# AQIS Import Clearance Risk Return
# ACERA 1001 Study B
# Rural Destination Inspection
# Report 2


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# Executive summary

## 1.1 Introduction

This report presents point and interval estimates of the future pathway risk and leakage for rural destination container inspection (RDI, also called Rural Tailgate Inspection), assuming a 100% inspection rate behind a 30% inspection rate for the External Container Inspection Regime (ECIR). The data used for the predictions were derived from AQIS inspection history and expert opinion. A simulation experiment was used to compute the estimates.

## 1.2 Outcomes

The specific outcomes are:

- The expected pathway leakage rate for rural–destined containers, assuming 100% inspection rate, 30% inspection rate for the external container inspection regime (ECIR), and using 2008 inspection results, is 0.073%. Reasonable upper and lower limits for this figure are (0.03%, 0.13%).
- The expected pathway leakage rate for ECIR containers, using 2008 inspection results and 30% inspection rate for ECIR, is 0.72%. Reasonable upper and lower limits for this figure are (0.70%, 0.75%).
- The expected contamination approach rate for ECIR containers, using 2008 inspection results, is 0.99%. Reasonable upper and lower limits for this figure are (0.97%, 1.01%).

## 1.3 Risk–return context

In order to preferentially allocate resources to the activities that face the highest risk, the Cargo Branch is developing and implementing policies for the application of a risk-return approach on a number of activities.

Under Increased Quarantine Initiatives (IQI), Programs were nominally required to intervene for 100% of volume, and obligated to achieve a minimum level of intervention. The prescribed minimum level varied across AQIS Programs. This approach provided information on the amount of activity that was to be undertaken and a numerical level that was to be achieved, as measures of performance.

Biosecurity risk management principles state that rather than focusing efforts on maintaining a prescribed level of activity or quantitative measure of performance, resources should be allocated on the basis of statistical intelligence and scientific assessment. Intervention levels should be responsive to changing risks, and performance should be measured against maintaining an acceptable level of risk.

Future risk management strategies will entail resourcing and guiding a level of intervention to maintain leakage at less than a determined level, where leakage is considered to be the (estimated) amount of undetected movement of goods or vessels of quarantine concern through an intervention process.

### 1.3.1 Relevance to Beale review

Among the many recommendations made by the Beale report (Beale et al., 2008), this study directly targets:

**44** The balance and level of biosecurity resources across the continuum should be determined by a consistent analysis of risks and returns across programs. The level and allocation of resources should be comprehensively reviewed against risk-return profiles at least every five years.

- This report proposes a risk–sensitive monitoring program that can be deployed for allocating resources.

**52** The National Biosecurity Authority should undertake a continuing program of analysis of risk pathways using data collected from pre–border intelligence and border inspections at control points along the continuum. The results of this analysis should be used to update risk management strategies and measures.

- This report examines the quarantine risk associated with the movement of shipping containers to rural areas.

# 2

# Background

This project, ACERA project 1001b, extends the conclusions of ACERA projects 0804 (Robinson et al., 2008) and 0804a (Robinson et al., 2009a). Briefly, the earlier reports provided a summary of current AQIS Import Clearance (IC) processes, proposed a risk framework and an analytical strategy for using historical data to identify high–risk import pathways and to prescribe candidate monitoring regimes based on the estimated risk, and demonstrated the application of the strategy using six case studies.

This report follows from and extends the work reported by Robinson et al. (2009b), which presented an analysis of historical AQIS inspection data and a spreadsheet tool that could be used to compute the risk for the rural destination pathway.

This phase of the rural destination case study uses a similar methodology to that presented in ACERA reports 0804 and 0804a. The goal is to advise on the effect upon the rural destination container pathway of 100% rural destination container inspection (RDI) in the context of 30% ECIR.

Presently, interest lies in distinguishing between *actionable* and *non–actionable* contamination, however, this distinction is unavailable in the historical inspection data. Accordingly we are constrained to identifying *high–level* contamination, which is contamination that led to the containers being sent for a wash.

## 2.1 Deliverables

The deliverables of ACERA project 1001b are as follows:

1. a report on the rural tailgate inspection regime required to maintain the risk of high level contamination below 1% (Robinson et al., 2009b),
2. a subsequent report that details statistical models and examples of use as noted above (this report), and
3. a training workshop and operational deployment (not needed as no change to policy or practice is recommended).

# 3

# Rural Destination Inspections (RDI)

## 3.1 Introduction

In this chapter, we demonstrate the use of statistical risk analysis on a new case study, for external rural destination container inspections, using data supplied by AQIS. External rural destination container inspections refer to the inspection of all shipping containers that are to be delivered to rural destinations. A rural destination has a postcode defined by AQIS as a 'rural postcode'.

The rural destination inspection records available for this study were at the Quarantine Entry level, which may contain numerous containers. Therefore the contamination rate should be interpreted at the entry level, not the container level. This means that the reported contamination rate will be conservative from the point of view of container–level risk; that is, the actual risk will be likely to be less than the reported risk. The inspection records include observation of both high–level and low–level contamination; within this report, *contamination* refers to *high–level contamination*.

## 3.2 Developments

We now detail the necessary changes to the risk model that was reported in Robinson et al. (2008).

1. The risk model previously focused on the risk represented by a pathway before AQIS intervention. We now consider the risk existing after intervention — the leakage. The leakage results from less than perfect effectiveness in the intervention process. The leakage might reflect the technical limitations of the methods used by inspectors or decisions made as to what inspection (if any) is done for various pathways. Estimating leakage and the effectiveness of a process are linked, and usually requires an extra inspection — a leakage survey — after normal intervention, although there are other ways of doing so. Because the leakage will depend on the actual contamination rate, we need to define both the observed leakage (that which is calculated from the inspection results) and the leakage risk rate that takes into account our uncertainty about the approach rate as well as uncertainty that comes from statistical variation in the inspection data.

2. All of the early–phase risk–return strategies put forward as a response to Beale have proposed inspecting a substantial portion of the relevant pathways, for example, 30–40%,

instead of the 100% that was previously inspected. In the previous studies (0804, 0804a), the pathway was either completely inspected, or monitored at a low rate. Inspection regimes that encompass a substantial proportion of the pathway, say greater than 30%, can lead to correspondingly substantial reductions in the amount of quarantine risk material that is leaked. This reduction follows the capture and removal of a substantial portion of the contaminated items from the pathway.

3. The risk model previously allowed for only one intervention. In the case of rural–destination containers, up to two interventions are possible: at ECIR and at RDI. The intervention at ECIR will affect the risk at RDI, and therefore will also affect the expected leakage at RDI.

In summary, these developments recognize that in detecting and responding to non–conformities, AQIS may substantially lower the leakage that is associated with a pathway. Furthermore, a pathway may have more than one intervention, and the joint effect of such interventions should be considered on the risks and leakages.

## 3.3 Methods

We constructed a simulation experiment to assess the inspection regime. The goal of the simulation experiment was to mimic the proposed inspection regime on randomly–generated but known streams of consignments a large number of times, and to estimate the risk and the leakage. The estimates of these quantities that were earlier reported were derived from this process. The simulation experiment used the following algorithm.

1. The following initial values were obtained from Robinson et al. (2009b)
   - For sea containers approaching ECIR
     - Count approaching is 1919982.
     - Number detected with actionable quarantine risk material is 18771 (0.98%).
     - Inspection rate is 30%
     - Inspection effectiveness is 95%
     - Effectiveness standard deviation is 2%.
   - For sea containers approaching RDI
     - Count approaching is 35151 (1.8% of overall approach rate).
     - Inspection rate is 100%
     - Inspection effectiveness is 90% (Assumed)
     - Effectiveness standard deviation is 3%. (Assumed)
2. Repeat the following steps 1000 times (see Appendix A for fuller details).
   (a) Simulate the number of containers going to ECIR and bypassing ECIR.
   (b) Take into account the inspection effectiveness to simulate what is found at ECIR inspection and hence what is missed.
   (c) Simulate the number of containers going to RDI for both the ECIR and non–ECIR streams

(d) Simulate what is found at RDI in the ECIR stream

(e) Simulate what is found at RDI in the non–ECIR stream

3. Collate and examine the results.

## 3.4 Results

- The expected leakage rate for rural–destined containers, using 2008 inspection results and 30% inspection rate for ECIR, is 0.073%. Upper and lower limits for this figure are (0.03%, 0.13%).
- The expected leakage rate for ECIR containers, using 2008 inspection results and 30% inspection rate, is 0.72%. Upper and lower limits for this figure are (0.70%, 0.75%).
- The expected contamination approach rate for ECIR containers, using 2008 inspection results, is 0.99%. Reasonable upper and lower limits for this figure are (0.97%, 1.01%).

Figures 3.1 and 3.2 show the distributions of the results of the simulations.

### 3.4.1 Notes

1. The simulated distribution of the risk for RDI is more variable than that for the leakage of ECIR because only a subset of the containers are inspected at ECIR, and only a subset of the containers arriving at RDI have been inspected at ECIR.
2. Unlike previous reports (Robinson et al., 2008, 2009a,b) we no longer assume that the inspections are 100% effective.
3. This analysis ignores the 100% inspection of giant African snail (GAS) and land–bridge sea containers. Ignoring these inspections leads to a more conservative assessment of risk than would arise from including them, that is, it makes the risk seem higher.
4. All analyses were performed using the open–source, free statistical environment R (R Development Core Team, 2009).

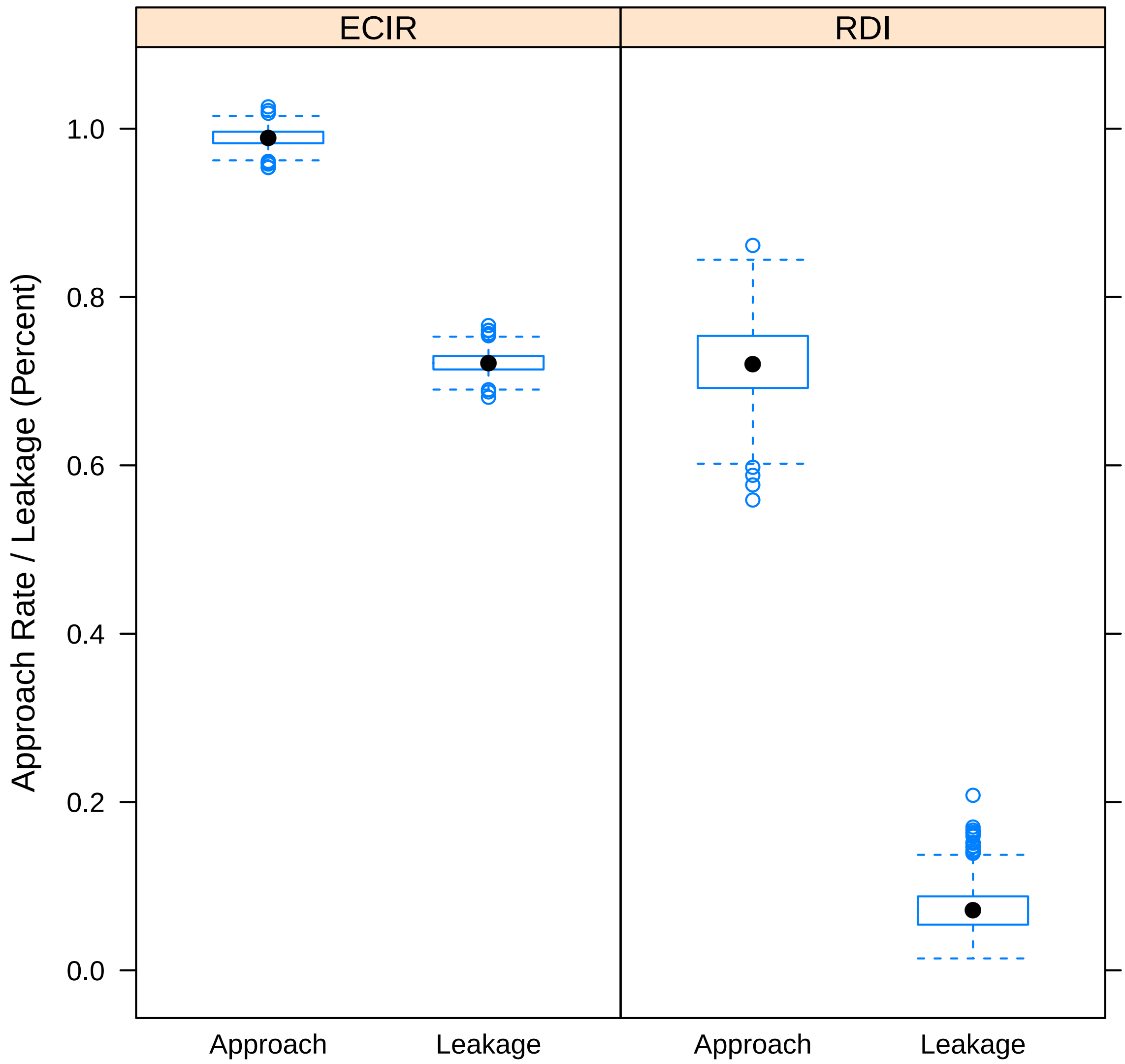


Figure 3.1: Boxplots of simulation results. The two pathways are ECIR (left panel) and RDI (right panel). Within each panel is the simulated approach rate pre– and post–inspection, expressed as a percentage of the number of containers arriving at each intervention. The central dot reports the median, the box surrounds the innermost half of the data, and the whiskers encompass the range of most of the rest of the data.

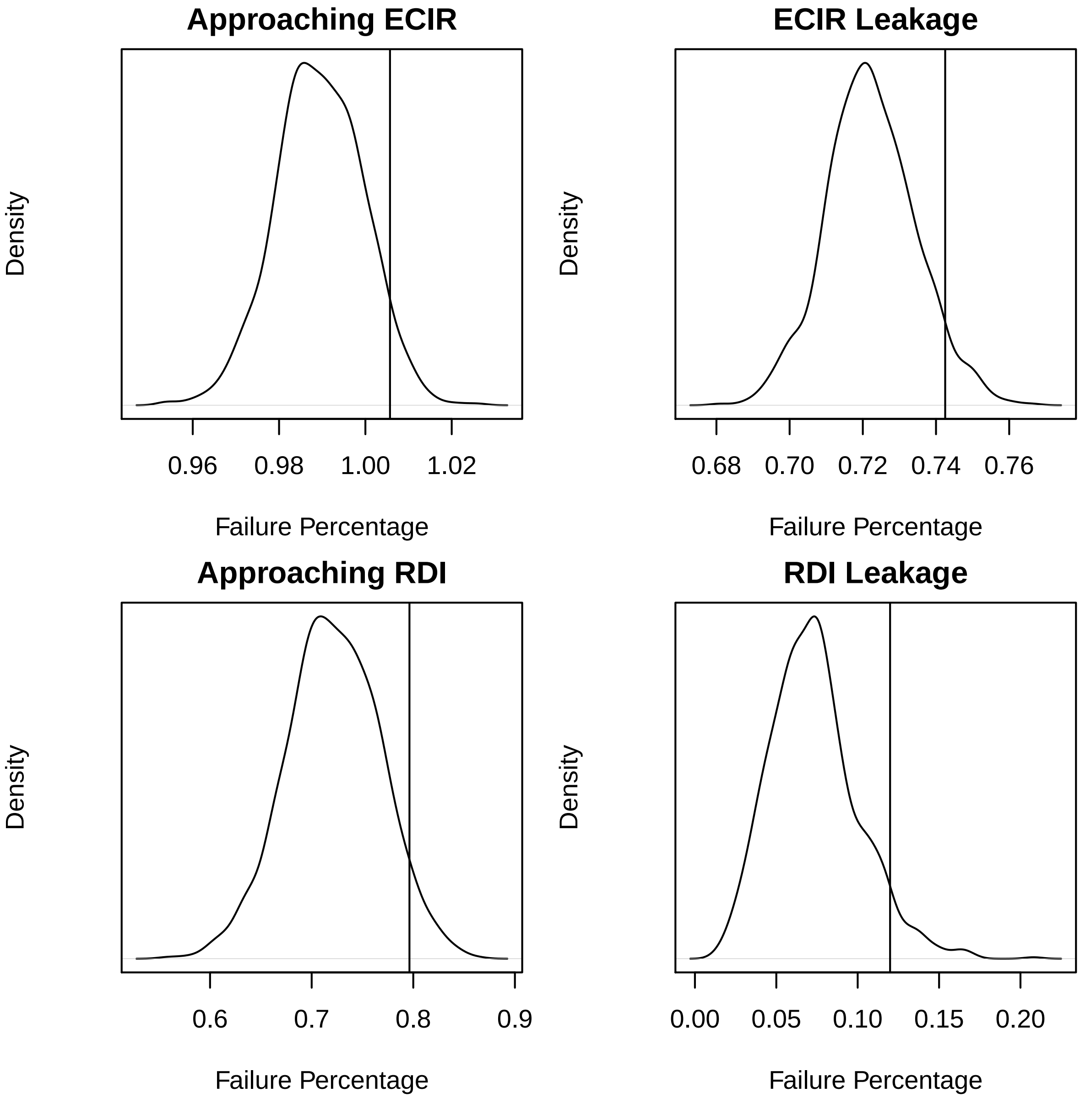


Figure 3.2: Density plots of simulation results. The two pathways are ECIR (top panels) and RDI (bottom panels), and the conditions are pre–inspection (left panels) and post–inspection (right panels). A vertical line has been added to each plot to show the $95^{\text{th}}$ percentile of the distribution. This percentile reports the non–conformity risk rate for the stream before inspection and the leakage risk rate for the stream after inspection.

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# Appendix A

# Simulation Details

Here we present the simulation algorithm. A simple analytical calculator may well present a reasonable approximation.

1. Repeat the following steps 1000 times.
   (a) Randomly generate a Beta random number from a distribution derived from $n = 1919982$ inspections that has lower 95% quantile at 18771/1919982/0.95, which represents the true underlying failure rate for sea containers approaching ECIR.
   (b) Generate a Beta random number, with mean 0.95 and standard deviation 0.02, which represents the estimated true underlying effectiveness of ECIR inspections.
   (c) Generate 1919982 random binary (0,1) values, with probability equal to the Beta random variable generated in step 1a. The 1's are then failures.
   (d) Filter these 1919982 numbers by the ECIR inspection process, as follows. All zeros stay at 0. Any 1 for which a uniform random number is less than the inspection rate and another uniform random number is less than the inspection effectiveness is converted to 0. This set of numbers is the post–ECIR inspection status.
   (e) Generate a Beta random number, with mean 0.9 and standard deviation 0.03, which represents the estimated true underlying effectiveness of RDI inspections.
   (f) Subset these 1919982 numbers down to a proportion that will undergo RDI, for example 35000.
   (g) Filter these 35000 numbers by the RDI inspection process, as follows. All zeros stay at 0. Any 1 for which a uniform random number is less than the inspection rate and another uniform random number is less than the inspection effectiveness is converted to 0. This set of numbers is the post–RDI inspection status.
2. Use the quantiles of the distributions of the post–ECIR inspection status and the post–RDI inspection status as the ends of the interval estimates of the leakage rates.

# Appendix B

# Change Log

**24 October 2009** Risk–return material added to executive summary.

**21 August 2009** Initial version.