tests no damage nor oil leak was stated.

5. TESTS RESULTS EVALUATION

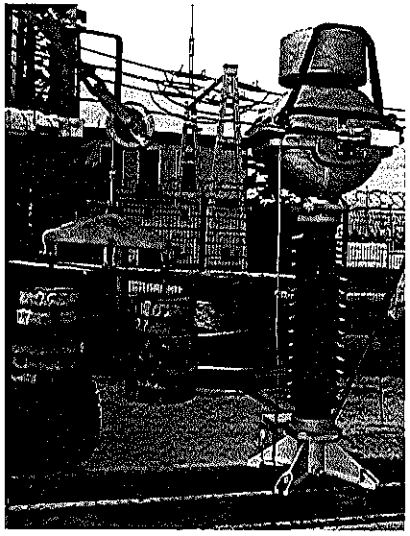
According to criteria given in IEC 61869-1:2007 p. 7.4.5 the results of tests of tested current transformer is positive for:

F_R = 3600 N.

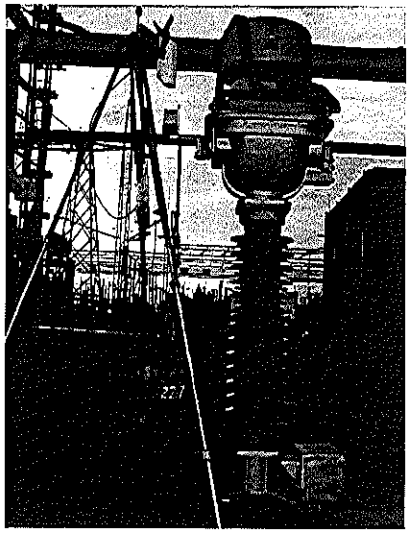
ANNEX 1 **Photographs taken during the tests**



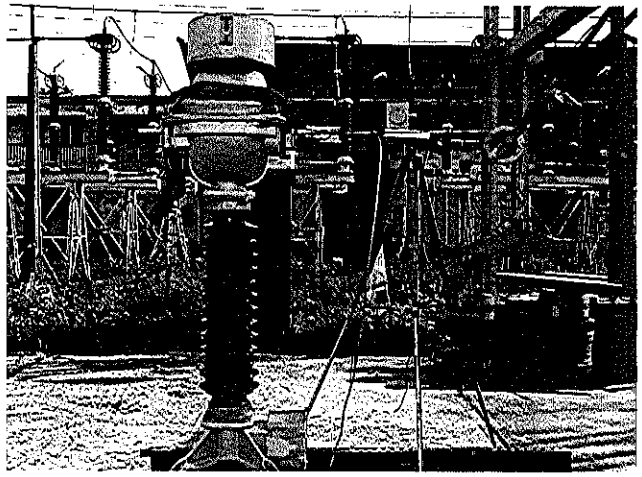
Phot. 1. Longitudinal load of terminal P1



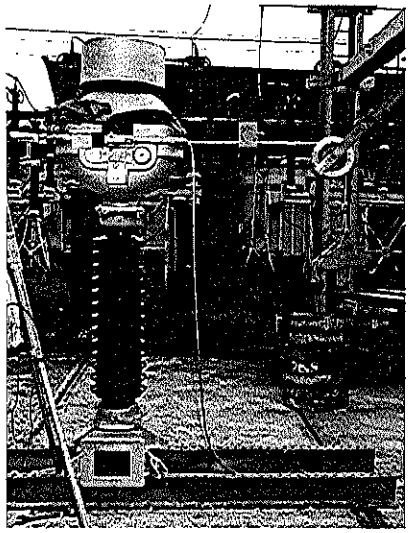
Phot. 2. Transverse load of terminal P1



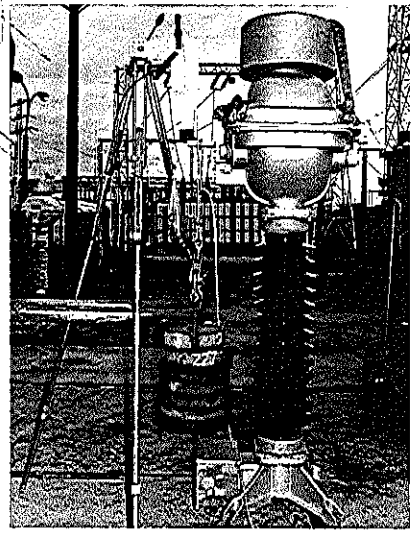
Phot. 3. Vertical load of terminal P1



Phot. 4. Longitudinal load of terminal P2 600 A

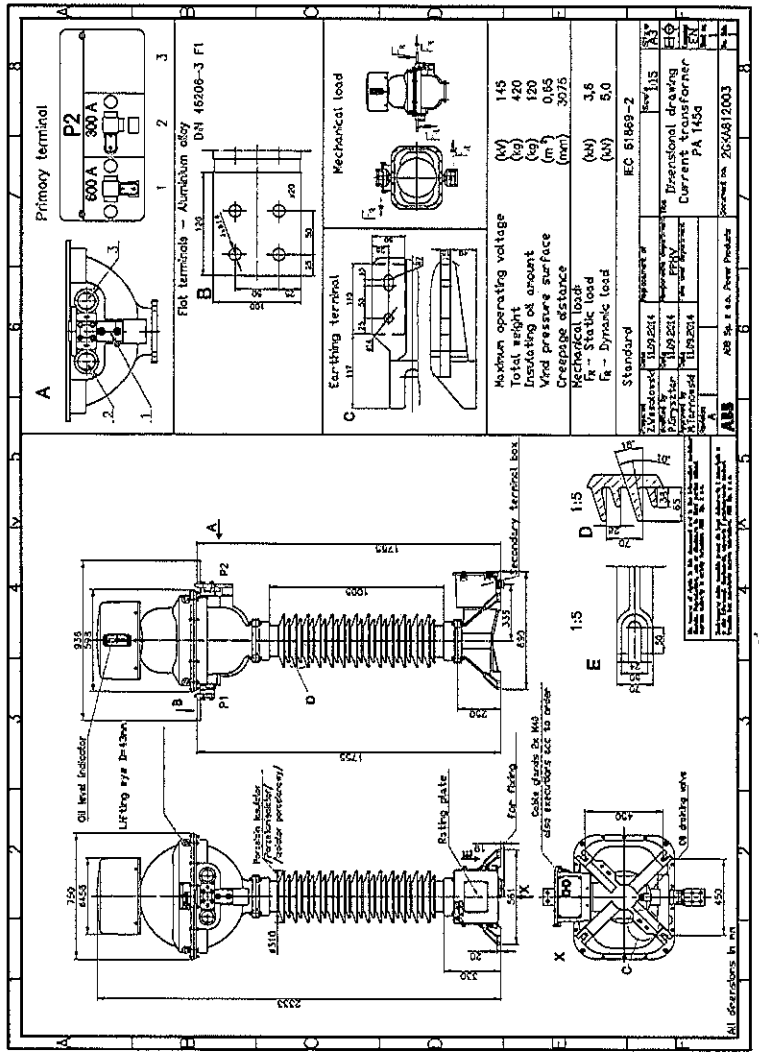


Phot. 5. Transverse load of terminal P2 600 A



Phot. 6. Vertical load of terminal P2 600 A

ANNEX 2 **Documentations delivered by orderer**



ABB

Current Transformer

				Type	PA 145a
Insulation level	145/275/650 kV	Standard	IEC 61869-2	fn	50 Hz
Oil type	Nytro Libra	Weight / Oil weight	420 / 120 kg	Temp. range	-40°C→+40°C
S/N	2GKP014A1287181				

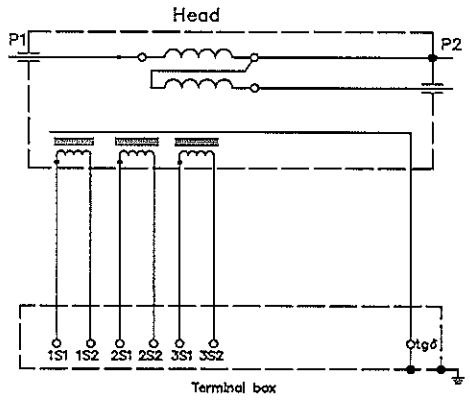
K_n 300-600/5-5-1 A/A

I_{th}/1s 40-40 kA I_{dyn} 100-100 kA

I_{cth} 450-900 A

	A	VA	Class	FS/ALF	Ext.%
1S1-1S2	5	40	0,2	5	150
2S1-2S2	5	60	5P	20	
3S1-3S2	1	120	10P	15	
4S1-4S2					
5S1-5S2					
6S1-6S2					

Transportation: Vertical / Horizontal



Instrument transformer electrical diagram

ATTENTION!
1. HIGH VOLTAGE AT OPEN CURRENT SECONDARY TERMINALS XS1 – XS2
2. DURING INSTRUMENT TRANSFORMER OPERATION TERMINAL tgδ MUST BE EARTHED

C0033

INSTYTUT ENERGETYKI
INSTITUTE OF POWER ENGINEERING
LABORATORIUM WIELKOPRĄDOWE
HIGH CURRENT LABORATORY

01-330 Warszawa
ul. Mory 8
tel. 22 34-51-386
tel./fax 22 836-80-16
e-mail: ewp@ien.com.pl
www.ien.com.pl/ewp

AB 323

RAPORT Z BADAŃ NR EWP/47/E/2014-1

OBIEKT BADAŃ: Przekładnik prądowy typu PA 145a

PRODUCENT: ABB Sp. z o.o. Oddział w Przasnyszu
ul. Leszno 59
06-300 Przasnysz

BADANIA WYKONANO NA ZAMÓWIENIE: ABB Sp. z o.o. Oddział w Przasnyszu
ul. Leszno 59
06-300 Przasnysz
Zamówienie nr 4500574872 z dnia 22.07.2014 r.

RODZAJ BADAŃ: Próba nagrzewania

PROCEDURA BADAŃ: IEC 61869-1:2007, IEC 61869-2:2012, IEC 62271-1:2011, PN-EN 61869-1:2009E, PN-EN 61869-2:2013-06E, PN-EN 62271-1:2009/A1:2011E

DATA OTRZYMANIA OBIEKTU: 23.07.2014

DATA WYKONANIA BADAŃ: 30.07-31.07 2014

WYNIK BADAŃ: Pozytywny dla prądu I_{cth}=1800A (zakres 1500 A)

W BADANIACH UCZESTNICZYŁ:

KIEROWNIK BADAŃ: mgr inż. Mariusz Sul

KIEROWNIK LABORATORIUM: mgr inż. Lidia Gruza

Warszawa, 5.08.2014r.

Spis treści

Raport zawiera 12 stron kolejno numerowanych, w tym:	
1	rysunek
1	fotografia
2	załączniki

1.	Opis obiektu badań
Obiekt badań	Przekładnik prądowy
Typ	PA 145a
Numer fabryczny	2GKP014A1287155
Producent	ABB Sp. z o.o. ul. Leszno 59 06–300 Przasnysz
Rok produkcji	2014
Izolator	Kompozytowy
Liczba uzwojeń	5
Typ oleju	Nytro Libra
Droga upływu	3075 mm
Waga oleju	120 kg
Waga całkowita	360 kg
Wymiary	Wg rys. nr 2GKA614301

Laboratorium dokonało identyfikacji obiektu badań na podstawie dostarczonych dokumentów podanych w p. 3, załącznik nr 1. Badany obiekt pokazano na Fot. 1. Obiekt został przygotowany do prób przez Zleceniodawcę.

2.	Parametry deklarowane przez producenta	
Najwyższe napięcie robocze		145 kV
Częstotliwość znamionowa		50 Hz
Prąd znamionowy cieplny długotrwały, I_{cth}		1800 A
Prąd znamionowy krótkotrwały cieplny, I_{th}/ 1s		63 kA
Prąd znamionowy dynamiczny, I_{dyn}		158 kA

Uzwojenie	Prąd znamionowy uzwojeń	Moc znamionowa uzwojenia	Klasa dokładności	FS/ALF	Ext.%
1S1-1S2	5 A	200 VA	0,2	10	120
2S1-2S2	1 A	100 VA	0,1	5	120
3S1-3S2	5 A	20 VA	5P	60	
4S1-4S2	1 A	35 VA	10P	40	
5S1-5S2	1 A	40 VA	10P	20	

3.	Dokumentacja techniczna obiektu badań
1.	Rysunek nr 2GKA614301 – Rysunek wymiarowy. „Przekładnik prądowy PA 145", ABB Sp. z o.o. Power Products, zatwierdzony 01.08.2014
2.	Rysunek nr 2GKK314141 –„Tor prądowy, pręt 40 Cu, rura 60x4 Al. 3600A", ABB Sp. z o.o. Power Products, zatwierdzony 24.06.2014
3.	Protokół sprawdzania przekładnika prądowego, typ PA 145, Nr fabr.: 2GKP014A1287155, ABB Sp. z o.o., Przasnysz, 16.07.2014

4.	Zakres badań

Uzgodniony ze Zleceniodawcą program badań obejmował:

Lp.	Rodzaj badań	Badania wg wymagań normy		Miejsce wykonania badań
1.	Sprawdzenie nagrzewania	IEC 61869-1:2007 p. 6.4 i 7.2.2, IEC 61869-2:2012 p.6.4.1 i 7.2.2.204 IEC 62271-1:2011, tablica 3	A	EWP

EWP	Badanie wykonane w Instytucie Energetyki przez Laboratorium Wielkoprądowe.
A	Metoda badań akredytowana przez Polskie Centrum Akredytacji. Certyfikat akredytacji nr AB 323.

5. Przebieg prób i ich wyniki

Próba wg IEC 61869-1 p. 6.4 i p. 7.2.2; IEC 61869-2 p.6.4.1 i 7.2.2.204. Przekładnik prądowy został zainstalowany na stanowisku probierczym tak jak w eksploatacji. Zasilanie doprowadzono do zacisków pierwotnych P1- P2/A.
Uzwojenia wtórne obciążono mocami: 1S1-1S2 ⇒ 200 VA, cos φ = 1; 2S1-2S2 ⇒ 100 VA, cos φ = 1; 3S1-3S2 ⇒ 20 VA, cos φ = 1; 4S1-4S2 ⇒ 35 VA, cos φ = 1; 5S1-5S2 ⇒ 40 VA, cos φ = 1.

Uzwojenie pierwotne prądowe P1 i P2/A zwarto na zakresie 1500 A. Na życzenie Zleceniodawcy prąd w uzwojeniu pierwotnym członu prądowego podczas prób był równy I_{cth} = 1800 A.
Próbę wykonywano do ustalenia się temperatur.

Przyrost temperatury uzwojeń mierzono metodą przyrostu rezystancji i obliczano z zależności:

$$\Delta T = \frac{R}{R_0 \alpha} = \frac{R_1 - R_0}{R_0 \cdot 0{,}004}$$

Podczas próby, co 1 h wykonywano pomiary rezystancji obciążanych uzwojeń, odczytywano wychylenie wskaźnika poziomu oleju i wskazania termoelementów. Rozmieszczenie termoelementów pokazano na Rys. 1.

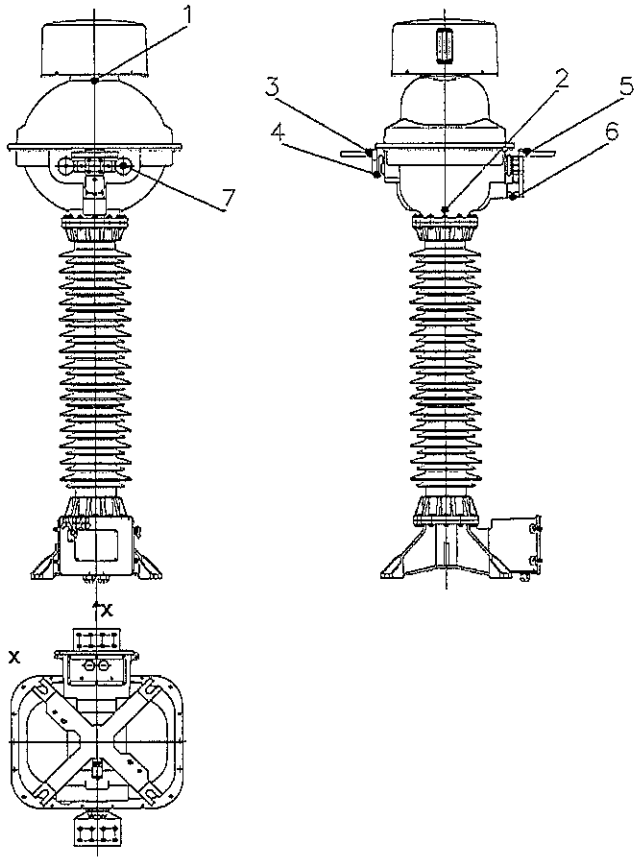
Wyciąg z protokołu nagrzewania podano w Tablicy 1. Zestawienie wyników badań podano w Tablicy 2.

Aparatura pomiarowa

Pomiary temperatury wykonywano termoelementami typu K (NiCr-NiAl) – niepewność pomiaru ± 0,3°C[1].
Temperaturę otoczenia mierzono termometrami rtęciowymi umieszczonymi w oleju, rozmieszczonymi w odległości 1 m wokół obiektu badań, na wysokości 1 m nad podłogą - niepewność pomiaru ± 0,3°C[1].
Pomiary rezystancji wykonano przy użyciu miernika typu 2291 produkcji Tettex – niepewność pomiaru 0,001 mΩ[1]

[1] Podane wartości niepewności stanowią niepewności rozszerzone przy poziomie ufności ok. 95 % i współczynniku rozszerzenia $k = 2$.

INSTYTUT ENERGETYKI
LABORATORIUM WIELKOPRĄDOWE
Raport z badań nr
EWP/47/E/2014-1



Rys. 1. Rozmieszczenie termoelementów podczas próby nagrzewania:
1 – olej (nad cewką prądową), 2 – głowica (przewężenie nad flangą łączącą głowicę z izolatorem), 3 – zacisk P1 (u podstawy płetwy zacisku), 4 – zacisk P1 (u podstawy zacisku stałego), 5 – zacisk P2/A (u podstawy płetwy zacisku), 6 – zacisk P2/A (u podstawy zacisku stałego), 7 – termopara wewnątrz przekładnika w torze prądowym 3000 A.

Tablica 1. Wyniki próby nagrzewania przekładnika kombinowanego PA 145a, nr fabr. 2GKP014A1287155

Nr termo-elementu	Czas nagrzewania [h]																					
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
ΔT 1, K	-	2,2	7,8	13,7	18,0	20,8	22,6	24,8	26,6	28,0	29,2	30,3	31,2	31,8	32,5	33,2	33,6	34,1	34,6	35,0	35,3	35,8
ΔT 2, K	-	4,3	8,4	11,9	14,6	16,6	18,0	19,7	21,0	21,7	22,8	23,6	24,3	24,8	25,4	26,0	26,4	26,8	27,2	27,4	27,6	27,9
ΔT 3, K	-	23,2	28,6	31,5	33,0	34,5	35,3	36,7	37,2	37,8	38,5	39,0	39,5	39,8	40,2	40,6	40,7	41,0	41,2	41,5	41,6	41,6
ΔT 4, K	-	28,1	33,6	36,7	38,5	40,2	41,5	43,2	43,7	44,6	45,4	46,2	46,5	47,2	47,4	48,0	48,3	48,7	49,1	49,3	49,6	49,6
ΔT 5, K	-	18,9	24,9	28,4	30,2	31,7	32,5	33,9	34,5	34,9	35,7	36,1	36,5	36,7	37,0	37,5	37,6	38,0	38,3	38,4	38,7	38,8
ΔT 6, K	-	20,5	26,6	30,2	32,4	34,2	35,2	36,8	37,3	38,1	38,7	39,4	39,8	40,2	40,6	40,9	41,1	41,6	41,7	42,0	42,3	42,3
ΔT 7, K	-	15,5	21,9	26,7	29,9	32,7	34,6	36,9	38,2	39,5	40,7	41,7	42,5	43,4	44,0	44,7	45,2	45,8	46,3	46,7	47,1	47,4
T_{otf}, °C	23,5	23,8	24,4	25,0	25,2	25,4	25,9	25,7	25,8	25,9	26,0	26,0	26,1	26,1	26,2	26,2	26,3	26,3	26,3	26,4	26,4	26,5
$R_{151-152}$ mΩ	456,16	464,59	470,27	477,78	485,33	493,04	499,86	506,57	513,30	518,85	524,43	529,73	533,95	538,40	542,29	545,68	548,90	551,77	554,33	556,79	559,01	561,03
$R_{251-252}$ Ω	5,5170	5,5999	5,6680	5,7649	5,8571	5,9507	6,0409	6,1256	6,2065	6,2819	6,3514	6,4180	6,4736	6,5272	6,5784	6,6199	6,6608	6,6984	6,7309	6,7621	6,7909	6,8160
$R_{351-352}$ mΩ	594,58	605,83	613,91	623,22	633,06	642,73	652,00	660,94	669,79	677,38	684,75	691,84	697,03	702,99	708,27	712,54	716,84	720,86	724,22	727,58	730,37	733,36
$R_{451-452}$ Ω	5,7350	5,7923	5,8617	5,9541	6,0492	6,1462	6,2402	6,3307	6,4152	6,4934	6,5667	6,6349	6,6943	6,7507	6,8024	6,8469	6,8887	6,9274	6,9611	6,9945	7,0227	7,0507
$R_{551-552}$ Ω	6,0568	6,1347	6,2117	6,3102	6,4123	6,5140	6,6128	6,7085	6,7957	6,8779	6,9536	7,0248	7,0863	7,1449	7,2000	7,2454	7,2885	7,3288	7,3644	7,3990	7,4288	7,4580
$R_{P1-P2/A}$ mΩ (zakres 1500 A)	0,0657	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
$\Delta T_{151-152}$, K	-	4,6	7,7	11,8	16,0	20,2	24,0	27,6	31,3	34,4	37,4	40,3	42,6	45,1	47,2	49,1	50,8	52,4	53,8	55,2	56,4	57,5
$\Delta T_{251-252}$, K	-	3,8	6,8	11,2	15,4	19,7	23,7	27,6	31,2	34,7	37,8	40,8	43,3	45,8	48,1	50,0	51,8	53,5	55,0	56,4	57,7	58,9
$\Delta T_{351-352}$, K	-	4,7	8,1	12,0	16,2	20,2	24,1	27,9	31,6	34,8	37,9	40,9	43,1	45,6	47,8	49,6	51,4	53,1	54,5	55,9	57,1	58,4
$\Delta T_{451-452}$, K	-	2,5	5,5	9,6	13,7	17,9	22,0	26,0	29,7	33,1	36,3	39,2	41,8	44,3	46,5	48,5	50,3	52,0	53,4	54,9	56,1	57,4
$\Delta T_{551-552}$, K	-	3,2	6,4	10,5	14,7	18,9	22,9	26,9	30,5	33,9	37,0	40,0	42,5	44,9	47,2	49,1	50,8	52,5	54,0	55,4	56,6	57,8
Wychylenie wskaźnika oleju, mm	0	2	4	5	8	10	13	15	18	21	23	25	26	27	29	30	31	32	32	33	33	33
$I_{151-151}$, A	0	6,05	6,06	6,04	6,03	6,05	6,05	6,00	6,04	6,06	6,04	6,04	6,03	6,04	6,04	6,05	6,05	6,03	6,03	6,03	6,03	6,03
$I_{P1-P2/A}$, kA	0	1,815	1,818	1,810	1,806	1,812	1,816	1,801	1,809	1,819	1,815	1,809	1,804	1,806	1,806	1,809	1,809	1,807	1,803	1,803	1,805	1,805

Tablica 1. cd.

Tablica 1. Wyniki próby nagrzewania przekładnika kombinowanego PA 145a, nr fabr. GKP014A1287155

Nr termo-elementu	Czas nagrzewania [h]				
	22	23	24	25	26
ΔT 1, K	36,1	36,1	36,5	36,6	37,1
ΔT 2, K	28,2	27,8	28,1	28,2	28,5
ΔT 3, K	42,0	42,1	42,2	42,1	42,4
ΔT 4, K	50,0	50,3	50,3	50,5	50,8
ΔT 5, K	38,9	39,1	39,2	39,2	39,5
ΔT 6, K	42,4	42,6	43,1	43,2	43,6
ΔT 7, K	47,7	47,8	48,2	48,3	48,8
T_{otf}, °C	26,5	26,6	26,8	27,0	27,1
$R_{151-152}$ mΩ	563,10	565,09	566,66	567,97	569,32
$R_{251-252}$ Ω	6,8419	6,8629	6,8853	6,9064	6,9209
$R_{351-352}$ Ω	735,81	738,66	741,07	743,13	745,24
$R_{451-452}$ mΩ	7,0754	7,0989	7,1208	7,1417	7,1608
$R_{551-552}$ Ω	7,4834	7,5095	7,5322	7,5530	7,5748
$R_{P1-P2/A}$ mΩ (zakres 1500 A)	-	-	-	-	0,0881
$\Delta T_{151-152}$, K	58,6	59,7	60,6	61,3	62,0
$\Delta T_{251-252}$, K	60,0	61,0	62,0	63,0	63,6
$\Delta T_{351-352}$, K	59,4	60,6	61,6	62,5	63,3
$\Delta T_{451-452}$, K	58,4	59,5	60,4	61,3	62,2
$\Delta T_{551-552}$, K	58,9	60,0	60,9	61,8	62,7
Wychylenie wskaźnika oleju, mm	34	34	34	35	35
$I_{151-151}$, A	6,05	6,01	6,04	6,05	6,04
$I_{P1-P2/A}$, A	1,809	1,803	1,807	1,807	1,807

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Tablica 2. Przyrosty temperatur uzyskane podczas próby nagrzewania przekładnika PA 145a nr fabr. 2GKP014A1287155

Uzwojenie	ΔT [K]	ΔT_{dop} [K]
1S1-1S2	62,0	65 [1), 2)]
2S1-2S2	63,6	
3S1-3S2	63,3	
4S1-4S2	62,2	
5S1-5S2	62,7	

Nr termo-elementu	Miejsce pomiaru termoelementem	ΔT [K]	ΔT_{dop} [K]
1	Olej	37,1	55 [1), 2)]
2	Głowica (przewężenie nad flangą łączącą głowicę z izolatorem)	28,5	40 [3)]
3	Zacisk P1 (u podstawy płetwy zacisku)	42,4	65 [3)]
4	Zacisk P1 (u podstawy zacisku stałego)	50,8	
5	Zacisk P2/A 3000A (u podstawy płetwy zacisku)	39,5	
6	Zacisk P2/A 3000A (u podstawy zacisku stałego)	43,6	
7	Tor prądowy 3000 A	48,8	65 [1), 2)]

[1)] wg IEC 61869-1, [2)] wg IEC 61869-2, [3)] wg IEC 62271-1,
ΔT - przyrost temperatury; ΔT_{dop} – wartość dopuszczalna w stanie ustalonym

6. Podsumowanie

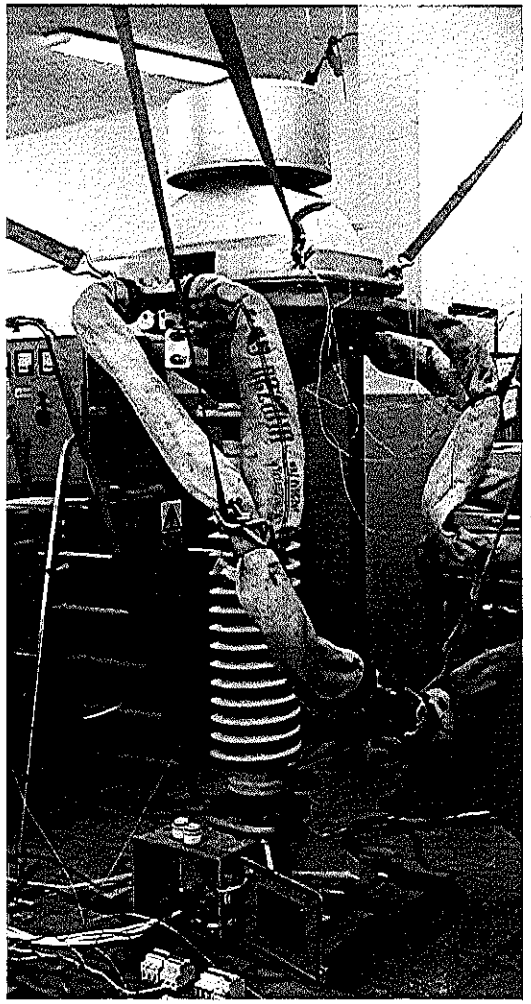
W badanym przekładniku prądowym typu PA 145a z izolatorem kompozytowym, w wyniku próby nagrzewania prądem I_{cth}= **1800 A** na zakresie 1500 A, nie stwierdzono przekroczenia dopuszczalnych przyrostów temperatur. Badany przekładnik spełnił wymagania norm: IEC 61869-1:2007, IEC 61869-2:2012 i IEC 62271-1:2011.

7. Opinie i interpretacje

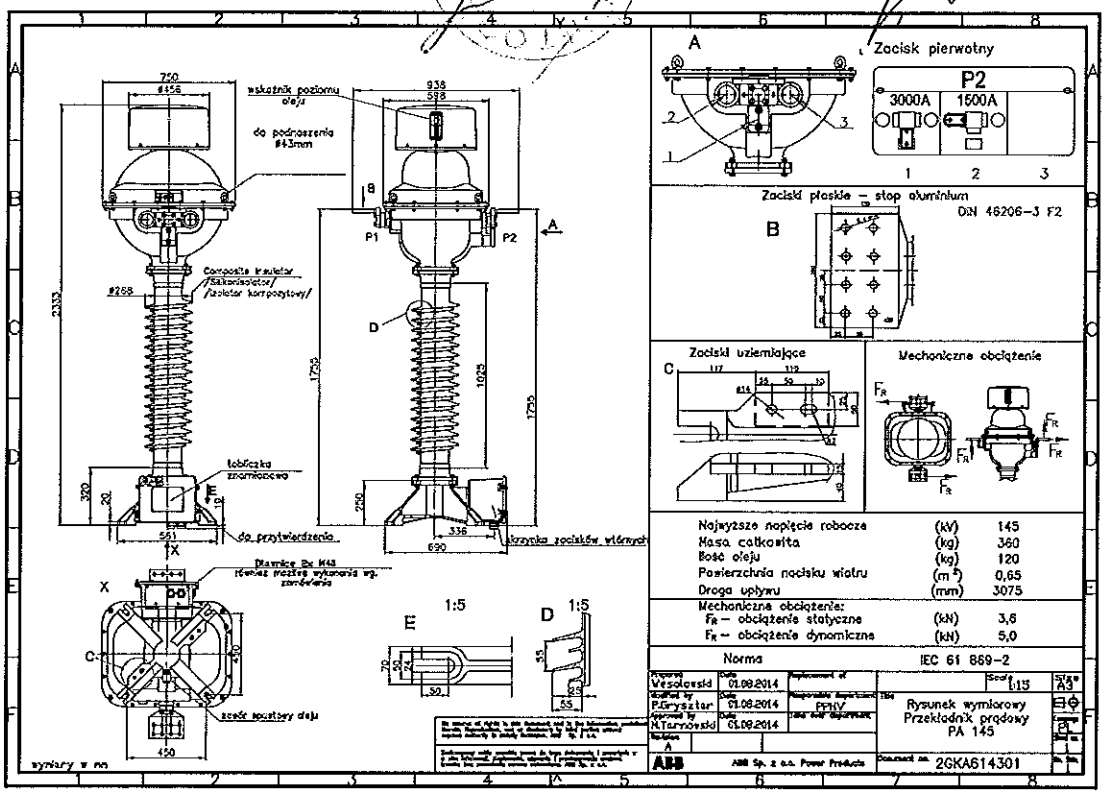
Brak

INSTYTUT ENERGETYKI
LABORATORIUM WIELKOPRĄDOWE
Raport z badań nr EWP/47/E/2014-1

8. Dokumentacja fotograficzna

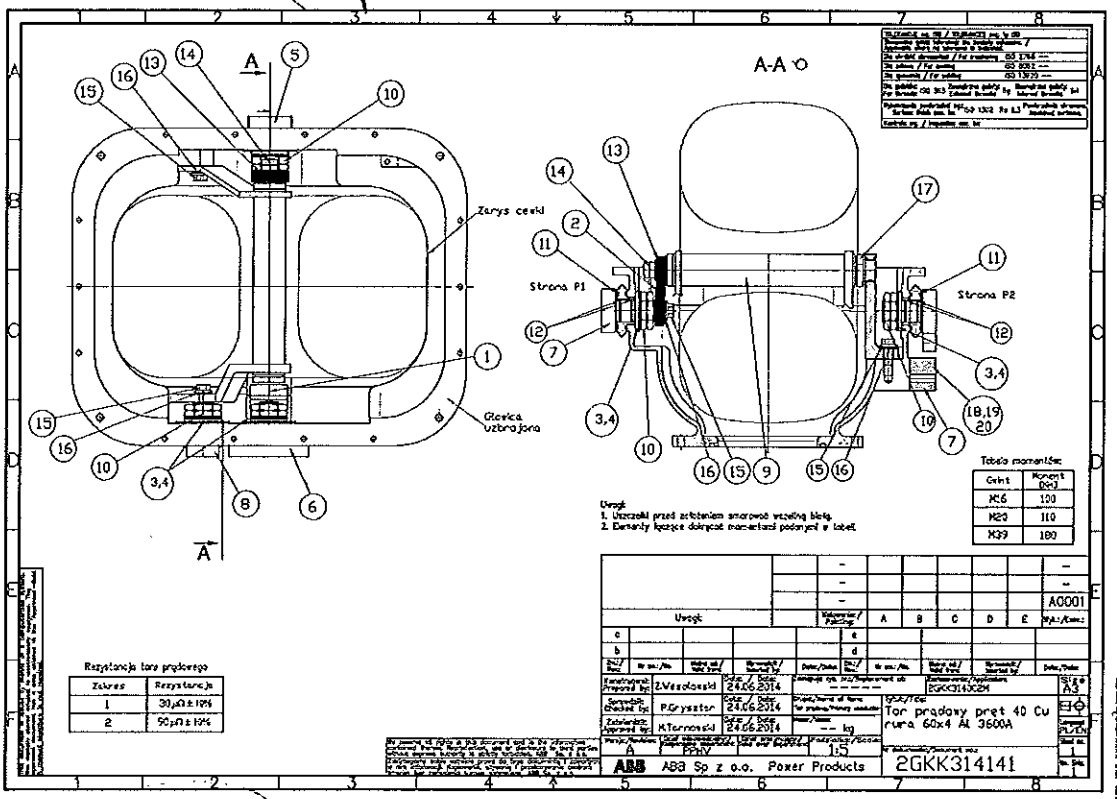


Fot. 1. Przekładnik prądowy na stanowisku probierczym podczas próby nagrzewania



Strona 11 / 12

Załącznik nr 1.



Strona 12 / 12

Załącznik nr 2.

HIGH VOLTAGE LABORATORY
INSTYTUTU ENERGETYKI
01-330 WARSZAWA, ul. Mory 8, tel. (22)3451242
tel. fax. 836-80-48, e-mail: ewn@ien.com.pl

APPENDIX 1 for test report EWN/11/E/12-2

Documents provided by ABB Sp. z o.o. used as base of identification of test object:

- Manufacturer Conformity Declaration
- Dimension drawing No. 2GKA614117 (19.01.2012)
- Electric diagram of Current instrument transformer
- Drawing of rated nameplate

DECLARATION OF CONFORMITY No. 001/PA_IEN/2012
(acc. to ISO/IEC 17050-1)

Manufacturer: ABB Sp. z o.o. Dept. in Przasnysz

Address: Str. Leszno 59
06-300 Przasnysz / POLAND

Product: Current transformer type PA 123/145

Above mentioned product comforms with the following standard :

Standard	Title	Edition/Date
IEC 60044 - 1	Current transformers	1.2 / Feb. 2003

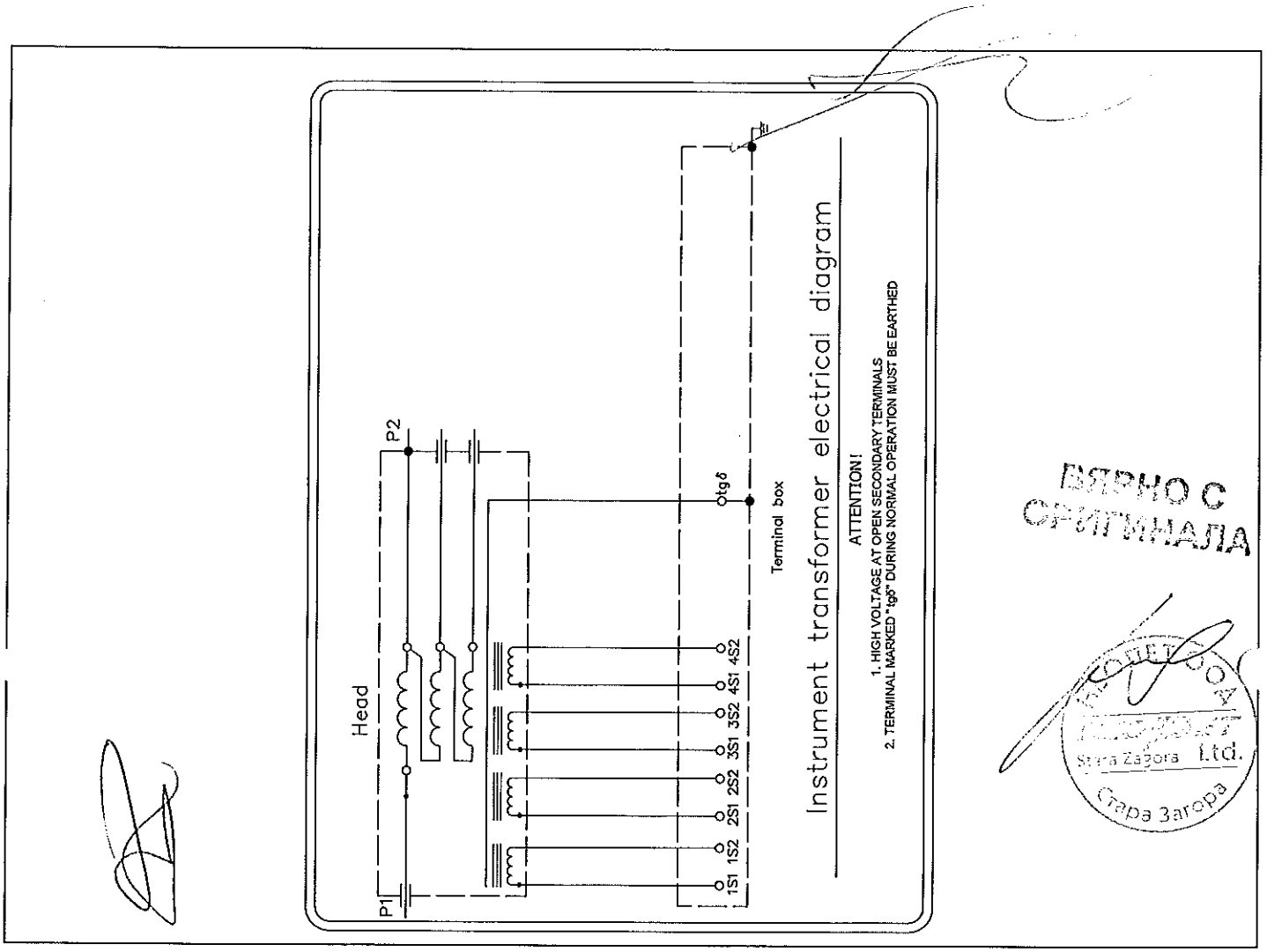
Additional information:
Serial numbers: **2GKP011A1084700; 2GKP011A1084701; 2GKP011A1084704; 2GKP011A1084705.**

Place and date of issue of declaration

Przasnysz 02.04.2012.

Dyrektor Lokalnej Jednostki Biznesu Wysokich Napięć ABB Sp. z o.o. Paweł Radecki

(Name) (Signature)



ВЕРНО С ОРИГИНАЛА

Стара Загора Ltd.

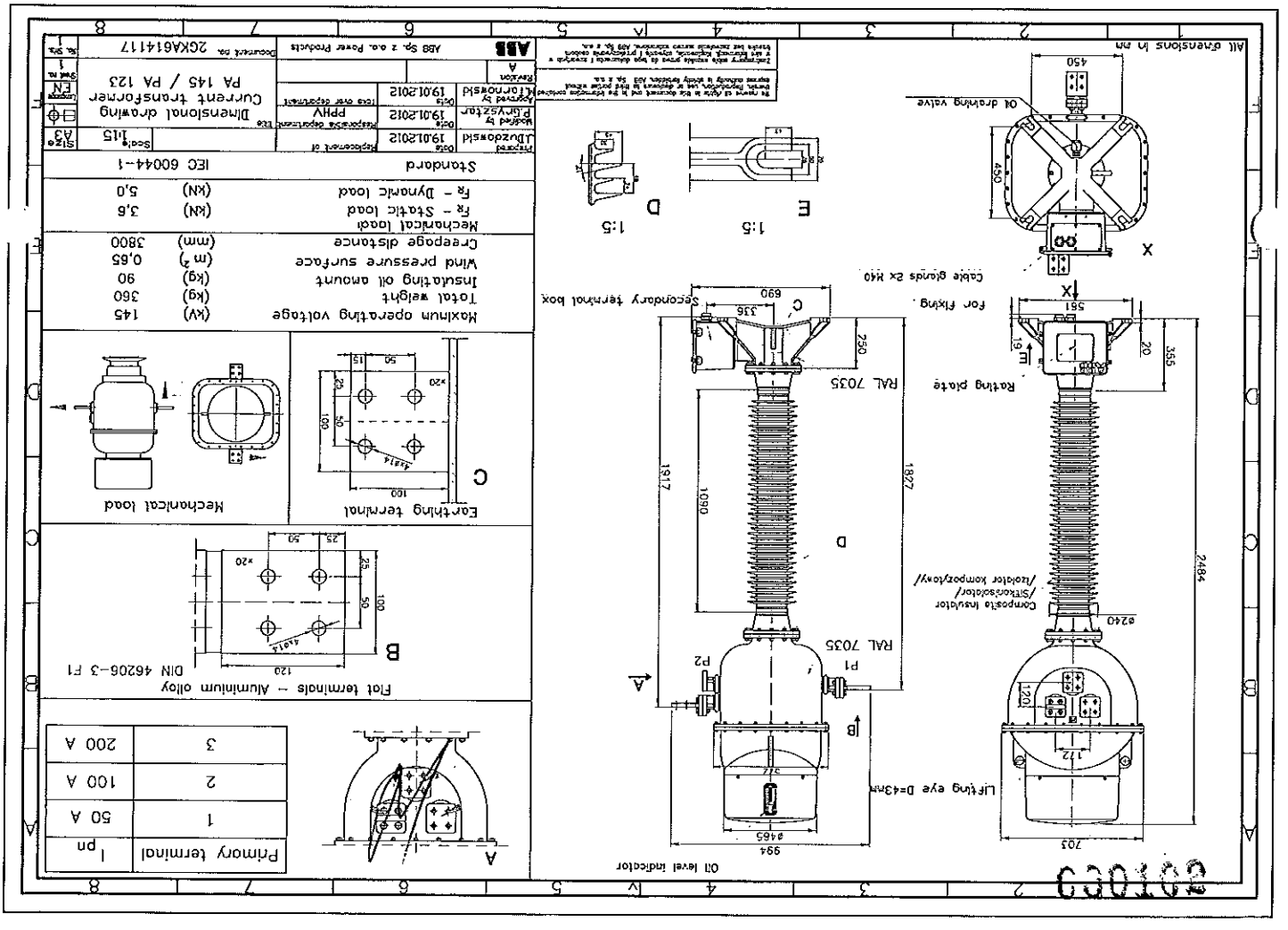


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ABB

Current Transformer

Insulation level	145/275/650 kV	Standard	IEC 60044-1	fn	50 Hz
Oil type	Nytro Libra	Weight / oil	360 / 90 kg	Temp. range	-40°C → +40°C
SN	84700 / 11				

Type: PA 145

K_n: 50-100-200/5-1-5-1 A/A

$I_{th}/1s$: 40-50-50 kA I_{dyn}: 100-125-125 kA

I_{cth}: 100-200-400 A

	1S1-1S2	2S1-2S2	3S1-3S2	4S1-4S2	5S1-5S2	6S1-6S2
A	5	1	5	1		
VA	5	5	10	10		
Cl.	0,5	0,5	5P	5P		
FS/ALF	5	5	10	10		
Ext.%	200	200				

Transportation: Vertical / Horizontal

Стара Загора
Stara Zagora Ltd.

ВЯРНО С ОРИГИНАЛА

000103

HIGH VOLTAGE LABORATORY
INSTYTUTU ENERGETYKI
01-330 WARSZAWA, ul. Mory 8, tel. (22)3451242
tel. fax. 836-80-48, e-mail: ewn@ien.com.pl

APPENDIX 2 for test report EWN/11/E/12-2

Reports of routine test and determination of errors of current transformer type PA 123 performed in Factory Laboratory of ABB sp. z o.o.

- Tests before type test and special test (Measurements before type test and special tests) - 2GKP011A1084700 – 19.01.2012,
- Tests after type test and special tests completed (Measurements after type test and special test completed) - 2GKP011A1084700 – 26.03.2012.

ABB Sp. z o.o. 06-300 Przasnysz ul. Leszno 59	Routine test report of current transformer (before type tests)	TYPE: PA 123 / PA 145 Serial no: 2GKP011A1084700

Ith 1s [kA]:	Idyn [kA]:	Icth [A]:	Insulation level:	IEC 60044-1
40-50-50	100-125-125	100-200-400	145/275/650 kV	50 Hz

Winding	Isn [A]	Sn [VA]	class	Rated ratio [A/A]
1S1-1S2	5	5	0,5FS 5	50-100-200/5
2S1-2S2	1	5	0,5FS 5	50-100-200/1
3S1-3S2	5	10	5P 10	50-100-200/5
4S1-4S2	1	10	5P 10	50-100-200/1

List of performed tests:

1. Oil dielectric parameters check before transformer filling (oil after treatment): tg δ : IEC 60247, breakdown voltage : IEC 60156 ☑
2. Verification of terminal markings ☑
3. Oil tightness test: oil overpressure: 0,8 bar / 24h – no traces of oil leakage ☑
4. Power-frequency withstand test on primary windings - Up = 275 kV, f = 50Hz ☑
5. Partial discharge measurement ☑
6. Power-frequency withstand test on secondary windings - Up = 3 kV/60s, f = 50Hz ☑
7. Inter-turn overvoltage test for current transformers - lower value (U peak=4,5kV or U peak at Icth) / 60s ☑
8. Determination of errors ☑
9. Verification of secondary limiting e.m.f. (check of instrument security factor (FS) and accuracy limit factor (ALF)) ☑
10. Measurement of secondary windings insulation resistance (1kV DC) - R >= 100 MΩ ☑
11. Measurement of primary windings insulation resistance (2,5kV DC) - R >= 3000 MΩ ☑
12. Measurement of capacitance and dielectric dissipation factor - tg δ ☑
13. Determination of core magnetization characteristics ☑
14. Measurement of windings' resistance ☑

Oil dielectric parameters check before transformer filling (oil after treatment)

- Measurement of oil tg δ according to IEC 60247
  tg δ = 0.08 %; electrical stress = 1kV/mm, f = 50Hz, oil temp. = 90°C ±1°C

- Measurement of oil breakdown voltage according to IEC 60156
  Mean breakdown voltage = 81.43 kV, Relative standard deviation = 5.07 %;
  f = 50Hz, oil temp. = 25 °C, measurement with the stirrer, type of electrodes used: partially spherical.

Sample	Breakdown voltage [kV]
1	83.9
2	85.2
3	77.8
4	86.2
5	78.7
6	76.8

Partial discharge measurement

- Measurement according to procedure A
  (PD test voltages were reached while decreasing the voltage after the power-frequency withstand test on primary windings)
  Stress voltage: 275 kV / 60 s
  Frequency: 50 Hz

Test voltage	1,2 Um = 174 kV	1,2 Um / √3 = 100.5 kV
Level of partial discharge	2.5 pC	2.7 pC

Remarks: background noise level: 1.6 pC (measured after voltage switch off), measuring circuit was calibrated with 5pC (calibrating charge)

Inter-turn overvoltage test for current transformers

Winding	Peak voltage on secondary winding [kVpeak]	Current in primary winding [A]
1S1-1S2	0.128	400
2S1-2S2	0.608	400
3S1-3S2	0.256	400
4S1-4S2	1.12	400

Determination of errors (ΔI%), (δI min), cos φ = 0,8 lagging (cos φ= 1 for S < 5VA)

Ipn (A): 50

1S1-1S2: 5 VA	0,05 In	0,2 In	1,0 In	2,0 In
ΔI	-0.845	-0.584	-0.089	0.071
δI	30.0	14.4	-1.2	-3.9

1S1-1S2: 1.25 VA	0,05 In	0,2 In	1,0 In	2,0 In
ΔI	0.242	0.218	0.247	0.282
δI	22.7	17.4	8.6	5.6

2S1-2S2: 5 VA	0,05 In	0,2 In	1,0 In	2,0 In
ΔI	-0.645	-0.412	0.013	0.166
δI	27.1	13.7	0.6	-1.8

2S1-2S2: 1.25 VA	0,05 In	0,2 In	1,0 In	2,0 In
ΔI	0.382	0.348	0.348	0.360
δI	18.3	12.4	7.1	5.3

3S1-3S2: 10 VA	1,0 In
ΔI	0.509
δI	13.5

4S1-4S2: 10 VA	1,0 In
ΔI	0.212
δI	13.3

Ipn (A): 100

1S1-1S2: 5 VA	0,05 In	0,2 In	1,0 In	2,0 In
ΔI	-0.842	-0.585	-0.087	0.076
δI	29.6	14.1	-1.0	-4.0

1S1-1S2: 1.25 VA	0,05 In	0,2 In	1,0 In	2,0 In
ΔI	0.260	0.241	0.263	0.297
δI	22.0	16.3	8.2	5.2

2S1-2S2: 5 VA	0,05 In	0,2 In	1,0 In	2,0 In
ΔI	-0.615	-0.426	0.011	0.162
δI	26.2	14.4	0.8	-1.6

2S1-2S2: 1.25 VA	0,05 In	0,2 In	1,0 In	2,0 In
ΔI	0.373	0.351	0.348	0.358
δI	16.0	12.2	7.0	5.5

3S1-3S2: 10 VA	1,0 In
ΔI	0.512
δI	13.2

4S1-4S2: 10 VA	1,0 In
ΔI	0.214
δI	13.1

Ipn (A): 200

1S1-1S2: 5 VA	0,05 In	0,2 In	1,0 In	2,0 In
ΔI	-0.840	-0.665	-0.116	-0.008
δI	30.0	18.3	0.0	-1.3

1S1-1S2: 1.25 VA	0,05 In	0,2 In	1,0 In	2,0 In
ΔI	0.042	0.080	0.192	0.198
δI	17.6	12.2	4.9	4.0

2S1-2S2: 5 VA	0,05 In	0,2 In	1,0 In	2,0 In
ΔI	-0.609	-0.409	0.017	0.185
δI	26.4	14.0	0.6	-1.7

2S1-2S2: 1.25 VA	0,05 In	0,2 In	1,0 In	2,0 In
ΔI	0.383	0.357	0.349	0.359
δI	16.0	12.3	7.0	5.8

3S1-3S2: 10 VA		4S1-4S2: 10 VA	
	1,0 In		1,0 In
Δ I	0.536	Δ I	0.223
δ I	12.6	δ I	12.9

Measurements uncertainty: $\Delta_I = \pm 0{,}045\ \%$, $\delta_I = \pm 2{,}3$ min

Verification of secondary limiting e.m.f.
(check of instrument security factor (FS) and accuracy limit factor (ALF))

Winding	e.m.f. [V]	Iexc measured [A]	Iexc required [A]	Condition
1S1-1S2	5.91	> 5	> 2.5	☑
2S1-2S2	27.02	> 1	> 0.5	☑
3S1-3S2	21.48	0.55	< 2.5	☑
4S1-4S2	105.17	0.12	< 0.5	☑

Measurement of capacitance and dielectric dissipation factor - tg δ

Temperature: 22.2 °C, Frequency: 50 Hz

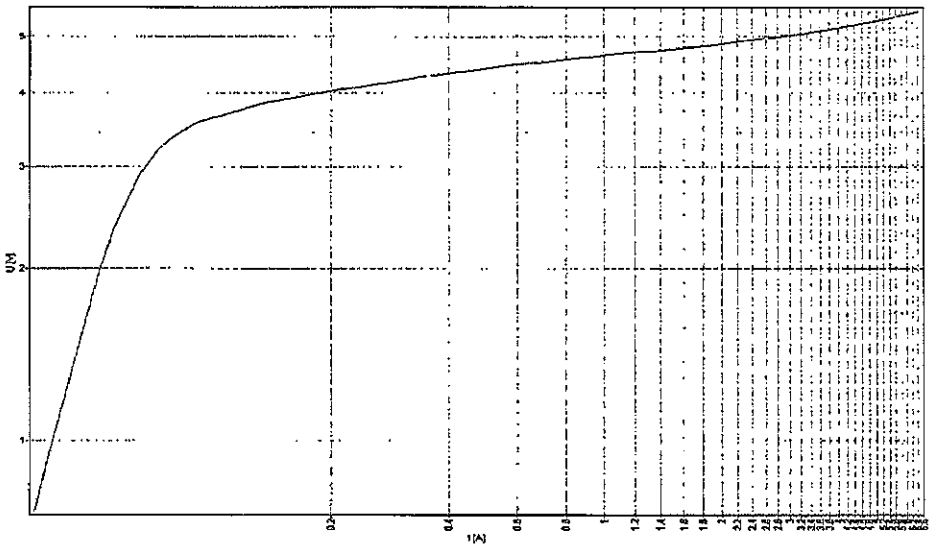
Primary voltage	Tg δ [%]	Capacitance [pF]	Leakage current [mA]
10 kV	0.22	973	3.133
63 kV	0.22	973	19.16
71 kV	0.22	973	21.74

Measurement of windings' resistance

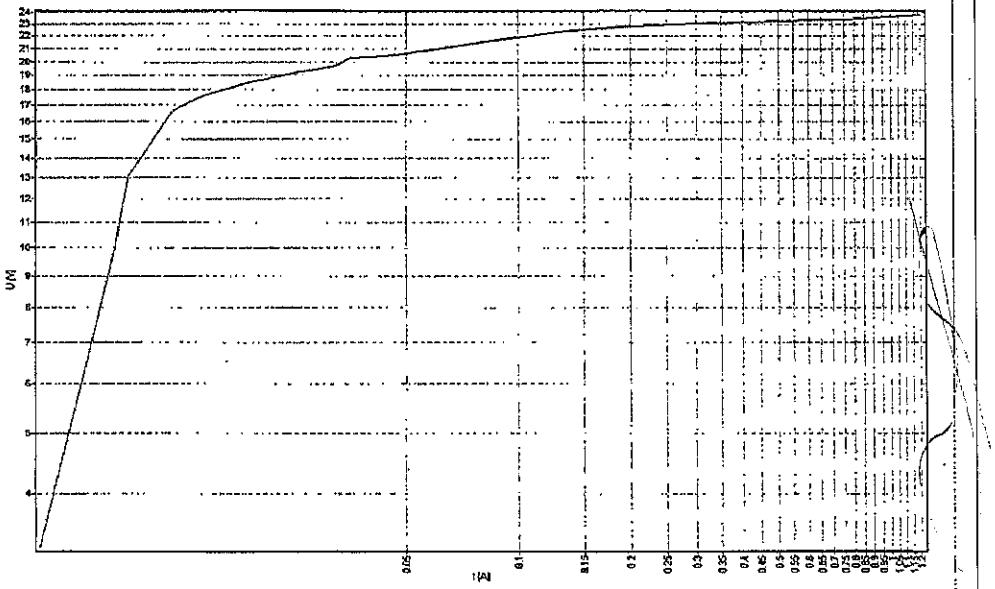
	R (22 °C)	Rct (75 °C)
P1-P2 range 50A	252.0 μΩ	304.5 μΩ
P1-P2 range 100A	80.0 μΩ	96.7 μΩ
P1-P2 range 200A	32.0 μΩ	38.7 μΩ
1S1-1S2	0.036 Ω	0.043 Ω
2S1-2S2	0.410 Ω	0.495 Ω
3S1-3S2	0.030 Ω	0.036 Ω
4S1-4S2	0.528 Ω	0.638 Ω

Determination of core magnetization characteristics:

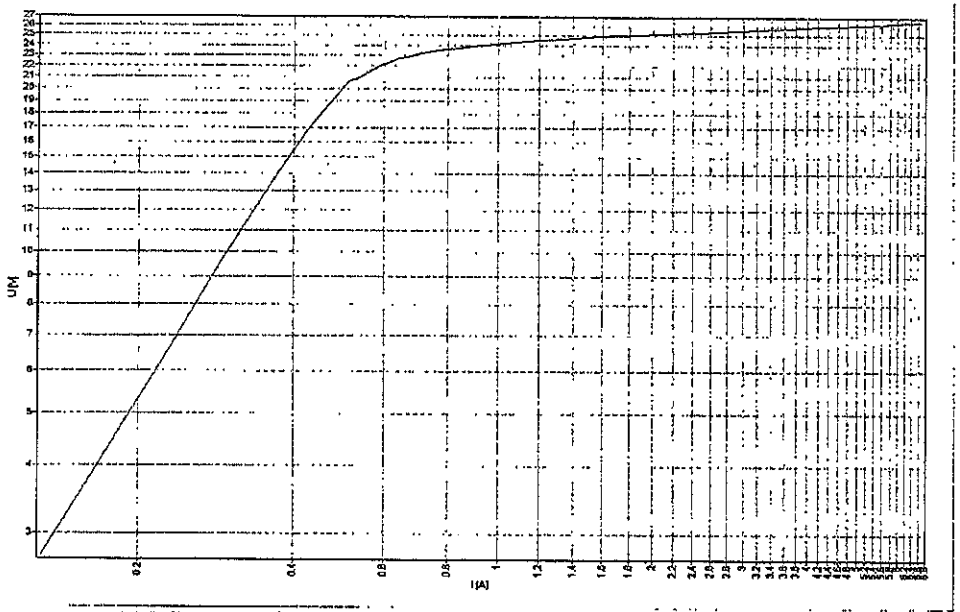
1. Winding 1S1-1S2; f = 50Hz



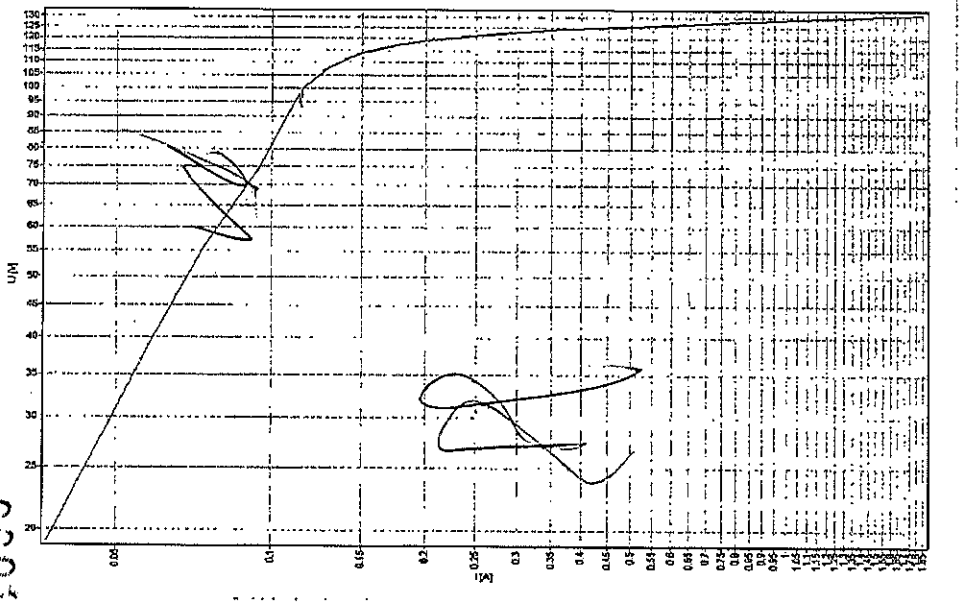
2. Winding 2S1-2S2; f = 50Hz



3.Winding 3S1-3S2; f = 50Hz



4. Winding 4S1-4S2; f = 50Hz



Rating plate:

ABB

Current Transformer | Type: PA 145

Insulation level	145/275/650 kV	Standard	IEC 60044-1	fn	50 Hz
Oil type	Nytro Libra	Weight / oil	360 / 90 kg	Temp. range	-40°C→ +40°C
SN	84700 / 11				

K_n 50-100-200/5-1-5-1 A/A

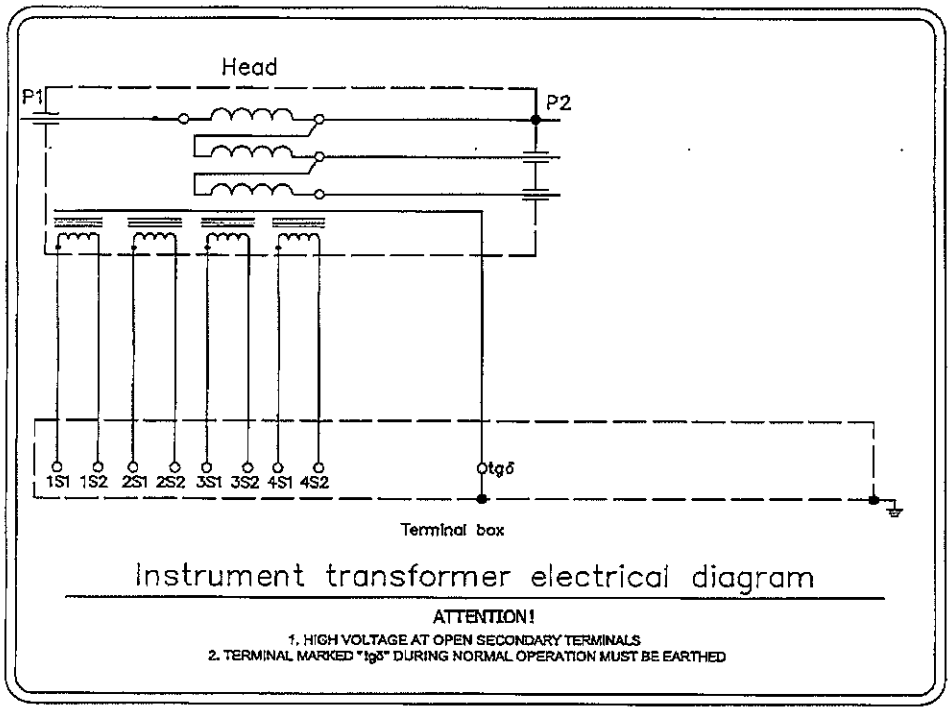
I_{th}/1s 40-50-50 kA I_{dyn} 100-125-125 kA

I_{cth} 100-200-400 A

	1S1-1S2	2S1-2S2	3S1-3S2	4S1-4S2	5S1-5S2	6S1-6S2
A	5	1	5	1		
VA	5	5	10	10		
Cl.	0,5	0,5	5P	5P		
FS/ALF	5	5	10	10		
Ext.%	200	200				

Transportation: Vertical / Horizontal

Electrical diagram plate:



Checked by: OG-4 KJ-21

Przasnysz, 2012-01-19

The tests were witnessed by:

Representative of
HIGH VOLTAGE LABORATORY
INSTYTUT ENERGETYKI
01-330 WARSAW, Mory 8

Kierownik Wydziału Produkcji Ograniczników i Przekładników ABB Sp. z o.o. Oddział w Przasnyszu Paweł Dębski

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ABB Sp. z o.o. 06-300 Przasnysz ul. Leszno 59	Routine test report of current transformer after dielectric type tests	TYPE: PA 123 / PA 145 Serial no: 2GKP011A1084700

Ith 1s [kA]:	Idyn [kA]:	Icth [A]:	Insulation level:	IEC 60044-1
40-50-50	100-125-125	100-200-400	145/275/650 kV	50 Hz

Winding	Isn [A]	Sn [VA]	class	Rated ratio [A/A]
1S1-1S2	5	5	0,5FS 5	50-100-200/5
2S1-2S2	1	5	0,5FS 5	50-100-200/1
3S1-3S2	5	10	5P 10	50-100-200/5
4S1-4S2	1	10	5P 10	50-100-200/1

List of performed tests:

1. Power-frequency withstand test on primary windings - Up = 220 kV/60s, f = 50Hz ☑
2. Partial discharge measurement ☑
3. Power-frequency withstand test on secondary windings - Up = 3 kV/60s, f = 50Hz ☑
4. Inter-turn overvoltage test for current transformers - lower value (U peak=4,5kV or U peak at Icth) / 60s ☑
5. Determination of errors ☑
6. Verification of secondary limiting e.m.f. (check of instrument security factor (FS) and accuracy limit factor (ALF)) ☑
7. Measurement of secondary windings insulation resistance (1kV DC) - R >= 100 MΩ ☑
8. Measurement of primary windings insulation resistance (2,5kV DC) - R >= 3000 MΩ ☑
9. Measurement of capacitance and dielectric dissipation factor - tg δ ☑
10. Measurement of windings' resistance ☑

Partial discharge measurement

- Measurement according to procedure A
  (PD test voltages were reached while decreasing the voltage after the power-frequency withstand test on primary windings)
  Stress voltage: 220 kV / 60 s
  Frequency: 50 Hz

Test voltage	1,2 Um = 174 kV	1,2 Um / √3 = 100.5 kV
Level of partial discharge	8 pC	2.5 pC

Remarks: background noise level: 1.3 pC (measured after voltage switch off), measuring circuit was calibrated with 5pC (calibrating charge)

Inter-turn overvoltage test for current transformers

Winding	Peak voltage on secondary winding [kVpeak]	Current in primary winding [A]
1S1-1S2	0.128	400
2S1-2S2	0.608	400
3S1-3S2	0.256	400
4S1-4S2	1.15	400

Determination of errors (ΔI%), (δi min), cos φ = 0,8 lagging (cos φ = 1 for S < 5VA)

Ipn (A): 50

1S1-1S2: 5 VA					1S1-1S2: 1.25 VA				
	0,05 In	0,2 In	1,0 In	2,0 In		0,05 In	0,2 In	1,0 In	2,0 In
ΔI	-0.847	-0.578	-0.087	0.074	ΔI	0.250	0.230	0.257	0.289
δi	29.9	14.2	-1.2	-3.9	δi	22.3	16.5	8.3	5.5
2S1-2S2: 5 VA					**2S1-2S2: 1.25 VA**				
	0,05 In	0,2 In	1,0 In	2,0 In		0,05 In	0,2 In	1,0 In	2,0 In
ΔI	-0.651	-0.382	0.003	0.153	ΔI	0.362	0.347	0.345	0.358
δi	27.3	12.4	0.7	-1.1	δi	16.5	12.4	7.2	5.5

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3S1-3S2: 10 VA	
	1,0 In
ΔI	0.518
δI	13.4

4S1-4S2: 10 VA	
	1,0 In
ΔI	0.219
δI	13.1

Ipn (A): 100

1S1-1S2: 5 VA				
	0,05 In	0,2 In	1,0 In	2,0 In
ΔI	-0.843	-0.573	-0.087	0.074
δI	29.8	14.3	-1.1	-3.9

1S1-1S2: 1.25 VA				
	0,05 In	0,2 In	1,0 In	2,0 In
ΔI	0.255	0.234	0.257	0.288
δI	22.5	16.5	8.3	5.7

2S1-2S2: 5 VA				
	0,05 In	0,2 In	1,0 In	2,0 In
ΔI	-0.645	-0.376	0.011	0.150
δI	28.2	12.4	0.6	-1.0

2S1-2S2: 1.25 VA				
	0,05 In	0,2 In	1,0 In	2,0 In
ΔI	0.386	0.352	0.344	0.358
δI	17.2	12.7	7.5	6.1

3S1-3S2: 10 VA	
	1,0 In
ΔI	0.519
δI	13.5

4S1-4S2: 10 VA	
	1,0 In
ΔI	0.214
δI	13.0

Ipn (A): 200

1S1-1S2: 5 VA				
	0,05 In	0,2 In	1,0 In	2,0 In
ΔI	-0.884	-0.603	-0.154	0.028
δI	33.3	15.4	1.0	-2.0

1S1-1S2: 1.25 VA				
	0,05 In	0,2 In	1,0 In	2,0 In
ΔI	0.033	0.078	0.162	0.200
δI	18.4	12.8	5.4	3.7

2S1-2S2: 5 VA				
	0,05 In	0,2 In	1,0 In	2,0 In
ΔI	-0.623	-0.368	0.011	0.149
δI	26.4	12.4	0.8	-0.9

2S1-2S2: 1.25 VA				
	0,05 In	0,2 In	1,0 In	2,0 In
ΔI	0.374	0.352	0.344	0.345
δI	16.1	12.3	7.0	6.5

3S1-3S2: 10 VA	
	1,0 In
ΔI	0.514
δI	13.3

4S1-4S2: 10 VA	
	1,0 In
ΔI	0.216
δI	13.1

Measurements uncertainty: Δ_I = ± 0,045 %, δ_I = ± 2,3 min

Verification of secondary limiting e.m.f.
(check of instrument security factor (FS) and accuracy limit factor (ALF))

Winding	e.m.f. [V]	Iexc measured [A]	Iexc required [A]	Condition
1S1-1S2	5.90	> 5	> 2.5	☑
2S1-2S2	27.02	> 1	> 0.5	☑
3S1-3S2	21.47	0.53	< 2.5	☑
4S1-4S2	105.16	0.12	< 0.5	☑

Measurement of capacitance and dielectric dissipation factor - tg δ

Temperature: 22.3 °C, Frequency: 50 Hz

Primary voltage	Tg δ [%]	Capacitance [pF]	Leakage current [mA]
10 kV	0.22	973	3.188
63 kV	0.22	973	19.24
71 kV	0.22	973	21.73

Measurement of windings' resistance

	R (22.8 °C)	Rct (75 °C)
P1-P2 range 50A	256.0 μΩ	308.5 μΩ
P1-P2 range 100A	83.0 μΩ	100.0 μΩ
P1-P2 range 200A	34.0 μΩ	41.0 μΩ
1S1-1S2	0.036 Ω	0.043 Ω
2S1-2S2	0.410 Ω	0.494 Ω
3S1-3S2	0.030 Ω	0.036 Ω
4S1-4S2	0.528 Ω	0.636 Ω

Rating plate:

ABB

Current Transformer | Type: PA 145

Insulation level	145/275/650 kV	Standard	IEC 60044-1	fn	50 Hz
Oil type	Nytro Libra	Weight / oil	360 / 90 kg	Temp. range	-40°C → +40°C
SN	84700 / 11				

K_n 50-100-200/5-1-5-1 A/A

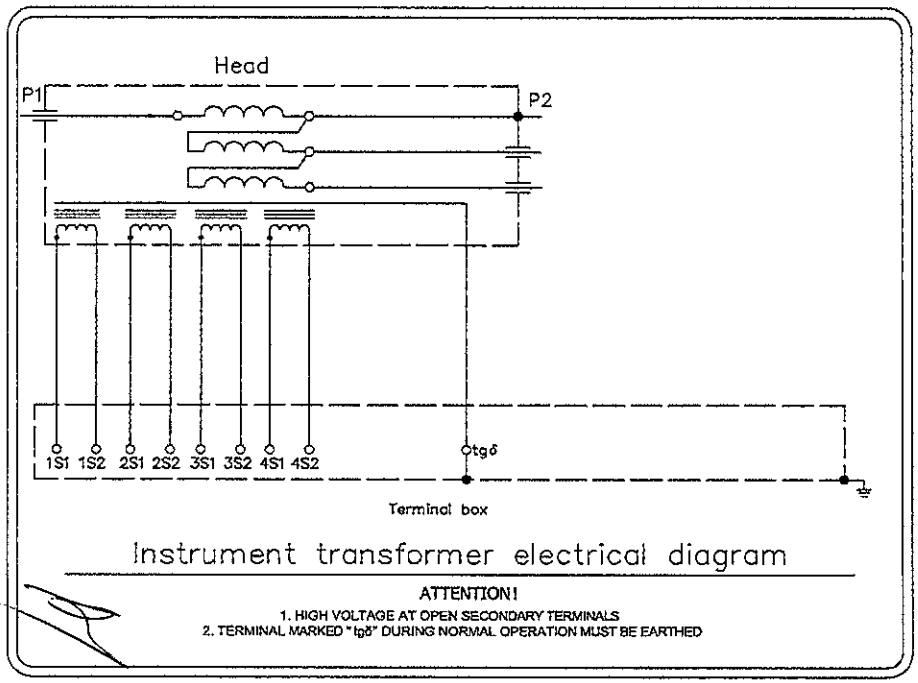
I_{th}/1s 40-50-50 kA I_{dyn} 100-125-125 kA

I_{cth} 100-200-400 A

	1S1-1S2	2S1-2S2	3S1-3S2	4S1-4S2	5S1-5S2	6S1-6S2
A	5	1	5	1		
VA	5	5	10	10		
Cl.	0,5	0,5	5P	5P		
FS/ALF	5	5	10	10		
Ext.%	200	200				

Transportation: Vertical / Horizontal

Electrical diagram plate:



Checked by: OG-4 KJ-21

Przasnysz, 2012-03-26

The tests were witnessed by:

Representative of
HIGH VOLTAGE LABORATORY
INSTYTUT ENERGETYKI
01-330 WARSAW, Mory 8

Kierownik Wydziału Produkcji
Ograniczników i Przekładników WN
ABB Sp. z o.o.
Oddział w Przasnyszu
Paweł Dębski

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HIGH VOLTAGE LABORATORY
INSTYTUTU ENERGETYKI
01-330 WARSZAWA, ul. Mory 8, tel. (22)3451242
tel. fax. 836-80-48, e-mail: ewn@ien.com.pl

EWN/11/E/12-2

APPENDIX

3

APPENDIX 3 for test report EWN/11/E/12-2

Report of performed tests in Distribution Equipment Laboratory of Institute of Power Engineering in Warsaw.

- Test Report No. EUR/12/E/12-1E (Mechanical tests.)

INSTITUTE OF POWER ENGINEERING
DISTRIBUTION EQUIPMENT LABORATORY

01-330 Warsaw, ul Mory 8
tel.fax. +48 22 836-73-35
tel. +48 22 345-13-86

TEST REPORT No. EUR/12/E/12-1E

TEST OBJECT: Current transformer type PA 145 / PA 123 with composite insulator
Serial No. 84700/11

MANUFACTURER: ABB Sp. z o.o. Division in Przasnysz, ul. Leszno 59, 06-300 Przasnysz

TESTS ORDERED BY: Internal order No. EWN/11/E/12 dated 10.05.2012

TYPE OF TESTS: Mechanical tests

TESTS PROCEDURE: According to IEC 60044-1:1996+A1:2000+A2:2002

DATE OF TESTS: 28.03.2012

TESTS RESULT: Positive for
F_R = 3600 N and resulting dynamic load

Tests result refers only to the test object

THE TESTS WERE WITNESSED BY: -

Test engineer
Tomasz Kaczmarczyk

HEAD OF LABORATORY
Lidia Gruza

Warsaw, 14.05.2012

C00110

Contents **Page**

Report contents:

numbered pages	9
tables	1
photographs	6

1. TEST OBJECT

1.1 Description

Current transformer type PA 145 / PA 123 is used for supplying of measuring and protection circuits in the network of highest voltage for equipment 145/123 kV and frequency 50 Hz. The transformer consists of current transformer mounted in composite enclosure immersed with transformer oil.

1.2 Technical data

The Manufacturer attributed the following construction data to the test object.

Highest Voltage for Equipment	145/123 kV
Rated frequency	50 Hz
Rated continuous thermal current	50 A, 100 A, 200 A
Rated short-time current	40 kA, 50 kA, 50 kA
Rated dynamic current	100 kA, 125 kA, 125 kA
Rated static load	3600 N

1.3 Technical documentation

For the purpose of tests the orderer delivered the following technical documentation:
- dimensional drawing current transformer PA 145 / PA 123, No. 2GKA614117, 19.01.2012,
- rating plate

prepared by ABB Sp. z o.o. (Annex 2).

The laboratory proceeded the identification of test object on the base of above documentation and the nameplate.

1.4 Preparation for tests

The test object was prepared for test by factory.

2. SCOPE OF TESTS

Test program, agreed with orderer, comprised the following tests according to requirements of IEC 60044-1:1996+A1:2000+A2:2002:
- mechanical tests acc. to item 9.3 of above standards for F_R = 3600 N and resulting dynamic load of terminals P1 and P2 200 A.

3. TEST AND MEASURING CIRCUITS

For the tests the transformer was fixed to the rigid construction of the test stand.

Mechanical tests were performed applying the load consecutively to the transformer's terminals as shown on photographs 1 to 6 in Annex 1.

4. TESTS AND THEIRS DETAILED RESULTS

Mechanical tests were performed 28.03.2012. Tests results present table 1.

During the tests the photos were made (Annex 1 presents the photographs)
- phot. 1 to 6 - current transformer during mechanical tests

Table 1. Results of static load withstand tests at F = 3620 N and dynamic*)

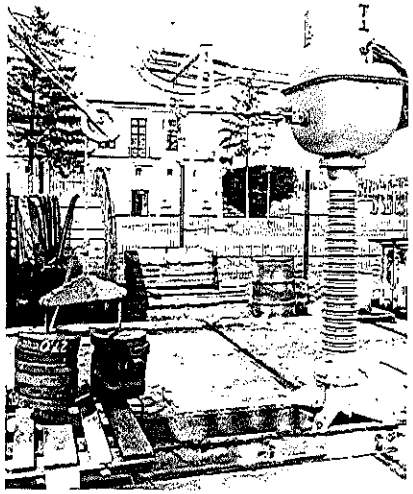
Test No.	Terminal	Load direction	Test time	Observations
-	-	-	s	-
1	P1	longitudinal	60	After tests no damage nor oil leak was stated.
2	P1	longitudinal	dyn.*)	
3	P1	transverse	60	After tests no damage nor oil leak was stated.
4	P1	transverse	dyn.*)	
5	P1	vertical	60	After tests no damage nor oil leak was stated.
6	P1	vertical	dyn.*)	
7	P2	longitudinal	60	After tests no damage nor oil leak was stated.
8	P2	longitudinal	dyn.*)	
9	P2	transverse	60	After tests no damage nor oil leak was stated.
10	P2	transverse	dyn.*)	
11	P2	vertical	60	After tests no damage nor oil leak was stated.
12	P2	vertical	dyn.*)	

Remark:
*) Dynamic tests were performed by sudden loading the terminal by the weight 3620 N.

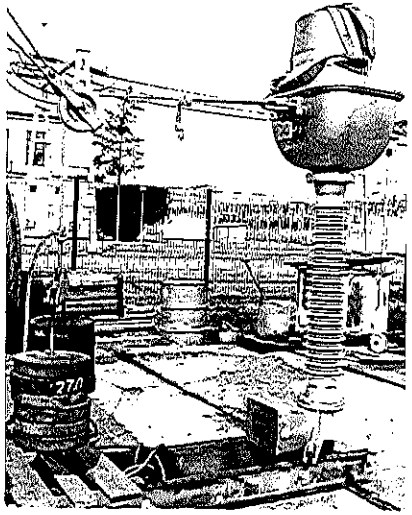
5. TESTS RESULTS EVALUATION

According to criteria given in IEC 60044-1:1996+A1:2000+A2:2002 the results of tests of tested current transformer is positive for:
- F_R = 3600 N and resulting dynamic load.

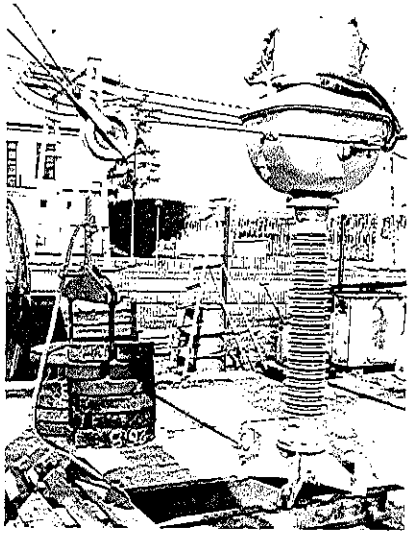
ANNEX 1 **Photographs taken during the tests**



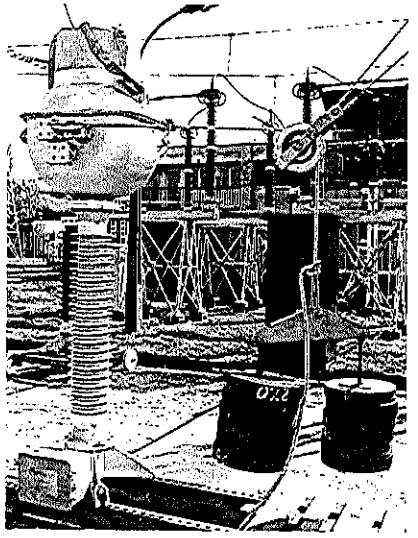
Phot. 1. Longitudinal load of terminal P1



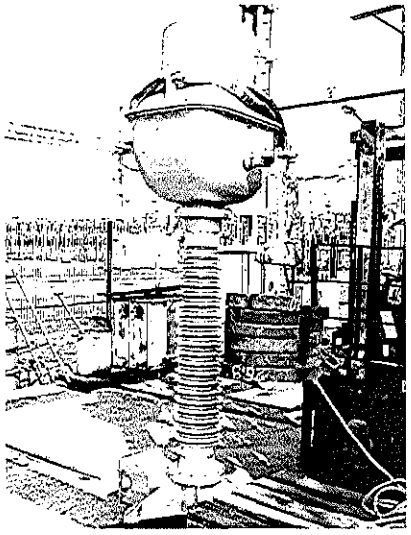
Phot. 2. Longitudinal load of terminal P2 200 A



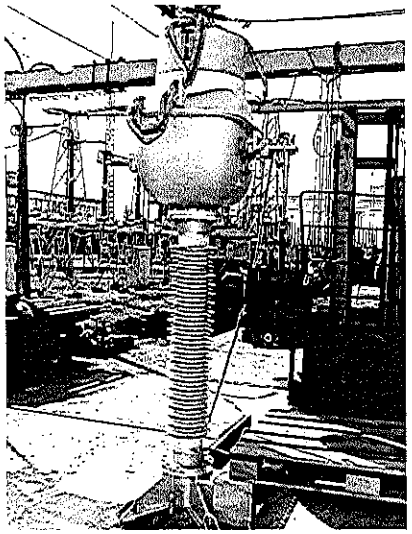
Phot. 3. Transverse load of terminal P1



Phot. 4. Transverse load of terminal P2 200 A

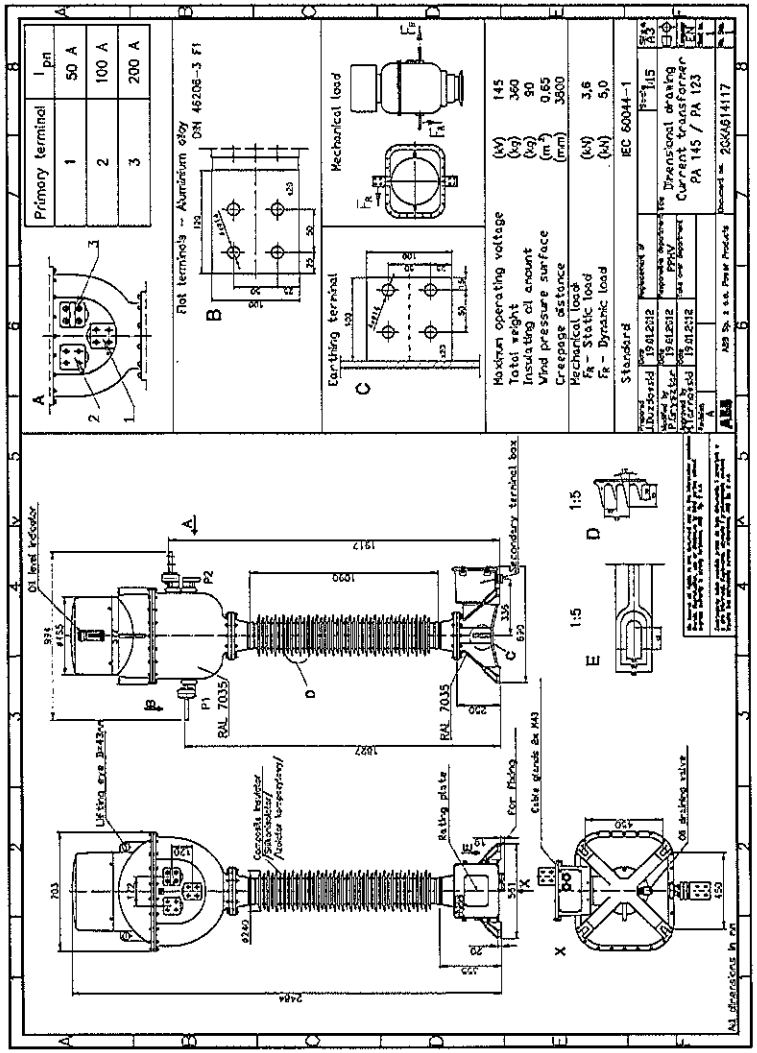


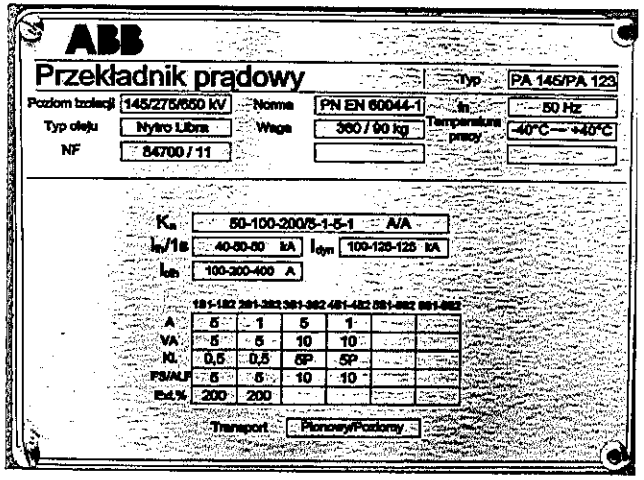
Phot. 5. Vertical load of terminal P1



Phot. 6. Vertical load of terminal P2 200 A

ANNEX 2 **Documentations delivered by orderer**





APPENDIX 4 for test report EWN/11/E/12-2

Lightning impulse test. Impulse 1,2/50 µs, full and chopped:

- Oscillograms of test currents and detection currents.

HIGH VOLTAGE LABORATORY
POLAND 01-330 WARSZAWA, ul. Mory 8
fax: (+4822) 836-80-48, mail: ewm@ien.com.pl

Lightning impulse test of the current transformer

project : ewn11e12-u2 test date 30-03-2012

Test - object - data

WNR EWN/11/E/12-2 TR-No. 84700/11 O.-No.

test object	PA145		vector group		
output		kVA	BIL	650	
voltage	145	kV	frequency	50	Hz

customer ABB Sp. z o. o., ul. Zeganska 1, 04-713 Warszawa

LI lightning-impulse

no.	Up [kV]	T1[µs]	T2[µs]	Tc[µs]	remark
1	-324.7	1.09	51.4		LI: P1 - RW(50.0%)
2	-649	1.1	51.7		LI: P1 - FW(100.0%)
3	-375.5	1.1		3.32	LI: P1 - CRW(57.5%)
4	-745	1.13		3.32	LI: P1 - CFW(115.0%)
5	-744.6	1.13		3.37	LI: P1 - CFW(115.0%)
6	-649.7	1.1	51.7		LI: P1 - FW(100.0%)
7	-649.6	1.09	51.8		LI: P1 - FW(100.0%)
8	-649.9	1.1	51.8		LI: P1 - FW(100.0%)
9	-650.2	1.09	51.7		LI: P1 - FW(100.0%)
10	-649.8	1.09	51.8		LI: P1 - FW(100.0%)
11	-648.9	1.09	51.8		LI: P1 - FW(100.0%)
12	-649.4	1.1	51.8		LI: P1 - FW(100.0%)
13	-649.7	1.1	51.7		LI: P1 - FW(100.0%)
14	-649.5	1.1	51.8		LI: P1 - FW(100.0%)
15	-649.7	1.09	51.8		LI: P1 - FW(100.0%)
16	-648.7	1.09	51.9		LI: P1 - FW(100.0%)
17	-649.1	1.1	51.9		LI: P1 - FW(100.0%)
18	-649.6	1.1	51.8		LI: P1 - FW(100.0%)
19	-649.8	1.1	51.8		LI: P1 - FW(100.0%)
20	325.9	1.09	51.6		LI: P1 - RW(50.0%)
21	651.2	1.1	52.1		LI: P1 - FW(100.0%)
22	650.7	1.09	52.1		LI: P1 - FW(100.0%)
23	650.7	1.1	52.1		LI: P1 - FW(100.0%)
24	650.8	1.09	52.2		LI: P1 - FW(100.0%)
25	650.1	1.1	52.2		LI: P1 - FW(100.0%)
26	650.3	1.09	52.1		LI: P1 - FW(100.0%)
27	650.2	1.09	52.1		LI: P1 - FW(100.0%)
28	649.5	1.1	52.2		LI: P1 - FW(100.0%)
29	650.2	1.1	52.1		LI: P1 - FW(100.0%)

HIGH VOLTAGE LABORATORY
POLAND 01-330 WARSZAWA, ul. Mory 8
fax: (+4822) 836-80-48, mail: ewm@ien.com.pl

Lightning impulse test of the current transformer

project : ewn11e12-u2

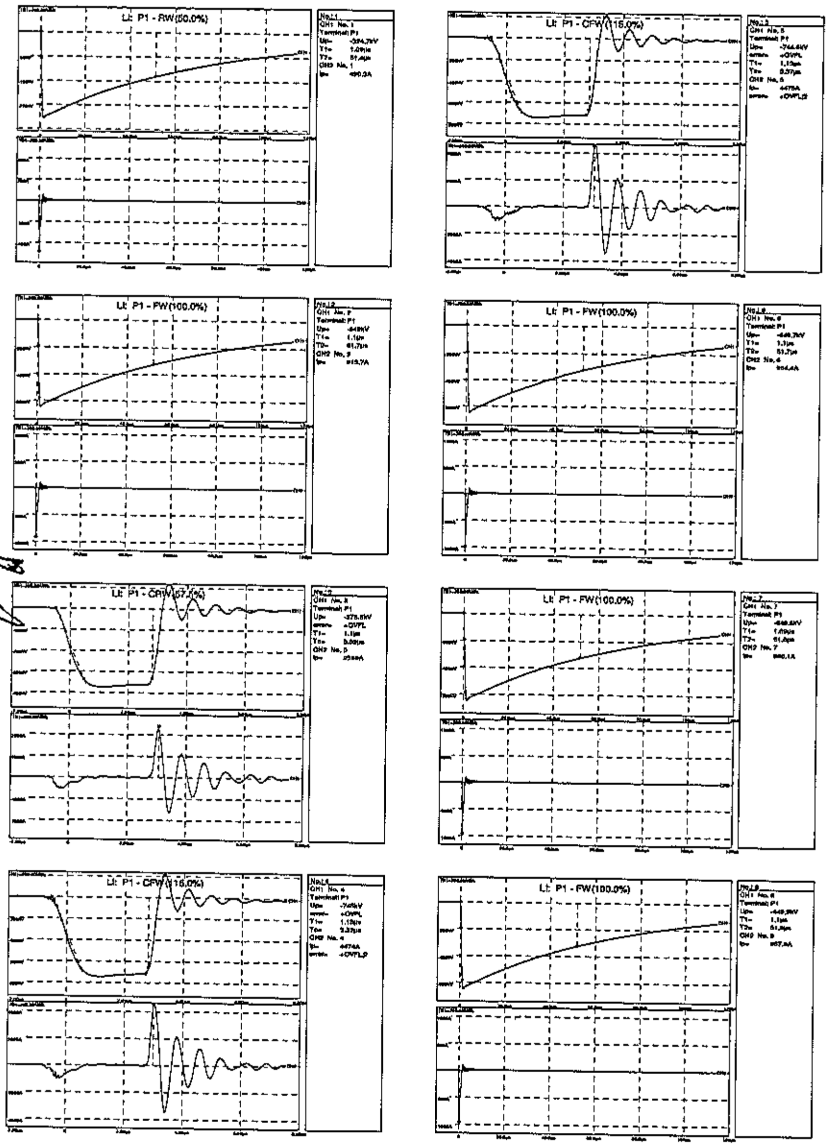
30	650	1.1	52.1		LI: P1 - FW(100.0%)
31	649.1	1.09	52.3		LI: P1 - FW(100.0%)
32	650.5	1.1	52.1		LI: P1 - FW(100.0%)
33	649	1.1	52.3		LI: P1 - FW(100.0%)
34	649.2	1.09	52.3		LI: P1 - FW(100.0%)
35	650	1.1	52.2		LI: P1 - FW(100.0%)

HIGH VOLTAGE LABORATORY

POLAND 01-330 WARSZAWA, ul. Mory 8
fax: (+4822) 836-80-48, mail: ewn@ien.com.pl

Lightning impulse test of the current transformer

project : ewn11e12-u2

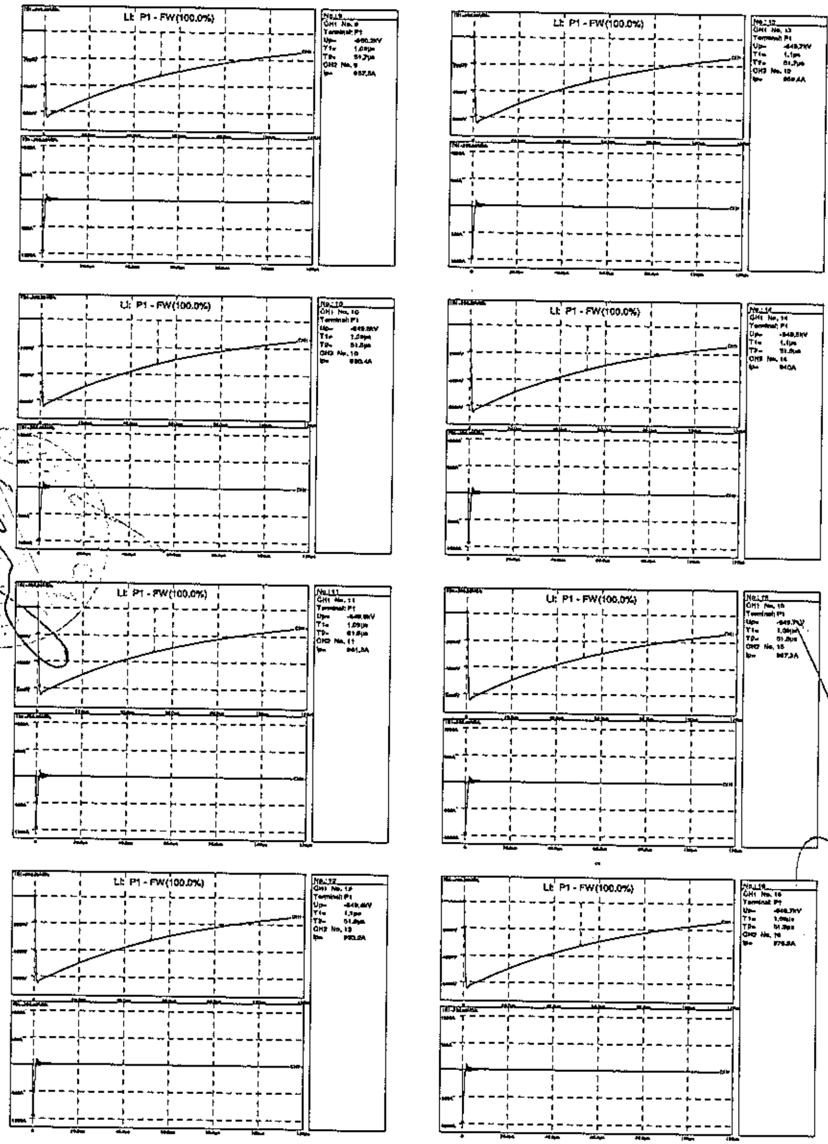


HIGH VOLTAGE LABORATORY

POLAND 01-330 WARSZAWA, ul. Mory 8
fax: (+4822) 836-80-48, mail: ewn@ien.com.pl

Lightning impulse test of the current transformer

project : ewn11e12-u2

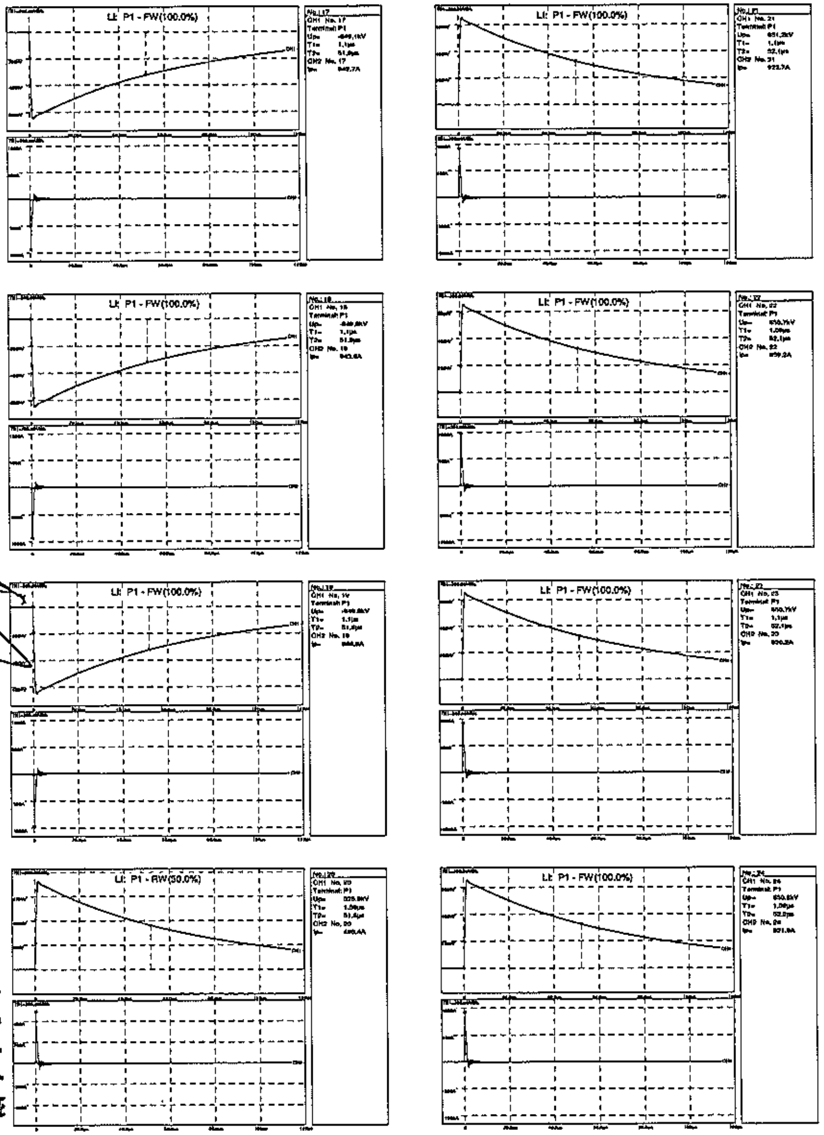


HIGH VOLTAGE LABORATORY

POLAND 01-330 WARSZAWA, ul. Mory 8
fax: (+4822) 836-80-48, mail: ewn@ien.com.pl

Lightning impulse test of the current transformer

project : ewn11e12-u2



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Lightning impulse test of the current transformer

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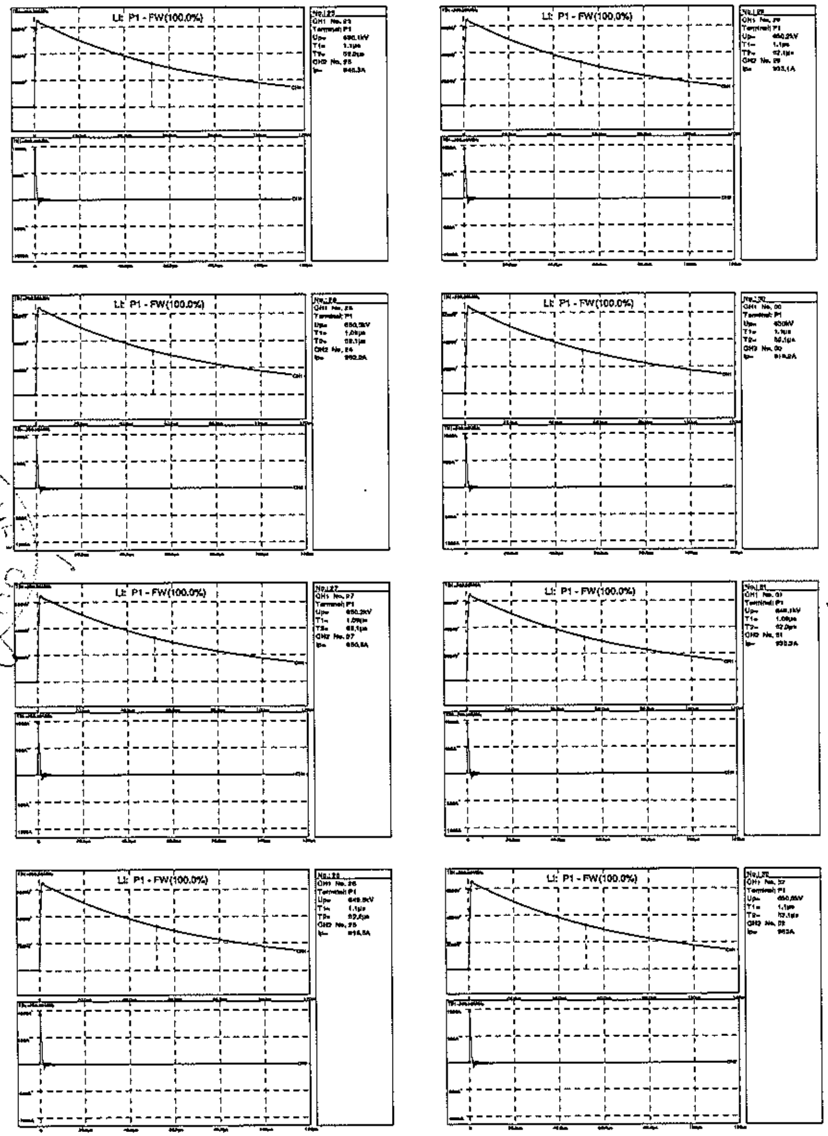

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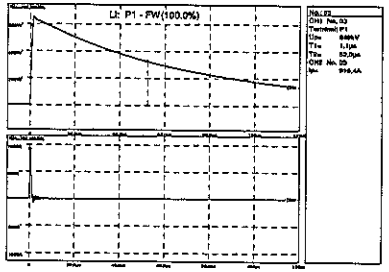
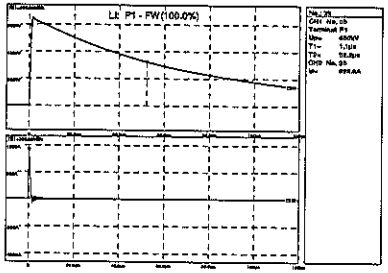
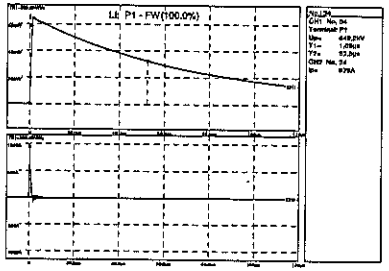
fax: (+4822) 836-80-48, mail: ewn@ien.com.pl







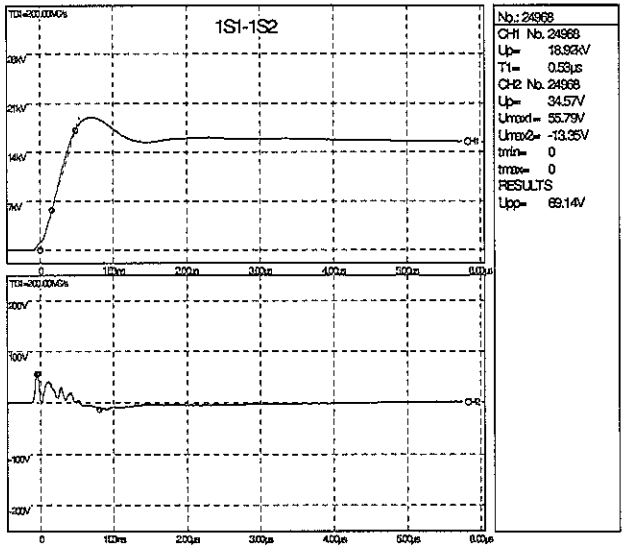
HIGH VOLTAGE LABORATORY
INSTYTUTU ENERGETYKI
01-330 WARSZAWA, ul. Mory 8, tel. (22)3451242
tel. fax. 836-80-48, e-mail: ewn@ien.com.pl

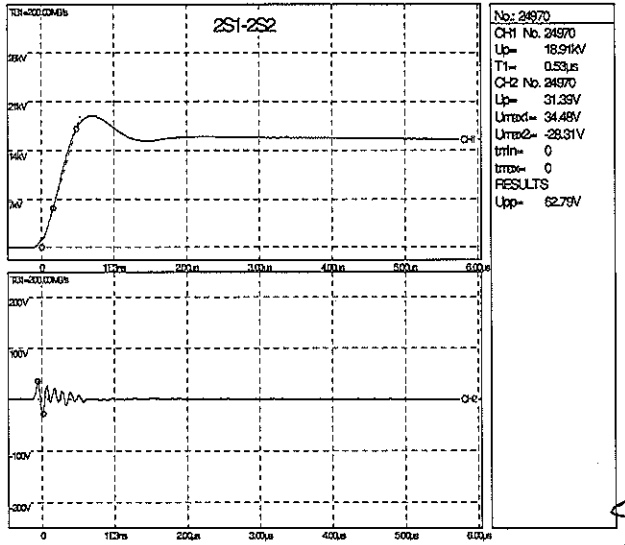
APPENDIX 5 for test report EWN/11/E/12-2

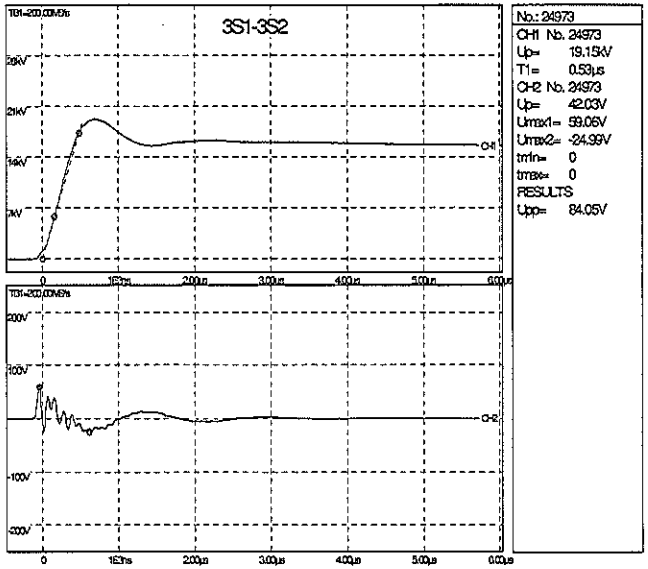
Transmitted overvoltage measurement:

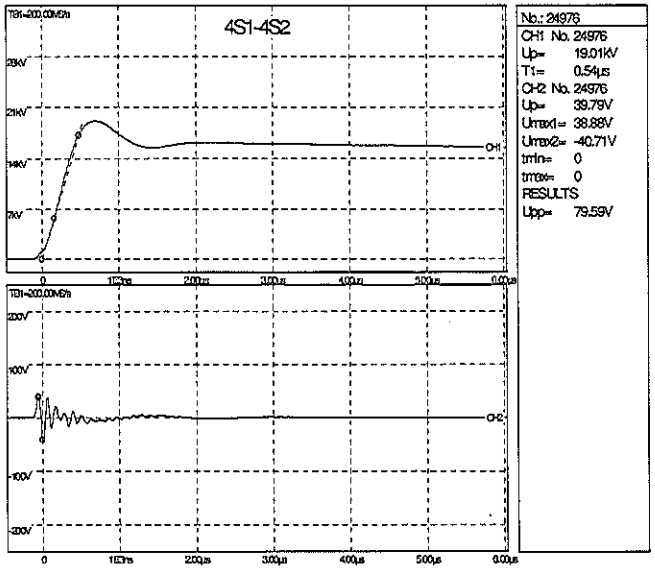
- Oscillograms of measured transmitted to secondary windings overvoltages.

Transmitted overvoltage measurement of PA 145 factory number 84700/11









84700

LABORATORIUM WYSOKICH NAPIĘĆ

INSTYTUTU ENERGETYKI

LABORATORY ACCREDITED
BY THE POLISH CENTRE FOR ACCREDITATION

Accreditation Certificate of Testing Laboratory
No AB 272

AB 272

TEST REPORT

No. EWN/11/E/12-2

Tests of current instrument transformer type PA 123 (PA 145) for insulation level LI 650kV/AC 275kV, manufactured by ABB sp. z o.o.

Warsaw, March 2012

TESTS REPORTS No EWN/11/E/12-2

TEST OBJECT:	**Current instrument transformer type PA 123 (PA145) Serial No: 2GKP011A1084700 (84700/11)**
TEST ORDERED BY:	**ABB Sp. z o.o. 04-713 Warszawa, ul. Żegańska 1**
ORDER NO:	**4500380553/2 – 20.01.2012**
SCOPE OF TEST:	**Selected type tests and special tests**
PROCEDURA OF TESTS:	**in accordance with standards: PN-EN 60044-1:2000 (EN 60044-1:1999)**
RECEIVING OBJECT DATE:	**January 2012**
DATE OF TESTS:	**January 2012 – March 2012**
TESTS RESULTS:	**are presented in following parts of report** Test results are concern to tested object only.

Tests was performed in witness of representatives of ABB sp. z o.o. :

Marcin TARNOWSKI M.Sc.E.E.
Paweł DĘBSKI M.Sc.E.E.
Jarosław DUZDOWSKI M.Sc.E.E.
Zbigniew WESOŁOWSKI M.Sc.E.E.

TEST PERFORMER:	**Jan SZOKALSKI M.Sc.E.E.**	SIGNATURE
TEST OVERSEERER:	**Jerzy MIKOŁAJCZYK M.Sc.E.E.**	SIGNATURE
HEAD OF HIGH VOLTAGE DEPARTMENT:	**January L. MIKULSKI, Ass. Prof., Dr. hab. E. E.**	SIGNATURE

Warsaw, March 2012

CONTENTS

The Report contain:
18 numbered pages
In Report are presented:
5 drawing
1 numbered table
6 appendixes
and non numbered diagrams and tables

HIGH VOLTAGE LABORATORY
INSTYTUT ENERGETYKI
POLAND 01-330 WARSZAWA, ul. Mory 8, tel. (+48 22) 836-80-48, fax (+48 22) 836-80-48 e-mail: ewn@ien.com.pl
EWN/11/E/12-2

1. COMPETENCE OF THE LABORATORY

The High Voltage Laboratory of Institute of Power Engineering (IEn) in Warsaw is in possession of accreditation issued by the Polish Centre for Accreditation (Accreditation Certificate of Testing Laboratory No AB 272) concerning following tests:

Insulators and insulator strings	–	lightning and switching impulse tests
	–	power-frequency voltage 50 Hz tests
	–	radio interference measurements
Distribution substations	–	lightning and switching impulse tests
	–	power-frequency voltage 50 Hz tests
	–	radio interference measurements
Circuit breakers, disconnectors	–	lightning and switching impulse tests
	–	power-frequency voltage 50 Hz tests
	–	radio interference measurements
Insulators	–	lightning and switching impulse tests
	–	power-frequency voltage 50 Hz tests
	–	radio interference measurements
Current and voltage transformers	–	**lightning and switching impulse tests**
	–	**power-frequency voltage 50 Hz tests**
Power transformers	–	lightning and switching impulse tests
	–	power-frequency voltage 50 Hz tests
Lightning arresters and limiters	–	lightning and switching impulse tests
	–	power-frequency voltage 50 Hz tests
Cables and cable fittings	–	lightning and switching impulse tests

Note! Tests described in sub-clauses 4.8, hereby Report are not comply the scope of Laboratory accreditation.

Hereby Report concerning test results obtained in other competent laboratories - (see Appendixes 2,3) :

- Distribution Equipment Laboratory of Institute of Power Engineering in Warsaw having Accreditation Certificate PCA Nr AB 324
- High Current Laboratory of Institute of Power Engineering in Warsaw having Accreditation Certificate PCA Nr AB 323
- Factory Laboratory of ABB sp. z o.o. in Przasnysz - Regional Verification Office in Warsaw - determination of errors and test in range of type tests at supervision of representative of High Voltage Laboratory of Institute of Power Engineering in Warsaw.

2. DESCRIPTION OF TEST OBJECT

The tested object was current instrument transformer type PA 123 (Pa 145) manufactured by ABB sp. z o.o. 04-713 Warszawa, ul. Żegańska 1, had following parameters:

Serial number 2GKP011A1084700 (84703/11)

- Rated primary current 50 – 100 – 200 A
- Rated short-time current I_{th}/1s 40 –50 – 50 kA
- Rated dynamic current I dyn 100 – 125 – 125 kA
- Rated frequency 50 Hz
- Rated insulation level LI 550kV/ AC 230kV*)
- Minimum creepage distance 3800 mm (composite insulator)

*) **Attention ! All voltarge test was performed for insulation level LI 650kV/AC 275kV (for current transformer type PA 145).**

View of rated nameplates of tested transformers show figure 1.

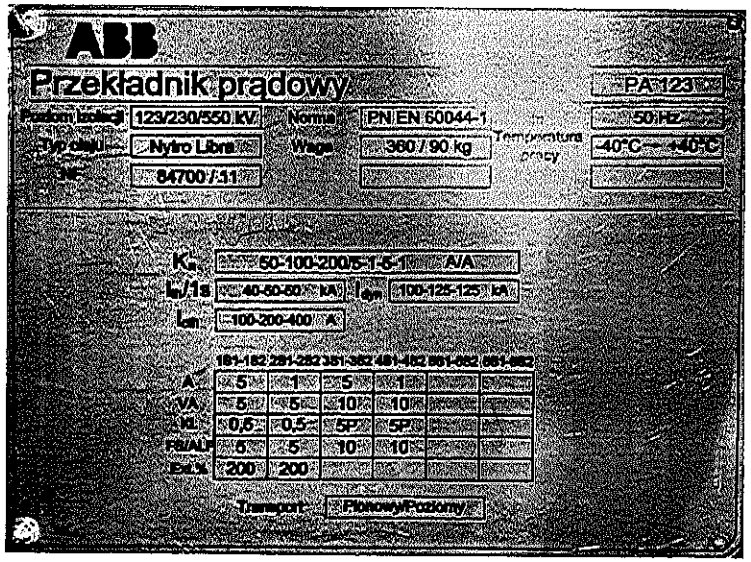


Fig. 1 Rated nameplate of tested transformer

Identification of tested object was done at following documents attached to hereby Report (Appendix 1):

- Manufacturer Conformity Declaration,
- Dimension drawing No. 2GKA614117 (19.01.2012),
- Electric diagram of Current instrument transformer,
- Drawing of rated nameplate.

3. AGREED SCOPE OF TESTS

According to ordered selected tests were done comply following standards:

- PN-EN 60044-1:2000 + A1:2003 +A2:2004 „Przekładniki. Część 1: Przekładniki prądowe" (EN-60044-1:1999 + A1:2000 + A2:2003 „Instrument transformers. Part 1: Current transformers").

On request of ordering party the additional special test were performed. The performed test results are contained in Table 1.

Table 1. List of performed tests

Item	Performed tests	Requirement
TYPE TESTS		
1	Lighting impulse test	PN EN 60044-1, p.7.3
2	Wet test for outdoor transformers	PN EN 60044-1, p.7.4
3	Determination of errors	PN EN 60044-1, p. 11.4, 11.6, 12.4
4	Measurement of the radio interference voltage (RIV)	PN EN 60044-1/A1, p. 7.5
SPECIAL TESTS		
5	Chopped impulse test on the primary winding	PN EN 60044-1, p. 9.1
6	Measurement of capacitance and dielectric dissipation factor	PN EN 60044-1, p. 9.2
7	Mechanical test	PN EN 60044-1, p. 9.3
8	Transmitted overvoltage measurement	PN EN 60044-1/A2, p. 9.3

During mentioned above tests at Factory Laboratory of ABB sp. z o.o. in Przasnysz Leszno 59 Street, were performed determination of errors of transformer to prove positive results of consecutive tests. The complete tests were performed according to mentioned above standards. The tests were supervised by representatives of High Voltage Laboratory of Institute of Power Engineering in Warsaw in purpose to prove results of tests. The tests stands are under authority of Regional Verification Office in Warsaw (No. stand S08/OUM1-5/01 XVI i S08/OUM1-5/01 XVII).

4. PERFORMED TESTS

4.0 Routine test and determination of errors before tests in IEn and after tests finishing.

Before delivery the transformer to IEn Laboratory and after type test and special test completed in ABB Factory Laboratory in Przasnysz were performed determination of errors measurement under supervision of representative of IEn. During test were checked:

- verification of terminals marking,
- power-frequency withstand test on the primary winding 50 Hz, U_{test} = 275 kV, t = 60 s,
- partial discharge measurement for current transformers q<10pC (U_m) q < 5pC ($1{,}2 \cdot U_m / \sqrt{3}$),
- power-frequency withstand test on secondary windings 50 Hz, U_{test} = 3 kV, t = 60 s,
- power-frequency withstand test between sections 50 Hz, U_{test} = 4,5 kV, t = 60 s,
- determination of errors.

The test results are presented in reports attached to hereby Report (Appendix 2):

- Tests before type test and special test (Measurements before type test and special tests) - Report No. 2GKP011A1084700 – 19.01.2012,
- Tests after type test and special tests completed (Measurements after type test and special test completed) - 2GKP011A1084700 – 26.03.2012.

It were proved that all tests required in routine test gave positive results. It were proved that all metrological properties of transformer are comply accurate classes for all winding.

These tests results are base for later determination of errors for purpose of verification result of tests described below.

4.1 Lightning impulse test

Test was done in test arrangement of surge generator type Haefely 5 MV, 375 kJ. Equivalent circuit diagram is shows on Figure 2. The test was performed on standardized lightning impulse 1,2/50μs. The purpose of test was checking internal insulation of transformer. The influence of atmospheric condition on test voltage value was not taken into consideration.

The Lightning impulse test was performed jointly with chopped impulse test on the primary winding (clause 3.8 of hereby Report).

Test condition:

- Full impulse test voltage U = 650 kV,
- Chocked impulse test voltage 1,15 · 650 kV = 747,5 kV,
- Sequence of impulses:
  positive polarity – 15 full impulses,
  negative polarity – 1 full impulse, 2 chocked impulses, 14 full impulses,
- During test was recorded test voltage and current flowed through along of current transformer.

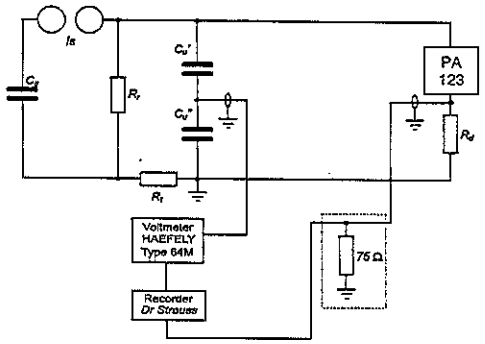


Fig. 2 Equivalent circuit diagram of test arrangement for lightning impulses:
$C_g = 0{,}125$ μF, $C_u = 1{,}2$ nF, $R_t = 175$ Ω, $R_r = 600$ Ω, $R_d = 8{,}95$ Ω.
Measurement uncertainty - 1,5 %

The oscillograms not shows failures of transformer insulation.

Result of test - positive.

Recorded oscillograms of all applied impulses are shown in Appendix No. 5 of hereby Report.

4.2 Wet test for outdoor transformers

The test was performed in arrangement of test transformer type TuR 700kV, 0,5A. according to standard PN-EN 60060-1:2011 (EN 60060-1:2010). Equivalent circuit diagram is presented on Figure 3.

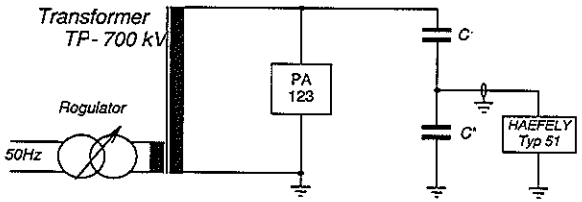


Fig. 3 Equivalent circuit diagram for power frequency voltage 50 Hz:
C = 200 pF (C' in series with C")
Measurement uncertainty - 1,5 %

During wet test for outdoor transformers the transformer was wetting by artificial rain at parameters:

- vertical component of precipitation $H_v = 1{,}6$ mm/min
- horizontal component of precipitation $H_h = 1{,}7$ mm/min
- water electrical resistivity $\rho = 98$ Ωm

The test voltage **U=275 kV** (corrected according to density of air) was applied during 1 minute.

During test were not observed any flashover or failure of insulation.

Test result - positive.

Fig. 4 Wet test of current transformers type PA 123 (PA 145) at power frequency voltage 50 Hz.

4.3 Determination of errors

4.3.1 Determination of errors

Measurements of errors for current transformers was performed in Factory Laboratory of ABB sp. z o.o. in Przasnysz 59 Leszno 59 Street, under supervision of representative of IEn.
The measurement was done two times:

- Tests before type test and special test (Measurements before type test and special tests) - Report No. 2GKP011A1084700 – 19.01.2012,
- Tests after type test and special tests completed (Measurements after type test and special test completed) - Report No. 2GKP011A1084700 – 26.03.2012.

Detailed information about tests results consists Appendix No. 2 of hereby Report.

Analyzing test results for current transformer was found that:

- **For measurement windings 1S1-1S2(5A) class 0,5S FS5 and 2S1-2S2(1A) class 0,5FS5:**
  - **for currents 0,05 I_n current error $\Delta I(\%) < 1,5\%$ and phase displacement $\delta_n(\min) < 90$ min.**
  - **for currents 0,20 I_n current error $\Delta I(\%) < 0,75\%$ and phase displacement $\delta_n(\min) < 45$ min.**
  - **for currents 1,0 I_n i 1,2 I_n current error $\Delta I(\%) < 0,5\%$ and phase displacement $\delta_n(\min) < 30$ min.**
- **For protective windings 3S1-3S2(5A) class 5P10 and 4S1-2S2(1A) class 5P10:**
  - **for currents 1,0 I_n current error $\Delta I(\%) < 1\%$ and phase displacement $\delta_n(\min) < 60$ min.**

For each of current windings values of error are contain in range compatible to appropriate class of accuracy.

4.3.2 Verification of instrument security factor FS of current part measurement windings of instrument transformer

The tested current transformer has two measurement windings:
1S1-1S2 → I_n= 5 A, S_n=5VA, class 0,5S FS5;
2S1-2S2 → I_n= 1 A, S_n=5VA, class 0,5 FS5.
The results of determination of core magnetization characteristics and veryfication of limiting e.m.f (check of instrument security factor (FS)) are present in Report No. 2GKP011A1084700 – 19.01.2012– (Appendix No. 2 of hereby Report).

It was found that instrument security factor FS is equal to 5 for measurement windings of current transformer is determined properly.

Test result - positive.

4.3.3 Verification of Limits of error ALF for protective winding of current part of instrument transformer

The tested combined transformer has two windings for protection purposes:
3S1-3S2 → I_n= 5 A, S_n=10VA, class 5P10;
4S1-4S2 → I_n= 1 A, S_n=10VA, class 5P10.

The results of determination of core magnetization characteristics and veryfication of limiting e.m.f (check of accuracy limit factor (ALF)) are present in No. 2GKP011A1084700 – 19.01.2012– (Appendix No. 2 of hereby Report).

It was found that limit of error ALF equal 10 for windings for protection of current transformer is determined properly.

Test result - positive.

4.4 Radio interference voltage measurement

Following to requirement of IEC/CISPR 18-2 the measurements was performed in testing arrangement as is show on Figure 5. The interference voltage was measured on resistance 300Ω at frequency 0,5 MHz. To determinate coefficient of correction +24 dB before measurement the instrument was calibrated by stabile signal generator . To measurement of interference voltage the instrument LMZ-5 was used. The level of background was checked for range of test voltages 0 - 150 kV. Interference voltages originated form testing arrangement, radio broadcasts etc., were below 5μV (14 dB).

According to PN EN 60044-1/A1 interference voltage at voltage $Up=1.1\cdot U_m/\sqrt{3}=92$ kV has not to exceed the value $RIV_{dop}=2500\mu V$.

The instrument had logarithmic scale:

$RIV_{dop}=2500\mu V \rightarrow 68$ dB (0 dB = 1 μV).

Before the test, the instrument transformer was supplied with voltage $1,5\cdot U_m/\sqrt{3}$, held for 30 sec. Next, within about 10 sec the voltage was decreased to value $1,1\cdot U_m/\sqrt{3}$, held for 30 sec.

The measurements were done at test voltages in range $0,3\div1,1\cdot U_m/\sqrt{3}$.Test voltage was decreased step by step with value 0,1xUp since $Up=1,1\cdot U_m/\sqrt{3}$ up to value $Up=0,3\cdot U_m/\sqrt{3}$. Next, voltage was increased by this same values and finally deceased again.. For each of test voltage the measurement of radio interference voltage were performed and registered level in last series of decreasing voltage was drawn in function of test voltage Utest.

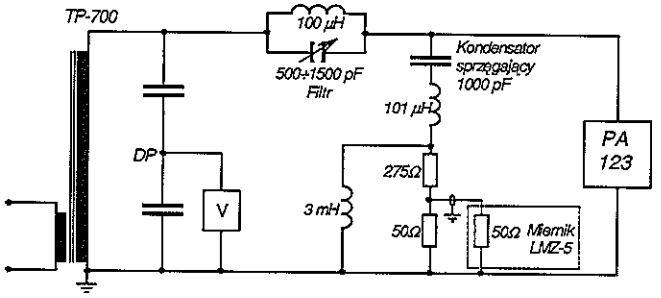
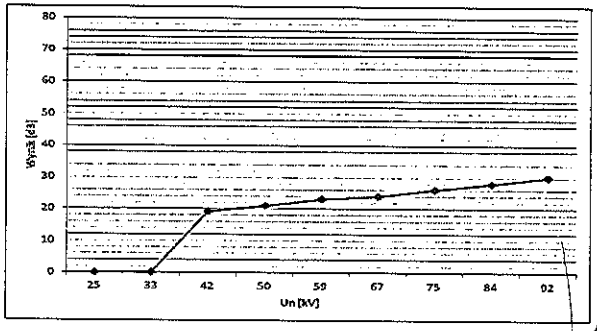


Fig. 5 Test arrangement for Radio interference voltage measurement

The results of measurements are present in Table and diagram below.

Up [kV]		92	84	75	67	59	50	42	33	25
xUn/√3		1,1	1,0	0,9	0,8	0,7	0,6	0,5	0,4	0,3
[dB]	→	6	5	2	0	-1	-2	-5	-	-
	←	6	3	2	0	-1	-3	-5	-	-
	→	6	3	2	0	-1	-3	-5	-	-
Wynik	[dB]	30	28	26	24	23	21	19	-	-
	[μV]	32	25	20	16	14	11	9	-	-



Measured Radio Interference Voltage RIV = 32 μV (30dB) is much less than permissible level $RIV_{perm}=2500$ μV (68dB).

Test result - positive.

4.5 Chopped impulse test on the primary winding

Chopped Impulse Test was supplemented to Lightning Impulse test 1,2/50μs and was described in clause 4.3 of hereby Report.

Recorded oscillograms not show of failure of insulation of current transformers. Test result - positive.

Oscillograms of all applied impulses are present in Appendix No. 4 of hereby Report.

4.6 Measurement of capacitance and dielectric dissipation factor

The measurement was performed st at ABB's Factory Laboratory (Raports No. 2GKP011A1084700 – 19.01.2012 and No. No. 2GKP011A1084700 – 26.03.2012 of Factory Laboratory ABB sp. z o.o. Przasnysz Division).

Condition of measurements:

Up = 10 kV; $110/\sqrt{3}$ kV = 63,5 kV; $123/\sqrt{3}$ kV = 71 kV

Ambient temperature during measurement was 22,2°C and (22,3°C).

Test results are present in table below:

Up [kV]	C_x [pF]	tgδ [%]
10	973 (973)	0,22 (0,22)
63,5	973 (973)	0,22 (0,22)
71	973 (973)	0,22 (0,22)

The standard specifications for capacitance and dissipation factor for instrument transformers not provide criterion for these parameters. The Standard PN-EN 60044-1:2000 (EN 60044-1:1999) only contain note that value of dissipation factor is usually less than 0,5%.

4.7 Mechanical tests

The mechanical tests were performed in Distribution Equipment Laboratory of Institute of Power Engineering in Warsaw. The test consist in applying to the transformer mechanical load – static and dynamic, in three direction in turn. Static load was 20% higher than standard requirement for II class of load. The test conditions were as follow:

$F_R = 3600$ N, $t = 60$ s

It was assumed that dynamic load is 1,4 times higher than static load.

During the tests behaving of current transformer was correct. After test not stated any damages or oil leakage.

Test result - positive.

Detailed information about test arrangement, performed tests and tests results are present in Report No. EUR/12/E/12-1E – 28.03.2012 – (Appendix 3)

4.10 Transmitted overvoltage measurement

During the test to the HV terminal of transformer were applied impulse voltage. It were recorded maximal value of overvoltages which came in each secondary windings - both current and voltage. According to requirement of Standard for impulse 0,5/50 μs and value $U_{test}=1,6 \times \sqrt{2} \times U_m/\sqrt{3} \equiv 189$ kV the values of transmitted overvoltages can not exceed 1,6 kV. During all measurements to the transformer were applied lightning impulses at value ten times less, that is $U_1 = 16$ kV. Concerning linear of phenomenon, registered overvoltages should have values less than 160 V (peak-to- peak value).

Registration was don by digital oscilloscope of "Dr Strauss" with input impedance 50 Ω and transmission band 200 MHz.

Results of test are present in table below.

Winding	Overvoltage value $U_{pp}/2$ x 10 [V]
1S1-1S2	346
2S1-2S2	314
3S1-3S2	420
4S1-4S2	398

It was found that for each of secondary winding of transformer transmitted overvoltages not exceed value of 1600 V.

Test result - positive.

The oscillograms of all applied and registered impulses are present in Appendix No. 6 of hereby Report.

5. SUMMARY

- The current instruments transformer type PA 123 (PA 145) manufactured by ABB sp. z o.o. 04-713 Warszawa, ul. Żegańska 1, with parameters described in clause 2 of hereby Report and identified on base provided documents (as presented in Appendix No. 1) was performed.
- The current instruments transformer type PA 123 (PA 145) for insulation level LI 650kV/ /AC 275kV **passed positively** selected type test according to requirement of standard:
  - PN-EN 60044-1:2000 + A1:2003 +A2:2004 „Przekładniki. Część 1: Przekładniki prądowe" (EN-60044-1:1999 + A1:2000 + A2:2003 „Instrument transformers. Part 1: Current transformers").

and according program described in Table 1, clause 3 of hereby Report.

6. LIST OF APPENDIXES

Appendix No. 1

Documents provided by ABB Sp. z o.o. used as base of identification of test object:

- Manufacturer Conformity Declaration
- Dimension drawing No. 2GKA614117 (19.01.2012)
- Electric diagram of Current instrument transformer
- Drawing of rated nameplate

Appendix No. 2

Reports of routine test and determination of errors of current transformer type PA 123 performed in Factory Laboratory of ABB sp. z o.o.

- Tests before type test and special test (Measurements before type test and special tests) - Report No. 2GKP011A1084700 – 19.01.2012,
- Tests after type test and special tests completed (Measurements after type test and special test completed) - 2GKP011A1084700 – 26.03.2012.

Appendix No. 3

Report of performed tests in Distribution Equipment Laboratory of Institute of Power Engineering in Warsaw.

- Test Report No. EUR/12/E/12-1E (Mechanical tests.)

Appendix No. 4

Lightning impulse test. Impulse 1,2/50 µs, full and chopped:

- Oscillograms of test currents and detection currents.

Appendix No. 5

Transmitted overvoltage measurement:

- Oscillograms of measured transmitted to secondary windings overvoltages.

AC 117

INSTYTUT ENERGETYKI (INSTITUTE OF POWER ENGINEERING)
Zespół ds. Certyfikacji (Certification Department)

PRODUCT EVALUATION REPORT

Nr DZC/135c/E/2014-1

Product name and symbol: **HV current transformer, single-phase, outdoor, type: PA 123a**

Supplier: **ABB Sp. z o.o., Oddział w Przasnyszu, ul. Leszno 59, 06-300 Przasnysz**

Warsaw, February 2015 r.

Author: Grażyna Wieczorek M. Sc.

Contents:

APPENDIX – Type test reports, special test reports and Manufacturer's Statement (pages not numbered)

Non-conformities observed:

None found

General evaluation result:

Positive
Based on the analysis made , herewith I conclude for granting of compliance certificates to the HV current transformers type PA 123a , with composite or ceramic insulator, manufactured by ABB Sp. z o.o., Oddział w Przasnyszu

Grażyna Wieczorek 26.02.2015

Full name signature date

1. Introduction

Report from evaluation of HV overhead, single-phase, current transformer series, types: PA 123a , manufactured by ABB Sp. z o.o., Oddział w Przasnyszu, was developed within the certification process carried out by Zespół ds. Certyfikacji (Certification Team) upon manufacturer's application (Contract No DZC/135c/E/2014 of the 06th October 2014)
This document concerns the new series of current instrument transformers featuring design modifications and type marked: PA 123a.

The PA 123a current transformers are designed for feeding measurement and protection systems in electrical power grids with the highest system voltage of 123 kV and frequency of 50 Hz. Current transformers consist of a current element located inside an enclosure with a composite insulator (cover configuration: straight and spiral) or with a ceramic insulator filled with transformer oil.

The PA 123a current transformer series tests were carried out on selected representatives at the laboratories of Instytut Energetyki (Institute of Power Engineering) in Warsaw and Instytut Elektrotechniki (Electrotechnical Institute) in Warsaw as well as (within the range of product tests and errors measurements) at the manufacturer's laboratory. The selection procedure of measurement transformer representatives included the most severe conditions resulting from the current transformer design and occurring during the temperature-rise tests, short-circuit withstand, voltage and mechanical tests such as: values of continuous and short-circuit currents, winding wire cross-section, different main circuits, power of windings for measurement and protection, housing types, accuracy classes, etc. Tests were carried out on eleven selected transformer prototypes. The results are valid for the entire transformer series acc. to the list as suggested for certification. Test results confirming the transformers features are listed in the reports in cl. 2 of this document. The test results were compared against requirements of the following standards:

- PN-EN 61869-1:2009
  Instrument transformers – Part 1: General requirements
- PN-EN 61869-2:2013-06
  Instrument transformers – Part 2: Detailed requirements for current transformers
- PN-EN 61869-3:2011
  Instrument transformers – Part 3: Detailed requirements for voltage transformers
- PN-EN 60529:2003
  Protection class provided by the housing (IP)
- PN-EN 62262:2003
  Degrees of protection against external mechanical impacts as provided by electric device enclosures (IK coding)

Customer/manufacturer: ABB Sp. z o.o., Przasnysz holds the complex certificate for the following standards: ISO 9001:2008, ISO 14001:2004 and PN-N-18001:2004 – certificate No 0198 150 01525 issued by TÜV Rheinland Polska Sp. z o.o.

2. List of applied documents

The current transformers design and the test results were evaluated and analysed based on the following documents delivered by the Manufacturer and included in the reports:

D1. Report No EWP/10/E/2014-1e, Temperature-rise test -PVA 145a (360 A), IEn, High Current Laboratory, Warsaw, January 2014

D2. Report No EWP/47/E/2014-1e, Temperature-rise test -PA 145a (1800 A), IEn, High Current Laboratory, Warsaw, January 2014 r.

D3. Report No EWP/35/E/2013-1e, Temperature-rise test -PVA 145a (2400 A), IEn, High Current Laboratory, Warsaw, January 2014 r.

D4. Report No EWP/35/E/2013-2e, Temperature-rise test -PVA 145a (900 A), IEn, High Current Laboratory, Warsaw, January 2014 r.

D5. Test Report No 8595/A/NZL/NBR/15, Temperature-rise test -PA 145a (3000 A), IEl, Distribution Equipment Test Laboratory Warsaw, January 2015 r.

D6. Report No EUR/34/E/14-1 E, Mechanical tests, IEn, Distribution Equipment Laboratory Warsaw, September 2014 r.

D7. Report NoEUR/34/E/14-2 E, Mechanical tests, IEn, Distribution Equipment Laboratory Warsaw, September 2013 r.

D8. Report No EUR/34/E/14-3 E, Mechanical tests, IEn, Distribution Equipment Laboratory Warsaw, September 2014 r.

D9. Report No EUR/34/E/14-4 E, Mechanical tests, IEn, Distribution Equipment Laboratory Warsaw, September 2014 r.

D10. Report No EUR/71/E/13-3 E, Short-time current test, Test for composite error, test of strength against short-circuit in the secondary circuit, IEn, Distribution Equipment Laboratory Warsaw, January 2014 r.

D11. Report No EUR/74/E/13 E, Short-time current test, Test for composite error, IEn, Distribution Equipment Laboratory Warsaw, December 2013 r.

D12. Test Report No 8596/A/NZL/NBR/15, Short-time current test, IEl, Distribution Equipment Test Laboratory Warsaw, January 2015 r.

D13. Report No EUR/71/E/13-4 E, Short-time current test, Test for composite error, IEn, Distribution Equipment Laboratory Warsaw, January 2014 r.

D14. Report No EUR/23/E/14 E, Short-time current test, Test for composite error, IEn, Distribution Equipment Laboratory Warsaw, May 2014 r.

D15. Test Report No EWN/145/E/13 Type tests, special tests and additional tests of combined transformers type PVA123a i PVA145a manufactured by ABB sp. z o.o., IEn, High Voltage Laboratory, Warsaw, January 2014 r.

D16. Test Report No Nr EWN/11/E/12-1, Type tests, special tests and additional tests of Voltage transformer typu PV 123, manufactured by ABB sp. z o.o., IEn, High Voltage Laboratory Warsaw, October 2012 r.

D17. Test Report No Nr EWN/11/E/12-2, tests of Current transformer type PA 123 (PA 145) with insulation level LI 650kV/AC 275kV, manufactured by ABB sp. z o.o., IEn, High Voltage Laboratory Warsaw, October 2012 r.

D18. Report No EWP/35/E/2013-3e) , Sprawdzenie ochrony przed uderzeniem mechanicznym, IEn, High Current Laboratory, Warsaw, February 2014 r.

D19. Report No 8281/A/NZL/NBR/12), IP tests for terminal box, IEl, Distribution Equipment Test Laboratory Warsaw, Warsaw, July 2012 r.

D20. Dimensional drawings:
- _ Dimensional drawing Combined instrument transformer PVA 123a-145a 2GKK614122/ABB R&D_TS_KU568/13 (17.12.2013),
- _ Dimensional drawing Combined instrument transformer PVA 123a-145a 2GKK614123/ABB R&D_TS_KU571/13 (17.12.2013),
- _ Dimensional drawing Combined instrument transformer PVA 123a-145a 2GKK614123/ABB R&D_TS_KU572/13 (17.12.2013),
- _ Dimensional drawing Combined instrument transformer PVA 123a-145a 2GKK614120/ABB R&D_TS_KU569/13/A (17.12.2013),
- _ Dimensional drawing Combined instrument transformer PVA 123a-145a 2GKK614121/ABB R&D_TS_KU569/13 (17.12.2013),
- _ Dimensional drawing Current transformer PA 145, 2GKA612004 (01.08.2014),
- _ Dimensional drawing Current transformer PA 145, 2GKA612002 (11.09.2014),
- _ Dimensional drawing Current transformer PA 145, 2GKA612001 (11.09.2014),
- _ Dimensional drawing Current transformer PA 145, 2GKA612003 (11.09.2014),
- _ Dimensional drawing Voltage transformer PV 123, 2GKV614114/ (19.01.2012),
- _ Dimensional drawing Current transformer PA 123 (PA 145), 2GKA614117 (19.01.2012),
- _ Dimensional drawing Current transformer PA 145, 2GKA612004 (01.08.2014),
- _ Dimensional drawing Current transformer PA 145, 2GKA614301 (01.08.2014).

D21. Routine test reports and accuracy check reports – see reports from tests D1÷D5, D10÷D17

D22. Rating plates – see reports from tests D1÷19

D23. Electrical diagrams – see reports from testsD1÷D5, D10÷D17

D24. Manufacturer's Statement issued on 2nd March 2015 r. –concerns total active power dissipated in current transformer windings.

3. Testing laboratory competences

Type tests, routine tests and special tests for PA...a transformers were carried out at the following laboratories:

- Laboratorium Wysokich Napięć (High Voltage Laboratory), a unit of Instytut Energetyki (Institute of Power Engineering) in Warsaw, holding the PCA Accreditation Certificate of the Research Laboratory PCA No AB 272.
- Laboratorium Urządzeń Rozdzielczych (Distribution Equipment Laboratory), a unit of Instytut Energetyki (Institute of Power Engineering) in Warsaw, holding the PCA Accreditation Certificate of the Research Laboratory PCA No AB 324.

- Laboratorium Wielkoprądowe (High Current Laboratory), a unit of Instytut Energetyki (Institute of Power Engineering) in Warsaw, holding the PCA Accreditation Certificate of the Research Laboratory PCA Nr AB 323.
- Laboratorium Fabryczne ABB Sp. z o.o. (ABB Manufacturing Plant Laboratory) in Przasnysz – Punkt Legalizacyjny OUM Warszawa (OUM Warsaw Verification Unit) – deviation measurement, and product tests under supervision of Instytut Energetyki (Institute of Power Engineering), Laboratorium Wysokich Napięć (High Voltage Laboratory).
- Laboratorium Badawcze Aparatury Rozdzielczej (Distribution Equipment Test Laboratory), a unit of Instytut Elektrotechniki (Electrotechnical Institute) in Warsaw, holding the PCA Accreditation Certificate of the Research Laboratory PCA No AB 074.

4. Test result list

4.1. Type tests and additional tests

The tests were made on selected PA ...a, PVA ...a and PV ... transformer designs (various rated currents for the current elements, various main circuit designs, various design of secondary circuits, different accuracy classes and various insulation covers, etc.) The tests results are valid for the entire transformer series acc. to the list as suggested for certification. Table 1 shows produced by manufacturer's solutions for the main circuits of current transformers. Representative designes for short-circuit tests and temperature-rise tests were selected from that list.

PVA...a and PA ... a transformers were selected to temperature-rise test based on the most heat-exposed design solutions.

Dielectric tests were made for two transformers type : PVA 123a, and 145a as well as PA 123 (145) and PV 123.

The short-circuit withstand tests were made for PVA...a and PA ...a transformers. Representatives designs were selected according to their main circuits exposition to dynamic and thermal effects.

Table 2 shows performed tests. Their scope meets requirements included in respective standards for: type tests, special tests, routine tests, and some additional requirements. Respective item numbers in PN-EN 61869 and IEC 61869 as well as report numbers with detailed test results are listed.

Results of all tests were positive.

4.2. Routine tests

Routine tests and accuracy class tests were carried out at the manufacturer's laboratory for all the transformers tested under the IEn supervision.

The tests included:

- oil measurements before filling the instrument transformer,
- Verification of markings of terminals,
- Power-frequency voltage withstand tests on primary terminals,
- Power-frequency voltage withstand tests on secondary terminals,
- partial discharge intensity,
- inter-winding insulation test,
- Test for accuracy,
- over-current coefficient determination,
- magnetisation characteristics determination,
- Measurement of capacitance and dielectric dissipation factor,
- winding resistance measurement.

Test results were listed in protocols, their numbers being the same as that of the transformer tested. After the voltage tests and short circuit tests, additional routine tests and accuracy class tests were carried out.

Tests result: positive

Table 1. Main circuit list:

Circuit design description	Current circuit assembly drawing number	Drawing title	Max current Icth	Max current Ith (1s) /Idyn	Performed positive tests with current Icth	Performed positive tests with current Ith (1s)/Idyn
Rod ϕ40 Cu	2GKK314130A000 1	Main circuit, rod ϕ40 Cu	3000 A	63/158 kA (40 kA/3s)	PA 145a 8595/NZL/NBR/15	PA 145a 8596/NZL/NBR/15
Rod ϕ40 Al	2GKK314131A000 1	Main circuit, rod ϕ40 Al	2400 A	63/158 kA	PVA 145a EWP/35/E/2013-1	PVA 145a EUR/74/E/13
Rod ϕ40 Al + pipe ϕ60x4 Al	2GKK314132A000 1	Main circuit, rod ϕ40 Al + rura ϕ60x4 Al	2400A -1800 A	63-63/ 158-158 kA	PVA 145a EWP/35/E/2013-1 PA 145a EWP/47/E/2014-1	PVA 145a EUR/74/E/13
Rod ϕ40 Al + pipe ϕ60x4Al + 2 turns of cable 240mm2	2GKK314133A000 1	Main circuit, rod ϕ40 Al + rura ϕ60x4Al + 2 turns of cable 240mm2	2400A -1800A -900 A	63-63-40/158-158-100 kA	PA 145a EWP/47/E/2014-1 PVA145a EWP/35/E/2013-1 EWP/35/E/2013-2[1)]	PVA 123a EUR/71/E/13-3
1 turn of cable 240mm2	2GKK314134A000 1	Main circuit 1 turns of cable 240 mm2	900 A	40/100 kA	PVA 145a EWP/35/E/2013-2[1)]	PVA 145a EUR/23/E/14
2 turns of cable 240mm2	2GKK314134A000 2	Main circuit 2 turns of cable 240 mm2	900 A	40/100 kA	PVA 145a EWP/35/E/2013-2[1)]	PVA 145a EUR/23/E/14

3 turns of cable 240mm2	2GKK314134A000 3	Main circuit 3 turns of cable 240 mm2	900 A	40/100 kA	PVA 145a EWP/35/E/2013-2[1)]	PVA 145a EUR/23/E/14
4 turns of cable 240mm2	2GKK314134A000 4	Main circuit 4 turns of cable 240 mm2	900 A	40/100 kA	PVA 145a EWP/35/E/2013-2[1)]	PVA 145a EUR/23/E/14
5 turns of cable 240mm2	2GKK314134A000 5	Main circuit 5 turns of cable 240 mm2	900 A	40/100 kA	PVA 145a EWP/35/E/2013-2[1)]	PVA 145a EUR/23/E/14
6 turns of cable 240mm2	2GKK314134A000 6	Main circuit 6 turns of cable 240 mm2	900 A	40/100 kA	PVA 145a EWP/35/E/2013-2[1)]	PVA 145a EUR/23/E/14
7 turns of cable 240mm2	2GKK314134A000 7	Main circuit 7 turns of cable 240 mm2	900 A	40/100 kA	PVA 145a EWP/35/E/2013-2[1)]	PVA 145a - NF 86144 EUR/23/E/14
8 turns of cable 240mm2	2GKK314134A000 8	Main circuit 8 turns of cable 240 mm2	900 A	40/100 kA	PVA 145a EWP/35/E/2013-2[1)]	PVA 145a EUR/23/E/14
2+2 turns of cable 240mm2	2GKK314135A000 1	Main circuit 2+2 turns of cable 240 mm2	900 A – 900 A	40-40/ 100-100 kA	PVA 145a EWP/35/E/2013-2[1)]	PVA 145a EUR/23/E/14
3+3 turns of cable 240mm2	2GKK314135A000 2	Main circuit 3+3 turns of cable 240 mm2	900 A – 900 A	40-40/ 100-100 kA	PVA 145a EWP/35/E/2013-2[1)]	PVA 145a EUR/23/E/14
4+4 turns of cable 240mm2	2GKK314135A000 3	Main circuit 4+4 turns of cable 240 mm2	900 A – 900 A	40-40/ 100-100 kA	PVA 145a EWP/35/E/2013-2[1)]	PVA 145a EUR/23/E/14
2+2+4 turns of cable 240mm2	2GKK314136A000 1	Main circuit 2+2+4 turns of cable 240 mm2	900 A – 900 A -900 A	40-40-40/100-100-100 kA	PVA 145a EWP/35/E/2013-2[1)]	PVA 145a EUR/23/E/14
3 turns of cable 120mm2	2GKK314137A000 1	Main circuit 3 turns of cable 120mm2	360 A	20/50 kA	PVA 145a EWP/10/E/2014-1	PVA 145a EUR/71/E/13-4
6 turns of cable 120mm2	2GKK314137A000 2	Main circuit 6 turns of cable 120mm2	360 A	20/50 kA	PVA 145a EWP/10/E/2014-1	PVA 145a EUR/71/E/13-4
9 turns of cable 120mm2	2GKK314137A000 3	Main circuit turns of cable 120mm2	360 A	20/50 kA	PVA 145a EWP/10/E/2014-1	PVA 145a EUR/71/E/13-4
12 turns of cable 120mm2	2GKK314137A000 4	Main circuit 12 turns of cable 120mm2	360 A	20/50 kA	PVA 145a EWP/10/E/2014-1	PVA 145a EUR/71/E/13-4
3+3 turns of cable 120mm2	2GKK314138A000 1	Main circuit 3+3 turns of cable 120 mm2	360 A – 360 A	20-20 / 50-50 kA	PVA 145a EWP/10/E/2014-1	PVA 145a EUR/71/E/13-4
6+6 turns of cable 120mm2	2GKK314138A000 2	Main circuit 6+6 turns of cable 120 mm2	360 A – 360 A	20-20 / 50-50 kA	PVA 145a EWP/10/E/2014-1	PVA 145a EUR/71/E/13-4
3+3+ turns of cable 120mm2	2GKK314139A000 1	Main circuit 3+3+6 turns of cable 120mm2	360 A – 360 A -360 A	20-20-20/50-50-50 kA	PVA 145a EWP/10/E/2014-1	PVA 145a EUR/71/E/13-4
Rod ϕ40 Cu + pipe ϕ60x4 Al	2GKK314159A000 1	Main circuit rod ϕ40 Cu + pipe ϕ60x4 Al	3000 A- 1800 A	63-63/158-158 kA (40 kA/3s)	PA 145a EWP/47/E/2014-1 8595/NZL/NBR/15	PA 145a 8596/NZL/NBR/15

[1)] See Manufacturer's Statement issued on 02.03.2015 r. concerning limitation of active power of windings resistance to 80 W.

Table 2. List of tests made for type PA...a current transformer

Item	Test type	Requirements	Report numbers
TYPE TESTS			
1	Short-time current test	PN EN 61869-2, p.7.2.201	8596/NZL/NBR/15 EUR/71//E/13-3 EUR/71//E/13-4 EUR/74//E/13 EUR/23/E/14
2	Temperature-rise test	PN EN 61869-1, p. 7.2.2 PN EN 61869-2, p. 7.2.2	EWP/10/E/2014-1 EWP/47/E/2014-1 EWP/35/E/2013-1

			EWP/35/E/2013-2 8595/NZL/NBR/15
3	Impulse voltage withstand test	PN-EN 61869-1, p.7.2.3 PN EN 61869-2, p. 7.2.3	EWN/145/E/13
4	Wet test for outdoor type transformers	PN-EN 61869-1, p.7.2.4 PN-EN 61869-2, p.7.2.4	EWN/11/E/12-1 EWN/11/E/12-2
5	Tests for accuracy	PN EN 61869-2, p. 7.2.6.201 ÷ 203	EWN/145/E/13 and protocols from manufacturer's laboratory
6	RIV test	PN EN 61869-1, p. 7.2.5.1	EWN/145/E/13
7	Test for composite error	PN EN 61869-2, p. 7.2.6.203	EUR/71//E/13-3 EUR/71//E/13-4 EUR/74/E/13 EUR/23/E/14
8	Terminal box verification of the IP coding	PN EN 61869-1, p. 7.2.7.1 PN-EN 60529, p.13.14	8281/NZL/NBR/12
9	Mechanical impact test (IK)	PN EN 61869-1, p. 7.2.7.2 PN-EN 62262	EWP/35/E/2013-3
	SPECIAL TESTS		
10	Chopped impulse voltage withstand test on primary terminals	PN-EN 61869-1, p.7.4.1 PN EN 61869-2, p. 7.4.1	EWN/145/E/13
11	Mechanical test	PN-EN 61869-1, p.7.4.5	EUR/34/E/14-1 EUR/34/E/14-2 EUR/34/E/14-3 EUR/34/E/14-4
12	Transmitted overvoltage test	PN-EN 61869-1, p.7.4.4	EWN/145/E/13
13	Measurement of capacitance and dielectric dissipation factor	PN-EN 61869-1, p.7.4.3 PN EN 61869-2, p. 7.4.3	and protocols from manufacturer's laboratory

5. SUMMARY

Based on the test results for selected representatives of transformers series type PA 123a and PA 145a, PVA 145a and PV 123 As well as on analysis of the standards, it was found that:

- There were performed all tests from the type test range, special tests and additional tests sufficient for a complete evaluation of the apparatuses.
- Instrument transformer errors tests and instrument transformer secondary circuit designs were analysed, and their metrological properties were confirmed.
- PA 123a instrument transformer main circuit designs were analysed. It was found out that the short-circuit tests and temeprsature-rise tests as carried out are binding for all design solutions.
- Tests were made according to requirements of the 61869 series standard (PN and IEC)
- Taken the test results under consideration, the technical data listed in Table 3 may be referenced to the PA 123a instrument transformer series.

- This document may be a basis for issuing compliance certificates for PA 123a instrument transformer series manufactured by ABB Sp. z o.o. Oddział w Przasnyszu. The certificate validity date is suggested to be November 2017.

Table 3. List of technical data assigned to PVA 123a

Transformer type PA 123a	
Highest voltage of current transformer [U_m]	≤ 123 kV
Rated frequency [f_R]	50 Hz
Rated insulation level	AC 230 kV / LI 550 kV
Burden class	F_R=3600N
External insulation – minimal creepage distance of insulator: • ceramic insulator • composite insulator	 3640 mm 3800 mm
Degree of protection to mechanical impact of enclosure [1]	IK7
Degree of protection of secondary terminal enclosure	IP55
Current element	
Rated primary current [I_{pr}]	50 A ÷ 3 000 A
Extended current rating	do 200%
Rated continuous thermal current [I_{cth}]	≤ 3000 A
Rated short-time thermal current [I_{th}] during 1 s	20 kA lub 40 kA lub 63kA
Rated short-time thermal current [I_{th}] during 3 s	20 kA lub 40kA
Rated dynamic current [I_{dyn}]	50 kA lub 100 kA lub 158 kA
Rated secondary current [I_{sr}]	1 A lub 5 A
Core power to measurements and to protection (S_r)	1VA – 200 VA
Measure core accuracy class (cl.)	0,1; 0,2; 0,2S; 0,5; 0,5S; 1; 3; 5
Protective core accuracy class (cl.)	5P; 10P; 5PR; 10PR; PX; PXR; TPX; TPY; TPZ

REMARKS: [1] Do not apply to ceramic insulators

APPENDIX

Type test reports, special test reports and manufacturers statements (pages not numbered)

D1. Report No EWP/10/E/2014-1e, Temperature-rise test – PVA 145a (360 A), IEn, High Current Laboratory, Warsaw, January 2014 r.

D2. Report No EWP/47/E/2014-1e, Temperature-rise test -PA 145a (1800 A), IEn, High Current Laboratory, Warsaw, January 2014 r.

D3. Report No EWP/35/E/2013-1e, Temperature-rise test -PVA 145a (2400 A), IEn, High Current Laboratory, Warsaw, January 2014 r.

D4. Report No EWP/35/E/2013-2e, Temperature-rise test -PVA 145a (900 A), IEn, High Current Laboratory, Warsaw, January 2014 r.

D5. Test report No 8595/A/NZL/NBR/15, Temperature-rise test -PA 145a (3000 A), IEl, Distribution Equipment Test Laboratory, Warsaw, January 2015 r.

D6. Report No EUR/34/E/14-1 E, Mechanical tests, IEn, Distribution Equipment Laboratory, Warsaw, September 2014 r.

D7. Report No EUR/34/E/14-2 E, Mechanical tests, IEn, Distribution Equipment Laboratory, Warsaw, September 2013 r.

D8. Report No EUR/34/E/14-3 E, Mechanical tests, IEn, Distribution Equipment Laboratory, Warsaw, September 2014 r.

D9. Report No EUR/34/E/14-4 E, Mechanical tests, IEn, Distribution Equipment Laboratory, Warsaw, September 2014 r.

D10. Report No EUR/71/E/13-3 E), Short-time current test, Test for composite error, test of strength against short-circuit in the secondary circuit, IEn, Distribution Equipment Laboratory, Warsaw, January 2014 r.

D11. Report No EUR/74/E/13 E Short-time current test, Test for composite error, IEn, Distribution Equipment Laboratory, Warsaw, December 2013 r.

D12. Test report No 8596/A/NZL/NBR/15, Short-time current test, IEl, Distribution Equipment Test Laboratory, Warsaw, January 2015 r.

D13. Report No EUR/71/E/13-4 E, Short-time current test, Test for composite error, IEn, Distribution Equipment Laboratory, Warsaw, January 2014 r.

D14. Report No EUR/23/E/14 E, Short-time current test, Test for composite error, IEn, Distribution Equipment Laboratory, Warsaw, May 2014 r.

D15. Test report No EWN/145/E/13, Type tests, special tests and additional tests of combined transformers type PVA123a i PVA145a produkcji ABB sp. z o.o., IEn, High Voltage Laboratory, Warsaw, January 2014 r.

D16. Test report No EWN/11/E/12-1, Type tests, special tests and additional tests of current transformer type PV 123, manufactured by ABB sp. z o.o., IEn, High Voltage Laboratory, Warsaw, October 2012 r.

D17. Test report No EWN/11/E/12-2, Tets of current transformer type PA 123 (PA 145) with dielectric level LI 650kV/AC 275kV, manufactured by ABB sp. z o.o., IEn, High Voltage Laboratory, Warsaw, October 2012 r.

D18. Report No EWP/35/E/2013-3e) , Mechanical impact test, IEn, High Current Laboratory, Warsaw, February 2014 r.

D19. Report No 8281/A/NZL/NBR/12 IP tests for terminal box, IEl, Distribution Equipment Test Laboratory, Warsaw, July 2012 r.

D20. Statement issued on 2nd March 2015 r. refers to the total active power dissipated in the current transformer windings.

Instytut Elektrotechniki
Electrotechnical Institute

ZESPÓŁ LABORATORIÓW INSTYTUTU ELEKTROTECHNIKI
LABORATORIUM BADAWCZE APARATURY ROZDZIELCZEJ
ul. M. Pozaryskiego 28, 04-703 WARSZAWA
tel.: +48 22 812 23 38, fax: +48 22 812 04 07

Testing Laboratory is accredited by Polish Centre of Accreditation, signatory of EA MLA. No. AB 074

AB 074

TEST REPORT No. 8595/A/NZL/NBR/15

Test objects:	**Current transformer PA 145a**
Client:	ABB Sp. z o.o. ul. Leszno 59, 06-300 Przasnysz
Manufacturer:	ABB Sp. z o.o. ul. Leszno 59, 06-300 Przasnysz
Test specification:	Temperature rise test
Normative document(s):	PN-EN 61869-2:2013-06
Reference/Order number:	504-021300/038
Date of tests completion:	15 January 2015 r.
Test results:	POSITIVE

Authorised by

Przemysław Berowski, Ph.D.

Head of Laboratories of the Electrotechnical Institute

Robert Franaszek, M.Sc.

WARSAW, 11.02.2015

This Test Report comprises 12 sheets in total.

Table of contents

1 List of applicable standards

- **PN-EN 61869-1:2009** Instrument transformers – Part 1: General requirements
- **PN-EN 61869-2:2013-06** Instrument transformers – Part 2: Additional requirements for current transformers

2 Range of tests performed

- Temperature rise test by PN-EN 61869-2:2013-06 clause 7.2.2

3 Ratings assigned by the manufacturer

Test object:	Current transformer
Type:	PA 145a
Manufacturer:	ABB Sp. z o.o., ul. Leszno 59, 06-300 Przasnysz
Serial No.:	2GKP014A1287155
Year of manufacture:	2014
Rating plate:	Figure 1, page 10
Design documentation:	1. Dimensional drawing No. 2GKA612004
	2. Drawing of current circuit No. 2GKK314159A0001

Rated primary current	I_{pr}	1500 – 3000 A
Rated continuous thermal current	I_{cth}	1800 – 3000 A
Rated frequency	f_r	50 Hz
Highest system voltage	U_m	145 kV
Rated power-frequency withstand voltage		275 kV
Rated lighting-impulse withstand voltage		650 kV
Rated short-time thermal current	I_{th}	63 – 63 kA
Rated dynamic current	I_{dyn}	158 – 158 kA
Rated duration of short circuit	t_k	1 s

Detailed list of components specified in technical project:

1. Dimensional drawing No. 2GKA612004
2. Drawing of current circuit No. 2GKK314159A0001

4 Temperature rise test

Test performed according to PN-EN 61869-2:2013-06 clause 7.2.2

Condition of test object before test:..... New

Date of test:..... 14 January 2015 r.

Ambient temperature:

- Before test..... 20,4°C
- After test..... 18,8°C

Duration of the test:..... 24 h 25 min.

Test current:..... 1. 3 600 A

..... 2. 3 000 A – after 16 hours

Frequency:..... 50 Hz

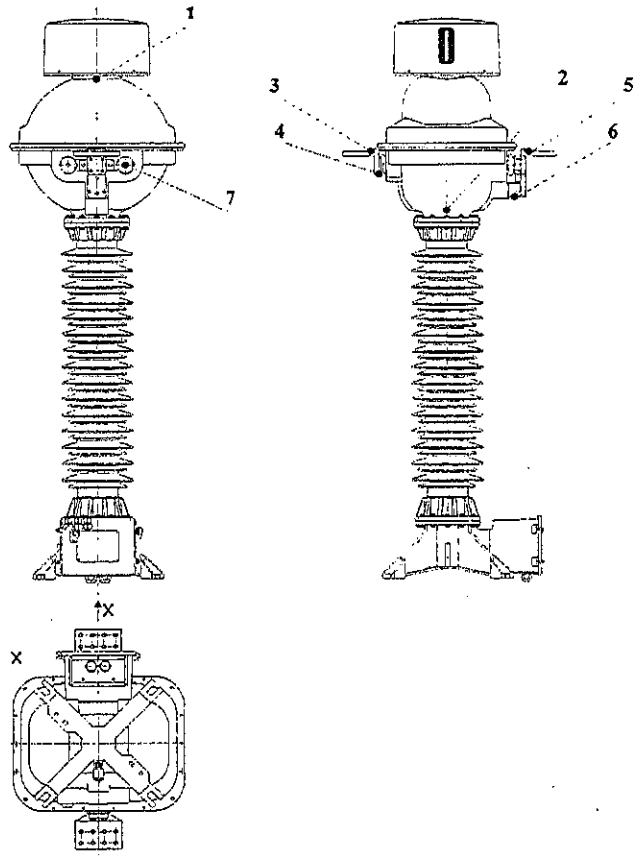
Primary current range:..... 3000 A

Supply connection:..... Bars Cu 3x1000 mm^2

Test object on testing stand:..... Phot. 1 – 2, page 9

The temperatures were measured with used of recorder HIOKI 8423, No. NBR-801-30600 and thermocouples type K.

Measurement points



Temperature rise test at current 3000 A / 50 Hz - results

Table 1 Temperature rise test results

Thermocouple location	Thermocouple No.	Stabilized temperature rise [K]	
		Measured	Permitted
Oil in top core	1	31,80	55
Head	2	29,45	---
Connection terminal P1	3	54,25	75
Bolt connection P1	4	56,25	75
Connection terminal P2	5	48,95	75
Bolt connection P2	6	47,70	75
Current circuit 3000 A	7	49,15	---

Table 2 Resistance and temperature rise of secondary windings test results

Heating time [h]	Measurements									
	T_a [°C]	$R_{1S1-1S2}$ [mΩ]	$R_{2S1-2S2}$ [Ω]	$R_{3S1-3S2}$ [mΩ]	$R_{4S1-4S2}$ [Ω]	$\Delta T_{1S1-1S2}$ [K]	$\Delta T_{2S1-2S2}$ [K]	$\Delta T_{3S1-3S2}$ [K]	$\Delta T_{4S1-4S2}$ [K]	Deflection of the oil level indicator [mm]
0	17,20	450,2	5,458	587,5	5,675	0	0	0	0	0
1	18,15	463,2	5,540	601,5	5,722	7,30	3,65	5,70	2,00	4
2	19,00	467,9	6,601	608,2	5,789	10,00	6,40	8,50	4,90	8
3	19,50	474,1	5,676	616,3	5,863	13,50	9,95	12,00	8,20	12
4	19,85	480,4	5,756	624,7	5,946	17,10	13,75	15,75	11,95	15
5	20,15	487,3	5,841	633,5	6,034	21,00	17,95	19,80	16,10	18
6	20,25	493,7	5,923	642,2	6,119	24,65	22,10	23,95	20,25	19
7	20,35	500,3	6,003	650,8	6,203	28,40	26,30	28,15	24,50	21
8	20,40	506,1	6,076	658,5	6,280	31,70	30,20	32,05	28,45	22
9	20,50	511,7	6,147	665,8	6,354	34,90	34,05	35,85	32,40	23
10	20,50	516,9	6,211	672,8	6,421	37,85	37,65	39,60	36,10	25
11	20,55	521,6	6,270	678,9	6,483	40,55	41,00	42,95	39,55	26
12	20,55	525,6	6,323	684,7	6,540	42,80	44,05	46,15	42,85	27
13	20,60	529,8	6,375	690,0	6,593	45,20	47,10	49,20	45,95	28
14	20,65	533,3	6,420	694,8	6,641	47,20	49,75	52,00	48,85	28
15	20,60	536,7	6,463	699,5	6,685	49,10	52,30	54,75	51,55	28
16	20,70	539,8	6,501	703,3	6,725	50,90	54,65	57,10	54,05	29
17	20,60	540,6	6,517	704,4	6,749	51,35	55,55	57,80	55,40	28
18	20,50	541,5	6,529	705,6	6,764	51,80	56,30	58,55	56,35	26
19	20,45	541,2	6,535	706,2	6,771	51,65	56,55	58,90	56,75	25
20	20,15	542,0	6,537	701,4	6,775	52,05	56,75	59,05	57,00	25
21	18,75	541,7	6,537	706,3	6,773	51,55	56,65	59,00	56,90	25
22	18,35	541,7	6,533	706,2	6,769	51,50	56,45	58,90	56,65	24
23	18,60	541,1	6,528	705,8	6,764	51,20	56,10	58,60	56,35	24
24	18,85	541,0	6,523	705,0	6,758	51,20	55,85	58,15	55,95	23
Permitted temperature rise						65 K				

Table 3 Resistance and temperature rise of primary windings test results

	Before test	After test
Date of test	14.01.2015	15.01.2015
$R_{P1-P2/A}$, [μΩ]	29	34,5
Ambient temperature [°C]	20,4	18,8
Temperature rise [K]	—	48,1
Permitted temperature rise [K]	—	65

Resistance was measured at direct current : ..... primary circuit: 100 A
..... secondary circuit 5 A: 0,5 A
..... secondary circuit 1 A: 0,1 A

The measuring instrument type RMO100GP No. 14G743G

According to PN-EN 61862-2 clause 7.2.2.203 was estimated thermal time constants as the time elapsed until 63% of maximum estimated temperature rise.

Table 4 Thermal time constants

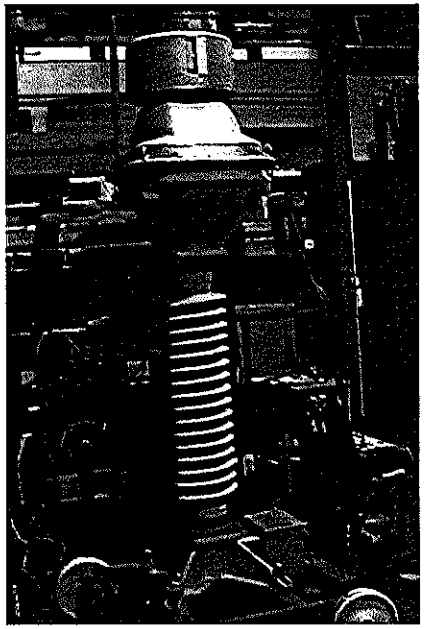
Thermocouple location	Thermocouples No.	Time constant T_c [h]
Oil in top core	1	6
Head	2	4
Connection terminal P1	3	1
Bolt connection P1	4	1
Connection terminal P2	5	1,5
Bolt connection P2	6	1,8
Current circuit 3000 A	7	2,5

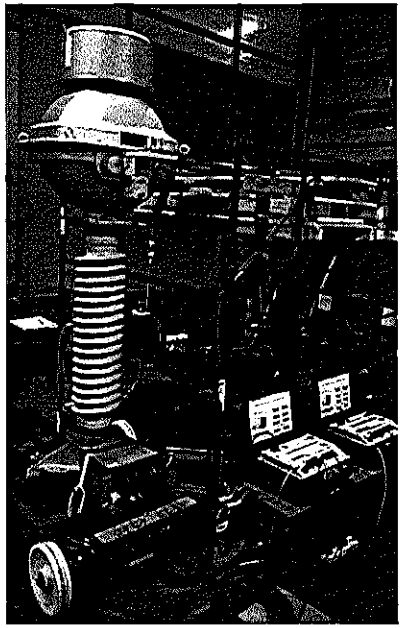
Condition of tested object after the test:

- The stabilized temperature rise of various parts of the current transformer did not exceed the values specified in the PN-EN 61869-1:2009, clause 6.4.1, table 5.
- No deterioration and failure was noted.

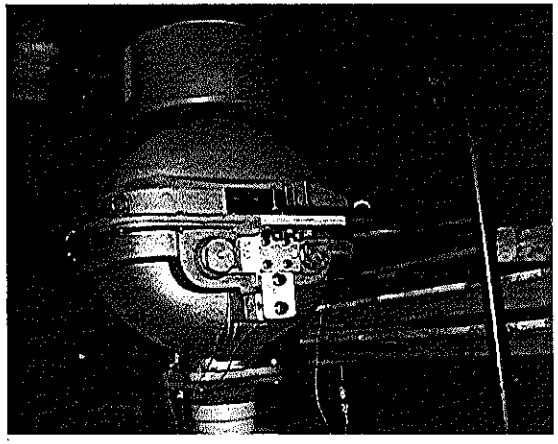
Test result: Object passed the test

5 Photographs





Phot. 1 Test object on temperature rise testing stand



Phot. 2 Test object on temperature rise testing stand

6 Drawings

ABB

Current Transformer | Typo: PA 145a

Insulation level	145/275/650 kV	Standard	PN-EN 61869-2	fn	50 Hz
Oil type	Nytro Libra	Weight / Oil weight	360 / 120 kg	Temp. range	-40°C ⎓ +40°C
S/N	2GKP014A1287155				

K_n 1500-3000/5-1-5-1-1 A/A

I_{th}/1s 63-63 kA I_{dyn} 158-158 kA

I_{cth} 1800-3000 A

	A	VA	Class	FS/ALF	Ext.%
1S1-1S2	5	200	0,2	10	120
2S1-2S2	1	100	0,1	5	120
3S1-3S2	5	20	5P	60	
4S1-4S2	1	35	10P	40	
5S1-5S2					
6S1-6S2					

Transportation: Vertical / Horizontal

Figure 1 Rating plate

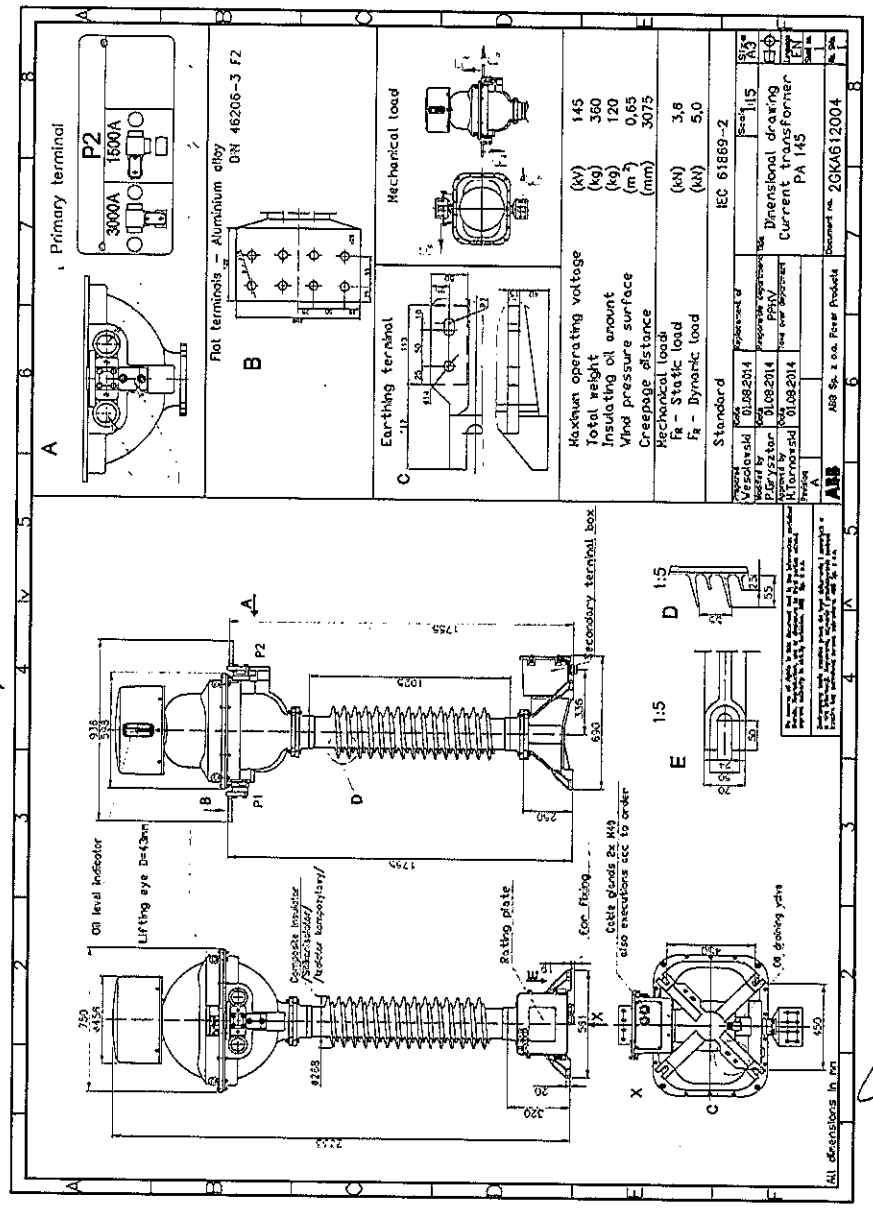


Figure 2 Dimensional drawing

7 Uncertainty electrical and non electrical quantities in laboratory

Measured quantity	*Range*	*Frequency*	*Measured parameter / uncertainty [%]*			
Voltage U / Divider RC	0 ≤ U ≤ 1000 V	dc - 20kHz	RMS	≤ ± 1.5	Peak	≤ ± 1.0
		> 20kHz	RMS	≤ ± 2.5	Peak	≤ ± 2.0
	1000 V ≤ U ≤ 10 kV	dc - 20kHz	RMS	≤ ± 2.0	Peak	≤ ± 1.5
		> 20kHz	RMS	≤ ± 2.5	Peak	≤ ± 2.0
	U > 10 kV	50Hz - 20kHz	RMS	≤ ± 3.0	Peak	≤ ± 2.5
		> 20kHz	RMS	≤ ± 3.5	Peak	≤ ± 3.0
Current I / Shunt	0 ≤ I ≤ 100 A	dc - 5kHz	RMS	≤ ± 1.5	Peak	≤ ± 1.0
			Joule integral	≤ ± 2.0	Peak – Peak/√8	≤ ± 2.0
		> 5kHz	RMS	≤ ± 2.0	Peak	≤ ± 1.5
			Joule integral	≤ ± 3.0	Peak – Peak/√8	≤ ± 3.0
	100 A ≤ I ≤ 10 kA	dc - 5kHz	RMS	≤ ± 1.5	Peak	≤ ± 1.0
			Joule integral	≤ ± 2.0	Peak – Peak/√8	≤ ± 2.0
		> 5kHz	RMS	≤ ± 2.0	Peak	≤ ± 1.5
			Joule integral	≤ ± 3.0	Peak – Peak/√8	≤ ± 3.0
	I > 10 kA	dc - 5kHz	RMS	≤ ± 2.0	Peak	≤ ± 1.5
			Joule integral	≤ ± 3.0	Peak – Peak/√8	≤ ± 3.0
		> 5kHz	RMS	≤ ± 2.5	Peak	≤ ± 2.0
			Joule integral	≤ ± 3.5	Peak – Peak/√8	≤ ± 3.5
Current I / Current transformer	0 ≤ I ≤ 100 A	50Hz - 5kHz	RMS	≤ ± 2.0	Peak	≤ ± 1.5
			Joule integral	≤ ± 2.5	Peak – Peak/√8	≤ ± 2.5
		> 5kHz	RMS	≤ ± 2.5	Peak	≤ ± 2.0
			Joule integral	≤ ± 3.0	Peak – Peak/√8	≤ ± 3.0
	100 A ≤ I ≤ 10 kA	50Hz - 5kHz	RMS	≤ ± 2.0	Peak	≤ ± 1.5
			Joule integral	≤ ± 2.5	Peak – Peak/√8	≤ ± 2.5
		> 5kHz	RMS	≤ ± 2.5	Peak	≤ ± 2.0
			Joule integral	≤ ± 3.0	Peak – Peak/√8	≤ ± 3.0
	10 kA ≤ I ≤ 30 kA	50Hz - 5kHz	RMS	≤ ± 3.0	Peak	≤ ± 2.5
			Joule integral	≤ ± 3.5	Peak – Peak/√8	≤ ± 3.5
		> 5kHz	RMS	≤ ± 3.5	Peak	≤ ± 3.0
			Joule integral	≤ ± 4.0	Peak – Peak/√8	≤ ± 3.5

Resistance R *bridge, multimeter*	20 µΩ ≤ R ≤ 600 µΩ	≤ ± 5 %
	0.6 mΩ ≤ R ≤ 600 mΩ	≤ ± 3 %
	0.6 Ω ≤ R ≤ 100 MΩ	≤ ± 1 %
Frequency f *oscilloscope, recorder TR*	≤ 10 kHz	≤ ± 0.2 %
	10 kHz ≤ f ≤ 1 Mhz	≤ ± 0.5 %
Time t *oscilloscope, recorder TR*	≤ 1 µs	≤ ± 20 %
	1 µs ≤ t ≤ 1 ms	≤ ± 10 %
	> 1 ms	≤ ± 10%
Temperature T thermocouples	-50 °C ≤ t ≤ 100 °C	≤ ± 0.2°C - *thermometer*
	-100 °C ≤ t ≤ 200 °C	≤ ± 0.8 °C - *thermocouples K, recordor*
Relative humidity	20 % do 90% RH	≤ ± 5 % RH
Length Lengthmeter	≤ 1 mm	≤ ± 0.05 mm
	1 mm ≤ l ≤ 30 mm	≤ ± 0.1 mm
	> 30 mm	≤ ± 5 %
Gas pressure p	≤ 20 bar	≤ ± 5 %
	20 bar ≤ p ≤ 200 bar	≤ ± 10 %
Atmosph. pressure		≤ ± 0.01 MPa

Instytut Elektrotechniki
Electrotechnical Institute

ZESPÓŁ LABORATORIÓW INSTYTUTU ELEKTROTECHNIKI
LABORATORIUM BADAWCZE APARATURY ROZDZIELCZEJ
ul. M. Pożaryskiego 28, 04-703 WARSZAWA
tel.: +48 22 812 23 38, fax: +48 22 812 04 07

Testing Laboratory is accredited by Polish Centre of Accreditation, signatory of EA MLA. No. AB 074

AB 074

TEST REPORT No. 8596/A/NZL/NBR/15

Test objects:	**Current transformer PA 145a**
Client:	ABB Sp. z o.o. ul. Leszno 59, 06-300 Przasnysz
Manufacturer:	ABB Sp. z o.o. ul. Leszno 59, 06-300 Przasnysz
Test specification:	Short-time current tests
Normative document(s):	PN-EN 61869-2:2013-06
Reference/Order number:	504-021300/038
Date of tests completion:	23 January 2015 r.
Test results:	POSITIVE

Authorised by
Przemysław Berowski, Ph.D.

Head of Laboratories of the Electrotechnical Institute
Robert Franaszek, M.Sc.

WARSAW, 11.02.2015

This Test Report comprises 28 sheets in total.

Table of contents

1 List of applicable standards

- **PN-EN 61869-1:2009** Instrument transformers – Part 1: General requirements
- **PN-EN 61869-2:2013-06** Instrument transformers – Part 2: Additional requirements for current transformers
- **GOST 7746-2001** Current transformers. General specifications [1]

2 Range of tests performed

- Short-time current test by PN-EN 61869-2:2013-06 clause 7.2.201

[1] These standards are outside scope of certification by PCA, but IEL laboratory is entitled to carry out test according to GOST standards under a the confirmations of competence by ENERGOSERT and ORGES.

3 Ratings assigned by the manufacturer

Test object:	Current transformer
Type:	PA 145a
Manufacturer:	ABB Sp. z o.o., ul. Leszno 59, 06-300 Przasnysz
Serial No.:	2GKP014A1287155
Year of manufacture:	2014
Rating plate:	Figure 1, page 16
Design documentation:	1. Dimensional drawing No. 2GKA612004
	2. Drawing of current circuit No. 2GKK314159A0001
	3. Routine test report of current instrument transformer before short-time current test - type: PA 145a, No. 2GKP014A1287155; ABB Sp. z o.o., Przasnysz, 17.12.2014
	4. Routine test report of current instrument transformer after short-time current test - type: PA 145a, No. 2GKP014A1287155; ABB Sp. z o.o., Przasnysz, 30.01.2015

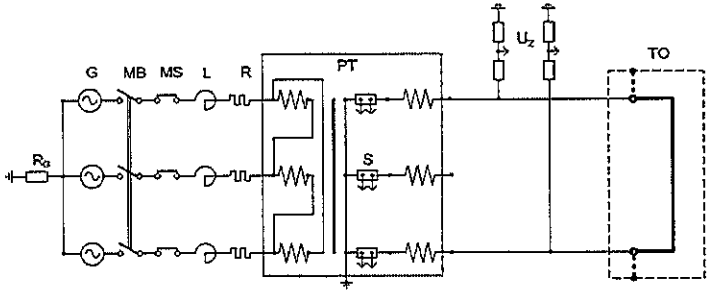
Rated primary current	I_{pr}	1500 – 3000 A
Rated continuous thermal current	I_{cth}	1800 – 3000 A
Rated frequency	f_r	50 Hz
Highest system voltage	U_m	145 kV
Rated power-frequency withstand voltage		275 kV
Rated lighting-impulse withstand voltage		650 kV
Rated short-time thermal current	I_{th}	63 – 63 kA
Rated dynamic current	I_{dyn}	158 – 158 kA
Rated duration of short circuit	t_k	1 s

Detailed list of components specified in technical project:

1. Dimensional drawing No. 2GKA612004
2. Drawing of current circuit No. 2GKK314159A0001

4 Short-time current test

Test performed according to PN-EN 61869-2:2013-06 clause. 7.2.201.



Sch. 1 Test circuit

G	Generator	**MB**	Master Breaker	**MS**	Making Switch
L	Reactors	**R**	Resistor	**PT**	Power Transformer
S	Current Measurement	**U_z**	Voltage Measurement	**TO**	Tested Object

Supply parameters:

- Power ..... 283 MVA
- Voltage ..... 4,5 kV
- Current ..... 63 kA
- Impedance ..... 71 mΩ
- Frequency ..... 50 Hz
- Earthing condition:
  - Generator ..... Earthed by 700 Ω
  - Short-circuit point ..... Insulated

Dynamic test at dynamic current 158 kA

Test object: ..... Current transformer PA 145a

Primary current range: ..... 1500 A

Condition of test object before test: ..... New

Date of test: ..... 23 January 2015 r.

Ambient temperature: ..... 2°C

Expected current parameters:

- Test peak current ..... I_p ..... 158 kA
- Duration of short-circuit ..... t_k ..... 0,06 s

Test object on testing stand: ..... Phot. 1, page 15

Test results: ..... Table 1, page 6, Osc. 90065, page 10

Scaling oscillogram: ..... Osc. 90064, str. 9

Table 1 Test results

Oscillogram No.	90065
Symmetrical current (r.m.s)	76,6 kA
Peak value of current	161,3 kA
Duration	61,8 ms

Condition of tested object after the test:

No deterioration and failure was noted.

Test result: Object passed the test

Dynamic test at dynamic current 100 kA

Test object: .....Current transformer PA 145a

Primary current range: .....1500 A

Condition of test object before test:.....After dynamic test

Date of test:.....23 January 2015 r.

Ambient temperature:.....2°C

Expected current parameters:

- Test peak current .....I_p..... 100 kA
- Duration of short-circuit.....t_k.....0,06 s

Test object on testing stand: .....Phot. 1, page 15

Test results:.....Table 2, page 7, Osc. 90066, page 11

.....Table 3, page 7, Osc. 90067, page 12

.....Table 4, page 7, Osc. 90069, page 13

Scaling oscillogram: .....Osc. 90064, page 9

Table 2 Test results 1

Oscillogram No.	90066
Symmetrical current (r.m.s)	48,0 kA
Peak value of current	101,2 kA
Duration	61,8 ms

Table 3 Test results 2

Oscillogram No.	90067
Symmetrical current (r.m.s)	48,1 kA
Peak value of current	101,3 kA
Duration	61,3 ms

Table 4 Test results 3

Oscillogram No.	90069
Symmetrical current (r.m.s)	47,6 kA
Peak value of current	101,39 kA
Duration	81,7 ms

Condition of tested object after the test:

No deterioration and failure was noted.

Test result: Object passed the test

Thermal test at thermal current 63 kA

Test object: .....Current transformer PA 145a

Primary current range: .....1500 A

Condition of test object before test:.....After dynamic tests

Date of test:.....23 January 2015 r.

Ambient temperature:.....2°C

Expected current parameters:

- Test current.....I_k.....63 kA
- Duration of short-circuit.....t_k.....1 s

Test object on testing stand: .....Phot. 1, page 15

Test results:.....Table 5, page 8, Osc. 90071, page 14

Scaling oscillogram: .....Osc. 90064, page 9

Table 5 Test results

Oscillogram No.	90071
Symmetrical current (r.m.s)	63,2 kA
Peak value of current	124,1 kA
Voltage on primary terminals P1-P2	24,54 V
Duration	1,23 s
Integral I^2dt	4,93 GA^2s

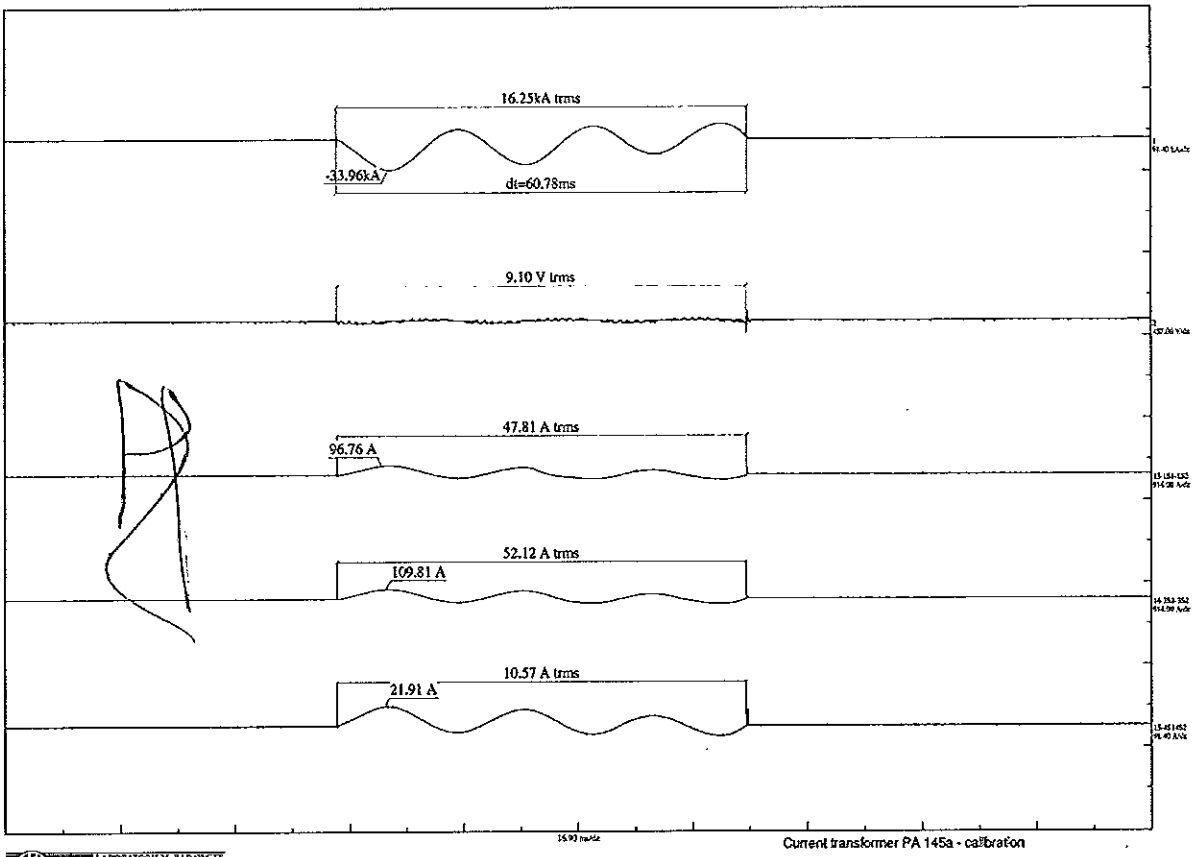
Condition of tested object after the test:

No deterioration and failure was noted.

Test result: Object passed the test

Current transformer complies with the requirements of:

- **short-time current test at thermal current 63 kA/1 s and at dynamic current 158 kA**
- **short-time current test at thermal current 40 kA/3 s and 3 dynamic tests at dynamic current 100 kA.**



Current transformer PA 145a - calibration

LABORATORIUM BADAWCZE APARATURY ROZDZIELCZEJ WARSZAWA

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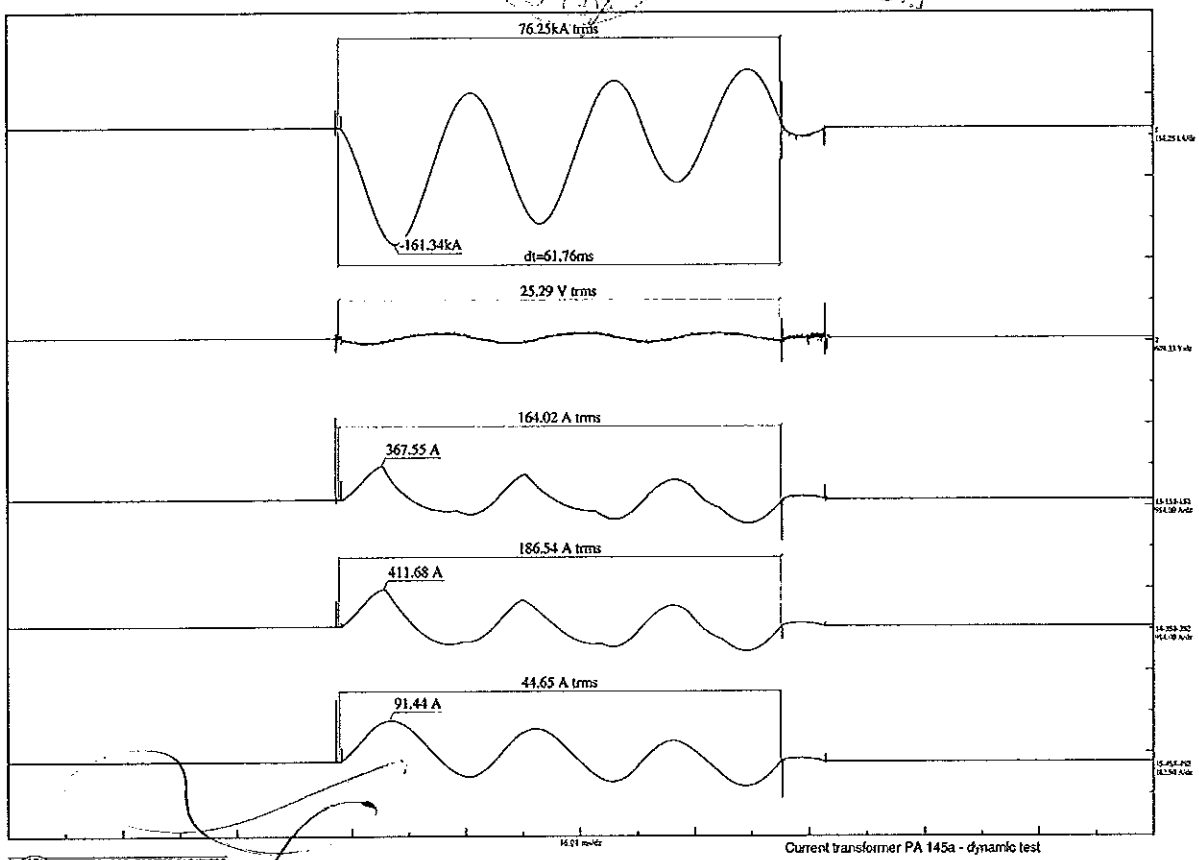
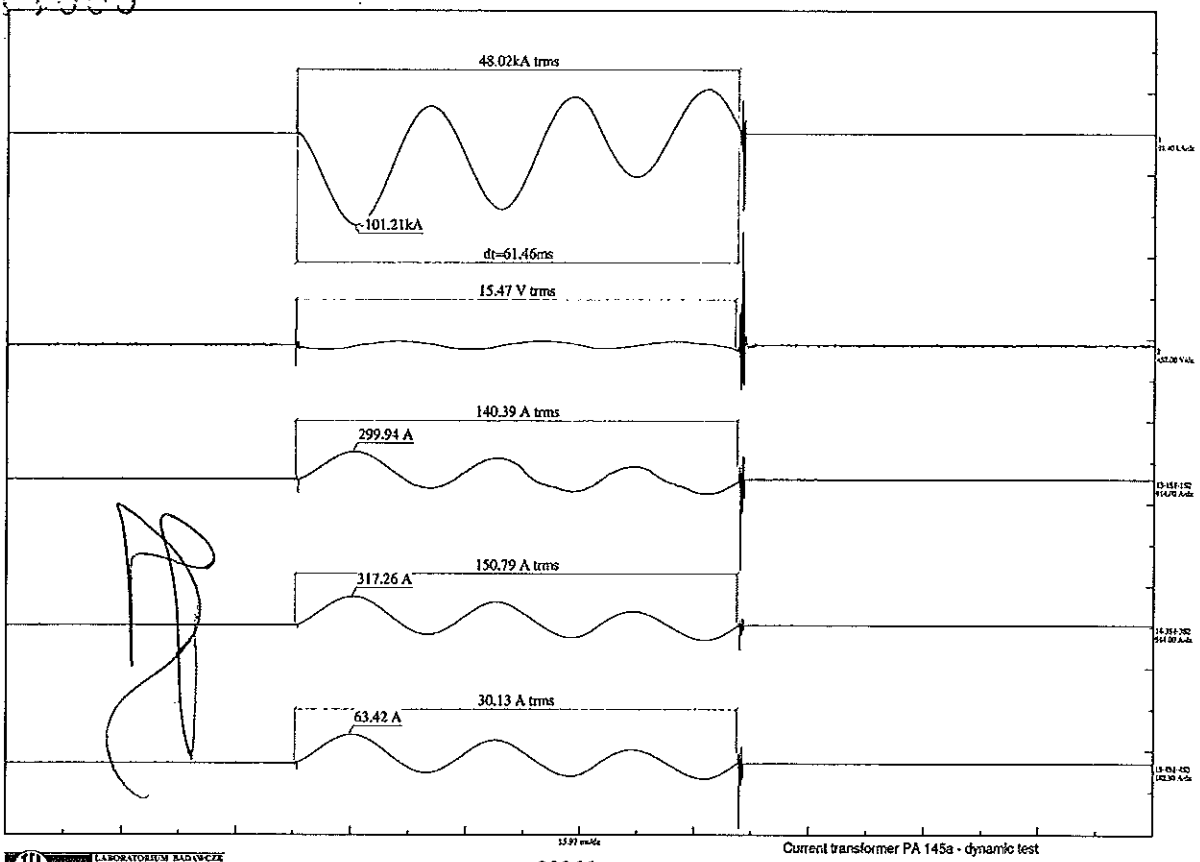


Current transformer PA 145a - dynamic test

LABORATORIUM BADAWCZE APARATURY ROZDZIELCZEJ WARSZAWA

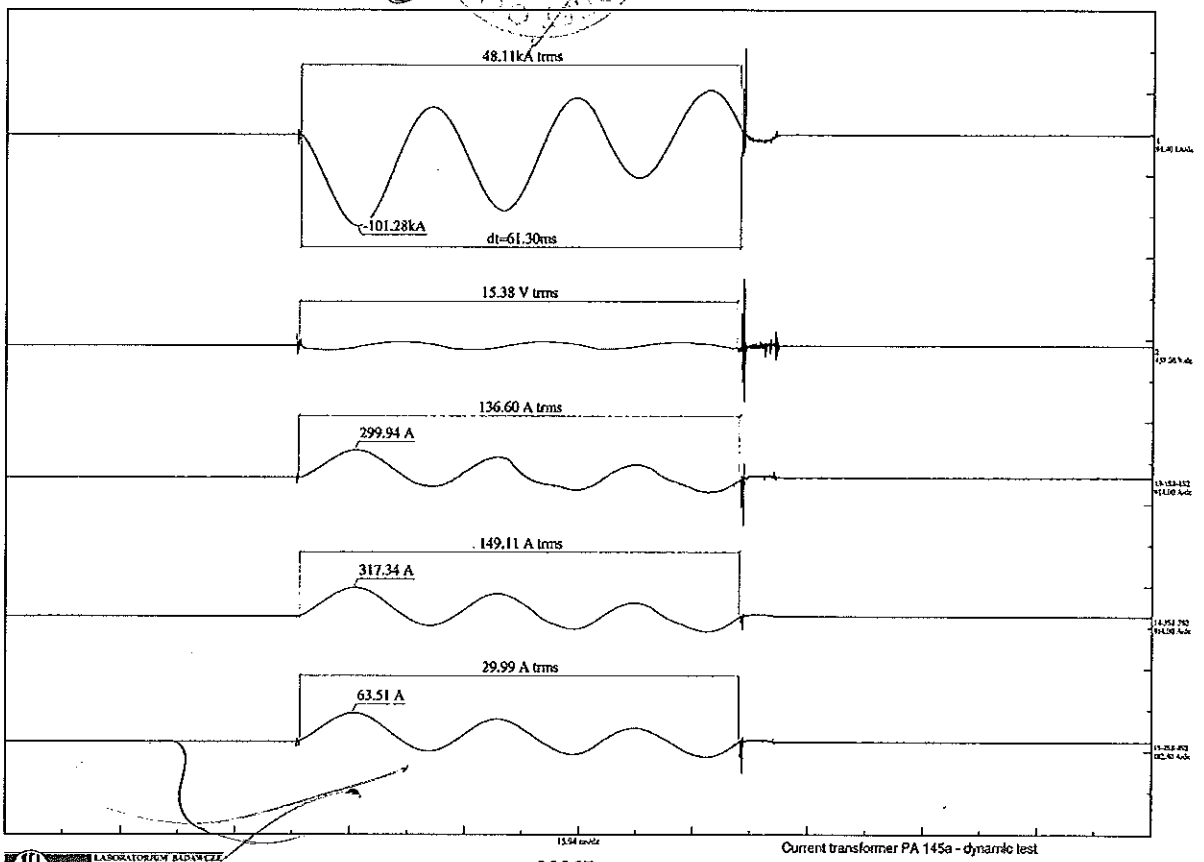
Data: 2015-01-23 14:39:04 Oscylogram Nr: 90065



Current transformer PA 145a - dynamic test

LABORATORIUM BADAWCZE APARATURY ROZDZIELCZEJ WARSZAWA

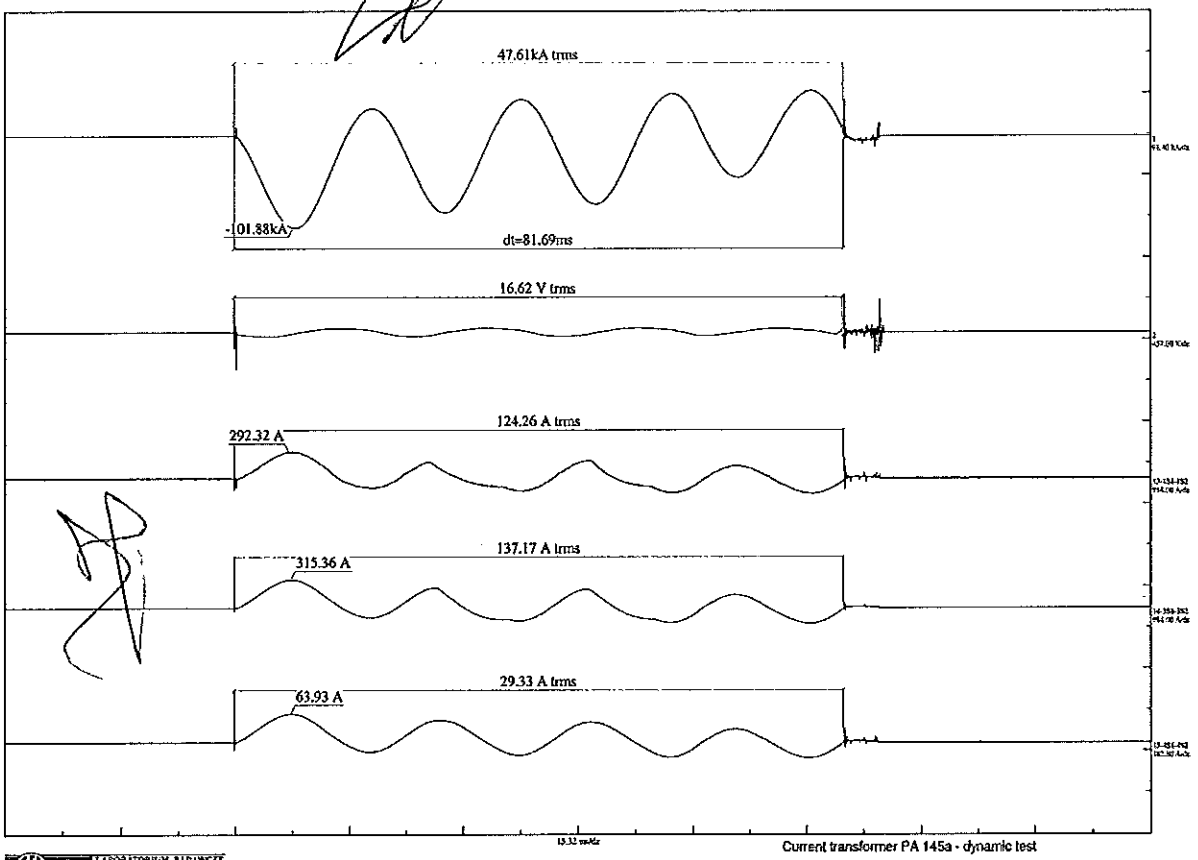
Data: 2015-01-23 14:52:00 Oscylogram Nr: 90066



Current transformer PA 145a - dynamic test

LABORATORIUM BADAWCZE APARATURY ROZDZIELCZEJ WARSZAWA

Data: 2015-01-23 15:03:30 Oscylogram Nr: 90067



LABORATORIUM BADAWCZE APARATURY ROZDZIELCZEJ WARSZAWA

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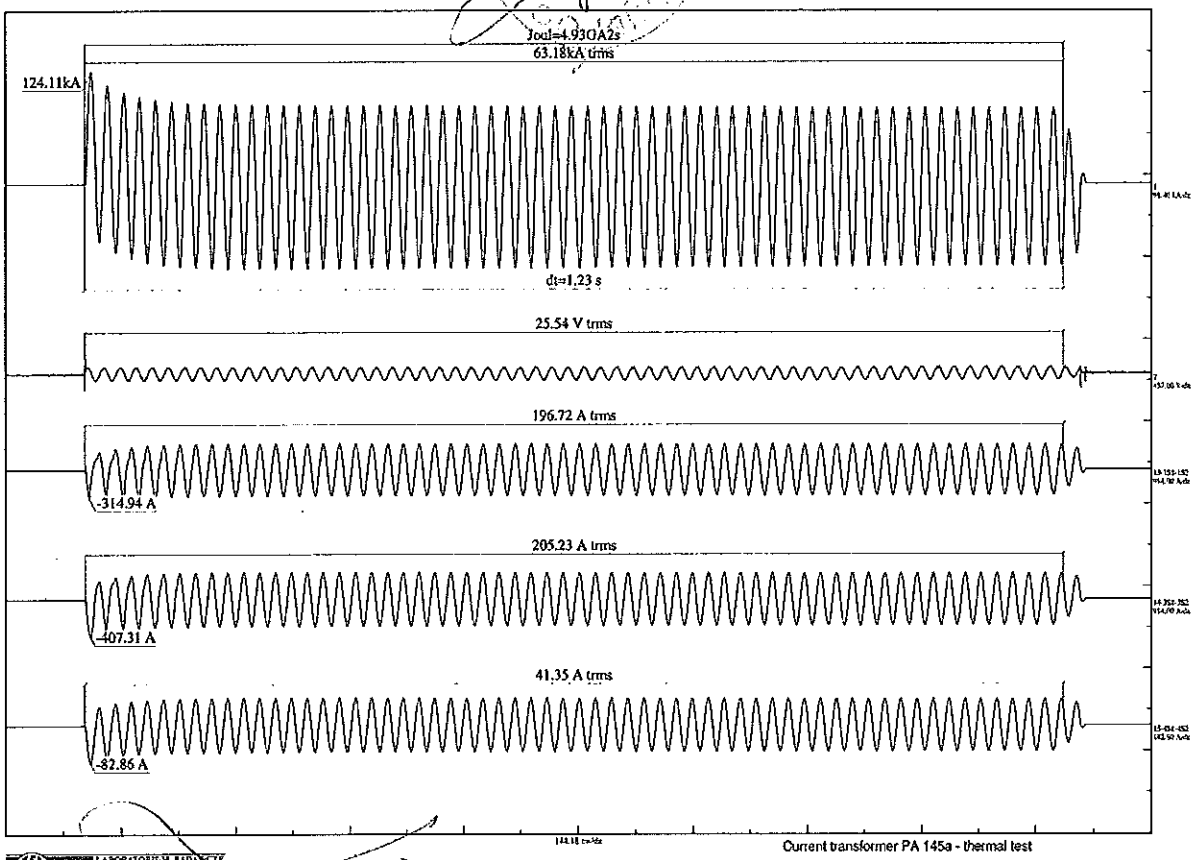
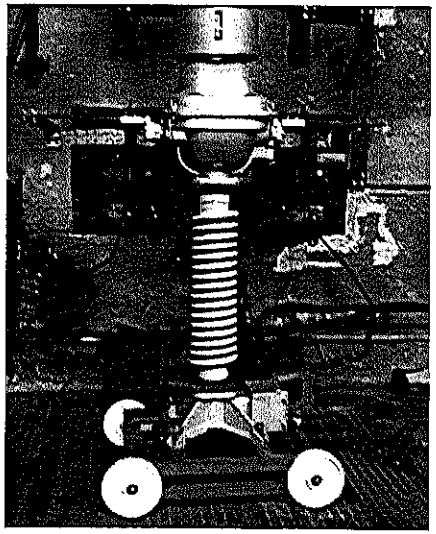


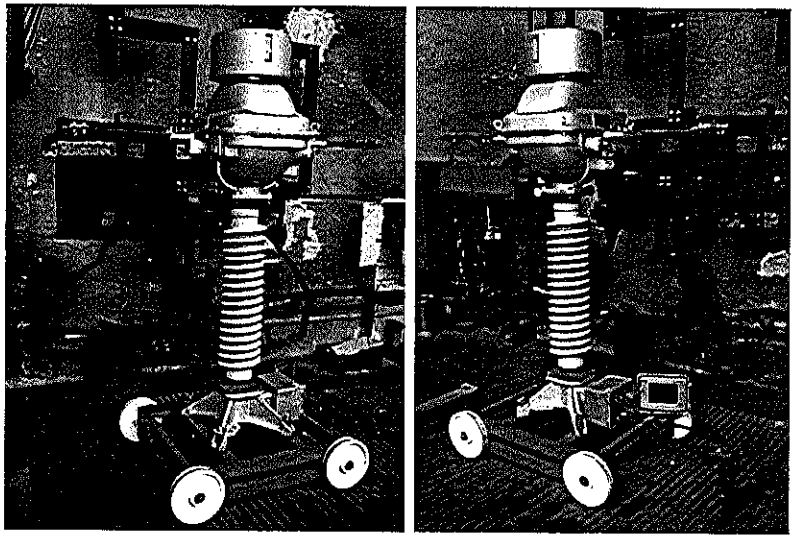
LABORATORIUM BADAWCZE APARATURY ROZDZIELCZEJ WARSZAWA

Data: 2015-01-23 15:39:30 Oscylogram Nr: 90071

5 Photographs



Phot. 1 Test object on short-time current testing stand



Phot. 2 Test object after tests

6 Drawings

ABB

Current Transformer | Type: PA 145a

Insulation level	145/275/650 kV	Standard	PN-EN 61869-2	fn	50 Hz
Oil type	Nytro Libra	Weight / Oil weight	360 / 120 kg	Temp. range	-40°C — +40°C
S/N	2GKP014A1287155				

K_n 1500-3000/5-1-5-1-1 A/A

$I_{th}/1s$ 63-63 kA I_{dyn} 158-158 kA

I_{cth} 1800-3000 A

	A	VA	Class	FS/ALF	Ext.%
1S1-1S2	5	200	0,2	10	120
2S1-2S2	1	100	0,1	5	120
3S1-3S2	5	20	5P	60	
4S1-4S2	1	35	10P	40	
5S1-5S2					
6S1-6S2					

Transportation: Vertical / Horizontal

Figure 1 Rating plate

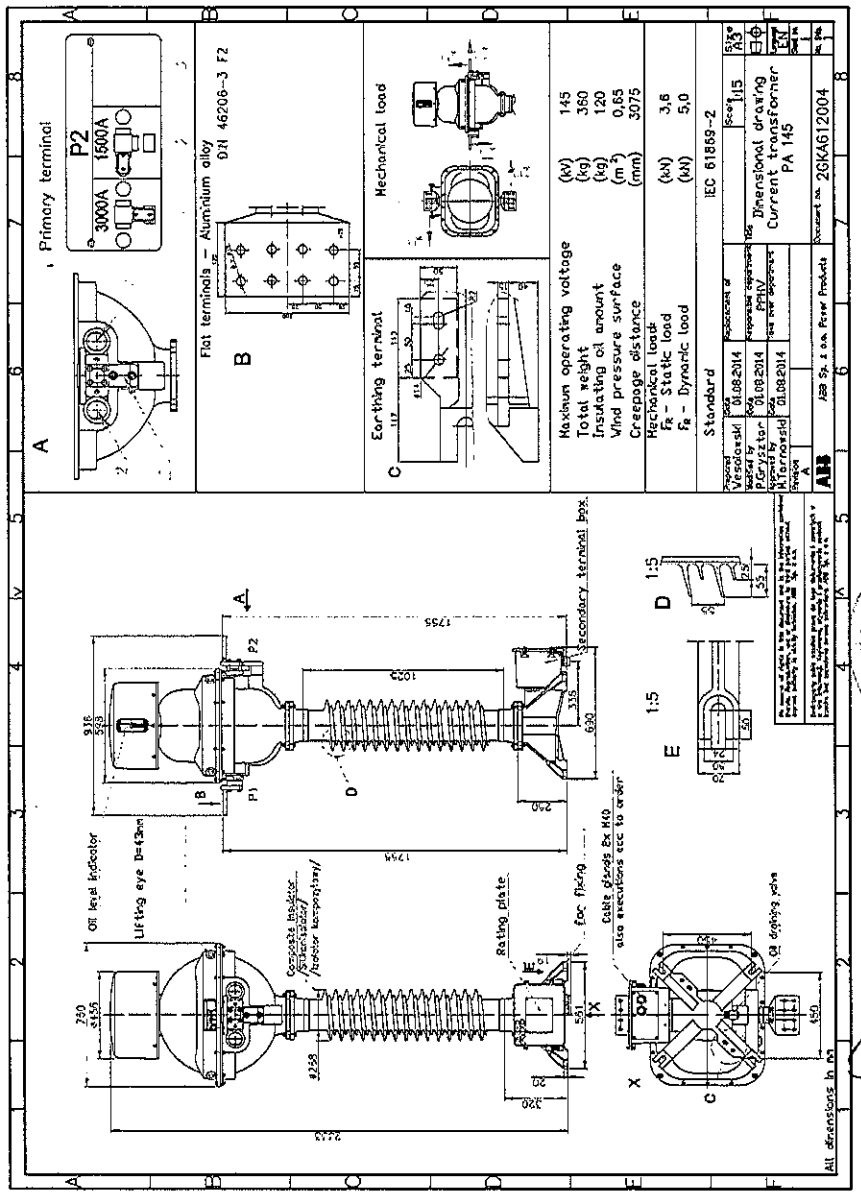


Figure 2 Dimensional drawing

7 Uncertainty electrical and non electrical quantities in laboratory

Measured quantity	*Range*	*Frequency*	*Measured parameter / uncertainty [%]*			
Voltage U / Divider RC	0 ≤ U ≤ 1000 V	dc - 20kHz	RMS	≤ 1.5	Peak	≤ 1.0
		> 20kHz	RMS	≤ 2.5	Peak	≤ 2.0
	1000 V ≤ U ≤ 10 kV	dc - 20kHz	RMS	≤ 2.0	Peak	≤ 1.5
		> 20kHz	RMS	≤ 2.5	Peak	≤ 2.0
	U > 10 kV	50Hz - 20kHz	RMS	≤ 3.0	Peak	≤ 2.5
		> 20kHz	RMS	≤ 3.5	Peak	≤ 3.0
Current I / Shunt	0 ≤ I ≤ 100 A	dc - 5kHz	RMS	≤ 1.5	Peak	≤ 1.0
			Joule integral	≤ 2.0	Peak – Peak/√8	≤ 2.0
		> 5kHz	RMS	≤ 2.0	Peak	≤ 1.5
			Joule integral	≤ 3.0	Peak – Peak/√8	≤ 3.0
	100 A≤ I ≤ 10 kA	dc - 5kHz	RMS	≤ 1.5	Peak	≤ 1.0
			Joule integral	≤ 2.0	Peak – Peak/√8	≤ 2.0
		> 5kHz	RMS	≤ 2.0	Peak	≤ 1.5
			Joule integral	≤ 3.0	Peak – Peak/√8	≤ 3.0
	I > 10 kA	dc - 5kHz	RMS	≤ 2.0	Peak	≤ 1.5
			Joule integral	≤ 3.0	Peak – Peak/√8	≤ 3.0
		> 5kHz	RMS	≤ 2.5	Peak	≤ 2.0
			Joule integral	≤ 3.5	Peak – Peak/√8	≤ 3.5
Current I / Current transformer	0 ≤ I ≤ 100 A	50Hz - 5kHz	RMS	≤ 2.0	Peak	≤ 1.5
			Joule integral	≤ 2.5	Peak – Peak/√8	≤ 2.5
		> 5kHz	RMS	≤ 2.5	Peak	≤ 2.0
			Joule integral	≤ 3.0	Peak – Peak/√8	≤ 3.0
	100 A≤ I ≤ 10 kA	50Hz - 5kHz	RMS	≤ 2.0	Peak	≤ 1.5
			Joule integral	≤ 2.5	Peak – Peak/√8	≤ 2.5
		> 5kHz	RMS	≤ 2.5	Peak	≤ 2.0
			Joule integral	≤ 3.0	Peak – Peak/√8	≤ 3.0
	10 kA ≤ I ≤ 30 kA	50Hz - 5kHz	RMS	≤ 3.0	Peak	≤ 2.5
			Joule integral	≤ 3.5	Peak – Peak/√8	≤ 3.5
		> 5kHz	RMS	≤ 3.5	Peak	≤ 3.0
			Joule integral	≤ 4.0	Peak – Peak/√8	≤ 3.5

Resistance R *bridge, multimeter*	20 μΩ≤ R ≤ 600 μΩ	≤ 5 %
	0.6 mΩ≤ R ≤ 600 mΩ	≤ 3 %
	0.6 Ω ≤ R ≤ 100 MΩ	≤ 1 %
Frequency f *oscilloscope, recordor TR*	≤ 10 kHz	≤ 0.2 %
	10 kHz ≤ f ≤ 1 Mhz	≤ 0.5 %
Time t *oscilloscope, recordor TR*	≤ 1 μs	≤ 20 %
	1 μs≤ t ≤ 1 ms	≤ 10 %
	> 1 ms	≤ 10%
Temperature T thermocouples	-50 °C≤ t ≤ 100 °C	≤ 0.2°C - *thermometer*
	-100 °C≤ t ≤ 200 °C	≤ 0.8 °C - *thermocouples K, recordor*
Relative humidity	20 % do 90% RH	≤ 5 % RH
Length Lengthmeter	≤1 mm	≤0.05 mm
	1 mm≤ l ≤30 mm	≤0.1 mm
	>30 mm	≤ 5 %
Gas pressure p	≤ 20 bar	≤ 5 %
	20 bar ≤ p ≤ 200 bar	≤ 10 %
Atmosph. pressure		≤ 0.01 MPa

8 Annex A – Routine test report of current instrument transformer before short-time current test

ABB Sp. z o.o. 06-300 Przasnysz ul. Leszno 59		Routine test report of current instrument transformer	TYPE: PA145a Serial no: 2GKP014A1287155	
Ith 1s [kA]: 63-63	Idyn [kA]: 158-158	Icth [A]: 1800-3600	PN-EN 61869-2	50 Hz

Winding	Isn [A]	Sn [VA]	class	Ratio [A/A]
1S1-1S2	5	200	0,2FS 10	1500-3000/5
2S1-2S2	1	100	0,1FS 5	1500-3000/1
3S1-3S2	5	20	5P 60	1500-3000/5
4S1-4S2	1	35	10P 40	1500-3000/1

List of performed tests:

1. Oil dielectric parameters check before filling (oil after treatment): tg δ acc. IEC 60247, breakdown voltage acc. IEC 60156 ☑
2. Verification of terminal markings ☑
3. Pressure and tightness test: oil overpressure: 0,8 bar / 24h – no traces of oil leakage ☑
4. Power-frequency withstand test on primary winding - P1+P2: Up = 230kV / 60s, f = 50Hz ☑
5. Partial discharge measurement ☑
6. Power-frequency withstand test on secondary windings - Up = 3 kV/60s, f=50Hz ☑
7. Inter-turn overvoltage test - lower value (U peak=4,5kV or U peak for Icth) / ☑
8. Determination of errors ☑
9. Determination of the over current factors: FS, ALF ☑
10. Measurement of capacitance and dielectric dissipation factor - tgδ ☑
11. Determination of core magnetization characteristics ☑
12. Measurement of windings' resistance ☑

Oil dielectric parameters check before filling (oil after treatment)

- Measurement of oil tg δ according to IEC
  Tg δ = 0.1983 %; electrical stress = 1kV/mm, f = 50Hz, oil temp. = 90C

- Measurement of breakdown voltage according to IEC 60156
  Mean breakdown voltage = 76.27 kV, Relative standard deviation = 5.87
  f = 50Hz, oil temp. = 25.4 °C, measurement without the stirrer, type of electrodes used: partially spherical.

Sample	Breakdown voltage [kV]
1	77.7
2	77.9
3	72.7
4	83.2
5	70.4
6	75.7

Partial discharge measurement

- Measurement according to procedure A (PD test voltages were reached while decreasing the voltage after the power-frequency withstand test on primary winding)
  Stress voltage: 275 kV / 60 s
  Frequency: 50 Hz

Test voltage	1,2 Um = 174 kV	1,2 Um / √3 = 100.5 k
Level of partial discharge	1 pC	0.9 pC

Remarks: background noise level: 0.7 (measured after voltage switch off),
measuring circuit was calibrated with 5 pC (calibrating

Inter-turn overvoltage test

Winding	Peak voltage on secondary winding [kVpeak]	Current in primary winding [A]
1S1-1S2	4.5	1450
2S1-2S2	4.5	350
3S1-3S2	4.5	1000
4S1-4S2	3.24	3600

Determination of errors ε I %), Δφ I min)

Ipn (A): 1500

1S1-1S2: 200 VA				p.f. = 0,8 lag.
	0,05 In	0,2 In	1,0 In	1,2 In
ε I	-0.313	-0.147	-0.042	-0.032
Δφ I	6.3	3.1	1.0	0.7

1S1-1S2: 50 VA				p.f. = 0,8 lag.
	0,05 In	0,2 In	1,0 In	1,2 In
ε I	-0.056	0.046	0.089	0.092
Δφ I	3.9	1.8	0.9	0.8

2S1-2S2: 100 VA				p.f. = 0,8 lag.
	0,05 In	0,2 In	1,0 In	1,2 In
ε I	-0.058	-0.039	-0.003	-0.003
Δφ I	1.3	0.3	-0.5	-0.4

2S1-2S2: 25 VA				p.f. = 0,8 lag.
	0,05 In	0,2 In	1,0 In	1,2 In
ε I	0.015	0.014	0.017	0.018
Δφ I	0.3	0.2	0.0	0.0

3S1-3S2: 20 VA				p.f. = 0,8 lag.
	1,0 In			
ε I	-0.016			
Δφ I	0.3			

4S1-4S2: 35 VA				p.f. = 0,8 lag.
	1,0 In			
ε I	-1.323			
Δφ I	63.5			

ε I				
Δφ I				

Ipn (A): 3000

1S1-1S2: 200 VA				p.f. = 0,8 lag.
	0,05 In	0,2 In	1,0 In	1,2 In
ε I	-	-	-0.043	-
Δφ I	-	-	1.0	-

Measurements uncertainty: $\varepsilon_I = \pm 0{,}045\ \%$, $\Delta\varphi_I = \pm 2{,}3$ min

Determination of the over current factors:

- Instrument security factor (FS) of measuring cores

Winding	Io [A]	U [V]	E_{FS} [V]	Condition	Assessment
1S1-1S2	5	233.67	422.08	U < E_{FS}	☑
2S1-2S2	0.5	227	526.03	U < E_{FS}	☑

- accuracy limit factor (ALF) – test for composite error ε_c of protective cores

Winding	E_{ALF} [V]	Ie [A]	ε_c [%]	Condition	Assessment
3S1-3S2	430.12	0.047	0.02	$\varepsilon_c \leq 5\%$	☑
4S1-4S2	1625.98	0.898	2.25	$\varepsilon_c \leq 10\%$	☑
5S1-5S2		0.242		$\varepsilon_c \leq$	

Measurement of capacitance and dielectric dissipation factor - tg δ

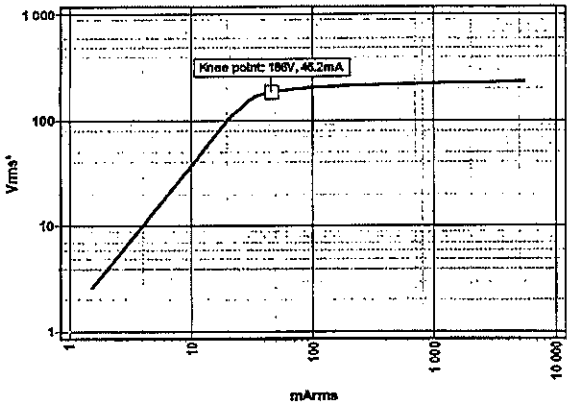
Temperature: 23 °C, Frequency: 50

Primary voltage	Tg δ [%]	Capacitance [pF]	Leak.current [mA]
10 kV	0.24	1124	3.575
76 kV	0.24	1125	26.87
84 kV	0.24	1125	29.73

Core magnetization characteristics:

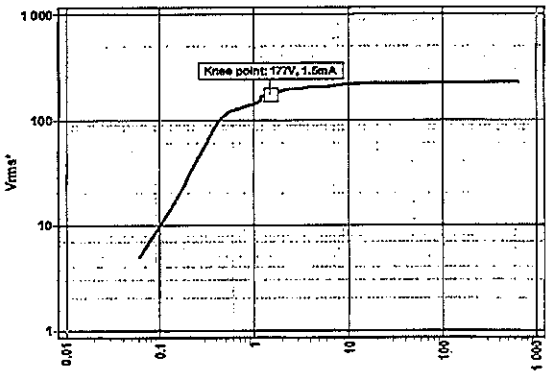
Winding 1S1-1S2

[V]	[mA]
234	5313.7
231.8	3068.1
229.6	1998.1
224.5	942.9
219.3	468.63
212.9	206.3
204.6	97.07
186.1	46.27
167.6	34.48
148.2	29.26
129.2	25.57
91.1	18.91
53.2	13
15.5	5.47
2.6	1.56



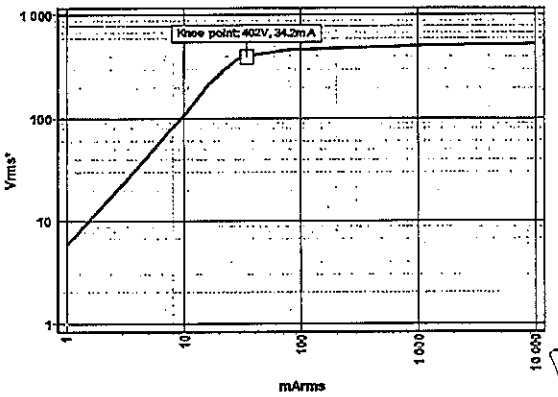
Winding 2S1-2S2

[V]	[mA]
228.5	645.1
205.2	3.9
191.8	2.07
186.3	1.89
183	1.77
179.4	1.63
176	1.43
172.8	1.35
169.3	1.21
162.7	1.55
133.6	0.77
102.3	0.44
67.3	0.33
32	0.21
5	0.06



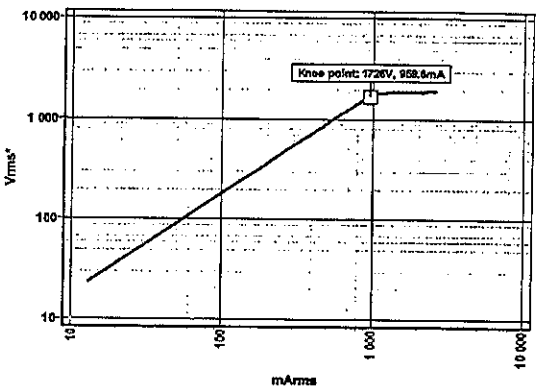
Winding 3S1-3S2

[V]	[mA]
525.1	9728
523.8	8209
520.3	4990.4
518.7	3801.5
506.4	1070.4
474.3	140.39
459.1	78.03
442.6	53.68
404.7	34.65
368	28.14
330.8	24.68
293.8	21.8
182.3	14.74
69.5	7.21
5.8	1.01



Winding 4S1-4S2

[V]	[mA]
1924.7	2612.2
1916.6	2155
1905.1	1669.8
1888.6	1321.3
1834.8	1068.3
1800.2	1020.7
1739.8	968.8
1684.2	932
1514.7	832.1
1364.8	748
1205.8	660
852.6	468.29
507.6	279.63
153.2	84.7
23.4	13.23



*) Average rectifier effective value.

Measurement of windings' resistance

	R (23 °C)	Rct (75 °C)
P1-P2 range 1500A	63.0 μΩ	75.9 μΩ
P1-P2 range 3000A	26.0 μΩ	31.3 μΩ
1S1-1S2	0.452 Ω	0.545 Ω
2S1-2S2	5.330 Ω	6.419 Ω
3S1-3S2	0.590 Ω	0.711 Ω
4S1-4S2	5.650 Ω	6.805 Ω

Checked by: Gosia OG-4 KJ-21

Przasnysz,

9 Annex B – Routine test report of current instrument transformer after short-time current test

ABB Sp. z o.o. 06-300 Przasnysz ul. Leszno 59	Routine test report of current instrument transformer After short time current test	TYPE: PA145a Serial no: 2GKP014A1287155	
Ith 1s [kA]: 63-63	Idyn [kA]: 158-158	Icth [A]: 1800-3600	PN-EN 61869-2 50 Hz

Winding	Isn [A]	Sn [VA]	class	Ratio [A/A]
1S1-1S2	5	200	0,2FS 10	1500-3000/5
2S1-2S2	1	100	0,1FS 5	1500-3000/1
3S1-3S2	5	20	5P 60	1500-3000/5
4S1-4S2	1	35	10P 40	1500-3000/1

List of performed tests:

1. Oil dielectric parameters check before filling (oil after treatment): tg δ acc. IEC 60247, breakdown voltage acc. IEC 60156 ☑
2. Verification of terminal ☑
3. Pressure and tightness test: oil overpressure: 0,8 bar / 24h – no traces of oil leakage ☑
4. Power-frequency withstand on primary winding - P1+P2: Up = 247,5kV / 60s, f = 50Hz ☑
5. Partial discharge ☑
6. Power-frequency withstand test on secondary - Up = 3 kV/60s, f=50Hz ☑
7. Inter-turn overvoltage - lower value (U peak=4,5kV or U peak for Icth) / 60s ☑
8. Determination of errors ☑
9. Determination of the over current factors: FS, ALF ☑
10. Measurement of capacitance and dielectric dissipation factor - tgδ ☑
11. Determination of core magnetization characteristics ☑
12. Measurement of windings' resistance ☑

Oil dielectric parameters check before filling (oil after treatment)

- Measurement of oil tg δ according to IEC
  Tg δ = 0.1983 %; electrical stress = 1kV/mm, f = 50Hz, oil temp. = 90C

- Measurement of breakdown voltage according to IEC 60156
  Mean breakdown voltage = 76.27 kV, Relative standard deviation = 5.87
  f = 50Hz, oil temp. = 25.4 °C, measurement without the stirrer, type of electrodes used: partially spherical.

Sample	Breakdown voltage [kV]
1	77.7
2	77.9
3	72.7
4	83.2
5	70.4
6	75.7

Partial discharge measurement

- Measurement according to procedure B

Stress voltage: 247,5 kV / 60 s
Frequency: 50 Hz

Test voltage	1,2 Um = 174 kV	1,2 Um / √3 = 100,5 k
Level of partial discharge	1.1 pC	1 pC

Remarks: background noise level: 0.7 (measured after voltage switch off),
measuring circuit was calibrated with 5 pC (calibrating

Inter-turn overvoltage test

Winding	Peak voltage on secondary winding [kVpeak]	Current in primary winding [A]
1S1-1S2	4.5	1450
2S1-2S2	4.5	350
3S1-3S2	4.5	990
4S1-4S2	3.19	3600

Determination of errors ε I %), Δφ I min)

Ipn (A): 1500

1S1-1S2: 200 VA				p.f. = 0,8 lag.
	0,05 In	0,2 In	1,0 In	1,2 In
ε I	-0,314	-0,148	-0,043	-0,033
Δφ I	6.2	3.0	0.9	0.7

2S1-2S2: 100 VA				p.f. = 0,8 lag.
	0,05 In	0,2 In	1,0 In	1,2 In
ε I	-0.062	-0.043	-0.003	-0.007
Δφ I	1.5	0.4	-0.6	-0.3

3S1-3S2: 20 VA		p.f. = 0,8 lag.
	1,0 In	
ε I	-0.017	
Δφ I	0.3	

5S1-5S2: 0 VA		p.f. = 1
	1,0 In	
ε I		
Δφ I		

1S1-1S2: 50 VA				p.f. = 0,8 lag.
	0,05 In	0,2 In	1,0 In	1,2 In
ε I	-0.041	0.045	0.088	0.091
Δφ I	3.9	1.7	0.9	0.8

2S1-2S2: 25 VA				p.f. = 0,8 lag.
	0,05 In	0,2 In	1,0 In	1,2 In
ε I	0.014	0.011	0.012	0.010
Δφ I	0.3	0.3	0.2	0.3

4S1-4S2: 35 VA		p.f. = 0,8 lag.
	1,0 In	
ε I	-1.328	
Δφ I	63.2	

Ipn (A): 3000

1S1-1S2: 200 VA				p.f. = 0,8 lag.
	0,05 In	0,2 In	1,0 In	1,2 In
ε I	-	-	-0.044	-
Δφ I	-	-	1.0	-

Measurements uncertainty: $\varepsilon_I = \pm 0{,}045\ \%$, $\Delta\varphi_I = \pm 2{,}3$ min

Determination of the over current factors:

- instrument security factor (FS) of measuring cores

Winding	Ie [A]	U [V]	E_{FS} [V]	Condition	Assessment
1S1-1S2	5	233.75	422.57	U < E_{FS}	☑
2S1-2S2	0.5	227	526.81	U < E_{FS}	☑

- accuracy limit factor (ALF) – test for composite error ε_c of protective cores

Winding	E_{ALF} [V]	Ie [A]	ε_c [%]	Condition	Assessment
3S1-3S2	430.4	0.047	0.02	$\varepsilon_c \leq 5\%$	☑
4S1-4S2	1626.33	0.896	2.24	$\varepsilon_c \leq 10\%$	☑

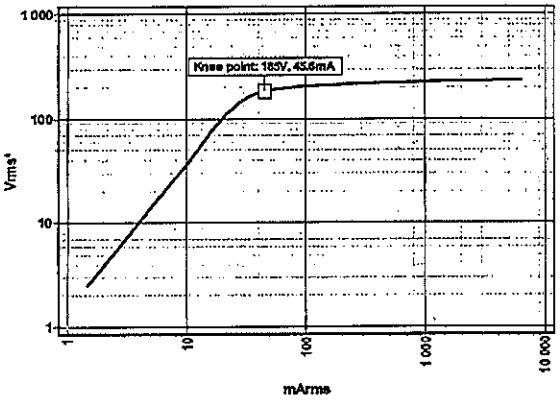
Measurement of capacitance and dielectric dissipation factor - tg δ
Temperature: 22.6 °C, Frequency: 50

Primary voltage	Tg δ [%]	Capacitance [pF]	Leak.current [mA]
10 kV	0.24	1127	3.592
76 kV	0.24	1128	26.9
84 kV	0.24	1128	29.78

Core magnetization characteristics:

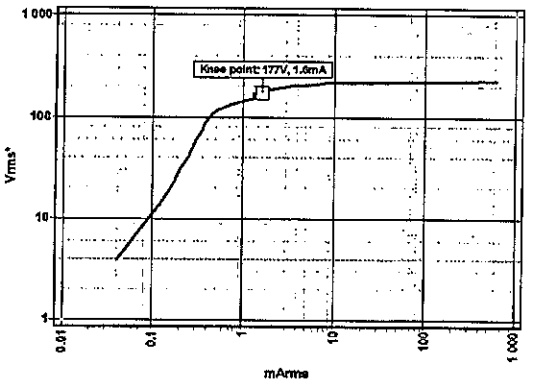
Winding 1S1-1S2

[V]	[mA]
234.6	6267
233.4	4558
231.2	2625.9
227.9	1511.7
216.5	321.59
208.8	133.29
203.6	90.26
184.7	44.86
166	33.81
147.4	26.87
128.7	25.04
91	18.62
53.6	12.97
16	5.53
2.4	1.5



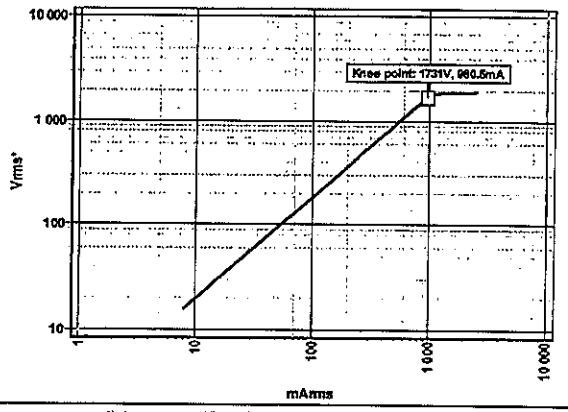
Winding 2S1-2S2

[V]	[mA]
228.4	610.7
204.5	3.78
189.1	2.08
186.3	2
182.6	1.84
179.2	1.69
175.8	1.55
172.7	1.47
169.3	1.31
162.2	1.63
131.4	0.73
100.3	0.42
65.1	0.32
30.2	0.2
3.8	0.04



Winding 4S1-4S2

[V]	[mA]
1923.8	2526.7
1914.6	2019.7
1903.9	1621.3
1885.5	1277
1863.8	1140.6
1824.8	1048.2
1785.5	1002.7
1729.2	959.3
1667.7	919.7
1509	827.1
1186	647.8
849.1	465.35
505.9	277.91
152.9	84.27
15.5	8.02



*) Average rectifier effective value.

Measurement of windings' resistance

	R (22 °C)	Rct (75 °C)
P1-P2 range 1500A	63.0 μΩ	78.1 μΩ
P1-P2 range 3000A	26.0 μΩ	31.4 μΩ

1S1-1S2	0.460 Ω	0.555 Ω
2S1-2S2	5.470 Ω	6.609 Ω
3S1-3S2	0.589 Ω	0.712 Ω
4S1-4S2	5.640 Ω	6.815 Ω
5S1-5S2	6.120 Ω	7.395 Ω

Checked by: Gosik OG-4 KJ-21

Przasnysz, 2015-01-30