

CN95025TB

CNIC-00919  
SEPC-0001

# 中国核科技报告

CHINA NUCLEAR SCIENCE  
AND TECHNOLOGY REPORT

大亚湾核电站常规岛安装的质量保证体系

QUALITY ASSURANCE SYSTEM FOR  
CONVENTIONAL ISLAND ERECTION OF  
DAYA BAY NUCLEAR POWER PLANT



中国核情报中心  
原子能出版社

04

China Nuclear Information Centre  
Atomic Energy Press



施中良：高级工程师，山东省电力工业局计划发展部主任。

Shi Zhongliang: Senior engineer, director of Planing & Developing Department, Shandong Electric Power Bureau.

CNIC-00919

SEPC-0001

# 大亚湾核电站常规岛安装的质量保证体系

施中良 吴锁志 孟祥科

(山东核电公司)

## 摘 要

介绍了山东核电公司在承担大亚湾核电站常规岛安装工程中,质量保证体系建立、运转及不断完善的过程。较系统地阐述了质量保证大纲和大纲程序编制原则与主要内容,并从理论与实践的结合上,介绍了构成质量保证体系的主要部门如何根据自己的质量责任,围绕质量保证大纲确定的原则和质量保证大纲程序的要求协调有序地工作,实现了质量保证三环节与四要素的有机结合,从而实现了常规岛安装工程的高质量。肯定了业主与上级管理部门进行质保监督与管理评审对推动企业质保体系有效运转的积极作用。常规岛安装工程的实践证明,独立于工程部门的质保部和独立于施工部门的质检科对工程建设中一切影响质量的重要活动和服务进行严格的检查监督,对保证工程质量有十分重要的作用。

# **QUALITY ASSURANCE SYSTEM FOR CONVENTIONAL ISLAND ERECTION OF DAYA BAY NUCLEAR POWER PLANT**

**Shi Zhongliang Wu Suozhi Meng Xiangke**

**(SHANDONG ELECTRIC POWER CONSTRUCTION CORP.  
NUCLEAR POWER CONSTRUCTION COMPANY)**

## **ABSTRACT**

The process concerning the establishment, operation and perfection of Quality Assurance System (QA system) experienced by Shandong Electric Power Construction Corporation, Nuclear Power Construction Company (SEPC-NPCC) during the implementation of Conventional Island Erection (CIE) in Daya Bay Nuclear Power Plant is introduced. Apart from systematic description of the principle for working out QA programme and QA procedures and their main contents, it is also detailed, on a combination of theory with practice basis, how the major departments constituting the QA system such as Quality Assurance, Quality Control, Construction and Administration & Business Departments have made fruitful efforts as per the individual responsibility for ensuring the work quality and having in mind the principles specified by QA programme and the requirements of QA procedures. As a result of the reasonable combination of the 3 crucial points and the 4 essential elements of the QA system, and then high quality of CI erection has been realized. The importance of quality supervision and management review by the owner and upper levels of authorities for ensuring effective operation of QA system is affirmed. The practical experience of CIE project proves that the strict inspection/surveillance on all activities and service affecting quality carried out by QA Department independent of project management and QC Dept, independent of construction management are of quite importance for ensuring the project quality.

## INTRODUCTION

Daya Bay Nuclear Power Plant in Guangdong Province with its construction scale of  $2 \times 900$  MW PWR units consists of Nuclear Island (NI), Conventional Island (CI) and Balance of Plant (BOP).

The CI equipment and their system supplied by GEC-ALSTHOM are erected by Shandong Electric Power Construction, Nuclear Power Construction Company (SEPC-NPCC).

Nuclear power Plant is the positive achievements in science and high technological results, with strict requirement of technical standards, complicated equipment/systems and high costs. In case of an accident occurred in a nuclear power plant, the disastrous consequences would be caused.

In order to obtain satisfactory operation performance of CI equipment/systems in the future, the individual organizations undertaking such assignments as equipment system design, manufacturing, erection and commissioning should establish a stringent Quality Assurance System (QA system).

QA system means a system, established by an organization to obtaining good quality with assurance & confidence. It is an organic whole in combination with organization, document system, recording system and surveillance mechanism. The QA system operates in line with the quality objective and quality policy specified according to quality assurance programme, and enables the quality-related activities to be carried out by qualified personnel, as per the approved procedures and under controlled conditions.

In order for ensuring effective operation of QA system, great attention has to be paid to good combination of the 3 crucial points and the 4 essential elements.

(1) The 3 crucial points refer to:

Quality Plan, Quality Control and Quality System Review.

Quality Plan— A document specially setting out the specific quality practices resources and sequence of activities relevant to certain product, process service, contract or project.

Quality Control— All activities in a planned and systematic way that are necessary for keeping certain product, process or service quality to meet the stipulated requirements.

Quality System Review— An evaluation to be made by the management

department for determining whether the present condition of quality system is in conformance with the quality policy and for determining the new objectives after the change of conditions.

**(2) The 4 essential elements of the QA system:**

The 4 essential elements of the QA system are **Comprehensive Organization, Extensive Document System, Authentic Recording System and Stringent Surveillance System.**

a. **Comprehensive Organization**—Organizations which participate in the construction of nuclear power plant and are engaged in activities affecting the quality, should establish a well-organized organization with clear administrative levels for managing, guiding and executing the engineering activities and define the detail aspect of the departments (including all the personnel) regarding responsibilities, authority, internal and external coordination channels, communication and work interfaces. A strict system of job responsibility is performed, so as to ensure that all problems are being attended.

It is worth mentioning that in the organization a department being independent of project of engineering department or construction department shall be set up, which is responsible for quality inspection, surveillance and audit. All of the important activities and services affecting quality in construction of nuclear power plant shall be effectively controlled by qualified personnel from the independent quality inspection/surveillance organization. QA, QC personnel are authorized to carry out verification independently. Any non-conformance (a deficiency in characteristics, documentation or procedure which renders the quality of an item unacceptable or indeterminate) found, shall be timely/effectively corrected and such correction is mandatory. QA, QC personnel are only responsible for quality. All Quality Assurance activities are not constrained from cost and schedule consideration.

b. **Extensive Document System**—The operation of QA system must be dependent on the effective codes, guide, programme, procedures, drawings and specifications etc. Contractors produced their QA programme, programme procedures, quality plan, project procedures etc. According to IAEA No. 50—C—QA National Nuclear Safety Code and QA programme of the owner. Every activity related quality will be carried out in accordance with the relevant procedures or regulations.

c. **Authentic Recording System**—All QA activities must have the real

and reliable records. The records which are produced by qualified personnel, with qualified equipments are evidence to evaluate the effectivation of QA activities and to realize the quality objective.

d. **Stringent Surveillance System**—The effectiveness of Quality Assurance is thoroughly reflected through the routine surveillance and periodic QA audits. In the process of CI erection, all quality-related activities shall be finally verified by the authorized QA/QC personnel using approved procedures, thus ensuring that every activity is strictly supervised.

## **1 ESTABLISHMENT OF QA SYSTEM AND DESCRIPTION OF QA PROGRAMME**

### **1.1 Establishment of QA System**

The establishment of SEPC-NPCC QA system is roughly divided into 3 stages.

#### **1.1.1 Preliminary QA Programme (Stage One)**

In accordance with the stipulation in CI erection tendering document, the contractor has to submit to the owner of the plant the preliminary Quality Assurance Programme which shall be in conformity with the "Quality Assurance for Safety in Nuclear Power Plant" (No. 50-C-QA) issued by IAEA.

In the light of technical service agreement between SEPC and GEC-A, following the arrival in their posts of Deputy Project Manager, Manager of Planning Dept. and QA Manager the formal QA Programme and QA procedures are commenced to be produced. Based on the general consideration in the preliminary QA programme and recommendation from GEC-A experts, the method and the number for working out QA programme and QA procedures are finalized. Adopting the format of GEC-A QA Programme, using the QA manual that was implemented at the Torness Project in UK as chief source, and taking into account the requirement of management procedures of the owner and the ripe experience of SEPC in the project management, one QA programme and 20 QA procedures (SEPC's QA manual) were at last produced. Then the QA manual was soon reviewed and approved by the owner-GNPJVC.

#### **1.1.2 The Initial Operation of QA System (Stage Two)**

With the commencement of system/item erection and based on the requirement of QA programme and relevant procedures the first internal QA Audit was conducted by SEPC QA Department, and one month later the first

**Table 1 Comparison Regarding QA Procedures  
Between GNPP CIE & Torness CIE Projects  
(Based on QA Procedures, Rev. E)**

serial No.	Designation of QAP	Days Bay CIE Project (Guangdong)			Torness CIE Project (UK)		
		QAP No.	Items	Appendices	QAP No.	Items	Appendices
1	On Site Organization Regulations (OSOR)	QAP 2.01	35	3	/	/	/
2	Document Control	QAP 2.02	46	1	998-5204	26	4
3	Field Design & Field Design Change	QAP 2.03	40	3	998-5212	26	4
4	Procurement Control	QAP 2.04	20	4	998-5213	20	2
5	Material Control	QAP 2.05	53	19	998-5202 5205	30 21	3 1
6	Welding & NDE	QAP 2.06	37	12	998-5209	32	14
7	Control of Welding Consumables	QAP 2.07	48	6	/	/	/
8	Inspection & Testing	QAP 2.08	29	3	998-5211	16	1
9	Measuring & Testing Equipment Control & Calibration	QAP 2.09	35	9	998-5206	31	0
10	Non-conformance Control	QAP 2.10	79	8	998-5215	44	3
11	Audits	QAP 2.11	50	3	/	/	/
12	Correspondence Control	QAP 2.12	50	4	998-5201	54	3
13	Control of Tools & Tackle	QAP 2.13	39	7	998-5207	25	0
14	Control of Lifting Equipment	QAP 2.14	42	3	998-5208	26	0
15	Training	QAP 2.15	67	4	998-5214	25	4
16	Prefabrication	QAP 2.16	27	1	/	/	/
17	Personnel & Labour Control	QAP 2.17	35	2	/	/	/
18	Control of Erection Status	QAP 2.18	33	4	/	/	/
19	Format of QA Procedures	QAP 2.19	3	4	998-5210	32	1
20	Drawing Control	QAP 2.20	34	4	998-5203	29	4
21	Cable & Bulk Material Control	QAP 2.21	36	4	/	/	/
22	Consumables Control (Other Than Welding Consumables)	QAP 2.22	23	0	/	/	/
	<b>Total</b>	<b>22</b>	<b>861</b>	<b>108</b>	<b>15</b>	<b>438</b>	<b>42</b>

external QA Audit was carried out by the owner. Findings of both audits re-



sulted in an overall revision of SEPC QA programme and QA programmatic procedures. The revised QA programme and QA procedures must be submitted to the National Nuclear Safety Administration (NNSA) for review. Based on the assessment and proposal of NNSA in respect of work liaison between QA & QC, QA involvement in non-conformances and responsibility for inspection, etc., SEPC revised the first edition of the PWSAR and the related QA procedures accordingly (see Table 1 attached), thus determining the relationship of QA & QC, clearly defining QA's surveillance and control over QC's activities. Especially, NC control and the close-off of each non-conformance shall finally be reviewed by QA Department.

### **1.1.3 Formal Operation of QA System and Perfecting (Stage Three)**

In this stage personnel training of various trades was performed. In addition it was obviously observed that establishment of certain working procedures was necessary for the implementation of specific requirements in the QA programme and QA programmatic procedures. Therefore the preparation of management procedures and specific working procedures, by perfecting the document system, ensured the execution of recording system.

The QA system not only covers Quality Management (QA & QC Dept.) but also covers Construction Dept., Administration & Business Dept., QA surveillance of the owner as well as the review of the upper management authorities. Problems taking place in any chain link will certainly be reflected in the quality of construction activities, document or management aspects. In order to standardize the action of the company's employees the programming of project management shall have to be realized.

## **1.2 Description of Main Contents of CIE QA Programme**

QA programme for CI erection is the programmatic document guiding the CI erection activities in Daya Bay Nuclear Power Plant, which consists of the main text of QA programme and 22 QA procedures.

### **1.2.1 Policy Statement**

The policy statement signed by the Project Manager stresses that during the implementation of CI erection all activities affecting quality shall abide by the principle of QA programme. The Project Manager is responsible for strict implementation of the QA programme of SEPC's employees on site and its subcontractors. The QA Manager is responsible for the independent verification of the execution of the QA programme and QA procedures and ensures

that all the quality-related documents are registered, preserved, distributed and controlled as per the approved procedures.

### **1.2.2 Quality Assurance Programme**

The QA Programme mainly describes the basic principles to be followed regarding the code of Practice published by IAEA and the existing nuclear safety code and regulations of the People's Republic of China.

The QA programme specifies that the activities related quality shall be in the controlled condition and implemented by the competent personnel as per qualified procedures and using qualified equipment.

The QA programme definitely specifies that the upper management authorities shall carry out management review and make records for the status and availability of QA programme at least one times a year.

Findings (deficiencies), whether they are found through the contractor's internal assessment of QA programme, or by the owner of the plant, or by the upper management authorities, shall be corrected accordingly. QA Manager is responsible for the periodic assessment & update of QA programme and QA procedures so as to ensure their efficiency.

### **1.2.3 Organization**

The On Site Organization Regulations (OSOR) defines the responsibilities of individual department (including its personnel), levels of authority, lines of internal & external communication and emphasises that:

a. Execution of the QA programme involves both performers and verifiers and it is not the sole domain of a single party;

b. The attainment of the quality objectives is accomplished by those who have been assigned responsibility for performing the work;

c. Verification is a key link in the quality assurance activities, and it is carried out by those who do not have direct responsibility for performing the work whether it is inspection, surveillance or audit. So, fair and object are ensured.

### **1.2.4 Document Control**

The Document Control procedures describe the measures established for control of receiving, collection, preparation, review, approval, distribution and preservation of all documents (such as codes, standards, guide, detailed rules, drawings and correspondence, etc.) affecting quality. Documents are reviewed for adequacy and approved by authorized personnel for issue and use

at locations where the prescribed activity is performed before the activity is started.

An updated master document list exists to assure that obsolete or superseded documents are replaced with updated and applicable document revisions.

#### **1-2-5 Field Design and Field Design Change Control**

For certain systems and/or components stipulated in the contract but necessary carrying out field design or design changes, this procedure specifies the codes, standards, technical specifications and contract requirements necessary for the design and design changes, and such design and design changes shall be verified.

Verification activities for design and design changes shall be documented.

#### **1-2-6 Procurement Control**

SEPC only purchase consumable material and equipment such as tools and tackle, construction appliances and instruments, etc. Most of the materials and equipment are supplied to SEPC by GEC under a separate contract.

For the procurement of material with quality requirements, the quality level and the scope of work to be accomplished by the suppliers shall be stated, and the requirements for technical aspects such as testing, inspection and acceptance as well as codes, standards and specifications necessary for the testing, inspection and acceptance shall be given, meanwhile the required document including related quality records should also be provided. Prospective suppliers of material and equipment shall be selected after evaluation on their ability to satisfy SEPC QA purchasing requirements. The evaluation involves technical and QA aspects, upon approval of the evaluation report the procurement activities can be started.

#### **1-2-7 Material Control**

This procedure mainly describes the control measures regarding receiving, storage, maintenance, handling and issue of materials. Item identification is specially emphasised in this procedure.

The supplied & purchased equipment and site fabricated items shall be suitably identified and recorded in the entire control process. Non-conforming items / items that can not be accepted during the inspection and acceptance of received materials (items) shall be stored in the non-conforming items area and quarantine area respectively, such items shall be handled as per relevant procedures.

During the storage of materials/items, periodic inspection, maintenance and preservation shall be done in line with the maintenance schedule provided by the manufacturer. Maintenance activities for material/items in the warehouse shall be done by the storekeepers, and maintenance activities for those materials/items issued to site shall be done by the Construction Team. Both maintenance activities shall be timely recorded.

A specific working procedure for materials/items handling and transportation is established so as to prevent materials/items from damage. The required special tools/tackle, transportation facilities shall be subject to test prior to use for verifying that they are in compliance with the requirements.

#### **1.2.8 Process Control**

This procedure describes the methods to control special processes affecting quality such as welding, heat treatment- and non-destructive testing, and to assure that they are accomplished by qualified personnel using applicable written procedures and in line with the applicable codes, standards, specifications or other special requirements.

The control of all the special processes, execution and accomplishment of activities shall be totally recorded.

#### **1.2.9 Inspection and Test Control**

For the purpose of verifying conformance of items and services with the documented inspection, working procedures & drawings, SEPC establishes an individual procedure for inspection and test, which specifies in detail that QC Dept. shall prepare and implement the Quality Plan (QP) for each single system (project) and that the completed activities shall be verified for ensuring their conformance with documented instructions, drawings and specification. Meanwhile the procedure also clarifies the scope of work for quality inspection, system acceptance & handover, and responsibilities of related departments as well as the documented records submitted along with project (system) hand-over.

The contents of QP mainly include work scope, quality levels, methods and quantity of inspection reference documents and standards for acceptance, requirements for quality records, the responsible party that implements the activities, inspection & acceptance levels of management (SEPC Construction Team, the Company and the Owner) as well as types of acceptance (random inspection, witness points and hold points). It is particularly emphasised that

any mandatory inspection hold points which require witnessing or inspection shall be verified by the owner or its designated representative, beyond which work may not proceed without the consent of the owner or its designatnal representative. To ensure that the range, type and accuracy of measuring & testing equipment used in inspection & test are qualified, the procedure for control of Measuring & Test Equipment is established, which details the control measures, requirement and responsibility for assuring that tools, gauges, instruments and other measuring & testing devices are properly controlled throughout the procurement, preservation, maintenance, inspection, identification, calibration, use on site and scrap.

#### **1.2.10 Non-Conformance Control**

Non-conformance is defined by the IAEA as " A deficiency in characteristics, documentation or procedure which renders the quality of an item unacceptable or indeterminate." The socalled non-conformances refer to non-conforming items/services not in compliance with the design drawings, quality standards, acceptance criteria, technical requirements and project procedures, etc. during their manufacturing, transportation, storage, erection, testing and commissioning of project equipment & materials.

The non-conformance control procedure describes the total process control measures against the above mentioned non-conforming items/services from their discovering, reporting, review, confirmation and corrective actions to assure that any deficiencies are all under strict control and that corrective actions are timely taken and completely documented.

#### **1.2.11 Corrective Action**

In case of any activity affecting quality found, appropriate action shall be taken. Corrective actions shall be documented and reported to appropriate levels of management. And sometimes corrective actions shall be approved prior to their implementation.

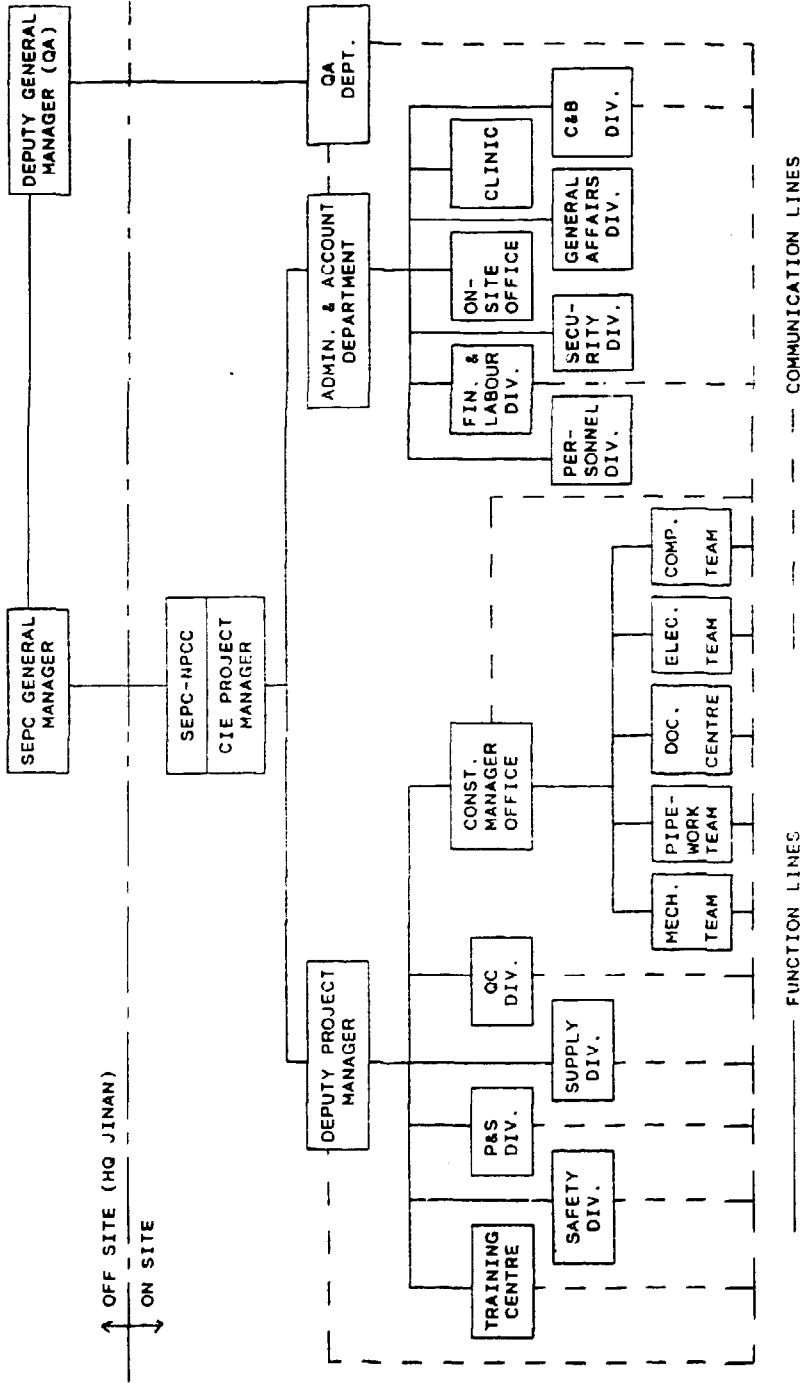
#### **1.2.12 Quality Assurance Records**

The requirements for records are emphasised in the above paragraphs. Besides, neat and clear writing, complete and accurate content of the QA records are required. Records are kept in such a way that they are readily retrievable but secure enough to prevent loss, damage or deterioration.

#### **1.2.13 Audit**

In order to verify the correct implementation of QA programme and QA

**Table 2 CIE Management Organization**



procedures and to verify their effectiveness, planned, systematic and document-based internal & external audits shall be carried out as per related stipulations of IAEA. Audits shall be performed according to written procedures and/or checklists. Auditors are selected or appointed by the organization responsible for audits. Findings of the audits shall be documented and issued to relevant audited Departments. Follow-up actions should be taken to verify that non-conformances, non-compliances discovered during the audit are corrected.

### **1.3 Organization of SEPC-NPCC**

#### **1.3.1 Organization**

According to the requirements of the owner of the Nuclear Power Plant (GNPJVC), the Organization of SEPC-NPCC is divided into 3 main branches (see Table 2: CIE Management Organization)

a. The Production Branch—Headed by the Deputy Project Manager, it comprises of 6 Departments or Divisions and 4 erection teams. In order to facilitate management, the deputy project manager is assisted by the Construction Manager for the supervision of the site organization.

b. The Administration and Business Branch—Headed by the Administration and Business Manager, it is responsible for 7 divisions regarding administrative and financial affairs.

c. The QA Branch—Headed by the QA Manager, it is responsible for the promotion and operation of the QA system. The On-Site QA Department is directly responsible to the Deputy QA General Manager of SEPC in Shandong (please refer to the attached organization chart).

#### **1.3.2 Responsibilities of SEPC Management for Quality Assurance**

##### **a. Project Manager:**

Ensuring that SEPC site personnel and its sub-contractors are instructed to comply with its associated Quality Procedures.

By implementation of management procedures, ensuring that all activities in respect to administration, construction and services shall be fully controlled.

##### **b. Deputy Project Manager:**

Assisting the Project Manager in the management of contractual project, ensuring that applicable managerial procedures are prepared and effectively controlled; ensuring high quality of erection activities and compliance with the requirements of CIE QA programme.

**c. QA Manager:**

Report to the QA Deputy General Manager of SEPC in Jinan, Shandong regarding all activities of the CI erection.

Prepare and implement the QA programme and procedures as per the QA requirement of CI erection contract.

Periodically review the QA programme & QA procedures in order to ensure the QA requirement.

Liaise with the Deputy Project Manager regarding all aspects of on-site erection activities.

The qualification of all the QA personnel are in compliance with the requirement of IAEA 50-SG-QA7 (QA Organization for Nuclear Power Plant) and authorised by the supervisory department or organization.

**d. QC Manager:**

Report to the Deputy Project Manager. Responsible for the preparation and implementation of activities regarding Quality Plan and Quality Control relating to appropriate standards and specifications, prepare QC procedures and QA procedures and/or management procedures associated with QC activities.

The Quality Control Division (including the NDE Section) which is supervised by the Deputy Project Manager is also an important part of the QA system.

**e. Administration & Business Manager:**

Assisting the Project Manager in the implementation of administration functions and site services; performing authority of Project Manager in his absence and being responsible for qualification review, training and examination of SEPC—NP personnel.

**f. Construction Manager:**

Report to the Deputy Project Manager in respect of site erection activities. Responsible for the implementation of QP, erection procedures and technical instructions; responsible for preparation, review and implementation of QA and management procedures associated with site erection activities; providing instructions to site construction & safety training.

## **2 OPERATION OF QA SYSTEM**

### **2.1 Main Activities of QA Dept.**

#### **2.1.1 The QA audits were conducted in line with the requirements as speci-**



### **ified in IAEA 50-C-QA and SEPC QA programme & QA procedures**

An audit is a QA activity with plan and code performed to determine, by investigation, examination and evaluation of objective evidence the adequacy of, and adherence to, the established procedures, instructions, specifications, codes, standards, administrative or operational programmes and other applicable documents, and the effectiveness of implementation.

The scope of audit covers QA system review, organization, personnel training, design control, document control, special; process control, non-conformance control, corrective actions, records, etc.

Audit can be divided into two kinds: internal & external audits. Internal QA audit takes place every six months, so does the external audit (on request of GNPJVC). The audit will not necessarily cover the full QA programme at each visit, sections will be audited so that in 12 months the QA programme will be completely covered.

However, audit shall be conducted when one or more of the following conditions exist;

a. when a systematic, independent assessment of programme effectiveness is considered necessary;

b. when it is necessary to determine the capability of a contractor's QA programme before awarding a contract or purchase order;

c. when significant changes are made in the functional areas of the Quality Assurance Programme, such as significant reorganization or revisions of procedure;

d. when it is suspected that the quality of an item or a service is in jeopardy owing to a deficiency in the QA programme.

During the period from March 1989 to May 1991, 5 internal & 6 external audits were performed. Details of the audits are listed in Table 3.

Defects or deficiencies found during the audits can be identified with non-compliances (a deficiency in characteristics, documentation or procedures which renders the quality of an item unacceptable or indeterminate) and observations. Corrective actions for non-compliances are mandatory, while those of observation is suggestive. Up to the end of May 1991, 217 Corrective Action Requests (CAR) and 130 observations were issued from the internal and external audits, in which 174 CAR & 50 observations were issued during internal audit, 43 CAR and 80 observations issued during the external, which indicates

that the internal audit is more strictly controlled than the external, more problems are suggestively issued during the external audits. Nevertheless SEPC management requested that corrective actions for both CAR and observations should be taken so that work improvement could be attained.

Non-compliances, depending on their relative harm to the Quality System, are classified into C1—the most serious in nature, C2 & C3—the minor ones. In general non-compliances such as C1/C2 always lead to amendment of QA programme & QA procedures. At the conclusion of an external audit, the findings shall be accepted by the project manager by his signature, and the internal audit findings be accepted by the department chiefs. Then corrective actions are taken based on the recommendations and the required deadline in the defect notices. The corrective actions should be documented.

**Table 3 Internal & External QA Audit Results**

Internal QA Audit by SEPC QA Dept.	Audit No.		1		2		3		4		5		6	
	Date		6-10/3/89		5-7/9/89		8-12/3/90		11-14/9/90		5-8/3/91			
	Defects Found		NC	OB	NC	OB	NC	OB	NO	OB	NO	OB	NC	OB
	Number of Defects		34	-	69	5	17	11	41	17	13	17		
External QA Audit by GNPJVC	Date		27-18/ 04/89		5-9/12/89		5-7/6/90		5-9/11/90		2-5/4/91		27/3-2/4/ 90 by HQ Jinan	
	Defects Found		NC	OB	NC	OB	NC	OB	NC	OB	NC	OB	NC	OB
	Number of Defects		9	11	10	11	6	16	8	15	4	12	6	15

NC — Non-Conformance, OB — Observation.

The Corrective Action Request (CAR) issued during the audits is mandatory and require to improve erection and management activities. For example, SEPC Supply Division had evidently broken the transportation procedures and ignored the control of transportation quality plans, and frequently applied no control to the overload lifting risks caused by CRTC (China Road Transportation Company). The current status of contract material had not been accurately stored in a computer, and some information printed out from the computer is not correct. During the second internal QA audit Supply Division was issued with 17 defect notices. Owing to their corrective actions, carefully & thoroughly taken, QA audits since last November in 1990 had not found any non-compliance.

### **2. 1. 2 Assessment of the suppliers & subcontractors**

The assessment (including technical & QA aspects) of the potential suppliers or subcontractors shall be conducted in accordance with the procedure PMS-52 (approval procedure for potential subcontractors and suppliers, of construction and erection contractors, and main contractors representatives on site, issued by GNPJVC), and SEPC QA Procedure QAP 2. 04 (Procurement Control) and QAP 2. 11 (Audits) is for ensuring their qualifications. SEPC Construction Department is responsible for the technical assessment, and QA Department for the QA assessment. The assessment results shall be documented and submitted to GNPJVC with Sub-contractor Evaluation Sheet & Material Submittal Sheet attached for their approval. The erection contractor is only allowed to purchase materials (products) from the suppliers officially approved by the customer.

The contract materials shall be provided by the customer, so the assessment of the contract material suppliers shall be performed by the customer. The potential suppliers for supplying non-contract materials with QA requirements such as welding rods, gases, paint, chemicals and instruments, etc. shall be assessed by the erection contractors. In line with Chapter 9 of the CIE Contract QA classifications are identified with QA<sub>1</sub>, QA<sub>2</sub>, QA<sub>3</sub> and QA<sub>NC</sub>. SEPC have, up to the end of May 1991, employed 25 suppliers/subcontractors already approved by GNPJVC, 9 in China and 16 in Hong Kong. It has been proven by the fact that giving priority selection to a qualified supplier is regarded as an effective measure for ensuring the acceptable quality of the purchased materials, thus preventing imitative, poor quality products from sneaking into the plant, thus avoiding any potential risks affecting quality.

### **2. 1. 3 Routine QA Surveillance by the Erection Contractor**

The performance of routine QA surveillance by the QA auditors is always concentrated on the management functional divisions and all the erection teams. QA surveillance is normally implemented to verify:

- a. The correctness of status of document used (such as drawings, procedures, standards, specifications, instructions, etc.);
- b. The proper control and identification of materials;
- c. Correct use of lifting appliances;
- d. Non-conformances for contract material are timely dispositioned;
- e. Implementation regarding the preservation/maintenance of contract equipment;
- f. Calibration and their validity date of tools measuring equipment and var-

ious gauges;

g. Proper control of particular processes (welding, heat treatment, NDE, etc) ...

Same as QA audit activities, QA surveillance places emphasis on the verification of documentary evidence. It is definitely specified in IAEA 50-C-QA2 (Quality Assurance Records System for Nuclear Power Plants) that all the activities related quality should have to be documented. The 108 appendices attached to the SEPC 22 QA procedures bear the records for all activities affecting quality, by means of which the QA auditors carry out verification for ensuring that the QA programme and QA procedures are entirely and effectively implemented.

Findings observed during QA surveillance shall be issued respectively in the form of memorandum (MEMO) and Quality Assurance Surveillance Report (QASR), MEMO is characterized as suggestive, whereas the corrective actions of QASR must be taken according to the deadline required due to its being of a mandatory nature. Only when the corrective actions are totally completed, through verification, can they be closed out by signature. Up to the end of May 1991 SEPC QA Department have accumulatively issued 67 QASRs and 15 MEMO.

Taking the improper protection of stainless steel for example, QA Department issued QA/QC joint instruction for the "Protection of Stainless Steel Materials during the Storage, Handling and Erection" with 11 details attached. And furthermore, for the transportation and positioning of some large & heavy equipment such as Moisture Separate Reheater (MSR), in order for the operation to be implemented in perfectly safe condition, a control beforehand was exercised, at first a MEMO was issued 20 days before the commencement of transportation and positioning of Unit 1 MSR—a huge vessel which measures 350T in weight, 6.5 m in width and 8 m in height. It was to be transported from jetty to the main turbine hall by China Road Transportation Corporation.

## **2.2 Main Activities of Quality Control (QC) Division**

QC Division subordinate to project management and it is a functional department as well as Construction Department.

### **2.2.1 Producing Quality Plan**

The principal basis for producing QP refers to erection procedures, drawings, instructions, specifications and technical standards provided for the individual subsystem by GEC-A, as well as stipulations in SEPC QA Procedures—" Inspection and Testing Control". Each QP describes in detail the

**following of each sub-system :**

- a. workmanship and item necessary to be inspected, accepted and recorded;**
- b. reference information needed for inspection;**
- c. acceptance criteria;**
- d. method of inspection, quantity to be inspected;**
- e. levels of authority for acceptance and method of acceptance etc.**

**For those important work processes, witness points (W. P) & hold points (H. P) shall be set, and which shall be reviewed by both Construction & QA Departments and reported to the owner of the plant for approval.**

**QP is used for quality inspection and acceptance during the individual sub-system erection, it actuates control over each important work process, thus it is esteemed to be essential document for implementation of project quality control.**

#### **2.2.2 Quality Surveillance Over the Material Receiving, Storage, Preservation and Maintenance, Handling & Transportation**

**Together with Supply Division, the specific personnel assigned by QC Division is responsible for inspection and supervision of arrived materials, warehouse storage, preservation & maintenance and site transportation. Deficiencies and non-conforming items discovered shall be recorded in the non-conformance report format and follow-up action shall be taken. Materials with quality requirement shall be strictly controlled.**

#### **2.2.3 Measurement & Acceptance of Civil Structures and Measurement Prior to Equipment Erection**

**QC Division is responsible for measuring activities regarding concrete foundation, built-in fittings, steel structures constructed and handed over to SEPC by the civil engineering contractor, which covers horizontal, centre point measuring and point of ground settlement in the process of equipment erection.**

**In view of the strict quality requirement for nuclear plant erection, apart from the above-mentioned measurement, pipelines and main steel structures shall also be measured one after another, detailed records are produced accordingly and measurement reports are presented for ensuring the correctness of erection.**

#### **2.2.4 Control of Welding Operation**

**To keep the required quality of welding operation strict control over the qualification of welders, correct use of welding consumables, correctness of**

welding workmanship and welding procedures, heat treatment of welds, temperature control and status of welding equipment shall be performed.

#### **2. 2. 5 Non-Destructive Examination (NDE)**

NDE is a kind of quality examination of the welds visually and internally. For ensuring the required quality of NDE, working procedures for NDE shall be followed stringently. These procedures specify in detail the control of personnel qualification, instrument & equipment, consumables & chemicals, calibration, use of and contents of test report, preservation of document/data, X-ray photographic negatives and working environment.

#### **2. 2. 6 Non-Conformance Control**

Non-conformance control, dealing with, on a document tracing basis, all the non-conforming items discovered/happened in the whole process of equipment/component manufacturing, transportation and erection, which are not in compliance with the contract/agreement, drawings, quality standards, erection procedures and technical requirements, keeps the non-conformances under stringent control and satisfactory disposal. The disposal of non-conformances shall be subjected to documentation and recorded. Re-preparation of test report and modification of QP are requested when necessary. Non-conformances can not be closed out until final verification of SEPC QA personnel and approval by GEC-A and GNPJVC.

#### **2. 2. 7 Measuring & Testing Equipment Control and Calibration**

The accuracy/precision of measuring & testing instruments is a key factor affecting quality. For ensuring the quality of CI erection all of the measuring & testing instruments used on site shall be periodically calibrated and identified by the authorized organization as per stipulations of related QA procedures. The instruments shall be subjected to inspect prior to use for confirming that they are within the specified validity period and maintain accuracy within necessary limits. Any instrument with deficiencies shall not be used in erection activities.

Two means are applicable for quality control throughout the process of erection /construction activities. One of which is that QC inspectors, based on the arrangement in the QP, are responsible for participating in and inviting QC personnel of the owner to attend the witness activities (if specified in the QP) or acceptance of the hold points, and signing the related erection record sheets. The other is that QC inspectors on site carry out random/sample inspection for assuring that work instructions, specifications & erection procedures are correctly implemented.

Over the past 4 years, QC Division produced 721 Quality Plans (excluding those concerning the disposal of non-conformances and extra work), accomplished witness activities for 10 337 hold points and witness points, offered 315 measurement reports, issued 960 internal MEMO, took 36 425 pieces of welds NDE photographic negatives and implemented random or 100% inspection of welding operation, welding rods control, cleanliness of pipelines, maintenance of equipment and arrived materials, erected pipeline, cable wiring, etc. These evidence signify that QC surveillance is CI erection is very strick. These QC surveillance and effective verification of records by QA surveillant made the whole erection activities under strick control of QA/QC and realized high quality erectio.

### 2.3 Main Activities of Construction Dept.

Apart form ensuring the qualified personnel are working in proper environment using appropriate tools & tackle as per approved QP and effective erection document, the Construction Dept. and individual Construction Team issued 106 work instructions, of which 50 relate to organization/coordination of construction activities, 29 relate to safety, quality and site management and 27 relate to technical aspects.

#### 2.3.1 Stringent Control of System/Subsystem Commencement

Inspection item by item shall be necessary for the following listed below, any system/subsystem that does not meet quality requirements shall not be allowed to commence.

**Table 4 Inspection Prior to System/Subsystem Erection Commencement**

Serial No.	Description	Inspection Prior to Commencement (d)	Responsible Dept.
1	Erection drawings are approved for use	30	Document Centre
2	Erection procedures are approved for use	30	Document Centre
3	Welding procedures & welders qualification approved	30	Erection Team QC Division, Construction Dept.
4	work-out, submission, approval and issuance of QP	30	QC Division
5	Measurement report for civil structures & foundations & submission (handover)	30	QC Division
6	Translation, check, printing & distribution of drawings, erection procedures and BS	40	Doc. centre, Erection Team
7	Preparation, review and approval of necessary internal procedures	20	Erection Team Const. Dept.

Serial No.	Description	Inspection Prior to Commencement (d)	Responsible Dept.
8	Determination of important construction scheme	30	Erection Team Const. Dept.
9	Determination of scope & interface for specific system/subsystem	20	Const. Dept.
10	Inspection, maintenance, verification & identification of tools & tackle, gauges and instruments used for erection	20	Erection Team QC Division, Safety Div.
11	Disposal of NC and corrective action taken prior to erection	20	QC Division, Supply Div.
12	Availability of non-contract materials	30	Erection Team Supply Div.
13	Application and approval of erection area and access way	10	Erection Team Const. Dept.
14	Coordination with civil, NIE & BOP construction	10	Erection Team Const. Dept.
15	Preparation & layout of construction site	10	Erection Team
16	Review and approval of equipment transportation procedures & QP	10	Supply Div., QC Div.
17	Inventory of arrived contract equipment, material, status of delivery of short supply	30	Supply Div.
18	Redistribution and/or allocation of labour force	30	Labour & Personnel Div.
19	Training of construction personnel and their qualification review	30	Training Centre
20	Inspection of site safeguard facilities	5	Safety Div.

### 2.3.2 Construction Activities Strictly Following the Latest Version of Drawings

In line with the stipulation of QA procedure, the status of drawings, design change, design for small bore pipes and local cables shall be controlled to ensure that the erection activities are carried out using qualified, effective and latest version of drawings.

### 2.3.3 End of Erection Status Report (EESR)

On final completion of system erection, an EESR shall have to be timely produced and submitted to the owner for review and acceptance. EESR is considered to be the written evidence for verifying whether or not the erection activities are efficiently conducted according to QA requirements.

### 2.4 Main Activities of Administration & Business Dept.

Based on the requirement of code of Practice for Nuclear Power, one of



the responsibilities of SEPC QA Department is for the training of personnel and their qualification. But in SEPC organizational structure the Training Centre is subordinate to the Project Branch and Administration & Business Dept. is responsible for distribution, management and employment of personnel.

For ensuring the qualification of personnel, everyone of them shall be subjected to one-week full-time training before entering into his working post, thus enabling them to understand the related management regulations for the nuclear power project, to perform activities as per relevant procedures. Those who are requested to go into the post with qualification requirements shall be trained and the certificate shall be issued.

Findings discovered in the previous QA Audits and classified as failing to observe the rules & regulations, the responsible personnel shall be subject to retraining. Such action is always considered to be one of the corrective measures. Over the past 4 years 105 training classes for various trades are performed, the trained personnel amounted to 3037 men-times and altogether 85 848 hours, 2.4 times per person on the average. Qualification certificates for 306 persons in special trades (such as electrician, welders, lifting operators, scaffolding men, mechanical operators, QC inspectors, QA auditors, NDE personnel and persons in charge of measuring & testing, etc.) are issued and filed. Due to combination of training and work practice, the personnel quality which is the basis of operating QA system effectively was ensured.

## **2.5 Routine QA Surveillance by the Customer**

Being under routine surveillance of GNPJVC QA Department and JVC MQC provides that, any erection or managerial activity adverse to quality of the project which took place in the CIE Contractor would generally be requested to take corrective actions. Findings observed during their QA/QC surveillance are normally passed to SEPC QA Department over phone or verbally for our understanding. SEPC QA shall have to establish the truthfulness of the problem pointed out by GNPJVC QA by exercising in depth investigation, then feed back to GNPJVC QA, afterwards official CAR is issued. On receiving CAR SEPC QA Department shall immediately make an arrangement, requesting the Team/Division concerned to implement corrective actions, reply to the actions required is submitted to GNPJVC for their review. The CAR cannot be closed until verification by GNPJVC QA shows it is acceptable. Up to the end of May 1991, 28 CAR were received from GNPJVC QA Department.

GNPJVC Project Department shall issue QSDR (Quality Surveillance

Deficiency Report) to the CIE Contractor in case of quality deficiencies which were pointed out on different occasions by GNPJVC QA/Project Departments, or on which corrective actions are promised to be taken but similar problems still happen; QSDR is regarded as the last step of QA surveillance, which is known as serious warning to SEPC. Up to the end of May 1991, 9 QSDRs had been issued to SEPC.

Corrective actions of any QSDR are more strictly required and stringently enforced than any QASR and CAR due to its importance and seriousness. The retraining of the relevant management personnel in Mechanical Team was introduced and work process discipline was issued due to the corrective actions of QSDR No. 3; QSDR No. 8, which disclosed a bad practice that the Team failed to inform GNPJVC of the "H" (hold) point appointment prior to the commencement of the next work process, brought about the retraining and reexamination for the team staff, as a result the irresponsible person was suitably & financially punished. The corrective actions of QSDR are normally reported in writing to GNPJVC Project Department by SEPC Construction Manager, same as CAR, QSDR could not be considered closed until verification by GNPJVC QA shows it is acceptable.

## **2.6 Management Review**

In addition to the above-mentioned NNSA (National Nuclear Safety Administration, PRC) that should conduct management review on the Quality system of the main contractors, IAEA should exercise safety analysis review on the QA system of the main contractors as well. Of course the safety analysis review by IAEA is mainly directed toward GNPJVC, but it is also aimed at the individual main contractors.

In the process of the three-week safety analysis review which started on 26/11/1990, eleven areas were subjected to an in-depth review by the IAEA experts who covered project management, quality assurance, civil construction, mechanical equipment, both nuclear & conventional, electrical and instrument & control (I&C) equipment, preparation for start-up & operation, personnel training & qualification, radiation protection and emergency response planning. Upon looking at the documentation and carrying out site visit for finding objective evidence the team could form a judgement whether the IAEA codes of practice and the QA programme established respectively by GNPJVC & the main contractors are totally & properly implemented.

The main conclusions made by the review team were summed up: "At the Guangdong Nuclear Power Plant construction site managers and workforce, a

truly international team, dedicated, qualified and experienced for completing this ambitious project. They are aware of their responsibilities for the safety of plant, personnel & the public. General, the work observed on site was satisfactory and documented". " In implementing the project in Guangdong, it was found that large achievements had been made in maintaining an aggressive construction schedule, high standards of construction and vigorous quality controls which the main contractors were also observed. Some exemplary practices were found to have been developed, which are worthwhile to be communicated to other nuclear power projects."

Some proposals and idea for improvement were given by the review team:

a. Numerous violations of procedures have been noted, as an integral part of establishing an overall safety culture at the site, and senior management of contractors should emphasize to all workers the need to follow procedures and require them to report problems. Supervisors should enforce this policy from the top level of management to the worker level.

b. Temporary storage of permanent documents is not safe. The original records should be securely stored in fire-proof steel cabinets. A review of the adequacy of the storage of documents such as master copies of as-built drawing should be undertaken to ensure that the records related systems are properly protected from all perils such as fire, water, humidity, loss and destruction.

c. To enforce the training for new people arriving on site and emphasize the importance of following QA procedures.

d. The problem that arc strikes can be observed on pipes should be corrected in real earnest.

e. The building of cable trays and installation of cables should be improved to prevent from rework and cable damage. Cables should not be routed or pulled over sharp surfaces during installation.

f. Great attention should be paid to the industrial safety, permanent lighting and site lighting which is installed with temporary power supplies should be improved, keep access ways clear from material by better planning of " in process" storage areas in the plant and removing waste material.

Owing to the high authority of IAEA and NNSA, review idea was performed immediately and played a important role to perfect the QA system of SEPC-NPCC.

### 3 CONCLUDING REMARKS

QA system is esteemed to be a systematic project due to its involving of

each quality-related domain. During implementing all quality-related construction and service activities, nuclear codes, safety regulations and standards of IAEA must be observed. QA programme and QA procedures approved by the owner and/or the upper management authorities shall be strictly followed, and the implementation of QA programme and QA procedures is mandatory. This mandatory is not only in the codes, the installation contract and the management orders, but also in economical responsibility system of project.

QA system lays emphasis on perfect organization, independence of QA organization, QA responsibility of individual departments, and ensures that QA organizations will conduct stringent, justice, objective and overall verification to all activities affecting quality, thus playing an active part in quality supervision and incident prevention. Through verification any deficiency/defect is timely discovered and then corrective action timely taken according to QA programme. Effectiveness of QA programme and QA procedures is inspected on a verification basis, and deficiencies of QA programme and QA procedures have been corrected and perfected. QA system aims at the completeness, effectiveness and applicability of documentation and records, and sufficient evidence to the activities.

In short, QA system reflects high-level management, of which the core idea may be summarized as one system (QA system), two principles (implementing management function according to systems, undertaking managerial responsibilities based on different levels of management), three crucial points (Quality Plan, Quality Control, Quality System Review) and four essential elements (Comprehensive Organization-ensuring that every activity is done by qualified responsible persons; Extensive Document System-ensuring that every activity is carried out in accordance with approved procedures or relevant regulations; Authentic Recording System-ensuring that the Quality system can be analyzed and evaluated in line with the factual document or evidence; Stringent Surveillance System-ensuring that every activity is strictly supervised). This is a system which is an entire system with close internal connections and which can be understood and implemented only by the enterprise with high quality of management and its leading crew with enterprising spirit. With this system an enterprise will certainly enhance its competitive power and have access to the domestic and international markets.

Translated by Wang Zixin

(京)新登字 077 号

图书在版编目 (CIP) 数据

大亚湾核电站常规岛安装的质量保证体系=QUALITY ASSURANCE SYSTEM FOR CONVENTIONAL ISLAND ERECTION OF DAYA BAY NUCLEAR POWER PLANT/施中良等著. —北京:原子能出版社, 1994. 12  
ISBN 7-5022-1315-5

I. 大… I. 施… III. ①核电站-常规岛安装-质量保证  
IV. TL374

中国版本图书馆 CIP 数据核字 (94) 第 06062 号



原子能出版社出版发行

责任编辑: 孙凤春

社址: 北京市海淀区阜成路 43 号 邮政编码: 100037

中国核科技报告编辑部排版

核科学技术情报研究所印刷



开本 787×1092 1/16·印张 1/2·字数 30 千字

1994 年 12 月北京第一版·1994 年 12 月北京第一次印刷

# CHINA NUCLEAR SCIENCE & TECHNOLOGY REPORT

This report is subject to copyright. All rights are reserved. Submission of a report for publication implies the transfer of the exclusive publication right from the author(s) to the publisher. No part of this publication, except abstract, may be reproduced, stored in data banks or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior written permission of the publisher, China Nuclear Information Centre, and/or Atomic Energy Press. Violations fall under the prosecution of the Copyright Law of China. The China Nuclear Information Centre and Atomic Energy Press do not accept any responsibility for loss or damage arising from the use of information contained in any of its reports or in any communication about its test or investigations.

ISBN 7-5022-1315-5



9 787502 213152 >