

# DEVELOPMENT AND APPLICATION OF CHINA CUSTOMS RADIATION DETECTION INTEGRATED SYSTEM

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## Abstract

China Customs began developing the integrated system of fixed radiation detection equipment in 2018, and put it into trial operation in early 2019. In 2019, more than 2,500 sets of fixed equipment will be integrated. The integrated system of radiation detection equipment transmits the alarm data, images and equipment status information scattered at ports nationwide to all directly affiliated customs and the management terminal of the General Administration of China Customs, providing auxiliary law enforcement basis for subsequent disposal or issuing instructions. The paper comprehensively introduces the application of China Customs Radiation Detection Integrated System in customs work from the aspects of equipment integration and data collection, data transmission processing and distribution, radiation detection link management, statistical analysis and panoramic display, equipment management and efficiency evaluation, system management and so on. The paper discusses the difficulties and solutions in the system deployment process and summarizes the mature experience in radiation detection management of China Customs.

## 1. INTRODUCTION

To combat the illicit trafficking of nuclear and other radioactive materials, china customs continuously strengthens the supervision capability including radiation detection at frontier ports. By the end of 2018, nearly 2500 sets of radiation portal monitors (RPMs) have been equipped at local customs nationwide. Meanwhile, china customs put a high value on development and application of new technology and methods, such as the RPMs based on spectrum analysis, detection equipment installed on mini-UAV platform, integrated equipment which could monitor nuclear materials and chemical/biological agents et al. In 2018, the responsibilities and personnel for entry and exit inspection and quarantine of the General Administration of Quality Supervision, Inspection and Quarantine (AQSIQ) have be assigned to the General Administration of China Customs (GACC). This significantly increase the working ability of china customs in nuclear security areas.

Currently, most of the RPMs run in single unit operation situation, which means all the alarm data are processed at local stations. Several local customs have developed regional management systems of radiation detection. For example, customs in Jiangsu province developed radiation monitoring system based on IOT and mobile internet technology [1]. In Tianjin, municipality directly under the Central Government, the local customs applied nuclear and emergency management system in 2013 [2]. Moreover, the radiation monitoring system based on cloud platform is also studied in china [3]. But the centralized and unified management system which integrates all the RPMs in china ports has not been realized. In order to establish a standard management and operation platform of radiation detection, china customs developed the integrated system in 2018. The system realizes the application platform of alarm data processing, equipment management, statistical analysis, panoramic display, emergency command, expert database maintenance and knowledge base management. In the same year, GACC selected two local customs to carry out the system operation test. The results show that the system meets the conditions for nationwide promotion and application. The paper introduces the system from the aspects of its network architecture, connection between the system and other operating systems, functional module and tests of the system.

## 2. NETWORK ARCHITECTURE

The system adopts centralized B/S architecture. According to the responsibilities and authorization situation, the system based on three level management mode, which is “Customs House-Customs District-GACC”.

The application server, web server, database server and file server are deployed in the General Administration. The application server is responsible for receiving structured data and collecting the unstructured data of alarms. The structured data of alarms is stored in database server while the unstructured data is stored in file server. Database server and file server interact with web server through HTTP protocol.

Customs District only need to deploy interface server and file server. The interface server receives the structured data and unstructured data uploaded by the equipment equipped at Customs House. The interface server also responsible for uploading the unstructured data of alarm to GACC through FTP protocol and uploading structured data through HTTP protocol. The system network architecture is as shown in Figure 1.

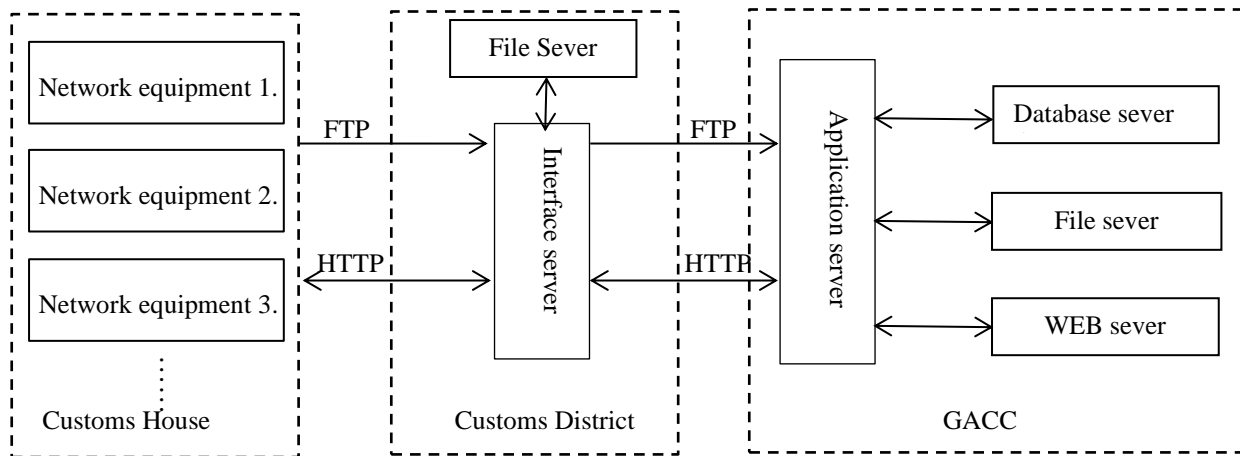


FIG 1. Network architecture of the integrated system.

## 3. CONNECTION WITH OTHER MANAGEMENT SYSTEMS OF CHINA CUSTOMS

Both the bottom data transmission and application interface interaction, there is a close correlation between the integrated system and other management systems, as shown in Figure 2.

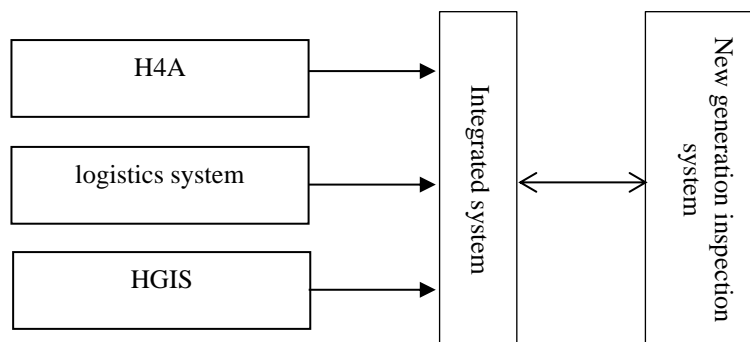


FIG 2. Correlation between the integrated system and other management systems.

Users of the integrated system is authorized by H4A system (Authentication, Authorization, Account and Audit). Through the container/vehicle number identification system or electronic bayonet system. The integrated system retrieves the basic logistics information, for instance, the declaration form, warehouse receipt and the monitoring video. The geographic information system of china customs (HGIS) can provide accurate geographic location of all networking devices for the integrated system. And the mobile version of the

integrated system can be installed in the new generation inspection management system. This is more convenient for frontline officers to input radiation detection result on site through mobile individual equipment.

4. FUNCTIONAL MODULES.

The system’s function modules consist of seven parts: panoramic display, data tracing, alarm processing, statistical analysis, resource base, equipment management and system management. According to the working responsibilities, different levels of customs are authorized with different functions, as shown in Table 1.

TABLE 1. FUNCTION AUTHORIZED TO DIFFERENT LEVEL CUSTOMS

	Panoramic display	Alarm processing	Data tracing	Statistics	Resource base	Equipment management	System management
GACC	●	—	●	●	●	●	●
CUSTOMS DISTRICT	○	—	○	○	○	○	—
CUSTOMS HOUSE	—	○	○	○	○	○	○

● Fully authorized, ○ Limited authorized, —Unauthorized

4.1. Panoramic display

The panoramic display function can directly display the basic detection information such as equipment allocation, alarm, operation status in a certain day/month/year in the national/directly subordinate customs area in the form of ring chart, histogram, etc. Panoramic display operation interface is shown in Figure 3.



FIG 3. Panoramic display operation interface.

4.2. Alarm processing

The alarm processing function is only authorized in the Customs House level. And all the RPMs in a certain Customs House are presented in the form of icons in the interface. Four icon colours (green, red, orange and gray) are used to indicate normal, alarm, fault and offline working states respectively. According to the working process of radiation detection of china customs, which is consistent with IAEA’s process [4] (detection, alarm confirmation, location and identification, subsequent disposal), the frontline officers will record the results of every step in the system. All the data will be uploaded to Custom District and GACC level. The declaration and warehouse receipt obtained from the logistics system can offer assistance in alarm processing.

### 4.3. Data tracing

With this function, customs officer can view all the monitoring results including the alarm and the regular passage information of vehicle. The key words used for searching data can be time, area, container number or the detection status. This function is not only the supervision and management mechanism for the daily monitoring work of customs officers, but also the accumulation of abundant detection data.

### 4.4. Statistics and analysis

The statistics and analysis function of the system can realize the data analysis and data reporting. Data analysis function shows the monitoring quantity and alarm quantity in a certain period of time of certain customs. Statistical data shall be submitted level by level according to the procedures of Customs House, Customs District and GACC. As the management requirements of China Customs, the Customs House and Customs District should submit radiation detection data through the system every month. And the General Administration will analyse the national alarm situation and share typical seizure cases with Customs House and Customs District.

### 4.5. Resource base

Resource base mainly includes two parts: experts base and knowledge base. The experts are classified to six fields: radiation detection, radiation protection, laboratory testing, follow-up disposal, operation and maintenance, calibration and verification. The GACC selects customs officers with professional background and working experience from the national customs to the expert database. And the professional knowledge such as the relative laws and regulations, practical operation methods of various detection equipment, case experience sharing is uploaded to the knowledge base. Through this function, customs officers can quickly retrieve technical support in relevant fields.

### 4.6. Equipment management

The equipment management function mainly realizes the information management of equipment efficiency. The accumulated working hours and maintenance status of the equipment is shown in the form of list. This function provides objective data for performance management of Customs equipment.

### 4.7. System management

The system management function is authorized to the Customs District and the GACC. The Customs District can set "whether the alarm is automatically transferred to recheck for confirmation" and "document polling". The general administration can maintain the dictionary of expert fields and knowledge classification.

## 5. INTEGRATION TEST AND SYSTEM TEST

### 5.1. Integration test

In December 2018, the GACC conducted an integrated test on the system and other related systems of china customs. The test scope includes interaction with HGIS, H4A and logistics system. The test results are listed in Table 2. The execution rate of this test case is 100%. The test pass rate is 100%. And there is no defect left. Finally the system passes the integration test.

TABLE 2. PASS RATE IN TEST SCENARIO

Content	Number of the test cases	Number of test cases passed	Planned pass rate	Actual pass rate	Result analysis
TEST CASES	9	9	100%	100%	No defects left

### 5.2. System test

In accordance with Chinese national standard GB/T 25000.51-2016, product quality including functionality, performance efficiency and information security are tested.

5.2.1. *Functional test*

Specific functions tested are as follows: data interface, data synchronization, alarm data processing, panoramic display, equipment and system management. The execution rate of 84 test cases is 100%. The test pass rate is 100%. And there are no serious defects left, listed in Table 3.

TABLE 3. PASS RATE IN FUNCTIONAL TEST

Content	Number of the test cases	Number of test cases passed	Planned pass rate	Actual pass rate	Result analysis
TEST CASES	84	84	100%	100%	No defects left

5.2.2. *Functional test*

Twenty-six application scenarios such as user login, real-time monitoring, alarm processing, equipment management, and individual system integration are used for performance efficiency test. Pass rate of the cases in functional test is 100%.

5.2.3. *Information security.*

After X rounds of testing, the system’s source code has no left A and B level security risks. The System meets safety requirements.

6. PROMOTION AND APPLICATION OF THE INTEGRATED SYSTEM

GACC select Shanghai and Urumqi customs as pilot user in 2018. RPMs equipped in these two customs have accessed to the system. Afterwards, seven district customs gradually realized system integration. All work is planned to be completed in one year. The following problems need to be solved in the overall deployment phase of the system.

**6.1. Data standardization**

At present, there are more than 20 kinds of RPMs from different suppliers equipped in china customs. In the later stage, during the deployment of all equipment in the country, standardized data transmission format needs to be established to ensure that different brands and types of equipment technically meet the network access conditions.

**6.2. Performance evaluation**

In order to ensure the reliability and accuracy of the RPMs, it is necessary to carry out a comprehensive test and evaluation of the performance of the access device before networking. In the process of system popularization and application, it is necessary to coordinate the time of network access and the evaluation, so as to achieve high efficiency of national networking.

**6.3. Funding guarantee.**

At the level of Customs District, customs should guarantee the funds for equipment access to the network and ensure the establishment of various hardware environments required for system deployment.

7. SUMMARY

Through the development and application of integrated radiation detection system, China Customs has realized the information management of radiation detection work, and built a three-level management platform, namely, Customs House, Customs District and GACC. Field test shows that integration and system test meet the project requirements. The system provides a standardized operation and management platform for customs radiation detection.

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