HAZOP Report
SRF Handling System
Hanson Cement

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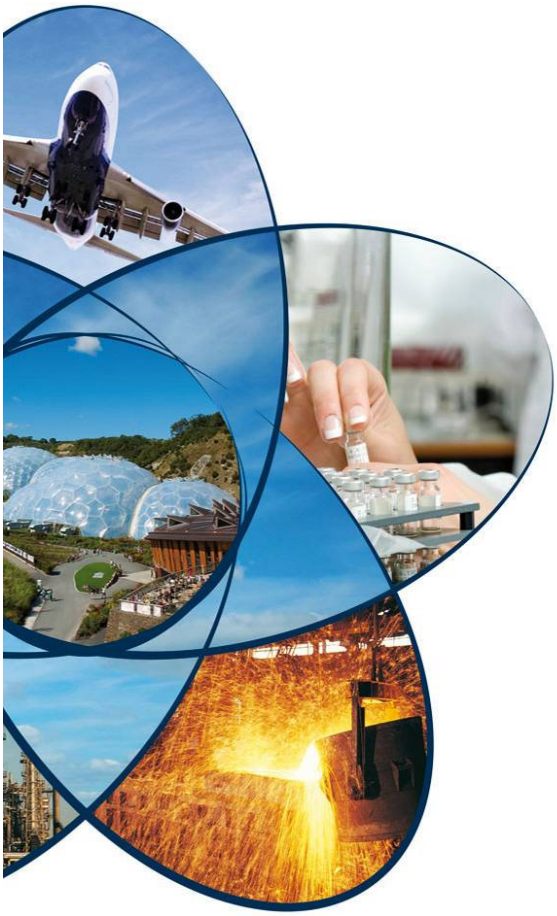

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This report is completed in good faith using a multidisciplinary team including staff and operators of the site. The procedure is a tried and tested procedure for the identification of hazards but relies on the experience and knowledge of the team members. The objective is to capture the issues raised during the studies and site tours. It is the responsibility of the operating management to ensure that statements made and stated procedures are actually in place and effectively implemented by the site. This report is not intended to be an audit of the implementation of such standards and procedures. Responsibility for the safety of the site and its operations remain solely with the operating company.

Revision history/

Rev	Version	Date	By	Notes
R0	00	29th June 2015	AT/EF	Original Issue - Draft

1 EXECUTIVE SUMMARY

This document is the output from the Stage 3 Hazard Study (HAZOP) carried out on the SRF Handling System. .

Nineteen specific actions were identified in the meeting and several actions were identified in the subsequent review. All the actions are listed in “Table 8.2 Hazop Actions” and will need to be addressed progressively by the Hanson Cement management in their respective areas of responsibility in compliance with Hanson Cement’s Safety and Environmental policy.

1.1 Conclusions & Key Issues arising from the HAZOP

1.1.1 External Fire

The system is vulnerable from fires from external sources. Vulnerability to most external fire sources is managed by the separation of the plant from other equipment. The prime residual risk comes from local equipment fires due to failures or friction. The management of these should be predominantly by the control of dust/material build-up due to leaks from the system.

The inclusion of additional passive or active fire protection measures should be guided by Hanson Cement’s insurer, as the risk is predominantly asset based.

Recommendation 1:
Implement a regular cleaning regime to ensure that build-up of material on external surfaces; especially dusts; does not occur.

1.1.2 Internal Fire

The system is vulnerable to internal fire from two sources; friction or failure of the equipment or ignition from hot gases/material from the kiln. Several actions have been raised about additional fire detection and suppression systems on the system internals and these should be followed as quickly as practical operating experience permits.

The likelihood of a fire is significantly increased if dust accumulates within the system due to inter-particle friction. Frequently early internal inspections have been recommended in the HazOp actions and this should be pursued with expediency as operating experience permits.

The kiln does not appear to pose a high risk due to the operational nature of the pneumatic conveying system relative the normal negative internal pressure of the kiln. Operating experience on similar conveying systems for kilns and boilers would suggest that efforts are best focussed on the other areas of the system.

Recommendation 2:
Review the requirement for additional internal fire detection/suppression in the areas identified in the HazOp actions.

Recommendation 3:
As per the HazOp actions the system should be checked for internal build-up of dust and cleaning or operational regimes established that remove of prevent the areas of build-up.

Contents

2 INTRODUCTION

Haztech Consultants Ltd. have been commissioned by Hanson Cement to conduct a Hazard Study (HAZOP) on their site at Coventry for the SRF system.

3 PLANT DESCRIPTION

The SRF system consists of the following main plant elements:

1. The SRF trailer (moving bed system and hydraulic system),
2. Unloading facility (docking station and twin conveying screws),
3. Drag chain conveyor,
4. Ferrous Separator (including reject bin),
5. De-agglomeration / screening (oversize removal, including the reject bin) / transfer screw conveyor,
6. Pre-weigh hopper and dosing valve,
7. Rotary valve and pneumatic conveying system (including blower system).

Some components were grouped because they are physically close-coupled, thereby any hazard would impact all the items; contain the same threats to the system and their normal operational functionality is tightly interlinked.

4 HAZOP

4.1 Scope of HAZOP

The scope of the study covered the whole FRS system. This includes the SRF delivery trailer under discharging operations, but excludes the positioning of the trailer. The transfer of SRF is followed all the way through to the kiln inlet, and includes the ancillary subsystems that are required for the SRF system to function.

4.2 Reference Documents

Hanson Cement provided layout, General Arrangement and mechanical drawings, which were displayed on an overhead projector during the meeting. These documents have not been reproduced or appended to this report and reference should be made to suitably dated master drawings held by Hanson Cement.

5 METHODOLOGY

5.1 Hazard Study Aims

Hazard Studies are a set of studies, usually six, carried out on Projects to ensure that Hazards are identified understood and properly controlled. The studies can be carried out on new or existing processes or on modifications. In addition to exposing safety, health and environmental issues they can also identify obstacles to operability. The technique applied depends on the stage of the study/project and some studies can use a guide diagram approach to identify hazards (e.g. Hazard Study Type 2). Others can be based on a checklist approach to prompt lateral thinking of deviations from design intent (e.g. Hazard Study 3 - often referred to as HAZOP). .

The HAZOP team discussed and agreed the limits of the study, the extent of each node of the facility, and the parameters that would be considered for each node using a P&ID provided by Bladon Jets. Prior to the plant study the Bladon Jets personnel gave the Haztech representatives a familiarisation tour of the process area.

The activities carried out on the fuel system facility are essentially batch processes. Certain key parameters were considered for each Node of the facility and Guide Words were used to systematically examine each key parameter in each Node. The key parameters were Flow/Speed, Temperature, Pressure, Moisture Content, Static, Composition/Concentration, Start-up, Shutdown, Commissioning, Maintenance / Guarding / Isolation, Equipment Registration, Materials of Construction, Level, General, Control System (Failure), Effluent (compatibility), as well as Shared Equipment and Services.

The Guide Words used are included in the table below (see overleaf). The HazOp tables include only the relevant guidance for each parameter.

Key plant activities were identified. The Hazard Study Leader applied the checklist of prompts referred to in the table systematically for each of the plant activities and team members contributed to identifying potential deviations from design intent. These were displayed to the team on a projector using Hazard Summary Tables.

The use of these tables is one method that ensures both thoroughness and consistency in conducting the study and recording the findings. Such tables provide a corporate knowledge for subsequent operational management to reference when making any future changes and/or training new staff, because they provide a concise summary of issues considered and key control measures provided. The tables (in Section 8.1), provide a concise summary of the hazards examined and their relevant control measures

The Hazard Study Leader applied the guidewords to each of the key parameters in turn in each node. The personnel from Bladon Jets then contributed by using their expertise to identify potential deviations from normal processing. The studies rely on multi-disciplinary teams to provide knowledge and experience that facilitates effective recognition of potential hazards and operability issues. A key objective is to eliminate hazards if at all possible by making the process inherently safe. This is not always possible so the Hazard Study team must agree on the most appropriate control measures that minimise the likelihood of an event occurring and mitigate the consequences.

Guide Word	Meaning	Example of Deviation
NO (NOT OR NONE)	The activity is not carried out or ceases	No flow in pipe No reactant charged to process Batch not cooled Check omitted No catalyst, etc.
MORE OF	A quantitative increase in an activity	More (higher, longer) quantity, flow, temperature, pressure, batch, concentration, time
LESS OF	A quantitative decrease in an activity	Less (lower, shorter) of above.
MORE THAN OR AS WELL AS	A further activity occurs in addition to the original activity	Impurities present, extra phase (solid or gas in liquid phase) extra (unplanned) process operation
PART OF	The incomplete performance of an activity	Reduced strength, missing component, operation only part completed
REVERSE	Inversion of the activity	Back-flow or back-pressure Heat rather than cool
SOONER/ LATER THAN	An activity occurring at the wrong time relative to other activities	The activity occurs at the wrong time
OTHER (THAN)	A different activity, material etc.	Wrong material charged, Non-routine conditions, start-up, shut-down, maintenance; cleaning, etc Failure of services

All the prompts were systematically addressed, but if issues were not relevant, had been addressed previously or if there were no further specific control measures and/or actions relevant, then this was recorded in the tables.

5.1.1 Key Plant Activities

The main operations carried out on this plant are:

1. Trailer offloading;
2. Transfer to the “filtering” system;
3. Buffering material for transfer to the kiln; and
4. Pneumatic conveying material to the kiln.

These operational sequences were used as the basis for the nodes within the HazOp.

5.2 Roles/Responsibilities

5.2.1 The Hazard Study Leader

He is responsible for ensuring that team members have an understanding of the hazard study process and for leading the team, carefully, through each step of that process. In order to achieve maximum effectiveness with full involvement of all team members, the Leader must maintain control and harmony during the meeting and avoid confrontation within the team. He/she is responsible for ensuring that the detail of the meeting and any actions are adequately and unambiguously recorded.

5.2.2 The Hazard Study Secretary

He is responsible for collating the process details, line diagrams and other documentation required for the study. He will document, concisely, the hazards identified during the meeting, their possible causes and consequences, any existing control measures and any actions for follow up work.

He will disseminate the action list, compiled during the meeting, to members as soon as practical after the meeting. The Study Secretary is also responsible for pulling together the backbone of the report before he and the Study Leader compile the details of the report.

5.3 Experience of Haztech personnel

The HAZOP team leader, Ed Fish, (First degree Chemistry and Biochemistry, Masters Degree Biomechanical Eng, Chartered Engineer) has broad experience in the fine chemical and pharmaceutical sectors as a design and safety engineer with both manufacturing companies and with major design houses. He spent 4 years working with ICI and its subsidiaries as a project/process engineer with a key focus on project safety. For the last 9 years he has been engaged as a Principal Associate with Haztech Consultants Limited focussing on Hazard Studies, risk assessments, design and safety engineering and relief systems..

The HAZOP secretary, Alan Tyldesley, is a former HSE Inspector and expert in the field of powder and dust explosions and fires. For the last 12 years he has been engaged as a Principal Associate with Haztech Consultants Limited focussing on Hazard Studies, fire and dust risk assessments.

5.4 Record of HAZOP Meetings

The HAZOP was conducted on a single day as per the record below: -

Meeting No. / date / Section

No.	Date	Section
1	25-Jun-205	ALL

5.5 HAZOP Team members

Name	Organisation	Role	Meeting No.		
			1		
Ed Fish	Haztech Consultants Ltd.	Hazard Study Leader	✓		
Alan Tyldesley	Haztech Consultants Ltd.	Hazard Study Secretary	✓		
Geoff Seal	Hanson Cement	Project Leader / Control and Electrical Engineer	✓		
Victoria Smith	Hanson Cement	Environmental Chemist	✓		
Elliot Wellbelove	Hanson Cement	Process Engineer	✓		
Stuart Mitchell	Hanson Cement	Production Engineer	✓		
David Quick	Hanson Cement	Plant Manager			

6 PROCESS DESCRIPTION

The sections below describe the material handled and the process and general control principles.

6.1 Material Characteristics

The material used in the process is SRF (Solid Recovered Fuel). Hanson Cement has a detailed specification for the material handled and the salient elements for the HazOp are summarised below:

- Particle size <40mm (in any dimension)
- Particle size <5mm (in at least 1 dimension)
- Water content <20% (typical <16%)
- No sawdust
- No coffee grounds
- No dust content

6.2 Process Description

Material is discharged batch-wise on demand from the (low) level in the pre-weigh vessel. The level in the offloading facility twin-screw feed area provides a permissive on “low” level; further material cannot be discharged from the trailer until material the in the offloading has reached a “low level”.

The offloading screw conveyors are variable speed and increase in speed if the level in the pre-weigh hopper falls. The drag chain conveyor uses the same control signals to increase and decrease speed in line with the pre-weigh hopper level.

The De-agglomerator, Magnetic Separator, Screening system and pre-weigh vessel feed conveyor are all fixed speed devices that transfer material to the pre-weigh vessel. These items provide a collective removal of oversized or foreign materials. Ferrous materials are rejected into one bin and oversized materials into a second bin. It should be noted that most oversized material is foreign matter rather SRF material that exceeds the specification.

Material is held in the pre-weigh vessel and discharged at a controlled rate to pneumatic conveying system. There is one valve that controls the feed rate based on the kiln demand and a second valve, which is notionally part of the conveying system.

The second valve is a rotary air lock that operates at a fixed speed and passes material into the pneumatic conveying system. The pneumatic conveying is carried out at approximately 0.2 barg (200 mbarg) using a blower. The piping rises to approximately half the height of the kiln where the material passes through an isolation valve that is closed in the event of high pressure (e.g. positive pressure) in the kiln.

7 REFERENCES

1. ICI Process SHE Guide No13 - Hazard Study Methodology, May 1997.

2. Haztech Consultants Ltd. HAZOP Study Proposal

8 ATTACHMENTS

1. HazOp Summary Tables
2. HazOp Actions Table
3. Diagrams

8.1 HAZOP Tables

HazOp tables are included for the following nodes:

1. Offloading (trailer/moving bed)
2. Unloading Facility
3. Drag chain conveyor
4. Ferrous Separator (including reject bin)
5. De-agglomeration; Screening / oversize (including reject bin) and twin screw transfer conveyor
6. Weighing / Dosing (hopper & valve)
7. Pneumatic conveying

8.1.1 Table 1

Deviation	Causes	Effect or Consequence	Measures to minimise Likelihood or Consequences	Action No.
Step/operation (line): Offloading trailer two docking stations, 2 moving floors,				
Drawing(s)				
Flow – High Speed - High	No off signal, level transmitters fail high	Spillage, paper and plastic chips, inside building not likely to blow around, potential damage to equipment	Hydraulic power should not overheat, fixed speed, CCTV supervision	
Flow – Low Speed - Low	Low pressure on hydraulic supply	Prehopper level falls	Alarm , coal feed takes over in case of loss of SF supply no hazard	
Flow – No Blockage	Mechanical failure, belt snapped	As above	Second offloading station can cut in	
Flow – Reverse Rotation - Reverse	Incorrect connection	insignificant	Control room can see no delivery, low belt speed	
Pressure - High		Leak of hydraulic fluid	Pressure relief on hydraulic system	1
Pressure - Low	As for low flow			
Temperature – High, other sources of ignition	Vehicle fire		Tractor unit removed during unloading	
Temperature - Low	Freezing conditions	Potential for flow blockage	Control room can see no delivery	
Moisture content - High		Potential for flow blockage	Control room can see no delivery	
Moisture content - Low	No hazard			
Static Build-up	Low probability	Material sticks together	Low speed of movement, high moisture content No issue	
Concentration - High	High long staple fibre content	Blockages, maintenance	No issue from change in mix of paper, plastic, but high fibre content can cause entanglement	
Concentration - Low	No issue			
Contaminants	Recovered fuel from secondary sources	Poor quality control by supplier	No experience of problems elsewhere	
Start-up - testing	Fault in power system to moving floor	Reverse direction of belt, leak from hydraulic system	Operator present at start up, drains sealed to prevent hydraulic fluid in water course,	2

Deviation	Causes	Effect or Consequence	Measures to minimise Likelihood or Consequences	Action No.
Step/operation (line): Offloading trailer two docking stations, 2 moving floors,				
Drawing(s)				
Shutdown - testing			System allows this to be stop started	
Commissioning	No issues identified			
Maintenance / Guarding / Isolation	Hot work	fire	PtW, need to ensure clearance fuel from equipment Only trained staff members can issue permits Not responsible for trailer faulty trailer dealt with on site by 3rd party, trailer on legs cannot roll away. Hydraulic connections are transferred from tractor unit to site power	
Equipment registration	N/A		Equipment owner responsible for trailers	
Materials of Construction				
Level - High	No issue			
Level - Low	Incomplete filled trailer	No consequence	Each delivery checked at weighbridge	
Control System -failure	Incorrect sequence of starting	Spillages or blockages	Low hazard, control system starts pneumatic system, then weigher, then trailer discharge, no hard wired interlocks, no significant hazard	
Effluents – compatibility	spillage	Enclosed bay, should not blow around	Product spill can be swept up	
Shared Services Electrical failure		Whole system stops		
Shared Services Compressed Air failure (control actuation)		Curtains may not close, any spilt product more likely to escape from bay		
Shared Services Nitrogen failure	N/A			
Shared Services Fire Water failure	Freezing, affects firefly and disc screener spray heads	Loss of fire protection	Pressure switch on water supply, system will be shut down, 250l static tank, fire hydrant available nearby	

8.1.2 Table 2

Deviation	Causes	Effect or Consequence	Measures to minimise Likelihood or Consequences	Action No.
Step/operation (line): Unloading screws				
Drawing(s)				
Flow – High Speed - High	Both trailers at same time	Downstream spillage, top of chain conveyor	Hydraulics currently configured to only work one moving floor at same time Screws have overload protection: high temperature and high current, capable of running product from both discharge bays	
Flow – Low Speed - Low		Low level alarms in pre-hopper Spillage possible	Detected by change in kiln temperature, and increased coal consumption, no hazard	
Flow – No Blockage	See above			
Flow – Reverse Rotation - Reverse			Build-up of fuel at outer ends of screws, no hazard	
Pressure - High	NA			
Pressure - Low	NA			
Temperature - High	Smouldering material in trailer	Burning material spreads	Firefly system designed to detect and protect downstream plant	
Temperature - Low			No hazard	
Moisture content - High			No hazard	
Moisture content - Low			No hazard	
Static Build-up	Too wet			
Concentration - High	N/A			
Concentration – oversize, excess fibre			blockages	
Contaminants			Switching suppliers has not previously caused problems, no experience of metal contaminant	
Start-up - testing			See previous table, can start from any condition	

Deviation	Causes	Effect or Consequence	Measures to minimise Likelihood or Consequences	Action No.
Step/operation (line): Unloading screws				
Drawing(s)				
Shutdown - testing				
Commissioning				
Maintenance / Guarding / Isolation		Access to screws while rotating	Floor cover moved into position before trailer driven away, with hard wired interlock, castell key system restricts access to rear, light beam detection across the front	
Equipment registration	Firefly water tank as pressure vessel			3
Materials of Construction	Some plastic parts may have limited lifetime		No issue	
Level - High				
Level - Low				
Control System -failure			See previous table	
Effluents – compatibility	N/A			
Shared Services Electrical failure			No issues	
Shared Services Compressed Air failure (control actuation)				
Shared Services Nitrogen failure	N/A			
Shared Services Fire Water failure				
Delivery Driver actions		Smoking	No smoking area, drivers don't approach plant	

8.1.3 Table 3

Deviation	Causes	Effect or Consequence	Measures to minimise Likelihood or Consequences	Action No.
Step/operation (line): Drag chain				
Drawing(s)				
Flow – High Speed - High		overheating	Plastic flights and chain guides	
Flow – Low Speed - Low	Broken flights	Loss of feed to kiln	No hazard	
Flow – No Blockage			Variable speed chain controlled by feed weigher Opening hatch at delivery end to release product if downstream is blocked, hard wired trip for open hatch, restricts access to moving parts Thermal and overcurrent protection on motor Rotation monitor for snapped chain	
Flow – Reverse Rotation - Reverse		Chain flows, material falls back		4
Pressure - High	N/A			
Pressure - Low	N/A			
Temperature - High			Bearings outside the casing	5
Temperature - Low				
Moisture content - High				
Moisture content - Low				
Static Build-up			Vecoplan marked as ATEC compliant	
Concentration - High	N/A			
Concentration - Low	N/A			
Contaminants	N/A			
Start-up - testing				
Shutdown - testing				

Deviation	Causes	Effect or Consequence	Measures to minimise Likelihood or Consequences	Action No.
Step/operation (line): Drag chain				
Drawing(s)				
Commissioning				6
Maintenance / Guarding / Isolation	Can be operated in isolation when in maintenance mode		training	
Equipment registration	N/A			
Materials of Construction			Routine maintenance requirements from manufacturer	
Level - High	See flow			
Level - Low	See flow			
Control System -failure			Loss of SF feed to kiln	
Effluents – compatibility	Damaged casing,		Potential for release outside any building, easily visible, low hazard	
Shared Services Electrical failure	N/A			
Shared Services Compressed Air failure (control actuation)	N/A			
Shared Services Nitrogen failure	N/A			
Shared Services Fire Water failure	N/A			

8.1.4 Table 4

Deviation	Causes	Effect or Consequence	Measures to minimise Likelihood or Consequences	Action No.
Step/operation (line): Mag separator, metal chute and 8m3 (0.3 t/m3) bin; fixed speed permanent magnetic drum, fuel delivered to separate chute				
Drawing(s)				
Flow – High Speed - High	Flow of product N/A			
Flow – Low Speed - Low				
Flow – No Blockage		No hazard		
Flow – Reverse Rotation - Reverse	Magnetic separator can run in reverse		Checked during commissioning, needs to be checked after relevant maintenance work	
Pressure - High	N/a			
Pressure - Low	N/A			
Temperature - High				7
Temperature - Low	N/A			
Moisture content - High			Condensation/ dust drying out	
Moisture content - Low				
Static Build-up	N/A		ATEX rated magnetic separator	
Concentration - High	Excess metal		Need to identify batch and challenge supplier	
Concentration - Low				
Contaminants	Range possible,			
Start-up - testing				
Shutdown - testing				
Commissioning				8
Maintenance / Guarding / Isolation			3 inspection hatches, Rittal key plus tool needed to open inspect for build-up of fibrous materials	

Deviation	Causes	Effect or Consequence	Measures to minimise Likelihood or Consequences	Action No.
Step/operation (line): Mag separator, metal chute and 8m3 (0.3 t/m3) bin; fixed speed permanent magnetic drum, fuel delivered to separate chute				
Drawing(s)				
Equipment registration	N/A			
Materials of Construction			Wear anticipated	
Level - High	blockage	Bin overfill	Paddle level detectors planned System designed to maintain set level	9
Level - Low	No issue			
Control System -failure		Loss of feed to kiln	No hazard	
Effluents – compatibility	Tramp metal in feedstock	Excessive quantities of tramp metal	Metal collects in open skip, needs to be checked at regular intervals.	10
Shared Services Electrical failure	No issue			
Shared Services Compressed Air failure (control actuation)	N/A			
Shared Services Nitrogen failure	N/A			
Shared Services Fire Water failure	N/A			
Close approach	Permanent magnets	Affects pacemaker wearers		11

8.1.5 Table 5

Deviation	Causes	Effect or Consequence	Measures to minimise Likelihood or Consequences	Action No.
Step/operation (line): twin rotating drum deagglomerator and star disc screener with reject bin indoors and twin screw conveyors				
Drawing(s)				
Flow – High Speed - High		Designed for max potential feed	Low speed monitors on rotating parts	
Flow – Low Speed - Low				
Flow – No Blockage				
Flow – Reverse Rotation - Reverse	Wrong rotation	System blocks up		
Pressure - High	N/A			
Pressure - Low	N/A			
Temperature - High	Oversize gets stuck in system	fire		12
Temperature - Low				
Moisture content - High	High water content of feed	Excess material rejected		
Moisture content - Low				
Static Build-up		N/A slow moving plant		
Concentration - High				
Concentration - Low				
Contaminants				
Start-up - testing				
Shutdown - testing				
Commissioning				13

Deviation	Causes	Effect or Consequence	Measures to minimise Likelihood or Consequences	Action No.
Step/operation (line): twin rotating drum deagglomerator and star disc screener with reject bin indoors and twin screw conveyors				
Drawing(s)				
Maintenance / Guarding / Isolation			Access hatch at reject end with safety interlock for power, other inspection hatches bolted closed	
Equipment registration			List of ATEX equipment on register, outside contractor	
Materials of Construction				
Level - High	Blockage in delivery chute		Consider paddle probe to detect blockage	
Level - Low				
Control System -failure	error	Shut down		
Effluents – compatibility				
Shared Services Electrical failure			Overcurrent and motor temperature protection	
Shared Services Compressed Air failure (control actuation)				
Shared Services Nitrogen failure				
Shared Services Fire Water failure			To be installed	

8.1.6 Table 6

Deviation	Causes	Effect or Consequence	Measures to minimise Likelihood or Consequences	Action No.
Step/operation (line): Weighing system, pre-hopper and reverse jet filter and rotary feeder				
Drawing(s)				
Flow – High Speed - High	Overfilling weigh vessel RJ air valve sticks open	Back up to screws Air leaks to atmosphere	High level probe, screws trip on overload Operator identifies, no hazard, excess use of compressed air	
Flow – Low Speed - Low	Loss of compressed air	RJ filter blocks	Air leaks in reverse through process, potential for explosion vent panel to open	14
Flow – No Blockage	Rotary valve trips		Loss of feed to kiln, no hazard	
Flow – Reverse Rotation - Reverse				
Pressure - High				
Pressure - Low	See blockages			
Temperature - High	Fire from upstream	Burning in filter	Process instructions are to stop upstream processes and blow forward to kiln	15
Temperature - Low	N/A			
Moisture content - High			No hazard	
Moisture content - Low			No hazard	
Static Build-up	Unusually dry product	Poor flow	Slow movement	
Concentration - High				
Concentration - Low				
Contaminants	Tramp in system	Rotary valve jams	Motor trips on overcurrent, whole system stops, shows on control room, no hazard	
Start-up - testing				
Shutdown - testing				
Commissioning				

Deviation	Causes	Effect or Consequence	Measures to minimise Likelihood or Consequences	Action No.
Step/operation (line): Weighing system, pre-hopper and reverse jet filter and rotary feeder				
Drawing(s)				
Maintenance / Guarding / Isolation	Need to remove rotary valve	various	Spilt fuel, but low hazard	
Equipment registration	Is system designed as pressure system and registered as such			13
Materials of Construction	See other tables			
Level - High	No issue			
Level - Low	No issue			
Control System -failure	No issue		Facility to restart separately from rest of process	
Effluents – compatibility	N/A			
Shared Services Electrical failure				
Shared Services Compressed Air failure (control actuation)				
Shared Services Nitrogen failure	N/A			
Shared Services Fire Water failure				

8.1.7 Table 7

Deviation	Causes	Effect or Consequence	Measures to minimise Likelihood or Consequences	Action No.
Step/operation (line): Pneumatic conveying, 90kw aertzon blower, isolation valve(s)? at calciner entry, pneumatic open, spring closed,				
Drawing(s)				
Flow – High Speed - High	Set to operate at single flow rate		No hazards, operational efficiency impact only flow conditions2-5 kg/Nm3, < 0.5 bar	
Flow – Low Speed - Low		Product settles out in horizontal system		17
Flow – No flow into kiln	Rodding point left open	Fuel blown around preheater tower	Potential source of fire	18
Flow – Reverse Rotation - Reverse	Loss of blower pressure and positive pressure from kiln	Hot gases into conveying system	Isolation valves, fuel drops out of flow	
Pressure - High	No issue			
Pressure - Low				
Temperature - High	See above		Conveying air not hot enough to soften plastics	
Temperature - Low				
Moisture content - High				
Moisture content - Low				
Static Build-up	No issue		Earth bonding throughout	
Concentration - High	No process issue		Controlled by calorific value	
Concentration - Low				
Contaminants	No issue			
Start-up - testing	Potential for blockage			
Shutdown - testing				
Commissioning				
Maintenance / Guarding / Isolation		Potential for hot gas escape	Covered by existing procedures for work on live system	
Equipment registration	N/A			

Deviation	Causes	Effect or Consequence	Measures to minimise Likelihood or Consequences	Action No.
Step/operation (line): Pneumatic conveying, 90kw aertzon blower, isolation valve(s)? at calciner entry, pneumatic open, spring closed,				
Drawing(s)				
Materials of Construction	erosion	Loss of wall material	Need to inspect selectively for wear	19
Level - High	Rotary valve pockets fail to clear	Low flow to kiln	No issue	
Level - Low				
Control System -failure	As above			
Effluents – compatibility	As above			
Shared Services Electrical failure				
Shared Services Compressed Air failure (control actuation)				
Shared Services Nitrogen failure	N/A			
Shared Services Fire Water failure	N/A			

8.2 HAZOP Actions

Table 1 HAZOP Actions

No.	Action	Resp
1	Where does the hydraulic relief valve open?	GS
2	Quantify fluid inventory of the hydraulic system.	GS
3	The Firefly pressure tank is to be added to the Pressure Vessel register for testing.	GS
4	Adjust at commissioning minimum speed setting for trip based on product fall back. Is there any anti runback device?	GS
5	Look for evidence of dust build-up at commissioning	GS
6	Determine fuel depth in conveyor at different delivery rates	GS
7	Periodic check for dust build-up; potential hot spots leading to increased fire risk.	GS
8	Check performance of magnetic separator	GS
9	Need and location for additional paddle level detectors to be reviewed during commissioning	GS
10	Include checking of tramp metal bin in operating procedures	GS
11	Consider warning sign in the area of the Magnetic Separator relating to risk to people with pacemakers	GS
12	Consider water spray protection on screener (Awaiting DSEAR assessment)	GS
13	Periodic Review of what collects in oversize reject bin, consider water spray if the material is not predominantly inert.	GS
14	Review consequence of reverse flow and overpressure in the bag filter pulsejets	GS
15	Consider over temperature detection for fire from upstream equipment in the pre-weigh vessel.	GS
16	See what company policy is for equipment protected by venting from dust explosions, and check to see if requires registration as pressure equipment	GS
17	Consider need to trip fuel on low air pressure from the blower	GS
18	Check procedure for ensuring plant is boxed up before restart	GS
19	Add SRF pneumatic conveying piping wall thickness checks to maintenance schedule	GS