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A Study on the Quality Control Process of Fire Extinguishing and Suppression Agents

May 2014

Final Report

U.S. Department of Transportation
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Transport Canada
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United Kingdom Civil Aviation Authority

NOTICE

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16. Abstract

Inadequate quality control of fire extinguishing and suppression agents may affect airworthiness through a reduction in fire protection capability, or pose a hazard to personnel where contaminated extingusihants are toxic.

Transport Canada, the Federal Aviation Administration, and the United Kingdom Civil Aviation Authority requested a study be carried out to review the processes used in North America and Europe for the quality control of agents in fire extinguishers and fire suppression systems. This report reflects the outcome of the study and contains recommendations for optimized processes for consideration by the airworthiness authorities and industry.

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LIST OF ACRONYMS

AD	Airworthiness Directive
AMO	Approved Maintenance Organization
APU	Auxiliary Power Unit
ARC	Airworthiness Review Certificate
ASTM	American Society for Testing and Materials
BCF	Bromochlorodifluoromethane
BTM	Bromotrifluoromethane (Halon 1301)
C of A	Certificate of Airworthiness
C of C	Certificate of Conformity
CAMO	Continuing Airworthiness Maintenance Organization
$CBrF_3$	Bromotrifluoromethane
CMM	Component Maintenance Manual
EASA	European Aviation Safety Agency
FAA	Federal Aviation Administration
FM	Factory Mutual Research Corporation
HHFE	Hand Held Fire Extinguisher
ICA	Instructions for Continued Airworthiness
ICAO	International Civil Aviation Organization
MRO	Maintenance Repair Organization
OEM	Original Equipment Manufacturer
ppm	parts per million
REACH	Registration, Evaluation, Authorization, and Restriction of Chemicals
UL	Underwriters Laboratory (USA)
ULC	Underwriters Laboratory Canada

EXECUTIVE SUMMARY

There have been instances of halon fire extinguishers being carried on board airplanes, which have extinguishing agents that do not meet the prescribed standards regarding their composition. Sub-standard extinguishing and suppression agents have the potential to provide inadequate fire protection capability and may present a hazard to personnel if the gases contained in the extinguisher are toxic.

While halon extinguishants are to be phased out due to their ozone-depleting characteristics, the quality control process, currently used for any extinguishing agent used in hand held fire extinguishers and fire suppression systems, has been brought into question based on recent experience.

Transport Canada, the Federal Aviation Administration and the United Kingdom Civil Aviation Authority requested a study be carried out to review the procedures used in North America and Europe for the quality control of extinguishing agents in fire extinguishers and fire suppression systems, so that recommendations may be made as to optimised processes for future consideration by the airworthiness authorities and industry.

The primary risk of introducing sub-standard extinguishing agent occurs during initial production and again during recycling, and may affect both newly manufactured equipment and in-service equipment on board aircraft that may be maintained or replenished. The study did not find any examples of on aircraft charging of fire extinguishers or suppression systems. Therefore, once the appropriate agent is introduced into a hand held fire extinguisher or equipment for an on aircraft fire extinguishing or suppression system, the remainder of the quality assurance process does not involve any further quality control of the agent. The quality standard of the agent on board aircraft is currently primarily dependent on the adequacy of the agent manufacturer's or agent recycler's certification and quality assurance system. These agent manufacturers' and agent recyclers' processes have been examined as part of this study, together with those of extinguisher manufacturers, maintainers, and other organizations that may handle fire extinguishing/suppression equipment, in order to mitigate the risk of sub-standard agent being installed on operational aircraft.

In North America, the production activity for hand held and system fire extinguishers is overseen by Underwriters Laboratory in the USA, and, in Canada, by Underwriters Laboratory Canada. European fire extinguishing and fire suppression equipment manufacturers for the aviation market would generally be accredited with a Production Approval in accordance with EASA Part 21 Subpart G, issued by the competent Authority of the Member State.

This study found that manufacturers of fire extinguishing and suppression equipment in North America and Europe appreciate their obligation to assure the quality of fire extinguishing/suppression agents used to fill their products, prior to release to service. However, this is achieved in different ways; ranging from acceptance of the agent supplier's certification only, through to separate and independent recertification of samples for comparison with (prior issued) supplier test certificates. This is conducted by industry within a contractual relationship

rather than a regulatory requirement when fire extinguishing manufacturers rely on third party test laboratory certifications rather than test certificates provided by the agent supplier.

The study concludes that the obligation to control and confirm the acceptability of agent (whether new or recycled), which is contained in the equipment should fall to the original equipment manufacturer or any other organization responsible for filling equipment with the relevant agent. This obligation should include the requirement for analysis and securing of a test certificate from an accredited test laboratory for the agent to be used in the equipment. Various other recommendations are made, including those aimed at ensuring that oversight and process are harmonized between new production equipment and those that are maintained by recharging with agent by any organization during the service life of such equipment.

1. INTRODUCTION.

Transport Canada, the Federal Aviation Administration, and the United Kingdom Civil Aviation Authority (hereafter referred to as the authorities) have requested a study be carried out to review the quality procedures used in North America and Europe for the quality control of agents used in fire extinguishing and suppression systems. This report contains the methodology, findings, conclusions and recommendations resulting from the study.

The study objectives were to investigate the existing quality control processes for fire extinguishing and suppression agents in North America and Europe so that recommendations might be made to standardize on best practice across the industry. These recommendations are intended to be used as a basis for optimized standards for future consideration by the authorities and industry. They are aimed at ensuring that the quality control processes are both cost effective and efficient, with changes to existing processes only being recommended if they result in a more effective control of fire extinguishing or suppressant agents.

The study addressed the approval process for both hand held fire extinguishers and agents used in on board systems.

2. BACKGROUND.

There have been instances of halon fire extinguishers being carried on board airplanes, which have extinguishants that do not meet the prescribed standards. Sub-standard extinguishants have the potential to provide inadequate fire protection capability and may present a hazard to personnel if the gases contained in the extinguisher are toxic. While halon extinguishants are to be phased out, due to their ozone-depleting characteristics, the quality control process currently used for extinguishing agents in hand held fire extinguishers and fire suppression systems has been brought into question based on recent experience.

On October 23, 2009, the European Aviation Safety Agency (EASA) published Safety Information Bulletin 2009-39 (reference 1) advising that significant quantities of Halon 1211 and Halon 1301 agent suspected to be outside the required specification had been supplied to the aviation industry for use in fire extinguishing equipment. This EASA action was based on advice from the UK Civil Aviation Authority that a UK based company had supplied contaminated fire extinguishing agent of varying purity to several companies involved in aircraft fire extinguishing equipment maintenance and/or manufacture.

Safety Information Bulletin 2009-39 was followed up on November 25, 2009, by an EASA Emergency Airworthiness Directive (AD) No. 2009-0251-E (reference 2) which went on to identify that the contaminated nature of the agent when used against a fire may lead to the release of toxic fumes possibly causing injury to aircraft occupants and/or may affect its fire-fighting capabilities.

In recognition of the EASA actions, the International Civil Aviation Organization (ICAO) issued a letter: AN3/25.1-10/2 (reference 3) on January 12, 2010, requesting states to “assess halon fire extinguishing supplies and take action as appropriate.”

This letter contained the following recommendations, which are of interest in relation to the objectives of this study:

a) States should require air operators, AMOs, aviation suppliers and manufacturers to verify the quality of halon in their possession or provided by suppliers, through effective testing or certification attesting to the quality of halon to an established and recognized international standard.

b) States should require organizations involved in recycling of Halon 1211 or 1301 to demonstrate the quality of the recycled halon in their possession and their control of the Halon purity in the recycling process; and

c) States should require that the quality systems of air operators, AMOs, aviation suppliers and manufacturers provide a means for requesting from halon suppliers certification documentation attesting to the quality of halon to an established and recognized international standard.

3. SCOPE.

This study is primarily based on the processes appropriate to halon extinguishers. However, other agents have also been considered.

Both hand held fire extinguishers and agents used in fire suppression systems have been addressed in the study.

The recommendations herein are intended to address the quality control process considered appropriate to all agents used on board airplanes.

4. OBJECTIVES.

The broad objectives of the study are:

1) To investigate the quality processes and procedures, currently used in North America and Europe for the control of extinguishing and suppression agents intended for use in fire extinguishers and fire suppression systems on board aircraft and;

2) To make recommendations as to how these quality processes and procedures may be enhanced to mitigate the risk of fire extinguishing or fire suppression agents which do not meet the requisite Standards being installed on operational aircraft.

5. METHODOLOGY.

5.1 PARTICIPATING ORGANIZATIONS.

The study has been informed by contributions from a range of organizations and agencies involved in the fire extinguishing and fire suppression agent industry including those that are installers or users of such equipment.

A table is provided in each appropriate section of this document which reflects the participation by relevant organizations. The number of organizations contacted was greater than those who eventually agreed to contribute to this activity.

5.2 DATA GATHERING AND PROCESS MAPPING.

For the purposes of data gathering and process mapping, the following activities were carried out, the findings of which are contained in section 6:

1) Liaison with relevant industry participants in the manufacture of agents, in particular those involved in the recovery, recycling, and reclamation of halon, in order to establish the processes used that are intended to assure the quality of the agent dispatched for aviation applications.

2) Liaison with manufacturers of fire extinguishers and fire suppression system equipment in order to establish the processes used to assure the quality of the agent used for filling their respective equipment and the control of any agent recovered from in-service use.

3) Liaison with fire extinguisher and fire suppression system equipment distributors on the handling of equipment and the associated quality assurance procedures.

4) Liaison with fire extinguisher and fire suppression equipment maintenance organizations and those involved in the filling or recertification of fire extinguishing equipment returned from in-service use in order to confirm the processes applied to assure release of such equipment back to service in accordance with the relevant approved data.

Liaison with aircraft manufacturers, aircraft maintenance organizations, and airlines, in order to establish the control regime and specifications used for installation of fire extinguishing equipment used to satisfy the relevant type design or operational regulations.

6. FINDINGS.

6.1 INTRODUCTION.

The information provided in this section is the result of visits and telephone discussions conducted with the organizations participating in this study.

As part of the process mapping for quality control of the agent, the route was investigated from the agent manufacturer through to maintenance carried out on equipment after removal from an airplane.

The findings are, therefore, broken down into the various principal sectors as follows:

Section 6.2 - Quality Control of Agent during Agent Manufacture
Section 6.3 - Quality Control of Agent during Agent Recycling and Testing
Section 6.4 - Quality Control of Agent during Equipment Manufacture
Section 6.5 - Quality Control of Agent during Equipment Distribution
Section 6.6 - Quality Control of Agent during Equipment Filling (Empty Production Item)
Section 6.7 - Quality Control of Agent during Aircraft Manufacture
Section 6.8 - Quality Control of Agent during Aircraft Maintenance
Section 6.9 - Quality Control of Agent during Equipment Maintenance

Each section contains information on the number and geographical location of participating organizations, a description of the outline certification process (illustrated by a process map), a discussion of the findings and concludes with sector specific recommendations.

6.2 QUALITY CONTROL OF AGENT DURING AGENT MANUFACTURE.

6.2.1 Introduction.

Since the establishment of the Montreal Protocol in 1989[1], which controlled the production of substances that deplete the ozone layer, such as halon, newly manufactured fire extinguishing and fire suppression agents (which includes halon replacements) are sometimes referred to as clean agents. Clean agents, where subject to recycling, could equally benefit from the recommendations contained in this study.

Agent manufacturers are invariably servicing a much wider market than aviation. In particular, they are engaged in the provision of agents to the wider firefighting market, in both commercial and domestic applications. The aviation targeted appliances are a very small part of an agent manufacturer's overall business.

There are a very limited number of providers of agent to the market. These agent manufacturing organizations do not carry any aviation authority accreditation nor are required to do so.

6.2.2 Agent Manufacturer Participants.

Table 1 shows the number of participating agent manufacturing organizations in this study by geographical region.

[1] Since undergone seven revisions

Table 1. Number of Participating Agent Manufacturing Organizations

Area	Agent Manufacturing Organizations
Canada	0
USA	2
Europe	1

6.2.3 Certification Process.

The processes employed are subject to quality control procedures which have been assessed by independent agencies resulting in accreditation such as ISO 9001, Underwriters Laboratory Canada, and Underwriters Laboratory (USA), or similar.

The study found that fire extinguishing and suppression agents are generally manufactured by organizations which by virtue of their size and operating practice have an in-house test laboratory capable of conducting sampling and certification of the quality of the agent produced.

There was no evidence found in North America or Europe to suggest that such certification is required to be verified by a third party organization prior to distribution of the manufactured agent to the customer.

When agents are released to fire extinguisher and fire suppression equipment manufacturers, this is supported by a test certificate against the associated Standard Specification (see listing below). These test certificates provide the results of the sample analysis which are based on the parameters delineated in the agent Standard Specification relevant to the agent type.

The common standards found to be used regarding halon were as follows:

1. ASTM D5632-08 - Standard Specification for Halon 1301 (reference 4)
2. ASTM D5632-12 - Standard Specification for Halon 1301 (reference 5)
3. ASTM D7673-10 - Standard Specification for Halon 1211 (reference 6)
4. ASTM D7673-10e1 - Standard Specification for Halon 1211 (reference 7)
5. ISO 7201-1 - Specification for Halon 1211 and Halon 1301 (reference 8)

6.2.4 Process Map.

A summary of the process for quality control of agent during agent manufacture is shown in figure 1.

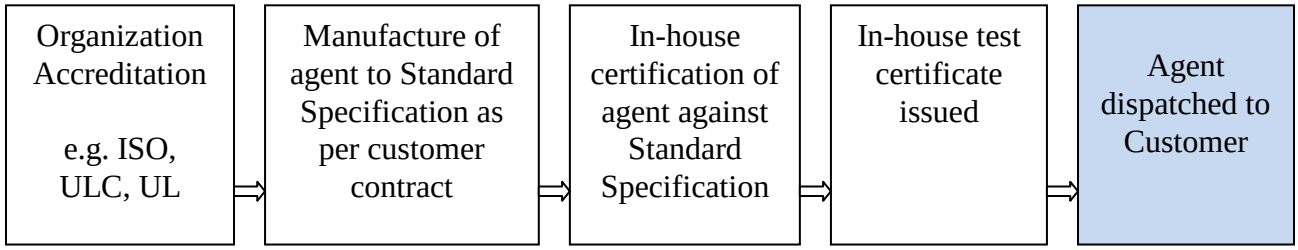

Figure 1. Quality Control of Agent During Agent Manufacture – Process Map

6.2.5 Discussion on Findings.

Direct aviation authority oversight of agent manufacturers for the purpose of assuring the standard of agent manufactured is not carried out and, although feasible, this is an unattractive option. Direct aviation authority oversight is likely to drive significant cost into this area of the market with limited value added to the overall quality control process. It is also unlikely that the authorities would have the resources, or be willing to extend existing resources, to provide approval to such a specialist and limited area of the aviation product supply chain.

Underwriters Laboratory Canada and Underwriters Laboratory (USA) conduct oversight of agent manufacturers in Canada and the USA respectively, where the agents carry a ULC/UL listing. The study did not find an equivalent to ULC/UL operating oversight of agent manufacturers in Europe.

It is more appropriate that the obligation for establishing a satisfactory quality standard of the fire extinguishing or suppression agent is placed on the equipment manufacturers as an integral part of their supplier management activities.

Approved/accredited equipment manufacturers must demonstrate to the satisfaction of the authorities or accreditation body that they have adequate quality assurance procedures in place for the correct execution of their approved scope of work. Supplier controls are a matter of contract between the original equipment manufacturer and the agent manufacturer/recycler as to how this oversight obligation is executed in practice.

The matter of oversight of fire extinguisher or suppression equipment manufacturers is discussed in section 6.4.

6.2.6 Sector Specific Recommendations.

a) There should continue to be no requirement for agent manufacturers to have any specific authority accreditation.

b) The following obligations for demonstration of compliance should be the responsibility of the original equipment manufacturer or any other organization responsible for filling equipment when purchasing agent from an agent manufacturer:

i. The relevant agent Standard Specification against which the agent is to be certified should be clearly stated in the contract between the parties.

ii. The agent manufacturer should be required to confirm that the agent has been manufactured in compliance with the relevant agent Standard Specification.

6.3 QUALITY CONTROL OF AGENT DURING AGENT RECYCLING AND TESTING.

6.3.1 Introduction.

Halon has a high commercial potential in the recycling market, due to controls now in place after the Montreal Protocol. Halon is an effective agent for dealing with certain aircraft fire threats. Halon is the most common agent that is subject to recycling.

It may be useful to clarify terminology used within the overall recycling sector, which is consistent with Decision IV/24 of the United Nations Environmental Programme Ozone Secretariat, as follows:

a. Recovery: The collection and storage of controlled substances from machinery, equipment, containment vessels, etc., during servicing or prior to disposal;

b. Recycling: The re-use of a recovered controlled substance following a basic cleaning process such as filtering and drying. For refrigerants, recycling normally involves recharge back into equipment.

c. Reclamation: The re-processing and upgrading of a recovered controlled substance through such mechanisms as filtering, drying, distillation and chemical treatment in order to restore the substance to a specified standard of performance.

However, the term recycling is used in this study as a collective to describe the generic process unless otherwise stated.

The study found that in North America and Europe the quality control processes applied to the recycling activity do not discriminate with respect to the agent being processed through them.

Import/export trade in halon has been restricted by national licensing and consequential financial implications of obtaining such licenses. Information provided during the study would suggest that contaminated halon from supplies originating outside of North America and Europe is not uncommon. Consequentially, agents to be recycled are treated by some recyclers as contaminated for quality control purposes, and they are recycled on this basis. A principal

element of the recycling process is the removal of propellants from the agent and separation out of refrigerants.
Recycling organizations vary significantly in size and associated capabilities, and the difference in quality control processes affecting recycling capability and reclamation, in particular, flows from this.

Recycling organizations supplying the aviation market are not subject to the direct oversight of the authorities unless the organization has an approval for a scope separate to recycling of agent, for example, Production, Maintenance/Overhaul of aviation equipment.

Suppliers of recycled agent fall within the quality assurance management obligations of the equipment manufacturer and maintenance supplier.

The study noted that some recycling organizations will no longer accept orders for their product unless there is an independent test laboratory verification of the quality standard of the agent provided for in the contract and accepted by their customer. This was seen as a reaction to the equipment recall activity following the UK's 2012 Lyontech case where substandard agent was provided for use in aviation fire extinguishers.

6.3.2 Agent Recycling Organization and Test Laboratory Participants.

Table 2 shows the number of participating agent recycling and test laboratory organizations in this study by geographical region.

Table 2. Number of Participating Agent Recycling and Test Laboratory Organizations

Area	Agent Recycling Organizations	Test Laboratories
Canada	2	1
USA	2	0
Europe	1	2

6.3.3 Certification Process.

Recycling companies in both North America and Europe that contributed to this study employ automated recovery and conditioning machines for halon (REACH[2]) to execute the clean-up process either from a position of known contamination or where it is necessary to refine a particular batch of agent to within the specification limits.

Different systems for storage or control of agents processed through the recycling organization's facilities were noted.

[2] Registration, Evaluation, Authorization & Restriction of Chemicals

Some companies in North America were found to transfer post recycled agent into a storage container that is used to satisfy their own internal demand or supplied to external customers. A sample of the agent is taken post recycling and prior to consolidation into the agent storage container. The storage container is then periodically sampled to confirm continued conformance to the specification requirements. This periodic sampling was identified to be one calendar month or as required during independent audit, such as part of an Underwriters Laboratory Canada or Underwriters Laboratory surveillance program.

Companies approached during the study that did not operate a storage container system provide sampling and associated certification for each batch container prior to dispatch.

The study found that in North America the distribution of recycled halon provided to manufacturers or filling organizations is sometimes carried out by separating a 1 ton container into 0.5 ton containers. Where this is the practice, the study found that the agent test certificate for the larger container was used to support the quality verification and dispatch of the smaller containers. Further sampling after filling the smaller containers was not done as part of the process.

The collection of agent samples requires a high degree of skill by the technician to avoid contamination of the sample. Water content contamination limits in halon at 10 ppm is a very restrictive parameter, and technicians were found to avoid undertaking sampling activity on wet days or for a particular period after the last rainfall in order to assure that samples were not contaminated by environmental conditions. The ASTM D5632 (reference 5), ASTM D7673 (reference 7), and ISO 7201-1 (reference 8) criteria are such that a technician breathing on test equipment may result in distortion of the test results.

Taking the test sample from the gas or liquid phase of the agent recycling process is significant in relation to the parameters of the Standard along with the associated temperature of the tank at the time the sample is taken. This data is recorded on a sample label or data sheet associated with the test sample.

The study found that third party test laboratories may be utilized to test samples supplied by the recycling organization (test laboratories may also be utilized by equipment manufacturers who do not have an in-house test laboratory). Test laboratories do not necessarily require the samples to be taken by their own technicians. Where the recycling organization has the responsibility of supplying agent samples to the test laboratory, the test laboratory is reliant on the accuracy of data recording by the recycling organization. Owing to the sensitivity of sampling methods, certain equipment manufacturers send their own representatives to their recycled agent supplier to conduct the sampling process themselves.

The equipment manufacturer’s procedure for deciding whether to use a test certificate produced by the recycling organization or one produced by an independent third party test laboratory is not clear. A pass certification against the Standard by the independent test laboratory was found to be taken as the normal trigger for progressing the agent within the production system of the

equipment manufacturer. Tests resulting in significant anomalies would be dealt with by liaison and investigation between the parties.

6.3.4 Process Map.

A summary of the process for quality control of agent during agent recycling is shown in figure 2:

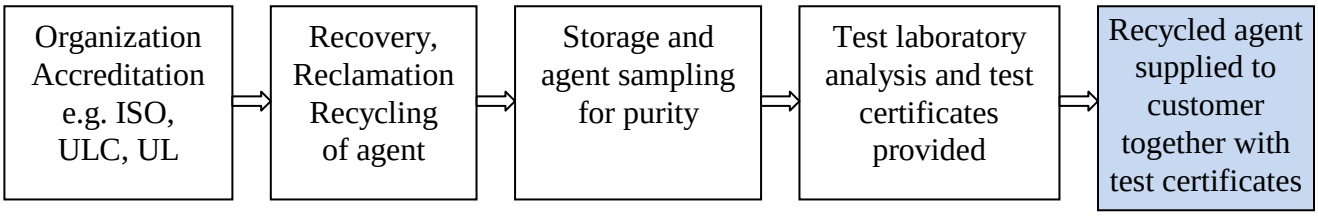

Figure 2. Quality Control of Agent During Agent Recycling - Process Map

6.3.5 Discussion on Findings.

The imposition of direct aviation authority oversight of agent recycling organizations for the purpose of assuring the standard of agent once recycled, although feasible, is an unattractive option. It would likely drive significant cost into this area of the market with limited value added to the overall quality control process. It is also unlikely that the authorities would have the capacity to provide approval to such a specialist and limited area of the aviation product supply chain.

It seems more appropriate that the obligation for establishing a satisfactory quality standard for the fire extinguishing or suppression agent is placed on those organizations responsible for filling fire extinguishing equipment, such as the equipment manufacturers, filling, or maintenance organizations as an integral part of their supplier management activities. Such organizations must demonstrate to the satisfaction of the authorities or accreditation body that they have adequate quality assurance procedures in place including the management of suppliers for the correct execution of their approved scope of work.

The most reliable confirmation of agent purity must be associated with direct sampling and testing of a particular batch of agent prior to its use in a particular application. The drawing down of batches of agent from a source container of agent may present a contamination risk to the derived agent. However, use of the test results from the source container during the certification process would not address the potential contamination risk. This risk could be mitigated or overcome by the equipment manufacturers' own commissioned testing of the particular batch prior to use of the agent in a particular application.

In respect of whether test certificates should be completed by independent test laboratories, it appears that there is no justification for this to become enforced by regulation. Where organizations possess the capability and competence to analyze agent samples and make the necessary certification within an acceptable quality assurance system, it is suggested that this should be allowed to continue. Where an organization does not possess such a capability, it

should fall to the organization to contract a suitably accredited test laboratory to conduct the work. This could be achieved by use of the Underwriters Laboratory accreditation system in North America. The study did not find any similar body in Europe providing the accreditation and oversight that is done in North America by Underwriters Laboratory Canada or Underwriters Laboratory. If such an accreditation was needed, EASA or the national airworthiness authority would be required to develop it.

The study also found instances of multiple test analyses and certifications being conducted on the same batch of agent. This is clearly a waste of resources. It is considered, therefore, that there may be economical savings to be made by the original equipment manufacturer clarifying where the burden of test certification is to be placed.

6.3.6 Sector Specific Recommendations.

a) Test laboratories should be appropriately accredited directly by the authorities or by a nominated organization on their behalf, such as UL/ULC

b) Agent sampling for the purpose of analysis and certification should be carried out by the test laboratory's own approved technicians or third party technicians who have been authorized under the test laboratory's accreditation.

c) It should remain possible for approval/accreditation to be provided to an organization that recycles the agent to use in-house test laboratory facilities to produce agent test certificates provided it can be shown that there is sufficient independence between the production and quality control management activities so that analysis and test certification is protected from detrimental program pressures or commercial interests.

d) Each batch (container) of agent intended to fill equipment should have a discrete test certificate.

e) A review should be conducted to establish whether the specification for halon purity required by the standards is unnecessarily stringent for airworthiness considerations, in particular, the water contamination limit of 10ppm. This may enable more efficient recycling of halon reserves with particular benefit to hand held fire extinguishers.

6.4 QUALITY CONTROL OF AGENT DURING EQUIPMENT MANUFACTURE.

6.4.1 Introduction.

In Europe, companies engaged in the manufacture of fire extinguishing and fire suppression equipment which are released with conformity for airworthiness purposes (EASA Form 1), are approved under Part 21 – Subpart G Production Organization Approval. This approval is provided by the competent Authority of the Member State of the European Union.

The company's quality control procedures supporting such an approval are administered by reference to the Production Organization Exposition and lower level procedures which are assessed initially by the competent authority and subject to revision approval controls.

In North America, companies may receive assessment and accreditation by an organization such as the Underwriters Laboratory Canada (ULC)/Underwriters Laboratory (UL) or Factory Mutual Research Corporation (FM) to allow an ULC/UL/FM approval reference may be applied to products being manufactured in accordance with the agreed standard and approved procedures. Within such agreements, the manufacturing organization retains quality control responsibility of its supply chain.

ULC/UL operates an extensive oversight program which includes field representatives who may typically be on-site at the manufacturers' facility 2-3 days per week depending on the volume of the relevant activity.

The ULC and UL accreditation systems are considered by UL to be harmonized. Mutual acceptability of products is not within the scope of this study. However, the study did find that the extent to which oversight is conducted on overhauled or serviced aviation products may differ between ULC and UL. For example, it is understood that in the USA, UL tags are not issued for overhauled or serviced aviation products and UL oversight generally does not extend to such activity. Discussions with ULC indicate that they do provide oversight and ULC tags for overhauled or serviced aviation products.

The study did not identify a requirement or regulation either in North America or Europe that obliges an equipment manufacturer to have a third party independent test laboratory certification for the quality standard of fire extinguishing or suppression agent.

There does not appear to be a requirement that hand held fire extinguishers supplied to the US aviation industry carry an airworthiness release (EASA Form 8130-3).

On-board fire extinguishing and suppression system equipment (other than hand held fire extinguishers manufactured under UL oversight as described above) are manufactured in Canada and the USA by organizations that have direct or delegated authority oversight.

The study did not find any organizations whose approval activities were based on the FM accreditation and differences between the UL and FM processes have not been assessed in this study.

6.4.2 Equipment Manufacturer Participants.

Table 3 shows the number of participating equipment manufacturers in this study by geographical region.

Table 3. Number of Participating Equipment Manufacturers

Area	Equipment Manufacturers
Canada	1
USA	5
Europe	3

6.4.3 Certification Process.

Fire extinguisher and fire suppression equipment manufacturers that took part in the study place purchase orders on their extinguishing agent suppliers which identify the Standard specification to which the agent must be certified and these purchase orders, where necessary, include any additional conditions of supply.

After the Lyontech investigation, certain equipment manufacturers increased the level of confidence in the certifications provided by their recycled agent suppliers by insisting on a third party test laboratory sampling and testing the agent prior to dispatch to the equipment manufacturer. The study also found that in certain cases the same batch of agent was sampled and verified for compliance to the Standard specification by a further independent source when delivered to the equipment manufacturer. This resulted in three assessments of the same batch of agent prior to the agent being processed for use in production items or possibly four assessments where the equipment manufacturer also had their own capability for sample testing.

Various equipment manufacturers operate a system of utilizing a particular production apparatus for the filling of one type of agent only. This is not the case in all situations and filling of bottles with different agents is a selectable function in certain operations using the same filling apparatus in the production process.

It was found that the standard process is for hand held fire extinguishers and fire suppression equipment to be dispatched in a filled state. However, the study found an example where hand held fire extinguishers may be filled by an organization other than the manufacturer. In this case, empty units are supplied. The empty bottles are certified as such and carry a different part number than filled units for the purpose of conformity certification. Instructions for completion of the process are then normally provided by the equipment manufacturer to the filling organization in the form of instructions contained in a Component Maintenance Manual (CMM) or a document having similar approved content. The filling organization is then responsible for final certification of the product for release in an airworthy condition.

Hand held fire extinguishers and fire suppression system equipment may be sold to equipment distributors, directly to aircraft manufacturers, airlines, or other users.

Equipment returned to the manufacturer containing extinguishant is serviced in-house where the capability exists, or it is sent to a recycling organization for recovery, reclamation, and/or recycling of the agent as necessary.

For those equipment manufacturers who do not conduct in-house recycling activities, agent recovered from returned equipment for forwarding to a recycling facility is stored separately from containers storing agent that is used for the filling new equipment.

The equipment manufacturers carry certain obligations within their production process for the quality of the complete item. In cases where multiple test certificates have been produced in the supply chain, it is left to the equipment manufacturers to make a determination as to which test certificate should be used if test results differ. However, the procedure for deciding which test certificate produced by the various parties should be used is not clear, and a pass certification against the specification Standard by an independent test laboratory is normally taken as the trigger for progressing the agent within the production system.

The study found that some equipment manufacturers will treat new production agent differently to recycled agent due to the perceived heritage of such products. Therefore, in relation to new production agent, reliance on the agent manufacturer's certification is made rather than invoking a condition for third party independent test laboratory certification as is commonly found in relation to recycled agent.

Fire extinguishing and suppression agent is generally delivered to the equipment manufacturers in 1 Tonne or 0.5 Tonne containers. The container is used to fill the equipment directly or in some cases may be split into smaller containers for ease of production purposes. Where this is the case, it was found that a further test or sample of the derived batches is made immediately prior to use in production by some organizations but not in others. This may be tested in-house or released to a third party independent test laboratory where a sample of the derived batch is taken.

One equipment manufacturer in North America was found to be supplied with the agent by their customer who directs them as to which equipment serials are to be filled with which batch of agent supplied.

Fire extinguishing or suppression equipment are dispatched from the manufacturer under a statement of conformity/Airworthiness Approval release/tag FAA Form 8130-3/EASA Form 1, and/or UL Tag where relevant in conformance to the approved design specification. Where such parts are intended for a particular aircraft type, this certification may also refer to the aircraft manufacturer's data to which conformity is being claimed.

6.4.4 Process Map.

A summary of the process for quality control of agent during equipment manufacture is shown in figure 3:

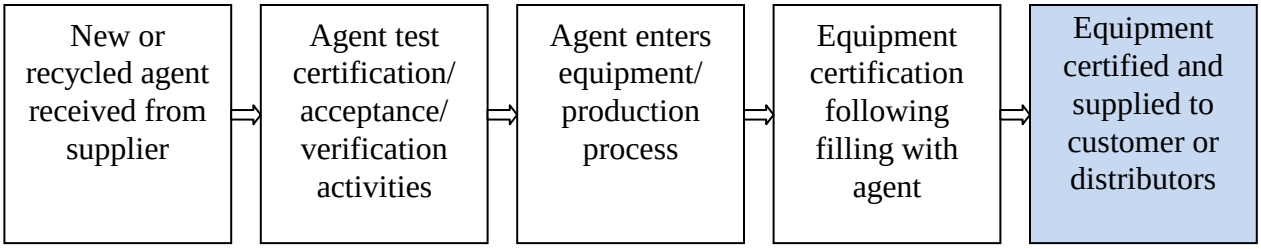

Figure 3. Quality Control of Agent During Equipment Manufacture Process Map

6.4.5 Discussion on Findings.

The study did not find any current examples of on aircraft charging of fire extinguishers or suppression systems. Equipment is installed as a discrete unit and is maintained by replacement. This supports the concept that the only realistic point in the quality control process where the standard of the installed agent can be regulated is at the point of filling the extinguisher or equipment concerned.

It is therefore considered that the obligation to control and confirm the acceptability of agent (whether new or recycled), which is contained in the equipment should fall to the original equipment manufacturer, or any other organization responsible for filling equipment with the relevant agent.

Equipment manufacturers are generally subject to direct authority oversight or oversight by ULC/UL in North America and will have received a level of quality assurance review as part of their approval including their policy and procedures for the control of sub-contractors or suppliers. Where equipment is produced, the control of such products is reliant on the airworthiness release process if no UL assessment/listing is provided or available for the equipment concerned.

Where an equipment manufacturer has been approved for test certifications to be made by their in-house laboratory with the appropriate independence between the quality and production management functions, it would be difficult to justify why this arrangement which covers many aspects of aircraft and aeronautical product certification should not continue.

In light of the UK 2012 Lyontech case, it is considered that it would be good practice that equipment manufacturers treat the receipt of agent as contaminated and conduct their own in-house analysis or contract a third party test laboratory directly once the agent is received into their facility. This is a practice the study found currently in operation by various equipment manufacturers.

It would also seem appropriate that, as a standard practice, the agent sampling for the purpose of analysis and certification by an in-house or third party test laboratory is carried out by the laboratory's own approved technicians or technicians authorized under their accreditation. This would ensure technician competence and provide accountability for the accuracy of test sampling and certification. It is acknowledged that organizations that choose to use a third party test

laboratory whether or not they have an internal testing capability may benefit from additional assurances from such third party independence.

Actions can be taken to avoid multiple sample test certificates for the same batch of agent. This can be done by the organization responsible for filling the equipment with agent by making a predetermination as to which test laboratory will produce the test certificate to be used for certification.

When multiple sample test certificates do exist in association with the same batch of agent and a pass/fail conflict is present, the organization responsible for filling equipment with the relevant agent should decide the level of assurance needed to resolve the conflict after investigation. This could involve testing by a third party test laboratory.

6.4.6 Sector Specific Recommendations.

a) It is recommended that the obligation to control and confirm the acceptability of agent (whether new or recycled), which is contained in the equipment should fall to the original equipment manufacturer or any other organization responsible for filling equipment with the relevant agent including the requirement for analysis and a test certificate for the agent to be issued from an accredited test laboratory.

b) Organizations filling other manufacturers' equipment should have the same level of authority or UL/ULC oversight as the equipment manufacturer.

c) For the purposes of quality control, agent supplied from an agent manufacturer or recycling organization should be processed as if it were potentially contaminated prior to securing a test certificate by the equipment manufacturer, certifying purity against the relevant Standard specification.

d) Each batch (container) of agent intended for filling equipment should have a discrete test certificate.

e) When the consolidation (banking) of agent is done, a test certificate should be secured for the consolidated agent prior to its use to fill equipment.

f) It should remain acceptable for the equipment manufacturer to use in-house test laboratory facilities to produce agent test certificates provided it can be shown that there is sufficient independence between the production and quality control management activities such that analysis and test certification is protected from detrimental program pressures or commercial interests.

g) Agent sampling for the purpose of analysis and certification should be carried out by the test laboratory's own approved technicians or third party technicians who have been authorized under the test laboratory's accreditation.

h) When multiple sample test certificates do exist in association with the same batch of agent and a pass/fail conflict is present, it is recommended that the organization responsible for filling equipment with the relevant agent should decide the level of assurance needed to resolve the conflict after investigation. This could involve testing by a third party test laboratory.

i) An assessment of the contamination risk associated with the filling of equipment from stations where the type of agent to be inserted is selectable should be conducted.

j) The most desirable situation is that an EASA Form 1/FAA Form 8130-3, be provided with all fire extinguishing and suppression equipment providing reference to the test certificate issued by the accredited test laboratory for the batch of agent used (even when UL/ULC oversight is being conducted).

k) If a requirement for an EASA Form 1/FAA Form 8130-3, is not to be imposed on all supplies of fire extinguishing and suppression equipment to the aviation market, consideration should be given to extension of UL oversight to surveillance of equipment maintenance activities on fire extinguishers and fire suppression equipment where appropriate.

l) The European authorities should consider whether surveillance of approved organizations involved in the manufacture of fire extinguishers and suppression equipment in particular achieves the same level of control as that provided under the ULC/UL system in North America.

6.5 QUALITY CONTROL OF AGENT DURING EQUIPMENT DISTRIBUTION.

6.5.1 Introduction.

The existence of fire extinguishers or fire suppression equipment distributors is common in the industry both in North America and Europe. This operates as a matter of convenience for end users particularly where the original equipment manufacturer (OEM) is located in a different country.

Financial considerations in shipping of fire extinguishing and suppression equipment are such that the normal protocol is for customers to purchase new replacement items as opposed to having items replenished.

Distributors who receive partly discharged vessels from airlines, maintenance, or equipment maintenance organizations will usually return the item to the manufacturer for maintenance or seek to appropriately extract any remaining agent and dispose of the item when they are qualified to do so.

Shelf life considerations for distribution are not believed to be a significant issue as the products have a relatively high turnover.

6.5.2 Equipment Distributor Participants.

Table 4 shows the number of participating equipment distributors in this study by geographical region.

Table 4. Number of Participating Equipment Distributors

Area	Equipment Distributors
Canada	1
USA	1
Europe	6

6.5.3 Certification Process.

The equipment distributors participating in this study simply pass on fire extinguishers or fire suppression equipment with the certification supplied by the manufacturer.

Within the distribution organizations, the normal quality control process followed is that the distributor's own quality procedures will provide for a comprehensive recording of the equipment's origin, its certification, and dispatch destination. This process is useful but is not operated universally. However, tracing records by distributors are not the only source available for tracking products which make their way onto aircraft, since these are responsibilities of production and maintenance organizations.

6.5.4 Process Map.

A summary of the outline process for quality control of agent during equipment distribution is shown in figure 4.

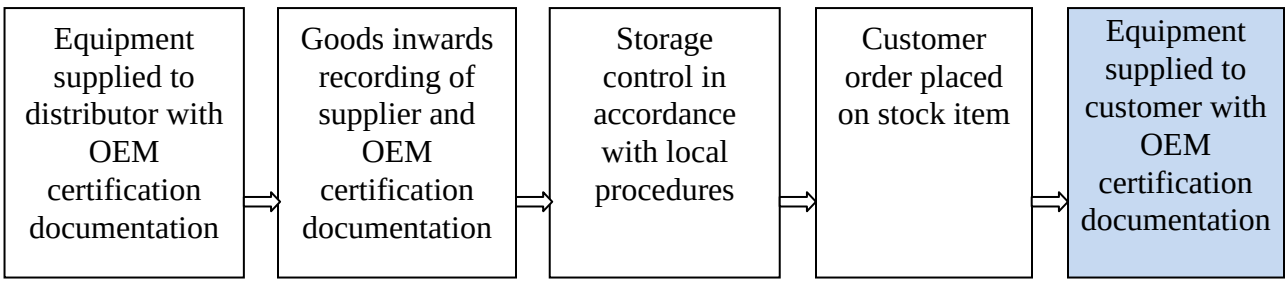

Figure 4. Quality Control of Agent During Equipment Distribution - Process Map

6.5.5 Discussion on Findings.

Distribution organizations are simply a step in the process and invariably depend on the certification activities carried out by the equipment manufacturers to support their transfer of airworthy products.

The quality control of agent was not found by the study to be affected by the activities carried out by these organizations.

6.5.6 Sector Specific Recommendations.

No recommendations are made for the quality control of agent during equipment distribution.

6.6 QUALITY CONTROL OF AGENT DURING EQUIPMENT FILLING (EMPTY PRODUCTION ITEM).

6.6.1 Introduction.

This study did not identify a significant number of organizations conducting filling of manufacturer-supplied empty equipment for initial production. Where this exists, it seems to be as a facilitator for simplicity in halon import/export considerations.

6.6.2 Equipment Filling Organization Participants.

Table 5 shows the number of participating equipment filling organizations in this study by geographical region.

Table 5. Number of Participating Equipment Filling Organizations

Area	Equipment Filling Organizations
Canada	0
USA	1
Europe	0

6.6.3 Certification Process.

The quality control considerations for filling empty OEM equipment are focused on ensuring that the unfilled products are uniquely identified in relation to the filled items, for example, with different part numbers for filled and unfilled products and that the agent is certified to the correct Standard specification in accordance with the approved design data and that the product is appropriately certified once complete.

Certification of the final product is completed in accordance with the equipment manufacturer's Component Maintenance Manual (CMM). The filling organization is unlikely to have the capability for in-house testing of the agent used to complete the production process. In the example found during this study, the quality of the agent is taken at face value from data supplied by the agent supplier or the independent test laboratory.

Some manufacturers insist on a particular batch of agent being used exclusively for their products. In addition, a record of which batch of agent is used in which fire extinguishers or suppression equipment are kept by the filling organization.

6.6.4 Process Map.

A summary of the process for quality control of agent during equipment filling is shown in figure 5:

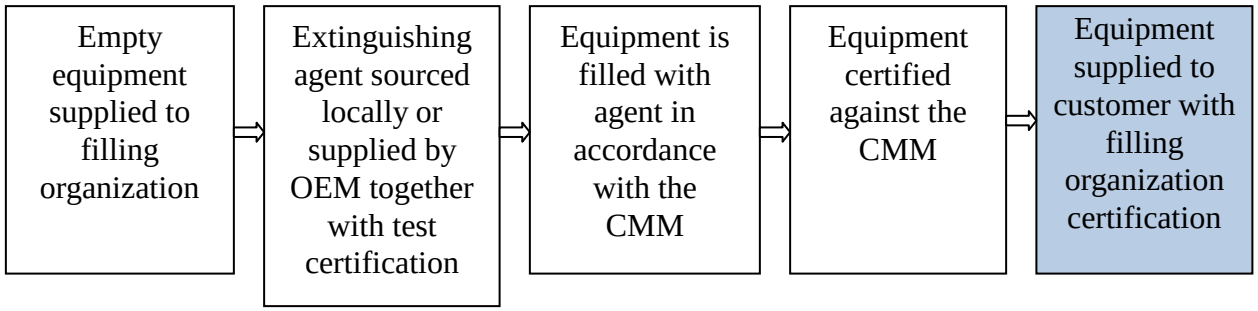

Figure 5. Quality Control of Agent During Equipment Filling Process Map

6.6.5 Discussion on Findings.

The integrity of the final product is dependent on unique part numbers being available for the filled and unfilled equipment.

The ability of filling organizations to conduct their own test analysis of the agent content was not found during the study. The agent together with its test certification is either sourced locally or provided by the equipment manufacturer for filling of nominated units.

The main issue to be considered is whether the filling organization has access to or implements the same quality assurance controls to which the equipment manufacturer is subjected. Since the activity being conducted is in essence part of a manufacturing process, it is appropriate that organizations involved in filling empty equipment for initial production should be subject to the same authority or accreditation organization oversight as that applied to equipment manufacturers. In this respect, the recommendations provided under section 6.4.6 are equally applicable to such organizations.

6.6.6 Sector Specific Recommendations.

a) See section 6.4.6

6.7 QUALITY CONTROL OF AGENT DURING AIRCRAFT MANUFACTURE.

6.7.1 Introduction.

Aircraft production in today's environment is a multinational activity with products, sub-assemblies, appliances, equipment, components, and parts coming from specialist manufacturers. Fire extinguishing and suppression equipment are specified by the aircraft manufacturers who make their selection based on the requirements appropriate to the aircraft type design.

The control of agent incorporated within the equipment is done by part number configuration control in the Type Design data and Instructions for Continued Airworthiness.

Aircraft manufacturers rely on the certification/release papers for the equipment concerned supported by an approved supplier listing or similar. There is no further agent quality checking in fire extinguishing or fire suppression equipment at the aircraft production stage. Quality assurance checks are limited to a check of the weight of the equipment to ensure it is within predetermined acceptance criteria.

6.7.2 Aircraft Manufacturer Participants.

Table 6 shows the number of participating aircraft manufacturers in this study by geographical region.

Table 6. Number of Participating Aircraft Manufacturing Organizations

Area	Aircraft Manufacturers
Canada	1
USA	1
Europe	1

6.7.3 Certification Process.

Aircraft manufacturers may be concerned about verification of agent quality during certain type certification or modification activities particularly where the characteristics of the agent are likely to influence demonstration of compliance with the airworthiness requirements. For example, excessive water content in the agent may affect the functionality of the extinguishing or suppression system during cold soak operations. However, generally the quality control process for production aircraft is reliant on the aircraft manufacturer’s supplier surveillance program and certificates issued to them by such suppliers.

The study did not find any examples of aircraft manufacturers directing their suppliers in relation to whether agent test certificates should be issued by the equipment manufacturer or by a third party test laboratory.

6.7.4 Process Map.

A summary of the process for quality control of agent during aircraft manufacture is shown in figure 6:

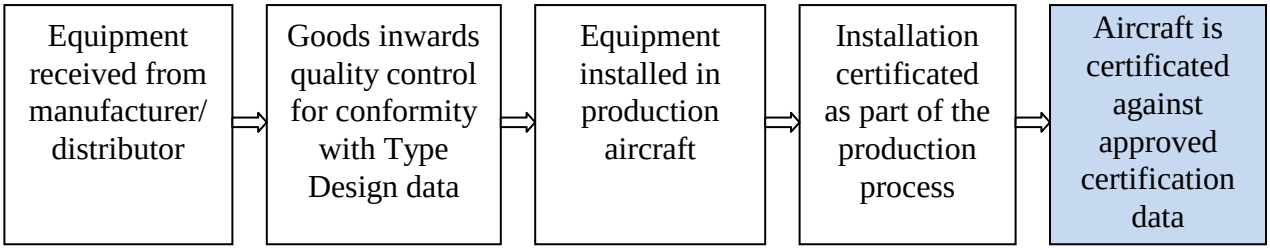

Figure 6. Quality Control of Agent During Aircraft Manufacture -Process Map

6.7.5 Discussion on Findings.

The study did not find any examples of on aircraft charging of fire extinguishant or fire suppressant systems. The aircraft manufacturers are, therefore, relying on the receipt of equipment containing agent which has been previously certified as compliant with the design specification. The aircraft manufacturer's supplier management system will incorporate quality surveillance of the supplier's activities as part of the assurance that the equipment specification is being adhered to. It is, therefore, understandable that no check on the agent within equipment supplied is done at the aircraft production installation phase.

6.7.6 Sector Specific Recommendations.

No recommendations are made for the quality control of agent during aircraft manufacture.

6.8 QUALITY CONTROL OF AGENT DURING AIRCRAFT MAINTENANCE.

6.8.1 Introduction.

The study found that the quality control practice for fire extinguishing and fire suppression systems that is done by airlines when performing their own maintenance activities is analogous to that executed by independent aircraft maintenance organizations.

It is an airline's responsibility to task the required maintenance in accordance with an approved maintenance program when it has its capabilities for maintenance planning and direction incorporated within an approval such as an Air Operator's Certificate or has the regulated support of an EASA Part M Subpart G Continuing Airworthiness Management Organization (CAMO) in Europe. This will involve the use of the aircraft manufacturer's Instructions for Continued Airworthiness for equipment approved as part of the type design, supplemental type design, or other installation approval.

Where servicing of fixed fire extinguishing or suppression systems is required, the normal procedure is for equipment to be removed and replaced. No on aircraft charging of fire suppression systems identified as part of the study. Hand held fire extinguishers are removed from the aircraft and replaced with a new item or recertified by a suitably approved maintenance organization.

6.8.2 Aircraft Maintenance Organization Participants.

Table 7 shows the number of participating aircraft maintenance organizations in this study by geographical region.

Table 7. Number of Participating Aircraft Maintenance Organizations

Area	Aircraft Maintenance Organizations
Canada	1
USA	0
Europe	1

6.8.3 Certification Process.

The basic airworthiness concept requires that the aircraft is maintained using approved equipment. This would mean a TC Form 1, in Canada, an FAA Form 8130-3, in the USA, and EASA Form 1, in Europe. However, the situation in the US with respect to hand held fire extinguishers appears to be that an airworthiness release (FAA Form 8130-3) is not required in order for hand held fire extinguishers to be fitted to an in-service aircraft though it is required for other fire protection equipment.

6.8.4 Continued Airworthiness Management.

European Regulation (EC) 2042/2003 (reference 9) details the rules for continuing airworthiness and maintenance of aircraft subject to EASA regulation. In accordance with Part-M Subpart G, all EASA aircraft types that qualify for an EASA Certificate of Airworthiness (C of A) are issued with a non-expiring C of A validated annually with an Airworthiness Review Certificate (ARC).

As part of the ongoing maintenance program for the aircraft, the Continuing Airworthiness Management Organization (CAMO) has responsibility for tasking the maintenance activities that are to be conducted on any aircraft in accordance with an approved maintenance program. This obligation means that the quality of the work done and the equipment used in the maintenance program are regulated and controlled. The Airworthiness Review Certificate (ARC) process represents a further opportunity for the Continuing Airworthiness Management Organization (CAMO) to confirm the quality of work carried out on the aircraft including the pedigree of fire extinguishing and suppression system equipment.

The tasking provided by the CAMO is based on the approved maintenance program and these reviews are invariably limited to an overview of the quality assurance process and prior manufacturers' certifications. No supplemental testing of fire extinguishing or fire suppression agents against the relevant Standard specifications is conducted at this stage.

In North America, continuing airworthiness responsibilities are allocated within the airline operational approval.

6.8.5 Process Map.

A summary of the process for quality control of agent during aircraft maintenance is shown in figure 7:

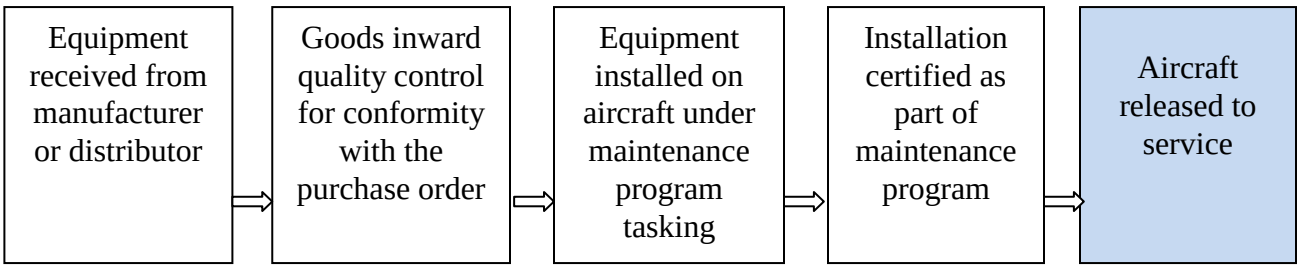

Figure 7. Quality Control of Agent During Aircraft Maintenance – Process Map

6.8.6 Discussion on Findings.

This study did not find any examples of on aircraft charging of fire extinguishing or suppression equipment. The aircraft maintenance organizations, therefore, rely on the receipt of equipment which has been previously certified as compliant with the purchase order. The equipment requirements will have been defined by the Maintenance Repair Organization's planning department or a tasking by the Continued Airworthiness Management Organization (CAMO), where applicable. There is no impact on the agent quality control process during aircraft maintenance.

However, there is some debate as to whether a hand held fire extinguisher carrying UL approval can be fitted to an aircraft registered in the USA, simply by virtue of UL approval only, rather than requiring an airworthiness release (FAA Form 8130-3). It is understood that UL oversight is related to new production activities only and, therefore, a UL tag is not available for equipment that has undergone maintenance. Therefore, in the case of a UL approved hand held fire extinguisher that has undergone maintenance and replenishment with agent, reliance cannot be placed on the serviced item conforming to the original specification since these maintenance activities will not be subject to further UL oversight.

6.8.7 Sector Specific Recommendations.

a) Consideration should be given to requiring hand held fire extinguishers that are to be installed on US-registered aircraft to carry an FAA Form 8130-3, or equivalent airworthiness release as opposed to any current reliance on a UL tag only.

b) The most desirable situation is that an EASA Form 1/FAA Form 8130-3, or equivalent airworthiness release be provided with all fire extinguishing and suppression equipment providing reference to the test certificate issued by the accredited test laboratory for the batch of agent used even where UL/ULC oversight is being conducted.

c) If a requirement for an EASA Form 1/FAA Form 8130-3, or equivalent airworthiness release is not to be imposed on all supplies of fire extinguishing and suppression equipment to the aviation market, consideration should be given to extension of UL oversight to surveillance of equipment maintenance activities on fire extinguishers and fire suppression equipment where appropriate.

6.9 QUALITY CONTROL OF AGENT DURING EQUIPMENT MAINTENANCE.

6.9.1 Introduction.

Organizations involved in the maintenance of fire extinguishing and suppression equipment within the aviation environment both in North America and Europe are accredited under Part 145 Maintenance Repair Organization or similar approval. The associated expositions and related procedures control the quality assurance activities which include maintenance of equipment to their respective Component Maintenance Manual (CMM). They are validated under a Certificate of Conformity or Airworthiness Release. CMMs will identify the Standard specification requirements for the fire extinguishing or fire suppression agent that must be achieved prior to release of a serviceable item of equipment.

6.9.2 Equipment Maintenance Organization Participants.

Table 8 shows the number of participating equipment maintenance organizations in this study by geographical region.

Table 8. Number of Participating Equipment Maintenance Organizations

Area	Equipment Maintenance Organizations
Canada	1
USA	2
Europe	2

6.9.3 Certification Process.

The provision of a data sheet and test certificate against the ASTM or ISO standard is provided by the supplier where the extinguishing agent is sourced externally.

When capability exists within an equipment maintenance organization for recycling the fire extinguishant, specifically halon gases, these are subject to sampling and certification activities. Some equipment maintenance organizations will subject each returned item to a halon identification test prior to transfer of the halon to a halon bulk storage container. In an example reviewed in this study, the bulk storage container is periodically sampled (e.g. every 2 weeks) and tested by an external test laboratory to confirm that the agent is within the parameters of the Standard specification used. Production items may be released from the facility in between periodic sampling. The study also found that such periodic sampling may be done on a calendar basis rather than based upon any particular status of the storage tank content.

The study found that new agent purchased from a supplier by equipment maintenance organizations is stored separate from agent that is targeted for the recycling process.

Equipment released from an authority approved maintenance facility will normally carry a TC/EASA Form 1, or FAA Form 8130-3, Airworthiness release. The study did not find any specific examples of maintenance organizations that did not carry an authority approval. However, a situation may exist in the USA where a company does not carry airworthiness authority approval even though the products they maintain may enter the aviation market. In this case, it appears that products released from such companies are reliant on the original UL tag even though there is no UL oversight of their maintenance activities.

6.9.4 Process Map.

A summary of the process for quality control of agent during equipment maintenance is shown in figure 8:

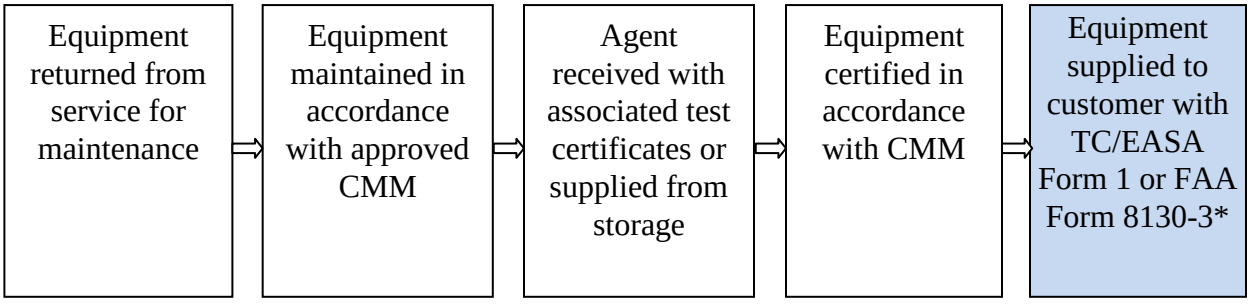

Figure 8. Quality Control of Agent During Equipment Maintenance - Process Map

* However, there may be exceptions to this release process as discussed in section 7.9.3.

6.9.5 Discussion on Findings.

The study found that a significant issue to be addressed is ensuring that fire extinguisher and suppression equipment with respect to the agent that have undergone maintenance are subject to the same quality assurance controls as those imposed on the original equipment manufacturer. In the USA, equipment in their OEM form may carry a UL approval but any subsequent maintenance by an organization will not be subject to UL surveillance. If, in such circumstances an airworthiness release (FAA Form 8130-3) for the equipment is not available, reliance cannot be placed on the serviced item conforming to the original specification because the organization doing the work would have no authority or UL accreditation for certified release of the serviced equipment.

6.9.6 Sector Specific Recommendations.

a) The obligation placed upon an equipment maintenance organization for quality oversight of the organization supplying the agent used to fill the equipment should be consistent with that placed on the original equipment manufacturer. This includes the requirement for analysis and a test certificate for the agent to be issued from an accredited test laboratory.

b) It is recommended that equipment maintenance organizations filling other manufacturer's equipment should have the same level of authority or UL/ULC oversight as the original equipment manufacturer.

c) Equipment maintenance organizations that have their own recycling facility should be accredited to provide the test certificates for the recycled agent themselves within their approval or seek an accredited third party test laboratory certificate.

d) Each batch (container) of agent intended for filling of equipment should have a discrete test certificate.

e) The most desirable situation is that an EASA Form 1/FAA Form 8130-3, be provided with all fire extinguishing and suppression equipment providing reference to the test certificate issued by the accredited test laboratory for the batch of agent used even where UL/ULC oversight is being conducted.

f) If a requirement for an EASA Form 1/FAA Form 8130-3, is not to be imposed on all supplies of fire extinguishing and suppression equipment to the aviation market, consideration should be given to extension of UL oversight to surveillance of equipment maintenance activities on fire extinguishers and fire suppression equipment, where appropriate.

7. GENERAL CONCLUSIONS.

The variety of manufacturing processes and commercial arrangements inherent in the industry in Canada, the USA, and Europe together with the fact that no on aircraft equipment charging is

conducted suggests that responsibility for purity of the fire extinguishing or fire suppressant agent should lie with the original equipment manufacturer or the filling or maintenance organization that places the agent into the specific equipment. As such, it is the original equipment manufacturer or filling/maintenance organization that should take responsibility for the securing a test certificate associated with the specific batch of agent for use within the production/maintenance of each item.

There appears to be no equivalent agency to Underwriters Laboratory Canada, or Underwriters Laboratory (USA) within the European quality assurance processes. The European authorities should consider whether surveillance of approved organizations involved in the manufacture of fire extinguishers achieves the same level of control as that is provided under the ULC/UL scheme in North America.

There are differences in how ULC and UL deal with or provide oversight for maintained equipment and consideration should be given to extension of UL oversight to surveillance of equipment maintenance activities on fire extinguishers and fire suppression equipment.

Sufficient information has been gained to enable the sector specific recommendations identified in each section of this report to be made. However, these recommendations should be the subject of additional review and a detailed cost/benefit evaluation.

8. SUMMARY OF PRINCIPAL RECOMMENDATIONS.

1. It is recommended that the obligation to control and confirm the acceptability of agent (whether new or recycled) which is contained in the equipment should fall to the original equipment manufacturer or any other organization responsible for filling equipment with the relevant agent. This includes the requirement for analysis and a test certificate for the agent to be issued from an accredited test laboratory.

2. Organizations filling other manufacturers' equipment should have the same level of authority or UL/ULC oversight as the equipment manufacturer.

3. There should continue to be no requirement for agent manufacturers to have any specific authority accreditation.

4. Test laboratories should be appropriately accredited directly by the authorities or by a nominated organization on their behalf such as UL/ULC.

5. Each batch (container) of agent intended for filling equipment should have a discrete test certificate.

6. A review should be conducted to establish whether the specification for halon purity required by the standards is unnecessarily stringent for airworthiness considerations, in particular, the water contamination limit of 10ppm. This may enable more efficient recycling of halon reserves with particular benefit to hand held fire extinguishers.

7. For quality control purposes, agent supplied from an agent manufacturer or recycling organization should be processed as if it were potentially contaminated prior to the securing a test certificate by the equipment manufacturer certifying purity against the relevant Standard specification.

8. Consideration should be given to requiring hand held fire extinguishers that will be fitted on US-registered aircraft to carry an FAA Form 8130-3, or equivalent airworthiness release as opposed to any current reliance on a UL tag only.

9. The most desirable situation is that an EASA Form 1/FAA Form 8130-3, or equivalent airworthiness release be provided with all fire extinguishing and suppression equipment providing reference to the test certificate issued by the accredited test laboratory for the batch of agent used even where UL/ULC oversight is being conducted.

10. If a requirement for an EASA Form 1/FAA Form 8130-3, or equivalent airworthiness release is not to be imposed on all supplies of fire extinguishing and suppression equipment to the aviation market, consideration should be given to extension of UL oversight to surveillance of equipment maintenance activities on fire extinguishers and fire suppression equipment, where appropriate.

11. The European authorities should consider whether surveillance of approved organizations involved in the manufacture of fire extinguishers achieves the same level of control as that provided under the ULC/UL scheme in North America.

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