#### 7.2.2.4 Understanding of the mitigation strategies to control impact of ash content variation

The proponent shall demonstrate understanding of the mitigation strategies to control impact of ash content variation.

### 7.2.3 Variability in particle size

#### 7.2.3.1 General

Accurate bounds of particle size variation within feedstock should be known. While some degree of particle size variability is unavoidable, large variations in particle size and texture result in the need for multiple size reduction onsite processing (e.g., screening, grinding).

#### 7.2.3.2 Understanding of size variation typical in available feedstock

The proponent shall demonstrate understanding of size variation typical in available feedstock.

The proponent should determine the upper and lower limit of acceptable particle size in feedstock. The proponent should cross-reference these limits with feedstock particle size data acquired from sampling. The vast majority of the variation (i.e., 95 to 99%) should be within the upper and lower limit.

#### 7.2.3.3 Understanding of factors that influence size variability

The proponent shall demonstrate understanding of factors that influence size variability.

#### 7.2.3.4 Understanding mitigation strategies to control impact of size variation

The proponent shall demonstrate understanding of mitigation strategies to control impact of size variation.

### 7.2.4 Variability in chemical content

#### 7.2.4.1 General

Accurate bounds of chemical content variation within feedstock should be known. While some degree of variability in the chemical content of feedstock is unavoidable, high variability in chemical contents in feedstock (e.g., lignin, carbohydrates, sugar) increases the likelihood that feedstock will not be optimal for a conversion process.

#### 7.2.4.2 Understanding the chemical content variation typical in available feedstock

The proponent shall demonstrate understanding of the chemical content variation typical in available feedstock.

#### 7.2.4.3 Understanding the factors that influence chemical content variability

The proponent shall demonstrate understanding of the factors that influence chemical content variability.

#### 7.2.4.4 Understanding the mitigation strategies to control impact of chemical content variation

The proponent shall demonstrate understanding of the mitigation strategies to control impact of chemical content variation.

### 7.2.5 Feedstock bale density

#### 7.2.5.1 General
High density bales of feedstock can decrease transportation costs, but density can cause problems during pre-processing. Bale density has been linked with feedstock issues such as low flowability, clogging, slow-down, and equipment shut downs, particularly when it is associated with high moisture and/or ash contents. It has also been linked to sampling issues when probe samples cannot pierce bales due to high density.

#### 7.2.5.2 Risks related to feedstock bale density
Risks related to feedstock bale density shall be assessed and an optimal bale density established.

If bale density causes trucks to exceed weight limits, or to run at less than cubic capacity, then bale density should be re-examined.

#### 7.2.5.3 Availability of feedstock at optimal bale density
Availability of feedstock at optimal bale density shall be established.

# 8 Category 5 — Feedstock scale-up risk

## 8.1 Risk factor: feedstock scale-up

### 8.1.1 Feedstock quality at production scale

#### 8.1.1.1 General
The physical and chemical properties of feedstock used in lab, pilot and field testing can fail to be representative of feedstock generated by large-scale operations.

It is important to conduct tests on feedstock representative of that which will be produced by large-scale operations. Failure to adequately test the full range of parameter values can result in severe problems during scale-up.

#### 8.1.1.2 Lab and field tests
Lab and field tests shall utilize feedstock that accurately represents feedstock variability of scale operations. Experimental design for field-scale tests should reflect all ranges of individual, and combination of, parameter values being tested.

All sampling methodology, samples and ranges used, test conditions and results, shall be documented as evidence for viable scale-up.

### 8.1.2 Capacity of supply chain components and infrastructure to scale

#### 8.1.2.1 General
Scale-up risk increases if supply chain components, or underlying feedstock infrastructure necessary for these components, cannot scale to handle the proponent’s feedstock requirements and throughput capacity. Capacity to scale should be demonstrated.

  

#### 8.1.2.2 Throughput rates and efficiencies of each supply chain component

The proponent shall demonstrate that throughput rates and efficiencies of each supply chain component are adequate for proposed plant scale.

Supply chain components should include (as applicable) planting, harvesting, densification, pre-processing, storage, and transport.

#### 8.1.2.3 Necessary underlying infrastructure component capacities

The proponent shall demonstrate that necessary underlying infrastructure component capacities are adequate for proposed plant scale.

Underlying infrastructure components should include (as applicable) land base, roads, equipment, labour, weather, regulatory, and social environments.

#### 8.1.2.4 Optimized plant size and design

The proponent's plant size and design should be optimized with the feedstock availability.

Proponent plant size should be aligned with the feedstock availability and other relevant factors.

### 8.1.3 Role of densification and pre-processing

**Note:** *Risk factor is also used in feedstock quality risk due to relevance.*

#### 8.1.3.1 General

Non-homogeneity of feedstock can be a major risk during plant scale-up. Densification and pre-processing of feedstock can de-risk scale-up by reducing feedstock variability through size reduction, drying, ash removal, densification, pelletization, or other unit operations to convert feedstock to required quality, shape, and other specifications.

Projects relying upon pre-processing (particularity in the form of pellets with consistent physical and chemical properties and high durability) have fewer quality, homogeneity, and flowability issues.

#### 8.1.3.2 Type of pre-processing and densification

The type of pre-processing and densification shall be identified (e.g., baling, pelletizing, or briquetting) including whether densification or pre-processing is done by suppliers or the proponent, and types of equipment used.

#### 8.1.3.3 Verify steady operation

The proponent shall verify steady operation of all steps of the pre-processing operation at scale.

#### 8.1.3.4 Bounds of variability of key quality specification variables

The bounds of variability of key quality specification variables post-pre-processing or densification shall be identified.

#### 8.1.3.5 Ratio of densified or pre-processed feedstock to natural feedstock

The ratio of densified or pre-processed feedstock to natural feedstock shall be determined, and such ratios shall be shown to be suitable and appropriately applied to the proponent.

### 8.1.4 Lab-scale, pilot-scale, and field scale testing

#### 8.1.4.1 General
Where feedstock supply chains need to be developed, it is necessary to establish applicability, feasibility, and practicality at commercial scale with lab-scale, pilot-scale, and, preferably, field-scale testing.

#### 8.1.4.2 Results of lab-scale testing
The proponent shall identify the results of lab-scale testing.

#### 8.1.4.3 Results of pilot-scale testing
The proponent shall identify the results of pilot-scale testing.

Lab or bench-scale testing should be followed by pilot-scale testing. Pilot tests should identify
a) consistency between lab and pilot-scales;
b) that any cost estimates conducted at production levels are consistent with results from lab and pilot tests; and
c) that assumptions made for scale-up are valid.

Pilot-scale tests should mimic a real-application environment to the extent possible, and should elicit statistically significant results.

#### 8.1.4.4 Results of field-scale testing
The proponent shall identify the results of field-scale testing.

Pilot-scale testing shall be followed by field-scale demonstrations. Data should be collected to show evidence of feasibility of scale-up to operational level.

Experimental designs for field-scale tests should reflect variabilities in different parameters, including all ranges of individual and combined parameter values being tested. Failure to adequately test the full range of feedstock parameter values could result in severe problems during actual operations and increases in operating costs.

For novel equipment used in the field or forest, manufacturers should be able to demonstrate the ability of the equipment to operate at the desired scale.

### 8.1.5 Facility start-up delays

#### 8.1.5.1 General
If facility start-up does not take place in the timeline originally indicated to suppliers, supply contracts might be terminated or breached.

#### 8.1.5.2 Significant delay in start-up
If the start-up has been significantly delayed, the proponent shall demonstrate that supply contracts are still valid and that danger of breach or termination is nominal.

  

# 9 Category 6 — Internal organizational risks

## 9.1 Risk factor: on-site inventory

### 9.1.1 Feedstock inventory days

#### 9.1.1.1 General
Feedstock inventory can be an effective mitigant of supply shortfall risk and temporary spot market price spikes for feedstock. In general, the quantity of on-site inventory maintained by the proponent should be sufficient to act as a buffer against seasonal shortfalls and temporary supply disruptions. There is no standard or best-practice number of inventory days.

#### 9.1.1.2 Schedule showing monthly feedstock inventory quantities maintained
The proponent shall produce a schedule showing monthly feedstock inventory quantities maintained.

Satellite storage yards shall count as on-site inventory if such yards are controlled by the proponent.

#### 9.1.1.3 Analysis detailing historical availability and price of feedstock
The inventory schedule shall be supported by an analysis detailing historical availability and price of feedstock in the case of existing supply chains.

At least 5 years of historical data should be used.

#### 9.1.1.4 Sensitivity modelling to anticipated disruption events
The inventory schedule shall be supported by sensitivity modelling to anticipated disruption events affecting availability and price of feedstock in the case of greenfield supply chains.

Anticipated temporary disruption events that shall be modelled include
a) regional climate;
b) regular seasonal impacts (e.g., seasonal road weight restrictions);
c) irregular weather impacts (e.g., excessive rain, cold or fire);
d) expected supplier breakdowns; and
e) pressure by existing competition.

Any expected supplier breach of feedstock quantity commitments should be considered.

#### 9.1.1.5 Inventory capacity
Inventory capacity of major competitors should be known and compared to the proponent’s inventory capacity.

### 9.1.2 Inventory degradation and contamination

#### 9.1.2.1 General
Feedstock degradation of on-site inventory can be a major source of supply chain risk. Dry matter loss, decomposition, moisture gain, and changes to chemical composition can drive the proponent’s cost and render feedstock unsuitable for further processing.

### 9.1.2.2 Expected feedstock changes and/or degradation

The proponent shall demonstrate understanding of expected feedstock changes and/or degradation during inventory, including at least

a) moisture;
b) decomposition;
c) chemical composition;
d) temperature (in relation to ignition temperature points); and
e) dirt and other contamination from ancillary sources (e.g., blowing plastics) or the ground.

### 9.1.2.3 Optimal/maximum feedstock inventory storage time

The proponent shall demonstrate understanding of optimal/maximum feedstock inventory storage time.

### 9.1.2.4 In cases where degradation is unavoidable

In cases where degradation is unavoidable, the bounds shall be mapped and potential impacts modelled, addressed, and limited.

### 9.1.2.5 Understanding of industry best practices for minimizing feedstock degradation

The proponent should demonstrate understanding of industry best practices for minimizing feedstock degradation (e.g., first-in/first-out principles).

To mitigate the risk of feedstock degradation, internal storage should be used. Agricultural feedstock may be stored in covered conditions such as warehouses or plastic tube silos.

For woody biomass, where the climate contains significant humidity, optimal feedstock pile management systems should not have piles stored for greater than one month.

For agricultural residue, feedstock should not be stored for extended periods, which can lead to significant product degradation.

## 9.1.3 Inventory fire

### 9.1.3.1 General

Inventory fire due to spontaneous combustion or arson can result in significant feedstock loss, facility shut-down, and financial impact.

### 9.1.3.2 Monitor internal temperature of inventory piles

The proponent shall monitor internal temperature of inventory piles to ensure consistent temperatures below self-ignition levels.

### 9.1.3.3 Mixing non-homogenous feedstocks within the same piles

The proponent shall not mix non-homogenous feedstocks within the same piles if risk of spontaneous ignition is determined to exist. If non-homogenous feedstocks are utilized, blending shall take place before utilization.

#### 9.1.3.4 Demonstrating internal policy governing how inventory piles are made

The proponent shall demonstrate internal policy governing:

a) how inventory piles are made (use of stackers, dozers or loaders);
b) size limits of piles (length, width, height); and
c) distance around/between piles.

The proponent shall demonstrate how these three approaches limit the impact of an ignition event.

Feedstock inventory should be stored in smaller piles/stacks or in windrow type piles so that in case of fire, combusting elements are easily separable. This should be the case especially during the first two weeks of pile/bale storage when moisture content differences are most pronounced.

#### 9.1.3.5 Developing a fire response plan

The proponent shall develop a fire response plan that outlines

a) the likelihood and impact of ignition events;
b) mitigation initiatives for such events (i.e., access to water, pile size, shape and spacing, fencing or security around piles, lightning rods); and
c) the course of action in case of a combustion event.

In cases where there is a high risk of arson or vandalism or where the impact of such events is high, feedstock should be secured.

### 9.1.4 Intake consistency and reliability of proponent

#### 9.1.4.1 General

Consistency of feedstock intake is valued by suppliers and contributes to supply chain strength. Consistency of the proponent's intake should be equal to, or better than, that of competing markets for feedstock supply of equivalent quality.

#### 9.1.4.2 Understanding the number of expected intake days

The proponent shall demonstrate understanding of the number of expected intake days, as well as number and duration of expected shutdowns.

The proponent should provide advance notification to suppliers of planned outages or shutdowns. In the case of unplanned shutdown, minimum advance notification should be given to all suppliers and specified in supplier agreements. In case of unplanned outages, monthly quantities should be prorated accordingly.

#### 9.1.4.3 Understanding the ability to continue to intake feedstock during unplanned outages or breakdown

The proponent shall demonstrate understanding of the ability to continue to intake feedstock during unplanned outages or breakdown.

#### 9.1.4.4 Understanding the consistency and reliability of intake versus local competitors

The proponent shall demonstrate understanding of the consistency and reliability of intake versus local competitors.

If intake consistency/reliability is less than local competitors, risk of supplier breach increases and inventory capacity should be increased.

## 9.2 Risk factor: internal feedstock yard operations

### 9.2.1 Receiving yard efficiency

#### 9.2.1.1 General

Efficiency of receiving yard operations directly impacts supply chain strength; yard efficiency is a function of unloading wait times, hours of operation, and required transport/unloading equipment. If receiving hours are atypical or inconvenient, or if unloading wait times are long due to congestion in the yard, suppliers are more likely to breach and supply chain integrity can be compromised.

#### 9.2.1.2 Structure of yard operations

The proponent's yard operations shall be structured in a manner that minimizes yard congestion, and supplier discharge time and cost.

Discharge time for suppliers should be less than 1 h on average. If wait times are excessive, proponent-supplier agreements should compensate the supplier for additional wait time.

If the facility is not yet built, a computer simulation should be carried out to determine the number of trucks that can be accommodated over a given time period, expected wait times, and potential congestion.

#### 9.2.1.3 Sampling and testing methods

The proponent's sampling and testing methods shall be consistently applied and based on industry standards, best practices, or be at least consistent with status quo for the region.

#### 9.2.1.4 Discharge of feedstock

Discharge of feedstock shall not require specialized equipment by suppliers.

The yard should enable discharge of most common equipment used for transport. For example, if suppliers traditionally deliver feedstock in open top dry van trailers, the proponent should not require walking floor trailers.

#### 9.2.1.5 Demonstrating yard operations benchmarking

The proponent should demonstrate that the following elements of yard operations are equal to, or better than, that of major competitors for feedstock:

a) receiving hours;
b) wait times (arrival-discharge-exit);
c) sampling and testing;
d) yard equipment; and
e) protocols for dealing with rejected loads.

The proponent should provide hours of operation that are coinciding with, or more flexible than, those of competitors.

### 9.2.2 Sampling and testing methods in yard

#### 9.2.2.1 General

It is important that sampling and testing methods accurately represent the quality of feedstock delivered by suppliers. Communication of sampling and testing procedures is necessary to ensure that suppliers understand expectations regarding feedstock quality.

Suppliers should have a direct line-of-sight between loads delivered and feedback on quality of material. Deliveries of out-of-specification material and deductions for such, if any, should be communicated promptly, and in a manner that enables suppliers to remedy issues.

#### 9.2.2.2 Responsibility

The supplier shall ensure that the necessary processes, sampling, and test methods are in place to ensure the quality of delivered feedstock.

#### 9.2.2.3 Application

Sampling and testing methods shall be consistently and promptly applied.

Samples should be tested immediately after receipt. Out-of-specification feedstock should be flagged, and issues communicated promptly to suppliers.

#### 9.2.2.4 Impact on wait times

Sampling and testing methods shall not unduly impact wait times.

#### 9.2.2.5 Communication

Sampling and testing methods shall be communicated to suppliers.

A robust guideline that includes testing method, testing frequency and data management should be specified in internal feedstock procurement protocols and communicated with suppliers.

#### 9.2.2.6 Based on industry standards

Sampling and testing methods shall be based on industry standard practices, or be at least consistent with status quo for the region.

The feedstock quality testing procedures should follow established local practices that are accepted by suppliers.

An analysis should be conducted to determine a statistically relevant sampling protocol to assure an appropriate balance of cost and quality risk. This protocol shall be implemented.

#### 9.2.2.7 Deductions for out-of-specification material

Deductions for out-of-specification material should be consistent with those for alternative markets.

### 9.2.3 Yard and equipment redundancy

#### 9.2.3.1 General

A lack of redundant equipment and infrastructure in the yard increases the impact of equipment breakdown. Major replacement parts should be available on-site to minimize impact.

#### 9.2.3.2 Building redundancy into yard equipment infrastructure
Redundancy shall be built into yard equipment infrastructure to minimize disruptions from equipment breakdowns.

Essential equipment, such as scales and truck tippers, should be given particular focus.

#### 9.2.3.3 Qualifying importance of each piece of yard equipment to the flow of feedstock
The importance of each piece of yard equipment to the flow of feedstock should be qualified and contingency plans in the event of breakdown should be specified.

Contingency plans should include
a) lists of equipment and spare parts to be held in inventory;
b) lists of nearest suppliers of essential equipment and spare parts that are not held in inventory;
c) pre-arrangements with contractors for repairs; and
d) expected timeframes for key repairs to take place.

### 9.2.4 Direct feed vs. indirect feed

#### 9.2.4.1 General
If feedstock is unloaded directly into reactor throat (or reclaimers) then control over quality is diminished and risk of quality issues increases. Discharge of feedstock on ground and subsequent loading into the reactor feed system enables visual inspections, quality testing, mixing, and, if necessary, rejection of substandard feedstock.

#### 9.2.4.2 Unloading feedstock in designated area
Feedstock shall be unloaded in designated area to allow for inspection and rejection before being utilized.

#### 9.2.4.3 Storing feedstock of different qualities
Feedstock of different qualities should be stored in a separate designated area and subsequently blended to achieve a more homogenous feed.

#### 9.2.4.4 Avoiding contamination of feedstock
An assessment should be undertaken that the surface to be used is suitable so to avoid contamination of feedstock with dirt, gravel, clay, or sand.

### 9.2.5 Smart devices in inventory management

#### 9.2.5.1 General
The use of advanced technologies in feedstock yards can lower the risk of quality variances and fire.

#### 9.2.5.2 Use of smart devices
The proponent’s inventory yard should incorporate smart devices that reduce risk of quality variances and fire.

  