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Corner Brook Pulp and Paper Limited
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Registration Pursuant to Section 49 of *The Environmental Protection Act*

Co-Firing of Tire Derived Fuel in the #7 Hog Fuel Boiler

TABLE OF CONTENTS

PROPONENT:

(i) Name of Corporate Body:

Corner Brook Pulp & Paper Limited

(ii) Address:

P.O. Box 2001
1 Mill Road
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A2H 6J4

(iii) Chief Executive Officer:

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Official Title: Vice President - Manufacturing
Telephone #: (709) 637-3462

(iv) Principal Contact Person(s):

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Alternate:

Name: Dwayne White
Official Title: Continuous Improvement and Technical Manager
Telephone #: (709) 637-3207

(v) Corporate Description:

Corner Brook Pulp & Paper Limited (CBPPL), a wholly owned subsidiary of Kruger Inc., operates an integrated pulp and paper mill in Corner Brook. Harvested pulpwood and wood chips from Newfoundland sawmills are used to produce a thermo mechanical pulp that is then converted into high quality newsprint and sold into international markets. The mill currently produces approximately 720 metric tonnes of newsprint daily and employs approximately 600 people in its operations. Payroll for 2010 will be in excess of $60 million, including employee benefits.

The mill has a woodlands management division, both with ISO and CSA certifications, plus operates a hydroelectric facility in Deer Lake. Additional information on forest management activities and environmental policies can be found at www.cbppl.com while information on the Kruger organization, including environmental policies, can be found at www.kruger.com.

THE UNDERTAKING:

(i) Nature of the Undertaking:

Tire Derived Fuel (TDF) is defined as a uniformly shredded product produced from whole scrap tires for use as a fuel.

Corner Brook Pulp and Paper Limited, with support of the Multi-Material Stewardship Board (MMSB), is proposing to install a TDF storage, handling and blending system to allow the addition of up to 5%, by weight, of TDF to the biomass feed to the #7 power boiler. A letter of support from the MMSB is attached in Appendix A.

According to the Rubber Manufacturers Association (RMA, 2009), at the end of 2007, 123 separate facilities in the US were permitted to use TDF with a total annual TDF consumption of approximately 172 million tires (2484 thousand tons). 42.9% of the TDF, or approximately 74 million scrap tires (1065 thousand tons) was used in pulp and paper mills. It is the largest application of TDF in the country. A list of US pulp and paper mills using TDF as a supplementary fuel source in 2009 is provided in Appendix B.

(ii) Purpose/Rationale/Need for the Undertaking:

To produce newsprint, steam energy is used. At CBPPL, this steam is produced with a state-of-the art, high-tech boiler, commissioned in 1995, that burns a combination of fossil fuels and renewable energy sources (biomass). Fossil fuels are Bunker C and waste oil. Renewable energy sources include fuels generated from mill operations (bark, sawdust, effluent treatment solids) and a variety of wood waste from nearby sources (sawmill waste, waste wood from the municipal landfill). In 2003 a steam turbine was added to the boiler system to optimize the steam energy produced - steam is now being utilized to generate electricity prior to being used for newsprint production. This electricity is being added to the provincial electrical grid and does help displace the use of some fossil fuels by NL Hydro in their Holyrood generating facility.

Currently, there are over 1.9 million tires stockpiled in Newfoundland. The stockpile consists primarily of approximately 1.7 million passenger and light truck tires, along with an estimated 200,000 medium truck tires. Previous attempts to arrange for a sustainable recycling and processing used tire program in Newfoundland & Labrador have been unsuccessful. As such, scrap tires generated by this province are now being shipped to Quebec for utilization as a fuel source. A long-term, viable solution for a used tire-recycling program for this province is desired.

In 2004, CBPPL retained the services of a qualified, experienced consultant, Sandwell EPC, to evaluate the feasibility of increasing the biomass burning capacity of the #7 power boiler. The main objective of the project was to be able to burn more biomass with the existing boiler while reducing the amount of fossil fuel needed. Since a source of TDF was readily available in Newfoundland, one of the alternatives studied included the addition of a new TDF storage, handling and blending system. TDF is a proven excellent fuel source, with low moisture and high heating value, and co-firing up to 5% by weight of TDF with the biomass would have many positive benefits. One benefit is that TDF would allow the mill to efficiently combust biomass sources with high moisture contents, such as the older bark stockpiles at many of the province's sawmill operations. Another key benefit is that TDF would allow further reductions in fossil fuel usage. It is the goal of CBPPL to eventually eliminate all use of Bunker C in its operation.

Following the promising results of the 2004 feasibility study, Sandwell EPC Inc. was again retained to complete engineering designs, equipment specifications, capital cost estimates and construction drawings for the biomass capacity increase project. As part of this contract, Sandwell was also required to conduct a detailed examination of the potential environmental impacts and concerns associated with using TDF in #7 power boiler. A copy of their report on environmental impacts is included in Appendix C.

In 2007 the mill proceeded with the engineered modifications designed to increase hog fuel-burning ability. Over $5 million in modifications were completed, including upgrades to the boiler's over-fire air system, upgrades to install a sectionalized under grate air system, the addition of a new hearth burner and the installation of an improved furnace camera system for operator feedback.

The current proposal is to first proceed with a TDF trial to ensure that all environmental limits and pollution control standards can be met. If the trial is deemed successful, the mill may then proceed with the engineered systems required for the co-firing of TDF.

DESCRIPTION OF THE UNDERTAKING:

(i) <u>Geographic Location:</u>

Corner Brook Pulp & Paper is located on west coast of Newfoundland, in the city of Corner Brook (2006 population: 20,083). Corner Brook is nestled among the folded and faulted Long Range Mountains, which are a continuation of the Appalachian Mountain belt, stretching up from Georgia in the southern United States. Set at the mouth of the Bay of Islands, the city is 40kms inland from the open waters of the Gulf of St. Lawrence.

The mill, which is situated on approximately 120 acres of land, is located along the waterfront area in Corner Brook. The property contains numerous production buildings, as well as wood and bark storage areas. This infrastructure for this project will be located in the bark storage area (Appendix D).

(ii) <u>Physical Features:</u>

A simplified flow chart for the proposed system is attached (Appendix E).

TDF Specification:

To provide more energy per unit, and less problems associated with feed, grate maintenance, ash handling and ash disposal systems, the TDF will be processed to remove a minimum of 95% of all free wire. The TDF will be delivered as a chipped product with a nominal size of approximately 1".

System Capacity:

The TDF handling system being proposed is suitable for the addition of an average of 4% TDF, by weight, to #7 boiler (maximum of 5%). Based on the present biomass quantities used, i.e., approximately 250,000 green metric tonnes per year, a TDF handling capacity of 28 bone-dry metric tonnes per day (BDMT/d), or 1.2 BDMT/h is needed for an average 4% TDF blend.

Reception, Unloading & Storage:

TDF will be delivered to the site using enclosed transport trucks. The trucks will be weighted on their way in and out for accurate inventory and billing purposes. The trucks will also be self-dumping, equipped either with tilting or with moving floor type trailers.

TDF will be dumped onto the concrete pad located directly in front of an existing chip bin (Appendix D). This bin was previously used for sawmill chip deliveries and will be converted into the TDF receiving bin. From the unloading pad, the TDF can be pushed directly into the receiving bin by the existing front-end loader.

To minimize risk to the pulp and paper process, it is important that TDF does not mix with the wood chips. The unloading pad is over 6 meters wide, 20 meters long and has a 4m high concrete wall on each side, allowing for secure segregation of the TDF. This pad will be used to store a maximum of 2 truckloads, or approximately 60 BDMT.

The receiving bin has a volume of approximately 180 m^3. Based on an average loose bulk density of 0.5 BDMT/m^3 for a 1" nominal tire chip, approximately 90 BDMT of chips can be stored inside the receiving bin (3 truckloads). Total storage capacity (pad + bin) is equivalent to approximately 5 days consumption at the rate of 1.2 BDMT/h.

Reclaim and Blending with Biomass:

From the unloading pad, the TDF will be loaded by the front-end loader into the receiving bin for blending with the biomass flow on the existing belt conveyor.

The receiving bin is equipped with a bottom drag chain conveyor with a variable speed drive. This conveyor will transport the TDF to an extraction/metering screw, which will in turn transfer it, at controlled rates, to the biomass reclaim conveyor. The 12" diameter screw conveyor is equipped with variable pitch flights for uniform extraction and with a variable frequency drive for the controlled blending of TDF with reclaimed biomass.

Low material level reading and alarm in the bin as well as high-level indication on the discharge hood over the extraction screw will be provided to monitor the flow of TDF throughout the system. The extraction screw will also be supplied with a motion switch.

The bin will be supplied with an overhead roof for protection against adverse weather such as freezing rain. The roof will be high enough to be out of reach of the bucket of the front-end loader. A certified and approved fire protection system will also be installed in the bin.

A new belt scale consisting of a single 3-roll idler mounted on load cells will be inserted on the biomass reclaim conveyor. The scale will be located shortly after the loading skirt, where the bark has already settled. This will provide a delay of approximately 8 seconds of biomass travelling time on the belt conveyor from the scale to the blending point with TDF, which is sufficient for the extracting screw to adjust the TDF flow accordingly.

An existing self-cleaning electro-magnet located near the discharge head of the biomass reclaim conveyor removes tramp iron from the biomass flow. Some testing with tire chips will be performed to ensure these chips are not attracted to the magnet and adjustments will be made as needed.

(iii) Construction:

Construction for this project is minor, with some basic civil and structural work to modify the receiving bin and conveying system. The work will be conducted by qualified personnel on the mill's operating site, subject to company environmental and safety policies. All work will be monitored by the mill's Engineering Department to ensure no environmental risks or pollution during construction, as well as to ensure a high quality installation.

(iv) Operation:

Feeding Control Philosophy:

The amount of TDF fed to the existing biomass reclaim conveyor is a function of the amount of biomass present on the belt. As previously noted, a new belt scale will be installed on the biomass reclaim conveyor at an upstream location from the TDF introduction point. It weighs in a continuous manner the amount of biomass and sends a signal to the variable speed drive of the TDF discharge and metering screw. The screw speed will be directly proportional to the amount of biomass, assuring a uniform blend of biomass/TDF. Woodroom Operators using a DCS and a system of video cameras, with feedback from Operators in the Steam Plant and the front-end loader Operator, will control the system.

Potential Sources of Pollutants:

Used tires or TDF are one of the most readily useable and highest heat content non-hazardous wastes available. According to the US EPA, testing has shown that TDF produces emissions that are comparable or in some cases better than conventional fuels. TDF has been successfully co-fired with coal and hog fuels in cement kilns, pulp and paper boilers and power utilities for over 20 years in the US and Europe while meeting all necessary emission and pollution standards (Duggirala, 2009). The main characteristics of TDF are provided below in Table 1.

Table 1 - TDF Characteristics[1]

Parameter	*Units*	*Value*
Moisture content	%	1-3
High Heating value, dry basis	GJ/t	38
Bulk Density, wet basis	Kg/m^3	500-650[2]
Elemental Analysis		
Carbon, C	%	84.4
Hydrogen, H	%	7.1
Oxygen, O	%	2.2
Nitrogen, N	%	0.2
Sulfur, S	%	1.2
Inorganics	%	4.8

[1] Biomass Capacity Increase, Sandwell EPC Inc., Study 121771A

[2] 1" nominal rubber chips, wire removed

As noted in Appendix C and in previous studies (see References), the use of TDF in a biomass boiler can have an impact on stack emissions and ashes leaving a plant. On the positive side, improved combustion efficiencies are expected, resulting in reductions in unburned carbon in the ashes and some potential improvements in the quality of stack emissions.

Other potential impacts on the environment associated with using TDF in a biomass boiler are primarily associated with ambient emissions of particulate matter, heavy metals (primarily zinc), sulphur dioxide, nitrous oxides and dioxins and furans. Disposal of ash with potentially elevated metal content (zinc and iron) is another area of concern.

In Newfoundland, the *Air Pollution Control Regulations, 2004*, prescribe ambient air quality standards for contaminants to maintain acceptable air quality for the protection of the environment and human health. Table 2 details the limits that have been established for the contaminants of concern associated with TDF usage. Source emissions testing (stack testing) and air dispersion modeling are used to determine compliance with these standards. In addition, CBPPL operates ambient air monitors at two locations in the city – the Corner Brook Hotel site which monitors total particulate matter, $PM_{2.5}$ and SO_2 and the Western Star site which monitors total particulate matter. Corner Brook also has a National Air Pollution Surveillance (NAPS) Network Station that monitors Criteria Air Contaminants (SO_2, CO, NO_2, Ozone, and $PM_{2.5}$).

Table 2 – Ambient Air Quality Standards

Contaminant	*Unit of Concentration*	*Concentration*	*Period of Time*
Particulate matter (total)	Micrograms per cubic meter of air	120 60	24 hour 1 year
Particulate matter (less than 2.5 microns), $PM_{2.5}$	Micrograms per cubic meter of air	25	24 hour
Zinc	Micrograms per cubic meter of air	120	24 hour
Sulphur dioxide (SO_2)	Micrograms per cubic meter of air	900 600 300 60	1 hour 3 hour 24 hour 1 year
Nitrogen dioxide	Total micrograms of nitrogen oxides per cubic meter of air, expressed as NO_2	400 200 100	1 hour 24 hour 1 year
Polychlorinated dibenzo-p-dioxins (PCDDs) & poly-chlorinated dibenzofurans	Picograms (TEQ) per cubic meter of air	5	24 hour

The change in emissions when using TDF depends on the type of facility configuration, air-pollution control equipment and the type of primary fuel being displaced or supplemented. The #7 boiler at CBPPL has several air pollution control devices, including mechanical dust collectors, a venturi wet scrubber with an adjustable throat, low NOx high efficiency burners and an advanced spreader stoker and ash removal system. As previously noted, in 2007, the boilers underwent further combustion process upgrades, improving its ability to efficiently combust solid fuels and reduce emissions.

Particulate Emissions

A study by Paprican (PR 1625, 2002) noted: "an efficient particulate control device is required to prevent increased particulate emissions when burning TDF. A proper feed system to provide a consistent and well-controlled feed rate is recommended. Proper combustion air control on the boiler is required to ensure efficient combustion of the TDF".

The #7 boiler at Corner Brook Pulp & Paper has a flue gas treatment system. The mechanical collectors remove larger fly ash particulates from the flue gas stream while the scrubber removes sub micron fly ash particles and is teamed with a cyclonic scrubber separator for efficient entrainment separation.

The purposed TDF Storage, Handling and Blending system will be routinely calibrated plus will have system alarms and automatic shut-off to ensure proper feed rates are always maintained.

The boiler upgrades completed in 2007 have improved combustion air control for maximum burning efficiency of biomass and any TDF. Stack testing and dispersion modeling completed since these latest upgrades indicate that the mill is well below ambient air quality standards for both total particulate matter and $PM_{2.5}$ for all averaging periods. The ambient monitors also confirm these results.

Heavy Metals

Rubber tires contain approximately 1.5% zinc as part of the tire formulation. The use of TDF can therefore result in an increase of zinc particles in the boiler stack emissions (zinc oxidizes into a fine particulate). Other heavy metals are only found in trace amounts in TDF (less than 0.01 percent) and, as such, these emissions are not expected to vary greatly when hog fuel or Bunker C is supplemented by TDF. The Sandwell study, Appendix B, reported reductions in some heavy metals and no significant change in others with TDF addition. Zinc was the exception.

Based on the research conducted, a major portion of the zinc will be rejected in the boiler ashes, a portion will be captured by the flue gas treatment system (effluent) and a portion will be emitted into the environment as particulate. However, given the results of the ambient air monitoring programs and the stack testing and dispersion modeling, it can be reasonably expected that any increase in particulate emissions resulting from TDF combustion will not exceed ambient air quality regulations.

Stack emission testing was conducted in 2005 to determine baseline emission rates for selected compounds, including zinc and other metals, from #7 boiler. This was done to allow evaluation of changes to emission characteristics in preparation for future alternative fuel testing.

Sulfur Dioxide (SO_2)

TDF typically contains 1.2% sulfur, which will be converted into sulfur dioxide in the boiler. The significance will depend on the sulfur content of other fuels.

At present, the mill is permitted to use Bunker C with average sulphur content of up to 2.0%. Hence, the use of TDF as a supplemental fuel could potentially lead to a decrease in SO_2 emissions. The pH of the scrubber water can be adjusted as needed to improve SO_2 removal and no increase in SO_2 emissions is anticipated.

Stack testing and dispersion modeling completed since the latest boiler upgrade indicate that the mill is well below ambient air quality standards for SO_2 for all averaging periods. The ambient monitors also confirm these results.

Nitrous Oxides (NO_x)

Nitrous oxides, including NO2, are formed by the reaction of oxygen and nitrogen in the air at the high temperatures reached during combustion. The Sandwell study found little change, and in some cases a decrease in NO_x emissions with TDF. Other reports confirm the trend for this pollutant to decrease (Pegg et. Al, 2007).

Stack testing and dispersion modeling completed since the latest boiler upgrade indicate that the mill is well below ambient air quality standards for NO_2 for all averaging periods. The NAPS monitors confirmed these results.

Dixons & Furans

Studies show that dioxins and furans are present in trace amounts throughout the environment. Minute amounts may be found in the air we breathe, food we eat, water we drink, soil and dust we come in contact with, and in consumer products. Dixons and furans are two families of related chemicals known as polychlorinated dibenzo-p-dixons and polychlorinated dibenzofurans. Of these, 17 pose a major health risk (Ontario Ministry of the Environment, 1997).

Dioxins and furans are formed when virtually all hydrocarbons are burned, including wood, coal and oil. Partially combusted hydrocarbons combine with chlorides to form dioxins and furans while the gas is being cooled from 450^{0}C to 200^{0}C. The quantity and type are impacted by combustion conditions, salt (chloride) concentrations and gas cooling speed.

The combustion conditions in boiler #7 are rigorous with a combination of high temperature, long gas residence time and gas turbulence that enhance complete combustion and minimize residual partially combusted materials. TDF's high energy content will further improve initial combustion of the fuel mix on the boiler grate and in the boiler's lower combustion zone.

The chloride content of TDF is comparable to most fossil fuels and the gas cooling temperature profile is not impacted by TDF, so these factors remain unchanged. The net result is that dioxin and furan formation is similar with and without TDF use. In some cases, the quantity and impact of these materials has decreased with TDF use due to minor differences in the chemical composition of intermediate combustion products.

Baseline stack emissions testing recorded an average dioxin and furan emission rate well below the ambient air quality standard of 5 pg/m^3.

Other Hazardous Compounds

As per the Sandwell study, PAHs (polycyclic aromatic hydrocarbons) and VOCs (volatile organic compounds) are typically reduced when TDF is added to a biomass boiler. The better combustions obtained with the addition of TDF is mainly responsible for the positive impact on these chemical concentrations in the flue gas.

Impact on Boiler Ashes

Increases of zinc and iron are expected. As previously noted, tires consists of approximately 1.5% zinc while the iron comes mainly from residual radial wire in the TDF.

The Sandwell study notes that ash disposal in a landfill is the most secure way to dispose of ash residues consisting of tire ash as the zinc will remain insoluble within the ash and not cause any leaching problems. Zinc will remain in bond in the landfill unless the fill's pH drops below 4. A pH of 4 is an extremely unlikely event, especially since ash has a relatively high pH (8 to 12 range), and natural occurrences of such low pH are very rare. If a landfill pH were to drop to 4 or below, due to some acidic material being directly and intentionally added, other ash metals would become soluble as well, posing a greater risk than the zinc concentrations.

Corner Brook Pulp & Paper will work closely with the city's landfill managers and the Department of Environment and Conservation to ensure the development of an ash management plan that meets all applicable regulations and standards.

Impact on Wet Scrubber Shower Water

Scrubber water is discharged into the mill's activated sludge effluent treatment plant. While the zinc content of the scrubber water is expected to increase, the volume of scrubber water into the mill's effluent is a very small percentage (approximately 2%) of the total volume of effluent treated daily. As per regulatory requirements, the final, treated effluent is sampled and tested routinely to ensure a non-toxic effluent compliant with regulatory limits. This testing includes on-line continuous monitoring, daily tests, weekly tests, plus environmental effects monitoring studies. Since it's commissioning in 1997, the effluent being discharged from the treatment plant is, on average, over 10 times below regulatory limits.

In consultation with the regulatory agencies, zinc concentrations in the effluent will also be monitored to ensure data is available for analysis in the event of any observed change in effluent quality.

Monitoring Strategy

As per the Environmental Protection Act, Corner Brook Pulp & Paper currently operates under the conditions of a Certificate of Approval from the Department of Environment & Conservation. This approval details the requirements for monitoring, testing and reporting of air emissions, effluent discharges and solid wastes.

To better understand the site-specific impacts of using TDF in the #7 boiler, it is proposed that CBPPL be approved to conduct a trial. Approximately 150 metric tonnes of TDF would be purchased for the trial. During the trial, TDF would be added to the biomass feed of #7 boiler is small increments, from 1% to a maximum of 5%. Stack testing will be conducted to quantify the impact of TDF on the boiler's emissions at the 1, 3 and 5% increments. Samples of ash would also be collected and sent for leachate analysis at each increment. As well, effluent treatment samples will be collected and sent for analysis at each increment. The results of the testing and sampling will allow a direct evaluation of the impact of using TDF in the #7 boiler at CBPPL. If areas of concern are identified, it may be possible to engineer solutions or alter operations to address these concerns. If it cannot be shown that TDF can be successfully co-fired in the #7 boiler while meeting regulatory requirements for the protection of human health and the environment then the project would be abandoned.

However, based on the in depth research conducted, the design of the #7 boiler with its flue gas treatment system and most recent upgrades, sound engineering practices and documented experiences at similar operations, the proponent expects to remain within regulated limits for all air emissions, leachate parameters and effluent discharges. This can only be confirmed by performing a trial.

(v) Occupations:

Employment will be created during the installation of the TDF storage and blending system at the mill. Operation of the installed systems will become the responsibility of existing trained operators. Environmental monitoring, system calibrations, system maintenance and quality control will all be achieved with existing, qualified, trained and experienced personnel.

The processing of tires into TDF and the transportation of the TDF to the mill will create further employment opportunities. The economic benefits of utilizing TDF at Corner Brook Pulp & Paper will significantly improve the mill's competiveness in a challenging market, helping to protect the 600 jobs that currently exist.

(vi) Project-related Documents:

The following project-related documents have been generated for the proponent:

- Biomass Capacity Increase, Sandwell EPC Inc. Study 121771A (2005)
- Biomass Capacity Increase, Sandwell EPC Inc. Study 121771B (2005)
- Boiler #7 Alternative Fuel Baseline Testing 2005, Air Testing Services

Other References:

Duggirala, Bhanu (2009), "Tire Derived Fuel Study", Tire Stewardship Manitoba.

Duo, W., Karidio, I., Cross L., Ericksen B. (2002), "Combustion and Emission Performance of a Hog Fuel Fluidized-bed Boiler with Addition of Tire-Derived Fuel", Paprican Research Report PRR 1625.

Energy Justice Network, "Tire Incineration in Paper Mills". (http://www.energyjustice.net/tires/files/scrapchn.html)

Hope, Mark (1993), "Specification Guidelines for Tire Derived Fuel", Waste Recovery Inc., Oregon.

Office of the Fire Commissioner, "Fire Protection Guidelines for Outdoor Tire Storage Yards", Department of Municipal and Provincial Affairs, Government of Newfoundland & Labrador.

Ontario Ministry of the Environment (1997), "Dioxins and Furans". (http://www.ene.gov.on.ca/cons/681e01.htm)

Ontario Ministry of the Environment (1991), "Scrap Tire Management in Ontario", Waste Management Branch, Report PIBS 1406.

Pegg, M. J.,Amyotte, P.R., Fels, M., Cumming, C.R.R., Poushay, J.C. (2007), "An Assessment of the Use of Tires as An Alternative Fuel", Department of Process Engineering and Applied Science, Faculty of Engineering, Dalhousie University.

Reisman, J.I. (1997), "Air Emissions From Scrap Tire Combustion", Office of Air Quality Planning & Standards, US Environmental Protection Agency Report EPA-600/R-97-115. (http://www.epa.gov/ttn/catc/dir1/tire_eng.pdf)

Rubber Manufacturers Association (RMA), "Scrap Tire Markets in The United States", 9th Biennial Report, May 2009. (http://www.rma.org/scrap_tires/)

APPROVAL OF THE UNDERTAKING:

The following is a list of permits, approvals and authorizations that may be necessary for the proposed project:

- Release of the Undertaking under the Environmental Assessment Provisions of the Environmental Protection Act, Department of Environment and Conservation.
- Certificate of Approval for Installation and Operation under the Approvals Provisions of the Environmental Protection Act, Department of Environment and Conservation.

SCHEDULE:

Pending acquisition of the appropriate approvals, it is anticipated that installation of the TDF system could be completed by August 31, 2010, assuming the results of the proposed trial are favorable.

FUNDING:

The proponent will fund this project.

APPENDIX A: Letter of Support from MMSB

REDUCE • REUSE • RECYCLE

September 23, 2010

Mr Craig Snelgrove
Engineering Manager
Corner Brook Pulp and Paper Ltd.
P.O. Box 2001
1 Mill Rd
Corner Brook, Newfoundland
A2H 6J4

Dear Mr Snelgrove:

We understand that Corner Brook Pulp and Paper Limited ("CBPPL" or "the company") plans to file under the Environmental Assessment process with the Department of Environment and Conservation for the use of Tire Derived Fuel (TDF), as a supplementary fuel at their mill in Corner Brook. The proponent believes that TDF is a more economical and potentially cleaner fuel than traditional and alternative fuel sources available to them, which will provide significant cost savings to CBPPL during a time when the company is facing major challenges to its very survival due to the global economic downturn.

Under the Waste Management Regulations and Environmental Protection Act, the Multi-Materials Stewardship Board (MMSB) has been given responsibility to introduce and manage waste diversion programs for products including used tires. Our research suggests that used tires can be an environmentally-acceptable, alternative energy resource when used in appropriate applications with suitable equipment to control emissions and particulate matter. In fact, TDF offers a higher thermal value per equivalent weight than many other fuel sources, including coal and biomass. TDF has been used extensively in many parts of the world since the early 1970's, and in fact is currently the preferred end-of-life solution for an estimated 54% of the over 300 million used tires generated in the US annually. Within Canada, it is an approved practice in British Columbia, Saskatchewan, Manitoba, and in Quebec.

MMSB
P.O. Box 8131 Station A
St. John's, NL A1B 3M9
Tel: 709 753 0948
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www.mmsb.nl.ca

As the agency authorized to manage end-of-life tires, MMSB supports Corner Brook Pulp & Paper's application, and would be agreeable to provide some or all of the used tires in its possession to the proponent for use as TDF feedstock, subject to: 1) acceptable results arising from the Environmental Assessment process; 2) completion of a mutually agreeable, long-term commercial arrangement for the transportation and processing of the stockpiled and future collection of used tires into TDF feedstock; and 3) compliance with any other regulatory or legislative requirements

Should you wish to discuss these matters with us as part of your review, please do not hesitate to contact Glenda Melvin at 709-753-0955

We look forward to the outcome of the Environmental Assessment process

Sincerely,

LEIGH PUDDESTER
Chair and CEO

APPENDIX B: List of US Pulp & Paper Mills using TDF

PAPER MILLS USING TDF AS A SUPPLEMENTAL ENERGY RESOURCE

The 2009 market analysis being completed by the Rubber Manufacturers Association has identified the following paper mills reportedly using TDF:

Company	Location
International Paper	Alabama
Smurfit-Stone	Alabama
GP	Arkansas
Domtar	Arkansas
IP	Arkansas
Interstate Paper	Georgia
SP Newsprint	Georgia
GP	Georgia
Boise	Idaho
New Page	Kentucky
Temple Inland	Louisiana
IP	Louisiana
Boise	Louisiana
New Page	Maine
IP	Maine
SD Warren	Maine
New Page	Michigan
Versa Paper	Minnesota
GP	Mississippi
IP	Mississippi
PH Glatfelter	Ohio
Bowater	South Carolina
IP	South Carolina
IP	South Carolina
Bowater	Tennessee
PCA	Tennessee
Temple Inland	Texas

All must conform to existing state and federal environmental regulations. Many have an extensive history of TDF use in excess of 5 years, and some over 15 years.

APPENDIX C: Sandwell EPC Inc. Environmental Impact Analysis

ANNEX I

ENVIRONMENTAL IMPACT OF USING TDF

ANNEX I – ENVIRONMENTAL IMPACT OF THE USE OF TDF

This section presents some information on the impact of using TDF in a biomass boiler.

In 2002, Sandwell in collaboration with Recyc-Quebec and Kruger, Trois-Rivieres has performed a feasibility study to assess the potential of Quebec pulp and paper mills in using scrap tire chips in their biomass boilers. Within the scope of this study, an extensive literature review was made to determine how many North American mills were using or were considering the use of TDF in their biomass boiler. Several mills were subsequently contacted in order to update and complete the information from the literature. A series of trials with and without TDF was performed at the Trois-Rivieres mill. The following sections give a summary of most of the information obtained at the time of the study as well as of the results obtained from the mill scale trials.

Table of contents

1) ***Survey of North American pulp and paper mills which are presently using or have used TDF in their biomass boiler***

In 1997, at least 20 US pulp and paper mills were using or were considering the use of TDF in their biomass boiler. At that time, the pulp and paper mills were using approximately 35 million of scrap tires annually. In Canada, at least one mill was using TDF on a regular basis. This mill was using 250,000 scrap tires per year with a mass input rate of 5% of total fuel input to the boiler.

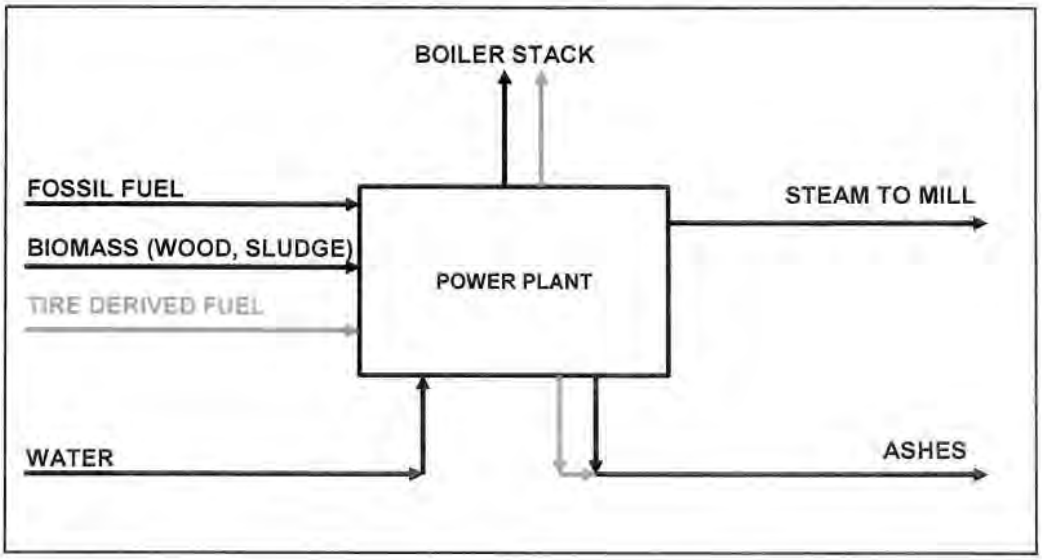
The following table gives a list of the surveyed North American mills using or having used TDF.

Many other pulp and paper mills as well as other types of industrial facilities have been using or are still using TDF for the production of energy The references included at the end of this annex give some listing of the pulp and paper mills and other industrial facilities using TDF in the United States in 1996, 2001 and 2003.

North American pulp and paper mills having used or using TDF
Literature review and survey performed by Sandwell in 2002

Mill	Boiler Type	Fume treatment system	Fuel types	Scrap tires consumption	
				%	PTE/y
Abitibi-Consolidated, Sheldon, TX	Fluidized bed	Venturi scrubber	Bark, sludge, TDF	25% heat basis	1,900,000
Bowater, Calhoun, TN	Fluidized bed	Electrostatic precipitator	Bark, sludge, TDF	< 1% weight basis	1,400,000
Bowater, Catawba, SC	Traveling grate (2 boilers)	Multiclone + electrostatic precipitator	Biomass, TDF	2.0% weight basis	1,100,000
Norske Skog, Port Alberni, BC	Fluidized bed	Electrostatic precipitator	Biomass, TDF	5% weight basis	265,000
Port Townsend Paper Corp, Port Townsend, WA	Traveling grate	Multiclone + scrubber	Bark, (TDF)	(7% heat basis)	Stopped using TDF few years back
Daishowa America Co Ltd (DACO), Port Angeles, WA	Fixed grate	Multiclone + venturi scrubber	Biomass, oil, TDF	2% heat basis	-
SP Newsprint Co, Newburg, OR	Fixed grate	Multiclone + electrostatic precipitator	Biomass, TDF	1-1.5% heat basis	-
Packaging Corp of America, Tomahawk, WI	Traveling grate (3 boilers)	Electrostatic precipitator	Bark, coal, TDF	1-2% basis not specified	-
Packaging Corp of America, Counce, TN	Traveling grate	Multiclone + electrostatic precipitator	Biomass, coal, (TDF)	(18% heat basis)	Stopped since 6 years
International Paper Co, Startell, MN	Traveling grate	Multiclone + venturi scrubber	Biomass, sludge, coal, TDF	4, 15-30% basis not specified	-
Smart Paper LLC, Hamilton, OH	-	-	-	-	-
Kruger, Trois-Rivieres, QC	Traveling grate	Wet scrubber	Natural gas, bark, sludge	12% heat basis	-

2) ***Impact of using Tire Derived Fuel for steam production***



This simplified flow diagram shows that the use of TDF in a biomass boiler can have an impact on stack fumes and ashes leaving the plant. The following sections give more information on the magnitude of the impact on gas and effluent emissions. In addition to that, the use of TDF can have several positive benefits on boiler operation and the environment:

- Improve stability of boiler combustion
  - Improved combustion efficiency
  - Improved quality of boiler stack fumes
- Allows to reduce or eliminate the use of fossil fuels
- Allows for an increased usage of process sludge or other biomass in the boiler
- Reduction in steam production costs
- Environmental benefits
  - Reduction in the piles of tires
  - Reduction in the proliferation of harmful insects
  - Reduced risk of fire (uncontrolled firing of tire piles)
  - Reduction in greenhouse gas emissions

Adding TDF to high moisture biomass fuel results in the following boiler operation improvements:

- Increased flame temperature on the grate for improved (more complete) bed combustion.

- Stabilization of the flame and elimination of blow back in the furnace.

- Lowering of unburned carbon in ash (both bottom ash and fly ash).

- Reduction in boiler draft fluctuations.

3) Description of mill trials performed in May 2002 at Kruger, Trois-Rivieres

In Trois-Rivieres, the biomass boiler is a Foster Wheeler traveling grate boiler with a wet scrubber for the flue gas treatment. In 2002, this boiler was using a mixture of bark, mill sludge and natural gas to produce the required steam for the pulp and paper production plant. Only a portion of primary and secondary sludge was added to the boiler due to its high moisture content. Natural gas was required in order to obtain the desired steam production.

The purpose of the trials with TDF was to burn all mill sludge produced as well as to reduce or eliminate the use natural gas in the boiler. Four trials were performed as described in the following table. The base case trial with no TDF was performed with all process sludge and no natural gas except for the preheating of combustion air.

Kruger Trois-Rivieres trials, May 2002
Fuel consumption (% weight basis)

Trial	% TDF (heat basis)	Primary sludge	Secondary sludge	Purchased bark	Self generated bark	Natural gas (1)	TDF	Total
1	**0**	27.8	6.4	48.9	16.0	0.9	0	100
2	**8.8**	28.2	6.6	40.7	16.2	0.9	7.4	100
3	**9.5**	28.1	6.5	40.0	16.2	0.9	8.3	100
4	**12.3**	28.3	6.6	37.4	16.3	0.9	10.5	100

(1) Combustion air preheating

One specific objective of the trials was to determine the environmental impact of using TDF on stack fumes emissions, ashes and effluents from the boiler plant. The results obtained would also be compared to some data reported in the literature. The following sections present the data obtained from the trials performed in Trois-Rivieres as well as the data collected from the literature review performed at the time of the trials.

Among results obtained from the 4 trials performed, some trial results are sometimes not following the general tendency observed with the other trial results. Several factors may have affected the results during operation and sampling :

- For each variable evaluated, only one set of samples was taken per trial and no trial was repeated. If a production upset or an experimental error occurred during the sampling procedure, the results were affected accordingly.

- An erratic supply of TDF happened from time to time during the trials. This happened more frequently during the trial at 8.8% TDF.

- The feeding system used for the trials was not an automated system and some variations in TDF feed flow could have happened during the sampling procedures.

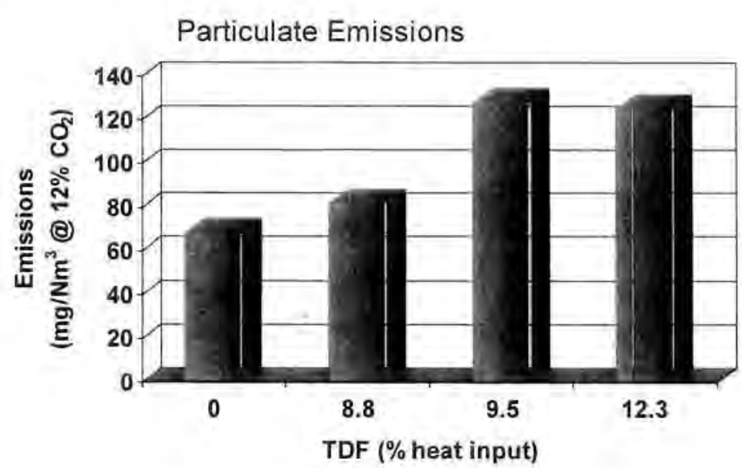
- The delay between the addition of TDF in the system and its input to the boiler was estimated and considered constant during the trials. This may not be entirely true for the whole testing and sampling procedure.

For these reasons, heavy metal results obtained for the trial at 9.5% TDF are sometimes not following the general tendency observed with other trials. Gas testing results for the trial at 8.8% TDF are also not always following the general tendency observed with other trials. Using all trial results however, one can assess the general tendency or impact of the use of TDF in the boiler.

4) Impact of TDF on boiler stack fumes

The following figures give the impact of TDF on the boiler stack fumes to atmosphere during the trials performed in Trois-Rivieres (May 2002). When available, tables with data from the literature are also presented.

Particulate emissions



Particulate emission results obtained from the Kruger, Trois-Rivieres trials show an increase in particulate concentration as a function of the increase of TDF.

The impact of adding TDF to an existing boiler can vary on a case by case basis. TDF has a much higher heating value than biomass and replacing biomass with TDF results in a higher adiabatic flame temperature of the fuel on the grate.

If the existing adiabatic flame temperature is too low, combustion is incomplete and unstable resulting in high CO and particulate (unburned carbon) emissions, furnace pulsations, blowbacks and boiler draft fluctuations. In this case the addition of TDF improves the performance.

As adiabatic flame temperature increases the volume of combustion bases increases and as a result so does the upward velocity of flue gas leaving the furnace. At some point this increased upward velocity will have a greater impact on particulate emissions than the improvement in completion of combustion and as a result particulate emissions will increase. Too high an adiabatic flame temperature can also lead to overheating of the grate and increases in thermal NO_x formation.

In Trois-Rivieres, the fuel being replaced (purchased bark) was relatively dry (40%) and the boiler furnace was quite short. The higher adiabatic flame temperature had a positive impact on the ability to burn the sludge but a negative impact on particulate emissions. The impact of the increased upward velocity leaving the furnace on particulate emissions was compounded by the relatively short furnace.

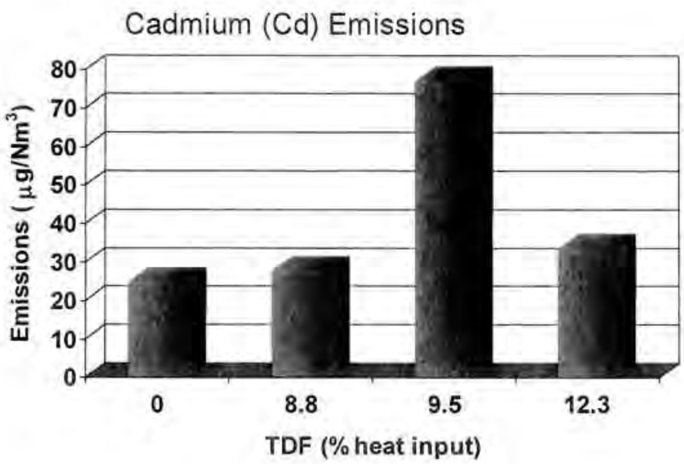
TDF was added to the fluid bed boiler at Norske, Port Alberni, BC, to replace poor quality hog fuel from dry land sorting which had high sand and ash content and low heating value. The poor quality of the hog fuel limited the boiler's hog fuel burning rate. The results of adding TDF to the hog fuel included higher hog fuel burning rate, more stable furnace operation, increase in bed temperature, and no increase in particulate emissions (see table below).

Norske Skog, Port Alberni, BC Stack fumes particulate concentration with and without TDF (1)			
Total particulates (mg/m^3 @ 12% CO_2)	**0% TDF**	**2% TDF (weight basis)**	**5% TDF (weight basis)**
Range	27 - 170	44 - 97	37 – 177
Average	77	65	76

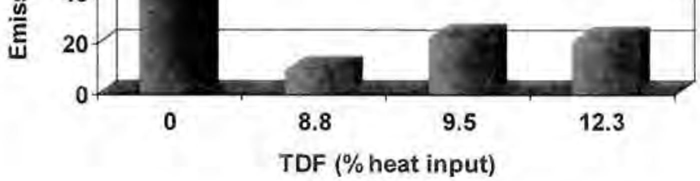
(1) Boiler type : Fluidized bed. Boiler fumes treatment system : Electrostatic precipitator

For Kruger, Corner Brook, we anticipate adding TDF will allow stable combustion and some increase in steam flow without fossil fuel however some fossil fuel will still be required to meet plant steam requirements.

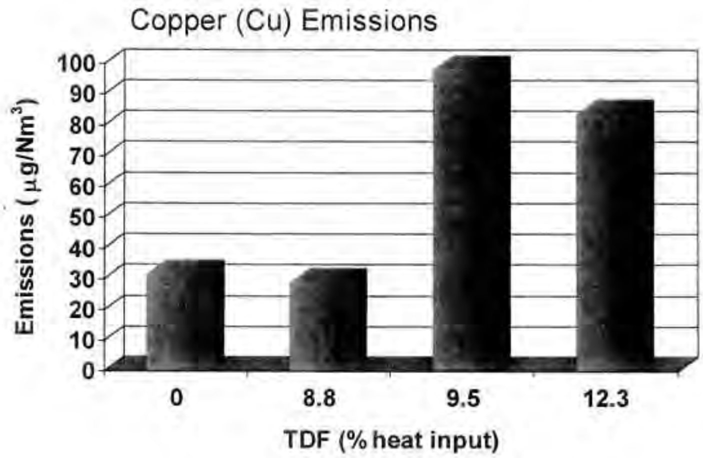
Metal emissions



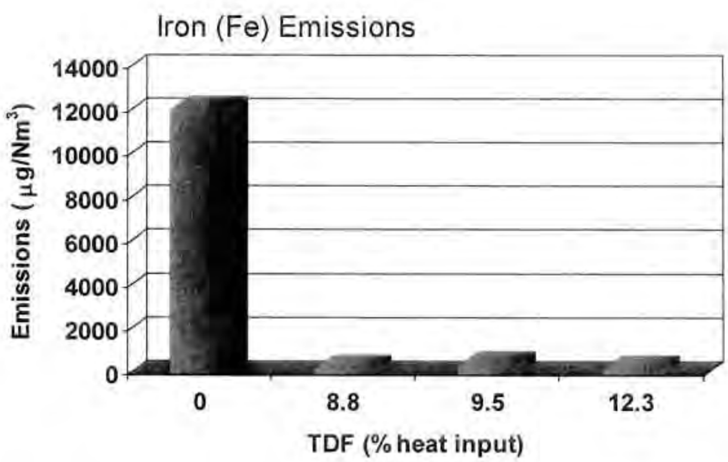
The Trois-Rivieres trial results show almost no change in flue gas cadmium concentration with the addition of TDF. Trial at 9.5% TDF is not following the same tendency of other trial results. The miscellaneous literature data presented in the following pages generally show very few change in cadmium emissions with boiler stack fumes.



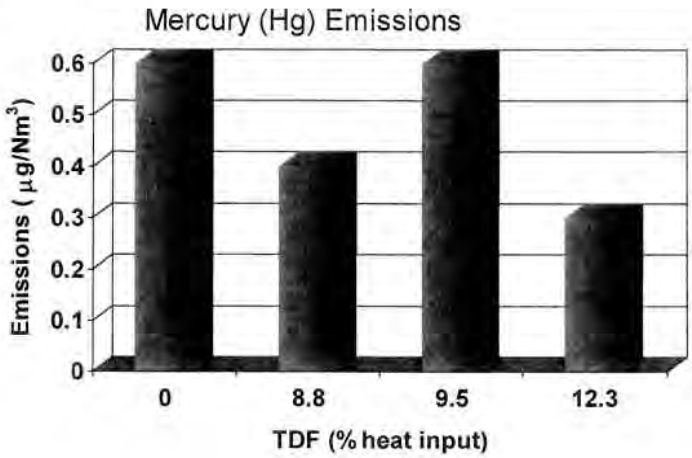
Chrome emissions are generally reduced with the addition of TDF. The TDF percentage did not have a great impact within the range evaluated. Literature data presented below shows similar tendencies or no changes in chrome emissions.



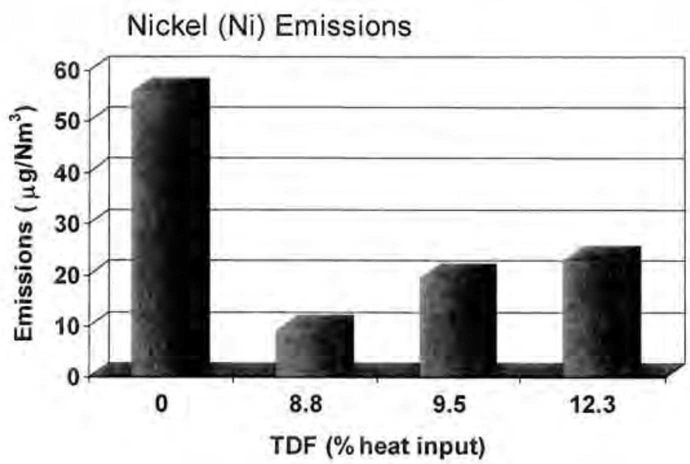
An increase in copper emissions as a function of TDF percentage is obtained. Since the copper content is low in tires, the increase observed may be due to a variation in the other fuels fed to the boiler or to the presence of contaminants.



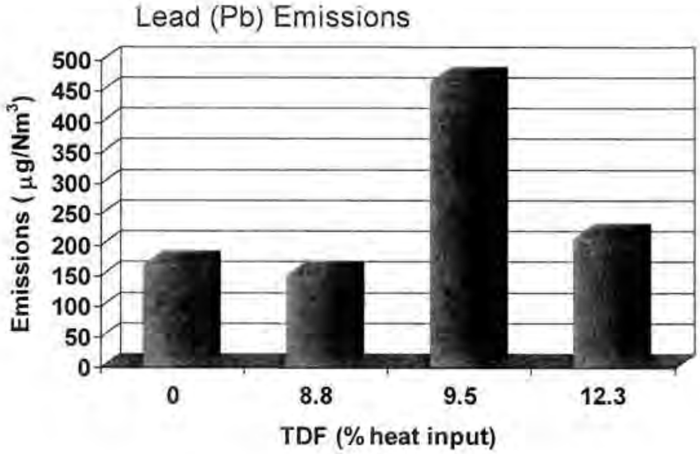
A decrease in Iron emission with the addition of TDF is obtained.



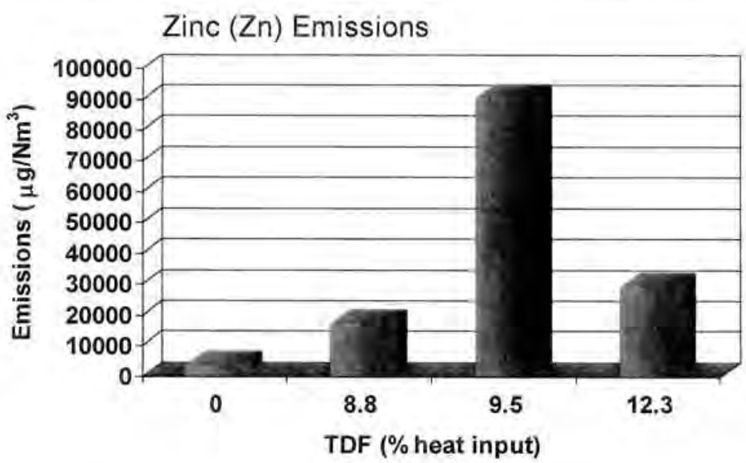
There was no significant change in mercury emissions with the addition of TDF. These results are consistent with the literature data presented below.



A decrease in nickel emissions with the addition of TDF is observed. As the amount of TDF increase a slight increase in nickel concentration is observed. Literature data presented below show the same impact as the one observed with the Trois-Rivieres trials.



There was almost no change in lead emissions. This is consistent with literature data where no change or slight reductions in lead emissions are observed. The Trois-Rivieres trial at 9.5% TDF is not following the general tendency of other results.



An increase in zinc emissions is observed. The trial at 9.5% TDF is not following the general tendency of other results. Most literature data presented below show an increase in zinc content of boiler stack fumes. Mills using electrostatic precipitators generally show no change in zinc emissions.

These results are consistent with the zinc content of TDF which is typically 1.52%. The use of TDF can therefore result in an increase of zinc particles in boiler stack emissions. Most of the zinc particles, however, are generally rejected with the ashes.

The following tables give the miscellaneous literature data that was reported in the 2002 Sandwell report on the impact of TDF addition on boiler stack fume metal content.

Port Townsend Paper Corp, Port Townsend, WA Impact of TDF on stack fumes metal content (1)				
Parameter	Biomass + 5% oil (2)		Biomass + 7% TDF (2)	
	(kg/h)	(g/MJ)	(kg/h)	(g/MJ)
Barium	-	110.7	-	150.7
Cadmium	0.004	18.4	0.003	12.5
Chrome	0.005	23.6	0.005	15.0
Copper	-	1038.7	-	987.6
Iron	-	859.9	-	1106.8
Lead	0.05	259.7	0.01	56.9
Nickel	0.05	296.3	0.05	25.4
Vanadium	0.09	388.2	0.0005	3.8
Zinc	1.4	6360.0	22.2	107,276.4

(2) Boiler type : Traveling grate. Boiler fumes treatment system : Multiclone + Scrubber
(3) Heat basis

Daishowa America Co Ltd (DACO), Port Angeles, WA Impact of TDF on stack fumes metal content (1)		
Parameter	Biomass + 12% oil (2)	Biomass + 11% oil + 2% TDF (2)
	(10^{-6} g/MJ)	(10^{-6} g/MJ)
Arsenic	1.4	2.7
Barium	4.9	12.5
Cadmium	1.3	2.5
Chrome	0.2	1.5
Copper	13.2	17.2
Iron	113.1	163
Lead	27.5	31.1
Nickel	1.5	1.6
Vanadium	1.3	3.2
Zinc	1055.7	7044

(1) Boiler type : Fixed grate. Boiler fumes treatment system : Multiclone + Venturi scrubber
(2) Heat basis

Packaging Corp of America, Tomahawk, WI Impact of TDF on stack fumes metal content (1)		
Parameter	**0% TDF (2)**	**1-2% TDF (3)**
	(kg/h)	**(kg/h)**
Arsenic	0.001	0.001
Cadmium	< 0.001	< 0.001
Lead	0.0086	0.0082
Nickel	< 0.004	< 0.004
Zinc	0.33	0.37
Mercury	0.0002	0.0003

(1) Boiler type : Traveling grate. Boiler fumes treatment system : Electrostatic precipitator
(2) Fuels : bark and coal
(3) Basis not specified

International Paper Co, Startell, MN Impact of TDF on stack fumes metal content (1). Data obtained in 1987.						
Parameter	**0% TDF (2)**		**15% TDF (3)**		**30% TDF (3)**	
	(kg/h)	**(10^{-2} g/MJ)**	**(kg/h)**	**(10^{-2} g/MJ)**	**(kg/h)**	**(10^{-2} g/MJ)**
Cadmium	0.001	0.0002	0.002	0.0007	0.004	0.0011
Chrome	0.004	0.0099	0.5	0.0004	0.039	0.010
Lead	0.011	0.0031	0.035	0.095	0.055	0.014
Zinc	0.036	0.011	5.6	1.7	14.1	3.7

(1) Boiler type : Traveling grate. Boiler fumes treatment system : Multiclone + Venturi scrubber
(2) Fuels : 25% bark, 20% process sludge, 55% coal
(3) Basis not specified

International Paper Co, Startell, MN Impact of TDF on stack fumes metal content (1). Data obtained in n1990.		
Parameter	**0% TDF (2)**	**4% TDF (3)**
	(kg/h)	**(kg/h)**
Cadmium	0.0011	0.0008
Chrome	0.022	0.002
Lead	0.023	0.016
Mercury	1.7×10^{-4}	3.6×10^{-5}
Zinc	0.11	1.6

(1) Boiler type : Traveling grate. Boiler fumes treatment system : Multiclone + Venturi scrubber
(2) 13% bark, 5% sludge, 82% coal
(3) 12% bark, 4% sludge, 80% coal, 4% TDF, basis not specified

Mill « A », WA Impact of TDF on stack fumes metal content (1)		
Parameter	**Biomass + 5% oil (2)**	**Biomass + 7% TDF (2)**
	(g/h)	**(g/h)**
Zinc	1440	22,200
Vanadium	90	0.6
Nickel	66	5.4
Lead	58	12
Chrome	5.4	3.0
Cadmium	4.2	3

(1) Boiler fumes treatment system : Multiclone + Venturi scrubber
(2) Heat basis

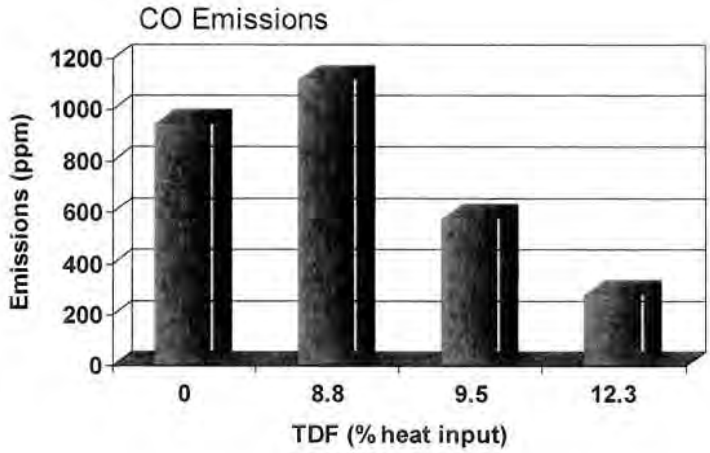
Packaging Corporation of America, Counce, TN Impact of TDF on stack fumes metal content (1)		
Parameter	**0% TDF (2)**	**≈ 18% TDF (3)**
	(g/h)	**(g/h)**
Cadmium	0.07	Not detected
Chrome	8.08	9.09 – 9.24
Lead	2.32	1.70
Maganese	1.53	2.64
Nickel	11.1	3.96 – 9.63
Vanadium	Not detected	Not detected
Zinc	10.8	3.97 – 121.8

(1) Boiler type : Traveling grate. Boiler fumes treatment system : Multiclone + Electrostatic precipitator
(2) Fuels : 64% wood waste and 36% coal
(3) Wood waste, coal and 4.5 t/h TDF. TDF% is estimated at approximately 18% (heat basis) or 7% (weight basis).

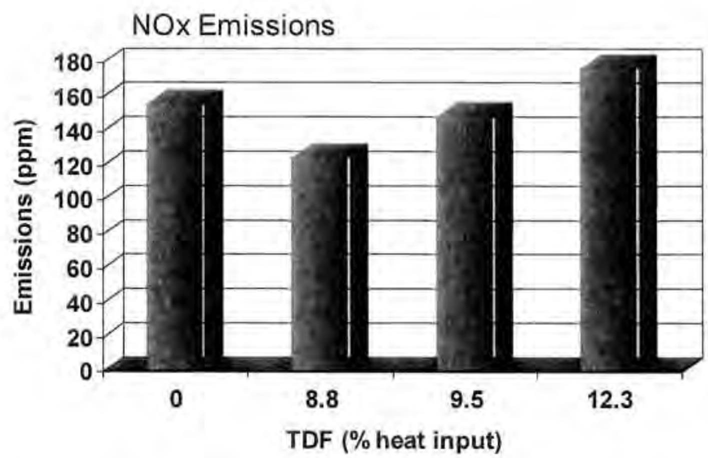
Norske Skog, Port Alberni, CB Impact of TDF on stack fumes metal content (1)			
Parameter	**0% TDF**	**2% TDF (2)**	**5% TDF (2)**
	(%)	**(%)**	**(%)**
Zinc	0.32	0.22	0.24
Iron	8.8	2.1	5.7
Chrome	0.8	0.1	0.9
Nickel	1.4	0.03	1.1

(1) Boiler type : Fluidized bed. Boiler fumes treatment system : Electrostatic precipitator
(2) Weight basis

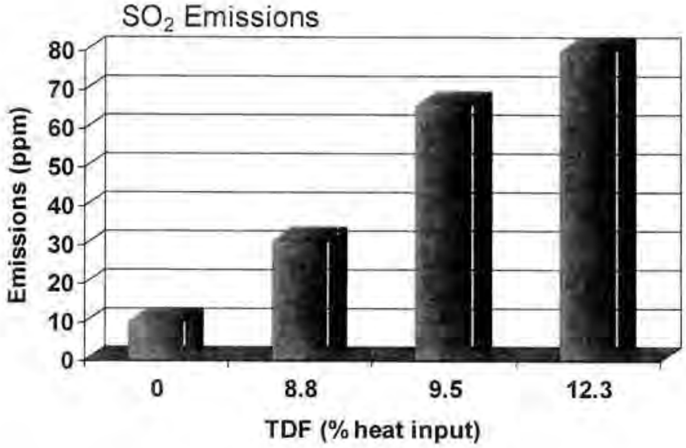
Gas content



The Trois-Rivieres trials show a decrease in CO emissions. This is due to the increase in combustion efficiency with the addition of TDF.



There was a decrease in NO_x emissions with the use of TDF. The increase in %TDF gave an increase in NO_x emissions. Literature data generally show no change or a decrease in NO_x emissions.



For these trials, there is a clear increase of SO_2 emissions as a function of the TDF tonnage to the boiler. There is basically no sulfur content in the boiler input fuels composed of natural gas, bark and sludge. Since TDF typically contains 1.23% Sulfur, it is anticipated that the addition of TDF to the present boiler fuels will give an increase of the boiler flue gas sulfur content.

For Kruger, Corner Brook, the present fuel types used are bark, sludge and No.6 oil. Typical sulfur content of No.6 oil varies between 0.7 and 3.5%. Depending on whether oil No.6 has lower or higher sulfur content than TDF, a proportionate reduction or increase in SO_2 will occur. Corner Brook uses No.6 oil containing less than 2% sulfur as dictated by the mill environmental permit. It is therefore anticipated that the use of TDF will have almost no impact on SO_2 emissions of boiler No.7.

The following tables give some literature data reported in the 2002 Sandwell report.

Packaging Corp of America, Tomahawk, WI (1) Impact of TDF on stack fumes gas content		
Parameter	**0% TDF (2)**	**1-2% TDF (3)**
	(kg/h)	**(kg/h)**
NO_x	52.0	48.7
CO	50.5	66.9
SO_2	82.3	121.8

(1) Boiler type : Traveling grate. Boiler fumes treatment system : Electrostatic precipitator
(2) Fuels : bark and coal
(3) Basis not specified

International Paper Co, Startell, MN Impact of TDF on stack fumes gas content (1). Data obtained in 1987.						
Parameter	0% TDF (2)		15% TDF (3)		30% TDF (3)	
	(kg/h)	(g/MJ)	(kg/h)	(g/MJ)	(kg/h)	(g/MJ)
NO_x	91.4	0.28	98.2	0.29	75.9	0.20
SO_2	35.5	0.11	47.5	0.14	75.4	0.19
H_2SO_4	4.6	0.01	4.6	0.01	4.6	0.01

(1) Boiler type : Traveling grate. Boiler fumes treatment system : Multiclone + Venturi scrubber
(2) Fuels : 25% bark, 20% process sludge, 55% coal
(3) Basis not specified

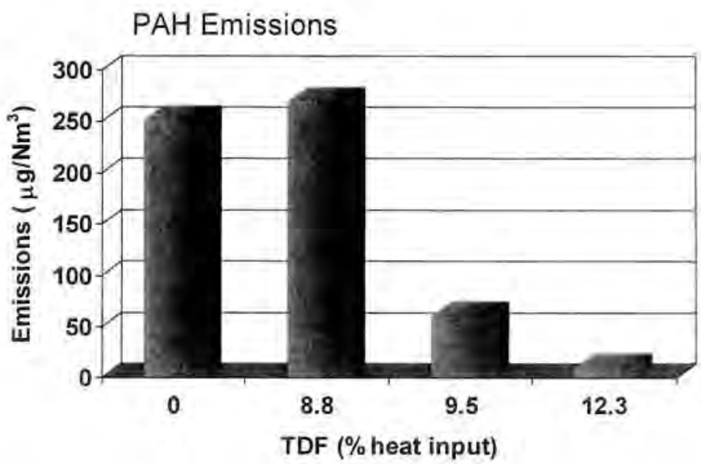
International Paper Co, Startell, MN Impact of TDF on stack fumes gas content (1). Data obtained in n1990.		
Parameter	0% TDF (2)	4% TDF (3)
	(kg/h)	(kg/h)
SO_x	121	126

(1) Boiler type : Traveling grate. Boiler fumes treatment system : Multiclone + Venturi scrubber
(2) 13% bark, 5% sludge, 82% coal
(3) 12% bark, 4% sludge, 80% coal, 4% TDF, basis not specified

Norske Skog, Port Alberni, CB Impact of TDF on stack fumes gas content (1)			
Parameter	0% TDF	2% TDF (2)	5% TDF (2)
SO_2 (ppm_v)	28	18	31

(1) Boiler type : Fluidized bed. Boiler fumes treatment system : Electrostatic precipitator
(2) Weight basis

PAH, dioxins & furans and VOC emissions



The trial results show a reduction in PAH emissions with the addition of TDF. These results are generally in agreement with the very few literature data that could be found at the date of the trials.

Port Townsend Paper Corp, Port Townsend, WA Impact of TDF on stack fumes PAH content				
Parameter	**Biomass + 5% oil (2)**		**Biomass + 7% TDF (2)**	
	(kg/h)	**(g/MJ)**	**(kg/h)**	**(g/MJ)**
Anthracene	0.01	4.3	0.05	11.5
Phenanthrene	0.05	180.5	0.09	332.0
Fluoranthene	-	197.6	-	101.3
Pyrene	-	107.3	-	163.5
Benzo(b) Fluoranthene	-	0.3	-	0.52
Benzo(k) Fluoranthene	-	0.3	-	0.3
Benzo(a) Fluoranthene	-	0.7	-	0.95
Chrysene	-	1.4	-	1.0

(1) Boiler type : Traveling grate. Boiler fumes treatment system : Multiclone + Scrubber
(2) Heat basis

Daishowa America Co Ltd (DACO), Port Angeles, WA (1) Impact of TDF on stack fumes PAH content		
Parameter	**Biomass + 12% oil (2)**	**Biomass + 11% oil + 2% TDF (2)**
	(10^{-6} g/MJ)	**(10^{-6} g/MJ)**
Anthracene	0.43	0.3
Phenanthrene	19.5	7.2
Fluoranthene	16.1	6.1
Pyrene	20.6	9.3
Benzo(b) Fluoranthene	1.0	-
Benzo(k) Fluoranthene	0.3	-
Benzo(a) Fluoranthene	-	-
Chrysene	-	-

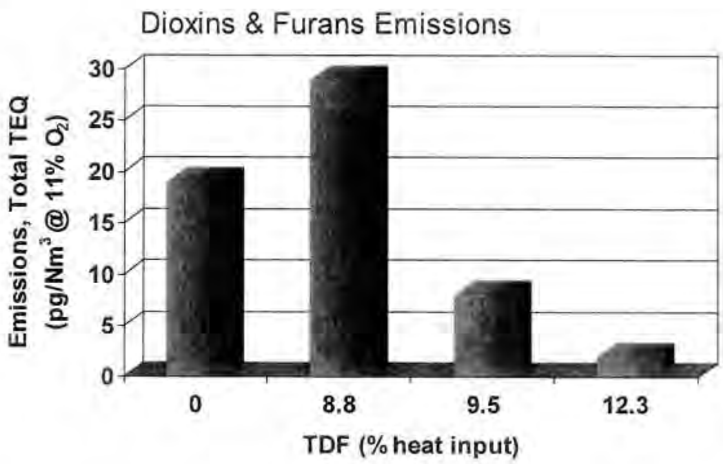
(1) Boiler type : Fixed grate. Boiler fumes treatment system : Multiclone + Venturi scrubber
(2) Heat basis

Mill « A », WA Impact of TDF on stack fumes PAH content (1)		
Parameter	**Biomass + 5% oil (2)**	**Biomass + 7% TDF (2)**
	(g/h)	**(g/h)**
Phenanthrene	41	72
Anthracene	1.2	2.4

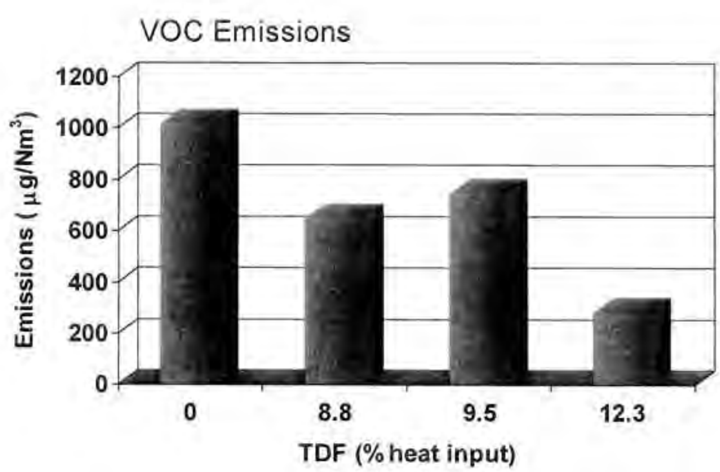
(1) Boiler fumes treatment system : Multiclone + Venturi scrubber
(2) Heat basis

International Paper Co, Startell, MN Impact of TDF on stack fumes PAH content (1). Data obtained in 1987.						
Parameter	**0% TDF (2)**		**15% TDF (3)**		**30% TDF (3)**	
	(kg/h)	**(g/MJ)**	**(kg/h)**	**(g/MJ)**	**(kg/h)**	**(g/MJ)**
PAH, total	75.0	-	1.2	-	0.3	-

(1) Boiler type : Traveling grate. Boiler fumes treatment system : Multiclone + Venturi scrubber
(2) Fuels : 25% bark, 20% process sludge, 55% coal
(3) Basis not specified



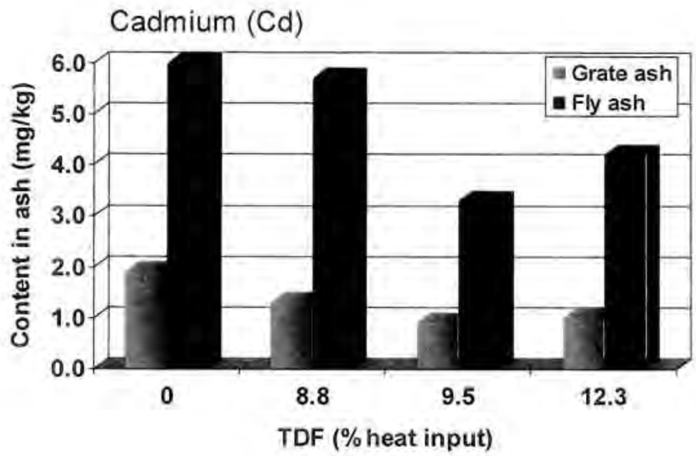
Dioxins and furans were generally reduced with the use of TDF. The trial results at 8.8% TDF are not following the tendency obtained with other trial results. A recent study published by Paprican on the variability and control of dioxins formation and emissions from coastal power boilers in BC showed that improved combustion efficiency reduces dioxins formation. This conclusion was reached using data collected from over 100 tests on the coastal power boilers. Proposed solutions to increase combustion efficiency include the use of high calorific value solid fuels such as coal and TDF.

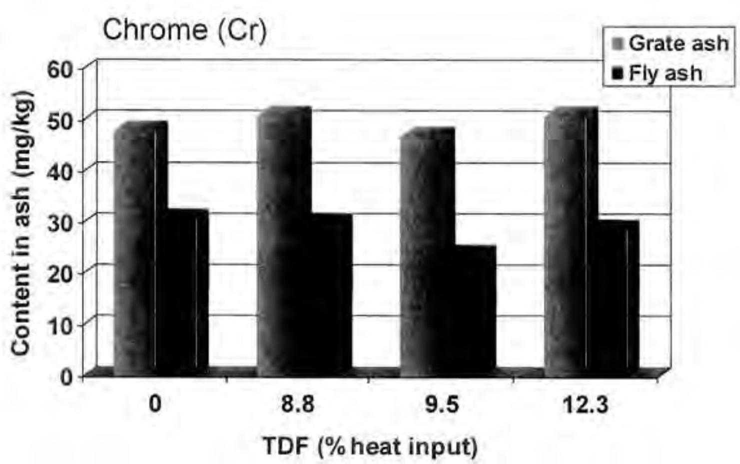


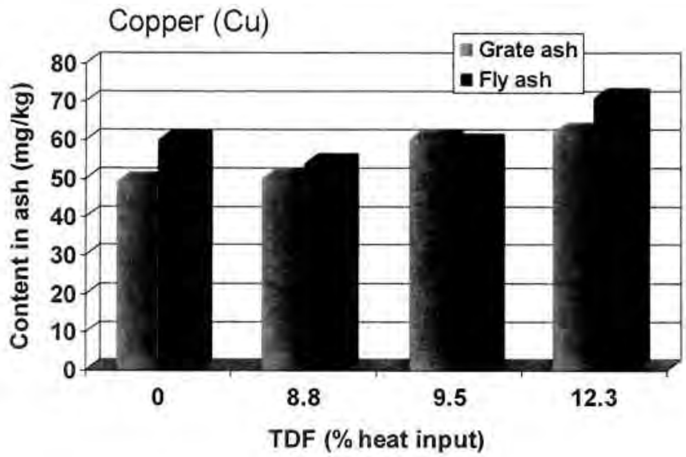
VOC emissions in boiler stack fumes were reduced with the use of TDF.

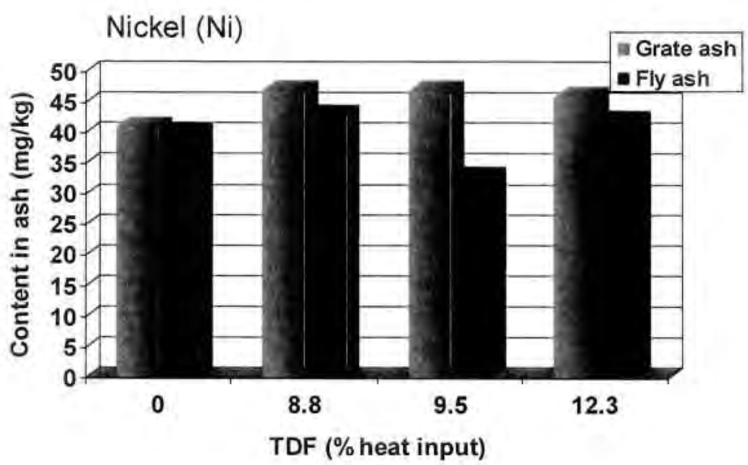
5) *Impact of TDF on boiler ashes*

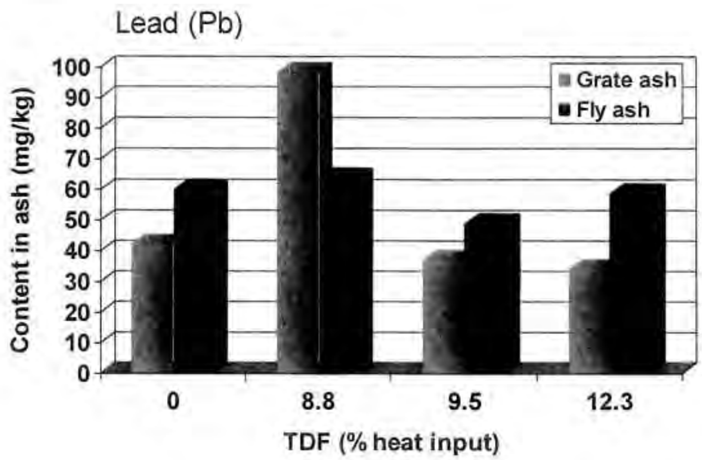
The following figures give the impact of TDF on the boiler grate and fly ashes during the trials performed in Trois-Rivieres (May 2002). Some data from the literature is also presented.



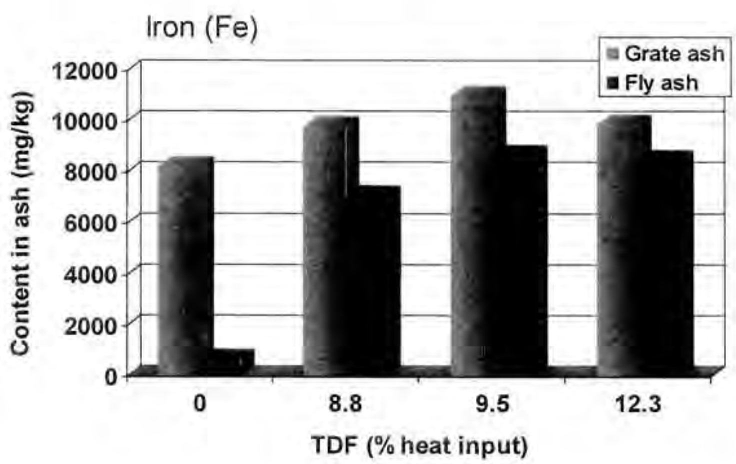



Copper (Cu)
Grate ash
Fly ash
Content in ash (mg/kg)
80
70
60
50
40
30
20
10
0
0
8.8
9.5
12.3
TDF (% heat input)

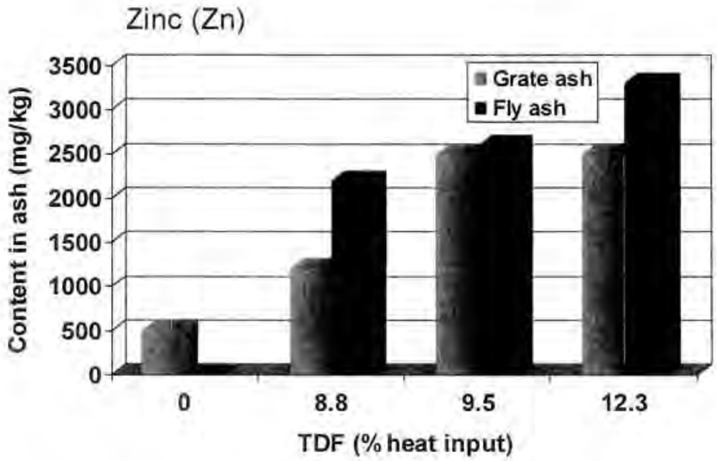

Nickel (Ni)
Grate ash
Fly ash
Content in ash (mg/kg)
50
45
40
35
30
25
20
15
10
5
0
0
8.8
9.5
12.3
TDF (% heat input)



Cadmium, chrome, copper, nickel and lead contents in grate and fly ashes were generally not affected by the use of TDF.

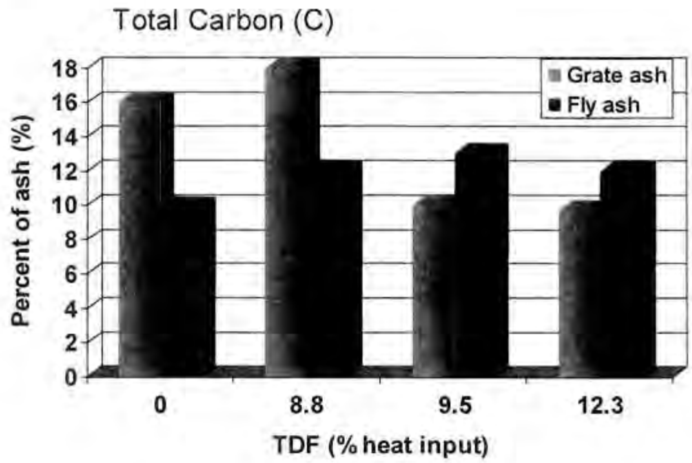


Iron has increased in both grate and fly ashes with the use of TDF. Iron comes mainly from the residual radial wire in the TDF.

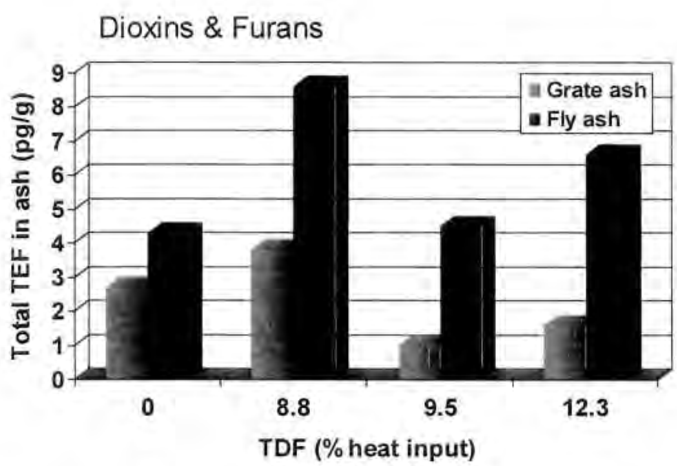


Zinc content on both grate and fly ashes increased with the use of TDF. This is consistent with the fact that TDF contains a high percentage of zinc (1.52%) as compared with other heavy metals.

Ash disposal in a landfill is the most secure way to dispose of ash residues consisting of tire ash as the zinc will remain insoluble within the ash and not cause any leaching problems. Zinc will remain bond in the landfill unless the fill's pH drops below 4. A pH of 4 is an extremely unlikely event, especially since ash has a relatively high pH (8 to 12 range), and natural occurrences of such a low pH are very rare. If a landfill pH were to drop to 4 or below, due to some acidic material being directly and intentionally added, other ash metals would become soluble as well, posing a greater risk than the zinc concentrations.



In general, there was a reduction of total carbon in the grate ash with the addition of TDF. A slight increase in fly ash carbon content was observed.



Dioxins and furans in grate ash generally decreased with the addition of TDF. There is no clear tendency for fly ash dioxin and furan content. Literature data reported by Norske Skog, Port Alberni showed no increase in dioxin and furans in fly ash.

Norske Skog, Port Alberni, CB Boiler ash characterization (1)			
Parameter	**0% TDF**	**2% TDF (2)**	**5% TDF (2)**
	(ppm, weight)	**(ppm, weight)**	**(ppm, weight)**
Grate ash (3)			
Cadmium	Not detected	Not detected	Not detected
Chrome	28	29	18
Nickel	20	21	15
Iron	17,400	27,600	25,300
Lead	Not detected	Not detected	Not detected
Zinc	211	1280	2940
Leachate extraction test	**(mg/l)**	**(mg/l)**	**(mg/l)**
Zinc	0.38	8.1	12.9
Fly ash			
Cadmium	1.0	0.7	0.9
Chrome	53	53	48
Nickel	27	29	25
Iron	24,300	37,300	40,300
Lead	55	40	57
Zinc	413	2640	6360
Leachate extraction test	**(mg/l)**	**(mg/l)**	**(mg/l)**
Zinc	4.6	20.8	104
Dioxins et furans	**(ppt)**	**(ppt)**	**(ppt)**
2,3,7,8 TCDD	539 - 978	-	400 - 910

(1) Boiler fumes treatment system : Electrostatic precipitator
(2) Weight basis
(3) Not screened

6) *Impact of TDF on wet scrubber shower water and grate ash conveyor overflow*

In Trois-Rivieres, the mill is using a wet scrubber to clean the flue gas from the biomass boiler. Water shower was collected and analysed for metal content. The overflow water from the grate ash conveyor was also collected and analysed for metal content. Results given in the two following table that there was no increase or a decrease in metal content of the water for all metals except for a slight increase in zinc content in the grate ash conveyer overflow water.

Kruger, Trois-Rivieres trials (May 2002) Impact of TDF on wet scrubber shower metal content (mg/l)				
TDF (% heat input)	**0 %**	**8.8 %**	**9.5 %**	**12.3 %**
Cadmium, Cd	< 0.005	< 0.005	< 0.005	< 0.005
Chrome, Cr	< 0.02	< 0.02	< 0.02	< 0.02
Copper, Cu	0.2	0.1	0.1	0.2
Iron, Fe	3.1	1.1	0.49	0.22
Mercury, Hg	0.0001	0.0001	< 0.0001	0.0001
Nickel, Ni	< 0.02	0.03	< 0.02	< 0.02
Lead, Pb	< 0.05	< 0.05	< 0.05	< 0.05
Zinc, Zn	0.45	0.04	0.02	0.02
Total (mg/litre)	**< 3.845**	**<1.345**	**< 0.705**	**< 0.535**

Kruger, Trois-Rivieres trials (May 2002) Impact of TDF on grate ash conveyer overflow (mg/l)				
TDF (% heat input)	**0 %**	**8.8 %**	**9.5 %**	**12.3 %**
Cadmium, Cd	0.007	0.008	< 0.005	< 0.005
Chrome, Cr	< 0.02	< 0.02	< 0.02	< 0.02
Copper, Cu	0.09	0.13	0.05	0.07
Iron, Fe	4.4	8.2	1.1	3.8
Mercury, Hg	0.0001	0.0001	0.0001	0.0002
Nickel, Ni	0.04	0.05	< 0.02	0.03
Lead, Pb	0.06	0.1	< 0.05	< 0.05
Zinc, Zn	0.44	3.0	1.4	3.5
Total (mg/litre)	**< 5.057**	**<11.508**	**< 2.645**	**< 7.475**

7) ***Quebec province environmental regulations***

Present regulation

In Quebec, the atmospheric emissions from a pulp and paper mill are regulated by the Regulation on the Air Quality : «Le Règlement sur la qualité de l'atmosphère», (c. Q-2, r. 20).

This regulation is applies to all combustion equipment burning fossil fuels, biomass or a combination of both. If other types of fuel are used, the norms for incinerators may apply. The following table gives the relevant norms for combustion equipment in a pulp and paper mill.

In addition to the norms presented in the table below, the combustion equipment cannot reject more sulfur dioxide than the equivalent of 2.0% sulfur weight based on heavy oil or coal heating (article 31, section X, Règlement sur la qualité de l'atmosphère).

Air emission norms for combustion equipment				
Fuel	**Power (MW)**	**New equipment (1)**		**Existing equipment (2)**
		Particles	**NO_X (3)**	**Particles**
Biomass (wood or wood residues)	< 3	600 mg/Nm³ (4)	n.a.	600 mg/Nm³ (4)
	≥ 3	340 mg/Nm³ (4)	n.a.	450 mg/Nm³ (4)
Mill rejects (other than wood or wood residues)	≤ 1 t/h (5)	100 g/100 kg of rejects	n.a.	150 g/100 kg of rejects
	> 1 t/h (5)	800 g/t of biomass and 180 mg/Nm³ (6)	n.a.	270 mg/Nm³ (6)
Oil	from 3 to 15	60 mg/MJ	n.a.	85 mg/MJ
	from15 to 70	45 mg/MJ	325 ppm	60 mg/MJ
	≥ 70	45 mg/MJ	250 ppm	60 mg/MJ
Gas	from 3 to 15	60 mg/MJ	n.a.	85 mg/MJ
	from 15 to 70	45 mg/MJ	150 ppm	60 mg/MJ
	≥ 70	45 mg/MJ	200 ppm	60 mg/MJ

(1) In operation after 14 November 1979.
(2) In operation before 14 November 1979.
(3) Dry basis, corrected for 3% oxygen volume.
(4) Dry basis, corrected for 12 % CO_2 volume.
(5) Incineration capacity.
(6) Dry basis, corrected for 50 % excess air.

Norms on solid rejects

The following table gives the norms applied to leachate water of landfill sites where ashes from combustion equipment are stored.

Norms applied to rejects for leachate and other water sources.			
Parameter		**Leachate water**	**Other water**
SS	mg/l	50	30
BOD_5	mg/l	50 (1)	30
Aluminum	mg/l	10	10
Chrome	mg/l	1	1
Iron	mg/l	10	10
Mercury	mg/l	0.05	0.05
Lead	mg/l	0.3	0.3
Zinc	mg/l	1	1
Phenol compounds	µg/l	50	10
Total sulfur (HS)	mg/l	1	1
Resin and fatty acids	µg/l	300	300

(1) The norm can exceed 50 mg/l when BOD_5 removal is equal to or greater than 90%.

Impact of using TDF on the application of environmental regulations

1) *Law on the Quality of the Environment « La loi sur la qualité de l'environnement, L.R.Q », Chapitre Q-2*

An autorisation certificate shall be requested and obtained from the Minister to burn TDF in a biomass boiler (article 22 of the law, section 4.2.8).

2) *Regulation on the Air Quality « Règlement sur la qualité de l'atmosphère », Q-2,r.20*

Sections XIV and XIX (incinerator) of the regulation would apply as soon as the mill start to burn TDF (the limit for particles emissions is 270 mg/Nm^3 instead of 450 mg/Nm^3).

When TDF is used to replace fossil fuel, section X of the regulation on sulfur dioxide emissions applies.

3) *Regulation on Solid Rejects « Règlement sur les déchets solides », Q-2, r.3.2*

With the use of TDF, the norms on leachate water apply for the ash disposal.

Proposed regulations

The provincial government is working on a proposal to modify the present regulation on the air quality. For instance, proposed limits for particle emissions are as low as 70 mg/Nm^3 for biomass boilers. Proposed limits for NOx varies between 26 and 125 g/GJ depending on fuel type used and power.

8) *Summary of Kruger, Corner Brook operation alternatives and their impact on fuel consumption and on the environment*

The following table gives a summary of the main alternatives evaluated with the use of TDF and their impact on fuel consumption and on the environment. All scenarios listed in the table are for an average steam production of 220,500 lb/h.

Case	Fuel Consumption, as fired (7)			Boiler stack fumes emissions				
	Biomass	TDF	No.6 Oil	CO (1)	Zn (1)	PAH (1) (2)	TEQ (1) (3)	GHG (4)
	Wet t/h	Wet t/h	Wet t/h	ppm	µg/Nm³	µg/Nm³	pg/Nm³	t CO_2/d
Present operation	26.2	0.0	4.21	1056	8366	279	22	330.4
0.5 tph TDF (5)	24.6	0.46	4.03	-	-	-	-	349.5
1.3 tph TDF (5)	21.8	1.33	3.69	-	-	-	-	386.4
More biomass + 0.5 tph TDF (6)	36.8	0.46	2.38	895	21,607	214	18	219.4
More biomass + 0.8 tph TDF (6)	36.8	0.82	2.09	772	31,712	164	15	222.4
More biomass + 1.3 tph TDF (6)	36.8	1.33	1.66	594	46,346	92	11	226.3

(1) **These numbers were calculated by performing linear regressions using the test results obtained at Kruger, Trois-Rivieres in May 2002 for different %TDF as heat input. The results presented here are therefore giving an indication only of the impact of TDF on boiler stack emissions for the Corner Brook mill. Testing should be performed for the specific Corner Brook boiler operating conditions and fuel types used in order to quantify the impact of TDF on stack emissions.** The Trois-Rivieres mill is using a traveling grate biomass boiler with a wet scrubber for flue gas treatment. Fuels types and quantities used during the trials are given in section 3 of this Annex I.

(2) PAH = Polynuclear Aromatic Hydrocarbons

(3) TEQ = Toxic Equivalent of 2,3,7,8 substituted dioxin and furan congeners

(4) GHG = Greenhouse Gases. Factors used for No.6 oil are 74.0 kg CO_2/GJ, 0.0180 kg CH_4/GJ and 0.00635 kg N_2/GJ giving an equivalent factor of 76.01 kg CO_2/GJ. Factor used for TDF is 84.9 kg CO_2/GJ. Biomass is considered CO_2 neutral.

(5) No modification to boiler except for some adjustment to air distribution to send slightly more air to grate and less to oil burners. Assuming that overfire air fan is operating at its maximum capacity of 114,311 lb/h.

(6) Boiler is modified. Modifications required are described in boiler supplier's proposal.

(7) Based on preliminary balances.

9) References

1- "U.S. Scrap Tire Markets 2003", Rubber Manufacturers Association, WA, July 2004, Document #TDF-022, http://www.rma.org/scrap_tires/scrap_tire_markets/

2- "U.S. Scrap Tire Markets 2002", published by the Rubber Manufacturers Association, WA, December 2002, http://www.rtinevada.com/pdfs/US_Scrap_Tire_Markets_2001.pdf

3- "The use of Scrap Tires as a Supplemental Fuel in Pulp and Paper Mill Boilers", M. Blumenthal, Rubber Association of Canada, Symposium on Scrap Tires, March 1996, Document #TDF-034, https://www.rma.org/publications/scrap_tires/index.cfm?CategoryID=572

4- "Investigations into the Variability and Control of Dioxins Formation and Emissions from Coastal Power Boilers", V. Uloth et al., Paprican, Prince-George and Vancouver, http://www.rfu.org/Incineration.htm

5- "Scrap Tire Characteristics"; Rubber manufacturers association; Document #GEN-011, https://www.rma.org/publications/scrap_tires/index.cfm?PublicationID=11294

6- "Air Emissions from Scrap Tire Combustion"; United States Environmental Protection Agency, Office of Research and Development, Washington, EPA-600/F-97-115, October 1997, published on the RMA's site, Document #TDF-005, https://www.rma.org/publications/scrap_tires/index.cfm?PublicationID=11268

7- "Use of Tire Derived Fuel (TDF) in a fluidized bed hog fuel power boiler at Pacifia Papers Inc. Alberni Specialties mill."; Cross, L., and Ericksen, B.; http://www.portaec.net/local/tireburning/use_of_tire_derived_fuel.html

8- "Tire Derived Fuel Trial in a Multi-Fuel Boiler."; Holland, R.M.; 1994 International Environmental Conference, TAPPI, 1994, pp. 605-608

9- « Measurement of Polynuclear Aromatic Hydrocarbons and Metals from Burning Tire Chips for Supplementary Fuel. », Drabek, J. and Willenberg, J. ; 1987 Tappi Environmental Conference, 1987, pp.147-152.

10- "Canada's Energy Outlook, 1996 – 2020 "; Ressources Naturelles Canada; http://nrcan.gc.ca/es/ceo/toc-96E.html

11- "Fuel and Energy Source Codes and Emission Coefficients."; http://www.eia.doe.gov/oiaf/1605/factors.html

12- "Fluidized Bed Combustion of Tires"; Kraft, D.L.; 1994 Tappi Engineering Conference, pp. 923-928.

13- "Supplementary firing of tire-derived-fuel (TDF) in a combination fuel boiler."; Joes, R.M., Kennedy, J.M., Heberer, N.L.; Tappi Journal, Vol. 73, No. 5, May 1990, pp. 107-113.

14- "Specification Guidelines for Tire Derived Fuel."; Hope, M.W.; 1993 Tappi Engineering Conference, pp. 1131-1139.

Sandwell

Project:	121771	Prepared by:	Jakub Wilczynski
Title:	Power Boiler	Checked by:	Doug Garson
Client:	Kruger	Date:	24-May-05
Location:	Corner Brool		

BOILER HEAT AND MASS BALANCE CALCULATIONS **CASE:** PRESENT, NO TDF OR COAL, PAHR = 600,00 BTU/H SQ FT

1. BOILER OPERATING CONDITIONS

Steam outlet pressure	psig	825	T-sat	5789.70	kPa absolute
Steam outlet temperature	°F	850	523.81	454.44	°C
Drum operating pressure	psig	950		6651.57	kPa absolute
Feedwater temperature	°F	281		138.33	°C
Ambient air temperature	°F	80		26.67	°C
Blowdown	%	1.3			°C
Flue gas exit temperature	°F	340		171.11	°C
Combustion air temperature	°F	540		282.22	°C
Primary air	°F	540		282.22	°C
Secondary air	°F	540		282.22	°C
Tertiary air	°F	540		282.22	°C
Preheated air temperature	°F	80		26.67	°C
Sootblowing steam	lbs/h	2500			

		TOTAL		Pri. sludge	Sec sludge	De-inking sludge	Bark	No.6 oil	TDF	coal
2. FUELS										
Fuel fired-dry basis	lb/h	34427.54976	25144.66011	2635.444776	940.6397526	0	21568.57558	9283	0	0
Fuel fired-wet basis	lb/h	66878	32451	7123	2542	0	47930	9283	0	0
Tonnes per day-dry	MT/day	374.79		28.69	10.24	0.00	234.80	101.06	0.00	0.00
Moisture content	%	48.52		63	63	72	55	0	0	10
Excess air	%	31.86		50.0	50.0	50.0	50.0	10	10	15
Combustible weight loss	%	5.924		10.0	10.0	10.0	10.0	1	1	0
Air fired in bed	%			60	60	60	60	30	0	50
Fuel fired in bed	%			100	100	100	100	0	0	50
3. SUMMARY										
Gross steam generation	lbs/h	220500	220500	6275	2274	0	87456	124495	0	0
Net steam generation	lbs/h	218000	Note: Net steam generation excludes soot blowing steam							
Heat input from fuels	MMBtu/hr	379.23	379.23	17.81	6.36	0.00	183.33	171.73	0.00	0.00
Net heat absorbed	MMbtu/hr	260.10	260.10	7.40	2.68	0.00	103.16	146.86	0.00	0.00
Efficiency	%	67.81	68.59	41.56	42.20	0.00	56.27	85.51	0.00	0.00
Total air	lbs/hr	367560	367560	20310	6941	0	201216	139092	0	0
Total products	lbs/hr	430902	430902	26913	9218	0	246497	148275	0	0
Total flue gas	lbs/hr	433402	Note: Total Flue gas includes soot blowing steam							
T-adiabatic	F	2099.42								

FUEL ANALYSIS-DRY BASIS		TOTAL	Pri. sludge	Sec sludge	De-inking sludge	Bark	No.6 oil	TDF	coal
C	%	61.88	44.8	39.9	39.09	54.67	85.7	84.4	67.3
H2	%	7.31	6.2	5	4.54	6.13	10.5	7.1	5.2
O2	%	26.51	38.1	29	31.26	36.39	0	2.3	16.2
N2	%	0.54	0.1	4.8	0.11	0.25	0.92	0.2	1.9
S	%	0.77	0	0	0	0.02	2.8	1.2	2.7
Ash	%	2.99	10.8	20.3	25	2.54	0.08	4.8	6.7
Total	%	100	100	100	100	100	100	100	100
HHV	Btu/lb	11015	6758	6758	6758	8500	18500	15500	12100

Sandwell

Project: 121771				Prepared by:		Jakub Wilczynski				
Title: Power Boiler				Checked by:		Doug Garson				
Client: Kruger				Date:	24-May-05					
Location: Corner Broo										
BOILER HEAT AND MASS BALANCE CALCULATIONS				**CASE 1: 1.31 tph TDF + BIOMASS TO MAX PAHR LIMIT OF 940,000 BTU/H SQ FT**						
1. BOILER OPERATING CONDITIONS										
Steam outlet pressure	psig	**825**	T-sat		5789.70	kPa absolute				
Steam outlet temperature	°F	**850**	523.81		454.44	°C				
Drum operating pressure	psig	**950**			6651.57	kPa absolute				
Feedwater temperature	°F	**281**			138.33	°C				
Ambient air temperature	°F	**80**			26.67	°C				
Blowdown	%	**1.3**				°C				
Flue gas exit temperature	°F	**340**			171.11	°C				
Combustion air temperature	°F	**540**			282.22	°C				
Primary air	°F	**540**			282.22	°C				
Secondary air	°F	**540**			282.22	°C				
Tertiary air	°F	**540**			282.22	°C				
Preheated air temperature	°F	**80**			26.67	°C				
Sootblowing steam	lbs/h	**2500**								
2. FUELS				Pri.	Sec	De-inking				
		TOTAL		sludge	sludge	sludge	Bark	No.6 oil	TDF	coal
Fuel fired-dry basis	lb/h	**42261.9313**	38600.00	**2635.44**	**940.64**	**0**	**32143.92**	**3662**	**2880.00**	**0**
Fuel fired-wet basis	lb/h	**87667**	45405	7123	2542	0	71431	3662	2909	0
Tonnes per day-dry	MT/day	**460.07**		28.69	10.24	0.00	349.93	39.86	31.35	0.00
Moisture content	%	**51.79**		63	63	72	55	0	1	1
Excess air	%	**39.38**		50.0	50.0	50.0	50.0	10	15	15
Combustible weight loss	%	**7.532**		10.00	10.00	10.00	10.00	1	1	0
Air fired in bed	%			60	60	60	60	30	50	50
Fuel fired in bed	%			100	100	100	100	0	100	100
3. SUMMARY										
Gross steam generation	lbs/h	**220500**	220500	6275	2274	0	130336	49111	32504	0
Net steam generation	lbs/h	**218000**	**Note: Net steam generation excludes soot blowing steam**							
Heat input from fuels	MMBtu/hr	**409.78**	409.78	17.81	6.36	0.00	273.22	67.75	44.64	0.00
Heat input from fuels	%	**100.00**	100.00	4.35	1.55	0.00	66.68	16.53	10.89	
Net heat absorbed	MMbtu/hr	**260.10**	260.10	7.40	2.68	0.00	153.75	57.93	38.34	0.00
Efficiency	%	**62.76**	63.47	41.56	42.20	0.00	56.27	85.51	85.89	0.00
Total air	lbs/hr	**422183**	422183	20310	6941	0	299875	54869	40187	0
Total products	lbs/hr	**504910**	504910	26913	9218	0	367357	58492	42930	0
Total flue gas	lbs/hr	**507410**	**Note: Total Flue gas includes soot blowing steam**							
T-adiabatic	F	**2588.76**								

Sandwell

Project: 121771		Prepared by:	Jakub Wilczynski
Title: Power Boiler		Checked by:	Doug Garson
Client: Kruger		Date:	24-May-05
Location: Corner Broo			

BOILER HEAT AND MASS BALANCE CALCULATIONS — CASE 3: TDF 0.81t/h + BIOMASS, PAHR = 937,000 BU/H SQ FT

1. BOILER OPERATING CONDITIONS										
Steam outlet pressure	psig	825	T-sat		5789.70	kPa absolute				
Steam outlet temperature	°F	850	523.81		454.44	°C				
Drum operating pressure	psig	950			6651.57	kPa absolute				
Feedwater temperature	°F	281			138.33	°C				
Ambient air temperature	°F	80			26.67	°C				
Blowdown	%	1.3				°C				
Flue gas exit temperature	°F	340			171.11	°C				
Combustion air temperature	°F	540			282.22	°C				
Primary air	°F	540			282.22	°C				
Secondary air	°F	540			282.22	°C				
Tertiary air	°F	540			282.22	°C				
Preheated air temperature	°F	80			26.67	°C				
Sootblowing steam	lbs/h	2500								
2. FUELS				Pri.	Sec	De-inking				
		TOTAL		sludge	sludge	sludge	Bark	No.6 oil	TDF	coal
Fuel fired-dry basis	lb/h	42085.02	37484	2635.44	940.64	0	32143.9155	4601	1763.68	0
Fuel fired-wet basis	lb/h	87479	45394	7123	2542	0	71431	4601	1781	0
Tonnes per day-dry	MT/day	458.15		28.69	10.24	0.00	349.93	50.09	19.20	0.00
Moisture content	%	51.89		63	63	72	55	0	1	10
Excess air	%	39.22		50	50	50	50	10	15	15
Combustible weight loss	%	7.530		10.00	10.00	10.00	10.00	1	1	0
Air fired in bed	%			60	60	60	60	30	50	50
Fuel fired in bed	%			100	100	100	100	0	100	100
3. SUMMARY										
Gross steam generation	lbs/h	220500	220500	6275	2274	0	130336	61710	19905	0
Net steam generation	lbs/h	218000	Note: Net steam generation excludes soot blowing steam							
Heat input from fuels	MMBtu/hr	409.85	409.85	17.81	6.36	0.00	273.22	85.12	27.34	0.00
Heat input from fuels	%	100.00	100.00	4.35	1.55	0.00	66.66	20.77	6.67	0.00
Net heat absorbed	MMbtu/hr	260.10	260.10	7.40	2.68	0.00	153.75	72.79	23.48	0.00
Efficiency	%	62.74	63.46	41.56	42.20	0.00	56.27	85.51	85.89	0.00
Total air	lbs/hr	420682	420682	20310	6941	0	299875	68945	24610	0
Total products	lbs/hr	503275	503275	26913	9218	0	367357	73497	26290	0
Total flue gas	lbs/hr	505775	Note: Total Flue gas includes soot blowing steam							
T-adiabatic	F	2468.10								
Grate Heat Relise	MBTU/h/sqft	937.16								

precision worldwide
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Project:				Prepared by:	Jakub Wilczynski					
Title:	Power Boile			Checked by:	Doug Garson					
Client:	Kruger			Date:	25-May-05					
Location:	Corner Broo									
BOILER HEAT AND MASS BALANCE CALCULATIONS				**CASE 4:**	TDF 0.45 t/h + BIOMASS, PAHR = 902,000 BTU/H SQ FT					
1. BOILER OPERATING CONDITIONS										
Steam outlet pressure	psig	825	T-sat		5789.70	kPa absolute				
Steam outlet temperature	°F	850	523.81		454.44	°C				
Drum operating pressure	psig	950			6651.57	kPa absolute				
Feedwater temperature	°F	281			138.33	°C				
Ambient air temperature	°F	80			26.67	°C				
Blowdown	%	1.3				°C				
Flue gas exit temperature	°F	340			171.11	°C				
Combustion air temperature	°F	540			282.22	°C				
Primary air	°F	540			282.22	°C				
Secondary air	°F	540			282.22	°C				
Tertiary air	°F	540			282.22	°C				
Preheated air temperature	°F	80			26.67	°C				
Sootblowing steam	lbs/h	2500								
2. FUELS				Pri.	Sec	De-inking				
		TOTAL		sludge	sludge	sludge	Bark	No.6 oil	TDF	coal
Fuel fired-dry basis	lb/h	41962.0405		2635.4478	940.639753	0	32143.9155	5250	992.1	0
Fuel fired-wet basis	lb/h	87338	45376	7123	2542	0	71431	5250	992	0
Tonnes per day-dry	MT/day	456.81		28.69	10.24	0.00	349.93	57.15	10.80	0.00
Moisture content	%	51.95		63	63	72	55	0	0	10
Excess air	%	39.12		50	50	50	50	10	15	15
Combustible weight loss	%	7.530		10	10	10	10	1	1	0
Air fired in bed	%			60	60	60	60	30	0	50
Fuel fired in bed	%			100	100	100	100	0	100	50
3. SUMMARY										
Gross steam generation	lbs/h	220500	220500	6275	2274	0	130336	70408	11207	0
Net steam generation	lbs/h	218000	Note: Net st							
Heat input from fuels	MMBtu/hr	409.89	409.89	17.81	6.36	0.00	273.22	97.12	15.38	0.00
Net heat absorbed	MMbtu/hr	260.10	260.10	7.40	2.68	0.00	153.75	83.05	13.22	0.00
Efficiency	%	62.74	63.46	41.56	42.20	0.00	56.27	85.51	85.97	0.00
Total air	lbs/hr	419634	419634	20310	6941	0	299875	78664	13844	0
Total products	lbs/hr	502123	502123	26913	9218	0	367357	83857	14779	0
Total flue gas	lbs/hr	504623	Note: Total F							
T-adiabatic	F	2418.70								
Grate Heat Relise	MBTU/h/sqft	902.65								

Sandwell

Project:		Prepared by:	Jakub Wilczynski
Title:	Power Boiler	Checked by:	Doug Garson
Client:	Kruger	Date:	20-May-05
Location:	Corner Brool		

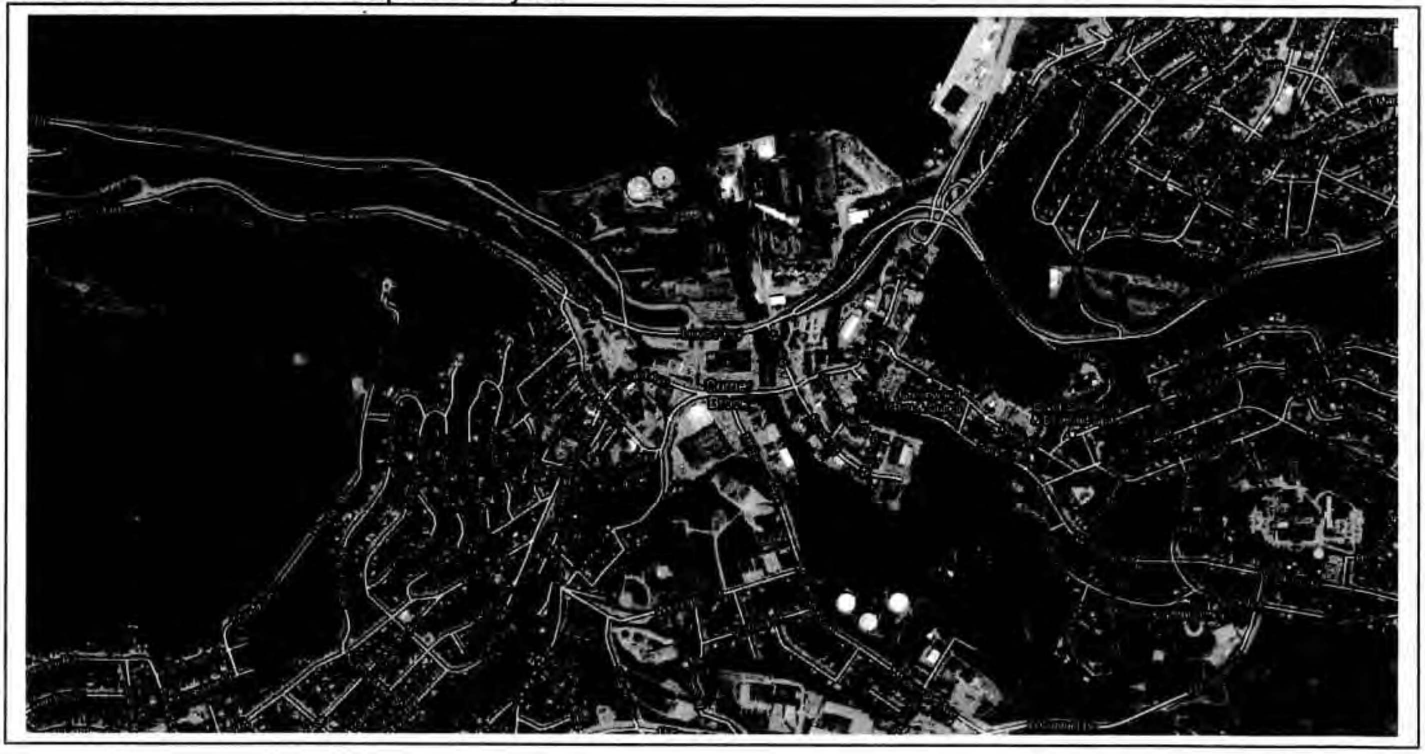
BOILER HEAT AND MASS BALANCE CALCULATIONS — **CASE 5:** 1.31 t/h TDF + BIOMASS, PAHR = 623,000 BTU/H SQ FT

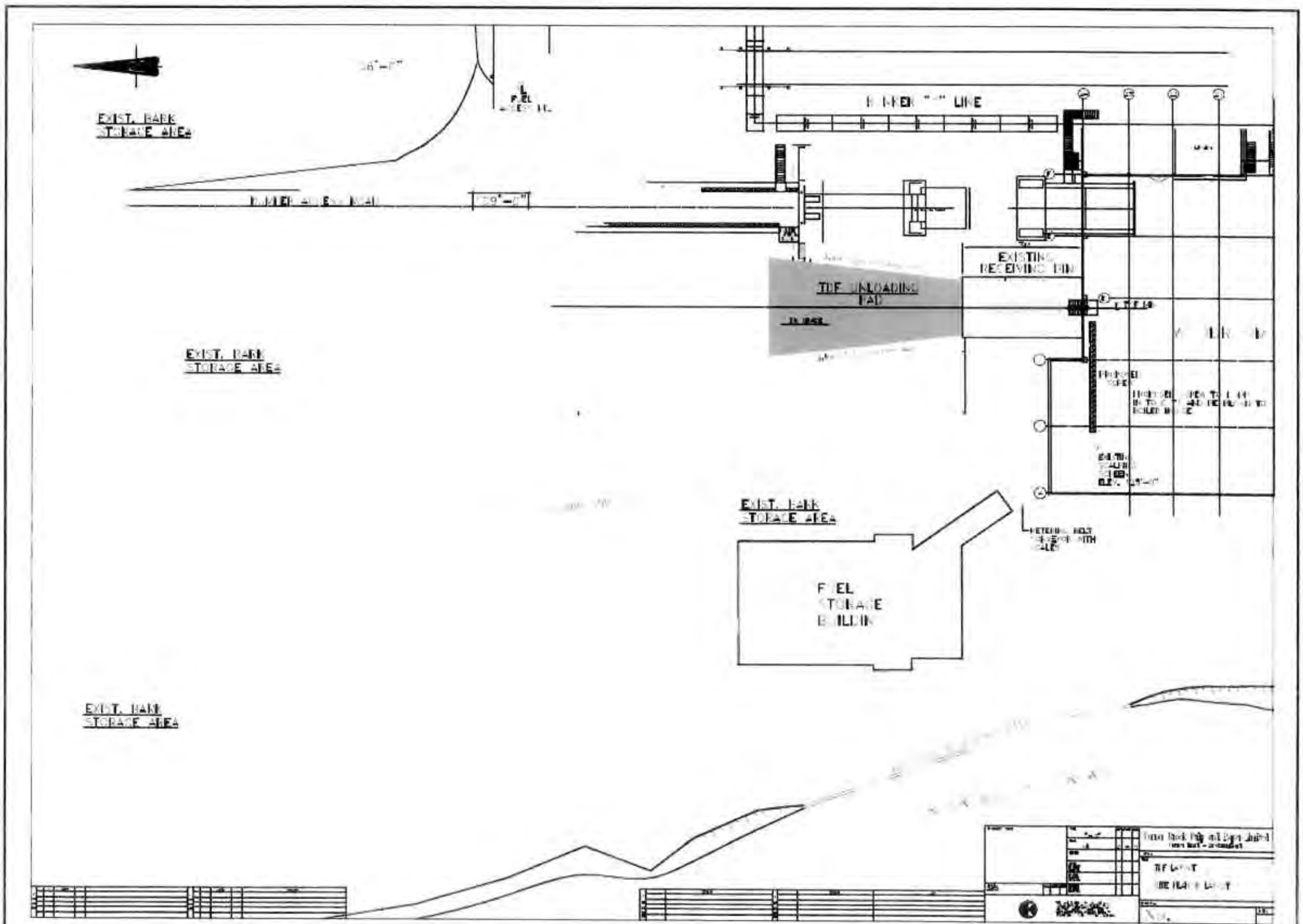
1. BOILER OPERATING CONDITIONS										
Steam outlet pressure	psig	825	T-sat		5789.70	kPa absolute				
Steam outlet temperature	°F	850	523.81		454.44	°C				
Drum operating pressure	psig	950			6651.57	kPa absolute				
Feedwater temperature	°F	281			138.33	°C				
Ambient air temperature	°F	80			26.67	°C				
Blowdown	%	1.3				°C				
Flue gas exit temperature	°F	340			171.11	°C				
Combustion air temperature	°F	540			282.22	°C				
Primary air	°F	540			282.22	°C				
Secondary air	°F	540			282.22	°C				
Tertiary air	°F	540			282.22	°C				
Preheated air temperature	°F	80			26.67	°C				
Sootblowing steam	lbs/h	2500								
2. FUELS				Pri.	Sec	De-inking				
		TOTAL		sludge	sludge	sludge	Bark	No.6 oil	TDF	coal
Fuel fired-dry basis	lb/h	31883.10863		2635.445	940.6398	0	17265.46	8153.54	2888.026	0
Fuel fired-wet basis	lb/h	59104	27220	7123	2542	0	38368	8154	2917	0
Tonnes per day-dry	MT/day	347.09		28.69	10.24	0.00	187.96	88.76	31.44	0.00
Moisture content	%	46.06		63	63	72	55	0	1	10
Excess air	%	29.13		50	50	50	50	10	15	15
Combustible weight loss	%	5.197		10	10	0	10	1	1	0
Air fired in bed	%			80	80	80	70	50	70	50
Fuel fired in bed	%			100	100	100	100	0	100	50
3. SUMMARY										
Gross steam generation	lbs/h	220500	220500	6275	2274	0	70008	109349	32594	0
Net steam generation	lbs/h	218000	Note: Net ste							
Heat input from fuels	MMBtu/hr	366.53	366.53	17.81	6.36	0.00	146.76	150.84	44.76	0.00
Net heat absorbed	MMbtu/hr	260.10	260.10	7.40	2.68	0.00	82.58	128.99	38.45	0.00
Efficiency	%	70.16	70.96	41.56	42.20	0.00	56.27	85.51	85.89	0.00
Total air	lbs/hr	350793	350793	20310	6941	0	161072	122171	40299	0
Total products	lbs/hr	406735	406735	26913	9218	0	197318	130236	43050	0
Total flue gas	lbs/hr	409235	Note: Total F							
T-adiabatic	F	2137.59								

Sandwell

Project:				Prepared by:	Jakub Wilczynski					
Title: Power Boiler				Checked by:	Doug Garson					
Client: Kruger				Date:	20-May-05					
Location: Corner Brool										
BOILER HEAT AND MASS BALANCE CALCULATIONS				**CASE 6: 0.45 t/h TDF + BIOMASS, PAHR = 676,000 BTU/H SQ FT**						
1. BOILER OPERATING CONDITIONS										
Steam outlet pressure	psig	825	T-sat		5789.70	kPa absolute				
Steam outlet temperature	°F	850	523.81		454.44	°C				
Drum operating pressure	psig	950			6651.57	kPa absolute				
Feedwater temperature	°F	281			138.33	°C				
Ambient air temperature	°F	80			26.67	°C				
Blowdown	%	1.3				°C				
Flue gas exit temperature	°F	340			171.11	°C				
Combustion air temperature	°F	540			282.22	°C				
Primary air	°F	540			282.22	°C				
Secondary air	°F	540			282.22	°C				
Tertiary air	°F	540			282.22	°C				
Preheated air temperature	°F	80			26.67	°C				
Sootblowing steam	lbs/h	2500								
2. FUELS				Pri.	Sec	De-inking				
		TOTAL		sludge	sludge	sludge	Bark	No.6 oil	TDF	coal
Fuel fired-dry basis	lb/h	33560.34984		2635.44478	940.639753	0	20101.27454	8891	992.07	0
Fuel fired-wet basis	lb/h	64218	30657	7123	2542	0	44669	8891	992	0
Tonnes per day-dry	MT/day	365.34		28.69	10.24	0.00	218.83	96.79	10.80	0.00
Moisture content	%	47.74		63	63	72	55	0	0	10
Excess air	%	30.94		50	50	50	50	10	15	15
Combustible weight loss	%	5.682		10	10	10	10	1	1	0
Air fired in bed	%			60	60	60	60	50	60	50
Fuel fired in bed	%			100	100	100	100	0	100	50
3. SUMMARY										
Gross steam generation	lbs/h	220500	220500	6275	2274	0	81506	119239	11206	0
Net steam generation	lbs/h	218000	Note: Net ste							
Heat input from fuels	MMBtu/hr	374.89	374.89	17.81	6.36	0.00	170.86	164.48	15.38	0.00
Net heat absorbed	MMbtu/hr	260.10	260.10	7.40	2.68	0.00	96.15	140.66	13.22	0.00
Efficiency	%	68.60	69.38	41.56	42.20	0.00	56.27	85.51	85.97	0.00
Total air	lbs/hr	361841	361841	20310	6941	0	187528	133219	13843	0
Total products	lbs/hr	422651	422651	26913	9218	0	229727	142014	14778	0
Total flue gas	lbs/hr	425151	Note: Total F							
T-adiabatic	F	2062.97								

APPENDIX D: Mill Map and Layout





APPENDIX E: Process Flow Diagram