State of California
AIR RESOURCES BOARD

RESEARCH PROPOSAL

Resolution 12-15

March 22, 2012

Agenda Item No.: 12-2-1

WHEREAS, the Air Resources Board (ARB) has been directed to carry out an effective research program in conjunction with its efforts to combat air pollution, pursuant to Health and Safety Code sections 39700 through 39705;

WHEREAS, a research proposal, number 2737-273, entitled "Emissions of Potent Greenhouse Gases from Appliance and Building Waste in Landfills" has been submitted by California Polytechnic State University, San Luis Obispo;

WHEREAS, the Research Division staff has reviewed and recommended this proposal for approval; and

WHEREAS, the Research Screening Committee has reviewed and recommends for funding:

> Proposal Number 2737-273, entitled "Emissions of Potent Greenhouse Gases from Appliance and Building Waste in Landfills" submitted by California Polytechnic State University, San Luis Obispo, for a total amount not to exceed $299,826.

NOW, THEREFORE, BE IT RESOLVED that the Air Resources Board, pursuant to the authority granted by Health and Safety Code section 39703, hereby accepts the recommendation of the Research Screening Committee and approves the following:

> Proposal Number 2737-273, entitled "Emissions of Potent Greenhouse Gases from Appliance and Building Waste in Landfills" submitted by California Polytechnic State University, San Luis Obispo, for a total amount not to exceed $299,826.

BE IT FURTHER RESOLVED that the Executive Officer is hereby authorized to initiate administrative procedures and execute all necessary documents and contracts for the research effort proposed herein, and as described in Attachment A, in an amount not to exceed $299,826.

I hereby certify that the above is a true and correct copy of Resolution 12-15, as adopted by the Air Resources Board.

Mary Alice Morency, Clerk of the Board

ATTACHMENT A

"Emissions of Potent Greenhouse Gases from Appliance and Building Waste in Landfills"

Background

The current uncertainty of the emissions estimates from waste foam in landfills is quite high, with estimates ranging from negligible to as much as 5.7 million metric tonnes of carbon dioxide equivalents ($MMTCO_2E$) per year. Waste insulating foam from refrigerator-freezers and building insulation that has been landfilled is assumed to be a significant source of greenhouse gases (GHGs) because the insulation contains foam expansion agents of chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), and hydrofluorocarbons (HFCs), which have high-global warming potentials (GWPs) ranging from 700 to 4750. However, previous limited studies suggest that actual foam GHG emissions from landfills may in fact be negligible. Laboratory research in Denmark suggests that much of the CFC foam expansion agent in the landfilled foam is biologically attenuated and reduced prior to emissions (HCFCs and HFCs are not attenuated). Additionally, limited landfill gas studies in Canada suggest that in a landfill with a methane gas collection and combustion system in place, up to 95 percent of the foam expansion agents are reduced to non-global warming constituents from auto-decomposition at high combustion temperatures (1150 to 1350 °F).

An ARB-funded 2010 study (Caleb Management Services) on insulating foam GHG emissions in California confirmed the significant potential of GHG emissions from landfilled foam, but actual emission measurements from landfills were not part of the scope of work. Although previous international and national landfill emission studies have not indicated any significant emissions of CFCs, HCFCs, or HFCs from landfills, the studies focused on municipal solid waste landfills and not those that accept large quantities of waste insulation foam. Therefore, we would not expect these previous studies to accurately reflect GHG emissions from landfilled foam. Additionally, none of the studies were conducted in California landfills, which have different requirements for alternative daily cover, maximum methane emissions, and other environmental requirements than non-California landfills. The previous studies were also inadequate because they did not take into account different climatic conditions typically found for landfills in California.

Objective

The proposed effort will determine the potent GHG emissions from landfilled insulating foam from recycled appliances and demolished buildings. The major objectives of the project are to: 1) develop a waste flow analysis of each stage of foam waste (from recycling to landfilling); 2) determine GHG emissions from each stage of foam waste prior to landfilling; 3) determine maximum potential GHG emissions from landfilled foam; 4) determine actual emissions of foam GHGs from landfills measuring surface flux emissions, landfill gas collection and combustion system emissions; 5) determine destruction efficiency of foam GHGs captured by landfill gas collection systems;

6) determine reductions of waste foam GHGs within landfill, through biological attenuation or capture/combustion; and 7) scale emissions and reductions results statewide.

Methods

Landfill(s) that accept significant amounts of waste insulation foam from recycled appliances and demolished buildings will be identified, and landfill cells with waste foam within the landfill will also be identified. Emissions of the targeted compounds (CFC-11, HCFC-141b, HFC-134a, and HFC-245fa) from foam expansion agents will be measured at the landfill surface using flux chambers and sampling canisters. The collected landfill gas emissions will then be analyzed for the target compounds to a parts per billion level, or a parts per trillion level if necessary. Results will be extrapolated to statewide emission levels based on the estimated tonnage of insulating foam disposed of each year in California.

Emissions will also be determined from the disposed waste foam that is often used as alternative daily cover on the surface of landfills. Flux chambers will be set up to capture gas emissions from the waste foam alternative daily cover. To determine the reduction of the target compounds through landfill gas collection and combustion systems, landfill gas measurements will be taken from the gas collection piping at the pre-combustion stage, then again at the post-combustion stage. Reduction efficiencies will then be made by comparing concentrations before and after combustion.

Expected Results

The GHG emissions from waste insulating foam will be determined from this research and results will be extrapolated to determine statewide emissions. Additionally, any foam GHG reductions that may occur from landfill gas collection and combustion systems will also be determined.

Significance to the Board

The results of this study will play a significant role in eliminating the current uncertainty in waste foam GHG emissions in landfills. The current emissions from waste foam may be as high as 5.7 $MMTCO_2E$, expected to increase 44 percent to 8.2 $MMTCO_2E$ by 2020 (as more buildings with polyurethane insulating foam reach demolition age). The research may confirm the higher emission estimates, or may indicate that the vast majority of foam GHGs landfilled are in fact reduced within the landfill and are not emitted into the atmosphere. The results will inform ARB on the preferred management options for waste foam, and whether additional mitigation strategies are required for waste foam GHGs or not.

The majority of current foam GHG emissions are from CFC-11, an ozone-depleting substance. Results from the research will also be used to refine ODS destruction credits that could be used in the offset protocol portion of the GHG cap and trade program.

Contractor:
California Polytechnic State University, San Luis Obispo

Contract Period:
36 months

Principal Investigator (PI):
Nazli Yessler, Ph.D.

Contract Amount:
$299,826

Basis for Indirect Cost Rate:
The California State University and the UC system have agreed to a ten percent indirect cost rate.

Past Experience with this Principal Investigator:
ARB has not previously worked with Dr. Nazli Yessler. Dr. Yessler is the Executive Director of The Global Waste Research Institute associated with Cal Poly, and is an expert in the field of landfill emissions and landfill waste issues.

Prior Research Division Funding to California Polytechnic State University, San Luis Obispo:

Year	2011	2010	2009
Funding	$0	$0	$249,637

BUDGET SUMMARY

Contractor: California Polytechnic State University, San Luis Obispo

"Emissions of Potent Greenhouse Gases from Appliance and Building Waste in Landfills"

DIRECT COSTS AND BENEFITS				
1.	Labor and Employee Fringe Benefits	$	121,555	
2.	Subcontractors	$	41,966	
3.	Equipment	$	0	
4.	Travel and Subsistence	$	11,490	
5.	Electronic Data Processing	$	0	
6.	Reproduction/Publication	$	0	
7.	Mail and Phone	$	0	
8.	Supplies	$	13,000	
9.	Analyses	$	85,600[1]	
10.	Miscellaneous	$	500	
	Total Direct Costs			$274,111
INDIRECT COSTS				
1.	Overhead	$	25,715	
2.	General and Administrative Expenses	$	0	
3.	Other Indirect Costs	$	0	
4.	Fee or Profit	$	0	
	Total Indirect Costs			$25,715
TOTAL PROJECT COSTS				**$299,826**

[1] Analyses are necessary for up to 150 gas canister samples collected to determine GHG emissions from landfilled foam. Emission concentrations from target CFCs, HCFCs, and HFCs may be in the parts per billion to parts per trillion levels for some samples collected, therefore, high-resolution analysis is required.

Attachment 1

SUBCONTRACTORS' BUDGET SUMMARY

Subcontractor: University of Illinois at Chicago:

Description of subcontractor's responsibility: Led by Dr. Jean Bogner, nationally recognized expert in landfill gas emission estimates, the subcontractor will assist Cal Poly San Luis Obispo primary investigator, Dr. Yessler, with gathering and analyzing background information, developing and constructing field testing equipment, developing the research experimental design, and conducting the field measurement tests.

DIRECT COSTS AND BENEFITS				
1.	Labor and Employee Fringe Benefits	$	33,151	
2.	Subcontractors	$	0	
3.	Equipment	$	0	
4.	Travel and Subsistence	$	5,000	
5.	Electronic Data Processing	$	0	
6.	Reproduction/Publication	$	0	
7.	Mail and Phone	$	0	
8.	Supplies	$	0	
9.	Analyses	$	0	
10.	Miscellaneous	$	0	
	Total Direct Costs			$38,151
INDIRECT COSTS				
1.	Overhead	$	3,815	
2.	General and Administrative Expenses	$	0	
3.	Other Indirect Costs	$	0	
4.	Fee or Profit	$	0	
	Total Indirect Costs			$3,815
TOTAL PROJECT COSTS				**$41,966**