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Glossary

This table defines key terms used in this document (formatted in *italics*). Where an italicised term is not listed in this table, its meaning is consistent with that defined in Attachment 1 of the *Technical Rules*.

Compliance monitoring program (CMP)	A program for <i>Generators</i> to monitor the performance of the plant to ensure ongoing compliance with performance standards.
Connection agreement	An agreement or other arrangement between the <i>Network Service Provider</i> and a <i>User</i> , which may form part of or include an <i>access contract</i> , that specifies the technical requirements that apply in relation to the connection of a <i>User's equipment</i> to the <i>transmission or distribution system</i> .
Generating system	A system comprising one or more <i>generating units</i> .
Generating unit	The equipment used to generate electricity and all the related equipment essential to its functioning as a single entity.
Generator	Any person (including a <i>User</i> or the <i>Network Service Provider</i>) who owns, controls, or operates a generating system that supplies electricity to, or who otherwise supplies electricity to the transmission system or distribution system.
Monitoring equipment	The testing instruments and devices used to record the performance of equipment for comparison with expected performance.
Plant change	Replacement of components or equipment or the refurbishment or change of system which is considered by relevant <i>Generator</i> as event that may affect the plant's capability to meet the particular performance standard.
R2 data, model validation and performance report¹	A report providing details of the tests conducted, assessed performance, model validation results, and registered (R2) data including final models and control system settings.
Renewable generation	Generation (solar, wind, ocean, hydropower, biomass, geothermal, biofuels and hydrogen) derived from renewable resources.
Routine testing	Regular and methodical checking that may require testing and calibration of equipment.
South West Interconnected System (SWIS)	The power system in South West of the state of Western Australia, extending from Geraldton to Albany areas and across to the Eastern Goldfields.
Sub-system	Any sub-system subcomponents which contribute to a generating system achieving its capability to meet the particular performance standard, e.g. excitation systems, connection equipment including associated reactive plant, auxiliary power supplies, protection relays, circuit breakers etc.
Synchronous generating unit	The alternating current generating units which operate at the equivalent speed of the frequency of the power system in its normal operating state.

¹ The structure and content of this report are specified in Western Power's Generator and Load Model Guidelines.

Technical Rules	The document published by Western Power, and updated from time to time, detailing the technical requirements to be met by Western Power on the transmission and distribution systems and by <i>Users</i> who connect facilities to the transmission and distribution systems.
Type testing	Testing a reasonable sample of plant within a larger population of plant of the identical type and model.

1 Introduction

1.1 Purpose and scope

The purpose of this document is to provide guidelines and assist *Generators* in establishing and maintaining a *compliance monitoring program (CMP)* for their power generating equipment.

The security of the *South West Interconnected System (SWIS)* depends on ongoing compliance of *Generators* with certain technical standards. Successful implementation and management by each *Generator* of a *CMP* will help to ensure safe and reliable operation of the power system and reduce the risk of major incidents occurring.

Western Power's *Technical Rules*² set out the obligations of *Users* to test equipment in order to demonstrate compliance with the technical and operational requirements outlined in the *Technical Rules*.

According to clause 3.3.3 of the *Technical Rules*, a *Generator* must undertake tests to verify compliance of its *equipment* with the relevant technical requirements.

As per clause 4.1.3 (b) of the *Technical Rules*, following commissioning, a *Generator* must negotiate in good faith with the *Network Service Provider* and agree on a *CMP* to confirm ongoing compliance with the applicable technical requirements of the relevant clause (3.3 or 3.6) and *connection agreement*.

Generators should undertake their own investigation of the requirements for compliance.

1.2 Document objectives

The key objectives of this document are to:

- Describe good electricity industry practice to assist in the development of *CMPs*.
- Provide compliance principles that can be used in developing a *CMP*.
- Describe technical standards that may apply to a particular *Generator*.
- Provide guiding information assisting *Generators* to develop their own *CMP*.
- Outline the need for *CMP* documentation.
- Provide other supporting information to assist *Generators* in preparing *CMPs*.

This document is closely aligned with (and adapts some elements of) the *Template for Generator Compliance Programs*² developed by the Reliability Panel of Australian Energy Market Commission (AEMC) for the National Electricity Market.

The Australian Standard AS 3806-2006 *Compliance Programs* provides principles for the development, implementation and maintenance of effective compliance programs within both public and private organisations. It is recommended that *Generators* apply this standard as a starting point in developing a *CMP*.

This document does not discuss requirements for generator registered data to be submitted to Western Power as part of *R2 Data, Model Validation and Performance Report* which is described in Western Power's *Generator and Load Model Guidelines*.²

² See Appendix D for download links for referenced documents.

1.3 Application of the Generator Compliance Monitoring Program Requirements

The Generator Compliance Monitoring Program Requirements applies to all generating equipment covered by the following *Technical Rules* clauses:

- 3.3 Combined rating of 10 MW or greater connected to transmission network.
- 3.6 Combined rating below 10 MW connected to distribution network.

It does not apply to energy systems rated at up to 30 kVA and connected to the low voltage system via inverters, which are covered by clause 3.7 of the *Technical Rules*.

The following *Technical Rules* clauses should be reviewed to assist with understanding the requirements for generator compliance testing and monitoring.

Table 1: Technical Rules clauses relevant to generator compliance testing and monitoring

Technical Rules clause	Description
3.2.1	Power System Performance Standards
3.3.2	Provision of Information
3.3.3	Detailed Technical Requirements Requiring Ongoing Verification
3.3.3.1	Reactive power capability
3.3.3.2	Generating Unit Performance Standard
3.3.3.3	Generating Unit Response to Disturbances in the Power System
3.3.3.4	Sudden Reduction in Active Power requirement
3.3.3.5	Ramping Rates
3.3.3.6	Safe Shutdown without External Electricity Supply
3.3.3.7	Restart Following Restoration of External Electricity Supply
3.3.3.8	Protection of Generating Units from Power system Disturbances
3.3.4.4	Frequency Control
3.3.4.5	Voltage Control
3.6.3	Information to be provided by the generator
3.6.5	Requirements of clause 3.3 applicable to small power stations
3.6.8	Power Quality and Voltage Change
3.6.13	Commissioning and Testing
4.1.3	Tests to Demonstrate Compliance with Connection Requirements for Generators
4.1.4	Routine Testing of Protection Equipment
4.1.5	Testing by Users of their own Equipment Requiring Changes to Agreed Operation
4.1.6	Tests of Generating units Requiring Changes to Agreed Operation
4.1.7	Power System Tests

Technical Rules clause	Description
Attachment 11	Test Schedule for Specific Performance Verification and Model Validation
Attachment 12	Testing and Commissioning of Small Power Stations Connected to the Distribution System

It is important that *Generators* proactively use their *CMP* for ongoing compliance, rather than adopting a "set and forget" approach. Regular reviews of the *CMP* will also ensure its consistency with the *Technical Rules* and provide a continual improvement focus. The date for next review should be specified in the *CMP*.

2 Principles and Guidelines

2.1 Compliance principles

Generators are recommended to apply the following compliance principles for development of their *CMPs*:

1. A *Generator* has overall responsibility for managing plant performance in accordance with its *CMP*.
2. Where plant performance may vary with time (i.e. protection, controls, alarms), *Generators* are accountable for managing the functionality, integrity and compliance of the plant in accordance with the applicable performance standards.
3. Where plant parameters do not vary with time, the compliance process should be restricted to confirmation that the plant continues to perform as intended with repeat testing when there are indications that the plant performance may have changed.
4. Implementation, active use and timely update of a *CMP* by a *Generator* will help ensure compliance with the *Generator* registered performance standards.
5. The *CMP* should represent *good electricity industry practice*.
6. The *CMP* should specify the objectives, outcomes and appropriate test intervals for testing and monitoring.
7. Where appropriate, the *CMP* should describe how performance will be verified following a disturbance event.
8. Include a range of compliance testing methods suitable for the plant. Consideration should be given to the technology of the plant, industry experience, advice from manufacturers, connection point arrangement, and cost and risk assessment.
9. The *CMP* should be regularly reviewed and updated.
10. The *CMP* should describe how the data and record keeping system will be implemented and maintained.

2.2 Technical standards compliance

The *Technical Rules* specify performance standards for all *Users* of the transmission and distribution systems. All *Users* must comply with requirements of the *Technical Rules*.

Performance of existing generators must not be degraded. As per clause 1.9.4(a) of the *Technical Rules*, all facilities and equipment in the transmission and distribution systems, all connection assets, and all *User* facilities and equipment connected to the transmission or distribution systems existing at the *Technical Rules* commencement date (1 July 2007) are deemed to comply with the requirements of the *Technical Rules*.

According to clause 1.9.5 a *User* or the *Network Service Provider* whose equipment is deemed by clause 1.9.4 to comply with the requirements of *TR* must ensure that the capabilities and ratings of that equipment are monitored on an ongoing basis and must ensure its continued safety and suitability as conditions on the power system change.

Users may apply for an exemption if they cannot meet requirements of the *Technical Rules*. As per clause 1.9.1 of the *Technical Rules*, an exemption from compliance with one or more of the requirements of *Technical Rules* may be granted to a *User* by the *Network Service Provider* in accordance with sections 12.33 to 12.39 of the *Access Code*³.

Generators that commenced operation prior to 1 July 2007 must comply with performance standards, in accordance with relevant rules or codes valid at the time of the connection.

According to clause 1.9.4(b) when equipment covered by clause 1.9.4(a) is upgraded or modified for any reason, the modified or upgraded equipment must comply with the applicable requirements of the *TR*. *Generators* must ensure all changes to plant are reported to Western Power and appropriately assessed as to whether they constitute a *plant change* in respect to each performance standard.

2.3 Need for compliance monitoring documentation

Appropriate documentation of the *Generator's* compliance monitoring results and analysis is an essential aspect of the *CMP*.

The overall compliance regime in the *Technical Rules* relies on cooperation of *Generators* and Western Power in developing and implementing a compliance program framework, which to function effectively requires that:

- *Generators* will establish and maintain *CMPs*.
- Western Power will conduct audits of *Generators' CMPs* on regular basis as part of its compliance monitoring activities.
- *Generators* will arrange external parties to independently audit their *CMPs*.

The compliance program should specify how the processes are managed in terms of issues such as records and document control, handling of non-compliances and management review. It should also include an assessment plan that specifies the monitoring and test procedures including required frequency of testing.

Generator's registered data and performance standards must be properly documented and kept up to date. Artefacts constituting registered data and performance standards documentation are described in Western Power's *Generator and Load Model Guidelines*.

Appendix A provides a check list for *Generators* to assess their *CMPs* for completeness and consistency with the compliance process. Appendix B provides a sample test procedure. Appendix C provides a non-compliance reporting form.

2.4 Compliance testing requirements

The schedule of tests for performance verification and model validation for synchronous generating units is provided in Attachment 11 of the *Technical Rules*, which also includes details of the requirements for test equipment and measurement signals. Western Power will specify test requirements for non-synchronous generating systems and loads.

³ See Appendix D for download links for referenced documents.

Technical Rules clauses 4.1.3 and 4.2.4 describe the obligations of both Western Power and *Users* for the preparation of commissioning programs, test procedures, setup of test equipment and provision of test data. It should be noted that only approved settings may be applied, and that control system settings or configuration may not be modified without prior approval from Western Power.

According to clause 4.1.3 (a) (1) (4) of the *Technical Rules*, a *Generator* must forward test procedures for undertaking the compliance tests required in respect of its equipment, including details of the recorders and measurement equipment to be used in the tests, to the *Network Service Provider* for approval 30 business days before the tests or as otherwise agreed.

According to clause 4.1.3 (a) (1) (5) of the *Technical Rules*, a *Generator* must also coordinate the compliance tests in respect of its equipment and liaise with all parties involved, including the *Network Service Provider* and *System Management*. The *Network Service Provider* or *System Management* may witness the tests and must be given access to the site for this purpose.

Following system events, Western Power or *System Management* may request a *Generator* to perform self-assessment, provide results of self-assessment and, if necessary, further testing. Additional details are available on the Western Power's website⁴.

Analysis of actual generator response to system disturbances is important and should be a part of the *CMP*. System disturbances can expose generators to larger impacts than the step response tests and truly demonstrate behaviour of the plant, particularly damping and governor response, accounting for performance due to non-linearities (e.g. saturation), limiter functionality and operation of other control functionality (e.g. ride-through sequences). Such analysis will contribute to better understanding the performance of the generator with respect to the relevant performance standards and allow further verification of the simulation models. Appropriate event recorders are recommended to be installed at the plant connection point to facilitate online disturbance recordings. Refer to the Western Power Generator and Load Model Guidelines for details of Western Power's computer model accuracy requirements and illustrations of methods used to compare measured and simulated responses against those accuracy requirements.

2.5 Guide for developing a generator CMP

Table 2 shown in this section provides information for testing methods and frequency of testing that can be used by *Generators* in developing a *CMP*.

The tests for the *CMP* should be designed as required by plant and technology and based on the *Technical Rules*, exemptions and Connection Agreement, and should be undertaken using suitable high speed recording equipment or data loggers.

The following considerations should be taken into account when using this information:

- It provides a series of options for testing methods and *Generators* should exercise their own judgement about which methods are the best to apply to their equipment in accordance with *good electricity industry practice*.

⁴ <http://www.westernpower.com.au/electricity-retailers-generators-commissioning-tests.html>.

- It is based on the assumption that all necessary connection studies and assessment have been performed and initial commissioning and compliance testing have been conducted by the *Generator*.
- The *Generator* registered data including a validated computer model have been submitted to and accepted by Western Power.
- Performance standards applicable to the *Generator* have been determined.
- The plant compliance with the performance standards has been established.

The *Generator* needs to take special care that its compliance testing regime does not jeopardise power system security or safety.

As per clause 5.7.1 of the *Technical Rules*, a *User* must promptly advise the *Network Service Provider* if the *User* becomes aware of any circumstance, including any defect in, or mal-operation of, any protection or control system, which could be expected to adversely affect the secure operation of the power system.

All tests undertaken for *CMP* (including those based on information in Table 2) must not take priority over personnel safety or power system security.

Table 2: Testing methods and frequency of testing

Category	TR clause	Testing methods	Frequency of testing
<i>Stability / Impact on SWIS</i>	2.2.7, 2.2.8, 2.2.9, 2.2.10	As suitable for plant technology and capability, demonstrated by: 1) Online measurement;	As required by Australian Standards, plant, technology and manufacturer.
<i>Reactive Power Capability</i>	3.3.3.1, 3.6.5	2) Facility tests; 3) Subsystem tests; 4) Type tests.	
<i>Response to Frequency Disturbances</i>	3.3.3.3(b), 3.3.3.3(d), 3.3.3.3(h)	The following methods may be considered:	The actual frequency of testing may be described in terms of the: <ul style="list-style-type: none"> • elapsed time (e.g. 3, 4, 5 years); • plant operating hours; • MWhrs generated; or • number of plant starts between testing.
<i>Response to Voltage Disturbances</i>	3.3.3.3(c), 3.3.3.3(e), 3.3.3.3(f), 3.3.3.3(g), 3.3.3.3(h)	<ul style="list-style-type: none"> • Monitoring of plant in-service performance; • Routine/continuous monitoring, periodic testing and/or calibration of relevant subsystem; 	
<i>Frequency Control</i>	3.3.3.4, 3.3.4.4	<ul style="list-style-type: none"> • Monitoring and testing capability levels and limiters settings by component; 	
<i>Voltage and Reactive Power Control / Excitation Control System</i>	3.3.4.5	<ul style="list-style-type: none"> • Investigating plant trips; • Verification of the model performance for a sample of equipment; 	
<i>Power Quality</i>	3.2.1(b), 3.2.1(c), 3.2.1(d), 3.6.8	<ul style="list-style-type: none"> • Assessment of system performance during disturbance events; • Analytical simulation of plant systems; 	
<i>Protection Systems</i>	3.3.3.8, 3.5.2, 3.6.10	<ul style="list-style-type: none"> • Transfer function measurements and step response tests with the unit unsynchronised and on load; 	
<i>Remote Monitoring</i>	3.3.4.1	<ul style="list-style-type: none"> • Direct measurement using power meters; 	
<i>Communication Equipment</i>	3.3.4.3, 3.6.9	<ul style="list-style-type: none"> • Modelling and simulation of plant characteristics; 	
<i>Power Station Auxiliary Transformers / Supplies</i>	3.3.5	<ul style="list-style-type: none"> • Reviewing and recalculating of system parameters at the point of connection. 	

Appendix A. CMP checklist

Item	Requirements	Assessment	Comment
1.	GENERAL		
1.1	Title includes the names of: power station, plant, plant owner, party preparing the CMP, party approving the CMP.		
1.2	The document has the date of release and revision number..		
1.3	The document has contact information of a party prepared the document.		
1.4	The document has a distribution list of companies it has been supplied to.		
1.5	The document structure includes but not limited to: table of contents, glossary of terms and abbreviations, sections, references and appendices.		
1.6	All tables and figures are numbered and cross-referenced where required.		
1.7	The document describes how tests will be coordinated with Western Power (see section 2.4 of this document).		
2.	GENERAL PROCEDURES		
2.1	The document lists the objectives of the CMP and describes relevant legal, contract and regulatory obligations with references to official published documents.		
2.2	Validity of the document is stated (i.e. valid from "date", current, superseded, date for next review etc.)		
2.3	The document lists all parties and personnel involved in the management of the CMP, their responsibilities and communication protocols.		
3.	REGISTERED PERFORMANCE AND COMPLIANCE		
3.1	The document describes the registered performance of the plant confirmed by compliance tests, R1 & R2 data ⁵ , computer model and approval dates. The registered performance is consistent with applicable performance standards of the Technical Rules and connection agreement.		
3.2	The document describes the compliance of the plant with requirements of the Technical Rules and/or other applicable codes. All relevant exemptions, special conditions and standards approved by Western Power and included in the <i>connection agreement</i> are stated.		
3.3	The document specifically describes the scope and timeframe for addressing any known non-compliance issues of the plant.		

⁵ Refer to Technical Rules Attachment 3 for definition of data categories.

Item	Requirements	Assessment	Comment
4.	COMPLIANCE METHODS, FREQUENCY OF TESTS AND EQUIPMENT		
4.1	The document describes compliance methods selected by the Generator to suit its specific plant characteristics. Methods are based on consideration of the technology of the plant, manufacturer advice, the connection point arrangement and assessment of the risk and costs of different testing methods.		
4.2	The document specifies cycles of recurrent tests for chosen methods. The frequency of tests is based on consideration of the technology of the plant, manufacturer advice, and assessment of the risk and costs of different testing methods.		
4.3	The document lists all equipment that is covered by the CMP. It includes power station transformers, reactive compensation devices, generator, excitation system, turbines-governor, auxiliary supply, protection systems, remote monitoring and other power station equipment of the Generator.		
5.	TEST EQUIPMENT AND SIGNALS		
5.1	The document describes the test equipment including test recorders, miscellaneous test items and field/SCADA measurement system that will be used to capture test data. Technical characteristics like AC/DC channels, accuracy, input range, resolution, scan rate are provided and assessed against requirement of Attachment 11 of the Technical Rules.		
5.2	Information about calibration of recorders is provided.		
5.3	Quantities to be recorded are provided for test data captured by all measurement equipment. The quantities are assessed against requirement of Attachment 11 of the Technical Rules. If some quantities required by Technical Rules are not included an explanation is provided.		
5.4	The quantities and format of test results is described and assessed against requirement of Attachment 11 of the Technical Rules.		
5.5	Availability of inputs and signals for connecting and measurement by test recorders is confirmed with the plant owner/operator.		
6.	SUMMARY OF TESTS		
6.1	The table summarising tests contains: description for each test, associated <i>Technical Rules</i> clause, corresponding test number, changes applied and test conditions according to Tables A11.1 and 11.2 of the <i>Technical Rules</i> .		

Item	Requirements	Assessment	Comment
7.	CONTROLS SETTINGS		
7.1	The document provides transfer function diagrams with current settings for generator control systems (AVR, OEL, UEL, PSS, Governor).		
7.2	The <i>CMP</i> should affirm that only approved settings may be applied. Control system settings or configuration may not be modified without prior approval from Western Power.		
8.	EQUIPMENT SPECIFICATIONS		
8.1	The document provides equipment specifications or references to equipment specifications.		
8.2	The document provides specifications for existing runback scheme or other special schemes implemented for the plant.		
9.	EQUIPMENT UPGRADES		
9.1	The document provides a list of all upgrades and modifications performed for the plant since the plant commissioning date.		
10.	RISK MANAGEMENT		
10.1	The document lists the risks to personnel, equipment and power system security associated with the testing and describes how they will be managed.		

Appendix B. Sample test procedure

B.1 Summary of tests

The following table is a summary of tests to be performed for the excitation systems of the generating unit. The tests are designed to demonstrate compliance with the requirements for the excitation control system defined in the *Technical Rules*.

This example shown for AVR voltage step test demonstrates typical description of a test in test procedures. In each individual case, all appropriate compliance tests applicable to the type, size and connection of generation plant should be included.

IMPORTANT:

1. Should the AVR consist of two channels, tests are to be performed in both channels to confirm consistency and identical performance in both regulators.
2. The PSS shall be in service for all tests.

Table B1: Summary of excitation system tests

Test	Description	Step size	Operating point		Timestamp	Test engineer
			MW	MVAR		
C2B.1	Step response with PSS on	±1%	95	Unity PF		

B.2 Synchronised voltage response tests at half load

B.2.1 Pre-test conditions

The operator shall ensure the following conditions (and not limited to) are fulfilled prior to the tests:

1. Excitation ON in AUTO mode and PSS on;
2. Unit at rated speed, rated voltage for initial conditions;
3. Unit synchronised to the network;
4. Active power level of 50% nameplate achieved;
5. Unity power factor at the machine terminals;
6. Turbine governor operating in speed control with governor droop set to 4%;
7. All generator protections should be in service with normal settings;
8. Note settings of all protective relays (high voltage alarm and trip; off-line over excitation; Volts/Hz protections) and manual reference setting limits before starting test.
9. Record steady state values of **Ut, Pe, Qg, Ufe, lfe, Uref, Upss** and the transformer tap position;

Stable response is to be confirmed at each step prior to proceeding to the next step magnitude.

For C2B tests, care must be taken not to excite large or prolonged oscillations in MW, etc. To avoid such oscillations, smaller step changes must always precede larger step changes.

B.2.2 Test C2B.1: Half load 1% step response with PSS in service

The aim of this test is to apply a step to the AVR summing junction with the unit running at rated voltage and speed, synchronised to the network at half load while the PSS is in service.

1. Apply a **+1%** step to the AVR summing junction to drive the unit into the overexcited region. Record using the high-speed recorder for 30 seconds;
2. Wait for unit to stabilise at new operating point;
3. Remove step. Record the step response for a period of 30 seconds;
4. Test completed.

If required, repeat in second AVR channel.

Appendix C. Non-compliance reporting form

NON-COMPLIANCE REPORT		NCR No:
Task leader:		Date Created:
Power station:		
Plant name:		
Identified non-compliance		
Non-compliance description	Name of the person reported	Date reported
Identified risks		
Risks	Description	Control measure
<i>Safety risks</i>		
<i>Risks to plant</i>		
<i>Risks to Network Service Provider and/or other Users</i>		
Investigation		
Causes of non-compliance	Remedial actions	Date to be completed by
Affected performance standards		
Performance	Description	Reference
<i>Registered performance:</i>		
<i>Actual under-performance:</i>		
<i>Upgraded performance:</i>		
Notifications		
Party notified	Person's name and document reference	Date
Repeat compliance testing		
Tests	Performance standard	Date
Completion / Sign of	Signature	Date
Task Leader:		
Company Manager:		

Appendix D. Reference document links

Western Power - Technical Rules (23 December 2011):

http://www.westernpower.com.au/documents/WE_n6800863_v9E_TECHNICAL_RULES_OF_23_DECEMBER_2011.pdf

Reliability Panel AEMC - Template for generator compliance programs (27 June 2012):

<http://www.aemc.gov.au/getattachment/10a3e5d0-e637-4257-b2e1-1e2dbc93b433/Template-for-generator-compliance-programs.aspx>

Western Power - Generator and Load Model Guidelines (31 March 2015):

http://www.westernpower.com.au/documents/Generator_and_Load_Model_Guidelines.pdf

Western Power – Generator Commissioning Tests

<http://www.westernpower.com.au/electricity-retailers-generators-commissioning-tests.html>

Electricity Networks Access Code 2004

[http://www.slp.wa.gov.au/gazette/gazette.nsf/gazlist/2c360789573c223148256f5c0010ed84/\\$file/gg205.pdf](http://www.slp.wa.gov.au/gazette/gazette.nsf/gazlist/2c360789573c223148256f5c0010ed84/$file/gg205.pdf)