Background and Medical History

	Question	Risk Factor	Reasoning	References	Suggestions
F1	Breed (or breeds) of Pig	N/A	Mixed reports in literature, not predicted to have an effect, but worth noting, especially if not a usual breed.	Moinard et al. 2003, Schroder-Petersen & Simonsen 2001	Effect of pig breed does not have clear implications for tail biting, all additional data are useful.
F5	Total number of rearing animals on the unit	N/A			Useful for further studies into tail biting. No solutions to suggest at this point.
F6	Total number of breeding animals on the unit	N/A			Useful for further studies into tail biting. No solutions to suggest at this point.
F7	Number of stock people working on unit? (number of staff present at same time)	N/A	Ratio of stock people to animals may be implicated in risk factor for tail biting, e.g. farms with tail biting are likely to have more sows per stockman (89 v 71) and more growing pigs per stockman (821 v 654) - however, this may be confounded by farm system used.	Moinard et al. 2003	All additional data in this field (ratio of pigs to stock people) are useful.
F11	What is the average P2 back fat?	N/A	Some evidence that low P2 back fat associated with tail biters - either individuals or genetic lines. Higher P2 may be associated with lower-stress animals.	Moinard et al. 2003, Beattie et al. 2000, Breuer et al. 2005	Useful for further studies into tail biting. No solutions to suggest at this point.
F8	What routine vaccinations have animals on the farm received?	N/A	Some vaccinations may reduce or prevent tail biting in circumstances in which it would be predicted; some gut problems are associated with higher levels of chewing behaviour (saliva produced by chewing can calm gut discomfort in some cases). Useful to know what the animals have been vaccinated against in case patterns emerge.		Some routine vaccines could reduce pigs' need to chew, so all information in this area could be useful.
F9	What other supplements / injections do animals on the farm receive?	N/A	Possible that some supplements may contribute to reducing prevalence of tail biting – all additional information in this area is useful.		Effect of routine supplements is unknown, but can add to current knowledge of factors affecting tail biting.
F10	Have pigs presently on the farm previously received or are they currently receiving medication for any illness?	N/A	Some evidence that treating ileitis may reduce tail biting; potential for wide-acting antibiotics to reduce discomfort that may be contributing to tail biting.	Almond and Bilkei 2006	Some treatments may reduce tail biting, depending on which symptoms they treat; additional information in this field could be useful.

Mixing History.

	Question	Risk Factor	Reasoning	References	Suggestions
F12	Are the pigs transported between farms (apart from transport to slaughter)?	30	Transport is a major stressor – and stressed pigs are more likely to tail bite.		Transport is a stressor and can increase unrest in the pigs. Look at reducing number of times the pigs have to be transported. Reduce transport stressors as much as possible; e.g. changing handling, grouping, mixing, avoiding high temperatures, bedding, length of journey and any other factors that may contribute to stress before, during and after the journey.
F13	If pigs were transported, did mixing of different groups (e.g. different pens, different farms) occur during transport?	30	Combination of mixing and transport is a major stressor. Additional risk of wounds forming.	Weary et al. 1999	Mixing and transport are both stressful events to pigs, and increased stress can lead to tail biting. Look at reducing mixing events combined with transport - keep litters separate during transport, or allow them to mix at an earlier stage. Mixing before weaning can produce more stable groups and reduce fighting.
F14	Are the pigs mixed on the farm (or at a previous farm) more than once after weaning (and before leaving finisher pens)?	20	Mixing is a stressor – and stressed pigs are more likely to tail bite. Ideally no mixing but not always practical. Mixing once, at weaning is accepted practice, mixing more than once likely to create unrest in pigs.	Non-mixed pigs & no tail biting - FAI	Mixing is a stressor, and stressed pigs are more likely to tail bite. Consider reducing number of mixing events. Where mixing has to occur, aim to reduce stress of the situation, e.g. gentle and quiet handling, provide space and/or barriers to allow pigs to avoid aggression, good ventilation to reduce overheating, provide bedding, increase access to food.
F15	Are the pigs moved more than twice between pen types, buildings or fields between weaning and slaughter?	20	Moving is a stressor – and stressed pigs are more likely to tail bite. Ideally no moving of pigs would take place, but this is rarely practical. Also, moving is an experience and enrichment –environmentally aware pigs will be less stressed by inevitable events such as transport. Moving once is acceptable, moving more than once is likely to create unrest in pigs. Moving may create injuries to the pigs which will be focussed on by other pigs. Moving between pen types will be a bigger stressor than moving into an adjacent and similar pen.	This would be worth investigating as the history of experimental animals is often unknown.	Moving pigs to new surroundings can be stressful, leading to tail biting. Look at reducing number of movements between pens, e.g. expanding pens, or starting with smaller group sizes. Make moving between pens or buildings as non-stressful as possible. Ensure good ventilation to avoid overheating during movement between pens. Check pigs' route between different areas to avoid baulking when moving.
F30	Were the sows / gilts moved to different accommodation, or mixed with unfamiliar animals during the second trimester of pregnancy?	10	Mixing pregnant pigs at this age is associated with more aggressive piglets, and with more stress reactive piglets.	ZSL meet. Jarvis et al. 2006	Some evidence that piglets born to sows that have been exposed to moving and mixing stressors in the 2nd trimester are more likely to be aggressive. Look at the system, and see if pigs could be mixed prior to pregnancy so that they are familiar when returned to the group, or if unfamiliar animals can be mixed during first trimester rather than later. If mixing at this time cannot be avoided, try to increase exposure of animals to be mixed before they meet.

Straw Provision and History

	Question	Risk Factor	Reasoning	References	Suggestions
F16	Have the pigs previously been provided with straw or particulate substrate during their time in an earlier part of the system BEFORE ARRIVING at this farm but now have no substrate? (only applicable when all stages of rearing NOT present on current farm, otherwise n/a)	90	Removing straw presents the highest risk of tail biting. The pigs have developed their rooting ability and will be performing it at high levels – removing a substrate leaves them trying to find alternatives to manipulate. Level of rooting behaviour will be highest in straw, and lower in other substrates and with objects. Defra code: Environmental enrichment 16. To enable proper investigation and manipulation activities, all pigs must have permanent access to a sufficient quantity of material such as straw, hay, wood, sawdust, mushroom compost, peat or a mixture of such which does not adversely affect the health of the animals.	Day et al. 2002, Ruiterkamp 1985	Pigs need something to root and chew on to reduce or prevent boredom. Taking straw away once pigs are used to manipulating it can create a worse tail biting problem as these pigs root more than pigs that have never had straw. See if straw or substrate can be added at this stage of production as well as earlier, or see which manipulable substrate/objects could be provided at all stages of production. Important that substrates or objects are not taken away once pigs have learnt to root at them.
F17	Have the pigs previously been provided with straw or particulate substrate BEFORE ARRIVING at this farm, but now have manipulable objects instead? (only applicable when all stages of rearing NOT present on current farm, otherwise n/a)	30	This again presents a high risk of tail biting - This is better than moving pigs from a quality environment to a barren one, but the objects may not fulfil the range of rooting behaviours that the pigs may have developed on straw.		Pigs need to have straw, a substrate or objects to manipulate to prevent them becoming bored. Consider whether the system could accommodate straw for the pigs, e.g. in racks or dispensers. If straw is not possible, aim to supply wood- or earth-based substrate (e.g. wood shavings, wood chip, spent mushroom compost).
F28	Are the sows housed in barren farrowing accommodation but have had access to straw or a particulate substrate before this?	10	N.B. Defra code. 16. To enable proper investigation and manipulation activities, all pigs must have permanent access to a sufficient quantity of material such as straw, hay, wood, sawdust, mushroom compost, peat or a mixture of such which does not adversely affect the health of the animals. Pigs may learn appropriate substrates to root in. Sow's rooting behaviour affects piglets' rooting behaviour. High risk if sow had substrate but roots a barren environment in front of piglets - she will show high levels of rooting at pen, as will piglets.	Chaloupkova 2006, Ekkel et al. 1995, Beattie, Walker & Sneddon (1996a)	Aim to provide straw to pigs at all stages to keep them occupied, including pre-farrowing. If this is not possible, provide straw or substrate (or manipulable objects) to sow in farrowing accommodation to direct piglets' foraging behaviour onto straw

Straw Qualities.

	Question	Risk Factor	Reasoning	References	Suggestions
R5	If straw or a straw like substance is provided, is it chopped as opposed to long?	12.5	Chopped straw loses its attractiveness to pigs as it fulfils fewer needs as a substrate and could therefore be increase frustration. May even increase tail biting as pigs are unable to fulfil rooting motivation on it.	Day 2000, O'Connell 2006	Source straw that has long strands rather than short, short straw does not have all the properties that make it so beneficial to pig welfare. Pigs do not root at short straw as much as long, and can become frustrated, leading to more tail biting.
R6	If straw, straw like or particulate substrate is provided is it replenished or added to less frequently than once a day?	10	Daily replenishment of straw reduces the prevalence of tail biting. The pigs react best to fresh straw, rather than stale, and there will be daily variation in properties of the straw. Fresh straw will be clean and interesting. Similarly, other substrates should be replenished regularly to keep them clean and rootable. Straw and substrates will eventually become fouled by transfer of food or faeces from pig's skin and will accumulate dust, dander etc.	Moinard et al. 2003, Hunter et al. 2001	Novelty can keep pigs interested in straw, rather than becoming bored. Add some straw every day; doesn't need to replace existing bedding, but can supplement it. Can be supplied from racks or dispensers to reduce manual workload.
R7	If a straw, straw like or particulate substrate is provided, are there times of day or night when it is not present in the pen?	10	Providing insufficient substrate means pigs will not have the opportunity to manipulate it at all times of day and can therefore increase frustration in pigs already motivated to root. Legislation: Environmental enrichment 16. To enable proper investigation and manipulation activities, all pigs must have permanent access to a sufficient quantity of material such as straw, hay, wood, sawdust, mushroom compost, peat or a mixture of such which does not adversely affect the health of the animals.	Keeling pers comm	Pigs should have straw or other substrates available at all times to keep them occupied - if not enough straw is available, pigs will become bored, or may become frustrated at being unable to reach the straw. Increase quantity of substrate provided, or increase number of times per day that the substrate is provided. Consider providing objects as well as the substrate so that the pigs always have something suitable to root or chew.

Medical History

	Question	Risk Factor	Reasoning	References	Suggestions
F18	Have any pigs from the current batch been culled due to tail biting or lesions caused by other pigs?	90	Shows history of severe biting in group, therefore likelihood that some pigs have propensity to bite, and some may have developed taste for blood.		Outcome - no specific solution - Culled pigs in group due to tail biting or lesions shows extent to which tail biting already present.
F19	Are any pigs on the farm currently removed from their group due to tail biting or lesions caused by other pigs?	80	Shows history of severe biting in group, therefore likelihood that some pigs have propensity to bite, and some may have developed taste for blood.		Outcome - no specific solution - Pigs removed from pen due to tail biting shows the extent to which tail biting is already present.
F20	Have any illnesses occurred in present batch of pigs?	80	Some illnesses such as ileitis, respiratory disease and PMWS associated with high TB levels	Moinard et al. 2003, Almond & Bilkei 2006	Some illnesses associated with tail biting because they increase the pigs' need to chew - look at treating or isolating these animals. Healthier animals are less likely to tail bite

Nutrition

*****INSUFFICIENT DATA OBTAINED TO TEST THE PILOT RISK SCORES - FOLLOW NUTRITIONISTS' ADVICE*****

	Question	Risk Factor	Reasoning	Refs	Suggestions
F22	Is sodium provision <0.17% (Salt (Na Cl) equivalent 0.47%)	*60*	0.2% salt (0.07% sodium) gives maximum potential growth. Recommendations up to 0.9 and 1.0% salt (0.25% Sodium) are suggested to reduce tail biting in outbreaks.	BPEX, BSAS	Salt imbalances can increase the risk of tail biting. Aim for 0.17% sodium (whether in Na Cl or Sodium Bicarbonate). Values up to 0.25% sodium can be used. Ensure access to drinkable water to avoid salt poisoning. Check that any additional salt in the food is well mixed before supplying, and that it stays well mixed over time.
F23	Is lysine percentage below 1.28% for 15-30kg animals; below 1.04% for 30-60kg animals; below 0.85 for 60-90kg animals?	*60*	Lysine is usually the limiting amino acid in the pig's diet. Lysine allows correct uptake of the other amino acids. Increased motivation to root may be due to pig seeking to restore balance of amino acids in the diet; additionally, amino acids can affect behaviour because they are involved in the processes of neurotransmission and production of hormones. Pigs with inadequate protein in diet, or inadequate uptake of protein show higher risk of tail biting.	Fraser 1987a, Gill (MLC) 2005, BPEX 2004	Amino acid imbalances can increase risk of tail biting. Aim for lysine percentage of 1.28% for 15-30kg animals; 1.04% for 30-60kg animals; 0.85% for 60-90kg animals. These levels calculated for 800g per day growth. Check that food is well mixed and stays consistently well mixed over time.
F24	Is lysine percentage above 1.28% for 15-30kg; above 1.04% for 30-60kg animals or above 0.85% for 60-90kg animals?	*50*	Pigs with an inadequate amino acid balance may also be more likely to tail bite. Correct balance of lysine is required for correct uptake of protein. Increased motivation to root may be due to pig seeking to restore balance of amino acids in the diet; additionally, amino acids can affect behaviour because they are involved in the processes of neurotransmission and production of hormones.	Widowski 2002, Fraser 2001, BPEX 2004	Amino acid imbalances can increase risk of tail biting. Aim for lysine percentage of 1.28% for 15-30kg animals; 1.04% for 30-60kg animals; 0.85% for 60-90kg animals. These levels calculated for 800g per day growth. Check that food is well mixed and stays consistently well mixed over time.
F25	Is tryptophan : lysine ratio less than 0.19?	*50*	Ratio of 0.19 calculated as "correct" balance for the pig's diet. Lysine is responsible for uptake of other amino acids from supplied protein. Tryptophan in humans affects mood, and has been shown in some examples in pigs to contribute to calmer animals, and to better gut wall development. Increased motivation to root may occur when the pig seeks to restore the balance of amino acids in the diet; additionally, amino acids could affect behaviour because they are involved in the processes of neurotransmission and production of hormones		Amino acid imbalances can increase risk of tail biting. Aim for a ration of 0.19 tryptophan : lysine. Check that food is well mixed and stays consistently well mixed over time.
F26	Is particle size within feed less than 0.5mm?	*20*	Small particle size contributes to gastric ulcers and stress.	Garth	Food particle size can affect the health of the gut wall; animals are often more likely to chew if they have gut discomfort. Mill food to larger particle size, or ask food suppliers to change particle size. Food particle size should be 0.5mm or larger (this refers to particle size within pellets, not pellet size).

Farrowing Accommodation.

	Questions	Risk Factors	Reasoning	References	Suggestions
F27	Are the sows unable to root at any straw or particulate substrate whilst in farrowing accommodation?	15	N.B. Defra code 32. In the week before the expected farrowing time sows and gilts must be given suitable nesting material in sufficient quantity unless it is not technically feasible for the slurry system used. Pigs may learn appropriate substrates to root in. Sow's rooting behaviour affects piglets' rooting behaviour. If sow can root at straw, should correctly direct rooting behaviour of piglets.	Chaloupkova 2006, Ekkel et al. 1995, Beattie, Walker and Sneddon (1996a)	Providing substrate for the sow improves her welfare, and can reduce her frustration; piglets can learn from the sow to root at straw rather than other pigs or pen fittings.
F29	Are the piglets provided with no straw or particulate substrate in farrowing accommodation?	10	N.B. Defra code 44. A part of the total floor where the piglets are and which is large enough to allow the animals to rest together at the same time, must be solid or covered with a mat or be littered with straw or any other suitable material. Providing straw or other substrate before weaning has been shown to reduce tail biting prevalence.	Chaloupkova 2006, Ekkel et al. 1995	Aim to provide straw (or alternative substrate if straw unavailable or impractical) from soon after birth, preferably also within reach of the sow to promote foraging behaviour that is directed onto the substrate.
F31	Are the sows provided with no manipulable objects in farrowing accommodation?	5	If sows or gilts are unable to have suitable nesting material due to the slurry system, alternatives should be provided to try to accommodate their need to manipulate nesting material. Defra code: Environmental enrichment 16. To enable proper investigation and manipulation activities, all pigs must have permanent access to a sufficient quantity of material such as straw, hay, wood, sawdust, mushroom compost, peat or a mixture of such which does not adversely affect the health of the animals.		If the sow cannot be provided with straw or another particulate substrate, she should be given other objects to root at - this will improve her welfare by giving her something to do, and the piglets can learn from her to manipulate objects rather than other pigs or pen fitting.
F32	Are piglets provided with no manipulable objects?	5	Piglets may learn appropriate substrates to root in by following the sow's rooting behaviour. If the sow can root at straw, this should correctly direct the piglets' rooting behaviour.	Chaloupkova 2006, Ekkel et al. 1995, Beattie, Walker and Sneddon (1996a)	Piglets need substrate or objects to manipulate to reduce their boredom. If not possible to include straw/substrate at this point, try adding small manipulable objects for piglets (larger for sow) to direct foraging behaviour onto appropriate objects rather than at barren pen or each other.

Straw and substrates

	Questions	Risk Factors	Reasoning	References	Recommendations
R1	Have the pigs previously been provided with straw or particulate substrate during their time in an earlier part of the system WHILST AT this farm but now have no substrate? (only applicable when all stages of rearing ARE present on current farm, otherwise n/a, see General history, above)	90	Removing straw presents the highest risk of tail biting. The pigs have developed their rooting ability and will be performing it at high levels – removing a substrate leaves them trying to find alternatives to manipulate. Level of rooting behaviour will be highest in straw, and lower in other substrates and with objects. Defra code : Environmental enrichment 16. To enable proper investigation and manipulation activities, all pigs must have permanent access to a sufficient quantity of material such as straw, hay, wood, sawdust, mushroom compost, peat or a mixture of such which does not adversely affect the health of the animals.	Ruiterkamp 1985 (Day et al. 2002)	See if straw or substrate can be added at this stage of production as well as earlier, alternately see which manipulable substrate/objects could be provided at all stages of production. Important that pigs are not deprived of substrates once they have developed rooting behaviour with it as they will have high levels of rooting motivation but no suitable outlet.
R2	Is the pen empty of substrate such as straw or straw-like substrate (e.g. hay, grass – fine, fibrous substance) and the pigs have no prior experience of similar substrates?	80	Strongest link between providing straw and reducing tail biting. Used as rooting and chewing substrate, as well as comfort in bedding and warmth. Similar substances also acceptable in this role. (Grass & hay are likely to be eaten more quickly leaving free time without substrate to manipulate). Defra code Environmental enrichment 16. To enable proper investigation and manipulation activities, all pigs must have permanent access to a sufficient quantity of material such as straw, hay, wood, sawdust, mushroom compost, peat or a mixture of such which does not adversely affect the health of the animals. Bedding 11. Where bedding is provided, this must be clean, dry and not harmful to the pigs.	EC directive 2001/93/EC, Schroder-Petersen and Simonsen 2001 (review), Van de Weerd et al. 2005, Day et al. 2002 etc	Priority to add straw type (fibrous) bedding if possible (only limiting factor to this is likely to be the slurry system); earthy substrate bedding if not; suitable manipulable objects if not. Ideally >5cm depth straw/substrate should be provided and should be added to or replenished daily. Straw should be long, not chopped. Straw provides a range of uses for the pig and is a valued rooting substrate, as well as providing thermal and physical comfort and a source of fibre.
R3	Is the pen empty of particulate substrates (e.g. wood chip, peat, mushroom compost, soil) and the pigs have no prior experience of similar substrates?	70	Although straw etc are best, other substrates may be more readily available and can fulfil some manipulation needs. Alternatives should include nutritional and ingestible properties to sustain interest. Consider bark, wood shavings, wood wool, wood chips, turf, sand, leaves, twigs etc etc. Peat preferred as a rooting substrate, but not necessarily as bedding. Defra code Environmental enrichment 16. To enable proper investigation and manipulation activities, all pigs must have permanent access to a sufficient quantity of material such as straw,	Beattie et al. 2001, Van de Weerd et al. 2003	If straw is already provided in sufficient quality and quantity, addition of particulate substrate is not relevant. If straw cannot be provided, look at providing a particulate substrate instead e.g. wood-based or earth-based substrate (e.g. wood shavings, wood chip, wood wool, spent mushroom compost, peat). Consider alternatives such as racks/dispensers, raised lip between solid and slatted areas, raised slatted area. Ideally sufficient substrate should be provided for use as well as

			hay, wood, sawdust, mushroom compost, peat or a mixture of such which does not adversely affect the health of the animals. 11. Where bedding is provided, this must be clean, dry and not harmful to the pigs.		bedding for improved welfare of the pigs (e.g. reduced bursitis and sores) but smaller amounts for manipulation will also improve welfare and reduce tail biting. If these substrates cannot be provided, manipulable objects should be provided that maintain the pigs' interest.
R4	Have the pigs previously been provided with straw or straw-like substrates but now have a different, particulate substrate?	30	Again there is a chance of increasing pigs tail-oriented rooting and manipulation if a range of behaviours were previously developed on straw but current substrate does not provide the same fulfilment. A suitable substrate should create a lower risk than an entirely barren environment or one with manipulable objects.		Important that pigs are not deprived of substrates once they have developed rooting behaviour with it. See if straw or substrate can be added at this stage of production, alternately see which manipulable substrate/objects could be provided at all stages of production.

If straw or a straw like substrate is present –

	Questions	Risk Factors	Reasoning	References	Suggestions
R8	Is less than 5cm depth present for 1/2 or more of the area over which it is provided?	10	Bedding of >5cm depth associated with good welfare in sows. Research shows than "only a handful" per pig is sufficient to reduce tail biting - keeps a pig occupied for over an hour. Probably useful if pigs are not having to compete for the straw.	van Putten, 1980, Ekesbo, 1973, Bracke et al. 2002	Increase amount of straw provided (or add useful manipulable objects and continue with existing amount of straw). >5cm depth keeps pigs occupied for a sufficient proportion of their time, and also reduces competition.
R9	Does it appear sub-optimal, e.g. excessively dusty, dark coloured, musty smell?	10	Will reduce straw use and hence increase possibility of pigs manipulating inappropriate objects such as tails. Additionally has potential health risks (respiratory disorders also linked with increased tail biting).		Improve the quality of straw provided - re-source the straw, or improve how straw is stored on the farm so that it stays palatable and has low risk of mycotoxins. Improve quality of enrichment for the pigs with additional substrates or objects so that poor straw is used as bedding rather than solely for manipulation.
R10	Is there limited access to the substrate (e.g. not all animals can contact it at once)?	10	Important that there is not limited access to the straw as it could mean that highly motivated pigs are not able to satiate rooting need.	Scott et al. 2006	Increase depth of substrate within pen, or the area it covers. Increase the number of objects provided, and space them out within pen (i.e. when suspended or attached) to allow all pigs to access them without competition.
R11	Is the pen deep bedded (>5cm depth of bedding in lying area, but not replaced regularly), rather than light bedded (e.g. frequent replacement of existing bedding)?	7.5	Although deep bedding provides thermal comfort, the straw loses some of its advantages as a substrate because it becomes less attractive to root in once fouled. Bedding in deep-bed system will inevitably become fouled, and may become wet if absorbing from dunging areas. Dampness and compactness of bedding reduces its attractiveness. Deep straw is better than no straw, but not as good as daily straw. Consider alternative system for providing bedding, e.g. partial removal of bedding and daily replenishment, or start with a small amount and add straw daily to renew interest in straw.	Hunter et al. 2001	Look at increasing replenishment rate of bedding (e.g. daily) and using a thinner bedding layer to start with (>5cm). Alternately add fresh straw daily to existing deep bed, or remove and replacing a portion of deep bed daily or weekly so that fouled straw doesn't build up.

If a particulate substrate is provided –

	Questions	Risk Factors	Reasoning	References	Suggestions
R12	Is there limited access to it (e.g. not all animals can contact it at once)?	12.5	Important that device does not have limited access – could mean that highly motivated pigs are not able to satiate rooting need on the object. Will depend on number of "attachment points" and number of pigs wanting to use it at once. Given the social facilitation that occurs in behaviours such as feeding in pigs, enrichment should be useable by all pigs at one time. As a rough guide, if enrichment is provided as a long object, use equivalent feed space requirement as a guide, otherwise consider how many points of attachment (e.g. separate ropes) are available.	Scott et al. 2006	Increase amount of substrate provided (or add useful manipulable objects and continue with existing amount of substrate). Increase number of points of access.
R13	Is less than 5cm depth present for 1/2 or more of the area over which it is provided?	10	Bedding of >5cm depth associated with good welfare in sows; increases thermal and physical comfort. Reduces likelihood of pigs competing to access substrate.	van Putten, 1980; Ekesbo, 1973. Bracke et al 2002	Increase amount of substrate provided (or add useful manipulable objects and continue with existing amount of substrate). >5cm depth (straw) keeps pigs occupied for a sufficient proportion of their time, and also reduces competition.
R14	Is the pen deep bedded (>5cm depth of bedding in lying area, but not replaced regularly), rather than light bedded (e.g. frequent replacement of existing bedding)?	7.5	Although deep bedding provides thermal comfort, the straw loses some of its advantages as a substrate because it becomes less attractive to root in once fouled. Bedding in deep-bed system will inevitably become fouled, and may become wet if absorbing from dunging areas. Dampness and compactness of bedding reduces its attractiveness. Deep straw better than no straw, but not as good as daily straw. Consider alternative system for providing bedding, e.g. partial removal of bedding and daily replenishment, or start with a small amount and add straw daily to renew interest in straw.	Hunter et al. 2001	Look at increasing replenishment rate of substrate (e.g. daily) and using a thinner layer to start with (>5cm). Alternately add fresh substrate daily to existing deep bed, or remove portion of deep bed and replace with fresh substrate daily/weekly.
R15	Does it contain no edible component?	7.5	Pigs are most likely to maintain interest in a substrate that can be ingested. E.g. plant based, or starch based	Van de Weerd et al. 2003	Consider substrate with some edible component, e.g. wood, flavouring, organic material, must not cause harm when ingested. Consider incorporating food items into substrate (chopped root vegetables)
R16	Does it contain no nutritional component?	7.5	Pigs most likely to maintain interest in an object with nutritional value, e.g. plant based, fibre, but flavour also important	Young et al. 1994, Van de Weerd et al. 2003, Day, Kyriazakis and Lawrence 1996, Schroder-Petersen and Simonsen 2001 (review)	Consider substrate with nutritional component, e.g. sugar, minerals/salts, water, herbs - can be a "coating" or "flavour"

Manipulable objects.

	Questions	Risk Factors	Reasoning	References	Suggestions
R17	Is the pen empty of manipulable objects? ("objects" in this case are non-particulate objects supplied for enrichment, not including other pen furniture such as feeders or drinkers)	50	Suggested in DEFRA code, but not stated in legislation per se. Provides outlet for rooting motivation provided it has the right qualities to retain the pigs' interest.	EC directive 2001/93/EC, Van de Weerd et al. 2003, Bracke, Zonderland and Bleumer 2006	Provide manipulable objects that are ingestible, edible, destructible and cannot be rooted into the dunging area, e.g. suspended logs, rope, straw bundles, straw in racks…. Objects have to be something that sustains the pigs' interest and that they get some satisfaction from rooting, such as nutrition, change in texture (with destruction), gut fill, novelty.
R18	Have the pigs previously been provided with straw or similar substrate at an earlier stage WHILST ON this farm, but now have manipulable objects instead? (only applicable to stages viewed on this farm, otherwise n/a, General History above)	30	This again presents a high risk of tail biting - This is better than moving pigs from a quality environment to a barren one, but the objects may not fulfil the range of rooting behaviours that the pigs may have developed on straw.		Consider whether the system could accommodate straw for the pigs, e.g. as racks or dispensers. If straw is not possible, aim to supply wood- or earth-based substrate (e.g. wood shavings, wood chip, spent mushroom compost).

If objects are provided for enrichment
(consider stones as enrichment objects in outdoor environment)

	Questions	Risk Factors	Reasoning	References	Suggestions
R19	Are they fouled e.g. dung on object, or 50% covered in dirt?	7.5	Pigs will not use objects which are fouled	Grandin 1998	Suspend objects or attach to pen walls to increase their interest and use to the pigs. (Ropes or hose-pipe used to hold objects can also be manipulated by the pigs)
R20	Do they contain no edible component?	7.5	Pigs are most likely to maintain interest in an object that can be ingested. (VDW)	Van de Weerd et al. 2003	Consider objects with something edible, e.g. wood, organic material, root crops, way of dispensing food (or water) or straw
R21	Do they contain no nutritional component?	7.5	Pigs are most likely to maintain interest in an object with nutritional value	Young et al. 1994, Van de Weerd et al. 2003, Dfay, Kyriazakis and Lawrence 1996, Schroder-Petersen and Simonsen 2001	Consider objects with nutritional component, e.g. sugar, minerals/salts, water, herbs

				(review)	
R22	Are they indestructible?	7.5	Pigs prefer destructible items to non-destructible ones	Feddes and Fraser 1994, Van de Weerd et al. 2003	Consider destructible objects - wood, organic, card / paper
R23	Are they replaced at unsuitable intervals? (e.g. are non-usable items remaining in pen, rather than being replaced, or are objects replaced less than 1x per week)	5	Pigs will only remain interested whilst the object has the properties they are attracted to. If the object(s) become too used, fouled or destroyed, they will provide less suitable enrichment.		Look to find longer-lasting (but still destructible) objects, or include inspection and replacement of manipulable objects into daily or weekly routine.
R24	Is there limited access to them (e.g. not all animals can contact it/them at once)?	5	Important that device does not have limited access – could mean that highly-motivated pigs are not able to satiate their rooting needs on the object. Will depend on the number of "attachment points" and number of pigs wanting to use it at once. Given the social facilitation that occurs in behaviours such as feeding in pigs, enrichment should be useable by all pigs at one time. As a rough guide, if enrichment is provided as a long object, use equivalent trough space requirement as a guide, otherwise, consider how many points of attachment (e.g. separate ropes) are available.	Scott et al. 2006	Increase depth of substrate within pen (>5cm), or the area it covers. Increase the number of objects provided, and space them out within pen to allow all pigs to access them without competition.
R25	Are they at floor level rather than suspended or fixed above floor level?	5	Objects will be less useful if they become soiled or fall into the dunging area. Above head-height an object would not be expected to fulfil role as rooting object, as pigs normally root in ground-level substrate. May be possible to hang objects just a few inches above-ground (although increased risk of fouling)	Grandin 1998	Suspend objects above floor level (rope, hosepipe, chain), this can maintain their interest to a pig as they will become less fouled. Alternately replace objects more frequently - objects will become less interesting to pigs if fouled.

Stocking density.

	Questions	Risk Factors	Reasoning	References	Suggestions
R35	Is the stocking density currently more than 100 kg per m2 or will it exceed 100kg per m2?	70	High stocking density is associated with higher tail biting prevalence. Possibly intolerance of other pigs, or possibly increased competition for resources, and reduced ability of pigs to walk freely around their pen. Table shows recommended minimum space allowances, N.B. large difference between 109kg pigs and 110kg pigs.	Schroder-Petersen and Simonsen 2001 (review), Moinard et al. 2003 (review), Randolph et al. 1981	Reduce stocking density - consider which points in system this could be included e.g. starting with smaller post-weaning groups, or dividing groups in grower stage. Look at combining smallest individuals into a new group early on. Look at whether pen can be expanded, or whether pens can be combined.

Lying area.

	Questions	Risk Factors	Reasoning	References	Suggestions
R45	Is temperature in the lying area outside recommended thermo-neutral zone for this size/weight of animal? (measure - info in tables)	60	Good evidence of higher tail biting prevalence at both higher and lower temperatures. These values are the extreme range at which a pig is physiologically coping with the temperature - it will be more comfortable between these values. Additional factors need to be taken into account, such as heat source (sow), bedding provision and floor type.	Garth	Check automated temperature systems more frequently, check ventilation rates for the building and that they are appropriate for the ages of pigs. Consider use of water for cooling, and have heating available for younger animals if necessary. Have provision for deeper bedding during cold periods. Look at providing partial lids for the pen, to provide a kennelled area that can maintain heat.
R46	Is atmosphere in the pen aversive, e.g. strong smell of Ammonia, dust, irritation caused to eyes or lungs?	60	Class atmosphere as aversive if strong smell of ammonia, if eyes irritated or tearing, or sore throat. Recommended Ammonia level below 20ppm for pigs. Humans can detect 5-10ppm ammonia by smell, 10-15ppm causes mild eye irritation. Above 15ppm causes eye irritation and tear flow. Recommended Hydrogen Sulphide level for pigs is below 10ppm. Humans find 10-20ppm H2S irritating to the eyes, slightly higher levels irritating to throat and lungs. Recommended Carbon Dioxide level for pigs is below 3000ppm. No standardised human sensory detection around these levels, but will increase effects of other aversive gases.	Garth Jensen	Check ventilation systems are appropriate for size of buildings and age of pigs. Look at air flow within building and see if gases can be diverted away from living areas - use of curtains below slatted floors to reduce slurry gases being drawn up through living areas. Check for obstructions outside air inlets. Avoid aligning pens across the direction of air flow. Look at whether full walls or lower walls with fencing at top can usefully direct airflow.
R47	Are there draughts in the lying area? (observations of substrate, lying behaviour of pigs, walkthrough)	60	Reducing draughts promotes more comfortable lying. Pigs will avoid draughty areas - possibly resulting in crowded lying area or disturbed sleep.	Gadd, 2003	Look for and block / divert draughts, add more bedding to lying area. Partial lids can reduce impact of downdraughts on lying areas. Baffles outside a building may help to slow air before it enters the building.
R49	Is there no provision to maintain the pigs at thermo neutral temperatures when external temperature gets too high or too low for measures such as existing ventilation? (e.g. lack of additional bedding, lack of showers or wallows)	40	Good evidence of higher tail biting prevalence at both higher and lower temperatures. Extreme temperatures due to weather also need to be dealt with to ensure comfort of the pigs. Sprinkler systems - either onto the pigs or into the air, showers and wallows can all help pigs to cool down. In cold weather, bedding provides insulation against the cold, and extra provisions are needed for the smallest animals.	Defra, 2003	Look at manual and automatic systems for helping the pigs maintain comfortable body temperature, e.g. hosepipe, sprinklers, wallows, shade, additional ventilation, or additional bedding, draught reduction, enclosed shelters (kennels / partial lids), heaters
R50	Is the lying area difficult to distinguish from the rest of the pen floor (e.g. no bedding, no change in	20	Legislation. DEFRA code 51 The lying area should always be kept dry and pen floors, including the dunging area, should be drained effectively. Where bedding is provided, this must be clean and dry, regularly topped up or changed, and not		Assist pigs in distinguishing areas - look at the pen layout as pigs use it and re-site bedding. Consider adding low wall to help differentiate areas within the pen. Consider where draughts are and direct them away from bedded

	floor type)?		detrimental to the health of the pigs. Pigs choose to lie away from dunging area. Lying area shouldn't be fouled by pigs, and should be dry.	Defra, 2003	areas. Add flooring over slats to increase available (comfortable) lying area. Enclose pigs in dunging area when first moved to pen to encourage dunging in that area. Wet floor (sprinklers) of dunging area to discourage its use as a dunging area.
R51	Does the dunging area extend into the lying area, e.g. areas of fouled bedding, or fouled floor?	20	Legislation. DEFRA code 51 The lying area should always be kept dry and pen floors, including the dunging area, should be drained effectively. Where bedding is provided, this must be clean and dry, regularly topped up or changed, and not detrimental to the health of the pigs. Also pigs will be forced to sleep in aversive conditions if dunging area encroaches on lying area. Pen design may be inappropriate if pigs are not using the lying and dunging areas as intended.	Defra, 2003	Check stocking density and reduce if crowded, look at earlier points in the system where this may be performed, e.g. non-thrifty individuals separated. Look at pigs' use of pen and re-site bedded area, look at whether draughts are affecting pigs use of pen and adapt pen to fit, or reduce draughts. Consider adding low wall to increase difference between dunging and bedding areas.
R52	Are feeders present in the lying area?	20	Passage of pigs to and from feeders will disturb resting pigs. Disturbed pigs may be provoked into aggressive actions, consequently disturbing others.	Gadd, 2003	Consider pen layout, and possibly re-site bedded area. Feeders in lying area will disturb resting pigs.
R53	Are drinkers present in the lying area?	20	Passage of pigs to and from drinkers will disturb resting pigs. Disturbed pigs may be provoked into aggressive actions, consequently disturbing others.	Gadd, 2003	Consider pen layout, and possibly re-site bedded area, drinkers in lying area will disturb resting pigs.
R54	Is the lying area wet or damp?	20	Legislation. DEFRA code 51 The lying area should always be kept dry and pen floors, including the dunging area, should be drained effectively. Where bedding is provided, this must be clean and dry, regularly topped up or changed, and not detrimental to the health of the pigs. Pigs do not choose to lie in wet areas unless too hot.	Gadd, 2003	Look at pigs' use of pen, consider position of bedded area and whether it should be moved, check leakage of pipes / drinkers. Look at sloping of pen floor and see if lying area could be moved to a better-draining area.
R55	Humidity	20	Note if air markedly dry or markedly humid, Recommended humidity level is 50-60% for pigs		See whether air can be humidified by use of humidifier, buckets of water or sprinklers.
R41	Is the lying area too small for all pigs to lie recumbent (may be close-packed)?	50	Defra code. 100 . The lying area, excluding the dunging and exercise areas, should be of sufficient size to allow all the pigs to lie down on their sides at the same time. Better if pigs can lie independently, especially in hot weather. Increases ability of pigs to walk around in pen between resources without disturbing other pigs.	Defra, 2003	Reduce stocking density / increase lying area so that pigs are able to rest/sleep on their sides. Lying recumbently is a sign of sleep/rest rather than lying ventrally which is still associated with activities such as rooting or tail biting.
R43	Is the lying area too small for all pigs to lie recumbent without contact?	20	Defra code. 100 . The lying area, excluding the dunging and exercise areas, should be of sufficient size to allow all the pigs to lie down on their sides at the same time. Better if pigs can lie independently, especially in hot weather. Increases ability of pigs to walk around in pen between resources without disturbing other pigs.		Reduce stocking density / increase lying area so that pigs are able to rest/sleep on their sides. Lying recumbently is a sign of sleep/rest rather than lying ventrally which is still associated with activities such as rooting or tail biting. Allowing all pigs to lie spaced apart reduces risks of individuals disturbing one another, and allows pigs to cool down in warmer environments. Likely to be a factor in tail biting in warmer conditions.

Feed and Drink Provision.

	Question	Risk Factor	Reasoning	References	Suggestions
R57	Is feed supply fully automated?	30	Manual feeding thought to reduce tail biting – possibly due to consistency of feeding.	Moinard et al. 2003, Bird 2003	Increase number of routine checks of food delivery into feeders, have manual back up available.
R58	Is food provided as pellets rather than meal or liquid?	30	Meal and liquid found to be associated with lower tail biting than pelletted. Also, pelletted feed associated with gastric ulcers (can be reduced if straw provided).	Moinard et al. 2003, Hunter et al. 2001, Amory, Mackenzie and Pearce 2006	Consider meal or liquid feed; providing straw to pen. If straw is already provided in the pen, this cancels out the risk, so no further action needs to be done for this question
R59	Is food dispensing system considered to be less reliable than would be preferred?	30	Not all automatic systems work well all the time. Lack of food, especially when expected will increase restlessness. Food supply also needs to be reliable.	Bird, 2003, Paul et al. 2006	Service system, increase regularity of checks of food in feeders, increase number of checks of system. Check where blockages are occurring and look for long term solutions, e.g. new parts, adapting existing system; look at whether pellet size or particle size would improve performance of equipment.
R60	Is water flow rate less than 1 litre per minute? (N/A if reservoirs of clean water present)	30	Flow rate can be limiting factor in access to water- pigs may also drink insufficient water rather than spend extra time drinking from slow drinker	Moinard et al. 2003	Check flow rate, increase number of drinker spaces if flow rate cannot be made appropriate
R61	Is feed provided in meals rather than ad lib?	25	Restricted feeding will increase competition between pigs.	Moinard et al. 2003, Hunter et al. 1991	Consider ad lib feeding, consider increasing number of meals. Look at whether feeders can be positioned to reduce competition (e.g. providing separate feeders). Increase gut fill between meals e.g. provision of straw or substrates
R62	Is less than one drinker point available per 10 pigs? (NB obstruction by other pigs) Count large bowl drinkers (Fordham-type) as 2 drinker points	20	DEFRA 75 Where nipple drinkers are used a drinking point should be available for each ten pigs on rationed feeding. On unrestricted feeding, one nipple drinker should provide adequate supply for 15 pigs given sufficient flow rates. Competition for drinker spaces likely to result in reduced access for some, with potential for tail biting	As feeders - Moinard et al. 2003	Consider re-sitting drinkers to improve access to pigs; add a step to assist smaller pigs in reaching drinkers. (Reduce number of pigs, increase number of drinkers.)

If feed is provided as meals –

	Questions	Risk Factors	Reasoning	References	Suggestions
R64	Either - Are insufficient feed spaces provided to enable all pigs to feed at once or is trough length inadequate to allow all pigs to feed at once?	60	Defra code 69 Where pigs are fed on a rationed feed level to control intake, you should ensure that adequate trough space is provided to ensure that all pigs can receive their allocation. As feed is restricted time-wise (provision of meals) high levels of competition will occur. If individuals to not chose to compete, they will not receive adequate food.	Defra 2003	Ensure that enough trough space is provided per pig and that enough individual feed spaces are provided.
R65	Is feed provided in less than 2 meals per day?	25	Reduced number of meals will increase the competition for food when it appears.	Moinard et al. 2003, Hunter et al. 1991	Increase number of meals. Increase availability of gut fill between meals, e.g. straw provision or suitable manipulable objects. Ensure reliability of feeder so that frustration is minimised.
R66	Is feed provided in more than 5 meals per day?	25	High number of meals disrupts resting behaviour within a group (LK) and can increase tail biting. TJ suggests optimum of 4 meals per day.	Keeling, Jensen pers comm 2007	Reduce to 4 meals per day. Either introduce new feeding regime with next batch of pigs, or switch to four feeds and provide a hand-fed ration for the 5th feed of the day, slowly reducing amount.

If feed is provided ad lib –

	Questions	Risk Factors	Reasoning	References	Suggestions
R67	Are there more than 5 pigs per feeder space if rectangular, or more than 4 pigs per space if round?	30	Competition for feeder spaces likely to result in reduced access for some, with potential for tail biting. (Some assurance schemes accept higher numbers of pigs to feed spaces than suggested here - these schemes also require other measures such as enrichment which will counteract the risk factor given here)	Moinard et al. 2003, Hunter et al. 1991, Hansen, Hagelso and Madsen 1982	Increase number of feeders or decrease group size; look at provision of head partitions or stalls to reduce competition whilst eating.
R68	Are feeder spaces obstructed (even partially) by corners, obstacles, or other pigs?	20	Siting of feeders could increase competition for spaces – not all feed spaces may be readily accessible, reducing the effective number available.	Moinard et al. 2003	Consider re-siting feeders to improve access for all pigs e.g. two or more on different sides of pen; include partitions to reduce ability of one pig to control others' access
R69	Are there more than 10 pigs per feeder space?	15	Competition for feeder spaces likely to result in reduced access for some, with potential for tail biting. (Some assurance schemes accept higher numbers of pigs to feed spaces than suggested here - these schemes also require other measures such as enrichment which will counteract the figure given here)	Moinard et al. 2003, Hunter et al. 1991, Hansen, Hagelso and Madsen 1982	Increase number of feeders or decrease group size; look at provision of head partitions or stalls to reduce competition whilst eating.
R70	Are there more than 15 pigs per feeder space?	15	Competition for feeder spaces likely to result in reduced access for some, with potential for tail biting.	Moinard et al. 2003, Hunter et al. 1991, Hansen, Hagelso and Madsen 1982	Increase number of feeders or decrease group size; look at provision of head partitions or stalls to reduce competition whilst eating. Ensure that system is fully ad lib and that non-competitive pigs will be able to access food at some time of day or night.
R71	Is the sideways movement of pigs uninhibited whilst feeding? (i.e. lack of head partitions / stalls)	15	Provision of individual feeding places reduces competition and threats between pigs whilst feeding.	Garth, RSPCA, Morrow and Walker 1994	Look at providing partitions or stalls between feed spaces to decrease possible aggression at the feeder.