APPENDIX 1
CONSTRUCTION SUPERVISION AND QUALITY ASSURANCE PLAN
(SAMPLE FRAMEWORK)
MARCH 2021

GOOD PRACTICE NOTE ON DAM SAFETY

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Construction Supervision and Quality Assurance Plan
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Objectives

This sample framework outlines the key elements of the Construction Supervision and Quality Assurance Plan (CSQAP), such as the roles and responsibilities of key entities involved in construction of a dam, quality control system/measures/key requirements, contraction records keeping procedure, and so on.

The CSQAP is one of four dam safety plans for certain dams¹ required by the World Bank Environmental and Social Framework/Environmental and Social Standard 4/Annex 1 on safety of dams, which include (a) CSQAP, (b) Instrumentation Plan, (c) Operation and Maintenance Plan (O&MP), and (d) Emergency Preparedness Plan (EPP). In the World Bank’s project cycle, the CSQAP is required at appraisal stage and generally submitted in the form of terms of reference (TORs) for Construction Supervision and Quality Assurance (CSQA) consultancy.

As this sample framework of the CSQAP contains all the essential requirements as the basis for consultancy tendering, Task Teams can easily convert it to ToRs by adding anything specific to the project (for example, minimum level of resources). The CSQA consultancy methodology should conform to that plan and add details based on consultants’ experience and know-how. Understanding of the CSQA requirements and reflection of the latter in the proposed methodology should have the largest weight in bid evaluation. A formal and more detailed Quality Assurance Plan is required to be submitted by the contractor and is subject to review and approval by the CSQA consultant on behalf of the owner of the project.

The quality assurance of construction work is critical for ensuring dam safety. Without an appropriate level of quality control, through a quality management system, there is the potential that design requirements and/or standards will not be met, which will adversely affect dam safety. This sample framework sets out the scope of the quality control system and procedures that should be implemented to demonstrate construction's compliance with the specified design requirements. In particular, the plan should cover the following key elements:

- The roles and responsibilities of key entities involved in construction of a dam and quality control
- The overall scope of the quality control system and key requirements
- The quality control measures including

¹ As per ESS4 - Annex 1, para 2, these are “large dams” and “small dams” that could cause safety risks or are expected to become large dams during their operating life.
- Visual inspection procedures and records;
- Field and laboratory testing procedures and records; and
- Critical areas and construction signoff

- The procedure of construction records keeping; and
- The procedure of the commissioning of the works

The CSQAP should establish the resources (staff, equipment, laboratory, vehicles, and so on) to be allocated for the execution of the plan. The level of such resources should be proportional to the complexity of the project and based on (a) the special conditions of contract and technical specifications, in unit-rates type contracts, and (b) the owner’s requirements, in turnkey/engineering-procurement-construction (EPC) type contracts.

Roles and Responsibilities of Key Entities

Depending on the size, type, and potential risk of the dam, the following key entities are generally involved in dam’s construction work and quality control:

- Owner
- Designer
- Contractor
- Supervising engineer (SE) or owner’s engineer (OE)\(^2\)

The contractor is directly responsible for quality control during construction and should describe the measures used in method statements for the different parts of the works. Such statements are scrutinized by the SE or OE. Inspection and testing of the work to verify its compliance with the contract requirements is essential for the completion of a safe dam.

The SE or OE is normally responsible for quality assurance, which should include reviewing and clearing the contractor’s Quality Assurance Plan, as well as monitoring its effectiveness throughout the construction period toward commission. Test records should be reviewed by the SE’s or OE’s site representative for compliance with the contractual and the design assumptions. The SE or OE should also have the ability to undertake independent inspections and tests considered necessary to confirm that the construction is completed in accordance with the design intent.

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\(^2\) The entity depends on the type of construction contract. Conventional, measurement-based contracts require an SE, traditionally referred to as the engineer, who is responsible for checking quality of construction, independently from the contractor, in compliance with contract documents and technical specifications in particular. In case of turnkey-type contracts, construction oversight is performed by the OE, or employer’s representative, who must ensure that works are executed and handed over according to the owner’s requirements. The term owner’s engineer applies to build-operate-transfer contracts, in which the contractor builds and operates the project for a concession period and then transfers it to the owner (generally a public entity). The employer’s representative is used in EPC contracts. The use of the two terms is often mixed in international practice.
Table A.1 summarizes the key roles and responsibilities of entities involved in quality control of construction works.

**TABLE A.1. Roles and Responsibilities during Quality Control of Construction**

<table>
<thead>
<tr>
<th>Entity</th>
<th>Key roles</th>
<th>Key tasks and responsibilities</th>
</tr>
</thead>
</table>
| Owner                                | Own and manage the project, including future O&M (or appoint a dedicated O&M entity) | Ensure all parties engaged to investigate, design, construct, commission, and operate the dam are suitably qualified and have their roles, powers, and responsibilities properly defined.  
Comply with all regulatory requirements, including any requirements specified in conditions attached to consents issued by regulators and the World Bank.  
Provide the necessary funding to achieve the required quantity and quality of inputs in a timely manner.  
Make regular payments to the other parties, according to contractual provisions and progress of the works.  
Process variation orders in consultation with the SE or OE. |
| Designer                             | Design the dam and associated facilities, including bidding documents preparation. Interact with the SE or OE, as necessary, to assist in design-relevant matters during construction. In some cases, to ensure continuity, the designer is retained to provide the functions of SE or OE. | Interact with the SE or OE to ensure that any changes required during construction meet the design criteria and do not impair the safety of the dam.  
As appropriate, assist the SE or OE in reviewing those contractor submittals that have design relevance and that the proposed materials and methodologies are consistent with the design intent.  
In coordination with the SE or OE, review and clear the contractor's engineering design that may affect the quality of the permanent works. |
| Supervising engineer/owner's engineer | Responsible for construction supervision and quality assurance            | Provide the owner with contract management support, ensuring effective administrative link between the owner and contractor.  
Ensure that the construction work is carried out in accordance with the contract design and specifications, typically with a team including full-time specialists, quality control inspectors, field technicians, and quantity surveyors.  
Review and approve the contractor's Quality Assurance Plan and monitor its effectiveness throughout construction, including the review of contractor's test records for compliance with the specifications and the design assumptions and additional tests or inspections as needed.  
Review and approve the contractor's method statements before construction as required in the technical specifications for all important elements of the project and check for any noncompliant methods, equipment, or materials to be corrected before work commencement. Handle contractor's claims in a timely manner and advise the owner accordingly.  
Advise the owner on variation orders.  
Liaise with the designer to resolve design changes that may be dictated by changed conditions or findings during construction. |
### Table A.1. continued

<table>
<thead>
<tr>
<th>Entity</th>
<th>Key roles</th>
<th>Key tasks and responsibilities</th>
</tr>
</thead>
</table>
| Contractor | Responsible for construction works and quality control under the oversight of the SE or OE | Provide all required resources for delivering quality construction works in a timely manner.  
Submit method statements before construction to demonstrate an understanding of the design as required in the specifications for all important elements of the project subject to the approval of the SE or review by the OE.  
Employ qualified staff with full understanding of the design and experiences of similar type of projects to detect when variations to specified procedures are necessary (for example, foundation treatment, material selection and placement, filter manufacture and testing, or concrete manufacture and testing). |

Note: OE = owner's engineer; O&M = operation and maintenance; SE = supervising engineer.

### Quality Control System: Key Requirements

In general, it is important to reflect the following key elements in the plan:

- Incorporating a mechanism to ensure design knowledge to define design’s adjustments to differing site conditions throughout construction

- Ensuring an appropriate contractor selection process, considering the complexity of the construction works and potential risks

- Ensuring the required level of supervision and quality assurance in different stages or phases

- Ensuring adequate on-site inspection and testing procedures, throughout construction, to verify that all construction is in accordance with the design

- Allowing for appropriate design change procedures, including, as appropriate, the designer’s checking and no objection

- Providing appropriate quality control system and procedures for confirming the quality of offsite manufacture, including verification of the supplier’s quality control records

- Establish and run a comprehensive record keeping system

It is also important to ensure that the SE or OE can check and verify the contractor’s quality control tests, including the following:

- Verification, signoff, and recording procedures for each element of the works

- Compliance and noncompliance criteria, as well as procedures for logging and dealing with noncompliances
• Hold points for inspection and signoff by the contractor and SE or OE

• Schedules, forms, and check sheets for the inspection, testing, and reporting of all quality control activities

**Quality Control Measures**

The plan should cover the following tasks for undertaking construction supervision and quality control.

**Visual Inspections**

The extent and frequency of visual inspections will vary, depending on site conditions, the importance of the work being inspected, and so on. More frequent inspections are usually necessary during the initial stages of construction when foundation conditions are exposed, foundation treatments are completed, material trials are completed, and initial dam construction gets under way.

Visual inspections and signoffs determine whether the requirements of the drawings and technical specifications are being met. Experienced inspectors with the ability to identify acceptable construction work are essential for effective quality control.

The contractor’s quality control procedures should include inspection sheets for individual elements of the work. These sheets should identify the project element, the date, the type of work, the tests carried out, and verification by the contractor’s supervisor that the work has been completed and checked. The SE or OE should review and sign the inspection sheet to authorize the next stage of construction to proceed.

**Field and Laboratory Testing**

The extent and frequency of testing depends on the amount of material to be placed and the importance of the material to dam safety. Examples of important field and laboratory tests for dams are listed in table A.2.

The numbers of field and laboratory tests should be statistically significant and representative of the dam component being tested. More frequent testing is usually necessary during the initial stages of dam construction to verify that the physical characteristics of the materials meet design requirements and that the adopted construction methods are appropriate, as well as to enhance the ability of inspectors to identify acceptable and unacceptable construction—typically test embankments, trial mix of concrete, grouting panels, rock bolt pull-out tests, shotcrete rebound tests, blasting trials, and so on. All field and laboratory testing should be completed in accordance with relevant procedures or standards by national regulators or internationally recognized organizations with comprehensive backgrounds in dam engineering (for example, International Commission on Large Dams [ICOLD], U.S. Bureau of Reclamations [USBR], and U.S. Army Corps of Engineers [USACE]).
TABLE A.2. Main Tests for Embankment and Concrete Dams

<table>
<thead>
<tr>
<th>Dam type</th>
<th>Main field and laboratory tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Embankment dams</td>
<td>• Material properties (Atterberg limits, gradations, permeabilities, water content, shear strengths)</td>
</tr>
<tr>
<td></td>
<td>• Material compatibility (core, filter, drainage, shoulder, and foundation material interfaces)</td>
</tr>
<tr>
<td></td>
<td>• Durability of filter and drainage materials</td>
</tr>
<tr>
<td></td>
<td>• Density (proctor compaction, relative density)</td>
</tr>
<tr>
<td></td>
<td>• Grout curtains (pressure and flow records)</td>
</tr>
<tr>
<td></td>
<td>• Grout quality (water-to-cement ratio, viscosity, cement finesse)</td>
</tr>
<tr>
<td>Concrete dams</td>
<td>• Concrete (water-to-cement ratio, cement content, maximum aggregate size, aggregate gradation, cement finesse, workability, compressive strength, aggregate quality)</td>
</tr>
<tr>
<td></td>
<td>• Reinforcing steel properties (yield point, elastic modulus)</td>
</tr>
<tr>
<td></td>
<td>• Pozzolan and fly ash acceptance tests</td>
</tr>
<tr>
<td></td>
<td>• Grout curtains (pressure and flow records)</td>
</tr>
<tr>
<td></td>
<td>• Grout quality (water-to-cement ratio, viscosity, cement finesse)</td>
</tr>
</tbody>
</table>

Critical Areas and Construction Signoffs

All areas that are critical to meeting the design intent and achieving dam safety should be identified before construction and highlighted in the Quality Assurance Plan as hold points for inspection and signoff by the SE or OE. Areas and items that typically fall into this category are

- Foundation preparation, including such items as shaping, joints and discontinuities treatment, degree of weathering, and dewatering;

- Work activity preparation—for example, formwork, reinforcing steel, embedded items, and area clearing for concrete pours;

- The quality and acceptability of key materials, whether they be concrete, earthfill, filter, or drainage materials;

- The bedding, jointing, backfilling, and protection of segregation of one zone into another through embankment dams;

- The installation of embedded items for equipment critical to dam safety, including monitoring instruments; and

- The fabrication and installation of gates and valves and their control system critical to dam safety.

Construction Records Keeping

Accurate and comprehensive construction records are important and provide a background for future dam safety evaluations and the design and construction of any necessary rehabilitation works. The level of detail will of course vary with the size, complexity, function, and the risk level of the dam.
The construction records should be stored in an appropriate records system and backed up to a separate location. These include investigation records, excavated foundation conditions, quality control testing and visual inspection records, monitoring records, construction photographs, and as-built drawings.

**Commissioning Procedures**

The commissioning procedures should outline each entity’s responsibilities, precommissioning requirements, commissioning procedures, and performance evaluation criteria. As part of a formal quality control system, detailed readiness checklists should be prepared and used for various components and activities. The SE or OE should assist the owner in ensuring that the Emergency Preparedness Plan is in place. The commissioning should be attended by the owner, contractor, and SE or OE; the designer could be summoned to assist as appropriate. The SE or OE should complete a report on the results of the commissioning, which summarizes the commissioning process, highlights any unexpected results, and comments on any necessary actions that were taken to address unexpected results.
### Annex A: Key Entities and Their Roles under Different Forms of Contract by FIDIC

<table>
<thead>
<tr>
<th>Item</th>
<th>Red Book</th>
<th>Yellow Book</th>
<th>Silver Book</th>
</tr>
</thead>
<tbody>
<tr>
<td>Separate contracts—for example, civil works and electromechanical works</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Tender design and specifications</td>
<td>Detailed</td>
<td>Less detailed and specified in employer’s requirements</td>
<td>Performance specifications only</td>
</tr>
<tr>
<td>Design and responsibility for design</td>
<td>Employer</td>
<td>Contractor</td>
<td>Contractor</td>
</tr>
<tr>
<td>Employer’s influence on design</td>
<td>Total</td>
<td>Less than Red Book, but employer has right to approval</td>
<td>None</td>
</tr>
<tr>
<td>Design preparation</td>
<td>Employer</td>
<td>Contractor and design must be approved by the engineer</td>
<td>Contractor and design must conform to employer’s requirements</td>
</tr>
<tr>
<td>Construction time</td>
<td>Fixed, but may be extended for agreed reasons</td>
<td>Fixed, but may be extended or reduced for actual subsurface conditions—for example, tunnels and foundations</td>
<td>Fixed</td>
</tr>
<tr>
<td>Geological risks and increased quantities</td>
<td>Employer</td>
<td>Risk sharing—for example, contractor for above ground and employer for subsurface</td>
<td>Contractor</td>
</tr>
<tr>
<td>Payment</td>
<td>Monthly, based on unit rates and measured quantities</td>
<td>Fixed with payment schedule, but with variations (additional payment or credit) for actual subsurface conditions</td>
<td>Fixed lump sum</td>
</tr>
<tr>
<td>Engineer for supervision and contract administration</td>
<td>Yes</td>
<td>Yes</td>
<td>Employer’s representative</td>
</tr>
</tbody>
</table>


*Note: FIDIC = Fédération Internationale Des Ingénieurs Conseils or International Federation of Consulting Engineers*

Regarding design and responsibility for design and design preparation under Red Book, although the design is almost all the times done by a consulting firm (designer) appointed by the employer, the contractual responsibility with the design remains with the employer.