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CASE BRIEF

Supreme Court on Air Pollution

THE CASE OF GREEN FIRECRACKERS

A Cautious Precautionary Approach?

Yogini Oke

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The Supreme Court of India has a stellar track record on environmental protection. It is credited with taking important steps to clean Delhi's air, protecting the Taj Mahal from industrial pollution, preserving forests and halting polluting activities in the Ganga. However, the life of environmental law exists beyond the courtroom and case books. While the recognition of important environmental principles as part of the law of the land is the first step towards environmental protection, we would be failing in our duty as environmental lawyers, activists and academics if we did not scrutinise the practical implementation of these principles. We must examine whether there is compliance with the Court's orders and directions, and if not, identify and address the reasons for this.

With this objective, the Vidhi Centre for Legal Policy has been tracking the implementation of five landmark judgments of the Supreme Court of India and the National Green Tribunal ('NGT') on environmental protection. These judgments span different geographical areas-the rivers of Uttarakhand, industrial areas in Telangana, Rhinoceros territory in Assam, and toxic air and landfills in Delhi. They also span different environmental issues-ecological threats posed by dams, efficacy of effluent treatment plants, wildlife conservation, air pollution, and waste management. Through a combination of field research, judgment analysis and interviews with petitioners, lawyers and other stakeholders, Vidhi has produced a set of five case briefs that provide a comprehensive overview of each of these judgments and their implementation on the ground. These briefs provide the legal background for each case, present the key facts, summarise the major orders and directions of the Supreme Court and NGT, and discuss the degree of success with which these have been implemented.

In focus in this case brief, is the judgment of the Supreme Court in Arjun Gopal v Union of India, a case which began as one on the various sources of air pollution in the Delhi NCR, but which ultimately focused on the adverse impact of firecrackers on air quality. The Supreme Court applied the precautionary principle to impose restrictions on the kinds of firecrackers that were permissible as well as at the time and period during which they could be burst.

Air Pollution in Delhi

The city of New Delhi, the capital city of India, has gained notoriety for being one of the most polluted places in the world. The situation is at its worst in the months between October to December, as winter sets in. Both human-made and natural factors result in this deterioration of air quality. Since 2016, Delhi's air quality has been making it annually to the headlines of national and international media.[1]

The Supreme Court of India ("**SC**") and the National Green Tribunal ("**NGT**") have both been very responsive to this issue. The SC's interventions through *MC Mehta versus Union of India*[2] and that of the NGT's in *Vardhaman Kaushik versus Union of India*[3] are landmark in terms of initiating institutional action on air pollution.

The Indian Institute of Technology- Kanpur's Comprehensive Study on Air Pollution and Green House Gases in Delhi, 2016,[4] points at six primary contributing sources to Air Pollution in Delhi and National capital Region ("**NCR**"). They are coal-fired power plants, vehicular pollution, burning of crop-residue, fly-ash emissions from ready-mix concrete batching plants, dust emissions from construction sites, and burning of municipal solid waste.

However, one of the epochal points in the 'pollution season' of North India, and of New Delhi is Diwali night. From this night onwards, it is a race towards the bottom in terms of air quality in Delhi. With toxicity already looming heavy in Delhi's still air from other sources, the bursting of firecrackers further deteriorates the air, and the respiratory health of the citizens of Delhi. Albeit dramatic, these assertions are scientifically supported by the CPCB's reports monitoring air quality in Delhi on pre- and post-Diwali nights.[5]

'Poor', or 'hazardous' air-quality,[6] as is found in Delhi on some days in winter, can have harmful impacts on human health. World Health Organization (**"WHO"**) documents the link between poor air quality and heart disease, stroke, chronic obstructive pulmonary disease, lung cancer, and acute respiratory infections in children.[7] Despite this evidence, the idea of firecrackers as a source of pollution and correspondingly, any action to curb it invokes a sentimental reaction. This is primarily due to the significance of bursting firecrackers on certain festivals, especially Diwali, and the fact that there is no scientific evidence to prove that firecrackers are more harmful than other sources of air pollution.

Against this background, three toddlers, Arjun Gopal, Aarav Bhandari, and Zoya Rao Bhasin, moved the SC of India, with their parents acting on their behalf. In their petition in *Arjun Gopal versus Union of India*[8] (***"the firecrackers case"***) the petitioners sought relief against various sources of air pollution, one amongst them being firecrackers.

The SC utilized the 'Precautionary Principle' in this case. According to this principle, scientific uncertainty should not be a reason for preventing action that may cause environmental harm. Reliance on principles of international environmental law and the procedural flexibilities[9] of 'Public Interest Litigation' have allowed the Indian courts to develop a unique jurisprudence in the area of international environmental law. In this case brief, we will attempt to see how such jurisprudence affects the '*implementability*' of the orders of the court. We intend to examine how directions and orders of the SC perform, when put into force on the ground in the context of the *firecrackers case*.

A child in New Delhi holding a phuljhari on the eve of Diwali in 2019

Arjun Gopal versus Union of India: A Brief of Facts

Parties to the Case

Initially, in the *firecrackers case*, the petitioners mentioned above had simply filed a 'Public Interest Litigation' where the Union of India was enlisted as the respondent. However, as the litigation coursed through the years, the number of interim applications to seek relief through intervenors significantly multiplied. The current number of respondents stands at a staggering 113. While some of these were intervenors, the current number of respondents also accounts for the executive bodies and scientific institutions who were impleaded in the matter through various orders.

Broadly, two groups of petitioners intervened in this matter. While the first category is made of those seeking to regulate firecrackers in some form due to their adverse impact on public health (children, doctors, animal-rights activists, affected citizens), the second category consists of those whose livelihoods are at risk in the event of such regulation (manufacturers and sellers of firecrackers). Also, a group called the Indic Collective advocating that the bursting of firecrackers is a religious activity, intervened in this matter. (*See Annexure I*)

Nature of Orders

In the *firecrackers case*, the SC gave a plethora of orders, adopting a range of regulatory approaches. While the SC initially imposed a blanket ban on the sale of firecrackers (*see Annexure I*), its latter orders favour a graded regulation approach. Through its subsequent orders, the SC sought to impose restrictions on what kind of firecrackers can be sold, and at what time they may be combusted. A brief summary of important orders is laid down in *Annexure II*.

Balancing the Right to Livelihood with a Right to Breath Clean Air

Due to the nature of the intervenors and interventions in the *firecrackers case*, the SC was confronted with a rather difficult choice.

The SC recognized that it had the dual responsibility of ensuring the right to health, and the citizen's right to breathe clean air under Article 21 in its order dated September 12, 2017. Citing the 'precautionary principle' it stated that the burden of proof of proving that a certain activity is not harmful, lies with the polluter. However, it commented that it had to balance these rights with its duty to protect the fundamental right

to livelihood and the right to engage in any business/ trade/ occupation guaranteed under Article 19 (1) (g) of the constitution. It further stated that it could only espouse an action that could be considered as a 'reasonable restriction' under Article 19 (1) (g). What do the courts do when faced with balancing constitutionally equivalent fundamental rights? The courts attempt to 'harmonize' the contents of these rights[10] using 'balancing measures' or 'neutralizing devices.[11]

In the *firecrackers case*, the introduction of 'green crackers' could be considered such a balancing measure. We will be looking at this concept of a 'balancing measure' or 'neutralizing device' later in this brief.

Development of Green Crackers

In an order dated August 14, 2018, the SC asked the Union of India to deal with the problems and issues concerning air pollution caused by bursting of firecrackers in Diwali. The Ministry of Environment, Forest & Climate Change (**"MoEFCC"**) consulted with i) National Environmental Engineering Research Institute. (**"NEERI"**), (ii) The Petroleum and Explosives Safety Organization (**"PESO"**), and (iii) Central Pollution Control Board (**"CPCB"**) regarding concrete solutions and short-term measures to be adopted to tackle the pollution problem that occurs due to firecrackers during Diwali. Based on suggestions from these organizations, the MoEFCC recommended the use of improved[12] and reduced[13] emission Firecrackers. (*See Annexure III*)

On 23rd October 2018, the SC ordered that only reduced and improved emission firecrackers may be manufactured and sold in the market.

A Memorandum of Understanding (**"MoU"**) between NEERI and firecracker manufacturers was signed, through which the technology of manufacturing 'new' and 'improved' variety crackers was transferred to the manufacturers. Subsequently on 26th November 2019 the SC passed an order regarding the setting up of 'quality control units' by manufacturers to ensure that the variants of crackers made by them are in accordance with prescribed formulations.

The SC on 3rd March 2020, took into notice Adv. Gopal Sankarnarayanan's (advocate for the petitioner) averment that certain manufacturers were manufacturing firecrackers using material whose usage in such manufacture had been banned by the SC. The averment further brought to the court's notice, the labelling of crackers contrary to the court's direction. The SC observed that if such allegations were true then the respondent-manufacturers would be guilty of contempt of the court's orders, and asked the Central Bureau of Investigation (**"CBI"**), Chennai to make detailed investigations into the violations.

The entire exercise of manufacture of green crackers was initiated because the SC cited the 'precautionary principle' and the 'right to breathe clean air'. As is evident from the description

above, the implementation of the SC's orders in this case has been on rocky terrain, with the court having to step in, first to ensure that manufacturers maintain quality control, and second to order the CBI to investigate the breach of its orders. In the next part of this brief, we will examine how the 'precautionary principle' has evolved in India, and how its evolution, and the procedural flexibility allowed in Public Interest Litigation affects the implementation of orders in the firecrackers case.

Only green firecrackers were allowed to be sold in Delhi through licensed vendors. According to firecracker sellers in Chandni Chowk, their business was affected due to the limited variety of 'green' firecrackers available in the market.

Understanding the Precautionary Principle

The Precautionary Principle in the International Context

Amongst International Conventions, the precautionary principle first found reflection in the 1982 World Charter for Nature. Later, it found expression in the 1992 Framework Convention on Climate Change, 1992 Convention on Biological Diversity, 1995 Fish Stocks Agreement, 2000 Biosafety Protocol, and 2001 Persistent Organic Pollutants Convention.

Even as there are many versions and definitions of the precautionary principle, the Rio Declaration definition of the Precautionary Principle is the most cited. The Rio Declaration provides:

> "*In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.*

Interpretation of the Precautionary Principle by the Indian Supreme Court

The precautionary principle was first established in India in *Vellore Citizens Welfare Forum versus Union of India* ("***the Vellore case***"). In the *Vellore case*, the SC identified three elements to the precautionary principle:

> "*1) Environment measures - by the State Government and the statutory Authorities must anticipate, prevent' and attack the causes of environmental degradation*
>
> *2) Where there are threats of serious and irreversible damage lack of scientific certainly should not be used as the reason for postponing, measures to prevent environmental depredation*
>
> *3) The "Onus of proof" is on the actor or the developer/industrial to show that his action is environmentally benign.*"

The SC relied on *Vellore case's* interpretation of the precautionary principle *in A.P Pollution Control Board versus Prof. M.V. Nayudu*[14] and *A.P Pollution Control Board II versus Prof. M.V. Nayudu*[15] (**"*APPCB I & II*"**). In these cases, the SC considered whether a hazardous industry should be permitted to establish itself within 10 km of reservoirs used for drinking water. In

relation to this decision, the SC utilized the precautionary principle for two purposes. First, the precautionary principle was used to emphasize the need for scientific inputs before adjudicating complicated issues of pollution to the environment. Secondly, the SC applied the principle in this case to establish that if during an activity, environmental harm may be caused due to the occurrence of an accident, then such activity ought to be curtailed prior to the occurrence of such an accident.

Difficulties in Judicial Implementation of the Precautionary Principle and Balancing of Rights

In India, the idea of 'precaution' or 'prevention' of environmental harms has found a place in the regulatory framework, such as Section 3 of the Environment (Protection) Act, 1986.[16] As far as the precautionary principle is concerned, it finds mention in section 20 of The National Green Tribunal Act, 2010, where it is listed amongst principles that the Tribunal shall rely on while passing orders and judgments. Given this scant legislative reference to the precautionary principle, the SC's interpretation of it in the *Vellore case*, and its subsequent judicial interpretations have been crucial in how the principle has shaped up.

Even as the precautionary principle has been used by the courts' as a tool to protect the environment, and public health of citizens, a lack of consistency in its normative framework, as well as its application has been pointed out by environmental law scholars.

For instance, Lavanya Rajamani critiques the judicial application of the precautionary principle in India for the lack of clarity as to the degree of risk that triggers the application of the precautionary principle, specific actions to be taken in response, the roles that costs play in assessing the degree of risks and the burden of proof to be fulfilled by the polluter. Similarly, Geetanjoy Sahu[17] in his article criticizes the non-uniform application of the precautionary principle in certain cases of large dams causing environmental destruction, where the principle has not been used.

Even as inconsistencies in the judicial application of the precautionary principle are critiqued, it is necessary to acknowledge that such a principle is not applied in isolation, but simultaneously with balancing the rights of other stakeholders. Earlier, we have pointed out that the court allowed the manufacture, sale, and bursting of 'green crackers', as a 'neutralizing device' or a 'balancing measure'.

To reiterate, a 'neutralizing device' or a 'balancing measure' is a court decision where the court attempts to harmonize two conflicting, but equivalent fundamental rights. While it has been acknowledged that there cannot be a one-size-fit-all formula in applying such a device, a general set of principles can be derived from *Sahara India Corporation versus SEBI*.[18] Even as Courts very often

engage in balancing equivalent rights, especially in the application of precautionary principle, no normative requirements of how such rights may be balanced are laid down.

Considering that the SC has the responsibility to protect the fundamental right to environment under the fundamental right to life under Article 21, the exercise of the precautionary principle very often pitches the 'right to health and environment' against the 'right to livelihood' and the 'right to freedom of trade and occupation'. In such a situation, where the courts are a balancing arbiter, clarity and consistency in how the courts may balance such rights, is perhaps as important as it is with respect to the normative and procedural application of the 'precautionary principle'.

Implementation of orders in the Firecrackers case

In order to understand the implementation of orders of the SC in the *firecrackers case*, it may be useful to examine it through various points in the supply chain of firecrackers, such as their sale, manufacture and usage.

A. Sale

We attempted to examine the implementation of orders in the *firecrackers case* by visiting the Sadar Bazar in Old Delhi. The Sadar Bazar, which is the wholesale hub of firecrackers in Delhi was without much activity a week prior to the Diwali of 2019. The authorised sellers of firecrackers were selling only green crackers. Preliminarily, this appeared to be a success, as far as the regulation of sale of firecrackers is considered.

However, an India Today reporter who went undercover for the investigation reported that 'non-green' firecrackers were sold through a black-market, in bulk. The undercover reporter also found that the sellers of such firecrackers through the black market were selling normal crackers as green crackers. At yet another site, the undercover reporter discovered that non-green firecrackers were being sold by a licensed shopkeeper who had acquired the license to sell only green firecrackers. The shopkeeper was selling 'non-green firecrackers' by labelling them 'green firecrackers.[19]

We ourselves experienced non-green crackers being sold as 'green crackers. Prior to Diwali, on Dussehra, we tried to find out if the crackers stuffed in various Ravana effigies are 'green'. In one of our field visits to a Ravana burning site, we were told that the Ravana effigy is stuffed with 'green-cracker' bombs. However, this couldn't have been true considering that NEERI has no approved formulations for 'bombs' at all. Till that time, the formulation was approved only for green '*phuljharis*' and '*anars*'.

B. *Manufacture*

The initial process of production of green crackers was done, exclusively, pursuant to the signing of an MoU between firecracker manufacturers and NEERI. Soma Basu, a veteran journalist from Tamil Nadu communicated to us that it was likely that many smaller manufacturers of firecrackers were left out of the process of entering into an agreement with PESO. Additionally, no details of the MoU, or any new licensing conditions are available on the PESO website.

With many livelihoods dependent on firecracker manufacturing in Sivakasi, orders relating to manufacture of green crackers may have caused some confusion on the ground. One distinguishing factor between green crackers and regular firecrackers is the absence of Barium compounds in the former. Smaller manufacturers in Sivakasi may have misinterpreted the orders, in the absence of additional information, to mean that any crackers without Barium compounds are green firecrackers. In an on-ground investigation in Sivakasi, we found out that some smaller manufacturers who were not a part of the companies who signed the MoU with PESO, continued to manufacture firecrackers without Barium Salts and Barium Nitrate (substances prohibited by the SC).

Firecracker sellers in Sivakasi spoke about the need to effectively educate people in this region about the green crackers, how they are to be manufactured etc. for effective implementation of the SC's order.

C. *Role of the Police*

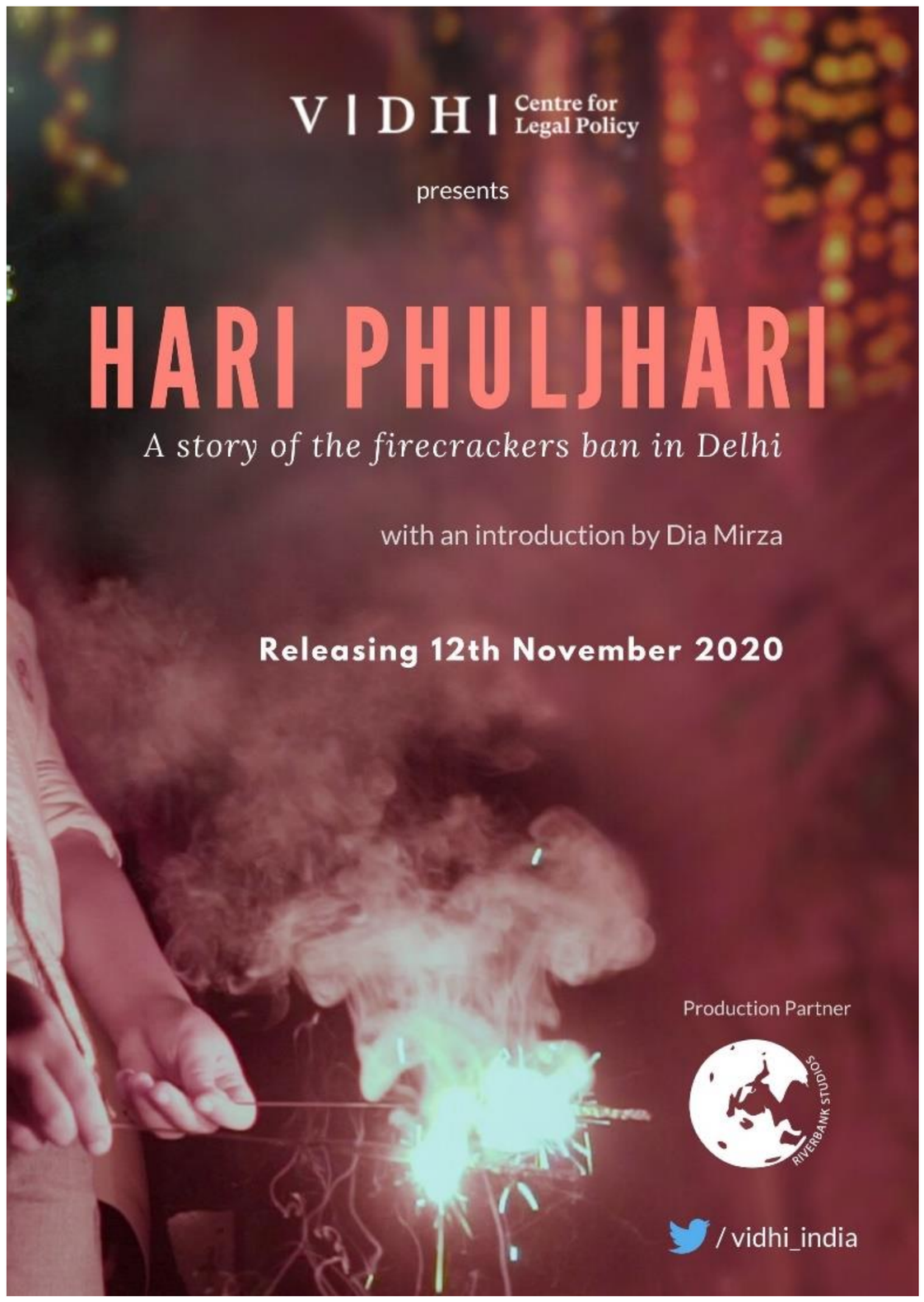
In accordance with the SC orders, only those manufacturers whose formulations were approved by PESO could produce two varieties of green crackers: *phuljharis* and *anars*. These crackers would only be allowed to be burst between 8 pm and 10 pm. However, these directions were not followed strictly as per news reports and our observations, within the Delhi region.

A journalist with *The Hindu* has already attempted to understand the reasons for the low sale of 'green firecrackers' for Diwali.[20] His answers include a range of factors, such as lack of variety, shortage of green crackers and difficulties in identifying green crackers by the police. Even as green crackers are supposed to have a specific QR code to identify them as such, the police report difficulties in identifying them without any advanced security features or lacking any high-quality-hologram.[21]

According to the SC verdict, SHOs of different areas were responsible for implementing various orders of the SC, in the *firecrackers case*. Sources from Delhi Police and their licensing unit spoke about the immense capacity strain that the SC orders in the *firecrackers case* place on an overworked police force, primarily in charge of maintaining law and order.

Conclusion

One of the reasons for choosing *the firecrackers case* as the subject of this brief is that even if it has a relatively limited ambit, it grants us a microcosmic view of a public interest litigation taken up for an environmental cause. It provides us a birds' eye view of how creative balancing measures used by the courts, the phenomenon that is continuing mandamus, and the application of broad environmental law principles interplay with each other to grant us and the petitioners, orders which perhaps surpass the courts' ability of supervision. As is the current case, in such cases, the petitioner herself must take upon the mantle of supervising implementation of the Courts' orders. The latest order in this case, ordering the CBI's intervention in monitoring the implementation of this order in Tamil Nadu, came only after Advocate Gopal Sankarnarayanan, the petitioner's father intervened on his behalf. On whose shoulders must the burden of implementation lie, the petitioner, the executive, or the court itself?



Hari Phuljhari is a film produced by Vidhi Centre for Legal Policy which tracks the implementation of the firecracker case around the Diwali of 2019. It is part of five films produced in association with Riverbank Studios on the implementation of environmental judgments.

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11. ibid, Khamroi.
12. See Order dated 23 October 2018 in Arjun Gopal versus Union of India 2016 SCC OnLine SC 1382
13. ibid.
14. A.P Pollution Control Board versus Prof. M.V. Nayudu (1999) 2 SCC 718).
15. A.P Pollution Control Board II versus Prof. M.V. Nayudu (2001) 2 SCC 62 140.
16. Section 3, The Environment Protection Act, 1986 states that "Subject to the provisions of this Act, the Central Government, shall have the power to take all such measures as it deems necessary or expedient for the purpose of protecting and improving the quality of the environment and preventing controlling and abating environmental pollution."
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Annexure I

Indic Collective Trusts' representation

1. The Indic Collective Trust (ICT) first moved an intervention application in 2017 in Writ Petition, W.P. (C) No.728 of 2015, seeking recall and/or modification of the order dated October 9, 2017 passed in I.A. No. 96202/2017 and restoration of the order dated September 12, 2017 passed in I.A. No. 52448/2017. The Application was moved by the ICT on the ground that the Order of October 2017 restored the ban originally directed by the Hon'ble Court in its Order dated November 11, 2016 and that such a ban was a severe and serious infraction of the cultural and religious rights of Indic communities not only in Delhi and the National Capital Region, but also across the country. It was the ICT's position that although the Order of September 12, 2017 itself was amenable to challenge, it struck a much more reasonable balance between the grievance of the Petitioner and the rights of those who were not for a blanket ban on firecrackers, compared to the Orders of November 11, 2016 and October 9, 2017;

2. It was also submitted to the Hon'ble Court that the Writ Petitioner had placed no new scientific material which warranted the restoration of the Order of November 2016 in October 2017. Critically, in imposing the blanket ban, the Court had failed to even consider, let alone analyze, the cultural and religious rights of a host of communities. The root of the problem was traced by the ICT to the *Noise Pollution* Judgement's approach to the nexus between Diwali and bursting of firecrackers, in particular Paragraphs 156-157 of the said judgment, wherein the Hon'ble Court proceeded to summarily hold that there was no nexus between the celebration of the festival of Diwali and the use of fireworks;

3. While the ICT does agree with sound limits being put on firecrackers, it is of the view that the Apex Court ought to have referred to authoritative texts before arriving at such a conclusion given that it has had far-reaching consequences on the public's perception of Diwali. In fact, the nexus appears to have been peremptorily denied merely because the submission was made on behalf of manufacturers of fireworks, which was no reason to deny the nexus given that the issue affects the rights of millions of members of Indic communities who are entitled to celebrate Diwali in accordance with their religious practices under Article 25(1). Simply stated, the *Noise Pollution* judgement's finding vis-à-vis absence of a nexus between fireworks and celebration of Diwali and its variants have been accepted as conclusive by Governments and this has resulted in circulars and campaigns which create and further negative stereotypes of Diwali. To demonstrate that the bursting of fireworks qualifies as an essential religious practice, reliance was placed on the following texts:

    I. Extracts from Kartika Mahatmya of Hari Bhakti Vilasa
    II. Extracts from Smriti Kaustubha of Anant Deva, edited by Wasudev Laxman Sastri Pansikar
    III. Extracts from Festivals, Sports and Pastimes of India by Dr. V. Raghavan, Vachaspati, Professor of Sanskrit, University of Madras
    IV. Extracts from History of Fireworks in India between A.D 1490 and 1900 by P.K.Gode
    V. Extracts from Studies in Indian Cultural History, Volume 2, P.K.Gode
    VI. Extracts from The Cultural Heritage of India, Volume IV by The Institute of Culture of The Ramakrishna Mission
    VII. Extracts from Concise Encyclopaedia of India by K.R.Gupta and Amita Gupta

    On the basis of the above texts, it was argued that the *Noise Pollution* judgement is a fit case for reference to a Constitution Bench under Article 145(3) since the Judgement had dismissed the existence of a nexus between Diwali and firecrackers in mere eight lines.

4. It was also argued that in the judgements dated September 12, 2017 and October 9, 2017 the Hon'ble Court itself had recognized that there are multiple factors which cause pollution in the National Capital Region, with use of fireworks being but one of them, and which admittedly was not the biggest contributor. In fact, crop burning was identified as the biggest contributor around the Diwali season. Therefore, the ICT expressed its objection to the entire exercise of addressing pollution in the National Capital Territory being limited to a discussion relating to fireworks and that too only with respect to the celebration of

Diwali without there being even a remote discussion on the rights of Indic communities under Article 25(1). It was pointed out that in the judgement of September 12, 2017, in Paragraph 51, the Hon'ble Court itself had observed that the extent of air pollution caused by bursting fireworks was not clear in the absence of empirical data;

5. It was also argued with respect to the application of the precautionary principle in such cases, that the shift from the Assimilative Capacity rule to Precautionary Principle in environmental jurisprudence is largely a consequence of rise of uncertainty as an essential aspect of environmental policy making. In other words, in situations where existing scientific tools are incapable of drawing a correlation between a certain activity and its effects on environment, erring on the side of caution would be the norm under the Precautionary Principle. However, it has been no one's case that there exist no scientific tools or methodologies which are adequate to establish a correlation between the use of fireworks during Diwali and air pollution. Therefore, it was argued that there was no reason for the application of the Precautionary Principle. Until a comprehensive scientific study is commissioned with the necessary inputs and the study throws up results which are inconclusive, there is no basis in facts and in law to invoke and apply the Precautionary Principle.

6. It was argued that the Precautionary Principle cannot be invoked arbitrarily by taking an alarmist position which does not in any manner address the year-round high average baseline/datum of pollution in the NCR and by limiting the enquiry to a specific occasion and a specific cause which admittedly is neither the sole nor the biggest cause of pollution either during the time of Diwali or the rest of the year. Surely, it cannot be anybody's case that the right to breathe pollution-free air comes alive only on the festive occasion of Diwali and remains buried under the smoggy and hazy layers of pollution in NCR for the rest of the year. The above arguments received a single para treatment in the Judgement of October 23, 2018. Subsequently, the ICT filed a separate Writ Petition raising the above arguments citing the above literature in additional to placing the material discussed hereinbelow;

7. In the ICT's Writ Petition, it was further submitted that since the ostensible object of imposing restrictions on the use of fireworks was to give effect to the right to breathe pollution-free air, presumably not just during Diwali, the scope of the enquiry with respect to pollution must necessarily be expanded so that meaningful measures may be taken to address the various causes of pollution. After all, a holistic approach to tackling pollution too is the mandate of environmental jurisprudence especially when there is consensus that (a) there is no one because which is solely responsible for pollution and (b) use of fireworks is certainly not the sole or primary cause. In this regard, reliance was placed on the 2018 Report on air pollution in the NCR, prepared by the Parliamentary Standing Committee on Science & Technology, Environment & Forests. Para 1.7 of the said Report contains a table which captures the various sources of pollution in the NCR during summer and winter seasons. What is pertinent to note is that use of firecrackers is not one of them. The portions of the Report which deal with firecrackers are Paragraphs 9.1-9.3, which are extracted below:

> *9.1 As has already been brought out in the report, since the last few years, the quality of air nosedives in Delhi and NCR with the onset of winters, the situation further deteriorates every year after Diwali when the quality of air goes from worse to worst. The situation was such during the last few years that Delhi was sheeted in a toxic smog that forced the closure of schools, power stations, construction sites, etc. As a result of this, in June 2017, the Supreme Court banned the sale of firecrackers in Delhi during the upcoming Diwali festival in an effort to prevent the usual spike in toxic air pollution levels that follow the festival.*
>
> *9.2 The Committee further observes that each year during Diwali, cheap firecrackers are burst, often manufactured using toxic chemicals, turning Delhi in to a 'Gas Chamber'. The Hon'ble Supreme Court in the year 2017 has directed to suspend and not renew the licences for possessing, stocking and selling of fire crackers in Delhi. The Committee appreciates the efforts made by the Central Government and the Government of NCT of Delhi in this direction in the form of banning the import of Chinese crackers and confiscating the available stocks.*
>
> *9.3 The Committee, however, feels that much more needs to be done in this regard. The Committee, therefore, recommends that the Central Government in consultation with the concerned State Governments should chalk out a mechanism whereby the cracker manufacturers are allowed to manufacture only low polluting crackers. The Committee also recommends that the Central Government*

should also consider issuing firm guidelines with regard to the chemicals to be used in crackers by the manufacturers for minimising their adverse impact on the environment and human health.

8. It was pointed out that according to the Report, firecrackers do not turn the quality of air from good to worst, but worse to worst. This supports the ICT's position that the high average of baseline pollution, which the Report refers to as "worse" especially during winters, should be addressed first in a holistic manner instead of adopting a narrow piecemeal approach which limits the scope of such a critical enquiry only to the use of fireworks during Diwali. Further, the Report recommends banning of import of Chinese firecrackers and use of low polluting crackers but does not recommend blanket ban on firecrackers. In addition to the above, the ICT placed reliance on research publications authored by Dr. Hiren T. Jethva and his team which shed light on the effect of crop burning on the pollution levels in the NCR. Dr. Jethva is a Research Scientist with the Universities Space Research Association (USRA) and the Goddard Space Flight Center of the National Aeronautics and Space Administration (NASA), USA. In a research paper published in 2018 and titled "*Agricultural Burning and Air Quality over Northern India: A Synergistic Analysis using NASA's A-train Satellite Data and Ground Measurements*", *Dr. Jethva and his team have concluded as follows:*

> *"Scientific significance, societal relevance, and relationships to future missions: The traditional practice of crop residue burning post-harvest over northwestern India causes hazardous levels air pollution over the populous northern India. In addition to its climatic impacts, extreme levels of particulate matter and trace gases emitted from crop fires during post-monsoon poses a serious threat to the human health of millions living in the region. While the increasing amounts of crop production ensure nation's food security, the lack of an effective crop residue management system has led farmers resorting to burning the waste that has played a major role in deteriorating regional air quality during post-monsoon. Willingness and partnership between the government and the agricultural sector is crucial for the adoption and enforcement of the viable alternatives to burning. Owing to its long-term record, NASA's A-train satellites have helped in tracking the temporal evolution of fires and resulting aerosol amounts over the region making possible to quantify the trends and spatial patterns. Currently in-orbit VIIRS instrument on board NASA-NOAA joint satellite mission Suomi-NPP will continue the record of fires and aerosol detection at higher spatial resolution."*

It is evident from the Report that crop-burning post-monsoon contributes significantly to deterioration in air quality and increase in particulate matter. Based on his analysis, Dr. Jethva concluded that the increase in PM2.5 levels around the Diwali festive period coincides with crop burning in Punjab and Haryana which affects not just the NCR, but the entire Indo-Gangetic Plain.

9. In a research paper titled "Short-term degradation of air quality during major firework events in Delhi, India" authored by Shivani et al in April 2018, following were the observations of the study as captured in the abstract:

> *"The effect of firework events on air quality was assessed from ambient fine particulate matter (PM2.5) collected during the Diwali period in two consecutive years, i.e., November 2015 and October 2016. The extensive firework activities led to the short-term degradation of air quality during the Diwali days. PM2.5 samples were chemically characterised for elements, water-soluble ionic species, organic carbon (OC) and elemental carbon (EC). Ba, K, Sr, S, Mg and Na showed significant increases in concentration on Diwali days compared to pre-Diwali days which revealed their association with firecrackers. Concentration of SO4 2−, NO3 −, Cl−, K+ and NH4 + ions contributed to the increases in PM2.5 concentration on Diwali days. Higher OC/EC ratios indicated the formation of secondary organic carbon during the Diwali period. This study concludes that the high PM2.5 level during Diwali 2016 was a result of contribution from fireworks on the Diwali night, trans-regional movement of pollutants due to crop residue burning, low wind speed (0.15 m s−1), and high humidity. It was observed that short-term exposure to Diwali is plausible to generate 1.3% increase in non-carcinogenic hazard index due to elements Al and Ba during Diwali 2016, whereas no significant variation was observed for the carcinogenic risk due to Pb. However, in 2015, the increase in non-carcinogenic hazard index was appreciably lower as compared to 2016."*

It is clear from the above that the effect of crop residue burning around the Diwali period has a significant and adverse bearing on the air quality in NCR which cannot be lost of sight of. Therefore, it was contended by ICT that a scientific discussion which calls for nuance and a holistic approach cannot be reduced to a

Diwali-centric discussion if the object is to find a viable lasting solution for year-round air quality woes in NCR.

10. It was further submitted that by making Diwali the focal point of the discussion on the issue of air pollution especially in schools, without addressing the year-round causes which have contributed to increase in the baseline of pollution in NCR, Government Circulars and campaigns have effectively led to creating a negative perception about the festival of Diwali, which has a bearing on the rights of Indic communities under Article 25(1) since such a lopsided discussion has stigmatized the celebration of Diwali. Critically, it was argued that such an approach does not help the discourse surrounding pollution either since the goal must be to create constructive awareness relating to all causes of pollution, especially those which are not seasonal but are prevalent all through the year;

11. It was argued that the exercise of rights under Article 25(1) is contingent on the availability of fireworks and therefore if its use itself is actively stigmatized, it will result in completely defeating rights under Article 25(1). This is akin to defeating the right of a reader to consume published information, through a state-sponsored campaign which stigmatizes the book. Therefore, for good or bad, the rights invoked by Indic communities under Article 25(1) are tied to the rights of manufacturers under Article 19(1)(g). This, by itself, cannot dilute rights under Article 25(1). It was also argued that the legal framework that applies to manufacture, distribution, sale of fireworks would reveal that the industry is heavily regulated in all aspects by Acts, Rules, Notifications and Judgements. Enumerated below in brief are the Acts, Rules, Notifications and Judgements which apply to the industry:

    A. Explosives Act, 1884
    B. Explosives Rules, 2008
    C. Noise Pollution Regulation and Control Rules, 2000
    D. The Factories Act, 1948
    E. Environment Protection Rules, 1986
    F. Notification No. D-18018/05/2007-08/Plan/SVK/PESO, dated 7th March 2008 to implement the *Noise Pollution* judgement regulating manufacture of firecrackers generating noise level exceeding 125 decibels.

    Clearly, the fireworks industry is a regulated one and the scope of regulation has progressively increased. In view of this, it is possible to regulate it further not just with respect to its manufacture, but also its use by consumers through the following measures which have been recommended in several scholarly publications such as "*Ambient Air Quality during Diwali Festival over Kolkata – A Mega-City in India*" Chatterjee et al., Aerosol and Air Quality Research, 13: 1133–1144, 201:

    I. Promotion of firecracker display as a community entertainment
    II. Prohibition of firecracker burning on roads/lanes and earmarking of large open spaces, away from residential areas, for firecracker display
    III. Crackers, exploding at a higher elevation (higher than the normal skyline of the locality) may be encouraged for a better dispersion.

1. The ICT also placed before the Court regulations which are in force in the UK and in the EU with respect to manufacture, sale and use of fireworks. By adopting such regulations and by mandating the use of low polluting chemicals, it is certainly possible to strike a balance between the right to breathe pollution-free air under Article 21, the right to celebrate Diwali in accordance with Indic faiths and traditions under Article 25(1) and the right of the fireworks industry under Article 19(1)(g) to which are tied to the rights under Article 25(1). A campaign which actively promotes a "no firecracker Diwali" would only prove that the system has proven itself incapable of regulation through proper enforcement and is therefore resorting to an undesirable alternative. If such a precedent were to be set, it would pave the way for discouraging and banning several activities which the Executive has failed to strictly regulate. For instance, since the meat industry and the leather industry are admittedly the biggest causes of pollution of the River Ganga, people must be dissuaded by the State from eating meat or using leather. Clearly, stigmatizing or banning an activity, which is amenable to regulation, is no solution since it only reflects poorly on the competence of the enforcement infrastructure. What is called for is a balanced approach to the legitimate rights of all stakeholders and a holistic approach to the issue of pollution. Unfortunately, the ICT's Petition was dismissed by the Court. As on date, there is no clarity on what are "Green Crackers" and a thriving industry which generated close to INR 6000 crores and employed lakhs of people has come to almost a grinding halt.

Annexure II

Important orders in the firecrackers case

Timeline	Event
11 November 2016	The SC directed the central government to suspend all licenses for permit sale of fireworks, wholesale and retail within the territory of NCR till further orders of the Court. (Blanket Ban)
12 September 2017	The SC passed several directions aiming at developing a 'graded approach' than a blanket ban on the manufacture of fireworks. Some of them are listed below: - ● Reduction of grant of temporary licenses by 50 percent. ● Strict adherence to the applicable legislations. ● The permanent licensees could exhaust the stock of crackers for 2017 but will be allowed to sell only 50 percent of the quantity permitted in 2017, in 2018.
09 October 2017	The SC Order dated 11 November 2016 was made operational during Diwali 2017 (Until October 31). The 9th October 2017 order was made operational in Delhi NCR during Diwali 2018. (From November 1, 2017)
23 October 2018	The Supreme Court passed several directions concerning manufacture and sale of firecrackers in Diwali of 2018: - ● Only reduced emission firecrackers could be used. ● Sale and manufacture of joined firecrackers (*lari*) was banned ● Use of barium Salts in firecrackers was banned. ● CPCB and respective State Pollution Control Boards/ Pollution Control Committees (SPCBs/PCCs) of the states and union territories directed to carry out short-term monitoring in their cities for 14 days (commencing from 7 days prior to Diwali and ending 7 days after Diwali) for the parameters namely, Aluminium, Barium, Iron apart from the regulatory parameters against the short-term Ambient Air Quality Criteria Values (AAQCVs) proposed by CPCB with regard to bursting of firecrackers. ● "On Diwali days or on any other festivals like Gurpurab etc., when such fireworks generally take place, it would strictly be from 8:00 p.m. till 10:00 p.m. only. On Christmas eve and New Year eve, when such fireworks start around midnight, i.e. 12:00 a.m., it would be from 11:55 p.m. till 12:30 a.m. only."
March 3, 2020	SC took cognizance of the petitioner's averment that its orders are not being followed by the respondents. The SC ordered Central Bureau of Investigation, Chennai to investigate into the allegation.

Annexure III

Posters and Brochures regarding 'New' and 'Improved' Firecrackers released by NEERI

STAKEHOLDER CONSULTATIONS

- Firecrackers based on new formulations including SWAS, STAR, SAFAL firecrackers were demonstrated to firework manufacturers (TANFAMA and TIFMA) PESO and CPCB at CSIR-NEERI from October 2018 onwards.
- Nearly 230 MoUs so far and 165 non-disclosure agreements (NDAs) have been signed with fireworks manufactures to facilitate hand-holding with stakeholders to enable smooth transition.
- Nearly 530 emissions testing certificates have been issued to fireworks manufactures for new and improved formulations meeting the stipulated guidelines of green crackers.

LEGAL/POLICY INTERVENTIONS

- Technical Committee was constituted for 'definition of green crackers' including CSIR-NEERI, PESO and CPCB officials based on directives of APEX court. Accordingly, the definition was finalized and submitted by CSIR to PESO for filing affidavit in APEX court on 16th January, 2019
- MoEF&CC directed CSIR-NEERI to develop the 'baseline emission values' to benchmark the green crackers and accordingly report was submitted on 22nd July, 2019 to MoEF&CC, CPCB, and PESO
- MoEF&CC also directed CSIR-NEERI to assess the Ba levels in PM after reduced usage of chemicals and additives in fireworks, findings have been included in the above referred report to MoEF.

Firecracker Testing Lab

Firecracker Emission Testing Facility

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GREEN CRACKERS

NEERI

BACKGROUND

- Fireworks are of growing environmental concerns due to emissions including particulate matter, SO_2 and Nox
- The Apex court imposed a **ban on the sale of firecrackers** in Delhi and NCR in 2017
- Indian Fireworks industry with annual turnover of over 6000-crore worth and annual growth rate of about 10 percent provides employment opportunities to over 5 lakh families directly or indirectly
- **Dr. Harsh Vardhan**, *Hon'ble Minister of Science and Technology & MoEF&CC* exhorted CSIR scientific community to initiate R&D to address this issue of growing environmental concerns due to fireworks emissions and also protect the growing economy of fireworks . Subsequently, in January 2018, eight institutes of CSIR (CSIR-NEERI, CEERI, IITR, IICT, NCL, CECRI, NBRI & CMERI) embarked on this project to develop reduce emission/green fireworks. CSIR-NEERI was assigned the task of coordinating this activity

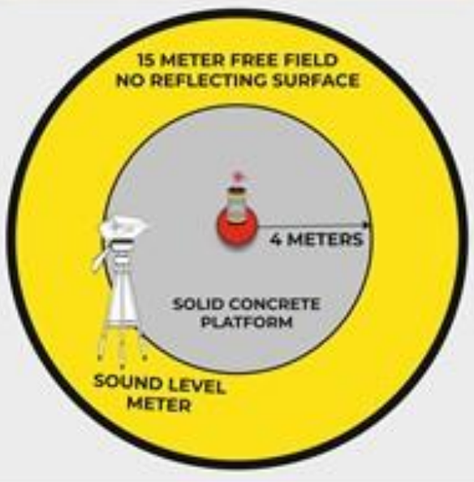
CSIR R&D INNOVATIONS

- CSIR-NEERI has developed "new formulations" without Barium Nitrate for some of the products of light and sound category of firecrackers including Chinese crackers, maroons , atom bombs, flowerpots , pencils and sparklers. These samples are meeting the stipulated norms of green crackers and the emissions test certificates have been issued accordingly.
- CSIR-NEERI jointly with fireworks manufacturers has also developed "improved formulations" (based on significantly reduced Barium Nitrate) for light category of firecrackers (chakkar , twinkling star based on wet formulations) by using CSIR-NEERI's additives. These samples are meeting the stipulated norms of green crackers and the emissions test certificates have been issued accordingly by CSIR-NEERI
- CSIR-NEERI has set up first of its kind state of art facility for emissions testing and noise testing of firecrackers.
- Raw materials Compositional analysis and Emission testing facility (RACE) has been launched at Sivakasi as a joint programme of CSIR, MoEF&CC and Fireworks manufacturers on 22nd August, 2019

DEFINITION OF GREEN CRACKERS

Reduced emissions crackers with pyrotechnic composition consisting of a fuel, oxidizer and an optional binder to give structural integrity for special effect of light and sound and having potential for generating less emissions in presence of additives.

Please refer CSIR-NEERI website for detail definition of Green Crackers



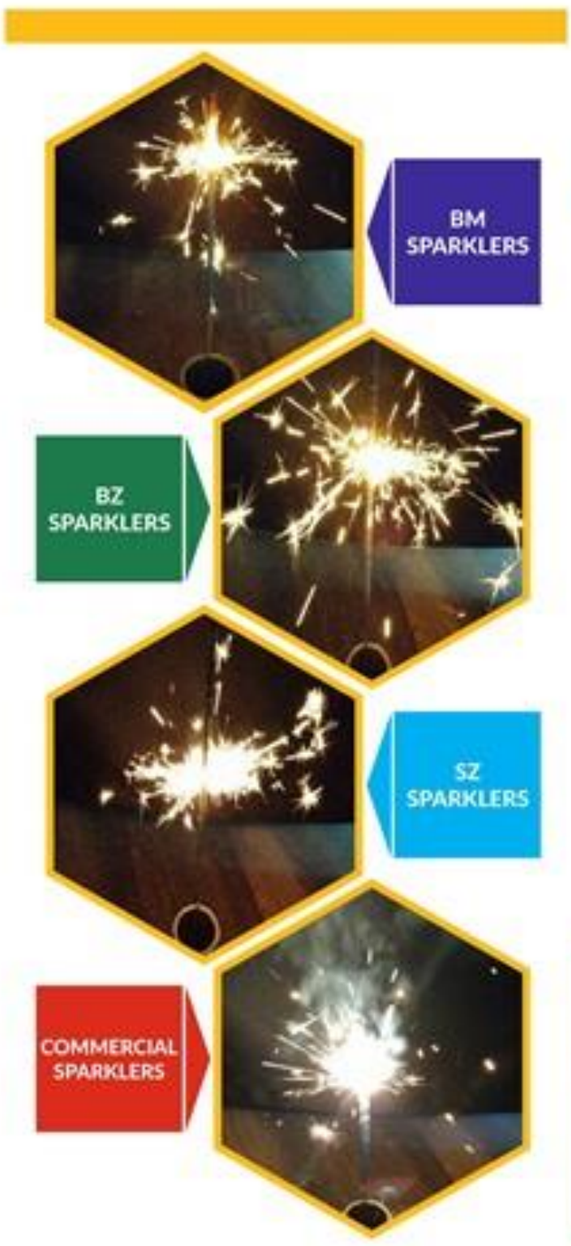
OTHER ACTIVITIES AND STEPS FOR IMPLEMENTATION OF GREEN CRACKERS

- CSIR-NEERI has disclosed the formulations for green crackers at its website for NDA signatories. However, it is not advisable to use without proper understanding of standard operating procedures and undergoing hands on training at CSIR-NEERI.
- In order to facilitate and expedite signing of NDA and training, CSIR-NEERI is regularly holding camp/programme for training and NDA signing (recently organized yet again). In specific, this camp/programme provides an opportunity to fireworks manufacturers to register and sign NDA there itself .
- For the purpose of avoiding spurious operations and entities, CSIR-NEERI is suggesting QR codes for each production so that we know what is getting produced.

The steps suggested by CSIR-NEERI to ensure meeting the stipulated norms/definition of green crackers are:

- Adoption of new and improved formulations on signing of NDA by manufacturer with CSIR-NEERI
- Submission of samples by fireworks manufacturers for
  (a) raw material characterisation and
  (b) emission testing for testing the samples at CSIR-NEERI or CSIR-NEERI's approved NABL labs to facilitate issuance of certificate by CSIR-NEERI
- In-principle approval to be accorded by PESO with understanding of usage of defined raw materials characteristics in the disclosed formulation and subsequent final authorization to be accorded based on requisite safety and stability tests
- Usage of green logo and QR coding for differentiation of green crackers from conventional crackers for monitoring and tracking.

The above progressive steps delineated by CSIR-NEERI shall ensure that the green crackers are implemented with envisaged positive environmental impacts



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GREEN SPARKLERS

NEERI

NOVEL FEATURES OF BM SPARKLER:
- Usage of magnalium powder reduces particulate matter.
- Boric acid as additive act as dust suppressant.
- Minimal use of Barium Nitrate.
- Usage of readily available safe and inert additives

SALIENT FEATURES OF BM SPARKLERS:
- Functional performance at par with commercial sparklers (longer burning duration & lesser residue by 5%, visually smokeless).
- PM reduction by 50%.
- Reduction in cost due to lesser usage of chemicals.
- Significant NOx reduction (more than 80%).
- Meeting the stipulated norms of green crackers

IMPROVED FORMULATIONS FOR SPARKLERS

BM SPARKLER

NOVEL FEATURES OF BZ SPARKLER:
- Usage of significantly reduced $Ba(NO_3)_2$ as oxidizer and zeolite powder as additive.
- Zeolite Powder as additive undergoes fragmentation to
  i) absorb SO_2 & NOx &
  ii) act as dust suppressant
- Minimizes use of Barium Nitrate

SALIENT FEATURES OF BZ SPARKLERS:
- Functional performance at par with commercial sparklers (longer burning duration & lesser residue by 5%, visually smokeless).
- PM reduction by 50%.
- Reduction in cost due to lesser usage of chemicals.
- Significant NOx reduction (more than 80%).
- Meeting the stipulated norms of green crackers

IMPROVED FORMULATIONS FOR SPARKLERS

BZ SPARKLER

NOVEL FEATURES OF SZ SPARKLER:
- Usage of NEERI's proprietary additive for significant reduction in particulate matter and gaseous emissions.
- Coating provides protection from moisture
- Functional performance at par with commercial sparklers

SALIENT FEATURES OF BM SPARKLERS:
- Complete substitution of conventional oxidizer i.e. $Ba(NO_3)_2$ with $Sr(NO_3)_2$ and zeolite powder as additive PM reduction by 30%.
- Significant NOx & SO_2 reduction.
- Meeting the stipulated norms of green crackers

NEW FORMULATIONS FOR SPARKLERS

SZ SPARKLER

CSIR-NEERI HAS DEVELOPED NEW FORMULATIONS USING OXIDIZERS OTHER THAN BARIUM NITRATE ($BA(NO_3)_2$) IN PRESENCE OF ADDITIVES HAVING FUNCTIONAL PERFORMANCE AT PAR WITH CONVENTIONAL SPARKLERS

SPARKLERS: A type of hand-held firework that burns slowly while emitting coloured flames, sparks, and other effects.

Background of $Ba(NO_3)_2$:
- Usage of Barium nitrate is presently banned as per APEX court ruling of 23.10.2018.

Salient features of Green Sparklers:
- CSIR-NEERI jointly with fireworks manufacturers has developed "New formulations" (without Barium nitrate) for sparklers by using CSIR-NEERI's additives.
- "Improved formulations" based on significantly reduced Barium Nitrate has also been developed jointly by fireworks manufacturers and CSIR (using CSIR's additives) However, the usage of these formulations by fireworks manufacturers is subject to approval of APEX court

NEERI's GREEN FLOWER POT

COMMERCIAL FLOWER POT

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GREEN FLOWER POTS

STAR - F

STAR - Z

नीरी NEERI

Definition of Green Flower Pot

CSIR-NEERI has developed new formulations for Flower Pots without usage of barium nitrate ($Ba(NO_3)_2$) in presence of additives with consequent reduction in emissions

Background of $Ba(NO_3)_2$

Usage of Barium nitrate is presently banned as per APEX court ruling of 23.10.2018.

USP of Green Flower Pot

Elimination of usage of Barium nitrate and PVC

Usage of readily available safe and inert additives

Functional performance at par with conventional flowerpots

Meeting the stipulated norms of green crackers

Novel features of Green Flower Pot

Zeolite undergoes fragmentation and facilitates
(i) Sorption of SO_2 and NOx
(ii) Functions as dust suppressant
(iii) In situ sequestration of metals

Iron oxide as additive reduces requirement of oxidizers

Iron oxide has potential for sequestering metals

Reduction in cost due to avoidance of Barium nitrate and PVC

Working Principle (STAR Z)

New formulation based on substitution of barium nitrate with potassium nitrate in presence of zeolite as additive undergoes fragmentation on ignition and provides sorbent and dust suppressant with consequent reduction in emissions.

Salient features of STAR Z & STAR F

New formulation based on potassium nitrate as oxidizer, zeolite as an additive and minimum usage of aluminium popularly known as STAR-Z

New formulation based on potassium nitrate as oxidizer, iron oxide as an additive and minimum usage of aluminium. This kind of pyrotechnic composition consisting of metal as fuel and metal oxide as oxidizer on ignition by heat, undergoes an exothermic reduction-oxidation (redox) reaction referred to as "thermite reaction" popularly known as STAR-F

STAR-Z has unique properties of releasing dust suppressant and diluent for gases emissions with consequent lesser emission of particulate matter and gases

STAR-F has unique properties of sequestering metal, particulate matter and gases

Particulate Matter reduction by a minimum of 30-40% due to the release of dust suppressant

Significant SO_2 and NOx reduction by 20% and 50% respectively

Usage of aluminium minimized by 70% with respect to their counterpart conventional flowerpot available in the Indian market

DEFINITION OF GREEN CRACKERS

IMPROVED FIREWORKS/FIRECRACKERS

Fireworks/firecrackers made with reduction in size of shell, elimination of ash usage etc., reduced usage of raw materials in the compositions, of uniform acceptable quality, and/or use of additives as dust suppressants to reduce emissions with specific reference to particulate matter(PM*) [SO_2 and NOx leading to:

- a minimum of PM reduction of 30 %
- a minimum of PM reduction of 20% and rest 10% of gaseous emission (mass of gases emitted based on composition) or more reduction of gaseous emission (mass of gases emitted based on composition)
- All of the above reduction shall be based on when compared with conventional composition for a given category of crackers/fireworks

NEW FORMULATION FIREWORKS/FIRE CRACKERS

Fireworks/fire crackers having new and improved formulations (substitution and reduction of raw materials in composition) to reduce emissions with specific reference to particulate matter(PM*), SO_2 and NOx as:

- a minimum of PM reduction of 30 %
- a minimum of PM reduction of 20% and rest 10% of gaseous emission (mass of gases emitted based on composition)
- All of the above reduction shall be based on when compared with conventional composition for a given category of crackers/fireworks

**metals are subset of PM*

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GREEN CRACKERS

SOUND EMITTING

NEERI

SAFAL

SAFE MINIMAL ALUMINIUM CRACKER

MINIMISES USAGE OF ALUMINIUM, PARTICULATE MATTER, SO_2 AND NOx EMISSIONS WITH MATCHING PERFORMANCE IN SOUND IN COMPARISON WITH RELATED COMMERCIAL CRACKER

NOVEL FEATURES OF SAFAL

Know-how based on concept of exploiting exothermic heat of sorption.
SAFAL has water immobilized in zeolite and other adsorbents.
SAFAL has adsorbents in dry form to react with moisture released from the adsorbent.
SAFAL has unique property of releasing water and/or air as dust suppressant and diluent for gaseous emissions.
Minimal usage of aluminium, potassium nitrate and sulphur.

SALIENT FEATURES OF SAFAL

SAFAL shows matching performance in sound (100-120dBA) with commercial crackers.
Overcomes issues of particulate matter and gaseous emissions.
PM reduction by 30%.
Significant NOx and SO_2 reduction (more than 30%).
Reduction in cost due to avoidance of KNO_3 and S.

SAFAL - USP

Releases dust suppressant and gaseous emissions absorber.

STAR

SAFE THERMITE CRACKER

MINIMISES PARTICULATE MATTER, SO_2 AND NOx EMISSIONS USING THERMITE-TYPE REACTIONS, WHEREIN A METAL OXIDE IS THE OXIDIZER AND METAL (ALUMINIUM) THE FUEL

NOVEL FEATURES OF STAR

Know-how based on improved pyrotechnic composition (thermite) of metal oxide and metal as fuel which on ignition by heat (using flash or gun powder) undergoes an exothermic redox reaction for bursting of crackers.
Significantly reduced ignition temperature in presence of additives.
Metal oxides including iron oxides, titania, alumina silicates act as oxidant in thermite reaction with aluminium as fuel.
Minimal usage of potassium nitrate and sulphur

SALIENT FEATURES OF STAR

STAR shows matching performance in sound (100-120dBA) with commercial crackers.
Overcomes issues of particulate and gaseous emissions.
PM reduction by 30% for STAR crackers.
Significant NOx and SO_2 reduction (more than 30%).
Reduction in cost due to avoidance of KNO_3 and S.

STAR - USP

Light and sound cracker with high luminous intensity!
Releases negative ion generator.

SWAS

SAFE WATER RELEASER

MINIMISES PARTICULATE MATTER, SO_2 AND NOx EMISSIONS WITH MATCHING PERFORMANCE IN SOUND IN COMPARISON WITH RELATED COMMERCIAL CRACKER

NOVEL FEATURES OF SWAS

Knowhow based on novel concept of exploiting exothermic heat of reaction (reaction of water with lime and unused Al) for bursting of crackers.
SWAS has water immobilized water in materials / additives (hydrogel, calcium peroxide) to react with lime and / unreacted Al.
SWAS has unique property of releasing water and/or air as dust suppressant and diluent for gaseous emissions.
Minimal usage of potassium nitrate and sulphur.

SALIENT FEATURES OF SWAS

SWAS shows matching performance in sound (100-120dBA) with commercial crackers.
Overcomes issues of particulate and gaseous emissions.
PM reduction by 30% for water based crackers.
Significant NOx and SO_2 reduction (more than 30%).
Reduction in cost due to avoidance of KNO_3 and S.

SWAS - USP

Additives release water / air and dust suppressant.

SWAS, STAR, SAFAL PROVIDES CRACKER WITH REDUCED EMISSIONS ... | TECHNOLOGY FOR CLEAN AIR

For any queries and clarification regarding this report,
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