FEMP
Federal Energy Management Program

Commissioning Guidance for Energy Savings Performance Contracts (ESPCs)

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Foreword

This Commissioning Guidance for Energy Savings Performance Contracts (ESPCs) is DOE's official guidance for ordering agencies under the current DOE ESPC IDIQ contract. This guidance document explains how commissioning of energy conservation measures (ECMs) and water conservation measures (WCMs) is incorporated into the ESPC process, roles and responsibilities in project commissioning, and key elements of commissioning. This document updates the previous version, released in 2015.[1] This guidance can also be used as applicable in the development of ESPC ENABLE and UESC performance assurance plans.

[1] https://www.energy.gov/sites/prod/files/2015/05/f22/ph3_cx_guide_23.pdf

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List of Abbreviations and Acronyms

Cx	commissioning
DOE	U.S. Department of Energy
ECM	energy conservation measure
ESCO	energy services contractor
ESPC	energy savings performance contract
FEMP	Federal Energy Management Program
IDIQ	indefinite delivery indefinite quantity
IGA	investment grade audit
M&V	measurement & verification
O&M	operation & maintenance
PA	preliminary assessment
PF	project facilitator
TO	task order
TO RFP	task order request for proposal
WCM	water conservation measure

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1 Introduction

Federal facility managers are challenged with maintaining aging federal buildings that are not energy efficient, require increasing expenditures for operations and maintenance (O&M), and often do not provide occupants with the comfort needed to maintain their productivity. They are also faced with increasingly ambitious federal energy, water, and emission goals. Energy savings performance contracts (ESPCs) provide a procurement mechanism to allow agencies to improve their facilities and reduce energy, water, and energy- and water-related costs, with no up-front cost to the agency, through projects developed, designed, installed, and financed by Energy Service Companies (ESCOs). In federal ESPCs, the ESCO must guarantee a level of energy savings[2] that is sufficient to pay for the project over the term of the contract.

ESPC projects focus primarily on energy savings benefits from retrofitting facilities with more efficient equipment and systems. However, an important goal of facility managers is for the project to result in improved (or ideally, optimized) building operations to enhance occupant comfort (and reduce service calls and complaints) and to provide conditions that promote worker productivity. Federal ESPCs are required to guarantee energy savings, and should ensure facility performance requirements and standards, such as lighting levels and space temperatures, will be maintained consistent with agency requirements.

Commissioning (Cx) of existing buildings, when done properly, goes beyond single measure solutions (such as replacing an inefficient piece of equipment with a more efficient equivalent) by systematically optimizing building systems. Cx of new equipment generally is the process of ensuring that *systems* are designed, installed, functionally tested, and capable of being operated and maintained to perform in conformity with the project and building requirements.

Cx is generally defined as procedures undertaken, often by the contractor, to assure that implemented energy conservation measures (ECMs) and water conservation measures (WCMs) and building systems perform interactively in accordance with design documentation and intent. The Cx process includes activities such as design and documentation review, performance validation, functional performance tests, and training.

For ESPCs more specifically, Cx is a quality-based process that sets, verifies, and documents the performance of systems to ensure that design intent is met. This contrasts with ECM/WCM performance measurement and verification (M&V), which is used to determine the energy savings that result from the ECMs/WCMs. Cx focuses on meeting the design intent and performance requirements (i.e., that the installed equipment or system has the ability to meet performance requirements such as temperature setpoints, light levels, etc.), while M&V focuses

[2] This guidance uses the term "energy savings" to include a reduction in the cost of energy, water, or wastewater treatment in an existing Federal building, including a reduction in the cost of related O&M (including repair and replacement).

primarily on measuring and verifying that performance and savings guarantees continue to be achieved.

The U.S. Department of Energy (DOE) indefinite-delivery, indefinite-quantity (IDIQ) ESPCs require Cx of the installed energy- and water-saving equipment and systems (see e.g., DOE IDIQ ESPC Generation 4, Section C.5.6.). This guidance provides a description of Cx for ESPC projects, including Cx roles and responsibilities related to Cx, reporting and documentation required. In addition, this guidance discusses how Cx can be used to ensure an ESPC project will meet or exceed facility performance requirements by optimizing the operation and efficiency of building systems and equipment.

2 Overview of Commissioning ESPCs

Cx is used in ESPC projects, from acquisition planning through project implementation and acceptance. The steps of planning, conducting, and reporting on Cx are summarized by project phase below.

2.1 Phase 1 – Acquisition Planning

A brief introduction to Cx and how it is used in ESPC projects is provided by the FEMP Federal Project Executive (FPE) during an initial ESPC briefing for the ordering agency. During this phase, the ordering agency begins to define project objectives and needs, which includes describing project, ordering agency and/or facility requirements.

2.2 Phase 2 – ESCO Selection and Preliminary Assessment

In preparing for ESCO selection, the ordering agency will broadly define project requirements, using details from the acquisition planning phase. Project goals and priorities will evolve through the process, along with the scope of the project and design intent, which will define the performance criteria. During ESCO selection and as the preliminary assessment proceeds, the ESCO and ordering agency will begin addressing Cx approaches and expectations. It is recommended that ordering agency Cx requirements, including project and ECM/WCM design intent, be discussed as part of the preliminary assessment kickoff meeting.

The preliminary assessment may include an outline of a proposed Cx approach, including ordering agency witnessing requirements. The ordering agency will identify areas in the Cx approach that need to be addressed in the investment-grade audit (IGA). The ordering agency also provides Cx specifications, requirements, and commitment in the task order request for proposal (TO RFP).

2.3 Phase 3 – Project Development: Investment Grade Audit, Proposal Development, Negotiation and Award of Task Order

During project development (Phase 3), as proposed ECMs/WCMs are defined, the preliminary Cx approach can be filled in with common Cx activities for each ECM/WCM. Typical Cx activities may include list of systems or equipment, procedures, functional tests and check list(s). These Cx activities will be updated and included as part of the Cx approach in the technical proposal. During project development the ordering agency should ensure their specific performance requirements are clearly defined in the contract – through the TO RFP; the Risk, Responsibility, Performance (RRP) Matrix; and the Cx approach prior to task order award.

2.3.1 Commissioning Approach

The Cx approach is a severable document that is submitted by the ESCO as part of the task order (TO) proposal. The Cx approach uses site specific data and factors needed to achieve facility performance requirements in accordance with the TO RFP and TO (see e.g., DOE IDIQ ESPC

Generation 4, Section C.5.6.a). The Cx approach should also describe the ESCO's Cx process and Cx team, including roles and responsibilities; how the ESCO intends to develop a detailed Cx plan; and key Cx activities.

2.4 Phase 4 – Project Implementation: Final Design, Construction, Post-Installation M&V and Commissioning, Project Acceptance

The majority of Cx activities occurs during Phase 4. This starts during the design process, after TO award, when the design and operating intent and project requirements are finalized. Cx may be done on an ECM/WCM-by-ECM/WCM basis but should also ensure that building systems perform interactively to meet the ordering agency project requirements.

2.4.1 Commissioning plan

After award of the TO the ordering agency reviews and accepts the design and construction package (e.g., final designs, drawings, and equipment specifications), the ESCO provides a Cx plan for acceptance that finalizes the Cx Approach and addresses each ECM/WCM with specific steps that will be taken during the Cx process (see e.g., DOE IDIQ ESPC Generation 4, Section C.5.6.b). . For each ECM/WCM, the detailed Cx plan addresses Cx instructions, methods, and checklists for design verification, operational and performance acceptance tests, equipment start sequences, testing and balancing, functional acceptance tests, and shakedown methods[3] (if applicable).

2.4.2 Commissioning preparatory meetings

During construction, prior to the start of Cx, FEMP encourages agencies to request Cx preparatory meetings. These meetings should be focused on understanding the detailed Cx schedule and ensuring coordination between all necessary parties. The ordering agency should ensure that all personnel identified for witnessing Cx activities are present at preparatory meetings and understand what their roles will be in the process. Impacts to normal facility operations that may be caused by the Cx process should be identified and communicated to impacted parties. Impacts to normal facility operations may include short-term events such as space temperatures outside of the ordering agency performance requirements.

2.4.3 Inspections and operational acceptance tests

As construction proceeds, the ESCO validates the readiness of equipment, systems, and controls through equipment startup and operational performance testing. Operational performance tests should include all newly installed systems or components and interrelated or connected systems.

2.4.4 Functional performance tests

Testing and evaluation of ECM/WCM performance under a full range of operating conditions for compliance with project and design intent is conducted, with the ordering agency witnessing of

[3] Shakedown refers to when any site utility is interrupted and then restored to determine if the systems operate in the expected manner (e.g., safety systems working as designed or needed, systems fail in safe mode, etc.)

the tests. Functional performance tests ensure that system(s) perform the function for which it was designed and intended.

2.4.5 Commissioning Report

The ESCO submits a Cx Report to the ordering agency that documents the results of the Cx activities, including the effect(s) of the ECM(s)/WCM(s) on facility performance requirements in accordance with the Cx plan and ordering agency requirements set out in the task order (see e.g., DOE IDIQ ESPC Generation 4, Section C.5.6.c). The ordering agency reviews, provides comments, and accepts the final Cx report, prior to full project acceptance.

3 Summary of Roles and Responsibilities in ESPC Project Commissioning

Throughout ESPC development, there are activities, roles and responsibilities related to Cx. The key activities by project phase are presented in the tables below, along with the roles and responsibilities of the ordering agency, project facilitator (PF), and ESCO.

Table 1. Cx Activities, Roles, and Responsibilities during Preliminary Assessment (Note that there are no requirements for Cx approach within PA deliverable).

Activity	Ordering Agency	PF	ESCO
Phase 2: Preliminary Assessment			
Preliminary Assessment (PA) kickoff meeting	Participates in initial Cx discussions. Describes/confirms project requirements.	Introduces Cx as part of the PA kickoff agenda, including agency and ESCO roles, agency Cx requirements and design intent.	Provides agency with Cx concept and methodology during meeting.
PA prepared and submitted			May submit draft Cx approach outline in PA.
PA review	Reviews PA; sends consolidated comments to ESCO. Identifies areas in Cx approach outline (if provided) that need to be addressed in proposal.	Reviews PA: identifies areas in Cx approach outline (if provided) to be addressed in proposal. Consolidates comments to send to ESCO.	Responds to comments. (Typically, the PA is not reissued; comments are addressed in IGA and proposal).
Notice of Intent to Award[4]/TO RFP issued along with PA comments.	Forms ordering agency Cx team. Adds Cx specifications, requirements, and commitment to TO RFP.	Provides input to agency on Cx for TO RFP; guides project requirement, design intent discussions.	Based on TO RFP, leads project, design intent discussions. Forms ESCO Cx Team.

Table 2. Cx Activities, Roles, and Responsibilities during Investment Grade Audit.

Activity	Ordering Agency	PF	ESCO
Phase 3: Project Development/Investment Grade Audit and TO Award			
IGA kickoff meeting	Participates in Cx discussions and updates ordering agency needs/objectives statement and project requirements document.	Consults with ordering agency on Cx goals and requirements as needed.	Provides ordering agency with draft Cx methodology for ECMs/WCMs and leads project requirements workshop.
Proposal preparation	Reviews draft Cx approach document to ensure proposed project aligns with project requirements and provides comments to ESCO. Witnesses baseline measurements and provides input to ESCO.	Reviews draft Cx approach and project requirements; consolidates comments.	Drafts Cx approach document, ensures solution meets ordering agency project requirements; reviews with agency and uses project requirements for IGA ECM/WCM development.

[4] Notice of Intent to Award is a letter issued by the ordering agency contracting officer if/when the ordering agency and ESCO agree to pursue to the project, before starting the IGA. The TO RFP is then issued that identifies the ordering agency's specific requirements.

Activity	Ordering Agency	PF	ESCO
Phase 3: Project Development/Investment Grade Audit and TO Award			
IGA completed, proposal prepared and submitted		Provides support to ordering agency on questions related to Cx.	Prepares and submits proposal, with Cx approach for included ECMs/WCMs that incorporates site-specific factors based on IGA results to meet ordering agency project requirements.
IGA and proposal review	Reviews proposal, including Cx approach using project requirements document as guide; provides comments to ESCO.	Reviews proposal, including Cx approach; consolidates comments.	Responds to comments and revises proposal and final Cx approach, as needed.

Table 3. Cx Activities, Roles and Responsibilities during Project Implementation/Construction and Post-Acceptance

Activity	Ordering Agency	PF	ESCO
Phase 4: Project Implementation/Construction			
Construction kickoff meeting	Hosts meeting, assigns Cx representative, reviews Cx activities for construction.	Participates in kickoff; provides draft agenda if requested.	Reviews planned Cx activities and assigns/identifies Cx agent for project.
Design	Reviews ECM/WCM design against project requirements and ECM/WCM design intent; provides comments/ approves design package.	Participates in design review if part of statement of work.	Integrates Cx process, project and ECM/WCM operation and design intent and Cx specifications with final design package.
Equipment Submittals	Reviews submittals against project requirements and ECM/WCM design intent; provides comments/ approves.	Reviews equipment submittals if part of statement of work.	Integrates Cx process, Cx specifications, project requirements and design intent with suppliers or subcontractors.
Cx Plan	Reviews and approves Cx plan.	Reviews Cx plan and provides comments to ordering agency.	ESCO/Cx agent provides Cx plan that addresses each ECM/WCM.
Installation	Coordinates access and outages; inspects installations and witnesses performance testing.	Participates in installation activities if part of statement of work.	Integrates Cx process, project requirements, and ECM/WCM inspections, startup and testing with construction contractors.
Training	Reviews, provides comments, and participates in training sessions.	Reviews training plan and provides comments to agency.	Issues training plans as outlined in proposal, schedules training and provides training aids, recording if specified.
Cx Activities and Report	Participates in Cx activities; witnesses Cx. Reviews and approves report.	Participates in Cx if part of statement of work. Reviews and provides comments to ordering agency.	Cx agent executes Cx activities, following previously approved Cx plan, coordinates ordering agency activities. Provides report.
Post-installation M&V	Witnesses; reviews and approves report.	Reviews and provides comments to ordering agency.	Conducts post-installation M&V activities; provides report.

Activity	Ordering Agency	PF	ESCO
Phase 4: Project Implementation/Construction			
Project acceptance	Conducts project inspection, reviews and provides notice of project acceptance and acceptance of project documents and punch list, including Cx Report, Post-Installation Report, as-built drawings, O&M manuals, etc. and accepts project.	Reviews project acceptance documents (including Cx Report, Post-Installation Report); provides comments to ordering agency.	ESCO notifies ordering agency of ECM/WCM installation completion, provides required project documents (including punch list, training, O&M manuals, as-built drawings), incorporates agency comments and finalizes documents (including Cx Report, Post-Installation Report).
Phase 5: Post Acceptance Performance			
Post-acceptance performance	If additional testing or measurements are needed (as described in the Cx and/or M&V plan), participates in and witnesses any needed seasonal testing; reviews/approves final Cx report.	Reviews and provides comments to agency.	If additional testing or measurements are needed (as described in the Cx and/or M&V plan), conducts seasonal testing; submits final Cx report incorporating agency comments.

4 Key Elements of Commissioning

4.1 Project Intent and Requirements

Early in the project, when the agency acquisition team and facility managers focus on defining the needs, priorities, and requirements for the project, they also begin defining project requirements in terms of energy and water performance and operational improvements needed in the facility — in other words, how the facility manager would define the project's success in improving building conditions, reducing energy and water costs, and reducing needs for maintenance or troubleshooting of energy systems.

The project requirements document should clearly define the agency's expectations and goals for the project and may be regularly updated as the scope of the project is defined and refined. The project requirements document provides the framework for communicating agency and facility needs, should be written with non-technical language and be understandable by everyone involved in the project, including the facility manager, maintenance staff, construction workers, architect, engineers, and equipment manufacturers. The project requirements developed during acquisition planning are typically summarized in the notice of opportunity as part of the statement of objectives.

By providing defined project requirements the ordering agency helps the ESCO target energy and water efficiency opportunities, and also helps to focus the IGA on capturing existing building operating conditions and establishing baselines from which to measure the opportunities for integrated energy savings and improved building operational conditions.

When project development begins in Phase 3, the ESCO can further refine the goals of the project and draft a project requirements document. A project requirements workshop, either in conjunction with the IGA kickoff meeting or a stand-alone meeting, with participation of the ESCO Cx team, project facilitator, and agency personnel, will facilitate this effort. Agency personnel who should be included are the same as those who would be involved in the IGA kickoff meeting: Contracting Officer (CO), contracting officer's technical representative (COTR), energy/facility managers, construction manager, and others — all of those who can affect or will be affected by the project.

Project requirements will continue to be refined throughout IGA development as changes in ECM/WCM specifications arise. The Cx approach will be included with the proposal, which describes the anticipated Cx activities based on included ECMs/WCMs, roles and responsibilities of key personnel for project implementation (Phase 4).

Documented project requirements also may guide the ESCO's development of a design intent document, which can be useful in guiding design of the ECMs/WCMs but is not always required.

4.2 Commissioning Approach

As part of the final technical proposal, the ESCO submits the Cx approach that incorporates site-specific data and factors needed to realize facility performance and project requirements. A draft Cx approach may be provided with the PA. The Cx approach describes project requirements, the Cx process for the project and key members of the Cx team. The Cx approach does not have details on specific functional testing and verification procedures, as those are developed and submitted with the Cx plan, as part of the design and construction package after task order award.

4.3 Commissioning Plan

The ESCO submits the Cx plan with the completed design and construction package after task order award, and the agency reviews for compliance with project requirements. The final Cx plan specifies activities to verify that each ECM/WCM and building systems meets the operation intent and perform interactively according to project requirements and design intent.

The Cx plan will define how the proposed ECMs/WCMs should operate, guide the design and installation review and resulting performance requirements, and specify the process of verification, including functional testing of the installed equipment/systems. Planned tests should include measurement of ECM/WCM performance to verify and document performance of equipment and systems, and to demonstrate the ECMs'/WCMs' improvement in building system operations or discover operating deficiencies to be corrected in the ECM/WCM or interfacing facility equipment.

The ordering agency should provide the ESCO the requirements for notification of testing; the ESCO must ensure the Cx plan affords the ordering agency the opportunity to witness all testing to be performed as a part of the Cx plan.

4.3.1 Commissioning Plan Contents

The final Cx plan should have the following contents:

Overview

- Abbreviations and definitions
- Project intent and requirements
- Purpose of the Cx plan
- Cx scope / objectives
- Equipment and systems to be commissioned

Commissioning Team: Roles & Responsibilities

- List Cx team members & contact information
- Description of roles and responsibilities, including identification of government personnel for witnessing Cx activities

Commissioning Process

- Final Cx plan
- Cx kick-off meeting, other meetings
- Management protocols
- Submittals, documentation, checklists, and written work products
- Pre-functional checklists, tests, and startup
- Functional tests and verification procedures
- Agency witnessing
- O&M manuals and warranties
- Training
- Schedule
- Seasonal testing

4.4 ECM/WCM Installation and Functional Performance Tests

As construction begins, the ordering agency and ESCO will review the Cx plan and all Cx activities that will take place during construction. The ESCO installs the ECMs/WCMs per agency-approved design and installation plans and uses Cx-related logs, checklists, and records required to document installation.

After installation, functional and operational performance tests are conducted to demonstrate the ECMs'/WCMs' performance in compliance with the project requirements, and to gauge how the ECMs/WCMs interact with existing facility equipment and achieve required building operating conditions. Any operating deficiencies are documented and resolved.

Operational performance tests comprise the validation of components of equipment, systems, and controls for readiness at equipment start. Test documents for mechanical, electrical, instrumentation and controls, life safety, and telecom are included. Though individual contractors may complete these tests, the ESCO is responsible for ensuring that functional and operational tests are conducted, and deficiencies resolved. Witnessing of these tests by the ordering agency must occur as specified in the negotiated and approved site-specific M&V plan. Operational performance test documentation are made available for agency review as needed. It is recommended that operational performance test results are included as appendices to the final Commissioning report provided to the ordering agency, along with ordering agency witnessing documentation.

Functional performance tests comprise testing and evaluation of ECM/WCM performance under operating conditions for compliance with project requirements. Warranties typically become active after system/ECM/WCM acceptance; warranty periods and requirements are described in the project contract specifications. Shakedown testing addresses inter-system dependencies and

intra-system components to verify safety, standby start, soft start and other performance functions that require multi-system interaction.

The agency witnessing must occur as specified in the negotiated and approved site-specific M&V plan. The ordering agency must ensure that all documentation has been submitted as described in the Cx plan and that all punch list items are complete.

4.5 Commissioning Report

After construction is complete but before project or ECM/WCM acceptance, the ESCO submits the Cx report.

The Cx report summarizes for each ECM/WCM the intended operational performance, equipment installation, testing equipment and specifications, results of functional performance tests, any operational deficiencies and course of action for their remediation, and compliance with project requirements and ECM/WCM/system design intent. Any seasonal testing requirements are identified and scheduled. After ordering agency review and written comments and any required revisions, the final report is submitted by the ESCO for approval.

An "interim" Cx Report is submitted if there are Cx activities that must occur after acceptance to cover functional and operations testing of seasonally operated equipment. (See "Commissioning and Project Acceptance" below.)

4.5.1 Commissioning Report & Record Book Outline

The Cx Report contains two major documents: The Commissioning Record Book and the Commissioning Summary Report.

Commissioning Record Book is documentation of the executed Cx plan. The Cx Record Book includes:

- Completed pre-functional checklists
- Completed functional tests
- Monitoring reports
- Additional information and documentation added as required (such as completed manufacturer's checklists and documentation of manufacturer start-up).

Commissioning Summary Report

Project overview:

- Executive summary
- List of participants & roles
- Brief project description
- Overview of Cx scope
- General description of testing & verification methods

For each piece of equipment or system, report on:

- Equipment meeting specifications
- Equipment installation
- Functional performance and efficiency
- Brief description of verification & testing methods used and observation & conclusions from the tests
- Equipment documentation & design intent
- Operator training

Appendix materials:

- Detailed list of all outstanding or non-compliance issues, including reference to the specific test, inspection, trend log, etc., where the deficiency is documented.
- Unresolved issues
- Summary of any design changes and location of additional information
- Cx meeting minutes
- Cx progress reports
- Site visit reports
- Findings
- Communications

4.6 Commissioning and Project Acceptance

Project acceptance marks the point when the ECMs/WCMs and the project are turned over to the ordering agency and constitutes the start of the post-acceptance performance period during which post-acceptance performance period payments are made to the ESCO.

Some requirements for ESPC project acceptance may be particular to the ordering agency, but they will always include Cx and M&V. A 30-day proof of performance may be required by the ordering agency to ensure systems are operating correctly for a specified duration (i.e. 30 days) prior to acceptance. The ESCO and ordering agency will follow an agreed-upon acceptance plan and checklist, which will require the ESCO to (among other things) submit the following before acceptance:

- Punch list items
- O&M manuals (system manuals) and assurance that O&M training is complete
- As-built drawings (record drawings)
- Post-Installation M&V report confirming ECMs/WCMs are operating consistent with the guaranteed energy savings

- Interim or final Cx report

Frequently an interim Cx report will be submitted before acceptance because seasonal testing of some ECMs/WCMs is required by the Cx or M&V plan. Seasonal testing entails, for example, Cx of chillers during the summer months and boilers during the winter months.

In this case, the ordering agency would accept the project pending final Cx and/or M&V, and payments to the ESCO would begin. The Cx and/or M&V plan would describe additional testing or measurements needed and the seasonal requirements for the later date. Any discrepancies identified would be handled as agreed to by the ordering agency CO or specified in the TO. After all post-acceptance Cx and M&V activities are completed, the ESCO would submit the final Cx report for review and approval by the agency. This should be described in the Cx plan and/or M&V plan.

The final Cx report and documentation of the acceptance of the Cx report should then be stored as part of the project contract file.

5 Additional Resources

While this cx guidance was developed specifically for federal ESPCs; much of the guidance will be of use to any performance-based contracting customer.

A variety of guidance and resources for commissioning federal facilities may be found on the FEMP Commissioning Process for Federal Facilities webpage, including a link to FEMP's document on Commissioning for Federal Facilities, which provides an overview and offers a practical guide to commissioning, recommissioning, retro-commissioning and ongoing commissioning of federal facilities.

Additional resources on ESPCs can be found on the FEMP Resources for Implementing Federal Energy Savings Performance Contracts web page.

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For more information, visit:
energy.gov/femp

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