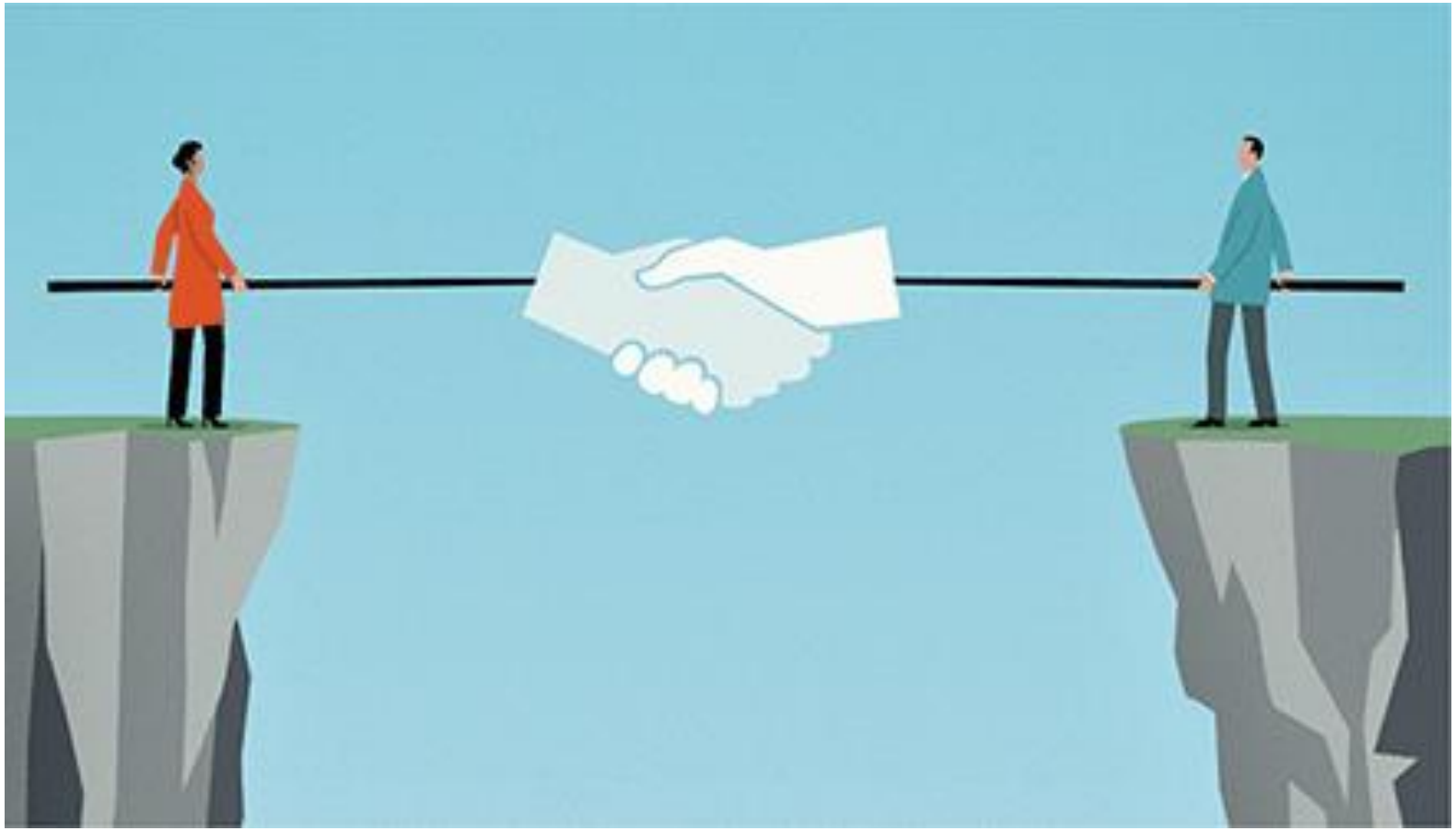
Policy Round Table on

"Enabling Circular Economy & Resource Efficiency in Aluminium & Cement Sectors: Utilizing spent pot lining (SPL) and other waste products of Aluminium sector"

09 June 2023

Jawaharlal Nehru Aluminium Research Development & Design Centre, Nagpur

Aluminium-Cement Industry Collaboration Scenario



Subject: Action Plan for Circular Economy – Metal (ferrous and non-ferrous).

Madam / Sir,

NITI Aayog, vide O.M. dated 04.03.2021, constituted a Committee on Circular Economy: Scrap Metal (ferrous and non-ferrous) under the chairmanship of Additional Secretary, Ministry of Steel. The Committee has finalised the report / action plan and the same was shared with NITI Aayog.

Thereafter, NITI Aayog. Vide OM dated 09.11.2021, NITI Aayog has forwarded the Action Plan for Circular Economy with timelines for implementation. As per the action plan, various actions have been marked for Ministry of Mines. In this regard, Ministry of Mines has identified the organizations for implementation of the said action plan on the points pertaining to Ministry of Mines. The list of actions along with the implementing organization is attached in Annexure A, B and C.

You are requested to take necessary action and furnish your comments/action plan, by 31st December,2021 at the latest.

Encl: As above

Yours faithfully,

Action Plan - Status

Ref	Agency	Action	Work Done	Status
Annex – A; Item No: 1	MoEF&CC, MoM	**Zero waste management policy for Al, Cu, Pb & Zn**	Policy drafted- Primary	Submitted 08-06-2022
			Policy drafted - Secondary	Submitted 02-08-2022
Annex – A; Item No:4	MoEF&CC, MoM	**Guidelines for mandating** • **Red Mud utilisation in cement industry** • **Dry stacking of red mud**	Guidelines formulated	
Annex – A; Item No: 5	MoEF&CC, MoM	**Guidelines for mandating use of SPL** • **Cement industry** • **Captive Power Plant (CPP)**	Guidelines formulated	
Annex – A; Item No: 9	MoEF&CC, MoM, CPCB	**SOP and compliance to air pollution norms for recovery of Zn from EAF/IF dust of steel industry**	Policy drafted	

Draft Guidelines for Utilisation of Spent Pot Lining in Cement Industry

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Ministry of Mines

Draft Guidelines for Utilisation of Spent Pot Lining in Captive Power Plants of Aluminium Smelter

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Ministry of Mines

Ref	Action
Annex – A; Item No: 4 & 5	Guidelines for environmentally sound management of SPL: i. Mandating the use of SPL in the cement industry ii. Mandating the use of SPL in the CPP

Contents

2 BACKGROUND & **3** SOURCE OF WASTE

Waste	No of units generating waste	Annual waste generation
Spent Pot Line	7 smelters	1,20,000 tons

Utiliser industry details

The annual installed capacity of cement production**: 509 million tons**

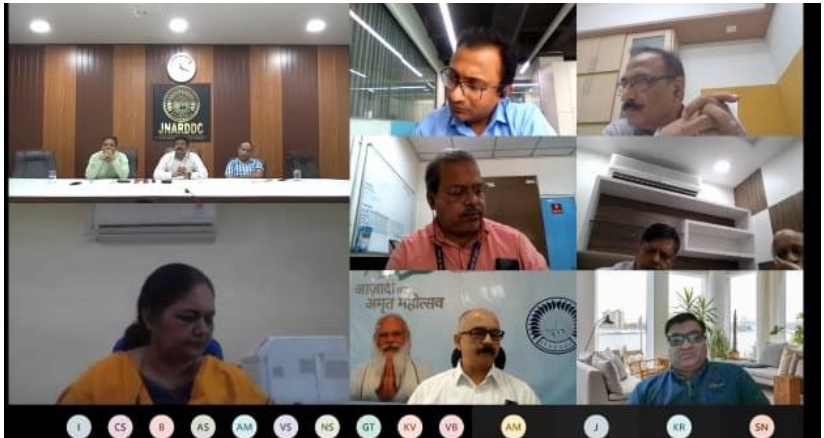
Cement production during FY21: **300 million tons**

143 integrated cement plants

102 grinding units

5 clinkerisation units

62 mini cement plants



5 MINIMUM PERCENTAGE UTILISATION & 6 TARGETS

Targets for SPL / Red mud utilisation in various potential applications

S No	Minimum Percentage utilisation of SPL	Target year from the date of issue of this notification
1	Preluding work	1st – 2nd
2	20	3rd
3	30	4th
4	40	5th
5	50	6th
6	60	7th
7	70	8th
8	80	9th
9	100	10th
	Legacy Waste	
1	25	5th
2	50	10th
3	100	15th

Minimum content of

- Red mud in cement: **0.5 - 3%** of total raw materials
- SPL in cement: **0.25% to 3 %** of total fuel requirement
- SPL in fuel: **0.5% to 3%** of total fuel requirement
- **or as optimized based on trials conducted by cement industries**

Aluminium Industries View

- SPL has F, Na & C, which are potentially valuable in industries
- F present is beneficial for reducing temperature of Clinker (fluxing) by ~100°C
- Due to large quantities of lime/Limestone, F(g) is scrubbed from kiln & fixed in clinker CaF_2.
- Na can benefit operating fuel with a high amount of S
- NH3 & CN present in SPL reduce Nitrous Oxide (NO_2) emissions from the cement kiln by ~1/3rd, and outcomes are non-hazardous, thereby falling in emission norms of Cement plants.

Treatment of SPL -Examples

- Rito Tinto Alcan –Saguenay , Quebec, Canada
  - Capacity 80,000 tons/year of SPL
  - Process based on treatment of SPL with water and acidic and basic solutions
  - Products: Carbon, CaF_2.....
- Alcoa –Gum Springs, Arizona, USA
  - SPL mixed with lime and calcium silicate and treated in a furnace at >700°C
  - Cyanides are destroyed, and fluorides bound in CaF_2
  - Product can be land filled at a hazardous waste site
- BEFESA –UK
  - Co-processing of SPL and salt cake from dross

Treatment of SPL -Examples

- U.S.-generated SPL was recycled up to 79% in cement kilns in 2010
- In 2009, 7449 tones of SPL were recycled in Australia, mostly in cement industry as AF

•Alcoa Worldwide Sustainability: Sustainability of Operations: Environmental: Emissions & Waste, 2012, http://www.alcoa.com/sustainability/en/info_page/operations_env_emissions .a sp, viewed on 1st March, 2012

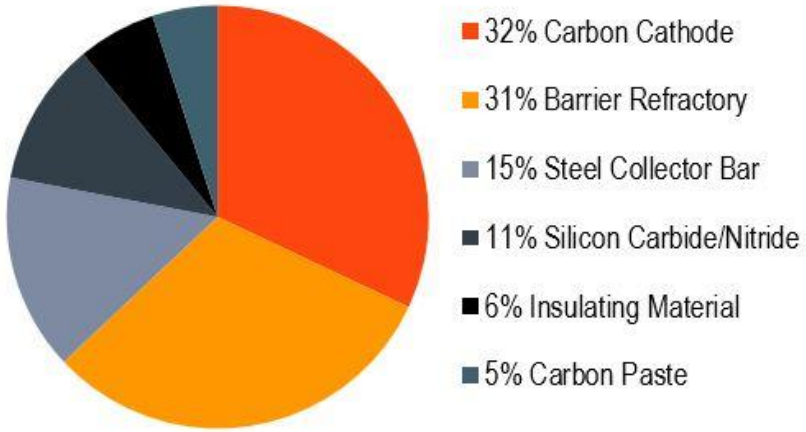
•Alcoa in Australia: Environmental Management: Waste, 2012, http://www.alcoa.com/australia/en/info_page/environ_waste.asp, viewed on 1st March, 2012

Cement Industries View

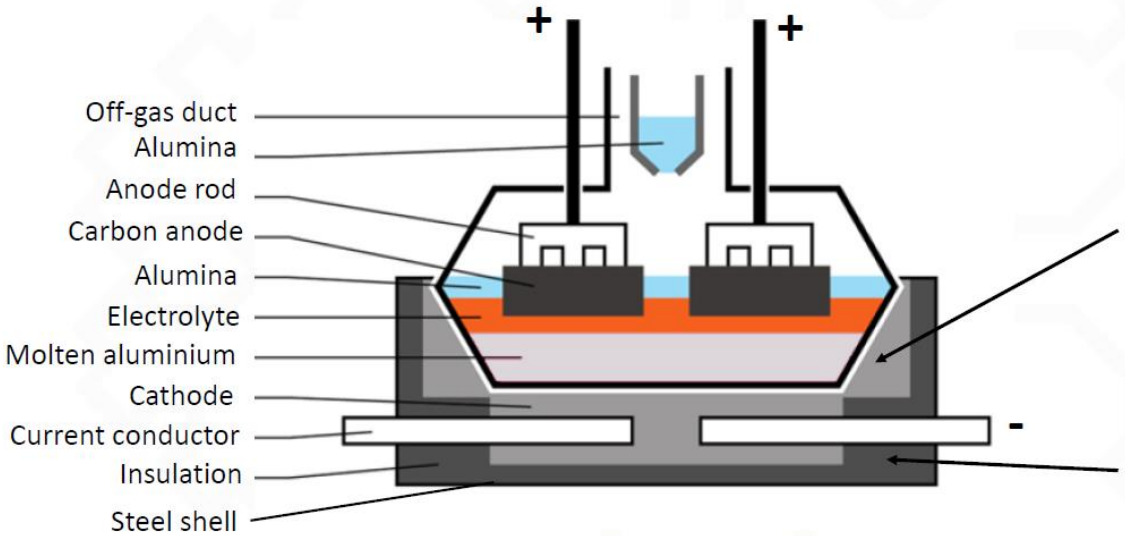
		JNARDDC View
1	**Sizing, Hardness & crushability: Very hard to crush and with Bond work index of 40-45 kWh/t [HGI 44 (As it is), 55 (wash)]**	Can be done. We are doing it at JNARDDC
2	**Variability (Homogenisation): Cement clinkering process is sensitive to small changes in the addition rate of F and Na.**	Desired composition can be achieved
3	**Process & maintenance impact: Abrasive, high & variable content of Na and F with high ignition temperature of carbon**	Can be established
4	**Willingness to pay for co-processing/proper disposal of SPL**	Unwillingness among the two
5	**Clearance from CPCB, lack of directives from regulatory authority , friendly disposal of SPL**	Can be taken up
6	**Waste quantification and national database on SPL**	Can be tabulated
7	**Safety & Transportation**	Non-issue

Origin of Spent Pot Linings (SPL)

Hazardous Waste from Aluminium Industry	Kg/ton of Aluminium
Spent Pot Linings	**20-30**
Dross (Primary)	15-30
Dross (Secondary)	80



Aluminium electrolysis cells renewed every 5 – 7 years



SPL

1st cut

2nd cut

Cut 1
Carbon Fraction

Cut 2
Refractory
Bricks

Typical SPL Composition

Major components (%)	First Cut SPL
SiO_2	1-8
Al_2O_3	8 - 20
Na_2O	10 - 15
CaO	1-3
C	54-66
F	6 - 12
Total Cyanide	100 - 1000 ppm
Leachable Cyanide	100 - 600 ppm

According to CPCB definition (2016) if any waste contains

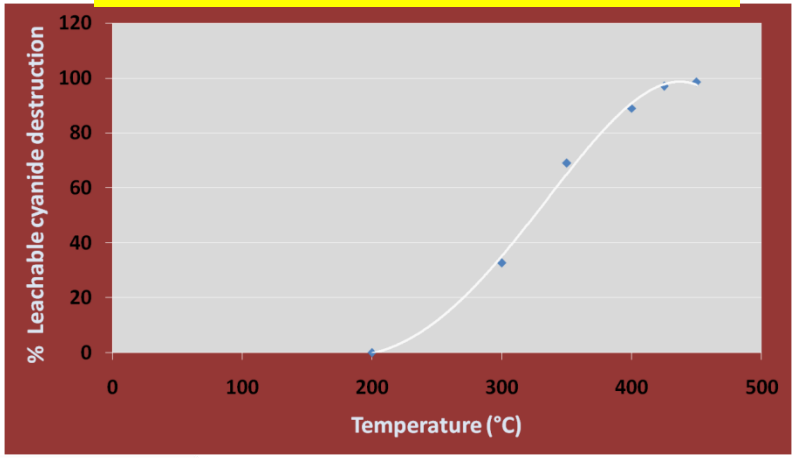
- ✓ leachable cyanide of more than 20 mg/lit (by TCLP method) and/or
- ✓ leachable fluoride of more than 180 mg/lit (by STLC method) is considered environmentally hazardous waste under the Class-A category and required safe handling.

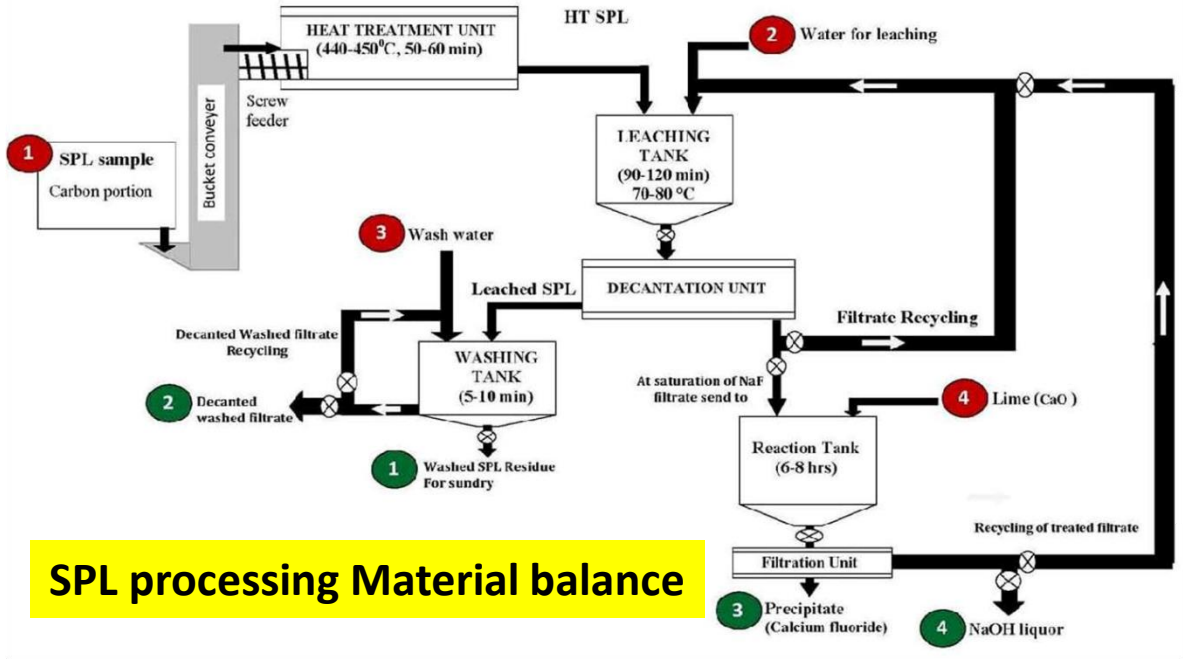
Sn	Component	1st cut carbonaceous(56%)	2nd cut Refractory(44 %)
1	Carbon	40 - 75	0 - 20
2	Total Fluoride (50-50)	10-20	4-10
3	Free Al_2O_3	0-15	10-50
4	Metallic Al	0 - 5	--
5	Calcium, CaO	0 - 6	0 - 8
6	Quartz, SiO_2	0-6	10-50
7	Phosphorus, P	0-650 g/t	0-300 g/t
8	Sulphur, S	<0.1	< 0.1
9	Total Sodium, Na (40-60)	5 - 15	1 - 5
10	Moisture	1 - 5	1 - 2
11	Total Cyanide, CN	0.01-0.5	0 – 0.01
12	Free Cyanide, CN	0 – 0.1	0 – 0.05

SPL Technology Developed by JNARDDC for NALCO /VEDANTA

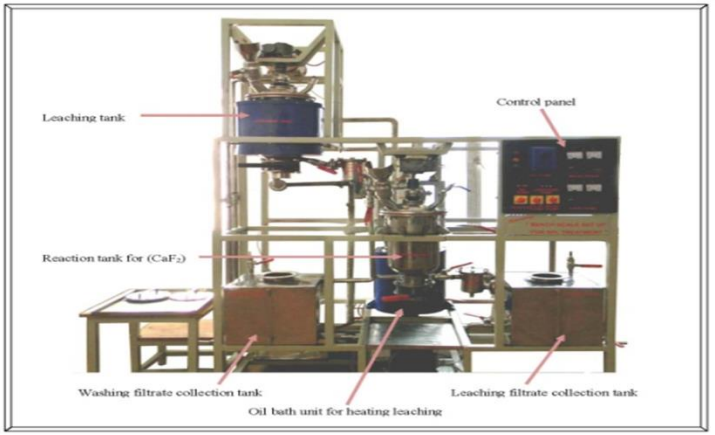
Electrically heated rotary tube furnace at JNARDDC

Heat Treatment of SPL





SPL processing Material balance



Bench Scale Unit at JNARDDC

Set up for 1st cut SPL treatment

(JNARDDC patented process)

Characteristics of Solid product (Carbon residue)

Composition of SPL material (Untreated SPL)

Elements/oxides	Composition
Carbon	70.14 %
Moisture	1.75 %
Crystalline water	1.05 %
Al2O3	8.34 %
SiO2	0.17 %
Fe2O3	0.80 %
CaO	0.72 %
Total CN^-	220.65 ppm
Leachable	118.60 ppm
Non-leachable	102.05 ppm
Total Na^+	9.52 ± 0.15 %
Leachable	4.26 %
Non-leachable	5.35 %
Total F^-	6.90 ± 0.38 %
Leachable	3.10 %
Non-leachable	4.22 %

Results of Treated SPL carbon product and untreated SPL

सीएसआईआर-केन्द्रीय खनन एवं ईंधन अनुसंधान संस्थान
नागपुर इकाई – II
(वैज्ञानिक तथा औद्योगिक अनुसंधान परिषद)
विज्ञान और प्रौद्योगिकी मंत्रालय, भारत सरकार

CSIR-CENTRAL INSTITUTE OF MINING & FUEL RESEARCH
NAGPUR UNIT - II
(Council of Scientific & Industrial Research)
Ministry of Science & Tech., Govt. of India

C S I R : CIMFR - AN ISO - 9001 : 2008 INSTITUTION

QP/RQA/F/15A

Statement of analysis in respect of **four (04)** samples received from **Jawaharlal Nehru Aluminium Research Development and Design Centre**,Amravati Road, Wadi, Nagpur.
Vide letter no. Nil Dt. 23.11.2015

Sr. No.	Party Sample No.	Weight In Gms.	On Air Dried Basis		
			Moist %	Ash %	GCV Kcal/kg
1.	Sample Code – 400(1) Res	60	0.5	20.6	6067
2.	Sample Code – 400(2) Res	60	0.5	21.0	6047
3.	Sample Code – 400(3) Res	53.3	0.5	20.1	6074
4.	Original	60	1.4	28.6	5283

Ref: IS 1350 Part I for Moist & Ash determination.
Part II for GCV

Sampling not done by C.I.M.F.R. Staff
This is not a certificate and cannot be produced in a court of law.

28/12/15

(Dr. S. P. Singh)
Sr. Principal Scientist &
Officer In-charge

Observations of
i. Untreated S neasurement.
ii. No remarka g the treated SPL analysis

Composition of treated carbon product after two wash

Elements/oxides	Composition
Carbon	81.21 %
Moisture	0.91 %
Al2O3	8.39 %
SiO2	0.2 %
Fe2O3	1.01 %
CaO	0.58 %
Total CN^-	80.56 ppm
Leachable	ND ppm
Non-leachable	80.56 ppm
Total Na^+	5.52 %
Leachable	0.05 %
Non-leachable	5.47 %
Total F^-	4.43 %
Leachable	0.03 %
Non-leachable	4.40 %

Criteria of SPL

- NO criteria for SPL as AF by Indian Cement industry
- Economics, availability, toxicity, volatiles, grindability, emissions
- Specific criteria to be defined for setting material AF
  - Energy …… ???
  - Sodium …….. ???
  - Fluoride…….. ???
  - Sulphur ……..???
  - *****-------?????
- Heavy metals ???
- Other properties for even fuel combustion
  - Particle size distribution
  - High and uniform calorific value
  - Free of detrimental contents like metals, glass, minerals
  - Moisture content

Conclusion

- No way to escape the utilisation of SPL with acceleration of CE & RE drives
- JNARDDC has technology for the same
- Cement industry must come out with their compositional requirement of SPL
- Profit sharing formula must be worked out between the Aluminium smelter and cement industry
- SPL is a hazardous waste material that can be transformed and safely re-used by the cement industry, resulting in a closed “industrial ecosystem”.

Thank You

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25 Years of Commendable Service to the Aluminium Industry
JNARDDC
Silver Jubilee Year
1989-2014

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Ministry of Mines
Government of India