Crop-specific Protocol
Potatoes

Effective 1st April 2014
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Preface

This crop specific protocol has been written to complement and avoid duplicating the generic principles of the Red Tractor Farm Assurance Fresh Produce Scheme and Appendices.

It is advisable to read the Red Tractor Farm Assurance Fresh Produce Standards and Appendices before reading this crop specific protocol.

This protocol is designed to stimulate thought in the mind of the reader and it contains crop specific parameters and guidance, where applicable, for the requirements stated in the Fresh Produce Standards.

Within this protocol the important requirements containing the words "must" (in bold type) will be verified during the Red Tractor Farm Assurance assessment and compliance will form a part of the certification/approval decision. Best practice requirements highlighted by the statement 'It is recommended that' will also be verified during the assessment but compliance will not be part of certification.

Any new standards have been prefixed in the text with (NEW)

Disclaimer and trade mark acknowledgement

Although every effort has been made to ensure accuracy, Assured Food Standards does not accept any responsibility for errors and omissions.

Trade names are only used in this protocol where use of that specific product is essential. All such products are annotated ® and all trademark rights are hereby acknowledged.

Notes:

Pesticide Information

The Red Tractor Fresh Produce Sector has been investigating ways of improving the service to members. Up to date information on plant protection products approved for use on the crops you grow is essential for your business. The Red Tractor Fresh Produce team has been working with Fera to provide tailored access to the LIAISON database for all Red Tractor Fresh Produce members. This system allows individual growers access to all information for plant protection products approved for use on the crops for which they are registered under the Red Tractor Fresh Produce Scheme. This information can be accessed directly via the Red Tractor Fresh Produce “Member services” page once you have logged in on the Red Tractor website at http://assurance.redtractor.org.uk/rtassurance/services.eb?goto=%2frtassurance%2fservices%2fpr_services.eb

A user manual has been produced for growers who are unfamiliar with the LIAISON system. This guide can be found when you log in to the Member Services page of the website. Searches will be filtered specifically for those crops for which members are registered and once a member has logged on to the site and clicked on the LIAISON hyperlink they will be directed to the LIAISON home screen.

This new service replaces the series of appendices which outlined all the registered pesticides available and cleared for use on that crop. The main disadvantage with the previous system was that as new approvals were granted or existing approvals revoked at any time, the lists in the appendices were effectively out of date as soon as the crop protocols had been published.

Members who do not have access to the internet and are therefore unable to access the LIAISON system can purchase paper copies of the most recent approvals for their crops at a cost of £25 per crop. Only credit card payment is acceptable. Members should contact Yvonne Powell-Wainwright on 01904 462613, stating their membership number, credit card details, name and address and the crop they are registered to grow to obtain the information they require, which will be posted to them the same day in paper form.

General Introduction

Following a systematic approach will help growers identify and manage the risks involved in crop production. This protocol is based on a typical crop production process and food safety, health & safety, environmental
and quality hazards are identified. Appropriate controls may then be established to minimise risk. Food safety
and health & safety issues always take precedent over quality and environmental controls.

The layout of this protocol follows the same structure as that used in the Red Tractor Farm Assurance Fresh
Produce Standards.

The content of the protocol is reviewed annually prior to the issue of updated editions. The review process
considers both new developments and all relevant technology which has emerged since the last review was
completed and which have been found to be both workable by the grower and beneficial to the environment.
The aim is to transfer such information and technologies to growers.

Acknowledgements

Red Tractor Farm Assurance Fresh Produce gratefully acknowledges the contribution of all consultees in the
preparation of this protocol, particularly the Potato Processors Association and David Hudson Potato
Services Limited. Thanks are also due to MG Consulting and the Potato Industry CIPC Stewardship
Group for work on the use of chlorpropham in potato stores.

SPECIAL NOTE FOR GROWERS SUPPLYING POTATO PROCESSING FACTORIES:

Most potato processing factories and certainly those represented by the Potato Processors Association
(PPA) will expect growers delivering potatoes to comply with and have completed the HACCP
documentation (PPA “bolt on” HACCP module) in the protocol appendix
CHOICE OF VARIETY OR ROOTSTOCK AND PLANT HEALTH CERTIFICATION (CV)

CV.1 Seed quality

The use of healthy seed can reduce the level of pesticides applied to the subsequent ware crop.

When selecting seed potatoes, growers should recognise the effect that location, health, management and handling of the seed crop have on the ware crop.

Growers should aim to purchase seed from seed producers within the Safe Haven Certification Scheme. The scheme offers strong protection from imported diseases such as ring rot.

CV.1.1 Planning seed purchase

Seed should be purchased on its quality rather than price alone. Early ordering will help secure better quality lots.

A good relationship with the seed supplier is essential. A direct dialogue between the seed and ware growers in all matters concerning the seed crop husbandry and treatments is important.

Seed should be supplied to an agreed production and tuber specification to suit to the intended ware market.

Seed suppliers should provide the following details:

- agent
- growers name and address
- date of tuber initiation
- tuber count
- date crop loaded in store
- details of all post-harvest chemicals and dates of application

Husbandry records of seed crop in field and store should be available to the ware grower on request.

CV.1.2 Seed Classification

Statutory seed classification can only be a very general guide to crop health.

CV.2 Seed treatments

All treatments should be discussed between seed producer and buyer. Fungicide use should be tailored to variety, seed health status and the intended market outlet for the subsequent ware crop. Judicious choice of fungicides for the seed crop can result in reduced need for chemical treatment of the ware crop. Fungicide treatments are not a substitute for sound husbandry.

CV.2.1 Application of fungicides to potato tubers

Most potato fungicides only protect against or suppress the development of disease and have no curative effect. Tubers should be largely free from soil so that the fungicide is applied directly on to the skin and target organism. The entire tuber surface should be covered by fungicide for effective control of silver scurf.

The British Crop Protection Council's (BCPC) leaflet “Guidelines for the effective chemical treatment of potatoes” 1991 and the SAC/BPC's Store hygiene cd 2004 are useful guides.

CV.2.2 Disease control in seed stocks

CV.2.2.1 Powdery scab (Spongospora subterranea)

Cultural control: The main methods of control are cultural (see Environmental Impact Section EC.3).

Chemical control: No completely effective chemical controls are available. There is an EAMU recommendation for fluazinam in seed crops.
CV.2.2.2 Stem canker/black scurf (*Rhizoctonia solani*)

**Cultural control:** Wider rotation and techniques to encourage early shoot emergence can reduce the effects of Rhizoctonia. See Environmental Protection Section EC.3

**Chemical control:** There are effective seed and soil treatments.

CV.2.2.3 Dry rot (*Fusarium spp.*)

See Environmental Protection Section EC.3.

**Cultural control:** Minimise tuber damage when handling and avoid excessive handling. Unfortunately, early harvesting which assists the control of other diseases can encourage Fusarium. Good skin set and appropriate store management will help prevent infection.

**Chemical control:** Seed tuber treatments can give reasonable control when they are applied at harvest. Some strains of *Fusarium* are resistant to thiabendazole.

CV.2.2.4 Gangrene and skin spot (*Phoma exigua* and *Polyscytalum pustulans*)

See Environmental Protection Section EC.3

**Cultural control:** Like many seed-borne diseases, gangrene and skin spot can be controlled by an integrated seed disease management strategy which involves:

- choosing drier, warmer seed production sites
- desiccating early with a fast acting chemical
- harvesting early and carefully in dry, warm soil conditions
- handling gently
- perhaps treating with a fungicide
- drying the crop thoroughly and keeping the crop dry
- curing properly
- storing at 4° C
- clean the seed store and containers prior to loading

Varietal susceptibility varies and this must be considered on certain seed production sites.

**Chemical control:** Chemical treatment is a small part of an overall control strategy for gangrene and skin spot.

Liquid fungicide sprays at store loading may help.

CV.2.2.5 Silver scurf (*Helminthosporium solani*)

See Environmental Protection Section EC.3

**Cultural control:** Strategies to control gangrene and skin spot will also help control Silver scurf. Cool (below 4° C) storage reduces the development of silver scurf. This may conflict with the need to sprout some seed.

**Chemical control:** If needed fungicides can be applied to seed stocks, either as soon as possible after lifting to prevent infection, or later to suppress sporulation and infection. Some strains of silver scurf are now resistant to thiabendazole.

CV.2.2.6 Black dot (*Colletotrichum coccodes*)

See Environmental Protection Section EC.3

CV.2.2.7 Blackleg (*Pectobacterium spp.*)

See Environmental Protection Section EC.3
Cultural Control: Current varieties vary in their susceptibility to blackleg. There are no guaranteed control methods for blackleg but seed producers and ware growers can minimise the risk of infection by adopting the following procedures:

- choose warmer, drier production sites for susceptible varieties
- stock seed (of known origin) should be stored cold and dry
- avoid poorly structured compacted growing sites
- plant in warm kind seed beds
- handle seed very gently
- fertilise correctly
- irrigate correctly
- desiccate early and completely
- harvest early on dry days and in good soil conditions
- positively dry the crop at store loading
- keep the crop cold and dry after curing, during transit and in store on the ware farm.
- Representative seed samples can be tested for blackleg bacterial loading. This test gives an indication of blackleg risk in the growing crop.

CV.2.2.8 Blackleg caused by Dickeya species

A new bacterial pathogen, Dickeya solani has emerged in Europe. It is a more aggressive but close relative of Dickeya dianthicola (used to be called Erwinia chrysanthemi). Seed stocks in Holland have been badly affected.

Specific control measures are yet to be developed but the controls listed above for Pectobacterium are appropriate for Dickeya. Seed is the most important source of infection and so careful seed sourcing is vital. The Safe Haven seed certification scheme will help growers avoid this new potato disease.

CV.2.2.9 Viruses

Virus diseases have to be kept at very low levels in seed crops. Virus control in seed crops involves isolation, roguing, aphid protection and early burn off. Aphicides are not effective in controlling non-persistent viruses like Potato virus Y.

Use of certified seed ensures low virus levels in the ware crop.

Home saved seed has no official inspection but the tubers can be tested for important viruses and other diseases.

CV.2.3 Grading facilities

Seed growers should have the ability to split the seed and ware fractions into store. At dressing out time it should be possible to split size the seed crop and where necessary spray the various fractions in a single operation.

Careful handling of warm (8-10°C) seed will prevent damage and disease.

CV.2.4 Harvesting dates

Early desiccation and harvest will significantly reduce the incidence of bacterial, fungal and viral disease.

CV.2.5 Inspection procedures

Official inspection of seed crops is mandatory but ware producers are encouraged to look at the growing and or stored seed crop.

CV.2.6 Storage of the seed crop

Many potato storage problems are the result of poor store management techniques. Good store management with close store monitoring will reduce the need for post harvest storage chemicals and ensure high storage out turns.
Good potato store managers will:

- only store potatoes which have adequately set skins, are relatively soil and damage free, have not been rained on and are unaffected by blight or blackleg
- monitor the store regularly, and record store temperatures and fan run hours from the date of loading
- dry and cure the crop as soon as it is loaded into store
- keep the crop at a steady holding temperature
- never tolerate condensation
- only handle potatoes gently at temperatures of at least 8°C
- only store the crop in clean buildings and containers

CV.2.7 Home-saved seed

Saving "seed" from ware crops with appropriate management and storage facilities can produce suitable quality seed.

Many ware potato buyers will not accept the routine use of aphicides to protect ware crops from virus.

Seed can carry and therefore spread nematode cysts. Growers using their own “seed” should consider the need to test their seed for cysts. Certified seed is only produced on potato cyst nematode free land.

SITE AND SOIL MANAGEMENT (SM)

SM.1 Site selection

Perfect potato sites and soils are rare and in practice a wide range of soils are capable of growing good crops of potatoes using appropriate management techniques such as de-stoning and de-clodding.

Field selection must involve a written assessment of the risk of hazardous foreign objects in the soil as well as an assessment of previous potato cropping, soil borne pests and diseases and weeds.

Free draining soils make management easier, alleviating planting and harvesting problems. Physical or chemical soil pans must be rectified to avoid rooting depth restriction.

Effective drainage systems and high soil organic matter will improve soil structure.

SM.2 Site history

SM.2.1 Environmental considerations

Sites for potato production should be selected with due consideration to conservation and the local environment. Consideration should be given to the compatibility of potato cropping with the existing conservation interest of the site particularly in the case of unimproved or semi-natural habitats.

Potato crops should not damage sites of archaeological interest.

Landowners have a statutory obligation under the Ancient Monument and Archaeological Areas Act 1979 to protect scheduled Ancient Monuments and Historic Buildings on their property.

SM.3 Rotations

SM.3.1 Crop rotations

SM.3.1.1 Pest and disease considerations

Wide rotations (at least 1 in 6 and preferably wider) are desirable. Close rotations can increase the risk of potato cyst nematode (PCN) and other soil-borne problems such as Rhizoctonia and Black Dot, which reduce yield and tuber quality.

SM.3.1.2 Double and continuous cropping
Double cropping and rotations closer than 1 in 5 will rapidly build up potato cyst nematodes, Rhizoctonia and volunteers. Other soil-borne problems (Black dot, powdery scab and Verticillium spp.) will also become a nuisance.

Continuous cropping should only be practiced with short season crops and in conjunction with special pest and disease testing.

Wider rotations, careful site selection, considered use of pesticides, targeted testing for particular pests and diseases and close crop monitoring should avoid over-heavy reliance on chemical control measures.

**SM.3.1.3 Weed considerations**

Most annual weed problems can be dealt within the potato crop. Perennial weeds are difficult to control in potatoes and can have detrimental effects on both yield and efficiency of harvesting. Perennial weeds should be controlled in previous crops.

**SM.3.1.4 Volunteer considerations**

Close potato rotations increase the risk of volunteer problems. Volunteer potatoes can act as carry-over hosts for many potato pests and diseases.

**SM.3.1.5 Volunteer potato control strategy**

Volunteer potatoes are very difficult to control in any crop but an integrated control strategy will help contain this problem:-

- grow potatoes in as wide a rotation as possible;
- lift potato crop early in kind soil conditions;
- leave as few small or waste potatoes in fields after harvest as possible;
- avoid or delay ploughing after potatoes;
- use glyphosate in cereal crops;
- consider the use of fluroxypyr in cereal and clopyralid in sugar beet.
- maleic hydrazide **should** only be used where market outlets permit **and** only if application conditions are ideal (this product leaves permissible residues in the tuber even when used according to the label);

**SM.3.2 Specific scientific predictive tests**

See - Environment Protection Section: EC.3.1.1 Potato cyst nematode (PCN), Free living nematodes (FLN), EC.3.1.2 Spraing (Tobacco rattle virus) EC.3.2.12 Spraing (Potato mop top virus) and EC.3.2.14 Wireworm. Soil tests are now available for Black dot and Rhizoctonia.

**SM.4 Soil management at planting**

Aim for a tilth as free of large clods as possible. Totally clod-free seed beds may depress yields and slumping of the ridges may occur. Current potato harvesters extract smaller clods and stones effectively.

_Excessive and or over deep cultivation is expensive, time consuming, damages soil structure and reduces yield. See Potato Council "Soil management for potatoes - updated 2012"_

**ENVIRONMENTAL PROTECTION & CONTAMINATION CONTROL (EC)**

**EC.1 The basic approach to crop protection**

**EC1.1 Integrated crop management**

**EC.1.1.1 Preparation of seed for planting**

The use of healthy seed will improve yield and crop quality and reduce the need for pesticide applications to the growing and stored ware crop.
Production systems for healthy seed combine the following good potato husbandry points:-

- in general select light soils in relatively warm, dry locations
- plant high quality stock seed into "kind" seedbeds
- destroy haulm early with fast-acting desiccants
- harvest gently in good soil conditions
- consider fungicide use at store loading and/or after curing
- once in store, dry the crop with forced ventilation
- cure the crop thoroughly
- store at a constant temperature avoiding condensation
- store in clean buildings and containers
- handle crop gently at temperatures over 8°C

EC.1.1.2 Physiological and chronological age of the planted seed

The optimum physiological and chronological age for seed will depend on variety, planting and harvest dates and intended market.

All seed should have open eyes at planting and should be cooler than the soil temperature. Avoid damage to the eyes (sprouts).

EC.1.1.3 Storage of seed on the ware growing farm

To keep seed in good physiological condition and to avoid disease development it is important to:-

- clean the seed storage building and containers
- avoid any unnecessary handling
- handle seed gently avoiding any sprout damage
- cure the seed if necessary
- store at a constant temperature
- avoid any condensation
- do not store seed in “big-bags”

EC.1.1.4 Lighting

For seed sprouted in trays or crates adequate light is required for sprout growth control.

EC.1.1.5 Fungicides

Fungicides to control seed-borne diseases can be applied by the ware grower pre-sprouting as a liquid over a roller table and/or as dusts or liquids on the planter. All seed fungicides can sometimes, for unknown reasons, have phytotoxic effects. Follow label instructions very carefully.

Choice of product, if any, depends on the intended market, previous products applied, the diseases found and likely problems.

Residues of seed fungicides are appearing in routine ware potato residue testing programmes. This may be due to “contamination” of potato boxes whilst in use as seed containers. Where possible don’t use seed boxes for ware potatoes and always inspect ware boxes prior to filling. Contaminated or dirty boxes must be cleaned before they are used for ware potatoes.

EC.2 Plant Protection Product Choice

Approved uses not included on the product label

In many circumstances, particularly for minor crops, product labels do not include all of the approved uses and growers wishing to check the approval notice of a particular product should note that this information is available using the LIAISON® search accessible via their RED TRACTOR Farm Assurance home page after logging in.
A search on the ‘Extension of Authorisation for Minor Use’ page of LIAISON® by crop or product name should yield a results page. A click on the product name should link to a summary of the approval information. Near the bottom of the summary is the specific off-label number (e.g. 0246/09) and this link will open up a pdf of the current EAMU document giving details of the extension of use.

EC.3 Pest, disease, physiological disorder and weed control

EC.3.1 Pest control

Integrated pest control systems ensure that chemical treatments are only used when absolutely necessary. Pesticide choice should be based on:

- identification of the pest and estimate of its likely damage
- use of non chemical control methods
- environmental considerations, including the presence of predators
- persistence of the chemical
- level of known resistance in the region
- prevention of resistance build up
- level of control required
- harvest date/interval
- previous chemical applications

EC.3.1.1 Potato cyst nematode (PCN)

PCN is the most important and most widely distributed pest of potatoes in the UK, affecting both yield and quality of potatoes.

Site selection

If PCN presence is suspected, fields to be cropped with potatoes need to be sampled and when possible the PCN species identified. Decisions about rotations, use of resistant and/or tolerant varieties and the need for chemical treatment can only be made on the basis of soil sampling and previous records.

Interpretation of soil sampling results

Nematicide treatment is usually recommended for "moderate" and higher PCN infestations (ADAS category).

For those in the "low" category, nematicide treatment is not advised unless:

- potatoes are grown in close rotation, or
- potatoes are grown on very light soils, or
- a variety very susceptible to PCN attack is to be grown, or
- *Globodera pallida* is present.

Integrated control

PCN is most effectively managed by integrating rotational control, chemical control and where appropriate, resistant varieties.

In the absence of potatoes PCN levels decline by 20-30% each year, depending on the species present and the site. This rate of decline may be even less where potato volunteers are present and so control of volunteers is important (see Site and Soil Management SM.3.1.5)

By using resistant varieties and nematicides rotations can be significantly reduced while still keeping PCN levels at acceptable numbers. However production systems based on rotations closer than 1 in 6 have to be planned and monitored very carefully.

Resistant varieties

Many commercial varieties have resistance to *Globodera rostochiensis*. Where such varieties have been repeatedly grown there has been a build up of *G. pallida*. This is a far more difficult species to control due to its slower rate of decline and its extended hatching period. Where possible, varieties should be chosen to avoid *G. pallida* becoming the dominant species.
At present there are no varieties with complete resistance to *G. pallida* but several have "partial" resistance. Unfortunately these varieties tend to be intolerant of PCN but will help contain PCN populations when used sensibly.

**Trap cropping** with *Solanum sisymbriifolium* (Sticky nightshade)

This relative of the potato has roots that stimulate the hatch of potato nematode cysts. *S sisymbriifolium* is a semi-tropical species and can be quite difficult to establish. There are no published results on its field efficacy.

**Chemical control:** Economic potato production will often require chemical control as part of an integrated control programme. Nematicide use depends on PCN numbers and species present, potato variety chosen, soil type and length of rotation. Accurate incorporation of nematicide granules, especially in stone and clod separation systems, is vital.

Operators applying nematicide granules must hold the appropriate NPTC PA4 qualification. Regular participation in the nematicide manufacturer's product stewardship programmes ensures the best use of nematicides.

**EC.3.1.2 Spraying (Tobacco Rattle Virus)**

The virus is restricted mainly to light sandy soils in which the free-living nematode vectors (stubby-root nematodes) are common. In some seasons susceptible varieties can be severely affected, with tubers being unacceptable for sale yet impossible to grade out.

Correct identification of "damage" is important. *Tobacco Rattle Virus* can be confused with *Mop Top Virus* and Internal Rust Spot. Reliable laboratory tests are now available.

**Site selection**

Soil sampling for the nematode vectors and previous experience of problems can give a guide to likely problems but laboratory soil tests can now identify the virus and provide a better assessment of risk. Fields with high populations of virus infected stubby-root nematode should only be cropped after careful choice of variety.

**Resistant varieties**

Varieties are known as "resistant varieties" (rarely infected and show no symptoms) "Spraying sensitive" varieties (show symptoms) and "Spraying susceptible" varieties (which may not show symptoms but can carry the virus). Resistant varieties can be useful on problem sites.

**Cultural control:** As the spraying virus infects many common weeds good weed control between potato crops may be helpful. Growing barley in rotation with potatoes on fields with a history of spraying may also help to reduce virus incidence. Choose seed and seed sources with care especially from sandy soils. A seed test on susceptible varieties could identify the virus and prevent its introduction to "clean" fields.

**Chemical control:** In fields with a known history of spraying, where nematode levels are high and the TRV virus has been identified do not crop with a "Spraying sensitive" variety even with chemical treatment. Nematicides only give a reduction in spraying symptoms with "Spraying sensitive" varieties.

Poorly managed "in furrow" application of granular nematicide may be a cause of tuber residues of nematicide. Staff operating nematicide application equipment should be appropriately qualified and attend refresher workshops on application technique.

**EC.3.1.3 Slugs**

Crops grown on heavy, cloddy soils or fields with a history of previous damage are most at risk from slug damage. Slug damage is often difficult to predict or reduce.

**Varetial susceptibility**

Select less susceptible varieties on slug prone sites.
**Cultural control:** Rotation, rainfall, variety, incorporation of organic matter, soil type and trash carry over from the previous crop all affect slug populations. The production of a fine soil tilth will suppress slug activity. Damage can be limited by lifting the crop as early as possible.

Parasitic nematodes are now commercially available as biological control but their efficacy on slugs in potatoes is not proven.

**Chemical control:** Whilst test baiting can give an indication of activity of slugs on the soil surface and may assist in accurate timing of application of slug pellets. Prophylactic treatment in high-risk situations may be appropriate.

Follow the Metaldehyde Stewardship Group Best Practice Guidelines to avoid contaminating ground water ([www.getpelletwise.co.uk](http://www.getpelletwise.co.uk)).

**EC.3.1.4 Wireworms**

Large wireworm populations occur only in permanent grassland but commercially significant wireworm damage is not unusual in crops grown on old arable soils.

**Site selection:** There is a high risk of wireworm damage to potatoes grown immediately after grass which has been down for 5 or more years; even in the 2nd, 3rd and sometimes 4th year after grass, wireworms can still be a problem. As chemical controls are only partially effective, cropping with potatoes after grass should be avoided.

Wireworm attack is also affected by bulk density and sand content of the soil, grass species diversity of the old sward and field aspect. However these relationships are not reliable enough to predict damaging populations.

**Cultural control:** The control of wireworms by cultural methods cannot be relied upon to prevent damage to potatoes grown soon after ploughing-in old grassland. However, once in an arable rotation, wireworm populations decline over a period of 3 to 4 years. Early harvesting may avoid some damage as the longer the crop is in the ground the worse the damage becomes. There are no resistant varieties but early bulking varieties may be ready to harvest before wireworm attack, usually in the late summer.

Buried, fresh carrot traps in the crop prior to potatoes may give an indication of likely wireworm problems in the potato crop.

Pheromone trapping may provide growers with a more accurate prediction of tuber damage. Adult beetles are trapped in the field the year prior to planting potatoes. The numbers of beetles caught can be related to the likely tuber damage in the following potato crop. However reliable catch thresholds are yet to be determined.

Intensive crop husbandry (lots of cultivation and generous use of crop protection products) in other crops in rotation with potatoes is often most effective in reducing and keeping wireworm populations down.

**Chemical control:** Soil sampling for wireworm larvae can be a guide to likely damage but it is certainly not reliable. Specially baited traps in the ploughed land may help guide the need for chemical treatment. Local knowledge and chemical control in crops previous to potatoes are important. The approved products give a reduction in wireworm damage, not control.

**EC.3.1.5 Cutworms**

Cutworm attacks can be severe, if somewhat sporadic. Serious damage is usually confined to un-irrigated, light land crops in Eastern England in long, hot, dry summers.

**Forecasting cutworm attacks**

Pheromone traps may be used to catch moths, but moth numbers are not a direct guide to correct spray timing. Spray timings should be based on dynamic models of egg and larval development (see the Horticultural Development Council www.hdc.org.uk). A minimum of 10 mm irrigation or rain, correctly timed, can give effective control of young cutworm larvae, and reduce the need for chemical treatment.
Cultural control: Backward and weedy crops are more prone to cutworm damage. Early planting, rapid establishment and effective weed control will minimise the risk of damage. Because young cutworms cannot survive in wet soil, frequent irrigation will help to prevent the development of damaging infestations. Irrigation can be timed to coincide with the presence of larvae in their first or second instar.

Chemical control: If a crop is considered to be at risk and irrigation or rain is not timely an insecticide should be applied according to local spray warnings.

EC.3.1.6 Aphids

In most years control of aphids on ware potato crops is unnecessary. However in some years heavy aphid feeding on the haulm can reduce yield and in a few varieties virus spread may be a problem.

Cultural control: Planting healthy, virus free seed from either classified seed crops or crops on which a virus test has been conducted will reduce the risk of virus spread in the ware crop.

Crop monitoring

Monitor ware crops regularly from May to July. Spraying will only be worthwhile if aphid numbers start to increase rapidly before end of July and if hot dry weather is forecast. Varieties susceptible to direct feeding damage may need to be sprayed a little earlier.

Chemical control: Before resorting to chemical control, take into consideration:

- location of crop
- over-wintering of aphid
- time of year
- aphid species and numbers present
- presence of aphid predators
- presence of bees especially when the crop has flowers
- recent weather patterns and weather forecast
- susceptibility of variety to aphid feeding damage
- importance of prevention of virus spread
- aphid resistance to chemicals

Feeding damage may be less of a problem than has generally been assumed and that the established threshold for feeding damage of 3 to 5 aphids per true potato leaf may be conservative for most varieties.

Aphid resistance and aphicide choice in ware crops

The Peach potato aphid, *Myzus persicae* can now be found with three different types of insecticide resistance. It is possible for some strains of *M. persicae* to have all three types of resistance which makes them immune to organophosphate, pirimicarb and pyrethroid insecticides. Organophosphate aphicides are no longer approved for potatoes.

The three types of resistance are esterase or E4, "Mace" and knockdown or kdr. The resistance mechanisms prevent certain insecticides from affecting the aphid.

There are newer insecticides that have no resistance problems yet acetamiprid (InSyst), flonicamid (Teppeki), pymetrozine (Plenum), thiacloprid (Biscaya) and thiamethoxam (Actara). Where an aphicide has to be used the choice should be based on:

- environmental considerations, including the aphid predators present
- aphid species in the crop
- persistence of the chemical
- level and type of *M. persicae* resistance in the region if known
- prevention of resistance build up
- level of control required
- where applicable the type of insecticide used for cutworm control in the potato crop and in other crops near the potatoes

Pyrethroid products kill more beneficial predators than aphicides from other chemical groups. *M. persicae* and grain aphids are now commonly resistant to pyrethroid insecticides. Pyrethroid products are best
Potato aphicides and their modes of action

<table>
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<th>Active ingredient</th>
<th>Chemical group</th>
<th>Mode of action</th>
<th>Resistance problems</th>
</tr>
</thead>
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<td>Aphox &amp; Phantom</td>
<td>pirimicarb</td>
<td>dimethyl carbamate</td>
<td>acetylcholinesterase inhibitor</td>
<td>Mace &amp; some E4</td>
</tr>
<tr>
<td>Actara</td>
<td>acetamiprid</td>
<td>nicotinoids</td>
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<td>pyrethroid</td>
<td>sodium channel modulator</td>
<td>Kdr &amp; some E4</td>
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<td>pyrimidine azomethine</td>
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<td>flonicamid</td>
<td>pyridine carboxamide</td>
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See also advice from the Insecticide Resistance Action Committee (IRAC) [http://www.irac-online.org](http://www.irac-online.org)

EC.3.2 Disease control

Introduction

Diseases should be controlled by the use of resistant varieties and cultural methods where possible. Chemical seed treatments can reduce disease incidence in the ware crop. If required, the choice of chemical to protect the ware crop should be based on:

- identification of the disease and estimate of likely damage
- environmental considerations
- persistence of the chemical
- level of known resistance in the region
- prevention of resistance build up
- level of control required
- harvest date/interval
- previous chemical applications
- varietal susceptibility
- market requirements

The role of potato volunteers or ground keepers

Volunteer potatoes can act as a soil reservoir for a number of potato diseases and pests. Every effort must be made to control ground keepers (see Site and Soil Management SM.3.1.5)

Intensity of rotation and previous cropping

Increasing the frequency of potato cropping, particularly for main crop or longer season varieties, will increase the risk from stem canker, black scurf, black dot, powdery scab and Verticillium wilt.

Cultivations

Impeded drainage can lead to bacterial rotting and powdery scab. Very deep planting in difficult soil conditions may increase the incidence of stem canker.
Irrigation

Irrigation applied at tuber initiation and for a further 4 weeks can reduce the severity of common scab. Excessive irrigation increases the risk from powdery scab, blackleg, black dot, pink rot, and creates conditions more favourable to late blight.

Harvesting

Early harvesting in good soil conditions is the most important cultural means of disease and quality control in the crop.

Early lifting of tubers with set skins reduces the incidence of silver scurf, skin spot, black dot, black scurf and bacterial rots. Late lifting increases the risk of tuber damage and poor fry quality. Avoid lifting tubers for storage with obviously scuffed skins.

Storage

Storage regimes are dictated by market outlet. Very low store temperatures (2 to 3°C) and inadequate curing increase the risk of skin spot and gangrene in susceptible varieties. Higher temperature (8°C+) storage favours the development of silver scurf, back dot dry rot, blight and bacterial rots.

Control of major diseases in ware crops

EC.3.2.1 Common scab (Streptomyces spp.)

Molecular testing techniques are confirming the presence of several different scab species or strains. Some of these scabs are not controlled by irrigation and thrive in acid soils.

Cultural control: Resistant varieties should be used when possible. Common scab is especially prevalent on light sandy soils, after old grassland and sometimes after heavy applications of lime. Carefully scheduled irrigation at and after tuber-initiation can reduce common scab on most varieties and soil types.

Chemical control: None is available.

EC.3.2.2 Blight (Phytophthora infestans)

Blight is the most important fungal disease of potatoes. Blight in the crop canopy can spread to the tubers resulting in marketing and or storage problems. The blight fungus is changing genetically and current strains are very aggressive and can develop very quickly in the crop if it is not protected by fungicide.

Several of the newer potato varieties are very susceptible to foliar blight.

Cultural control: Choose resistant varieties where possible.

Haulm growth on potato dumps must be destroyed with chemical desiccant or contained with black plastic sheeting. Ground keepers should be controlled. Seed stocks should be blight-free.

Depth of planting and ridge building should provide sufficient soil cover to minimise the risk of tuber infection from spores washing down from infected haulm.

Crops that are to be lifted green top are particularly vulnerable to tuber blight even if little foliar blight is visible. Crops with blight in the canopy should be desiccated and lifting delayed until at least 14 days after haulm death.

Blight forecasting techniques (Decision Support Systems) and electronic monitors can be used to determine optimum spray timings. Whilst these forecasting techniques are proving more reliable, they should be used in conjunction with local knowledge and experience to determine spray timings.

Chemical control: Blight cannot be eradicated once infection is present so fungicide sprays have to be prophylactic. Decision support systems can accurately predict blight spray timing and often reduce the number of sprays needed over a season.

Spray programmes start as plants begin to meet along the rows. If weather conditions conducive to blight
occur before the plants meet along the row, spraying must begin sooner.

Subsequent spray timings are dictated according to crop risk and disease pressure. Crops are considered low, medium and high risk according to locality, local blight pressure, weather conditions, cultural practice, variety and planting date. Potato blight spray programmes must use the minimum number of sprays necessary for good blight control.

The crop needs to be protected until the haulm is completely dead. Harvest should be delayed until 14 days after complete haulm death. Blight spray programmes should contain some fungicides known to protect against tuber blight and some fungicides with eradicant activity.

When blight is established in the crop it is still very important to follow the instructions on the fungicide label and adhere to good agricultural practice.

There are industry accepted phenylamide, Qol and Qil resistance strategies. Refer to the Fungicide Resistance Action Committee (FRAC) guidelines www.frac.info and product labels for specific details.

EC.3.2.3 Powdery scab (*Spongospora subterranea*)

Also see Choice of Variety Section CV.2.2

The disease is both seed and soil-borne. Spores of the fungus persist in the soil for many years. The fungus causes skin blemishes, or gross tuber distortion and it is a vector for potato mop top virus.

**Cultural control:** Powdery scab is often more serious when the soil moisture level fluctuates through the growing season. Compaction and poor drainage can also favour the disease. The disease risk is high on heavily irrigated light sandy soils.

Irrigate with a scheduling scheme to avoid over-watering.

Select a resistant variety on "problem" sites. Avoid obviously infected seed, although the relationship between disease levels on the seed and that on the ware crop is not straightforward.

**Chemical control:** No reliable chemical control is available.

EC.3.2.4 Stem canker/black scurf (*Rhizoctonia solani*)

Stem canker can be damaging in early crops where vigorous, early growth is needed for early bulking of the tubers. In main crops stem canker has a variable effect, according to the ability of the crop to compensate. Black scurf on the tubers spoils the appearance of the skin. Soil borne inoculum seems to be an increasing problem.

**Cultural control:** The fungus is seed and soil-borne. Short rotations should be avoided to prevent a build-up of *Rhizoctonia* in the soil.

Plant seed free of black scurf if possible. Techniques that ensure rapid plant emergence will reduce the incidence of stem canker. Late harvesting and or delayed lifting of skin set tubers encourage black scurf development on tubers in the soil.

**Chemical control:** Seed with obvious black scurf may benefit from fungicide treatment. Fields with soil infected by *Rhizoctonia* can be treated with a soil fungicide. Eye plug testing of seed and soil tests for *Rhizoctonia solani* may help determine the need for fungicide application. Operators applying the fungicide dusts and sprays must have the appropriate NPTC PA qualification.

EC.3.2.5 Dry rot (*Fusarium spp.*)

Also see Choice of Variety Section CV.2.2

**Cultural control:** Good skin set, gentle handling and rapid temperature pull down after curing should reduce incidence of dry rot. Very early harvesting in dry, warm soils is conducive to dry rot.

**Chemical control:** Fungicides applied at store loading can be effective but thiamethoxam resistant strains of *Fusarium* spp. are known to exist. Permissible thiamethoxam and or imazalil residues can be detected in potatoes that have been correctly treated with these fungicides. Some markets will not use potatoes treated
with thiabendazole or imazalil.

EC.3.2.6 Silver scurf (*Helminthosporium solani*)

Silver scurf is found on most seed tubers. It is an important skin blemish of stored potatoes for washing and pre-packing.

**Cultural control:** Crops should be desiccated early, lifted promptly, dry cured once in store, and then rapidly cooled and stored below 4°C. Low temperature storage can increase reducing sugar levels in the tubers which may affect their suitability for certain markets.

Stored crops should be inspected regularly for disease development. The disease seems to develop slowly on some varieties.

**Chemical control:** Seed treatments, in conjunction with cultural measures, can help control the disease.

Ware crops may be treated with thiabendazole and or imazalil at lifting but control may be disappointing if spray application is uneven or if thiabendazole resistant strains are present. Permissible residues of thiabendazole and imazalil can be detected in potatoes that have been correctly treated. Some markets will not use potatoes treated with thiabendazole or imazalil.

EC.3.2.7 Black dot (*Colletotrichum coccodes*)

Black dot is primarily a soil-borne disease that frequently develops on stems bases and roots. More worrying and costly however is the appearance of black dot on tubers destined for washing and pre-packing.

**Cultural control:** Choose less susceptible varieties and fields which have not had a long history of potatoes when ever possible. Early lifting, dry curing and rapid cooling to 3°C can reduce black dot development. The disease is a particular problem on irrigated peaty soils. Close rotations encourage black dot. Avoid obviously infected seed.

**Chemical control:** Fungicide soil and seed treatments can be used in conjunction with cultural control methods to avoid black dot on pre-packing potatoes. Soil testing for Black dot is now available and may help assess the need for fungicide use. Operators applying seed and or soil fungicides must have the NPTC PA qualification.

EC.3.2.8 Skin spot (*Polyscytalum pustulans*)

Also see Choice of Variety Section CV.2.2

Skin spot is primarily a seed-borne disease. Infected tubers can be unsuitable for pre-packing or give peeling problems to potato processors.

**Cultural control:** Use skin spot free seed from a known source. Lift crops early, dry cure and ensure complete healing of wounds. Do not apply chlorpropham (CIPC) before the crop is properly cured. Stores should be monitored frequently and if the disease is found, the crop should be marketed promptly. Low temperature storage and CIPC treatment may exacerbate the disease.

**Chemical control:** Fungicides applied at lifting may help control skin spot. Thiabendazole resistance has been found but its effect on control is not known. Permissible residues of thiabendazole and or imazalil can be detected on correctly treated tubers. Some markets will not use potatoes treated with thiabendazole or imazalil.

EC.3.2.9 Blackleg (*Erwinia now Pectobacterium spp.*)

Blackleg in ware crops is related to initial bacterial loading of seed, varietal susceptibility, seed storage conditions and soil conditions and temperatures at and after planting. High physiological age, very early planting in poor soil conditions and handling damage to seed tubers also encourage disease development.

*Erwinia chrysanthemi* (now called *Dickeya dianthicola*) another type of black leg has been seen in recent years. Yet another new bacterial pathogen, *Dickeya solani* has emerged in Europe. It is a more aggressive but close relative of *Dickeya dianthicola*. Seed stocks in Holland have been badly affected and down graded.
Most \( D. \text{ solani} \) infections in the UK seem to be associated with imported seed. Control measures are the same as those for black leg.

**Cultural control:** Blackleg control in ware crops follows the guidelines given in Section CV 2.2.7. The Safe Haven seed certification scheme will help growers avoid \( D. \text{ickeya solani} \). Bacterial loading tests of seed tubers can be a guide to possible problems.

**Chemical control:** None is available.

**EC.3.2.10 Other bacterial soft rots in store**

These rots frequently develop after late, wet, cold harvests especially if tubers are badly damaged. Tubers lifted with (often unnoticed) infections of some soil-borne fungi or tuber blight usually develop soft rots.

**Cultural control:** Harvest early in good soil conditions. Don’t long term store “rained on” loads or crops with tuber blight or other soil-borne fungi. Suspect crops should not be cured but thoroughly dried, cooled quickly and sold early.

Avoid condensation on tubers in the store. Close store monitoring will identify the development of soft rots.

**Chemical control:** None is available.

**EC.3.2.11 Aphid-borne viruses**

See Choice of Variety Sections CV.2.2

**EC.3.2.12 Spraing (Mop Top Virus)**

Potato Mop Top virus is carried by the powdery scab fungus. Damage by MopTop Virus is unusual. Control is difficult but some varieties are tolerant of the virus. The moptop virus “spraing symptoms” in the tuber are similar to damage caused by Tobacco Rattle Virus and internal rust spot. A tuber laboratory test is available that can confirm the precise cause of the damage. The test results ensure appropriate management of the disease.

**EC.3.2.13 Pink rot (Phytophthora erythroseptica)**

Pink rot is a soil-borne fungal disease that is usually “overtaken” by secondary bacterial soft rots.

**Cultural control:** Pink rot is favoured by wet soil conditions at the end of a hot dry summer. Over-irrigation, poor drainage and soil compaction are also implicated. Avoid growing potatoes in fields where pink rot has occurred.

**Chemical control:** None is available.

**EC.3.2.14 Verticillium wilt**

This is a common soil-borne disease that is not fully understood. In some seasons its presence accelerates crop senescence. The combined effects of PCN damage and Verticillium spp. invasion can be serious.

**Cultural control:** Varieties that are susceptible to stress may be more sensitive to Verticillium attack. Disease risk is increased by frequent potato cropping, poor soil structure, high levels of PCN, water stress and growing other Verticillium susceptible crops such as peas, linseed or strawberries in the rotation.

**Chemical control:** None is available.

**EC.3.2.15 Watery wound rot, violet root rot and rubbery rot**

All these diseases are soil-borne fungi and their incidence is sporadic and not usually important.

**Cultural control:** The watery wound rot fungus enters wounds made at harvest. Cool dry storage with little curing can suppress the disease in store if the problem is identified soon enough.
Violet root rot also affects carrots and sugar beet. Avoid fields where severe attacks have occurred in the past.

Rubbery rot can be a problem after over-irrigation or heavy rainfall on poorly structured soil.

Chemical control: None is available.

EC.3.2.16 Botrytis rot

This fungus may invade senescing or damaged haulm, especially during wet weather at the end of the season. On rare occasions tubers can be infected and a firm, dry rot develops during storage. No chemical treatment is available.

EC.3.2.17 Early blight (Alternaria solani and alternata)

Early blight is now seen quite widely in the UK. It is poorly controlled by late blight fungicides and so can be damaging. Some newer varieties seem quite susceptible to this disease. Visual identification of Alternaria spp. is difficult and can be confused with several other disorders.

See: “Discussion of potato early and late blight fungicides, their properties and characteristics.” Bradshaw NJ 8th Workshop of a European Network for Development of an integrated control strategy for potato late blight September 2004.

Chemical control: There are approved fungicides but spray timings and efficacy are not yet proven.

EC.3.2.18 Sclerotinia stalk break

Sclerotinia is a fungus that attacks a wide range of arable crops. Infection of potatoes is not common but the disease is seen in wetter seasons especially in Northern Scotland. Potatoes in rotation with rapeseed and beans may be at greater risk. There are no cultural or recommended chemical controls for ware crops.

EC.3.3 Physiological disorders

There are no chemical measures that give consistent or reliable control of these problems.

EC.3.3.1 Internal rust spot

Crops grown on light sandy soils in warm dry seasons seem to be most prone to this physiological problem. Varieties differ in their susceptibility to rust spot. It is difficult to distinguish between rust spot, tobacco rattle virus and potato mop top virus. Laboratory tests are available (see 3.1.2 and 3.2.12).

EC.3.3.2 Glycoalkaloid accumulation

To prevent high levels of these naturally occurring, poisonous compounds developing in the tubers, avoid over exposure to light or stress. For example, ensure good ridges are formed in the field; at lifting potatoes should be removed from the field as soon as possible and damage kept to a minimum. During storage and grading potatoes should not be left exposed to light for unnecessarily long periods.

EC.3.3.3 Pit rot

Pit rot is a poorly understood but sometimes quite serious disorder of tuber lenticels. Stores should be kept dry and well ventilated to prevent pit rot.

EC.3.3.4 Chilling injury

To avoid the possibility of internal flesh or vascular discoulouration potatoes should not be stored below 0°C. Temperatures below -2°C will freeze potatoes.
EC.3.3.5 Blackheart

Potatoes stored at normal temperatures should not be susceptible to oxygen starvation that causes blackheart. Problems can occur in well-sealed or infrequently ventilated refrigerated stores.

EC.3.3.6 Growth cracks, secondary growth, hollow heart, internal browning and misshapen tubers

Also see Irrigation Section IG.4.5.

Crops with steady tuber growth rates are usually free of these problems. A regular and even water supply is thought to be important in avoiding these disorders. Varietal susceptibility to each of these faults varies and choice of variety must be carefully matched to the site.

Crop desiccation in relation to rainfall following a drought can sometimes be timed to avoid the development of second growth in the tubers.

Correct seed spacing and timely haulm destruction will reduce oversized, cracked and hollow-hearted tubers. The causes of internal browning are not understood.

EC.3.3.7 Enlarged and "star-cracked" lenticels

Also see Irrigation Section (IG).

Cultural control: Carefully managed irrigation and cultivation will help avoid enlarged lenticels but very wet soils late in the season do induce the problem. Some varieties are known to be susceptible.

EC.3.3.8 Jelly end rot

Scheduled irrigation will help control jelly end rot.

EC.3.4 Weed control

Effective weed control protects yield, eases harvesting and minimises tuber damage.

Cultural aspects

Herbicide programmes have largely superseded traditional inter-row cultivations. Cultivations can damage the growing crop and may create clods. However well-timed shallow cultivations are commonly and successfully used on lighter soils.

An integrated weed control strategy involves:

- careful seedbed preparation, residual herbicides don't work well on cloddy soil
- ridging and inter-row cultivations where and when appropriate
- choice of appropriate herbicide
- planting healthy seed in good soil conditions to speed the development of a full canopy
- maintaining a complete crop cover for as long as possible
- controlling perennial weeds in previous crop

Choice of herbicides

The factors to be considered when selecting a potato herbicide are:

- weed spectrum
- soil type
- variety
- previously applied herbicides
- post potato crop cultivations
- following crop considerations and requirements
- crop growth stage
- choice of follow up chemical treatment
EC.3.5 Chemical haulm desiccation
Desiccating haulm speeds tuber skin set, prevents disease spread from the haulm to tubers, eases mechanical harvesting and controls tuber size. Chemicals vary in the speed with which they kill the haulm but speed of skin set is similar for all correctly used desiccants. The crop needs to be protected against blight until the haulm is completely killed.

EC.3.5.1 Mechanical haulm removal
Careful crop flailing can reduce the use of chemical desiccants. Mechanical haulm destruction techniques were thought to spread diseases within the crop canopy but this does not appear to be a problem. Haulm regrowth may be a nuisance but is easily managed.

EC.4 Nutrient requirement
Fertiliser application should be based on:
- soil analysis
- anticipated soil nitrogen availability
- potato crop response to individual elements
- variety
- time and duration of crop growth
- organic manure application
- market outlet requirements (e.g. dry matter or cooking quality)
- crop off-take information

Fertiliser recommendations and organic manure values are given in Potato Council (AHDB) “Crop nutrition for potatoes 2009” and DEFRA RB 209 Fertiliser Recommendations 8th ed. 2010.

Nitrogen
Excessive amounts and ill-timed applications of nitrogen can adversely affect crop performance and may be leached from the soil.

Organic manures and composts
Applications must be made in accordance with the DEFRA “Protecting our Water, Soil and Air, A Code of Good Agricultural Practice for farmers growers and land mangers” and the requirements in Nitrate Vulnerable Zones. Application of nitrogen in organic manures should not exceed a total of 250 kg/ha. This figure is lower in nitrate vulnerable zones.

The nutrient content of any organic manure applied must be taken into account in deciding inorganic fertiliser policy for the field.

See “Making the most of organic manures for optimum results and cost savings” BPC 2000.

“PAS 100:2011 Specifications for composted materials” and “Quality compost: benefits to potato production and soil quality” both at www.wrap.org.uk

The use of any domestic or industrial wastes as nutrients or soil conditioners should be discussed with end users of the crop. ADAS and SAC’s “Safe Sludge Matrix” provides guidelines on the use of sewage sludge.

IRRIGATION (IG)

IG.1 Predicting water requirement
Irrigation of potatoes has a great influence on tuber yield and quality. Accurate irrigation scheduling, in conjunction with weather forecasts, is essential to achieve the yield and quality the market demands, conserve water and to avoid disease and soil structure problems.
IG.2 Irrigation method

Where appropriate the use of soil moisture measurement devices, beds, tied ridges, booms and trickle systems will conserve water and reduce disease risk.

IG.3 Quality and supply

Where the annual irrigation water risk assessment indicates a risk of impurities in irrigation water, samples should be analysed for these contaminants.

IG.4 Quality aspects of irrigation

IG.4.1 Common scab

Common scab may be controlled by keeping soil around the developing tubers near to field capacity for 4 weeks after tubers begin to form. Maintaining such low soil moisture deficits (SMDs) requires frequent applications of small amounts of irrigation.

IG.4.2 Powdery scab

Irrigation regimes to minimise common scab increase the risk of powdery scab. Fields with a history of powdery scab should be irrigated very carefully and should be planted with a resistant variety (see Environmental Protection Section EC.3).

IG.4.3 Potato blight

Irrigated crops have to be considered vulnerable to potato blight and fungicide protection programmes should be planned accordingly (see Environmental Protection Section EC.3).

IG.4.4 Blackleg

Irrigation can create soil conditions favourable for the development of blackleg. Irrigation scheduling systems will help reduce these risks.

IG.4.5 Tuber quality parameters

Well-planned irrigation improves skin texture, tuber size and shape by avoiding large fluctuations in soil moisture. Careful irrigation management should reduce growth cracking, secondary growth, hollow heart, enlarged lenticels and jelly end rot.

IG.4.6 Irrigation stop dates

Irrigation stop dates will depend on crop cover, tuber size, maturity, soil type and moisture content, disease levels and the weather forecast.

HARVEST AND STORAGE (HS)

HS.1 Time of Harvest

Late harvesting is one of the biggest causes of loss of tuber quality. High quality crops that store well need to be lifted before soils become too wet and cold. For processing crops tuber dry matter and sugar levels may determine desiccation dates.

HS.2 Staff motivation and careful tuber handling

Poor harvesting and handling techniques cause bruised and damaged tubers that are the commonest quality problems in the industry. All growers should ensure that personnel and equipment involved in harvesting and handling the crop operate to the highest standard possible.

Sophisticated potato handling equipment needs sensitive, properly trained and well-motivated operators.
Through their training and management all staff will appreciate the nature and implications of potato damage and bruising.

**HS.3 Training**

a. The entire potato harvesting and handling staff should be trained or briefed annually on the importance of damage and how they can affect it.
b. Operators should receive specialist training on their machine, its correct operation and various adjustments.

**HS.4 Machinery**

Despite the excellent design of modern potato equipment, potatoes will still be damaged if the machinery is not operated correctly. To keep damage to an absolute minimum the following points should be followed closely:

- constant monitoring of machine settings and tuber damage to ensure optimum performance in the prevailing conditions.
- regular maintenance to ensure any potentially damaging features are eliminated.
- all machinery used needs to be compatible

**Potato damage monitoring techniques**

Regular damage monitoring and use of electronic potatoes will help reduce damage and reinforce staff commitment to careful crop handling. Monitoring must include sample washing to assess skin set and tuber surface damage as well as hot boxing and peeling to check for bruising.

**HS.5 Hygiene**

Members should ensure their potato crops are handled and stored to avoid contamination, damage or exposure to anything likely to affect their food quality.

Risk assessment controls must include records of:

- harvesting trailer cleaning
- potato store maintenance and cleaning
- where appropriate potato box checking, maintenance and where necessary cleaning
- potato grading staff briefings on hygiene standards and security of their personal belongings
- daily glass, grading equipment and plastics check
- pre-harvest potato field risk assessments

See appendices for examples of supporting documents for the above requirements / records

**HS.6 Post-harvest treatments**

**HS.6.1 Store management**

The store manager or crop owner is expected to have sole responsibility for the management of the store and any pesticide application to the stored crop.

Also see Choice of Variety Section CV.2.6

**Curing**

Curing to suberize or heal wounds reduces disease development and dehydration. Temperature and humidity affect the rate of curing.

"Dry curing" can reduce skin diseases and rots. It involves keeping the potatoes at about 12°C for about 10 days and ventilating each day with "dry" air for several hours to reduce humidity in the store.

Wet tubers and those suspected to be infected by blight and or blackleg are a special storage risk and need to be thoroughly dried, probably not cured, rapidly cooled, monitored closely and sold early.

**Storage temperature**
Properly insulated and ventilated stores will keep high quality potatoes well into the New Year. For longer term storage refrigeration is required to satisfy the rising quality standards of most outlets.

Optimum crop storage temperature depends on market outlet. Lower temperatures minimise silver scurf and sprout development but may encourage some diseases and can spoil fry quality

**HS.6.2 Post-harvest treatments**

**Storage chemicals**

The application of storage chemicals can be minimised or even avoided by use of an integrated seed, harvest and store management strategy. The use of chemicals for disease or sprout control will depend on the crop's growing conditions, storage regime, disease risk and time of store unloading.

Treatment with some potato storage chemicals is unacceptable to certain market outlets. Growers should check that their market will accept treated potatoes before treatment. All storage chemicals when applied correctly will leave detectable residues well within maximum residue limits. However some potato buyers prefer potatoes with very low or no detectable pesticide residues.

The use of chemical suppressants in many potato stores is still necessary. Current processing potato varieties cannot be stored at low temperatures or treated with ethylene and then fry or cook acceptably.

Non-processing potato crops can be stored for long periods without suppressants, using low temperatures.

Ethylene and crop oil treatments are now available for controlling sprout growth in low temperature non-processing stores.

**Application of storage chemicals**

All storage chemicals must be used according to the instructions on the label and as recommended in Defra’s “Code of practice for using plant protection products”. The Potato Industry CIPC Stewardship Group’s "Be CIPC Compliant" web site (www.cipccompliant.co.uk) gives practical guidance on CIPC use on potatoes.

**Application of CIPC (chlorpropham) sprout suppressant**

CIPC should only be applied once the crop has been properly cured and before any sprouting begins.

Food (cereal, rape or onion) and seed crops SHOULD NOT be stored in buildings where CIPC has been used.

**Advice on the use of CIPC**

Any advice to use CIPC on stored potatoes must (like any other crop protection product) come from a BASIS qualified adviser who is also a member of the BASIS Professional Register and has read the Scheme standards and agrees to advise on pesticide use in compliance with the standards (see "Fresh Produce Standards” 1.10.11, S.C. 1.5.)

**Guidelines for the use of CIPC in potato stores**

CIPC is a very important post-harvest product that is frequently found as a tuber residue in fresh market and potatoes for processing. These residues are usually low, within the MRL and are no risk to consumer health. To ensure safe and effective use of CIPC, store managers and their CIPC contractors or farm application operatives must be able to demonstrate responsible and minimum use of this product.

To achieve safe, even and effective application of CIPC, the following points and procedures must be implemented:

- Store managers must demonstrate that the least amount of CIPC for effective sprout control has been used.
- Store managers should plan their storage to ensure that only crops that need CIPC are treated and that only crops that need multiple treatments are treated as such. For example stored crops
should, whenever possible, be segregated by dormancy characteristics, variety and duration of storage to avoid any unnecessary CIPC applications.

- CIPC applications must only be carried out by specialist contractors who are members of the National Association of Agricultural Contractors "Applicator Group" or fully trained, qualified and experienced farm staff using appropriate equipment. Store managers / owners should only use CIPC contractors and operators who hold the new BASIS potato storage module.

- Whether applications are carried out by farm staff or specialist contractors the store manager must be able to provide documentation showing complete traceability of all aspects of each CIPC application. See appendices for an example of a CIPC application record sheet.

- Whether applications are carried out by farm staff or specialist contractors the operators must be experienced, trained, fully qualified (PA1 and PA9) and registered with NRoSO with records to prove this. (CFP)

- The CIPC application equipment must have a valid test certificate from an independent sprayer certification scheme such as NSTS. Certification, service and calibration records must be available for inspection. (CFP) Contact the National Sprayer Testing Scheme (NSTS) for current information on CIPC application equipment testing.

- Where CIPC is applied by contractor the store manager / crop owner must have an appropriately signed Contractors Commitment Document (see "Fresh Produce Standards" 1.10.2011, pages 62-63).

- Store managers must keep a current list of all their stores (owned and or rented) where CIPC is used.

- CIPC treated buildings should be clearly labelled with a permanent notice indicating CIPC has been used.

- Each store must have a signed and satisfactorily completed "Store Checklist" accompanying the last CIPC application (see critical control points).

- Completed Store Check lists and BASIS adviser's recommendation sheets should be available to the CIPC application contractor.

- Only approved formulations of CIPC can be used (CFP)

- Statutory and general label instructions and harvest intervals must be adhered to. (CFP)

- Full safety equipment should be on hand during CIPC application.

CIPC application techniques that can improve CIPC distribution and may help reduce the quantity of CIPC used and keep tuber residues of CIPC to a minimum.

1. Application and where necessary re-application timing.

   The store manager should ensure that the first application of CIPC is made after the crop is cured but before sprouts appear. Once properly cured, refrigerated stores (target holding temperature 3°C) are probably best treated BEFORE they reach their holding temperature. This action must be supported with a formal recommendation from an appropriately qualified (BASIS) adviser. Late first applications of CIPC always result in extra, unnecessary applications.

   The store manager must be responsible for identifying fresh or active sprout re-growth and the need to re-apply CIPC only when it is required

2. Product selection and dose rates applied.

   Store managers with their qualified advisers must be responsible for selecting and following the label dose rates. There may be circumstances where lower rates are appropriate.

   The maximum dose rates of CIPC (from any label, or any combination of labels):

   i. Total amount for fresh market is 36 g active substance / tonne
   ii. Total amount for processing markets is 63.75 g active substance / tonne

   The total quantity of active CIPC applied to any lot of potatoes should be declared at the point of sale

3. Crop temperatures.

   Close crop temperature control and keeping the crop at its minimum holding temperature will improve sprout control and reduce the number of CIPC applications.

   Using the recirculation fans prior to CIPC application will even out crop temperatures in the store and improve distribution of the sprout suppressant.
Do not raise the temperature of refrigerated stores prior to application of CIPC. But turn off the fridge plant and leave the re-circulation fans running for 6 to 12 hours PRIOR to CIPC application.

4. **Box stacking patterns and CIPC application ports.**
Box layouts for best air circulation will improve CIPC distribution. Pallet apertures should be aligned and boxes should never be stacked tight to walls. Stacking around the store door should allow air to return through the crop to the recirculation louvres or fridge unit.
Store managers should discuss box layout and positioning of application ports with their CIPC contractor or operator.
Fog should be delivered into the store unhindered and never be directed at the crop, boxes or walls.

5. **Bulk stores**
Bulk stores should only be treated with CIPC if the fog can be re-circulated continuously through the stack using a variable frequency drive to control the fan speed. This technique reduces CIPC use and improves sprout control.

6. **Part filled stores.**
Whenever possible avoid treating part filled stores. Failing this try to contain the part store in a lesser air space (see the Store Check List "Empty air space in stores")

7. **Store leakage.**
Leaky stores produce unwanted "fog drift" resulting in reduced doses, unnecessary repeat applications and environmental contamination. The store manager is responsible for excessively leaky stores. The CIPC applicator should alert the store manager of leaking stores.

8. **Application equipment and fog quality.**
The CIPC fogging equipment must be set to produce a dry "friable" fog. There must be no evidence of CIPC puddles or heavy crystalline deposits in the store. These are indicators of inadequate application technique.

CIPC residue testing.
Owners of CIPC treated crops are encouraged to test their own crops for CIPC tuber residues. Recognised sampling procedures should be adopted (see Potato Industry Stewardship Group "Guidelines for obtaining a potato sample for CIPC residue testing")

**Records of each CIPC application.**
Store managers **must** be able to provide records for each CIPC application to all treated stores (CFP)
See appendix for an example of a suitable record sheet
The date and name of the person requesting and or formally advising CIPC application.

1. The CIPC product name, MAPP number and dose.
2. The reason/s for the timing and dose of the application.
3. A declaration when the store may be re-treated with CIPC and when the crop may be moved from the store for sale or processing.
4. Confirmation of recognition of the date/s of all previous applications.
5. Confirmation that all application intervals have been observed.
6. The length of time the application took.
7. Any problems or irregularities that were noticed during application, for example, excessive store leaks, temperature gradients in the store, and inadequate "draw" of fog into the store, any CIPC spillage, and any difficulties in producing the fog.
8. Batch number/s of the product/s used.
9. Confirmation of the tonnage treated and volume (active substance) of CIPC used.
10. Store managers must be able to produce a record of the total CIPC active substance applied to each "lot" of potatoes on hand and at the point of sale
11. Where CIPC applications exceed 36g/tonne of active substance, crop owners **must** point out to
buyers that the potatoes can only be used for commercial processing.

RESIDUES AND CONTAMINANTS (RC)

Growers and advisers must keep tuber residues to a minimum. This issue is not simply meeting the MRL trading standard but ensuring that any individual or multi-residues are kept as low as possible.

The key targets are -

- Optimising late applications of crop protection products to the tuber.
- Optimising the use of all post harvest treatments
- Ensuring minimum harvest intervals are followed
- Ensuring application equipment is working correctly and that application techniques follow product label guidelines

The commonest pesticide residues found in potato tubers are: CIPC (chlorpropham), maleic hydrazide, imazalil and thiabendazole. Recently residues of azoxystrobin (Amistar), fosthiazate (Nemathorin), oxamyl (Vydate), pencycluron (Monceren) and propamocarb hydrochloride (found in Consento, Infinito, Merlin, Proxanil and Tattoo) have been discovered. These residues are virtually always below the MRL.

Reducing the doses and or widening the harvest intervals with these products is unlikely to reduce the residue level.

Tecnazene, which is not approved on potatoes, is occasionally found but this is usually a result of past contamination of storage containers or buildings.

Storage of crops other than potatoes in CIPC treated buildings

Buildings in which CIPC has been applied or that have contained CIPC treated potatoes for any length of time will contain CIPC deposits on or in their fabric. These deposits are impossible to remove completely. Cereals, rape or onions stored in these buildings are likely to "pick up" CIPC residues which can be over the MRL. These crops will be legally un-salable.

If the earlier use of any building is unknown it is possible to test fabric from these buildings for CIPC.

Buildings that have been CIPC treated or where CIPC can be detected in the structure SHOULDN'T be used to store crops other than potatoes.

Guidelines on minimising pesticide residues

These guidelines have been produced after consultation between crop stakeholders and the RT Fresh Produce crop author. They will be developed over the coming seasons as knowledge on minimising residues develops. Growers should consult with their crop protection adviser to ensure other best practices are not compromised before considering these guidelines. The table below lists the active ingredients that may give rise to crop residues and details alternative strategies.

<table>
<thead>
<tr>
<th>Active ingredient</th>
<th>Target pest, weed, disease</th>
<th>Current position</th>
<th>Suggested guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td>azoxystrobin</td>
<td>Black dot and black scurf</td>
<td>Very occasional residues near the lod MRL 0.05 ppm</td>
<td>Better application technique to avoid concentrations of spray on the soil Operators should attend manufacturers stewardship workshops</td>
</tr>
<tr>
<td>chlorpropham</td>
<td>Tuber sprouting in store</td>
<td>Low residues (l.o.d to 5ppm) are common MRL of 10.0ppm</td>
<td>Avoid mixing varieties of differing sprout growth in the same store Ensure uniform store temperatures, ideal box layouts and suitable wind conditions at application time Use a qualified and experienced CIPC applier Don't delay initial treatment as this results in increased</td>
</tr>
<tr>
<td>Compound</td>
<td>Disease(s)</td>
<td>Residues detected</td>
<td>Management</td>
</tr>
<tr>
<td>----------------------------------</td>
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</tr>
<tr>
<td>Dithiocarbamates (e.g. maneb &amp; mancozeb)</td>
<td>Late blight</td>
<td>Very occasional residues of a non systemic fungicide detected</td>
<td>Use low speed fans and balanced air system in bulk stores. Apply CIPC during pull down in cold stores.</td>
</tr>
<tr>
<td>Fosfiazate</td>
<td>Nematodes and wireworm</td>
<td>MRL 0.02 ppm</td>
<td>Do not use in furrow, follow application instructions on incorporation very carefully. Operators should attend annual stewardship workshops</td>
</tr>
<tr>
<td>Imazalil</td>
<td>Fungal diseases in stored tubers</td>
<td>Very low residues well within the 5 ppm MRL are found after application</td>
<td>Try not to use imazalil but ensure earlier harvesting, better management of store temperature and tuber drying. Refrigeration.</td>
</tr>
<tr>
<td>Maleic hydrazide</td>
<td>Volunteer potato suppression and sprouting in store</td>
<td>Tuber residues well within the 50 ppm MRL are always detected after application</td>
<td>Avoid leaving potatoes on the field at harvest. Do not plough after potatoes. Grow smothering crops after potatoes. Use appropriate herbicides in set aside and other crops. Do not use MH unless spray conditions and crop growth are ideal</td>
</tr>
<tr>
<td>Oxymyl</td>
<td>Nematodes</td>
<td>MRL 0.01 ppm</td>
<td>Follow application instructions on placement and incorporation of granules very carefully</td>
</tr>
<tr>
<td>Pencycuron</td>
<td>Seed dressing for black scurf and stem canker control</td>
<td>Approval is for application to seed only MRL 0.1 ppm</td>
<td>Residues in ware may be the result of contamination of ware boxes by treated seed. Keep seed boxes separate or inspect and clean all boxes prior to ware harvest Operators should attend annual stewardship workshops</td>
</tr>
<tr>
<td>Propamocarb hydrochloride</td>
<td>Fungicide for late blight control</td>
<td>Residues found are always very close to the LOD of 0.02 ppm MRL 0.5 ppm</td>
<td>Investigations into the reasons for recent residue finds (even though well within the MRL) are not conclusive</td>
</tr>
<tr>
<td>Tecnazene</td>
<td>Tecnazene is not now approved for use on potatoes but previous applications continue to contaminate stored tubers</td>
<td>Very low residues are very occasionally detected. These are carry over residues from treatment several years previously MRL 0.05 PPM</td>
<td>Ventilate empty stores and boxes suspected to be contaminated</td>
</tr>
<tr>
<td>Thiabendazole</td>
<td>Fungal diseases in stored tubers</td>
<td>As imazalil MRL 15.0 ppm</td>
<td>As fungal resistance to thiabendazole is common, review continued use. Suggestions under imazalil apply.</td>
</tr>
</tbody>
</table>
APPENDIX 1 - POTATOES

SPECIAL NOTE FOR GROWERS SUPPLYING POTATO PROCESSING FACTORIES:

Most potato processing factories and certainly those represented by the Potato Processors Association (PPA) will expect growers delivering potatoes to comply with and have completed the following HACCP documentation (PPA “bolt on” HACCP module)

PPA HACCP STANDARD - Revised 18th January 2012

<table>
<thead>
<tr>
<th>Section</th>
<th>Ref No</th>
<th>Requirement</th>
<th>Priority</th>
<th>Examples of Records</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0. Traceability</td>
<td>1.1</td>
<td>Through the use of relevant records (such as seed potato records, field diary, store diary etc.), it must be possible to trace any load of potatoes delivered to the customer back to the farm, store, field and seed lot.</td>
<td>Key</td>
<td></td>
</tr>
<tr>
<td>2.0. HACCP</td>
<td>2.1</td>
<td>The producer must hold a written HACCP based risk assessment of their potato supply operation, which is specific to that producer, considers all appropriate hazards within an accurate flow diagram and has been reviewed within the last 12 months.</td>
<td>Normal</td>
<td></td>
</tr>
<tr>
<td>3.0. Site Selection</td>
<td>3.1</td>
<td>For each field of potato production, a recorded foreign object and industrial pollution risk assessment must have been carried out as part of site selection, which takes into account stone content, proximity of any golf course, public footpaths, houses, roads, recreational areas or activities (e.g. shooting), industrial premises nearby and any other potential sources of contamination likely to affect the growing crop.</td>
<td>Normal</td>
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<tr>
<td></td>
<td>3.2</td>
<td>Records must be available to show that if fields selected for production have been determined as having potential hazards, corrective actions have been taken and / or controls are in place.</td>
<td>Normal</td>
<td>3.2.1 Staff Foreign Object Awareness Record</td>
</tr>
<tr>
<td>4.0. Crop Management</td>
<td>4.1</td>
<td>A written risk assessment must be carried out that has considered the risks of foreign objects, inc wood, metal, plastic, glass, weed seeds etc. by the use of organic manure.</td>
<td>Normal</td>
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</tr>
<tr>
<td>5.0. Equipment Maintenance</td>
<td>5.1</td>
<td>Records must be completed to demonstrate that equipment (e.g. planters, tractors, harvesters, vehicles, stores and grading equipment) have been inspected, repaired (if necessary) and cleaned before use.</td>
<td>Normal</td>
<td>5.1.1 Equipment and Building Maintenance Record</td>
</tr>
<tr>
<td>6.0. Pest Control</td>
<td>6.1</td>
<td>There must be a named person(s) responsible for managing pest control on site, who either manages the pest control personally or is the direct contact for the contractor and who ensures that all corrective actions are followed up in a timely manner.</td>
<td>Normal</td>
<td></td>
</tr>
</tbody>
</table>
### 6.0. Pest Control

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.2</td>
<td>Pest control practices are only to be undertaken by a contractor able to demonstrate approval by a National Pest Control Body or a person able to produce a copy of their training certificate from a recognized course.</td>
<td>Normal</td>
</tr>
<tr>
<td>6.3</td>
<td>Up to date copies of COSHH sheets for all pest control products must be held.</td>
<td>Normal</td>
</tr>
<tr>
<td>6.4</td>
<td>All bait stations must be numbered and included on an accurate, dated site plan of the premises.</td>
<td>Normal</td>
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<tr>
<td>6.5</td>
<td>All internal and external bait boxes must be locked, clearly labelled and secured in place. The nature and location of the bait stations must not pose any risk of contamination of the potatoes.</td>
<td>Normal</td>
</tr>
<tr>
<td>6.6</td>
<td>Records of inspections and follow-up visits must be able to demonstrate that pest activity is being adequately controlled.</td>
<td>Normal</td>
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<tr>
<td>6.7</td>
<td>There must be adequate external bait stations to give effective control of rodents.</td>
<td>Normal</td>
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<tr>
<td>6.8</td>
<td>Clear, unobstructed inspection corridors must be maintained around the exterior and interior of the store to enable easy access to bait stations.</td>
<td>Normal</td>
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<tr>
<td>6.9</td>
<td>The position of the baits must not pose a risk of contamination to potatoes.</td>
<td>Normal</td>
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<tr>
<td>6.10</td>
<td>Granular bait is not permitted.</td>
<td>Normal</td>
</tr>
</tbody>
</table>

### 7.0. Glass Control

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.1</td>
<td>Recorded daily glass and hard plastic checks must be completed during store loading and unloading.</td>
<td>Key</td>
</tr>
<tr>
<td>7.2</td>
<td>Recorded annual pre-storage glass checks for windows in neighbouring buildings and chitting stores must be completed.</td>
<td>Key</td>
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<tr>
<td>7.3</td>
<td>Lights in storage and grading areas must be protected.</td>
<td>Key</td>
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<tr>
<td>7.4</td>
<td>Procedures must be in place to control broken or unprotected glass (lights / thermometers).</td>
<td>Key</td>
</tr>
<tr>
<td>7.5</td>
<td>All glass breakages must be cleared up immediately and placed in controlled waste/dedicated glass containers. Records of all incidents must be held.</td>
<td>Key</td>
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</table>

### 8.0. Storage

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.1</td>
<td>The potential for foreign object contamination must be effectively managed through maintaining a sound store structure, with adequate pest proofing and hygienic working practices. Stores must be thoroughly cleaned prior to the storage season and records kept.</td>
<td>Normal</td>
</tr>
<tr>
<td>8.2</td>
<td>Louvres must be designed and constructed in order to protect the crop from exposure to light when open.</td>
<td>Normal</td>
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<tr>
<td>8.3</td>
<td>Procedures must be in place to prevent foreign material contaminating potato boxes.</td>
<td>Normal</td>
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</tbody>
</table>
8. Storage
8.4 Recorded checks must be completed to demonstrate that all boxes have been cleaned and are in a sound condition prior to filling.

8.5 All potato stores must be locked when not in use.

9. Grading
9.1 The potential for foreign object contamination must be effectively managed through maintaining all grading and associated equipment in sound condition, avoiding unsuitable temporary repairs, minimising metal-to-metal contact and by use of suitable materials for belts, cushioning etc.

9.2 The producer must complete daily, recorded checks to show that the grader and associated equipment such as lights and belts etc. will not pose a risk of contamination to the graded potatoes.

9.3 A signed glove register which covers all grading staff must be in place.

9.4 The full width of the inspection belt must be within easy reach of the inspectors and the potatoes must pass in front of the inspectors in a single layer.

9.5 The producer must provide suitable facilities for grading to be carried out in bad weather.

10. Hygiene
10.1 The producers must hold a hygiene policy on site, clearly stating eating, drinking, smoking and jewellery restrictions. The policy must be signed by all employees.

10.2 There must be appropriate and sufficient signs in place around the site in order to re-enforce the smoking policy.

11. Transport
11.1 Maintenance and cleaning records must be available to show all internal maintenance work carried out on bulkers and trailers used for transporting potatoes to the customer.

11.2 All bulkers and trailers are to be inspected for cleanliness and absence of foreign object contamination prior to loading to the customer. The checks must be recorded.

12. Training
12.1 Annual training on quality, food safety and hygiene must take place for all relevant staff (field operators, storage and grading). Signed training records must be held.

13. Incident Handling
13.1 The producer must be able to provide evidence that actions are taken following a customer complaint, in order to prevent re-occurrence of the issue.

13.2 There must be a procedure in place (site or customer specific) to isolate stock and notify the customer should potatoes become contaminated with glass, pesticides, oil diesel etc.
### Examples of Record Documents for PPA HACCP

**Grading Line Staff Foreign Object Awareness Record No: 3.2.1**

<table>
<thead>
<tr>
<th>Date</th>
<th>Store/Lot/Field</th>
<th>Where Documented</th>
<th>Graders Informed</th>
<th>Signed</th>
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</table>
### Equipment & Building Maintenance Record No: 5.1.1

**Tick as appropriate:**

- Cultivation Equipment
- Stone Separator
- Trailer
- Other
- Washer
- Ridger/Bed Former
- Forklift/Teleporter
- Grading Line
- Fertiliser Applicator
- Harvester
- Pesticide Applicator
- Potato Planter
- Potato Store

**Farm Name:**

**Producer Ref:**

All maintenance & calibration pre-use and during use to be recorded detailing all work done and spare parts used

**Machine:**

**Identification Number / Mark:**

<table>
<thead>
<tr>
<th>Date</th>
<th>Problem/Reason</th>
<th>Maintenance/Calibration Undertaken</th>
<th>Next Due Date</th>
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<tbody>
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</tbody>
</table>
### Storage Food Safety & Hygiene Check Record No: 8.1.1

#### Store / Building Identification No/Mark:

- The store is checked monthly during storage and daily during grading / unloading
- Any problems are noted and communicated to grading staff using the staff awareness sheet
- Lights are checked for any damage
- Stores checked for presence of any loose wood
- Any rodent presence is recorded

<table>
<thead>
<tr>
<th>Date</th>
<th>Lights</th>
<th>Wood</th>
<th>Store structure</th>
<th>Rodent presence</th>
<th>Action taken</th>
<th>Signed</th>
</tr>
</thead>
<tbody>
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Store Cleaning Record (Bulk Store / Box Stores) Record No: 8.1.2

- Floors to be swept of all debris
- Floors and walls are washed with pressure washer where applicable
- Ceiling, laterals and main ducts cleaned of all dirt where applicable
- Fan house, ventilation corridors and control shed are swept of all debris in all stores
- Sign off box when relevant action undertaken

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<thead>
<tr>
<th>Store</th>
<th>Swept</th>
<th>Washed</th>
<th>Out Store</th>
<th>Ceiling</th>
<th>Cleaned</th>
<th>Laterals</th>
<th>Cleaned</th>
<th>Fan</th>
<th>House</th>
<th>Swept</th>
<th>Ventilation corridor swept</th>
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### Box Check Record No: 8.4.1

**Box Check Into Store**

- All boxes checked pre-filling for damage - discarded or repaired as necessary
- All boxes checked post-filling for damage - action taken where necessary
- All boxes checked once in store for damage - action taken where necessary

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<tr>
<th>Date</th>
<th>Store</th>
<th>Checked Pre-Filling</th>
<th>Checked Post Filling</th>
<th>Checked In Store</th>
<th>Signed</th>
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</table>
### Grader Daily Check Record No: 9.2.1

**Identification No/Mark:**

- Clean all adhering soil off grading line equipment (including spirals and stars)
- Clean soil and dirt from around the grading line
- Clear all loose potatoes from the area around the grading line
- Check all elevators and hopper for loose and broken parts
- All repairs to machinery undertaken must be completed with care and attention to avoid risk of foreign object contamination and must be recorded on Equipment Maintenance Record
- All tools, spare parts etc must be stored in a safe place to avoid risk of foreign object contamination

<table>
<thead>
<tr>
<th>Date</th>
<th>Check and lubricate chains</th>
<th>Check Web and Belts</th>
<th>Check for worn / broken parts / temporary repairs</th>
<th>Lights in grading / washing area</th>
<th>Grader cleaned</th>
<th>Hopper</th>
<th>Elevator 1</th>
<th>Elevator 2</th>
<th>Checked by</th>
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</table>
Grader Personnel Check Record No: 9.3.1

Count in/Count Out
To include all potential personnel foreign object contaminants e.g. all personal protective clothing, gloves, plasters, tools, cleaning items etc.

<table>
<thead>
<tr>
<th>Date</th>
<th>Name</th>
<th>Details of Item</th>
<th>Check / Issue In</th>
<th>Initials</th>
<th>Check / Return Out</th>
<th>Initials</th>
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</table>
### High Risk – Daily Glass, Hard Plastics & Equipment Record No: 7.1.1

Daily checks to be made on all glass, hard plastic and grading equipment

<table>
<thead>
<tr>
<th>Date</th>
<th>Hopper</th>
<th>Coils/Screen</th>
<th>Stars</th>
<th>Washers</th>
<th>Elevator</th>
<th>Store Grade Lights</th>
<th>Trailer</th>
<th>Corrective Actions</th>
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</table>
## Glass and Hard Plastic Breakage & Clean Up Record No: 7.5.1

All incidents to be recorded

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>Details</th>
<th>Tractor/Trailer Reg if Applicable</th>
<th>Cleaning Method</th>
<th>Area and Operators Clothes &amp; Shoes Inspected</th>
<th>Broken Pieces Disposed Off in a Designated Container</th>
<th>Item Replaced</th>
<th>Signed Off</th>
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<td>Items Checked</td>
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</table>
## Potato Contamination Record No: 13.2.1

All incidents to be recorded (glass, hard plastics, pesticides, oil, diesel etc)

<table>
<thead>
<tr>
<th>Date of Incident</th>
<th>Location of Incident</th>
<th>Details of Incident</th>
<th>Potatoes Isolated</th>
<th>Potatoes Labelled 'Not for Use'</th>
<th>Area and Operators Clothes &amp; Shoes Inspected</th>
<th>Broken pieces Disposed of in Designated Container</th>
<th>Item Replaced</th>
<th>Signed Off</th>
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</table>
PRIOR TO LOADING DRIVERS MUST INSPECT THE TRAILER INTERNALLY AND EXTERNALLY AND ENSURE IT IS FREE FROM CONTAMINATION RISKS AND FOREIGN OBJECTS

<table>
<thead>
<tr>
<th>Internal Inspection</th>
<th>Tick if OK</th>
<th>External Inspection</th>
<th>Tick if OK</th>
<th>Description of Fault/Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal lights not broken and covered</td>
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<td>Lights and lenses intact</td>
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<tr>
<td>Rivets/screws/bolts not loose</td>
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<td>No rust by unloading area</td>
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<tr>
<td>Seals/mastic intact, not loose</td>
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<td>No external damage</td>
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<td>Free of contamination &amp; foreign objects</td>
<td></td>
<td>Door seals not damaged</td>
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<td>No strong smell</td>
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<td>Number plate fixings</td>
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<td>No pallets/wood chips/splinters/nails</td>
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<td>No rust/flaking paint</td>
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<td>No pests, insects or vermin</td>
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<td>Free of old crop</td>
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What was the previous load?

<table>
<thead>
<tr>
<th></th>
<th>Scheduled loading time at farm</th>
<th>Actual time arrived at farm</th>
<th>Actual time departed from farm</th>
<th>Scheduled delivery time at factory</th>
<th>Actual time arrived at factory</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

**Print Name**

<table>
<thead>
<tr>
<th></th>
<th>Print Name</th>
<th>Signature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driver:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supplier/Grower:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Please leave in your cab **ALL LOOSE** objects and any items liable to contaminate your load i.e. cigarettes, food, pens, jewellery, watches, mobile phones etc.
### Operator Training Record No: 12.1.1

<table>
<thead>
<tr>
<th>Date:</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Training Subject:</td>
<td></td>
</tr>
<tr>
<td>Trainer:</td>
<td></td>
</tr>
<tr>
<td>Content of Training:</td>
<td>•</td>
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<tr>
<td></td>
<td>•</td>
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<td></td>
<td>•</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Name of Attendee:</th>
<th>Signature:</th>
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<tbody>
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</tbody>
</table>
### Operator Hygiene Policy No: 10.1.2

- Smoking, eating, drinking and chewing are not permitted in the grader or potato store
- Smoking, eating and drinking is only permitted in designated areas
- The wearing of jewellery (to include sleeper earrings, rings and watches) is not permitted whilst working on the grader
- Personal items e.g. mobile phones, car keys, money, must be left in a secure place and not taken into the grader

I have read and understood the requirements:

**Date:**

**Name:**

**Signature:**
Potato Council Technical Publications

Copies of various publications on potato production, storage and marketing are available to levy payers and corporate members of the P.C. from:

AHDB Potato Council
Stoneleigh Park
Kenilworth
Warwickshire
CV8 2TL

Tel: 02476 692 051

Website: [www.potato.org.uk](http://www.potato.org.uk)

Free publications can be ordered through the publications line (number above) or by email: [publications@potato.org.uk](mailto:publications@potato.org.uk). Some reports are available to download from the website [www.potato.org.uk/about-us/knowledge-transfer](http://www.potato.org.uk/about-us/knowledge-transfer)

Technical publications specific to Scotland
SRUC – Scotland’s Rural College – SAC Consulting – Crop publications
[www.sruc.ac.uk/downloads/120312/crop_publications](http://www.sruc.ac.uk/downloads/120312/crop_publications)
### CIPC APPLICATION RECORD

<table>
<thead>
<tr>
<th>Business name:</th>
<th>Store name:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variety/Varieties:</td>
<td>Intended market:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Requested by:</th>
<th>Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confirmed by:</td>
<td>Date</td>
</tr>
</tbody>
</table>

**Reason for Application:**

**Application date:**

**Date and dose of all previous applications:**

**Dose and name of product used:**

<table>
<thead>
<tr>
<th>Store contents</th>
<th>Number of boxes</th>
<th>Total weight Potatoes (t)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Formulation:</th>
<th>Batch Number:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application Rate:</td>
<td>Total Required for Store:</td>
</tr>
<tr>
<td>Time Taken:</td>
<td>Total Applied to Store:</td>
</tr>
<tr>
<td>Date/Time Treated:</td>
<td>Harvest Interval:</td>
</tr>
<tr>
<td>Contractor:</td>
<td>Operator’s Name:</td>
</tr>
<tr>
<td>Fogger Identity:</td>
<td>NSTS No:</td>
</tr>
</tbody>
</table>

**Comments:**
(i.e. weather/wind conditions, problems during application, precautions taken, operator comments, condition of crop and or store fabric ...)

**Signed:**

**Date:**

---

Draft CIPC application record by courtesy of and thanks to Ajay Jina

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### STORE CHECKLIST

Assess your store against the criteria listed. Address any red categories before treatment and reassess. If red categories remain, DO NOT TREAT.

#### Key issue

<table>
<thead>
<tr>
<th></th>
<th>Guidelines</th>
<th>R</th>
<th>A</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>STORE LOCATION</td>
<td>Poor</td>
<td>Good</td>
<td>No</td>
</tr>
<tr>
<td>2</td>
<td>STORE INTEGRITY</td>
<td>Poor</td>
<td>Some</td>
<td>Poor/None</td>
</tr>
<tr>
<td>3</td>
<td>EMPTY AIR SPACE IN STORE</td>
<td>Poor</td>
<td>Fair</td>
<td>Good</td>
</tr>
<tr>
<td>4</td>
<td>CIPC APPLICATION POINT</td>
<td>Poor</td>
<td>Fair</td>
<td>Good</td>
</tr>
<tr>
<td>5</td>
<td>UNIFORM STORE ENVIRONMENT</td>
<td>Poor</td>
<td>Fair</td>
<td>Good</td>
</tr>
<tr>
<td>6a</td>
<td>BULK STORE SUITABILITY</td>
<td>Poor</td>
<td>Fair</td>
<td>Good</td>
</tr>
<tr>
<td>or 6b</td>
<td>BOX STORE SUITABILITY</td>
<td>Poor</td>
<td>Fair</td>
<td>Good</td>
</tr>
</tbody>
</table>

Assessed by .......................................................... Date ......................................

I confirm that this checklist has been shown to the advisor(s) giving the BASIS recommendation for application and to the CIPC applicator(s).

Signed .......................................................... Date ......................................

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ALWAYS READ THE LABEL. USE PESTICIDES SAFELY

© AFS 2014
Appendix 2 Control Points: Potatoes

<table>
<thead>
<tr>
<th>CQ.47</th>
<th>Potatoes</th>
</tr>
</thead>
<tbody>
<tr>
<td>CQ.47.2</td>
<td>Producers must be able to demonstrate that potato blight spray programmes use the minimum number of sprays necessary for good blight control.</td>
</tr>
<tr>
<td>CQ.47.6</td>
<td>If producers store potatoes and use CIPC (chlorpropham) they must be able to demonstrate that they have used the least amount of CIPC for sprout control.</td>
</tr>
<tr>
<td>CQ.47.7</td>
<td>Producers must be able to show that when selecting seed potatoes they consider the effect that location, health, management and handling of the seed crop have on the ware crop.</td>
</tr>
<tr>
<td>CQ.47.8</td>
<td>Any haulm growth on potato dumps should be destroyed with chemical desiccant or contained with black plastic sheeting.</td>
</tr>
<tr>
<td>CQ.47.9</td>
<td>Producers using CIPC must have a completed store check list for each store or building in which they have used CIPC.</td>
</tr>
<tr>
<td>CQ.47.10</td>
<td>Any storage buildings where CIPC has been used on stored potatoes must be clearly labelled with a permanent notice indicating CIPC has been used in the building.</td>
</tr>
</tbody>
</table>