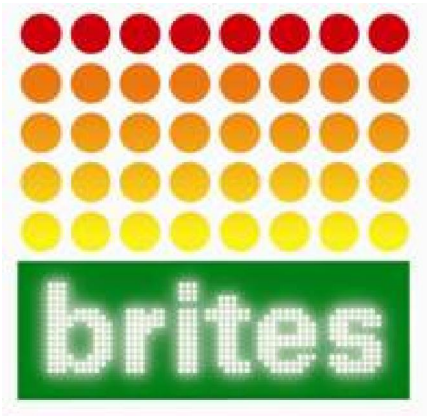


PRE-DELIVERY AND DESIGN CHECKLIST

FOR *BRITES* PELLETS

COMMERCIAL CLIENTS

May 2009

BALCAS PRE-DELIVERY AND DESIGN CHECKLIST FOR *BRITES* PELLETS – COMMERCIAL CLIENT

Balcas is the UKs No. 1 manufacturer of quality wood pellets. Our two manufacturing facilities in Northern Ireland and Scotland have a total capacity of 155,000 tonnes per annum. The following guide is written for specifiers, clients and boiler installers. Its intention is to give an insight to how we produce high quality pellets and what we offer as pellet delivery systems. It is also written to ensure that potential problems in using wood pellets as a fuel are minimised and that the appropriate design features for pellet silos and pellet deliveries are included.

SUMMARY

- Does your site have access for a truck delivery - dimensions 10-12m (L) x 3.9m (H) x 2.5m (W) and turning circle 20m to 18m? (the figures are for a rigid 3-axle vehicle and articulated vehicle respectively, i.e. a longer length but shorter turning circle for the articulated vehicle).

- Is the distance from the lorry to the pellet store within 20 metres – horizontal or vertical? This is the maximum we normally recommend for a standard pressure delivery at 0.5 to 0.7bar. If the answer is No - see below.

- If the distance is greater than 20m but less than 30m Balcas can deliver, but a site inspection would be needed to determine the extent of potential damage to the pellets from blowing at higher pressure. A client disclaimer accepting some damage to the pellets may need to be agreed.

- All commercial sites will require a site visit from a Balcas member of staff or representative.

- If the pellet silo is on an above ground floor or in an industrial tall silo, we can also offer a 20m delivery distance with guarantees. There needs to be a ‘soft’ bend at the top of the delivery route into the silo. During the very first delivery to a tall silo there could be some damage to the first pellets. This can be avoided by hand positioning of some bagged *Brites* at the base to cushion the pneumatically delivered load. If this is not possible then some limited damage to pellets is possible but this should have passed through the boiler system during the commissioning. Thereafter the client should ensure that the silo is not empty before a new delivery is made to minimise damage.

- Have you fitted at least two Storz A (or Cam-lock A400) fittings to enable the lorry to blow into the store and allow delivery air and dust created during delivery to escape? The second inlet can also be used to distribute the pellets more evenly across the pellet silo.

- Is the Storz A or Cam-lock fitting within the driver’s reach? (Chest height or lower is recommended). A pellet inlet pipe that requires a delivery driver to climb a ladder or platform is not acceptable.

- If there are extension inlet pipes into the store, such as in a longer, narrow store, they should be positioned approximately 20% and 50% along the length of the store to ensure even distribution of pellets in the silo.

- Is your store waterproof all year round and sufficiently vented via an exhaust pipe to allow dust to be removed when pellets are delivered?

- Is there sufficient ventilation in the store to prevent condensation build-up? This is particularly important with underground silos.

- Is the store air tight to prevent dust migration? This includes waterproof sealant at corners, joints, access points for pellet pipes and maintenance doors. A double Z-seal is advised for any access and maintenance doors.

- Is your store of sufficient strength to hold at least 10 m^3, approximately 6 tonnes, of wood pellets? The Balcas minimum for blown delivery is 4 tonnes and the lowest prices are available for loads of 16 tonnes or above so **Bigger is Better**.

- To calculate effective pellet silo volume, assume that only 65% of the total volume of the space is 'useful' volume for pellets once an inclined base is constructed.

- Is there a minimum floor slope of 40^o towards the feed/auger mechanism?

- Does your store have sufficient volume for at least three weeks storage? This allows less frequent deliveries. For larger projects a more frequent delivery is viable but taking account of holiday periods and bad weather, bigger storage does increase the flexibility of fuel ordering for the client.

- How many bends has the pellet intake pipe got? Two or less are recommended. Make sure the bends are 'soft', minimising pellet damage, with a radius of no less than 300mm and ideally 500mm. We can deliver pellets with greater than 2 bends but each additional bend increases damage to the pellets. We may have to assess the design or visit the pellet silo where there are more than 3 bends.

- Has your store got a flexible rubber cushion mat hung opposite the inlet pipe and in front of any far wall? This will limit pellet damage during delivery - it is essential that pellets are not blown against a wall or hard floor. The mat should not be placed immediately in front of the pipe but in front of any hard surface where the pellets are directed.

- Has your silo design been assessed for potential explosion risk? Though there is an extremely low risk if design good practice is followed, where fine dust is may be created there is a potential for explosion.

- An explosion risk mitigation assessment should include issues such as: earthing the pellet delivery pipes and delivery vehicle, the absence of electrical appliances in the silo, air-tightness, and separation between silo and boiler room. A clear three-pronged strategy should focus on 1) specifying Grade 1 quality pellets such as *Brites*, 2) minimising dust creation through good design, and 3) reducing ignition possibilities via earthing and keeping electrical equipment away from the internal pellet store. It may be appropriate, in the very rare event where an explosion is felt to be possible, to provide relief for the potential blast pressure created. Reference should be made to the DSEAR 2002 regulations (The Dangerous Substance and Explosive Atmosphere Regulations) and BS EN 14491:2006 'Dust Explosion Venting Systems'.

- A post installation check should be made by the consultant and client representative of the pellet silo and other related pellet fuel delivery measures to ensure that they have been installed properly to the proposed design.

- If your fuel handling system is primarily for wood chip fuel it can usually be utilised for wood pellet systems as well. This includes rotary agitators, walking floors and hook bin systems. There may be weight restrictions on fuel capacity however as wood pellets are generally more than 3 times as dense as wood chip.

- What is the length of the pellet auger? Augers longer than 8-10m may require a second auger to avoid pellet damage.

- Is your store free of electrical sockets, electrical fittings, lights and switches t prevent possible explosion with fine dust build up?

- At the annual or major service the pellet silo should be allowed to empty and cleaned out. Any residual dust on walls, the inclined floor or in the auger should be cleared to ensure there is no build-up over time.

Stewart Boyle
Business Development Manager – Southern England, Midlands and Wales
Mobile: 07980 076599 ; stewart.boyle@balcas.com

Alistair McGlynn
Business Development Manager – Scotland and N England
Mobile: 07912 652040 ; alistair.mcglynn@balcas.com

Disclaimer: *This Design Guide is provided by Balcas purely to assist designers and clients in avoiding poor design choices for pellet silo and delivery, which subsequently cause operational difficulties and potentially increase the running costs of the pellet boiler system. It reflects the practical experience of the issue as a provider of pellet fuel to many thousands of clients and silos since 2005. It is not intended to offer full design guidance or specific guidance on a unique project and we do not accept any liability for the views expressed in the Guide. Nor is it intended to give detailed legal advice on relevant regulations and legislation. The individual circumstances of each project must always be considered by the consultant or designer and further detailed advice sought where appropriate.*

NB. A separate guide will be available for domestic clients later this year.

ADDITIONAL DETAIL FOR PELLET SILO AND DELIVERY DESIGN

1. Total Quality Design – from sawdust to boiler

Balcas stress quality in all stages of its production and delivery of *brites* pellets. This includes regular checking during production every 30 minutes, and the testing of every load before it is delivered, or pre-screened to remove fines before being loaded into vehicles. The main tests carried out are specifically for durability and fines. We also test for moisture content. This ensures that under test the pellets have greater than 97.5% durability and less than 0.7% fines respectively. Balcas *Brites* pellets are also tested through independent laboratories to ensure full adherence to the CEN/TS 14961 European specification for pellets (see full specification in Annex 1).

Balcas 55,000t/yr Pelletising and CHP Plant, Enniskillen

Pellet mill (100,000t/yr capacity) and CHP plant, Invergordon, Scotland

Pellets Being Tested for Durability and Fines Content

Pellets from Scotland being put through a Screening Plant in Essex

Dust and Fines Extracted at Screening Plant

2. Pellet silo design

Pellet silos can be constructed in a variety of ways. These include pre-constructed modular metal (tall or low) or plastic systems, flexible bag systems, or bespoke constructed silos in blockwork-brick and wood inclined base. Balcas have delivered pellets to a wide variety of pellet silos so we have extensive experience over what type of silo works and what does not. The critical aspects of pellet silos for effective design and trouble-free operation are:

Volume Calculation

- Design the silo with sufficient volume to minimise the frequency of deliveries and access the cheapest price for fuel. The cheapest fuel options are for 16 tonnes or above. Taking account of the reserve in fuel needed when ordering new fuel, this requires an effective volume of 30m^3. 1 tonne of pellets occupies 1.65m^3 volume.
- To calculate the effective volume of a fuel silo, assume that only 65% of the gross volume of the silo space is available after the inclined base is installed.

Dust Creation and Potential Explosion Risks

- All silos should include a rubberised cushion mat in front of any hard surface such as a wall to prevent damage to the pellets on delivery (see Figure 2 below).
- Sharp angles and surfaces should be avoided to reduce the potential for making dust, as should void areas where dust can collect.
- Dust and any associated explosion risks should be taken account of when designing the silo. **A three-pronged risk mitigation strategy** should be developed. This means a strategy based on 1) procuring quality wood pellets such as *brites* to minimise disintegration and fines (pellet providers should be manufacturing to the CEN TS14961 standard or equivalent, with a total quality approach to manufacturing), 2) designing a pellet silo and delivery route that minimises dust creation, and choose a pellet provider with trained drivers who deliver at an appropriate pressure (no greater than 0.7 bar), and 3) reducing dust ignition by ensuring that no electrical appliances and electrical cables are located in the silo, and that pellet fill pipes and the delivery vehicle are earthed.
- The dust explosion risk mitigation strategy should ensure that there is clear separation between the silo and the boiler room; that the silo is air tight or a filter is available around any vent, that pellet fill pipes do not have many sharp bends causing pellet disintegration, and that a cushion mat is fitted to prevent pellets hitting hard surfaces. To mitigate any potential explosion, however remote that may be, explosion relief to the exterior world could be assessed for possible incorporation where that might be appropriate. The appropriate DSEAR regulations for explosive substances should be consulted, as should BS EN 14491:2006 for design of dust explosion venting protection systems.

Pellet Level Inspection and Sensors

- Sight glasses at a range of height levels in the silo are useful for visual inspection of pellet levels to avoid the client running out of fuel (see Figure 1).
- Infra-red systems such as proximity switches are highly recommended to highlight both when pellet levels are full (i.e. preventing over-filling) and levels are low, requiring re-ordering. Low-level pellet indicators should let the client know when there is less than 30% of the full volume left.

Access and Maintenance of Pellet Silos

- Silos need access points for internal maintenance, including sucking out pellets and servicing pellet augers. This should as a minimum be a 750mm by 500mm set high up on one of the four walls of the silo. A double seal door is needed to prevent dust escaping. A set of wooden slatted panels set in metal runners in front of the access door is needed to keep pellets away from the door (see Figure 3 below).
- During the major or annual service, pellets should be emptied from the silo and any residual dust on walls, floor and in augers cleaned out.

Hybrid chip and pellet systems

- Chip fuel silo and handling systems such as rotary agitators or walking floors can usually be utilised for wood pellet fuel. However, if these systems have a weight or height of chip restriction, these need to be adjusted for the much denser pellet fuel. For example if a 3m diameter rotary agitator system has a height restriction of 3m for chip fuel – i.e. total weight in the silo of 5 tonnes (20m^3 by volume) then no more 8-9 m^3 (5 tonnes) of pellets should be supplied. Similar restrictions can apply with walking floor systems to avoid hydraulic ram systems operating beyond design specification.

Figure 1 – Pellet Level Sight Windows

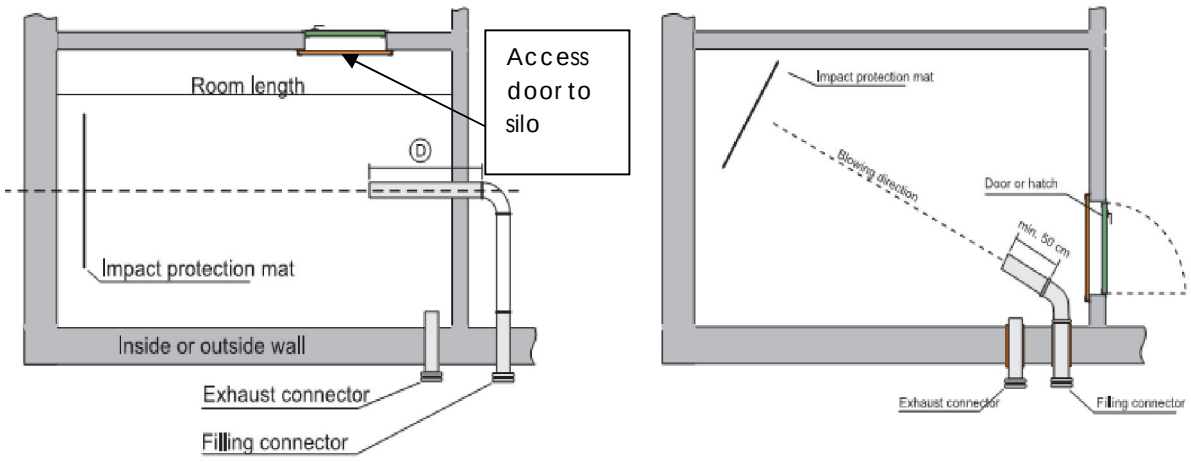


Figure 2 – Pellet Impact Protection Mat Location

High Level Access Door to Silo

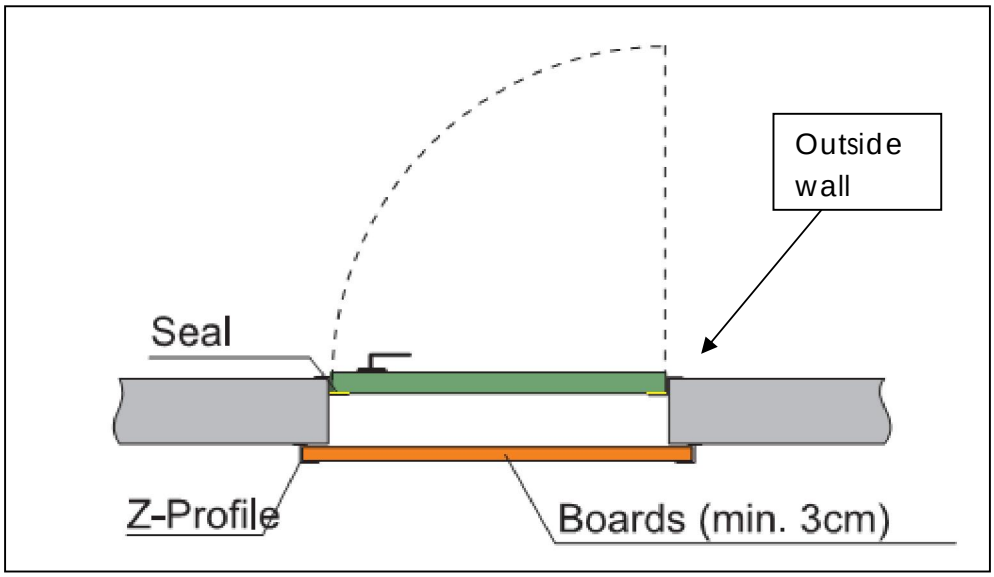


Figure 3 – Pellet Silo access door with effective Z-profile sealing and board protection

- There needs to be at least two pellet inlet and exhaust pipes. These allow both pellets to be pneumatically blown into the silo and also air and dust to escape. Dust should be captured by a dust bag or extraction system. If the silo is relatively long (i.e. greater than 3m long) then the pipes can be used as twin fill pipes with fuel delivery split between each pipe. To ensure adequate filling, the end of the pipes should be set 20% and 50% along the longest length of the silo.
- Some older pellet stores which are amended coal stores have had passive centrifuge systems fitted in the ceiling to allow even distribution across the silos. If the shape of the store is such that it is more difficult to fill easily from single or even twin pellet fill pipes, then additional fill pipes should be fitted.
- To minimise pellet disintegration and dust creation, the number of bends in the pellet inlet pipes should be minimised. Ideally these should be no more than 2 bends. The bends should be 'soft', i.e. no less than a radius of 300mm and ideally a 500mm radius to minimise damage. There should be at least a 500mm straight length between bends.
- If there are more than 2 bends in the system, Balcas will need to inspect the design and site to ensure that undue damage is not caused.

3. Pellet Delivery Vehicles

Balcas offer a range of delivery vehicles. These are all specialist pellet delivery vehicles and not converted animal feed lorries. They come as rigid or articulated vehicles.

BALCAS *brites* Vehicle and Dimensions

Articulated Vehicle
12m long and 3.9 m high
3 m wide and Turning circle 18m

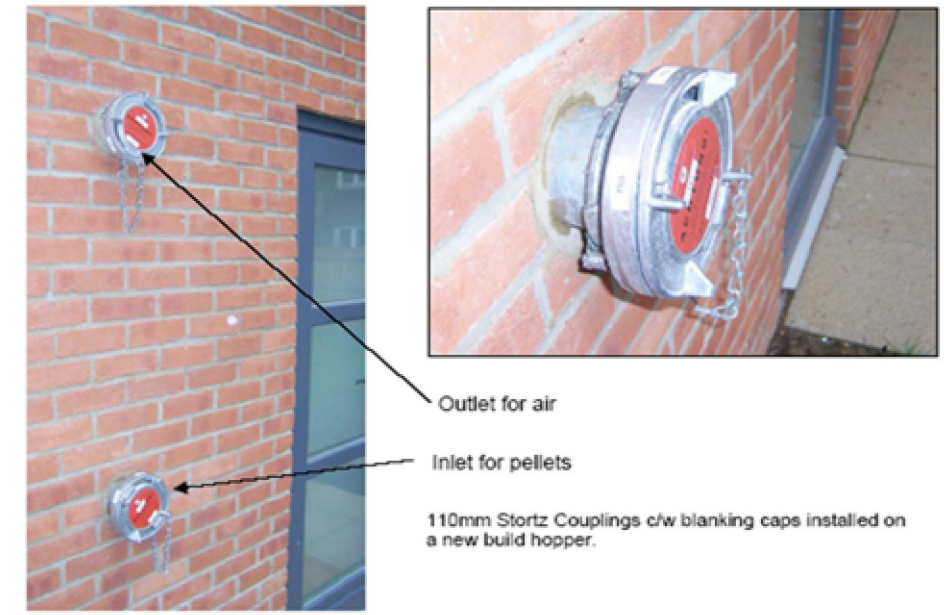
Rigid Vehicle
10m long and 3.9 high
3m wide and Turning Circle 20m

The pellet capacity of the Balcas delivery vehicles range from 16 to 22 tonnes. The total weight of the vehicles when fully loaded are between 22 to 30 tonnes.

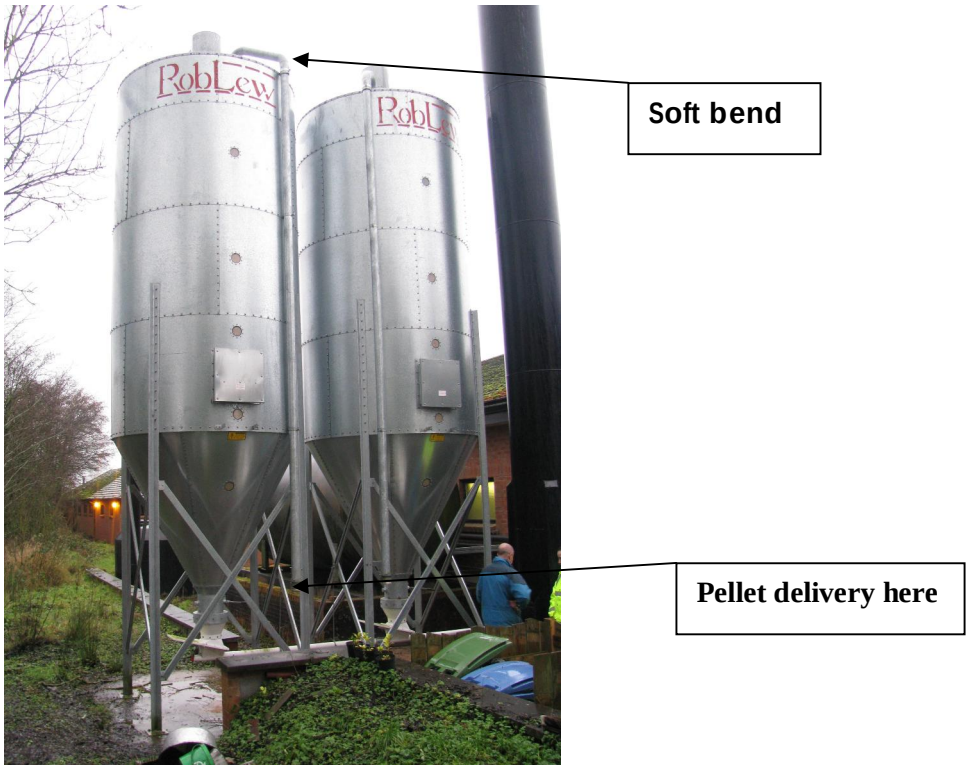
All Balcas delivery vehicles offer 'soft' delivery through standard 0.5bar to 0.7bar (commercial only) pressure delivery. They can offer up to 30 m delivery from the vehicle, but we strongly recommend a distance of no more than 20m from the vehicle to the silo inlet pipe. All have an on-board weighing system and most have a printer allowing accurate delivery notes to be provided.

Pellet Delivery in Action

Pellet Delivery into Pellet Silo with Dust Extraction



Pellet Fill and Exhaust Pipes (Storz A fitting) on outside of Pellet Silo



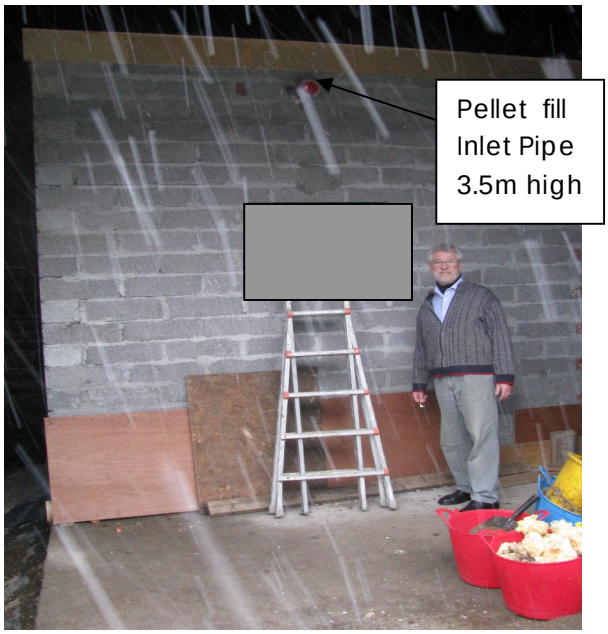
Tall pellet silos need a vertical fill pipe and soft bend at the top

Annex 1 – Wood Pellet Specification

***brites* conform to wood pellet standard: CEN/TS 14961**

Calorific value	**48kWh/10kg bag** **Circa 4,800kWh/tonne**
Mechanical durability	**› 97.5%**
Ash	**‹ 0.7%**
Moisture	**‹ 10%**
Additives	**‹ 1.0%**
Dimensions	**Diameter 6mm**
Length	**‹ 30mm**
Sulphur	**‹ 0.05%**
Fines	**‹ 1.0%**
Bulk Density	**650kg/m^3**

Annex 2 – Some of the main Faults with Pellet Silo Design



Inlet Pellet Pipe set too high for delivery driver (H&S issue)

Damp pellets, poor quality pellets and/or poor combustion causing clinkering

Auger too small allowing pellets to clog up inside

Pneumatic delivery system – with poor design pellets can bridge and cause blockages

Multiple faults with silo design – fill pipe too near ceiling leading to impact and dust, no impact mat on rear wall leading to disintegration, and heat sensor in flight path of pellets leading to disintegration, dust into the sensor (and hence compromising the fire alarm), plus electric lights and cable into silo leading to explosion risk

Twin Pellet Delivery Pipes with Impact Cushion Mats. The mats are too close to the pipes and will reduce the filling capacity of the silo

Emergency Access Door to Silo with sight Glass. Door not properly sealed so allowing dust to escape. It opens internally to silo which prevents access when silo is full and the sight glass is too small to be useful.