4.1. Introduction

Of the many dangers associated with the use of paraffin and paraffin appliances, the Paraffin Safety Association of Southern Africa (PASASA) point out three main categories of danger:

1. “Poisoning by means of ingestion of paraffin
2. Poisoning by means of indoor air pollution from combustion of paraffin, and
3. Fire incidents causing loss of opportunity, property, severe burns, poisoning through inhalations of toxic fumes and loss of life.” (Truran, 2004a.: 3)

In order to give an understanding of the appliances available for cooking with paraffin in South Africa and the scope of the problems associated with paraffin usage I have isolated the four most important dangers to the consumer:

4.2. Paraffin Stoves

4.3. Fire

4.4. Poisoning

4.5. Emissions

4.2. Paraffin Stoves:

“...the majority of fires in Duncan Village were caused by people going about their daily domestic activities: cooking, lighting and heating their homes. The heavy reliance on cheap, unsafe paraffin appliances in shack areas is one of the major causes of fire. With unemployment rates in many shack areas exceeding 40% of the adult population, household heads are always keen to economise. This often results in the purchase of cheap and unsafe appliances. The reliance on technically inferior flame stoves, for instance, contributes to the high incidence of fire” (Bank and Mlomo, 1996: 122)

John, Oosthuizen, Schwab, Brent, Immink and Rogers (1997) conducted a survey in the Western Cape in 1997, from this they established that many households cook food on paraffin stoves more than once a day, cooking only enough for the specific meal as the households did not possess refrigerators to store cooked food. In this same area it was discovered that
households with electricity would use it for lights and television only, but continue to use paraffin for cooking purposes (John, Oosthuizen, Schwab, Brent, Immink and Rogers, 1997).

“Stoves are consumer products used in every kitchen and are operated not necessarily by technical experts” (Krishna Prasad, Sangen, Sielcken, and Visser, 1983: 68).

In an article for Bona Magazine, McCracken (2003b.) claims that there are an estimated 18 million stoves in use in South Africa. However, Truran (2004a.) contradicts this claim: “It is impossible to determine how many stoves are currently in use or sold in South Africa every year. There are no statistics available” (Truran, 2004a.). He goes on to complete an estimated calculation to assist in giving a scope to the problem: “There are roughly 45,000,000 people in South Africa; there are roughly 5 people in each household; there are therefore roughly 9 million households; just under half of the households in South Africa use paraffin for energy requirements, usually cooking” (Truran, 2004a.). Through this approximation he arrives at a figure of 4 million paraffin stoves in use currently in South Africa (Truran, 2004a.). Lloyd (2004) indicates from personal communications with Tao Ying Industries (manufacturers of the Panda wick stove) that there are approximately 2 million paraffin wick stoves sold in South Africa annually.

“Because of the poor quality of the majority of stoves available, an estimated lifespan for a stove is about a year and a half, and an estimated 1 to 2 million stoves are sold in South Africa each year” (Truran, 2004a.)

Ahmed (2004) discusses how “equipment manufacturers continue to sell, with impunity, sub-standard paraffin stoves to the estimated 20 million South Africans who cannot afford safer appliances” (Ahmed, 2004). In 2003 PSASA commissioned independent tests on nine of the most popular paraffin stoves sold in South Africa, none of the stoves tested met the minimum safety standards (Ahmed, 2004). The PASASA website (2003) and PASASA Press Pack (2003) indicate that all of the wick stoves failed at least six of the tests conducted. Some of the tests the wick stoves failed include: the fuel container leak proof test, the fuel temperature in the fuel container generally exceeded the flashpoint of paraffin during usage due to heat
transfer through the body of the stove or the location of burner heat to the fuel vessel, and the
markings and instruction supplied with the stoves were inadequate (PASASA website, 2003; PASASA Press Pack, 2003). PASASA added to the set of SANS1906 (still under construction in 2003) tests, a knock over test, wherein a stove after burning for 1 hour was to be knocked over while still alight (PASASA Press Pack, 2003). All of the wick stoves tested spilt fuel when knocked over and this immediately burst into flames (PASASA Press Pack, 2003). These finding were presented to the SABS and the Department of Mineral and Energy Affairs to lobby for the setting of compulsory standards for paraffin appliances. In 2006 PASASA was rewarded for their hard work with the SABS standard SANS 1906 (2007): non-pressure stoves being set as a compulsory standard.

“Government will have to consider appropriate appliance/fuel combinations; households’ abilities to acquire these fuels and appliances; the availability of efficient and safe appliances and fuels; and the effect of pricing and financing on affordability.” (Energy White Paper, 1998: 9)

Truran (2004b.) lists the main stove issues:

- Stoves are cheap but they do not meet basic safety standards (Truran, 2004b.)
- Stoves have very basic / unsafe designs (Truran, 2004b.)
- Stoves wear out very quickly and have to be replaced regularly (3 months) (Truran, 2004b.)
- Stoves erupt in flames if knocked over while operational (Truran, 2004b.)
- Safer alternatives are usually too expensive for users (Truran, 2004b.)
- The current paraffin flashpoint is too low for existing domestic stoves (Truran, 2004b.)
- Paraffin stoves used are unsafe for domestic use (Truran, 2004b.)

“…evidence from a recent Markinor survey (unpublished, October 2003) suggests that the majority of burn injury incidents in the last year appear to have resulted from paraffin stoves exploding (52%) and paraffin stoves being knocked over (42%) making a total of 94% of the incidents. The other options open to respondents were; “Direct contact with a paraffin stove”, “boiling water in a pot on a paraffin stove”, “paraffin
light”, “paraffin heater”, “don’t know” and “Other, please specify”. Most of the remaining cases were reported to be caused by a paraffin light. In the same survey, among those surveyed who claimed to use paraffin (an estimated 43% of total households), 2% said they have had paraffin related fires in their homes in the past 12 months. This is an estimated 83,000 households reporting one (79%) or more (21%) fires in the past 12 months. When averaged out to a monthly figure, this is nearly 7,000 fires a month. Even if this estimate is twice as high as it should be, which is highly unlikely, and there were only an average of 3,500 fires a month, of which 3,290 of these incidents are as a direct result of inferior paraffin stoves (94% of the incidents), then this would remain a totally untenable situation” (Truran, 2004a.: 7).

Truran (2004a.), on behalf of PASASA in 2004, called for the removal of unsafe stoves from the market. He felt strongly enough to propose that the “stoves are a travesty against the rights of users, and a stumbling block to poverty eradication” (Truran, 2004a.: 7). He called on the government to outlaw, what he terms as “unsafe, substandard stoves”, as a matter of urgency (Truran, 2004a.: 7). He further called for the improvement of the SABS standards for both wick and pressure stoves; promoted the concept of having all stoves fitted with self-extinguishing devices to shut off the flame when the stove is knocked over; promoted incentives and support to assist entrepreneurs to gain market share with safer stove alternatives; and proposed a system of removing unsafe stoves from the market through a incentive scheme whereby the consumer would receive some sort of reward for each stove returned (Truran, 2004a.). Although in my opinion some of these proposals may be a little reactionary, there is no doubt in my mind that a better paraffin stove is necessary.

There are two types of paraffin stoves on the market in South Africa: the wick type stoves and the pressure type stoves. I give an overview of the key problems with each of these:

4.2.1. Wick Type Paraffin Stoves:

The earliest dated reference I can find to the wick stove is in Bussman, Visser and Sangen (1987) and Krishna Prasad, Sangen, Sielcken, and Visser (1983) where they indicate research
from 1937 by Romp\textsuperscript{1} on the combustion properties of wick type stoves wherein he indicated that the earliest known wick stoves are dated back to 1916, and the first time wick stoves were sold on the American market was around 1927.

Krishna Prasad, Sangen, Sielcken, and Visser (1983) have classified the two most common types of wick stoves by the burner style: the flat ‘open wick burner’ and the enclosed or ‘range wick burner’. They did find a third system which uses a fixed wick with fuel feed to the wick controlled by a fuel control valve (Krishna Prasad, Sangen, Sielcken, and Visser, 1983), this is similar to one of the stoves I purchased during my research (New Perfection No.2), but is not usual for wick stoves in South Africa.

The ‘open wick burner’ is typical of the wick stoves sold in South Africa (Panda, Man and Giant) wherein two or three wide crescent shaped wicks are moved up and down between an inner and outer perforated steel shell (Krishna Prasad, Sangen, Sielcken, and Visser, 1983). The ‘range wick burners’ have a higher number of wicks (from 6 to 12) which are each encased in a sleeve, with the wicks emerging from the sleeve to control the size of flame required (Krishna Prasad, Sangen, Sielcken, and Visser, 1983). The ‘range wick burner’ system also has the inner and outer perforated sheet steel shells which control air flow to the flame area, and both types of wick burners usually have an outer (non-perforated) shell which assists in keeping heat from radiating away from the central cores (Krishna Prasad, Sangen, Sielcken, and Visser, 1983). The fundamental workings of both these wick type paraffin stoves are through an asbestos or cotton wick which is “dipped into the fuel cell where it is soaked with paraffin. It is then turned upward and lighted” (Steenkamp, van der Merwe, and de Lange, 2000: 1). Both systems use the capillary force to draw fuel from the fuel container

\textsuperscript{1} Romp H.A.,1937, OIL BURNING, The Hague, Martinus Nijhoff
through the wick to the burning area (Bussman, Visser and Sangen, 1987). On start up the wet wick is lit and causes a sooty yellow flame that emits a lot of smoke (Bussman, Visser and Sangen, 1987). Once the stove is alight and the perforated shields are glowing hot the paraffin is vaporised at the wick burning area resulting in a cleaner blue flame to burn (Bussman, Visser and Sangen, 1987).

Krishna Prasad, Sangen, Sielcken, and Visser (1983) in discussion about the ‘open wick burner’ type stoves indicate that “even though various ingenious arrangements for channelling air to the flame were developed over the years, the power output of these burners is very low” (Krishna Prasad, Sangen, Sielcken, and Visser, 1983: 12). This, in their findings, makes wick stove cooking very well suited to simmering operations (Krishna Prasad, Sangen, Sielcken, and Visser, 1983), which suits, as Bank (1999) indicated, the cooking of typical South African low income household staple food types. Krishna Prasad, Sangen, Sielcken, and Visser (1983) indicate that the ‘range wick burner’ was developed in an attempt to “increase the power output of wick burners while keeping the combustion clean” (Krishna Prasad, Sangen, Sielcken, and Visser, 1983: 13).

In 2004, Lloyd analysed a used paraffin wick type stove (Panda) with the ‘open wick burner’ system and outlines some of the critical issues with paraffin wick stoves after some use. Some of his findings include:

- The integrity of critical components of the stove is lost due to the exposure to heat (Lloyd, 2004).
- Areas exposed to flame lose coating and as a consequence begin to rust (Lloyd, 2004).
• The filler cap and area surrounding the fuel container are badly designed resulting in poor fit of the cap and a pooling of paraffin in unsafe areas (Lloyd, 2004).
• Wicks wear unevenly causing uneven flame distribution (Lloyd, 2004).
• Lighting the stove is problematic as the user is required to remove the inner and outer perforated steel shells to get to the wick; through having to reach into this orifice the user can easily sustain burns (Lloyd, 2004).
• When initially alight the stove gives off a lot of smoke until the heat begins to properly vaporise the paraffin (Lloyd, 2004).
• The stoves leaked paraffin around the base (Lloyd, 2004).

Lloyd (2004) indicates some of the problems with paraffin wick type stoves lie in the body construction material, which is 0.3mm powder coated mild steel sheet metal. This sheet metal is easily destroyed due to oxidation from regular heating (Lloyd, 2004). New paraffin wick stoves can put out as much as “1.8kW and have a heating efficiency of about 35%” (Lloyd, 2004: 1). Once alight and burning for a little over half an hour the temperature of the paraffin in the stove tank, from his research, reached between 74.7°C and 87.8°C giving an average power output rate of 0.88kW (Lloyd, 2004). The stove efficiency was calculated at between 25.5% and 30.7% through the testing (Lloyd, 2004).

The stove’s owner discussed some of the issues related to the stove with Lloyd (2004). Of the safety concerns Lloyd (2004) expressed in his paper (leakage, fuel heat, deterioration), none of these were of concern to the user, but the wick’s poor performance due to burn deterioration was. In my experience this aspect could have been remedied by the user by simply pulling additional wick out of the wick mechanism. The manufacture intends for stove users to make this adjustment through supplying an extra long wick in the stove. However,
when one considers the other safety factors discussed by Lloyd (2004) the extension of life of this stove would surely have lead to an accident. The second issue of concern to the user was the smoking in use and through this the blackening of cooking pots. The third concern was uneven burning and the length of time the deteriorated wick took to heat up and the accompanying strong smell of paraffin in the household (Lloyd, 2004). Again, in my opinion, this is simply a function of the deteriorated wick and could have been remedied by the owner.

The temperature of the fuel in the fuel tank is the largest concern considering the fact that paraffin flash point is 43°C (SANS1906, 2005) (Lloyd, 2004). Lloyd (2004) concludes by suggesting a few changes to the testing procedures used when analysing stoves for the SABS regulation, some of his recommendations were included in the final SANS 1906 (2005).

Summary of the problems related to wick type paraffin stoves according to Truran (2004a.):

- The stoves generally leak at the base of the wick mounting, through the cap area or through corroded areas in the fuel vessel (Truran, 2004a.)
- Because of the design and construction of the stove, paraffin is able to pool on top of the stove (Truran, 2004a.)
- Due to the conducted transfer of heat through the diffusers (which get red hot during stove use) into the wick mechanism and down onto the fuel container, the fuel in these fuel containers reached temperatures above the flashpoint of 43°C (Truran, 2004a.; Lloyd, 2002). Additional heat transfer takes place through the closed body construction of some of the wick stoves (Lloyd, 2002).
- The instructions supplied with the stoves are of poor quality and often only in English, with few or no descriptive pictograms (Truran, 2004a.)
- The stoves are inefficient and give off high levels of carbon monoxide (Truran, 2004a.)
The stoves have poor thermal efficiency (Truran, 2004a.)

The stoves do not last long, particularly the better selling stoves such as the Panda (3 to 6 months) (Truran, 2004a.)

The stoves burst into flames if accidentally knocked over (Truran, 2004a.)

Add to this some of the problem factors found by Bussman, Visser and Sangen (1987):

- “The maximum power is still quite low in comparison to the woodstoves and gas stoves, resulting in longer cooking times
- At maximum power the stoves burn with yellow flames which soot the pan and give a foul smell
- It is difficult to adjust the fire to simmering power, which results in unnecessarily high fuel consumption
- Wicks wear out quickly
- The fuel reservoir is insufficiently shielded from the heat generated in the burner. Consequently after some time vapour escapes from the reservoir causing fire risks and loss of fuel
- Fuel spills easily from the reservoir when the stove is accidentally tilted” (Bussman, Visser and Sangen, 1987: 5)

4.2.2. Pressure Type Paraffin Stoves:

“The paraffin, (kerosene), pressure stove first appeared in 1892 when a Swede, Frans Wilhelm Lindqvist, registered his 'Sootless Kerosene Stove'. The design burned Paraffin gas which was vaporised from the liquid fuel in tubes forming the burner head. His design was so successful a Company was formed to manufacture the stove and 'Primus', (Latin for 'first), appeared to the World” (Base Camp, 1999).

In pressure paraffin stoves, the principle of working is that the pressured fuel is (higher than atmospheric level) fed through a hot vaporiser where the fuel evaporates before it is forced at high velocity through the vapour jet nozzle (Krishna Prasad, Sangen, Sielcken, and Visser,
There are two generally used mechanisms to create the pressure: a stationary installation in which the fuel is located at a level above the burner unit and by virtue of gravity creates enough pressure to run the stove; the second mechanism is “having a hermetically closed fuel container in which a small hand pump is incorporated” and through pumping air into the container the user creates enough pressure to run the stove (Krishna Prasad, Sangen, Sielcken, and Visser, 1983: 12). “Paraffin is vaporised as it passes through a fine jet which needs initial heating (generally with methylated spirits). Control is by adjusting the pressure in the tank” (Holm and Viljoen, 1996)

“The basic Lindqvist burner design was copied by manufacturers all over the world, many adopting the same method of numbering their models by the burner size and style, i.e. 00, No1, No5” (Base Camp, 1999).

Summary of the problems found with pressure paraffin stoves:

- The jet nozzles are difficult or impossible to remove for cleaning purposes
- The jet nozzles get blocked by carbon deposits from the heating up of the burner heat during operation or from “little sand particles in the kerosene” (Bussman, Visser and Sangen, 1987: 50)
- Even a small burr in the jet nozzle can convert the jet of fuel coming out of the jet nozzle to a mist spray, making the stove very dangerous to work with (Floor and van der Plas, 1991)
- The pressure type paraffin stoves are more expensive than the wick type paraffin stoves
- The stoves give off a loud jet like noise when working and this can be distressing to the user
- Pressure paraffin stoves require an additional fuel for preheating the burner (methylated spirits is often recommended by manufacturers)
• Pressure stoves “seem to offer less prospective opportunities for local production”
  (Floor and van der Plas, 1991)

This list is compiled from a combination of sources: Bussman, Visser and Sangen (1987); Floor and van der Plas (1991); Truran 2004a.; Truran (2004b.) and Kruger (2005).

Floor and van der Plas (1991) indicate from their research in Tunisia that users found the following problems:

• “the difficulty of lighting and controlling the flame
• The stability of the stove
• The complicated maintenance and
• The quality of the stove” (Floor and van der Plas, 1991).

4.2.3. Stove Conclusions:
According to the article in the Consumer Fair (2007) the results of the PASASA commissioned stove tests (pressure and non-pressure) from 2003 the SABS Test House concluded:

• “All brands tested failed to meet the minimum operating pressure requirements
• They all failed the assembly requirements as stipulated in the national standard
• 80% of the brands tested failed the capacity test
• 80% of the brands tested failed the fuel container requirements
• 80% failed pump assembly durability test
• 60% of the brands failed burner durability tests…
• All failed almost all instructions requirements
• 40% failed the combustion test” (CR Article, 2007)
The concern created by the release of the test results have prompted Consumer Fair to suggest a number of factors and features that should be included in the regulations (CF Article, 2007):

- The stove must not leak fuel (CF Article, 2007)
- The stove should be self extinguishing if knocked over (CF Article, 2007)
- The fuel in the fuel container should not become too hot (CF Article, 2007)
- The stoves should give off minimal emissions (CF Article, 2007)
- The stove should be made to be very stable (CF Article, 2007)
- The construction materials should ensure that the stove is strong enough to support the pot or pan (CF Article, 2007)
- The stove must not be able to be filled while it is burning (CF Article, 2007)
- Ergonomic factors should include the provision that the stove not burn the user when they touch the controls (CF Article, 2007)
- All stoves should include comprehensive safety instructions, which must include pictograms for illiterate users (CF Article, 2007)

In 1983, Krishna Prasad, Sangen, Sielcken, and Visser, conducted research and testing on a wide range of paraffin stoves from various countries around the world (China, Singapore, India, Thailand and Indonesia). In their findings on the stoves they gave a list of what they termed “user’s interest” which include factors that are not necessarily technical or economic in nature, but encompass the broader interface and user aspects of stove requirements in households (Krishna Prasad, Sangen, Sielcken, and Visser, 1983).

1. “Cost
2. Fuel economy
3. Sturdiness of construction
4. Mechanical construction quality
5. Storage tank temperature
6. Pan seating
7. Regulation ease
8. Ease of extinction of stove
9. Pan cleanliness
10. Ease of refilling

In all three research projects conducted for the World Bank: Krishna Prasad, Sangen, Sielcken, and Visser (1983), Bussman, Visser and Sangen (1987); and Floor and van der Plas, (1991) it was found that overall the wick stoves appeared to be “a generally better technical option than most pressure stoves” (Floor and van der Plas, 1991). In their research it was found that wick stoves have an average efficiency of 40% as compared to the 55% for pressure stoves; however wick stoves are cheaper and have fewer operational problems (Floor and van der Plas, 1991). Stove power was a concerning factor in many countries in which these researchers were working (Floor and van der Plas, 1991). Certain styles of cooking require higher power outputs, up to 5kW, which only pressure stoves could produce, while wick stoves tend to produce a maximum of around 3kW (Floor and van der Plas, 1991). “The pressure stoves, as far as we can see now, do not hold much prospect as a big competitor to wick stoves since they possess the main disadvantages of a kerosene stove (the smell!) with the added discomfort of noise. Of course they are much more expensive” (Krishna Prasad, Sangen, Sielcken, and Visser, 1983: 72).

Although both stove types have their problems, the wick type stoves have a broader range of problems. Yet in the studies shown, the technical factors that require attention in the
maintenance and use of pressure stoves are too complex for the user. This combined with stove cost factors appears to make the wick stove, although highly problematic, the consumers preferred choice. If some of the many problems were to be solved, coupled with maintaining a low price, this type of stove could still dominate the low income households cooking needs in South Africa for many years to come.

4.3. Fire:

“Each year devastating fires sweep through the tightly packed dwellings in informal settlements throughout the country, killing and maiming adults and children, wrecking livelihoods and destroying homes. Many of these are preventable” (PSASA Annual Report, 2003)

According to PASASA “more than 200 000 people per year are injured or lose their property from paraffin related fires” (PASASA Press Pack, 2003). They indicate the key cause to be the “continued use of unsafe and sub-standard paraffin stoves to which the majority of runaway fires in informal settlements can be attributed” (Kruger, 2005: 1). PASASA could find no regional or national registers detailing the cause of fires and burns related to paraffin, they do however cite a national survey conducted by Markinor2 in 2001 which reported that “46,517 paraffin related fires occurred in the last year” (PASASA Press Pack, 2003). From this Markinor found that of the households that suffered from paraffin related burns “63% of those burns were the results of paraffin stoves exploding” (PASASA Press Pack, 2003). The Paraffin Safety Association estimated that of the households that experience paraffin related fires a year, roughly 43% of these households experience 2 or more fires in the same year (Truran, 2004a.).

“It has been estimated in recent National Injury Mortality Surveillance System (NIMSS) that in 2001 unintentional burn deaths in South Africa were between 2,978 – 3,444. It was further estimated that paraffin could account for up to 75% of these burn deaths” (PASASA Press Pack, 2003)

Mabena (2003) has pointed at the living conditions in informal settlements as a key cause for fires to occur. Amongst his findings he explains that the narrow streets between informal houses make it “difficult for fire fighting vehicles and equipment to reach affected areas in good time” (Mabena, 2003). Additionally the problem of “non-existent street names complicate endeavours to reach people in need” and further to this “residents do not have access to public telephones near their homes to call for help in emergencies” (Mabena, 2003)

“When you take into consideration the home environment in which people utilize paraffin (cramped, informal living quarters made of highly combustible and toxic material such as treated or painted wood and plastics) the dangers become more apparent. Simply having naked flames in these environments, no matter which fuel is utilised, makes these environments highly unsuitable for the storage and use of paraffin.” (Truran, 2004a: 2)

Ahmed (2004) points to the paraffin stoves as being the primary cause for fires in informal settlements. In her research she has found that children are the majority of victims in these fires, with burns killing “more South African children between one and four years old than any other unnatural cause” (Ahmed, 2004) and fires are the fourth highest cause of death to children in South Africa aged between five and nine. “Those fortunate enough to survive often carry horrific, debilitating physical and emotional scars for life” (Ahmed, 2004).

“Almost all unelectrified households in South Africa use candles or paraffin for lighting, both of which have specific hazards. A large number of accidental fires occur every year in informal settlements, usually with devastating impacts on the residents’ property, and frequently resulting in the deaths of less mobile people, such as infants and the elderly. The causes of these fires include not only accidents with candles and paraffin lamps, but also poor quality paraffin appliances which sometimes explode under conditions of heavy or improper use. The impacts of these fires and burns, in social and economic terms, are significant in total” (Energy White Paper, 1998: 95).

Steenkamp, van der Merwe and de Lange (2000) indicate the cost of burn management as being an “economic burden on the health system and hospital expenditure” (Steenkamp, van der Merwe and de Lange, 2000: 5). According to their research the more serious the burn injury, the longer the stay for the patient in hospital and the higher the costs for treating the patient (Steenkamp, van der Merwe and de Lange, 2000). This cost is incurred for the most
part by the tax payer (noseweek, 2005). In the noseweek article from June 2005, the journalist points out that “a report commissioned by the national treasury estimates that paraffin-related incidents cost the country R104 – billion …every year” (noseweek, 2005). This includes the cost of medical treatment and recuperation of the devastated community (noseweek, 2005).

_When a fire occurs in a community, more than one home is invariably affected because of high winds and the fact that low income households tend to be built very close to one another. For people without security of tenure and without insurance, this is highly devastating. They often lose everything they have except the clothes that they were wearing at the time. Fear of victimisation for causing a fire in such circumstances is intense. There is often an interruption in economic and other activity for families and the cost of rebuilding their lives from scratch. Again, there is a burden on state resources (emergency services, health services, welfare services) which has an indirect impact on the economy and an avoidable burden to tax payers (Truran, 2004a.: 4)._  

4.3.1. Burns:  

“…in South Africa paraffin stoves are a major cause of burn injuries, but the occurrence of these injuries and the associated social factors have not been described carefully” (Steenkamp, van der Merwe and de Lange, 2000).

Steenkamp, van der Merwe and de Lange (2000) give a list of typical burn causes from paraffin stoves, citing wick stoves as the most common cause of injury.

According to their research the list includes the following main causes:

- The stove exploded (Steenkamp, van der Merwe and de Lange, 2000)
- The stove was knocked over (Steenkamp, van der Merwe and de Lange, 2000)
- In the household clothes / blankets caught fire (Steenkamp, van der Merwe and de Lange, 2000)
- The stove was fallen on (Steenkamp, van der Merwe and de Lange, 2000) (this last point may indicate that stoves are tripped over or knocked over if the stove is placed on the floor)

From their research they found that 37% of the injuries were caused by human error, but in the other 63% patients reported that the stoves “…’exploded’ or ‘blew’. This means that the stove’s flame increased in size both rapidly and uncontrollably” (Steenkamp, van der Merwe,
and de Lange, 2000: 4). In the report, patients complained that the stoves reacted erratically when used near a draught, lifting a pot off the stove during cooking sometimes caused the stove to ‘explode’, another danger expressed was that as the fuel tank emptied the stove also tended to ‘explode’ (Steenkamp, van der Merwe, and de Lange, 2000: 4). This is similar to statements made by PASASA (Kruger, 2005) and in the press (McCracken, 2003b.) in which claims are made that stoves ‘explode’ or had ‘blown up’; but this may not be entirely correct. According to Lloyd the stove can cause a conflagration, which is better interpreted as a flaring as the fuel flashpoint is reached and vapour is released through the cap or a split in the stove body or a leakage area around the body or if the stove is knocked over when lit. Either way the results are devastating fires.

Burn Treatment (2003) discusses the classification by degree of burns: “First-degree burns, such as sunburn, involve only losing epidermal tissue (the top layer of skin) and are not typically serious. Second degree burns are deeper, destroying dermis and nerve endings. Third degree burns are the deepest and most severe. They destroy all skin tissue and nerve endings and involve fatty tissue. Third degree burns generally must be skin grafted. Some surgeons refer to fourth degree burns where heat damage extends to deep structures, such as muscle, tendon and bone” (Burn Treatment, 2003). Additionally, Burn Treatment (2003) adds to the effects of fire the problems of smoke inhalation, which not only damages the lungs but also has the effect of “diminished oxygenation to the brain” (Burns Treatment, 2003). “In smoke inhalation alone (without the complication of burns), the brain is the target organ” (Burns Treatment, 2003)

“There is a subset of burns that do not always accompany fires. Many children experience severe burns obtained from hot liquids (or food) that were being cooked. The flimsy design of paraffin stoves (together with using pots that are too large for the

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3 This information obtained by the author from general discussions with Dr. P. Lloyd at the Technical Committee Meeting for Pressurised Paraffin Fuelled Appliances in 21 February 2006.
appliance) is something that we believe contributes significantly to these sorts or injuries.” (Truran, 2004 a.: 6)

Of the estimated 3 500 people killed each year from fires of which PASASA estimates 75% are caused by paraffin related incidents, children appear to be most vulnerable, with burns being cited as the leading cause of death amongst children aged between 0 and 4 years old and also children aged between 5 and 9 years old (PASASA Press Pack, 2003; Truran, 2004 a.). However, beyond the numbers of dead are those who live with disfiguring burns (Truran, 2004 a.). Truran (2004a.) discusses the need for reconstructive surgery, skin grafts, how scar tissue does not continue to grow as the child develops and the loss of limbs and digits from the burns. Further to this the complications of acceptance in society and severe trauma over the disfigurement, which in Trurans (2004a.) view can be difficult for the burn victim to cope with and unfortunately in his research the “suicide rate among these individuals is exceptionally high.” (Truran, 2004 a.: 5)

4.4. Poisoning:

PASASA (2003) indicate that “80,000 children ingest paraffin every year and that 40,000 children develop chemical pneumonia each year as a result of ingesting paraffin” (PASASA Press Pack, 2003). “Ingesting a small amount of paraffin will make a child extremely ill, but is not in itself life-threatening. Paraffin’s low viscosity, however, means it is easily aspirated or inhaled into the lungs. This can cause chemical pneumonia” which can prove to be fatal in children (Ahmed, 2004).

Of the number of cases of poisoning by ingestion, death occurs only in a small percentage, however the long term effects on survivors can also be inhibiting (Truran, 2004a.). “The long term symptoms of these conditions can be shortness of breath (hypoxia) and persistent lung damage” (Truran, 2004 a.: 3). Those suffering from these effects, particularly children, may
be limited in their social interaction and their families may incur financial costs for medical treatment (Truran, 2004a). 

Key factors to the ingestion, particularly by children, of paraffin in the household have been identified in the previous chapter; however it may be of value to restate them here:

- Paraffin is often stored in cooldrink bottles or milk bottles, the household may store water in similar bottle which can lead to children mistaking the two liquids
- Paraffin is toxic and if ingested can cause severe illness or even death
- High levels of illiteracy/poor education persists in low income areas and warning labels, safe use literature and education programmes are not often understood and paraffin users are often unaware that paraffin is poisonous/dangerous
- There appears to be a general lack of home safety awareness and practice
- Children are often left unattended in reach of stored paraffin or paraffin stoves
- There is an increase in child-headed households due to the effects of HIV/AIDS pandemic and children are now looking after their younger siblings
- The nature of low income household often requires both parents to be working or looking for work, leaving children to care for themselves often without adult supervision
- It is often difficult to store paraffin safely out of reach of children because of the construction of the dwelling and the potential lack of furniture

PASASA are promoting a solution to this aspect of the greater paraffin problem by lobbying government and fuel suppliers for regulations to be put in place for the distribution of pre-packaged paraffin in child resistant containers (Truran, 2004b.).

4.4.1. Child Resistant Containers

In the 1990’s PASASA developed a solution for the poisoning by paraffin by manufacturing and distributing a child resistant cap which was designed to fit a variety of typically available bottle types used for the transport and storing of paraffin in households. By 2002 over half a million of these caps had been distributed and were being used (Lloyd, 2002). This child resistant cap was preceded by a study in 1993 by Krug, Ellis, Hay, Mokgabudi and Robertson on the 2 litre child resistant paraffin container that they designed, manufactured and distributed. In their research the “main finding was that the incidence of paraffin ingestion dropped by 47% in the study area during the intervention period” (Krug, Ellis, Hay, Mokgabudi and Robertson, 1993). Of the other findings they ascertain that paraffin ingestion was most prominent in children between 12 and 23 months of age, more children appeared to drink paraffin during summer months when the paraffin is mistaken for water (Krug, Ellis, Hay, Mokgabudi and Robertson, 1993). During the study the researchers established that paraffin is generally stored where it is accessible to children (floor or table), some children were able to open the child resistant containers, and most children were not well supervised around the homes having access to all areas where paraffin and other household chemicals could be stored (Krug, Ellis, Hay, Mokgabudi and Robertson, 1993). Recommendations from their findings were: all paraffin should be sold in child resistant containers, work needed to be done on improving health education including dangers in the home, storage of paraffin containers needed better consideration as the child resistant containers were not adequate
deterrent for the children, and children should be carefully supervised in the home (Krug, Ellis, Hay, Mokgabudi and Robertson, 1993).

“It is time for major stakeholders in the energy sector in South Africa to consolidate efforts to protect children in poor and marginalised communities where the majority of paraffin poisoning incidents and deaths occur ...Research has demonstrated the effectiveness of child resistant containers (CRCs) in reducing childhood ingestion... What is needed now is legislation that requires all paraffin to be distributed in child resistant containers” (Matzopoulos, Carolissen, Jordaan, Austin and Jamieson, 2007)

Matzopoulos, Carolissen, Jordaan, Austin and Jamieson (2007), of the Medical Research Council, strongly encourage the legislation of mandatory safety standards for all paraffin sold for household use. They include:

- “The pre-packaging of all paraffin in containers with childproof safety devices…
- Distinct and recognisable warning labels on all containers …to improve consumers’ understanding of hazards
- A compulsory national standard for the chemical composition of paraffin specifically the requirements for aromatic content, sulphur content, flashpoint, etc…”

(Matzopoulos, Carolissen, Jordaan, Austin and Jamieson, 2007)

PASASA (Truran, 2004b.) have promoted this system of child resistant containers and have begun lobbying oil companies and government to set standards for the supply and distribution of such containers to consumers. Although PASASA (Truran, 2004b.) recognise that the initial cost implications for the fuel supply industry would be high, they believe that the benefits to society outweigh these costs. They have documented suggestions for a system which could include a bottle deposit scheme which would allow manufacturers to reuse and later recycle the packaging (Truran, 2004b.). Other suggestions include: putting in place mechanisms for legislative bodies to ensure that suppliers are regulated; ensuring that all the containers sold have a seal to assure consumers of the purity of the fuel; insisting on safety and warning labelling to educate the consumer; and developing a system of packaging this
fuel close to the refinery or oil company depot to reduce the potential risks of contamination
(Truran, 2004b.). They believe the design of a dedicated child resistant container could
include such features as a better system of pouring paraffin into appliances, thereby reducing
the risk of spilling the fuel (Truran, 2004b.). Furthermore this specialist container would
ensure that only quality paraffin reaches the consumer, thus eradicating the chances of
contamination by the mixing of fuel types (Truran, 2004b.) By ensuring a child proof cap is
part of this child resistant container, the main risk of child poisoning by ingestion could be
reduced or even eradicated (Truran, 2004b.).

In his outgoing chairman’s report (PASASA Annual report, 2003) Brian Goodwin discussed
the child-resistant caps distributed by PASASA. He indicates that distributing the caps
without supporting education campaigns proved ineffective; however PASASA learnt its
lesson from this first phase of the project and by “gaining as much cooperation and buy-in as
possible” (PASASA Annual Report, 2003: 7) future distribution would include education
programmes. In 2003, PASASA tested the Kleen Paraffin programme in which paraffin was
to be supplied in child resistant containers ensuring the supply of uncontaminated paraffin
(Peters, 2003). The success of this programme is still to be measured.

4.5. Emissions:
A key danger to households using paraffin appliances are the level of emissions generated
Truran (2004a.). Truran (2004a.) believes that the combustion of paraffin, which causes
indoor air pollution, does not get the same amount of attention as those other problems:
poisoning by paraffin and fires caused by paraffin appliances. However, in his view, indoor
air pollution is a “major cause for concern, especially in informal housing in cold winter
weather” (Truran, 2004 a.: 6). Poor performance of paraffin appliances results in “toxic
chemicals within paraffin being discharged into the air” (Truran, 2004a.) this generates dangerous levels of carbon monoxide, nitrogen dioxide, sulphur dioxide and particles (EPA, 1999). “If these are concentrated in a poorly ventilated home, they are bound impact, to some extent on the respiratory wellness of the inhabitants” (Truran, 2004a.: 6).

“Pollutants emitted through the burning of paraffin are typical of those associated with other types of fuels, including nitrogen dioxide, carbon monoxide, sulfur dioxide, polyaromatic hydrocarbons, and non-methane hydrocarbons” (John, Oosthuizen, Schwab, Brent, Immink and Rogers, 1997: ii). “Several potential, suspected or confirmed human carcinogens also are released during the combustion of paraffin. A particular concern are wick-type paraffin stoves, which tend to emit elevated levels of these carcinogens” (John, Oosthuizen, Schwab, Brent, Immink and Rogers, 1997: ii).

According to the United States Environmental Protection Agency (EPA, 1999), paraffin appliances give off varying amounts of carbon monoxide, nitrogen dioxide, particles, sulfur dioxide and unburned hydrocarbons and aldehydes. Each of these toxins has specific impacts on the household occupants:

- **Carbon monoxide (CO)** is odourless and effects may not be felt until it is “too late to take action against them” (EPA, 1999). Carbon monoxide exposure can cause: “Headaches, drowsiness, impaired judgement, nausea and / or vomiting. Prolonged exposure to high concentrations of carbon monoxide can lead to unconsciousness, brain damage and death. Babies, small children, pregnant women, the elderly, people with heart disease, and those taking medication or who are under the influence of drugs or alcohol are especially susceptible to CO poisoning.” (Leekha, 1999)

- **Nitrogen dioxide (NO₂)** causes “irritation of the respiratory tract and causes shortness of breath” (EPA, 1999). Children and asthma sufferers may be “more susceptible to the effects of nitrogen dioxide” (EPA, 1999). Exposure to nitrogen dioxide may cause children to contract colds and flu more easily (EPA, 1999)
• Particles in the air can cause “eye, nose, throat, and lung irritation” (EPA, 1999). “Certain chemicals attached to particles may cause lung cancer, if they are inhaled” (EPA, 1999).

• Sulfur dioxide can cause “eye, nose, and respiratory tract irritation” (EPA, 1999). With high levels of exposure this can cause the airways to narrow causing wheezing, chest tightness, or breathing problems. People most at risk are those with asthma who will react to even low levels of exposure (EPA, 1999).

On Air (1998) indicate that carbon monoxide is “produced whenever any fuel such as gas, oil, kerosene, wood, or charcoal is burned …if appliances are not working properly or are used incorrectly, dangerous levels of CO can result” (On Air, 1999). PEER Africa (1997) show that the “maximum allowable concentration for continuous exposure for healthy adults in any 8-hour period” (PEER Africa, 1997) is 50 parts per million (ppm) of carbon monoxide. At 200 ppm, the symptoms would be “slight headache, fatigue, dizziness, nausea” after exposure for 2 to 3 hours. At 400 ppm, the symptoms are “frontal headaches with 1 to 2 hours, life threatening after 3 hours” (PEER Africa, 1997). At 800 ppm “dizziness, nausea and convulsions within 45 minutes. Unconsciousness within 2 hours. Death within 2 to 3 hours” (PEER Africa, 1997). Beyond this point death will occur within an hour (PEER Africa, 1997).

The SANS1906 (2005) and SANS1243 (2007) both clearly state that paraffin users should “use the appliance in an adequately ventilated area to ensure satisfactory removal of smoke and fumes due to combustion and to allow circulation of air.” However in Truran’s (2004a.) research he found that “in low income dwelling situations, the stove often doubles as a heater and room ventilation is minimised to keep out the cold, damp and wind. In these sort of situations, the carbon monoxide alone can at best, cause dizziness, drowsiness and headaches (symptoms similar to altitude sickness) and at worst, death.” (Truran, 2004 a.: 3) Energy
Answers (1996) lends support to Truran’s (2004a.) findings and indicates that a lot of low income householders seal their homes to make them more energy efficient during the winter months. Unfortunately this makes the household susceptible to CO poisoning (Energy Answers, 1996). “Exposure to low concentrations over several hours can be as dangerous as exposure to high concentrations in a few minutes” (Energy Answers, 1996).

The SABS standards for non-pressure paraffin stoves and heaters SANS1906 (2005) and pressurized paraffin-fuelled appliances SANS1243 (2007) both give ratios for the carbon monoxide / carbon dioxide mixture: “When tested …the CO/CO₂ ratio shall not exceed 0.02” in SANS1243 (2007); with the non-pressure paraffin stoves and heaters adding in more specific requirements for emissions testing: “When operated at a power output of 1.5 kW, the burner shall emit not more than 0.03g particulate matter per minute, …the CO:CO₂ ratio shall not exceed 0.02 volumetric ratio” (SANS1906, 2005).

4.6. Conclusion:

The four key problems looked at in Chapter 4 are paraffin stoves, fire, poisoning and emissions. In concluding this section I summarise what I have learnt about these key issues.

PASASA indicate that there are about 20 million users of paraffin stoves in South Africa which equates to about 4 million stoves in use. Of the two types of paraffin stoves in circulation, the wick stove is most popular. Although the wick stoves don’t last as long as pressure stoves and have numerous safety related issues surrounding them, they are far less expensive than pressure stoves and don’t require high levels of technical know-how to maintain and run. Both the wick and pressure paraffin stoves failed the SABS standards tests commissioned by PASASA in 2003. Since those tests were conducted the standards have been improved upon and become more rigorous. The standard applied to wick stoves have
now become legislated (SANS1906, 2005). The fact remains that although there are serious issues with paraffin stoves, low income households need a means for cooking food. In the long term newer and safer fuels may become affordable, but in the short term safe and affordable paraffin stoves need to be manufactured to meet society’s needs.

Paraffin is a dangerous and flammable liquid fuel. This combined in stoves whose flashpoint is often exceeded in use, makes for a dangerous mix. Paraffin stoves are blamed as the largest single cause of fire in low income households. To further exacerbate this issue, low income homes, particularly those of informal settlements are built too closely together and are manufactured from found flammable materials. Fire-fighters cannot get to the epicentre of the fire as the roads between these houses are often too narrow and difficult to negotiate. Victims of these fires number in the thousands each year and beyond those that die, thousands are left homeless, injured and maimed from the fires. Of the victims those most vulnerable appear to be children aged between 1 year and 9 years. The victims of fire suffer long term needs that are costly both to their family and to the state, and through this the tax payer.

Around 80 000 children ingest paraffin each year and of this figure 40 000 develop chemical pneumonia (PASASA Press Pack, 2003). Again, as with fires the most vulnerable to paraffin ingestion and chemical pneumonia from paraffin are children. The main reason cited for this enormous concern is the system of paraffin distribution, wherein consumers of paraffin are required to supply their own containers to transport the fuel from the retailer to their homes. All too often these containers are the same type of containers that are used to store drinking water. The possible solution to this problem is child resistant containers. PASASA are busy lobbying government and fuel distributors to pre-package all paraffin to the consumer to not only solve the ingestion of paraffin but also to ensure that clean fuel is supplied for use.
Poor combustion of paraffin appliances results in “toxic chemicals within paraffin being discharged into the air” (Truran, 2004a.) this generates dangerous levels of carbon monoxide, nitrogen dioxide, sulphur dioxide and particles (EPA, 1999). The combination of poor ventilation and many hours of using an inferior quality paraffin appliance lead to dangerous levels of emissions which not only can cause serious lung diseases but can cause brain damage and in some cases kill.