FINAL REPORT

Short-term Consultancy: Upgrading of the production capacity of the Somaliland Red Crescent Society (SRCS) Biyo Miire ceramic water filter factory; by building a new gas burning kiln, including trainings of staff to operate the kiln and security training in Hargeisa, Somaliland)

Potters Without Borders

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Section 1: Background

1a - Project History

Problems with inadequate and low quality water supply cause serious problems in Somaliland. Safe clean drinking water has become a commodity, particularly so in more urban areas such as Hargeisa. Mined water is transported by water tanker and donkey cart for sale to most households.

Earlier this year the EU has responded to water scarcity with a substantial grant to improve availability of water in the four largest communities in the country. Required improvements to infrastructire will help, but there must also be parallel response to the needs of the urban poor and those in rural settings.

The Somaliland Red Crescent Society (SRCS), recognizing the positive health impact of ceramic pot filtration (CWF), decided to develop a ceramic water filter production facility in 2009. The CWF factory (Biyo Miire) at Hargeisa was developed by the Somaliland Red Crescent Society (SRCS) in response to a critical need for the provision of safe water to the population. Ceramic water filters (CWF) as a point of use technology, puts the ability to produce safe potable water into the hands of those who are most at risk.

Originally, technical assistance for the facility was sought from the operators of the Chugio filter factory in Limuru, Kenya, as well as through the organization Potters for Peace, through a grant originating in the European Union.

In late 2010 Potters Without Borders (PWB), Canadian sister organization to Potters for Peace, conducted a short term consultancy at the request of the Biyo Miire filter factory at Hargeisa, focusing on difficulties the team was experiencing with their wood fired kiln. One of the clear problems was that this kiln had been built from a very dense refractory brick, the only type available at the time of construction. Though durable, this brick is not energy efficient and the kiln requires a lot of time to cool. At the time a recommendation was made that the team begin to produce red brick using the clays used for ceramic water filter production. Instructions for brick making were shared and by the spring of 2012 more than 5000 brick had been produced. The aim of this was to begin building a kiln and start a transition from the use of wood to other fuels.

1b - Introduction:

During the last two years the Biyo Mirre factory has become one of the main users of firewood in the city, which not only impacts the environment, but also, because of the quantities of fuel required for daily firing, actually influences the market price of firewood. To reduce this impact, the SRCS and Biyo Mirre decided to work to reduce or eliminate the use of wood in favor of propane gas (LPG).

Wood used in a typical firing at the Biyo Miire filter factory

In preparation for the program PWB consultants developed a relationship with SOMGAS, the only local gas supplier, and negotiated with Mr. Hurre, on behalf of the SRCS, to seek assurances that they would be able to guarantee the regular supply of gas to the factory.

It was decided to seek an appropriate gas kiln design which the factory would be able to maintain locally, based on the use of the factory produced brick, but enhanced with an insulating fiber to increase efficiency. An existing design which was developed for ceramic water filter production in Yemen for the INGO GTZ by ceramic engineer Bernd Pfannkuche was chosen and discussions were held with the engineer designer in Seattle. Safety-shut off valves were imported from Germany. LPG burners and 300 square feet of 1 inch 6lb density (1600 deg C) ceramic fiber blanket was purchased for the work. The design was reduced in size from the original plans in order to be certain that the 22 Kg gas cylinders would be capable of maintaining temperature rise in the kiln. The modified design easily contains 126 filters for firing.

The consultancy took place from May 16th until June 16th 2012. Because of the logistics of travel from Canada to Hargeisa, Somaliland the actual physical work was conducted over only 26 days. Our ability to conduct the work in such a short time period was a result of the excellent cooperation between the SRCS, the German Red Cross, and the 17 workers at the Biyo Miire filter factory.

Upon arrival in Hargeisa meetings were held with all staff to assess the situation and determine if there were any major obstacles to proceeding with the construction of the LPG

fueled kiln. A meeting was held with SOMGAS (http://www.somgas.net/) the monopoly LPG supplier to the town, and an initial agreement for supply of fuel was obtained. The site of the kiln was agreed upon and work commenced.

The consultancy encompassed the preparation of all materials for kiln construction, negotiation with SOMGAS, purchase of materials for construction in Canada, the US, Germany and Somaliland. The consultants contracted local day workers, directly working alongside and supervising all aspects of kiln construction of the new LPG kiln and gas supply. Training in gas kiln operation were conducted and three firings of the new kiln were supervised, two firings with the consultants in attendance. Safety training was conducted by both the consultants and representatives from SOMGAS. The consultancy includes a year of online follow up technical consultancy.

Section 2: Kiln Building

2a - Introduction

We began preliminary design calculations as soon as the building site was approved. The area needed for the kiln itself was 3.6m x 2.2m, with an additional 1.5m x 3m for the door car. The kiln design was based on a plan by Bernd Pfannkuche, this original design was built in Yemen at the Silver Filters factory (Silverfilters.org) operated by Ali Saleh and managed by Richard Boni. The Yemen kiln uses 16 specially designed LPG burners and has a capacity of approximately 150 filters.

In addition to the fundamental changes involved with switching to an improved kiln design from their Mani type wood fueled kiln, SRCS and GRC had the following specifications which had to be incorporated in the modified design:

- Capacity of about 100 filters
- LPG as primary fuel (22Kg cylinders)
- Optional wood fuel in case of long term LPG supply interruption
- Maximum fuel efficiency
- Daily firing capability
- Enhanced safety features
- 11 hr firing time

Applying these requirements to Bernd Pfannkuche's Yemen design was a worthwhile challenge, and several viable solution were incorporated into the Hargeisa LPG kiln. There were two major expenses involved in the new plan, the first was the purchase of 6 rolls of one inch 6 Lb ceramic fiber insulating blanket, the second was the acquisition of 12 european magnetic safety shutoff valves.

(See section 3a - LP Gas System Safety)

Ceramic fiber is used in industry for high temperature insulation, it has incredible insulating properties. So much so, that one may have temperatures exceeding 1600 deg C on one side of the blanket, and an inch away the opposite surface will only be warm to the touch. Embedding this blanket within the walls of the kiln ensures that the new kiln will use fuel efficiently, with minimal loss to heat evaporation.

2b - Kiln Construction:

In addition to the two consultants, four labourers were contracted to work for the duration of the building process. Two masons and two general laborers worked 21 days straight without days off in order to complete the kiln. All systems relating to the LPG system were sub-contracted to pipefitters working for SOMGAS in close relationship with the consultants. Many hours were spent sourcing and purchasing tools and materials so that they could arrive on site

as or before they were needed. The budget in this area was exceeded due to lack of local information regarding costs involved in subcontracting gas fitting work.

The kiln structure was built using two sizes of brick. A small brick with three holes of +/- 11.6cm x 5cm x 19.5cm and a larger brick of +/- 14.7cm x 6.5cm x 23.5cm. The bricks were requested at the time of the last consultation and were hand pressed in wooden forms using a rough blend of 90 parts clay to 10 parts sawdust. This is the same mix from which filters are made in the factory. The bricks were then fired in a simple updraft kiln using fire wood.

Small bricks used for inner layer of kiln walls

Large bricks used for kiln base, outer wall layers, chimney

The first phase of construction involved forming a level foundation on which to begin the first layer of brick. This was completed rather quickly using a combination of brick, concrete, and rubble.

Level base foundation

Once this foundation was built the first course was dry laid briefly to verify the kilns internal dimensions. The first five courses pertaining to the burner access ports, and kiln base were laid using a screened mortar of 4:1 portland cement to sand. For effective use of materials, the kiln base was infilled with broken shards from rejected filters, this makes an ideal insulating substrate.

Rubble filled kiln base, with inset burner support bar

At this time a flat bar cut and drilled to specifications was installed into the brick work to carry the cast iron burners. All courses above this level were bonded with a special clay mortar made from equal parts black clay, red clay, and screened sand. Bricks being laid were first soaked in water for a few seconds in order not to dehydrate the mortar weakening the bond with the brick. Because the kiln was built with the capability of converting to wood fuel, the exit flue channel was built large and in-filled with loose brick and sand to allow for their removal during conversion.

Flue exit floor to chimney

When the base of the kiln was completed a form made from 8mm plywood and 4mm-6mm masonite was built to support the arch while it was built. This form, when installed, sits on two angle iron tracks to allow it to slide out more easily, also its size compensates for small wedges lifting the form in place, so that when the arch is complete the wedges are removed lowering the form onto the tracks **See following photos.*

Wooden arch form in progress

Burner ports and flue channel, base for kiln wall

The inner kiln wall was made from the smaller brick, laid flat. After this layer was finished, 1 inch of ceramic fiber layer was laid over the brick completely covering the kiln, and a second layer of larger brick was laid on edge, encapsulating the fiber in the wall. The completed wall measured 20 cm thick. The walls were then reinforced with sheets of expanded metal, welded to the LPG Carrier frame, leaving flexibility for heat expansion .

Ceramic fiber, outer wall begun

Carrier ring, expanded metal, burner access ports

The arch was completed and prepared for the removal of the wooden form. Once the form was removed the inside of the arch was chinked with small pieces of filter and clay mortar.

Arch form on wedges on angle iron track, ready for removal

Arch form removed, ready for chinking

From this point on, work progressed rather quickly. With the arch completed the next priority was the chimney. An angle iron frame was installed one meter above the kiln floor for the damper plate. large steel channels were embedded into the concrete floor for structural support. These were welded to the LPG carrier ring and attached across the top of the kiln using threaded rods.

After the U channels were installed the front and rear walls of the kiln were begun also using double layers of brick with ceramic fiber in between. Inner walls of the kiln have expansion joints built into each course which are stuffed with fiber.

Damper plate frame

Hole in ground for U channel

Inside of kiln, back wall expansion joints

Door form in place, U channel installed, excavation for door pad

The kiln floor, being structurally separate from the kiln walls, can be replaced when parts become worn. As part of the LPG to wood conversion process the floor leading to the firebox mouth openings is also dry laid and removeable.

The kiln door is built on a car with v-groove casters that run on an angle iron track embedded in a concrete pad in front of the kiln. This is a great improvement from the previous kiln which had operators bricking up and tearing out the opening every firing, a procedure which incurs significant wear on the surrounding structure.

Firebox mouth

Front of kiln, almost ready for fiber, door track installed on foundation

The LPG system was installed by local contractors to the SOMGAS propane distributor. We spent significant time customizing the installation for locally appropriate requirements.

LPG ring manifold

Cylinder manifold, regulator, emergency shutoff, water bath

2c: LPG Vs Wood fuel useage

Direct comparison between firewood and gas as fuel has two components. Purchase cost analysis must be balanced with labor cost estimates. Also, with the improvements made in kiln design and capacity, there are also benefits from decreased loss due to inconsistent firing practices.

(See Firewood Vs. Propane analysis - Appendix I)

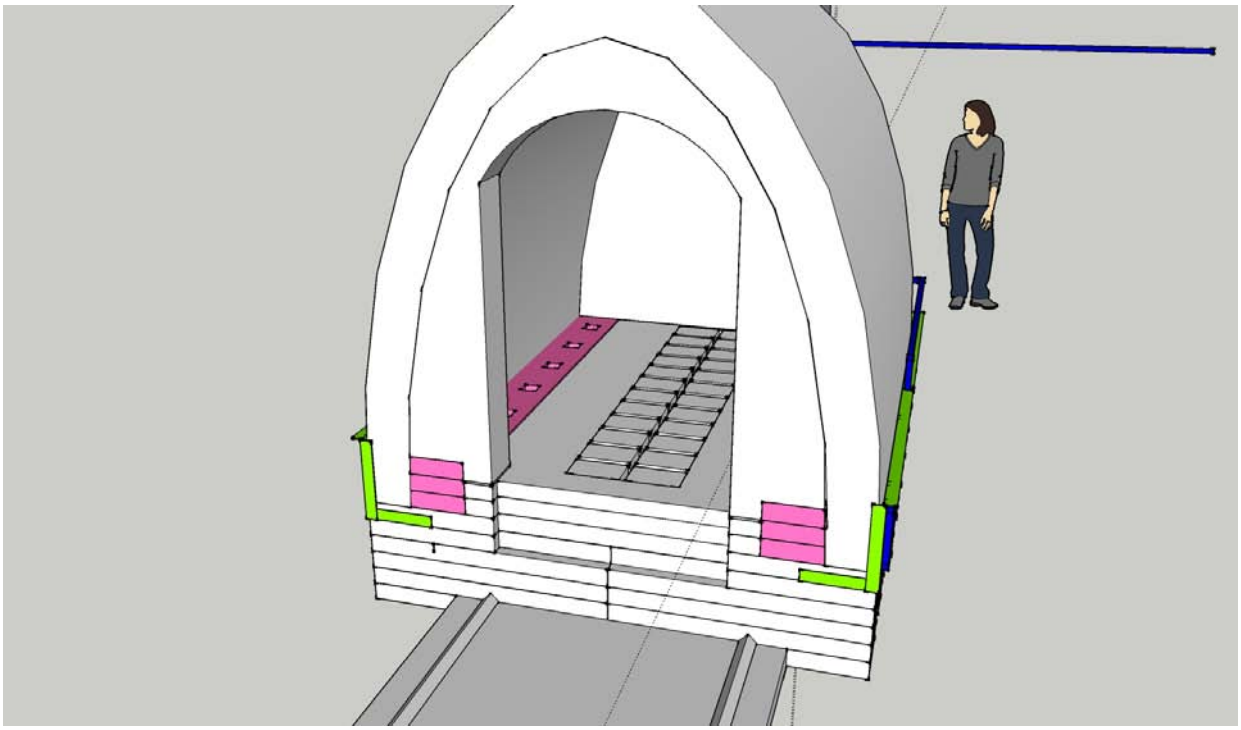
Besides cost comparison, improvements in health impact and ease of work should be considered. Firing with wood is a physically difficult, hot, demanding job.

2d: Fuel Conversion

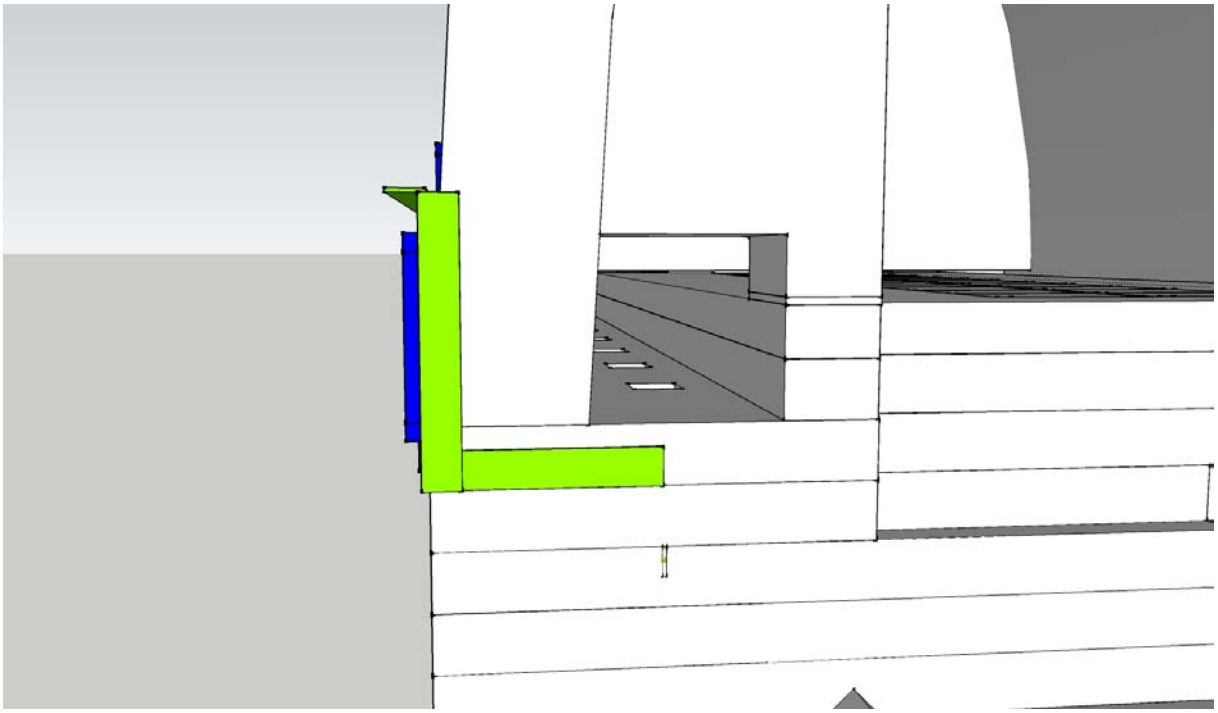
The decision to move to propane gas as a fuel was motivated by several considerations. Particularly, the increasing scarcity of wood coupled with the expansion of production. In the two previous years of production, the Biyo Miire factory has watched the price of firewood increase, and experienced several breaks in production due to lack of supply. In the feasibility study done

in 2010 which led to the development of this new kiln building project, LPG was identified as a viable fuel alternative, made more attractive by the comparison with the existing LPG kiln installation at the Silver Filters factory in Yemen.

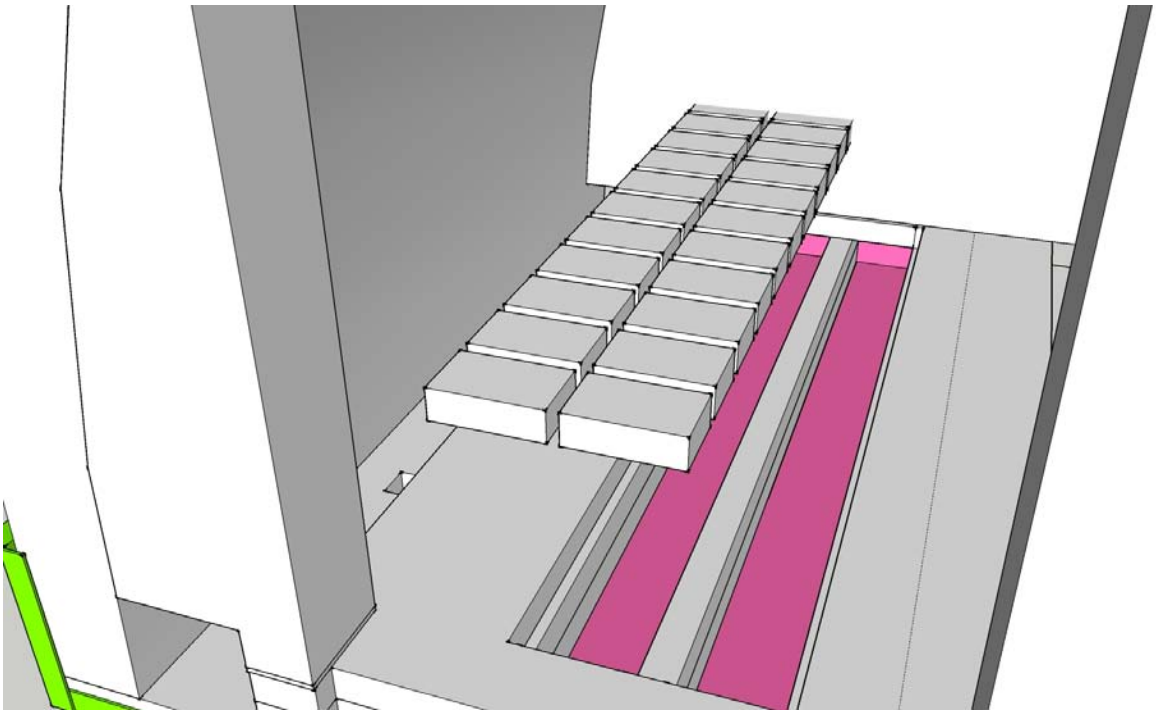
Somaliland has only one gas supplier (SOMGAS), the LPG supply originates in Iran, transported by barge through the gulf of Aden. It can be speculated that political or environmental instability increases the risk of interruption of supply. Because of this SRCS requested that the new kiln be built with the ability to convert back to wood fuel, if absolutely necessary. We were able to include modifications to the LPG design which allow the new kiln to burn wood. The conversion process will require all LPG burners to be removed, as well as “filler” bricks located in the flue channel, and firebox floors. Specific instructions to perform the conversion are included below. To convert the kiln to wood fuel will take a full day of preparation, the same if necessary to switch back to LPG.



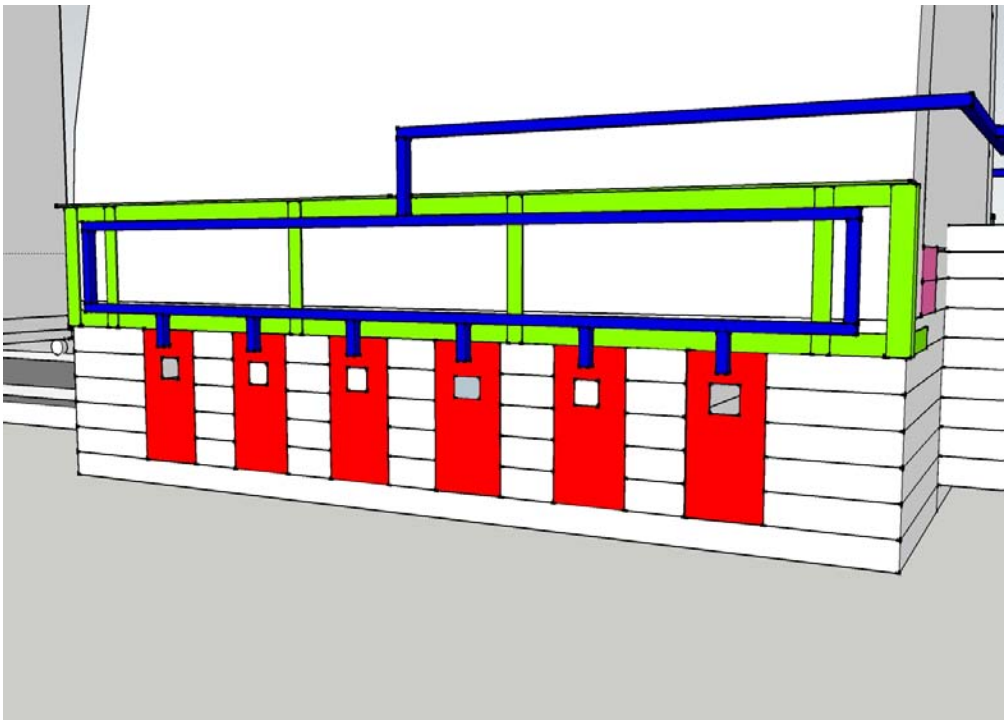
Bricks occupying areas defined in pink to be removed



Firebox with bricks removed



2 layers of brick must be removed from inside the flue channels, the floor bricks are then replaced, maintaining original spacing.



Disconnect all cylinders from the manifold. Remove all burners and flexible hoses. Brick over access ports leaving small holes for air intake. These holes each receive a removeable brick plug. Bag walls must be built to protect bottom filters from direct contact with flames.

2e: General Recommendations

(Priority recommendations in bold)

- **Removal of the sheet metal roof is a high priority ***
  The new kiln comes in contact with a wooden roof member and is a fire hazard. The roof must be raised at least 50 cm.

- **Electric line over kiln front must be moved**
  This line currently hangs down close enough to the kiln and gas installation to cause concern and poses a risk if it should burn or break.

- I**nstallation of two fire extinguishers as recommended by Mr. Hurre of SOMGAS**

- **Construction of a small roof over the gas cylinders to provide shade from direct sunlight**

- No standing on chimney flue channel
  The horizontal flue channel at the kiln rear connects the kiln tunnel to the chimney. This channel is not strong and workers must not stand on it.

- Window port in firebox doors
  Small spy ports with brick plugs should be installed in both the firebox doors to allow workers to easily see the burner flames for making adjustments.

- Cooking area for workers must be removed to the other side of the compound. It is too close to the gas installation and is a fire hazard.

- Installation of sign detailing startup and shutdown procedures for gas system. *(See Section 3e - Safe Kiln Operation Checklist)*

- Waterproofing of concrete water bath for cylinders must be completed to lessen leakage.

Section 3: Kiln Safety, Operation, and Maintenance

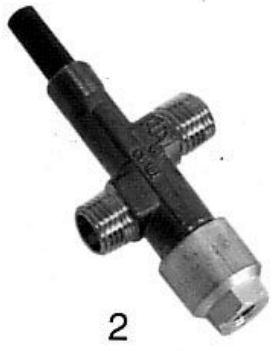
3a - LP Gas System Safety:

The use of gas as a cooking fuel is relatively recent in Somaliland. Factory use of propane in processing of materials is not common. The type of gas installation as is used in the new filter kiln is a first for the country, because of this our consultation involved the SOMGAS gas suppliers in the installation of the system, as well as the safety monitoring of the new kiln.

Safety features:

In order to properly address concerns of safety involved with the use of propane gas (LPG), additional safety precautions were taken in the design of the new kiln.
The kiln utilizes 12 cast iron burners, each equipped with a safety shut off valve which prevents gas flow when a flame is not present. Each burner also has a manual shut off valve.

One of the major expenses involved in building the kiln was incurred by the purchase of the safety valves from suppliers in the European Union. Each safety valve unit uses a button type valve and thermocouple sensor system. The thermocouple, when heated generates a signal which activates an electro magnet that holds the valve in the open position, if for any reason the flame should go out the thermocouple will signal to release the magnet and close the valve. In this way uncombusted gas can not build up in or around the kiln removing the danger of accidental combustion.



salzer gas safety valve

Gaco-cast iron burner

Each side of the kiln has a gas distribution ring which feeds six of the twelve burners. The kiln is supplied by a bank of eight 22 Kg cylinders. The cylinder bank consists of an upper and lower manifold each with positions for 4 cylinders. Each manifold is controlled by a ball valve. The upper and lower manifold divide the gas supply so that cylinders can be more easily changed. Each manifold has an auxiliary position for an additional cylinder if necessary. The 8 gas cylinders sit in a 40 cm deep cement water tank which serves to reduce freezing of the gas, which would cause the flow of gas to be reduced. With this system gas withdrawal can be managed so that cylinders do not exceed gas evacuation limits.

Pipe used for this installation is thick walled 1 inch steel, supplied by the gas contractor (SOMGAS). All pipe joints up to the burner supply hoses were sealed, painted, and soap tested by the gas contractor on behalf of SOMGAS.

The twelve MR-100 Cast iron burners employed in the kiln are rated at 100,00 BTU's /hour each (29 kilowatt).
Manufacturers website- http://www.gasappliancecо.com/pdf/venturi_spec.pdf
Obtained from- Seattle Pottery Supply 35 S Hanford St. Seattle 98134 (888) 587-0373 http://seattlepotterysupply.com/ .

Safety shut off valves were obtained from:
SÄLZER-ÖFEN ZEPHYR®
Blücherstr. 69 D-56349 Kaub-Viktoriastollen
Tel. 0049 (0) 6774 - 1452 Fax 0049 (0) 6774 – 8111
www.zephyr-brennoefen.de - E mail: info@zephyr-brennoefen.de

Main Gas Regulator - Rego 597FB high pressure regulator - http://www.regoproducts.com/
available through Ward burners - http://www.wardburner.com/

22 Kg Gas Cylinders - It is recommended that when newly filled gas cylinders are received at the factory, their valve seals should be soap tested to insure there are no leaks. Each cylinder should then be weighed, and the weight recorded in a log book. This will be a frequent activity since the kiln will use a number of cylinders per day. (see LPG Useage Log - Appendix I)

Gas cylinder bank manifolds and regulators

Gas ring manifold to burners

3b - Loading of the kiln:

Each time the kiln is fired it must first be inspected inside and out. It is important to make certain that the burner ports are clear of any debris or obstructions which may have fallen into the burners during the previous firing. The flue entrances in the center part of the kiln floor must be cleared of debris so that the exhaust gases can pass freely into the chimney.

Central flue tunnel area in centre of kiln floor

Care must be taken to load filters evenly in the kiln, leave space between the stacks of filters and the wall, so that both heat and exhaust can pass all around the filters and out the chimney. Filters stacked on the flue area in the center of the kiln floor (see picture) must not prevent heat from passing easily into the tunnel. Failure to do this can prevent even heating or stop the temperature from rising all together. Workers should step on this area carefully so that it does not break.

The kiln burner system is designed for optimum pressure of about 1.5 to 2 PSI (pounds per square inch) pressure. It is possible to operate at higher pressures but the increased gas flow can cause the gas cylinders to get so cold that the flow of gas will be inhibited.

The ideal firing schedule for firing filters is the same as for wood firing. The firing rate should increase at 75C/hour for the initial warm up and during the first 4 hours of firing until 300 deg C is reached. From 300 deg C (Hour 4) the rate increases to 100 deg C/hour until a temperature of 900 deg C is reached. This is followed by a 1 hour soak (hold at 900 deg C) at hour 10 . This schedule allows for the removal of carbon, but it is recommended that the kiln operators check filters for carbon until they are certain of the kilns characteristics.

The gas cylinders must be weighed and marked before each firing. In the first three test firings conducted during the consultant time in Hargeisa, a single burner was lit to begin the firing. One gas cylinder is opened to begin the firing, but when a second burner is added a second cylinder can also be added.

As the firing progresses past the first 4 hours warm up period, the operators must

carefully monitor the kiln temperature rise, recording temperature and the gas system pressure every 15 to 30 minutes. The higher the temperature the more frequent the monitoring and adjustment.

(See 1st Firing Kiln Log - Appendix I for examples)

After the initial warm up period, it is better to equalize the use of burners so that heat enters the kiln from both left and right sides as well as at the front and back. This may take some experimentation. If possible, it is better to have more burners firing on low rather than only a couple of burners on higher settings, so long as the burners are not so low that they turn off by themselves. This allows the heat to be more evenly distributed.

The chimney has been built larger than necessary for allowance to fire with wood. This allows more control of the exhaust and adequate draft when burning wood. When firing with LPG the chimney damper can be adjusted to 50% of opening. If the bottom of the kiln is cold compared to the top of the chamber, closing the damper plate a little should help to even the temperature. Care must be taken not to close the damper too much because this will cause oxygen reduction (indicated by dark smoke coming from chimney and burner ports, yellow flame from burners and carbon in the fired filters.

The door must be sealed completely with clay at the beginning of each firing after lighting the first burners.

The kiln wall is composed of two layers of red brick with a 1 inch thickness of ceramic fiber in the middle (1600 deg C 6 lb density). If repairs are necessary to the wall, care must be taken so that the ceramic fiber layer is not damaged. Extra ceramic fiber has been left in the factory storeroom for necessary repairs. Care should be taken to wear dust masks when working with exposed ceramic fiber.

Weighing LPG cylinders

LPG kiln operations and safety training

Full kiln after firing

Pattern loading of filters

Pyrometric cones

Inside kiln, burner port clearance from wares

Kiln fully loaded

Burner lit, detail

3c - Kiln Maintenance

Weekly maintenance of the kiln is necessary in order to ensure proper function and long life. This job must be performed by a careful individual with attention to detail. All kiln systems and the kiln structure must be inspected, then all inconsistencies and repairs must be logged. Use the checklist below to guide inspections and identify potential problems.

Kiln Maintenance Checklist:

Chimney
- -damper plate

Flue exits

Kiln Exterior
- -door and door car
- -Bricks around fireboxes
- -Bricks around door entrance

Burner access ports

Floor around kiln (sweep)

Kiln Interior
- -kiln floor
- -chinking

Burners
- -remove burners and inspect, every 2 months
- -clean burner spuds
- -make sure connections are tight
- -make sure burner is centered to burner port
- -inspect hoses for wear

LPG supply Manifold

3d - Recommendations:

The concrete pillar which was cut for the new gas line, must be re-cemented around the pipe.

- A simple cart for the transport of gas cylinders can be made from left over steel used in the kiln construction. We attempted to locate wheels for making a cart but unfortunately did not have enough time before our departure.

3e - Safe Kiln Operation Checklist

IN CASE OF EMERGENCY CLOSE MAIN SHUT OFF VALVE

CHECK LIST FOR EMPTYING GAS FROM LINES

1. **INSPECT ALL 12 BURNERS ARE OFF AND FREE OF OBSTRUCTIONS**
2. **OPEN KILN DOOR MINIMUM 10 cm**
3. **MAKE CERTAIN ALL VALVES AND REGULATOR ARE IN THE CLOSED POSITION AND THAT DAMPER PLATE IS OPEN ON CHIMNEY**
4. **MAKE CERTAIN ALL CYLINDER VALVES ARE CLOSED**
5. **UNSCREW REGULATOR TO 0PSI PRESSURE**
6. **OPEN EMERGENCY SHUTOFF VALVE**
7. **LIGHT BURNER (PARTLY OPEN VALVE, DEPRESS SAFETY VALVE AND LIGHT BURNER MAKING CERTAIN THAT THERMOCOUPLE IS IN FLAME)**
8. **WHEN FLAME GOES OUT OR GAS RUNS OUT CLOSE BURNER VALVE**
9. **CLOSE EMERGENCY SHUTOFF VALVE**

CHECK LIST FOR GAS FIRING START UP

1. **INSPECT ALL 12 BURNERS ARE OFF AND FREE OF OBSTRUCTIONS**
2. **WEIGH AND PREPARE GAS CYLINDERS AND INSTALL IN POSITIONS ON MANIFOLDS**
3. **MAKE CERTAIN ALL VALVES AND REGULATOR ARE IN THE CLOSED POSITION AND THAT DAMPER PLATE IS OPEN ON CHIMNEY**
4. **OPEN KILN DOOR MINIMUM 10CM**
5. **OPEN GAS CYLINDER VALVE(S)**
6. **OPEN MANIFOLD VALVE**
7. **ADJUST REGULATOR PRESSURE TO APPROXIMATELY 2PSI**
8. **OPEN EMERGENCY SHUTOFF VALVE**
9. **LIGHT BURNER (PARTLY OPEN VALVE, DEPRESS SAFETY VALVE AND LIGHT BURNER MAKING CERTAIN THAT THERMOCOUPLE IS IN FLAME)**
10. **ADJUST REGULATOR AGAIN**

CHECK LIST FOR GAS FIRING SHUT DOWN

1. **TURN OFF MAIN SHUT OFF VALVE**
2. **ALLOW FLAMES TO STOP ON BURNERS**
3. **SHUT OFF BURNER VALVES**
4. **TURN OFF UPPER AND LOWER MANIFOLD VALVES**
5. **CLOSE GAS CYLINDER VALVES**

Section 4: Biyo Miire SRCS Factory Process Review

4a - Introduction:

Biyo Miire Filter production is located in a neighborhood about 25 minutes from the Hargeisa city centre. The factory is in a walled compound originally built by a Danish NGO agency for training. The compound consists of a number of small office spaces which are used to house drying filters. The central areas of the compound are used for production activities, material storage and preparation, filter forming and post forming operations. In addition to the lpg kiln construction consultancy, work on the expansion of the facility was also begun.

It was requested that we take the opportunity to observe production procedures while spending time at the factory. During our work on the LPG kiln we were able to attend many manufacturing procedures and make minor recommendations pertaining to increasing productivity.

4b - Filter Forming:

Factory administration was particularly interested in the possibility of purchasing an additional filter press and mold set.

Examination of the forming process as well as workflow and scheduling procedures we suggested that viable alternatives to investing in additional equipment and potentially expanding the work force, that the factory management focus on increasing the efficiency of workflow, job sharing, and scheduling. If funds are invested in additional equipment, it would be reasonable to begin by purchasing an additional female mold, and improving the forming work process.

4c - Productivity Incentives

It is recommended that a system of incentive be put in place in order to fairly distribute gains made by increased production and quality. An example of this may be establishing monthly targets for both quality and production, equally distributing a monthly bonus as targets are exceeded. Also, it is possible that staff be included somehow in the process of improved work flow recommendations, in order to develop a system of worker feedback.

4d - Production Stoppages

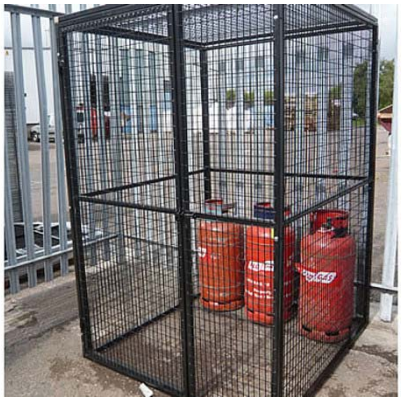
Current barriers to maintaining steady production are in major part due to mechanical breakdown stoppages. Without the implementation of regularly scheduled maintenance procedures the factory will continue to suffer breaks in production. Examples of this are:

1. The wood fired kiln, poor in design and lacking dedicated maintenance time will soon

collapse completely. It was suggested that now that the new LPG kiln is operational, that effort be made to measure and photograph the wood kiln, tear down the existing structure, saving the chimney, and rebuild it using the remaining large red bricks.

2. The first aid kits must be replenished ASAP to minimize stoppages due to small personal injuries. Kits must also be secured in areas which are accessible to all employees not in locked rooms such as the office, since the office is not open at all times. These kits must include burn dressings.

Supply chain interruptions are also a concern at the factory. The primary reason to switch fuel sources from wood to LPG was to ensure a steady supply. In order to facilitate this efforts were made to establish a LPG cylinder depot on the factory premises. In agreement with the distributor SOMGAS, it was recommended that a significant stockpile of LPG cylinders be housed at or near the factory in a secure safe location. In this way a buffer can be established between usage and potentially intermittent supply. Pictured below is an example of a typical factory compartment for gas cylinder storage.



Typical safe storage cage for gas cylinders

Suggested area in for gas cylinder storage

<u>4e - Filter Flow rate and strength assessment</u>

The ceramic water filters being produced at the filter factory in Hargeisa are very well made from a number of points of view. The overall strength of the filters is exceptional, so much so that the filters are actually being utilized as stands for flow testing of new filters. While filter strength is excellent, the fact that a high percentage of filters are passing flow tests on the low end of the scale (between 1 and 1.75 liters per hour) is a cause for concern. It is preferable to see the average flow rates increased closer to the 3 liter upper flow test limit.

A simple way to accomplish this is to increase the percentage of combustible material (sawdust) in controlled tests. Currently the 5.58% sawdust by weight ratio is low in comparison with other filter users. Raising the percentage of sawdust somewhat should not have a great impact on overall strength considering how strong the current mix is. We would recommend that the testing begin immediately.

A controlled test should begin with a test production of 30 filters with increased percentages of sawdust.

15 filters with an increase to 6.25% from the current weight.

15 filters with an increase to 7% from the current weight .

These 30 filters should be paired in the same areas of the kiln with standard filters so

that the heating is similar and a better comparison can be made.

Filter sales development

The SRCS has done a very good job in developing filter production and wholesale sales to the INGO community. It is important that the factory also make a commitment to raise the visibility of filters in the country as a whole. The consultants recommend that the SRCS now focus on methodologies for the expansion of retail sales.

- The SRCS needs a retail team to help create demand for filters in Hargeisa and other communities This can be a sales team paid on an incentive basis. It might be possible to seek assistance from Hargeisa area universities that would like to have marketing students assist the SRCS.

- Factory's expansion will allow for retail sales at the filter factory facility.

- Working filters should be installed in the factory for workers and visitors use.

- Relationship with hospital, clinics and pharmacies. Pharmacies can be encouraged to use filters by having filter water available to their clientele and at the same time have filters offered for sale.

- Filters should be promoted through the supermarkets and hotels in Hargeisa and should be available at any wholesaler who caters to outlying communities.

- Relationship with Somaliland's ministry of education should be sought so that filter use is taught and filtered water is available in schools.

- A cloth pre-filter sample has been developed by SRCS during our time in Hargeisa. Pre filters are an important addition to filters which increase filter life and reduce the frequency of filter cleaning. They should be included in filters supplied to areas where water is turbid.

- Often INGO sales involve delayed delivery of finished filters. Because of the limited available storage space it is recommended that the customers be charged for warehousing of orders beyond a two week grace period. This allows the factory to either warehouse the order within the facility if space allows, or to rent space outside the factory at the purchaser's expense.

- Factory managers would benefit from an opportunity to visit other filter factories engaged in gas firing of filters. The Yemen factory in Sanaa' would offer a good opportunity to gain experience with a similar production. PWB would be willing to make requests on behalf of SRCS to facilitate this for the factory's benefit.