



SECOND HIGH-LEVEL CONFERENCE ON AVIATION SECURITY (HLCAS/2)

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Agenda Item 3: Global Aviation Security Plan (GASeP)

**INNOVATIVE TECHNOLOGIES FOR IDENTIFICATION OF
CHEMICAL SUBSTANCES ON PREFLIGHT INSPECTION**

(Presented by the Russian Federation)

SUMMARY

This document contains material and recommendations on the use of innovative technology for identification of hazardous substances on preflight inspection, and provide implementation of the task of PD 3.2 and 3.3 of the Roadmap for the implementation of the ICAO Global Aviation Security Plan.

Action by the High-level Conference on Aviation Security is in paragraph 5.

1. INTRODUCTION

1.1 Inspection technologies now in use in most airports do not allow comprehensive identification of hazardous chemical substances on preflight inspection. Widely used x-ray inspection equipment is capable of detecting item outlines, containers with liquid and solid substances, yet, it cannot identify the chemical composition of the content and its safety. Even transportable liquid, aerosol and gel (LAG) containers up to 100 ml constitute a potential threat as components of explosive and toxic substances.

1.2 Raman analyzers of chemical substances based on the Raman scattering technique are now commonly used as aviation safety equipment. Miniaturization of optical and electronic components of Raman analyzers enabled manufacture of portable and bench-top versions ensuring chemical composition analysis through transparent packaging. Raman analyzers produced in North American, European, Asian countries and Russia have advantages over alternative FTIR analyzers, gas chromatographers, mass spectrometers due to a combination of factors (identification reliability and rate, ease of operation and low cost) and can become major technical instruments for identification of chemical substances complementing effectively the existing inspection systems.

1.3 The Raman technique of chemical agent analysis is currently at the final stage of approval as a preflight inspection standard at nuclear power plants (IEC standard 63085).

1.4 In the Russian Federation ChemExpert Handheld Raman Spectrometer (HRS) is being tested during passenger baggage security check in Sheremetyevo (Moscow, Russia) and Koltsovo (Yekaterinburg, Russia) Airports.

¹ English and Russian versions provided by the Russian Federation.

2. CHEMICAL SUBSTANCE IDENTIFICATION TECHNOLOGY

2.1 X-ray inspection equipment currently in use is incapable of distinguishing between a safety chemical substance and explosive, toxic, poisonous and other forbidden substances, which therefore requires additional methods ensuring timely detection of hazardous substances in the security check area. In such case the key requirement for passenger flow check is short analysis time (from several seconds to a minute) and the possibility of proximity identification of substances through packaging/container. The latter is required for safety of people in the inspection area as well as security of passenger property.

2.2 One of the most promising methods of express identification of chemical substances is Raman analysis. Identification is carried out by measuring the Raman scattering spectrum of the analyzable object on its exposure to laser emission and recognizing the acquired signal by comparing it with the reference database spectra. The high specification of signals from various molecule types ensures high reliability of recognition of various organic and inorganic substances with analysis time of 10-30 s and possibility of identification through transparent packaging/container. The analysis procedure does not require sample preparation, is realizable in a fully automatic mode and therefore does not require a specially trained operator. This enables integration of Raman analyzers into the airport operational security systems.

2.3 In the Russian Federation the currently used innovative technology is ChemExpert HRS, a certified aviation security tool, that has shown efficiency in two Russian airports, Sheremetyevo (Moscow) and Koltsovo (Yekaterinburg). Work is now well under way on extending application of ChemExpert HRS in other airports of the Russian Federation and other transportation hubs.

3. RAMAN IDENTIFICATION

3.1 ChemExpert HRS is a hardware-software system for express identification of liquid and solid substances by measurement and analysis of the signal of Raman scattering on substance molecules. The optical performance of the instrument enables high selectivity identification of organic and inorganic substances and the available reference databases total approximately >12'000 spectra including those of substances from List of main hazardous substances and articles forbidden for shipping on board aircraft (Doc 9284 AN/905 ICAO).

3.2 It is advisable to use ChemExpert HRS or similar equipment for chemical identification of potentially hazardous substances sequentially with visual analysis by x-ray inspection. In case of detection of suspicious items (including those in containers and packaging) with liquid, solid and powder substances in personal property of passengers further identification can be carried out in a specially equipped facility for Raman analysis. Solid and liquid objects can be analyzed through packaging or on clean surface. Visible-light transparent packaging and containers do not require opening prior to Raman analysis of their content. Substance from nontransparent containers can be analyzed using minimum sampling volumes.

3.3 The measurement and analysis process is controlled by an operator in the single-button mode and automated from the moment of transferring the object to the measurement position. The object to be analyzed is positioned by the operator. Analysis time is determined by the specific chemical substance, yet, in most cases it does not exceed 20 seconds. Analysis data are displayed on a standard PC and transmitted synchronously to the Airport Security System server. When prohibited items are detected, the ChemExpert software alarms about danger by means of color and/or audible indication with the name, chemical classification of the substance, corresponding risk phrases and security measures to be taken by the Airport Security System personnel.

3.4 The validity and pattern of the analysis data affect their presentation and the operator's ability to respond to the alarm. In case of unambiguous identification of the chemical substance the result is displayed with its hazard rate, risk phrases and hazard statements. Given two and more identified substances, the data on each of them is displayed with relevant hazard rate specification. When analyzing complex mixtures or substances missing in the reference database the ChemExpert program warns the operator of the presence of an unknown hazardous compound and issues a recommendation on prohibiting its carriage on board. On identification of a safety substance (or a combination of substances) or absence of distinct spectral characteristics of a chemical compound ChemExpert HRS allows its carriage. In case of incorrect positioning of the item or a disturbed measurement process the program indicates incorrect measurement and recommends making another analysis.

3.5 During each operation session ChemExpert HRS goes through self-testing and self-calibration. The performance of all the internal device modules is checked as an overall cycle using a reference object, after that operation with a flow of passenger property is allowed. The procedure excludes identification of chemical substances with a faulty or uncalibrated instrument.

3.6 The sequence of the acquired identification data is chronologically recorded in the security event logs of the airport security server and workstations. The report contains text-based information on identification time, place and data as well as the signal-spectrogram on each item and the corresponding reference signal. The data can be sent over for examination to law enforcement agencies. The report contents and the settings of the identification system are not editable by the operator in order to prevent data spoofing. In the administration mode the list of forbidden chemical substances and their categories can be configured and supplemented to adapt the chemical identification and alarm system to the requirements of a specific airport or transportation hub.

4. **CONCLUSION**

4.1 Raman identification technology enables to significantly increase the aviation safety level ensuring identification of chemical composition of suspicious solid and liquid items in passenger cabin bags and baggage and checking the safety of any chemical substances brought into the airport and on board aircraft.

5. **ACTION BY THE HIGH-LEVEL CONFERENCE**

5.1 The High-level Conference on Aviation Security is invited to:

- a) note the content of this working paper about the innovative technology used in Russian Federation in field of detection of hazardous chemical substances on preflight inspection;
- b) encourage the ICAO Secretariat Consider the significance of sharing best practices in this area between the States, including by means of AVSECPaedia; and
- c) agree on the need to continue works in this area.