Nabhani, F. and McKie, M. (2010) 'Implementation of a sustainable alternative to the disposal of spent foundry sand at landfill', *Foundry Trade Journal*, 184 (3675), pp.152-158.

Implementation of a sustainable alternative to the disposal of spent foundry sand at landfill

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Abstract

Many SMEs in the United Kingdom are being forced to change the way they manage and dispose of waste. In part, this change has been due to the introduction of landfill taxes by the Government, implemented to encourage companies to look at suitable and sustainable alternatives. This paper examines the application of key performance indicators (KPI) to monitor an SME's spent foundry sand (SFS) disposal over a one-year period. Monitoring the KPI initiated a company investigation to reduce SFS disposal to landfill and promote its beneficial reuse. Several alternative methods for SFS reuse were examined and a successful partnership was established with a asphalt producer after it was established that SFS could be substituted for virgin sand in asphalt manufacture. In addition to providing cost savings, for both partners, the partnership enabled SFS to be beneficially reused with a potential extension of its useful working life to about 60 years.

Introduction

The UK Landfill tax was introduced by the Conservative Secretary of State, John Gummer on 1st October 1996. Landfill tax is a method of enabling the UK to meet environmental goals, which were set out in the *Landfill Directive* that relates to the land filling of biodegradable waste. Increasing landfill taxes encourages manufacturing companies to investigate alternative methods for the disposal of waste. Using alternative waste treatment technologies and recycling methods can be more financially attractive for manufacturing companies looking for alternatives to disposing of waste and paying the landfill tax(1).

In many countries, landfill tax is imposed on landfills and other disposal facilities as a means of raising revenue, which is used for the long term mitigation of environmental impacts relating to the disposal of waste. It is also used as a method of inhibiting disposal by raising the cost in comparison to preferable alternatives i.e. (recycling). It is used in a similar manner to other government tax introductions such as excise or sin tax(1).

Waste disposal in landfill sites is discouraged for a number of valid reasons including:

- Materials which could be recycled such as wood, metals, paper and certain plastics can be re-used instead of being disposed to landfill.
- Climate change is being accelerated due to the gases produced at landfill sites. Landfill gases are produced on landfill sites because of bacterial decomposition, volatilisation and chemical reactions between substances within the landfill. Typically gases such as methane 45-60% and carbon dioxide 40-60% are produced at landfills. Other gases such as oxygen, ammonia, nitrogen, sulphides, carbon monoxide, hydrogen and nonmethane organic compounds (NMOCs) such as benzene, trichloroethylene and vinyl chloride are also produced. Some of these gases are accelerating the damage to the ozone layer(2).
- There is a lack of suitable landfill sites due to the ever increasing population. With the population increasing land is limited as it is required to provide housing and to support the requirements of an expanding society: more people generate more waste.
- Due to the introduction of landfill taxes it is becoming more expensive for companies to dispose of waste. This is a problem, especially considering the current economic downturn as companies are trying to reduce costs to keep themselves in business.
- The amount of tax levied is based on the weight of the material and whether the material is active or inactive. Active waste covers different types of material such as wood, plastics and piping. Inactive or inert waste covers materials such as brick, gravel, clay, soil, glass and with regards to this particular case study, sand. Active and inactive waste is often mixed for example brick which can be mixed with wood. In these cases where contamination takes place the waste is usually treated as active. The standard rate of tax is levied on active waste and the lower rate is levied on the inactive waste. As mixed waste is categorised as active, this incurs the higher tax bracket(3).

The landfill tax escalation is putting pressure on manufacturing on both SMEs and larger enterprises causing them to seek alternative methods of waste disposal. This is proving to be difficult for some companies struggling as a result of the major global economic crisis and the current emphasis on climate change and the environment. Landfill tax reached an all time high of £32 per tonne, up from £24 in the previous year, with the UK 2008 budget. The 2007 budget had announced annual increases in the standard rate of landfill tax of £8 per tonne from 2008/2009 until at least 2010/2011, by which time it will be as much as £48 per tonne. The government also announced that the aggregate levy, which has been frozen since its introduction, would increase in April 2008 from £1.60 to £1.95 per tonne(4).

The aggregate levy affects those businesses, such as foundries and asphalt producers, which use virgin sand.

The research reported in this paper was conducted to demonstrate how an SME, local to the North East of England, could overcome the ever-increasing costs of waste disposal to landfill by investigating and implementing a sustainable alternative. This was inspired and achieved by considering lean manufacturing methodology and tools and by implementing a Key Performance Indicator.

The SME is a sand casting foundry employing about 30 people which has been producing iron castings since 1947 for a wide variety of applications. Due to the increase in landfill taxes, scheduled until 2012, the company had to take actions that would reduce its disposal of spent foundry sand to landfill.

The company currently uses a mechanical SFS reclaimer to break down large lumps of sand from used moulds to produce fine grains that can be combined with a percentage of virgin sand to make new moulds. It is estimated that the company currently reclaims about 90% of the sand from used moulds. However, this means that 10% of the sand is disposed of to landfill and it is this 10% that the SME wishes to recycle using a sustainable alternative to disposal. The moulding sand is bonded with an alkaline phenolic binder. This chemical binder enables the sand to harden rapidly at ambient temperature to produce a mould that is sufficiently rigid to withstand the pressure from the molten metal. The chemical binder can be problematic in landfill disposal because it may be leached from the sand and cause environmental problems.

Adopting lean methodology, i.e. examining and implementing ways to reduce the amount of SFS disposal, can be monitored by using a specific KPI. The KPI was used to set a goal for the company to reduce the amount of sand taken to landfill by 20% within a one year period through the implementation of a sustainable alternative. The amount of SFS and general waste accumulated each month was monitored along with the cost of disposal. A suitable reuse alternative was identified with the objective of reducing the amount of SFS disposal to landfill.

Lean manufacturing

Lean manufacturing, or 'lean' as it is often referred to, is a manufacturing practice designed to consider the costs of resources for a given objective other than the creation of value for a customer. It evolves around eliminating waste i.e. reducing or eliminating time spent on non value adding activities. However, with regards to the SME, the disposal cost for SFS is considered to be a waste as it could, theoretically, be a by-product of the sand casting process and therefore actually generate funding for the SME rather than be a non value adding activity.

This paper examines an alternative method of reducing or eliminating the cost of SFS disposal to landfill by examining a sustainable and environmentally-friendly method of beneficial reuse. Continuously examining and improving methods for the reuse and recycling of SFS should reduce or eliminate the cost of SFS disposal.

Key performance indicators

Key performance indicators or KPIs (which are often referred to as 'key success indicators' or KSI) are created by many companies in order to help monitor and improve processes. The method of monitoring KPIs is often referred to as business activity monitoring or BAM. The method of monitoring and improving differs depending upon the organisation and the KPI in question. It is essential that quantifiable measurements are agreed upon prior to commencement and that they will reflect on critical success factors for the company. They must reflect on the company's goals and must be key to the company's success[5].

There are many different KPIs used within businesses to measure key goals such as increasing profit, increasing profit per employee, pre tax profit etc. With regards to the SME in question, the quantifiable KPI would relate to the ever-increasing cost of SFS disposal. This was seen by the SME as key to the future of the business. The cost of buying virgin foundry sand is increasing and so too is the cost of SFS disposal, both of which were targeted in the Government's 2007 budget. Therefore the KPI generated aimed to reduce the amount of SFS disposal to landfill. This was a quantifiable value because the company received an invoice from the waste disposal company every month detailing the tonnage of sand disposed, the cost per tonne and the cost of delivering and collecting the skip loads of spent sand[5].

However, simply measuring and monitoring the spent sand taken to landfill was not the sole objective of the exercise. The company sought both to reduce its disposal costs and demonstrate an improvement in environmental efficiency. The company sought a solution that would reduce SFS disposal to landfill and provide a reduction in disposal costs. The KPI that was implemented in September 2007 was to reduce the monthly amount of sand taken to landfill by 20% after one year, at which point the process would be reviewed and a new goal would be set[5].

Measuring and monitoring of spent foundry sand (SFS)

Table 1 was created from information obtained by the SME from the waste disposal organisation that it used for SFS disposal. It shows a period from April 2007 to April 2008 and provides information regarding sand tonnage disposed off, cost of disposal, container size, collection and haulage costs. Not only was the SFS monitored and measured over this period but so too was the general waste and mixed contaminated waste disposed of. Mixed waste is a problem; a container of sand could be contaminated with wood and therefore this then is regarded as mixed waste which is subject to a higher tax. The SME must ensure that the sand is kept clear of other skips containing general waste to prevent this being mixed in. The SME must also put procedures in place to ensure the correct and effective segregation of spent foundry sand and general waste. This is essential whether the sand is being taken to landfill or whether it is taken for a recycling cause.

The sand reclamation KPI was used to monitor:

- The SFS taken away per month.
- The number of empty containers delivered and containers of SFS taken away.
- The cost of SFS disposal (including the cost of delivering and collecting containers).

Table 1 illustrates the quantity of SFS removed each month from which it can be seen that the monthly disposed quantity of SFS is inconsistent. The number of containers received/removed and the weight of SFS disposal each month is also inconsistent. In one month a container filled with 18 tonnes of SFS was taken for landfill disposal compared with another month that showed an 11 tonne container being taken away. On average, the containers weighed 13 tonnes. If the tonnage could be increased and kept consistent month on month then it would take less containers to remove the sand. This equates to less road journeys for wagons reducing carbon dioxide emissions and reducing the cost of delivering and removing containers of sand.

The orders for castings per month, and therefore the quantity and weight of castings, SFS produced each month within the company remains constant. This is because the SME has a number of key customers who require a regular amount of castings per month. However occasionally a

	Apr-07	May-07	Jun-07	Jul-07	Aug-07	Sep-07	Oct-07	Nov-07	Dec-07	Jan-08	Feb-08	Mar-08	Apr-08
Sand Disposed													
Container Size (m^3)	12.20	12.20	12.20	12.20	12.20	12.20	12.20	12.20	12.20	12.20	12.20	12.20	12.20
Delivery of Containers	11.00	9.00	9.00	8.00	8.00	12.00	4.00	15.00	7.00	6.00	15.00	10.00	14.00
Collection/ Haulage	11.00	9.00	9.00	8.00	8.00	12.00	5.00	15.00	7.00	6.00	15.00	10.00	14.00
Disposal	11.00	9.00	9.00	8.00	8.00	12.00	4.00	15.00	7.00	6.00	15.00	10.00	14.00
Sand tonnage taken away	148.20	128.68	128.26	109.36	123.40	172.68	56.78	201.40	95.52	79.52	208.90	139.58	204.98
Average sand weight/container	13.47	14.30	14.25	13.67	15.43	14.39	14.20	13.43	13.65	13.25	13.93	13.96	14.64
Cost in £ /container for Delivery/Haulage	225.50	184.50	184.50	164.00	164.00	246.00	92.25	344.10	160.58	137.64	344.10	229.40	398.02
Cost in £ for Disposal of Waste	2,986.23	2,592.90	2,584.44	2,203.60	2,486.51	3,479.50	1,144.12	4,058.21	1,924.73	1,602.33	4,209.34	2,812.54	4,847.78

Table 1 Detailed table of expenditure and tonnage involved in disposal

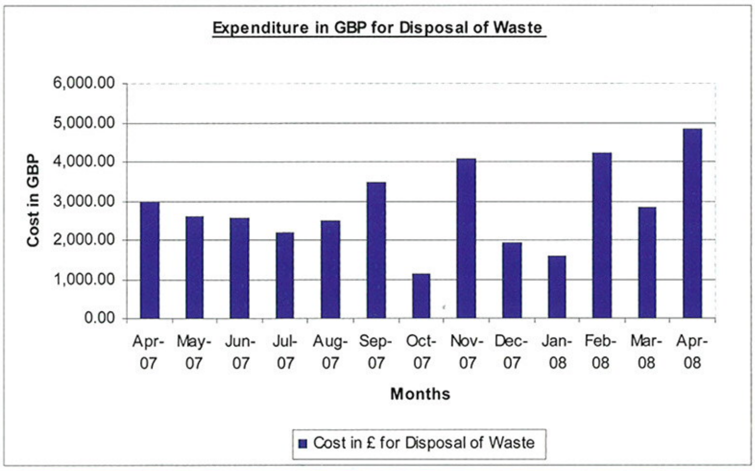

Fig. 1 Expenditure in GBP on monthly waste disposal

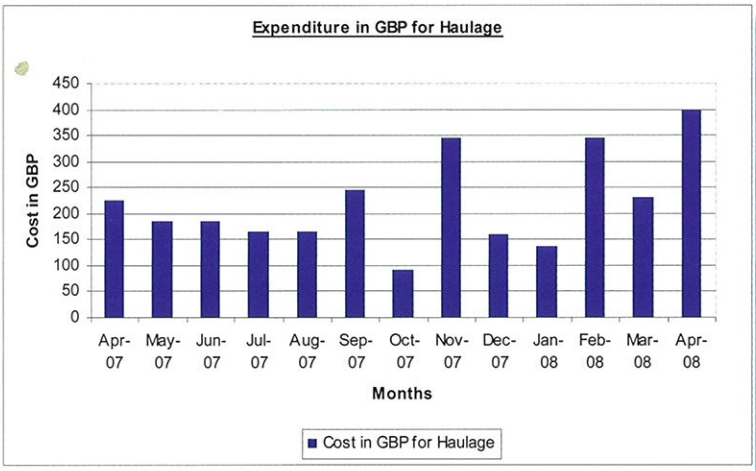

Fig. 2 Expenditure in GBP for haulage

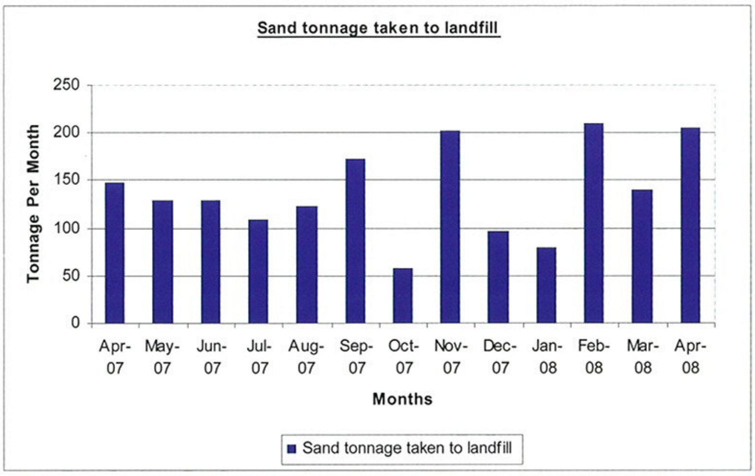

Fig. 3 SFS tonnage taken to landfill

batch of new castings may be required for a limited period maybe over a month for instance and in this instance the castings produced can increase and the sand required to produce these castings will also increase which can cause the sand tonnage taken away each month to be variable as shown in the graph. One of the main reasons for the large variation each month is due to the sand not being removed regularly each month and often the SFS disposal being neglected resulting in larger disposal loads the following month. There are other factors which are leading to the large variation of sand qualities taken away each month; these will be discussed in the following paragraphs.

The sand was often left outside in open-topped containers when the usual SFS store was full. This meant that the SFS retained water during periods of rainfall which increased the overall weight of the container. Therefore the foundry was not only being charged for the tonnage of sand taken from the premises but also for the rainwater. As the cost of the sand disposed is levied on the weight, one method to reduce costs would be to provide shelter for the SFS or cover the containers to prevent rain water from saturating the sand. By examining the results, it can be determined that during the summer months the average tonnage of sand disposal was slightly less than that during the winter, a percentage of which will have been made up of rain water. The average monthly SFS tonnage disposed from May to August 2007 was 122.43 tonnes whereas during the period November 2007 to February 2008 the average monthly SFS disposal was 146.34 tonnes. During December, manufacturing stops for a two week period (due to the festive season) and, therefore, less SFS is produced. However, there was still a 23.9 tonne increase in disposal per month thus it can be assumed that the wet winter conditions caused water saturation in the SFS leading to that increase.

As well as examining the weights and expenses of the past and present SFS loads, the main objective was to reduce or eliminate the quantity of sand taken to landfill by implementing a sustainable alternative.

Fig. 1 presents expenditure in UK sterling for SFS disposal from April 2007 to April 2008. The graph confirms that the cost, and therefore the quantity, of sand taken away over this period, is not consistent as mentioned previously. By monitoring the sand using a KPI a number of key improvements could be achieved. If the tonnage of sand being taken away per month can be averaged and become consistent, then the company's finances with regards to outgoing expenditure could be predicted each month. At present the company cannot predict how much sand will be taken away within the following six month period and consequently how much this will cost. This also relates to the expenditure in UK sterling for haulage, as illustrated in fig. 2, which has a direct correlation with the expenditure of waste disposal per month. It is again important to note that, although the foundry can attempt to be more consistent in taking away the sand, the variation will remain depending on order quantities and the size of casting moulds and number of cores. However if the sand is taken away and not neglected then the foundry can become more consistent with the amount of sand taken away.

In October 2007, the SME spent £1,236.37 for SFS disposal, however a month later in the same year (even before the price increase) the company spent £4,402.31. The reason for this is simple: the company disposed less SFS in October 2007 and then had to compensate for this by disposing of additional SFS in the following month. This excess sand took up more space within the company, which is problematic with regards to lean manufacturing which requires *just in time,* also known as JIT methodology, to take advantage of space and never overstock materials. Excess stock stored by the company has an overhead,

Use	Notes	Type of Foundry Sand
Foamed Concrete	Flowable fill, aerated concrete and controlled low strength material. In some cases substituting 100% foundry sand has shown a decrease in strength of the final product, since residual particles of resin may be adhered to the sand grains.	A percentage of greensand, alkaline phenolic and resin shell sands may be used as a fine aggregate replacement.
Agriculture	Certain foundry sand types can be mixed with various soils for the benefit of agriculture. Further investigation and tests are required.	Potentially Greensand.
Hot Rolled Asphalt	Partial replacement in 50% mix of fine aggregates. Well proven and successful application in UK and Overseas.	Green Sand – Clay Content reduces bitumen bleed from mix Alkaline Phenolic and resin shell sands are also suitable.
Concrete Block Making	Can be used in low density (aerated) and dense blocks. Potential for phenol leaching from stockpile material may require modification of process authorisations	Most sands including Greensand.
Sand Bags	Foundry sand has the potential to be used in sandbags in emergencies. Potential for phenol leaching requires further investigations.	Spent Greensand, potentially other sand types pending investigations.
Road base construction	Leaching of contaminants from unbound courses may pose problems – requires testing to ensure no adverse environmental impact.	Most chemically bonded sands may be used as substitutes for fine aggregates filler.
Brick Manufacture	Used as an aggregate filler. Iron spotting on brick surface may cause continuity problems for standard Bricks – but may be a desirable for special effect bricks	Most Sands including Greensand.
Cement	Cement uses sand and potentially spent foundry sand can be used to produce it. However as with foamed concrete the strength of the cement can decrease. This is caused by residual particles of resin that may adhere to the sand grains.	A percentage of greensand, alkaline phenolic and resin shell sands may be used as a fine aggregate replacement.

Table 2 Uses for spent foundry sand

therefore the less stock stored the more money the company has in the bank. If the company applied JIT to sand removal it could avoid excess storage and especially storage subject to water saturation. This would reduce both the weight and cost of SFS disposal and free space for other activities.

Monitoring the SFS taken to landfill and monitoring the costs was an advantage to the foundry as price increases could be monitored. For example, in April 2007 the cost of hauling one container was £41.00. In November 2007 this increased to £45.88, an increase of 11.9%. This cost increased further in April 2008 to £56.86, an additional increase of 23.93%. From April 2007 to April 2008 the cost of delivery and collection of one container rose by a total of 38.68%.

In April 2007, the cost of SFS disposal was £20.15 per tone; this increased to £28.43 per tonne in April 2008, an increase of £8.28 or 41%. This cost will increase annually because of the statutory annual increases in landfill tax to 2011 by which time it could reach £48 per tonne. This predicted increase provided a powerful incentive for the company to identify an alternative method for SFS disposal.

By carefully monitoring SFS disposal it was observed that one container load contained mixed waste. Mixed waste is categorised as a mixture of active and inactive waste or, in this case, general waste mixed in with SFS. When this occurs the SFS is treated as mixed waste and therefore incurs the higher active waste tax rate. Fortunately the container was of only 5 tonnes capacity and not the average 13 to 14 tonne container. By creating and monitoring the KPI, a number of key improvements could be made to the company's existing method of SFS disposal. The company's ideal approach was to achieve zero-cost disposal through beneficial reuse, providing both financial and environmental benefits.

An investigation of a sustainable alternative to SFS disposal

There are alternatives to SFS disposal to landfill[6] and these are summarised in Table 2.

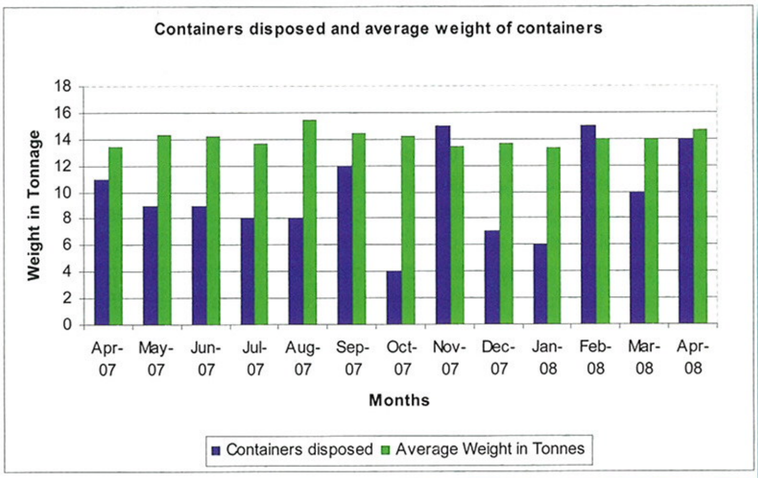

Fig. 4 Collections and containers average weight

Fig. 5 Annual cost to dispose of spent foundry sand from April 2007 to March 2008

Year	Waste Type	Price Per Tonne	Collect and Delivery Of Skip	Skip Size Cu. M
2007	Sand	20.15	20.50	12.20
2008	Sand	23.65	25.49	12.20
April 07-March 08	132.69	Average SFS in tonnes disposed/ month		
April 07-March 08	115	Loads taken/ year		
April 07-March 08	1,592.28	Tonnage sent to Landfill/ year		
April 07-March 08	£32,084.44	Total annual sand disposal costs		
April 07-March 08	£2,812.54	Annual haulage cost		
Total	£34,561.01	Total Cost (Excluding VAT)		
Large Enterprise New Price	£4.00	Per Tonne		
Annual Cost based on April 07-March 08 figures.	£6369.12	Annual Cost Quote		
Saving when compared to April 07-March 08 Total Costs	£28,191.89			

Table 2 presents several methods by which SFS might be reclaimed. However, some of these methods required further investigation before they could be certified as suitable alternatives to the company for its current SFS disposal to landfill. The research assessed the suitability of used alkaline phenolic sand for beneficial reuse applications.

Foamed concrete is often used to produce lightweight blocks for the construction industry. The manufacturing process includes the use of virgin sand to produce the concrete. Various used foundry sands have been evaluated for their suitability in concrete formulations. It has been established that substituting SFS for virgin sand can reduce the concrete's strength and this limits the proportion of SFS that can be used. Alkaline phenolic sand can be particularly problematic in this respect.

The application of various foundry sands for agricultural purposes has been examined, especially the mixing of clay-bonded SFS from greensand foundries with soils. However, alkaline phenolic sands require further evaluation because of concerns about chemical leeching from the SFS. The use of alkaline phenolic sand in brick manufacture has been proven successful at low SFS substitution rates according to one case study[7].

SFS may have the potential to be used in road construction and in sand bags for flood defences. The idea of using the SFS in sandbags was prompted by the UK summer flooding of 2007. The company investigated methods of using the SFS in hessian bags for use in some of the country's most badly flooded regions. A number of regional councils were interested in the idea but would not use the SFS unless it was first certified for use by the Environmental Agency due to concerns about possible contaminants. As this concern could not be resolved, the idea was put on hold.

The alternative uses for alkaline phenolic SFS appear to be limited due to the contaminants contained within the sand. As part of the research, a detailed chemical analysis was conducted on the company's SFS. It was established that most of the chemical binders were burnt off during the casting process, providing that the sand had been heated to a sufficiently high temperature by the metal. However, not all of the sand in a mould is subject to such high temperature and, consequently, residual resin can still remain in SFS.

The use of sand in asphalt production

The use of SFS, including alkaline phenolic sand, has been well researched and documented. This knowledge was used to find companies that might be interested in creating a partnership with the SME to implement a sustainable alternative to SFS landfill disposal. The proposed partnership would be beneficial to both parties: the SME would benefit from achieving the KPI goal of reducing sand disposal to landfill; and the partnering company would benefit from substituting SFS for the more expensive virgin sand. A major asphalt manufacturing enterprise that supplies UK contracts agreed to a collaborative project. However, before final commitment a number of tasks had to be undertaken by the companies.

The first task required comprehensive analysis of the SFS by the asphalt manufacturer's laboratory. This confirmed suitability of the SFS for asphalt production. The second task required gaining consent from the local county council to enable the asphalt manufacturer to utilise the SFS. This was achieved through further testing of the SFS to determine the influence of asphalt production temperatures on chemical emissions and to ensure that SFS had no detrimental effects upon asphalt properties. Once the local county council was satisfied, the third task was initiated and involved transporting a container load of SFS to the asphalt producer to enable production trials to be conducted.

The SFS was crushed, to break down lumps to grain size, and then screened to remove any foreign objects, such as general waste, iron pieces or grinding discs hidden within the sand, that could affect the asphalt manufacturing process. Grain size distribution was analysed as this influences the asphalt properties. The asphalt producer also tested various ratios of SFS to virgin sand to optimise asphalt properties. The production trials proved the feasibility of using SFS. This enabled the partners to agree a price for the SFS that would provide mutual benefits. The SME agreed to pay the asphalt manufacturer a price of £4 per tonne to cover the cost of collection and transportation.

Results

The financial benefits to the SME are presented in fig. 5 in which the costs before and after the partnership are summarised.

The KPI is recorded in fig. 6 from which it can be seen that there was a significant improvement once the partnership benefits were experienced in August 2008.

The monthly benefits can clearly be seen from Table 3 in which the bottom line figures show a ten-fold reduction in disposal costs.

Discussion

The average monthly cost of SFS disposal was £2,890.94 for the period from April 2007 to 2008. This is represented by the red line in fig. 6. The KPI goal was to reduce monthly SFS disposal to landfill by 20% within one year, represented in fig. 6 by the green line. Since the large enterprise started recycling the spent sand, the cost of disposal has reduced to an average of £580 per month. Not only has this venture between the two companies saved the SME money but it has also saved the large enterprise money too. Now the large enterprise no longer has to purchase as much virgin sand to manufacture the asphalt. A case study provided by the large enterprise showed that in 1997 a similar venture saved them £31,500 by not having to pay for virgin sand required for manufacture[8].

The information in Table 3 shows annual cost to the SME of SFS disposal prior to the KPI implementation. The total cost of SFS disposal in 2007 was approximately £34,561. If the SME produces the same amount of sand every year and the cost of transfer to the large enterprise remains at £4 per tonne, the SME can expect to pay £6369.12 providing a saving on April 2007 to March 2008 figures of £28,191.89.

The KPI drove the company to not only successfully achieve, but greatly exceed the annual goal of a 20% monthly reduction in SFS disposal to landfill in the first year. By August 2008, 100% of the sand taken away each month was recycled and re-used in other products and the company saved an average of 79.5% per month on SFS disposal costs, when compared to the average disposal cost between April 2007 and March 2008.

The SME also benefitted because the KPI identified that leaving the SFS outside caused SFS saturation during rainfall, significantly increasing the overall weight of SFS for disposal and, consequently, disposal costs. The company has also benefitted from regular and consistent monthly transfers of SFS. This has improved cost control by enabling accurate predictions of monthly expenditure. The company may also benefit from the release of the space previously allocated to excess SFS storage now that the SFS is removed consistently and efficiently by the large enterprise. This space represents a resource which can now be exploited by the company.

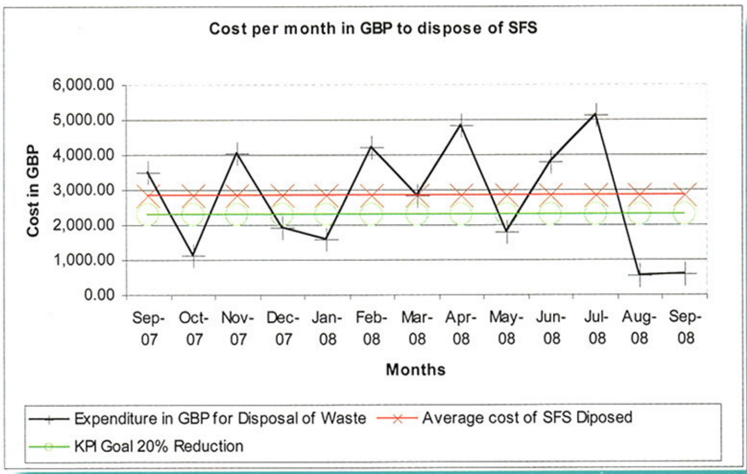

Fig. 6 Monitoring of the KPI after the implementation of the sand reclamation

SFS disposal to landfill increases the rate at which the landfill is filled, shortening its life span and using valuable space, especially as it accelerates the need for new landfill facilities. Ideally, all waste should be re-used or recycled to prevent both the consumption of resources and the use of landfill. This places the onus on all businesses to investigate methods for recycling and re-using their waste. This case study provides a sustainable alternative to simply disposing of waste to landfill. According to one study, hot rolled asphalt has an average service life of 18 years and that perpetual hot mixed asphalt pavements can last 60 years with additional overlays[9]. This means that the life of the SFS, beneficially used in asphalt, could be increased by 60 years, which is much preferred when compared to the alternative of dumping the SFS in landfill. In fact the life span of the SFS could be increased further as worn asphalt pavements can also be recycled and combined with virgin asphalt to produce a new product[9].

Conclusion

The implementation of a key performance indicator at an SME proved to be successful. The objective of reducing the sand taken to landfill by 20% in year one was not only completed but exceeded. The SME now recycles 100% of its spent foundry sand which was previously disposed to landfill. There are a number of other benefits to come from KPI implementation. The SME has now established a working relationship with a large enterprise. The SME can continue to monitor the KPI and ensure that the sand taken away per month is kept more consistent, therefore allowing them to control

Sand Disposed	Sep-07	Oct-07	Nov-07	Dec-07	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Sep-08
Container Size CU.M	12.20	12.20	12.20	12.20	12.20	12.20	12.20	12.20	12.20	12.20	12.20	12.20	12.20
Delivery of Containers	12.00	4.00	15.00	7.00	6.00	15.00	10.00	14.00	5.00	11.00	16.00	0.00	0.00
Collection/ Haulage	12.00	5.00	15.00	7.00	6.00	15.00	10.00	14.00	5.00	11.00	16.00	8.00	8.00
Disposal	12.00	4.00	15.00	7.00	6.00	15.00	10.00	14.00	5.00	11.00	16.00	8.00	8.00
Sand tonnage taken away	172.68	56.78	201.40	95.52	79.52	208.90	139.58	204.98	76.50	160.30	216.04	140.00	150.00
Average	14.39	14.20	13.43	13.65	13.25	13.93	13.96	14.64	15.30	14.57	13.50	17.50	18.75
Cost in £ for Delivery/Haulage	246.00	92.25	344.10	160.58	137.64	344.10	229.40	398.02	142.15	312.73	454.88	0.00	0.00
Cost in £ for Disposal of Waste	3,479.50	1,144.12	4,058.21	1,924.73	1,602.33	4,209.34	2,812.54	4,847.78	1,809.23	3,791.10	5,109.37	560.00	600.00

Table 3 Expenditure for SFS disposal from September 2007 to September 2008

expenditure more accurately. Implementing lean manufacturing techniques allowed the company to identify problems with SFS saturation and to free up space. The large enterprise will benefit from reusing the sand saving money when compared to purchasing virgin sand for manufacturing purposes.

The research has also been environmentally beneficial. The SME is no longer dumping spent alkaline phenolic sand in the landfill thus prolonging the life of the landfill by not allowing it to become saturated with sand. This will aid reductions in the amount of landfill sites created throughout the country. The trucks that deliver and collect the sand from the SME are no longer required to carry out the journey saving CO_2 emissions. The useful working life of the SFS could be increased by 60+ years, depending on addition of asphalt layers and the recycling of the asphalt after use.

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Health & Safety/Environmental

HSE Projects on Exposure to Airborne Contaminants – Part 2

The latest in Health & Safety and Environmental news for the foundry industry from the Cast Metals Federation.

In the May issue of *Foundry Trade Journal*, we looked at the current co-ordination of the Health & Safety Executive (HSE) on a number of projects designed to improve control of exposure to airborne contaminants, notably dusts and fumes - an issue of considerable interest to foundries.

We looked at the *Respiratory Protective Equipment* (RPE) project, which has followed on from the LEV (*Local Exhaust Ventilation*) Project, and also described a new project, the *Long Latency Health Risks Programme*, which is only just commencing. This month we look at the *Dust Initiative* which sets out to raise awareness of the risks associated with dust exposure.

Currently in progress, the *Dust Initiative* is principally involved in raising awareness of the risks associated with dust exposures in the foundry sector. Its aims are to change behaviour and culture in the industry so that management and workers are fully aware of the risks to health from exposure to dust and fumes and that appropriate protection measures are established, used and maintained by all.

A partnership team comprising the Cast Metals Federation (CMF), Castings Technology International (Cti) and several foundry groups has been formed to progress the project in the UK. HSE specialists from the Metals and Minerals Group are coordinating the project.

It was expected that all partners would contribute to the project and one of the initial objectives will be to seek ways to ensure maximum coverage of the industry to ensure that all workers exposed to foundry dust are suitably informed and protected. The partnership team's report will then key in to the whole HSE project with the objective of minimising the level of dust in the foundry through successful ventilation and then implementing guidelines for effective use of RPE, where required.

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