



KAPRA & ASSOCIATES

New-Environment-Friendly

Pulse Plasma Rock Fragmentation Technology

For Rock Crack and Fragmentation
near downtown, animal farm, historical heritage, bridge, etc.



Using EPI

Electro
Power



Impactor

ASSOCIATES



Korea Electro Chemistry CO., LTD.



PETRO PLASMA CO., LTD.



DAEEUN PLASMA CO., LTD.



Korea Accelerator and Plasma Research Association
Physico Technology Laboratory



Welcome to KAPRA PTL World

The Korea Accelerator and Plasma Research Association (KAPRA) was established as a representative agency for the fields of charged particle accelerators, and plasma science and technology in Korea. It consists of professors and researchers.

The association was approved by the Ministry of Science and Technology (MOST) of Korea in 1991.

At the present, the main R & D areas at the KAPRA include the commercialization for both the particle accelerators and plasma science. Since its establishment, there has been two projects initiated by KAPRA.

One was Korea Superconducting Tokamak Advanced Research (KSTAR), and the other was Proton Engineering Frontier Project (PEFP).

KAPRA has carried out about 20 cooperative projects with industries. The total numbers of the Korean patents and the world ones obtained and applied are 30.

In 2001, Cheorwon Gun (County) in Gangwon Province invited KAPRA to build new laboratory in Cheorwon.

Every July, KAPRA organizes the international and domestic workshop with Chinese, Russian, American, German, and Japanese scientists on the plasma and particle accelerator science.



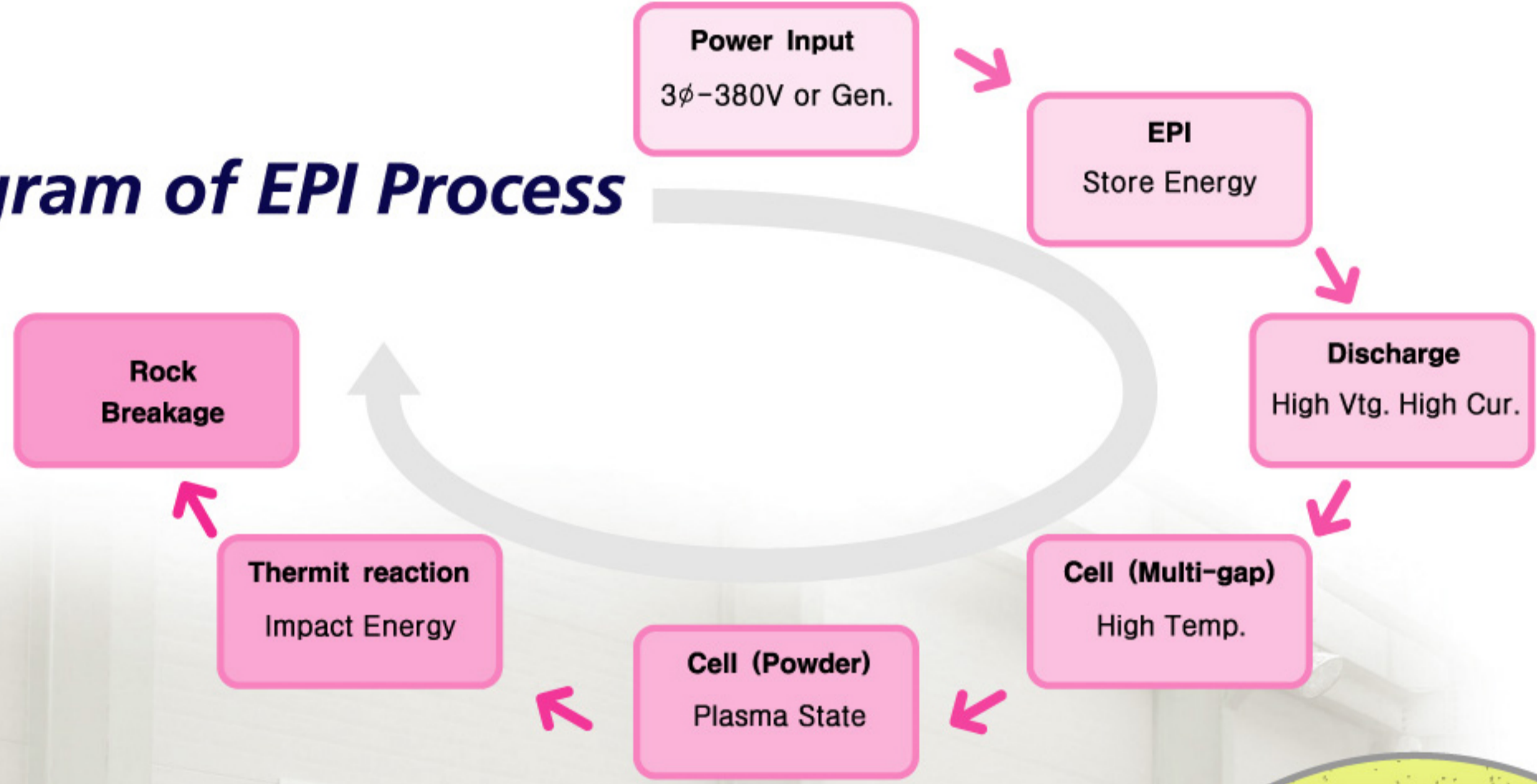
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EPI: Electro-Power Impactor

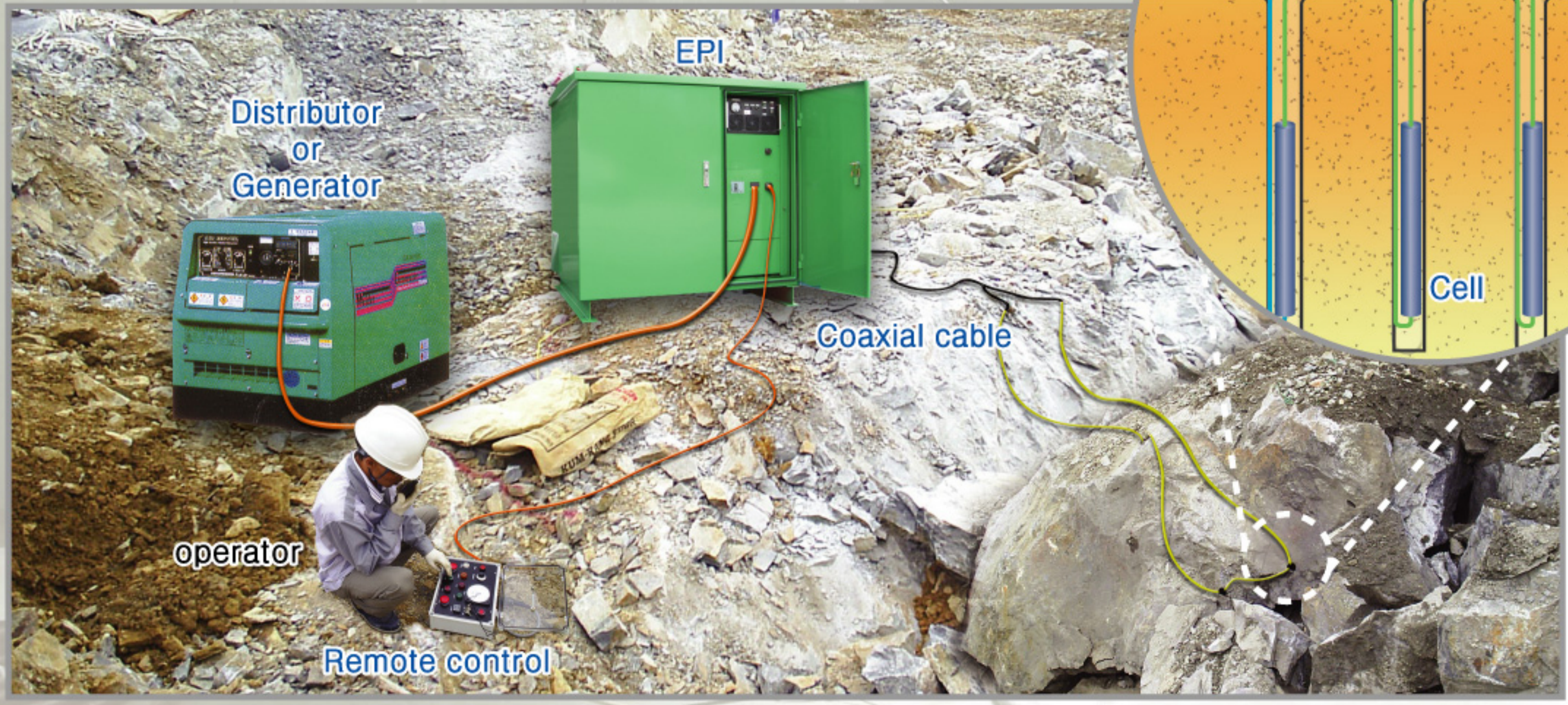


Input Power (kW)	20 (380VAC, 3 ϕ)
Capacitor Bank	9,000V DC, 830 μ F 8ea parallel circuit
Max. Storage Energy	268.92 kJ
Max. Output Energy	134,460 kW
Size(m)/Weight(T)	1.6(L) x 1.4(W) x 1.6(H) / 1.2

Diagram of EPI Process



Overall Concept

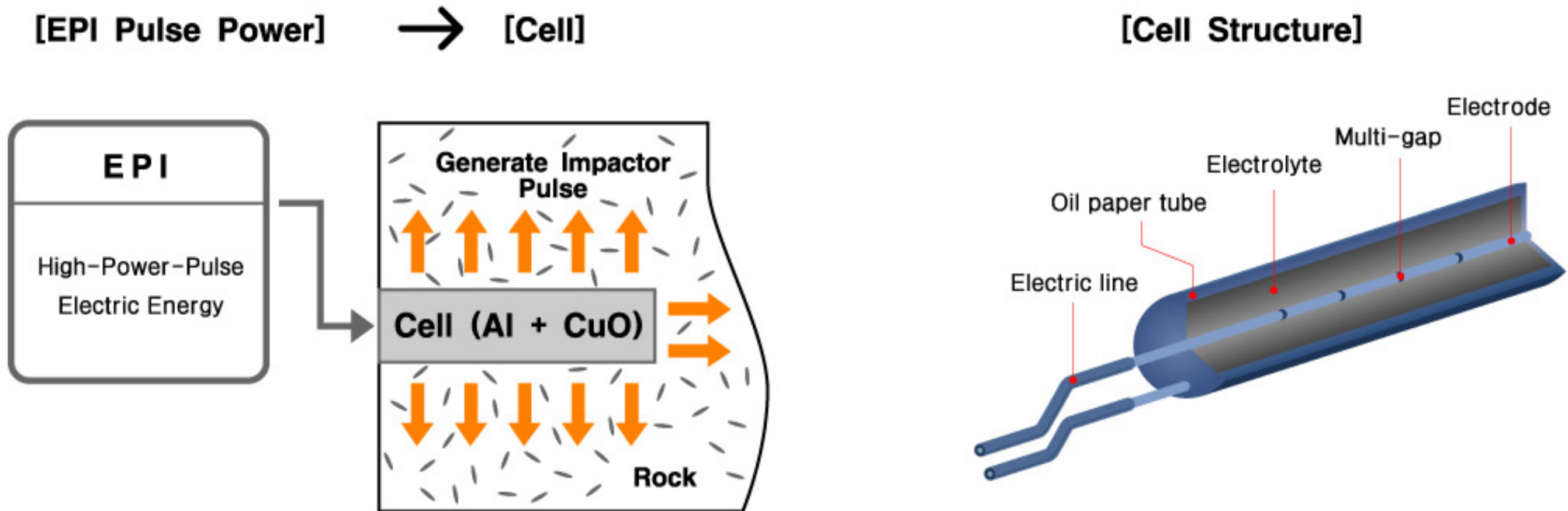


What is the EPI Pulse Plasma Rock Fragmentation?

EPI(Electro Power Impactor) Method

- The mechanism of the EPI Pulse Plasma Rock Fragmentation is composed of an EPI and Cells.

When high power pulse electric energy generated by an EPI is supplied to the Cells filled with powders of Aluminium and Copper Oxide in a milli-second, the cells (electrolyte) become plasma state, and generate high heat and impact wave (pulse), which makes the rock break with weak noise and vibration.



Reaction of the Cell

Gunpowder process generates big noise, vibration and gases such as oxygen, hydrogen, nitrogen, carbon, etc. by rapid expansion; while in EPI Plasma method, as it is a Thermit process, gases are not generated and only weak sound/vibration are occurred.



Kinds of the Cell



Diameter(mm)	Length	Weight	Energy	Hole (Light Rock)	Remarks
Cell : 34 (Hole : 51)	600mm	925g	3,784kJ	1.0m x 1.0m x 2.4m	Near-safety zone
	800mm	1,234g	5,048kJ	1.1m x 1.1m x 2.7m	General zone (Std)
	1000mm	1,542g	6,308kJ	1.3m x 1.3m x 3.0m	Far-safety zone

※ Cell sizes and number (1~7ea) are determined according to the safety level, rock hardness and distance.

Technical Information for Environment

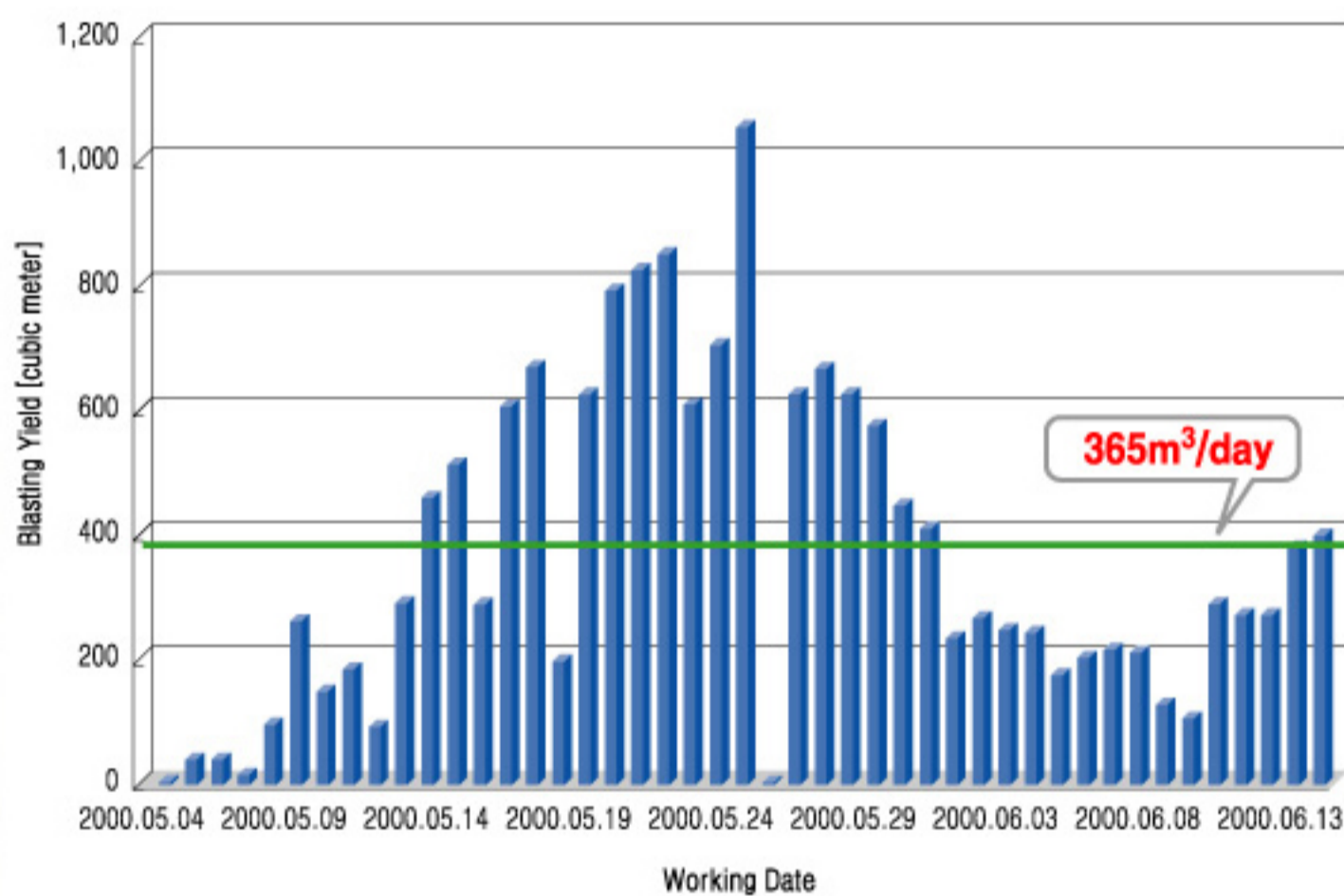
[Vibration Velocity Comparison Table]

Distance	EPI	Controlled Powder Blasting (CPB)	EPI / CPB
20m	0.092 kine	1.800 kine	About 1/20
30m	0.089 kine	1.150 kine	About 1/13
40m	0.047 kine	0.575 kine	About 1/12

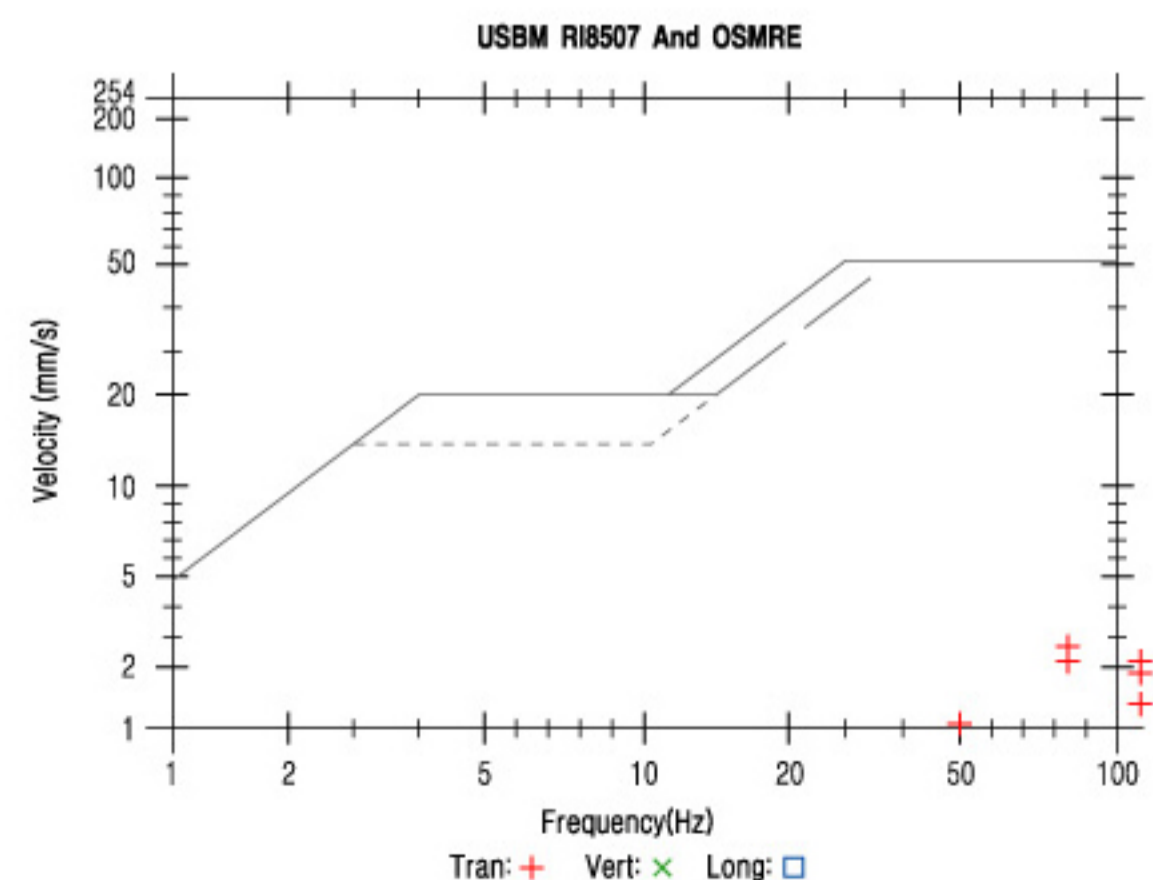
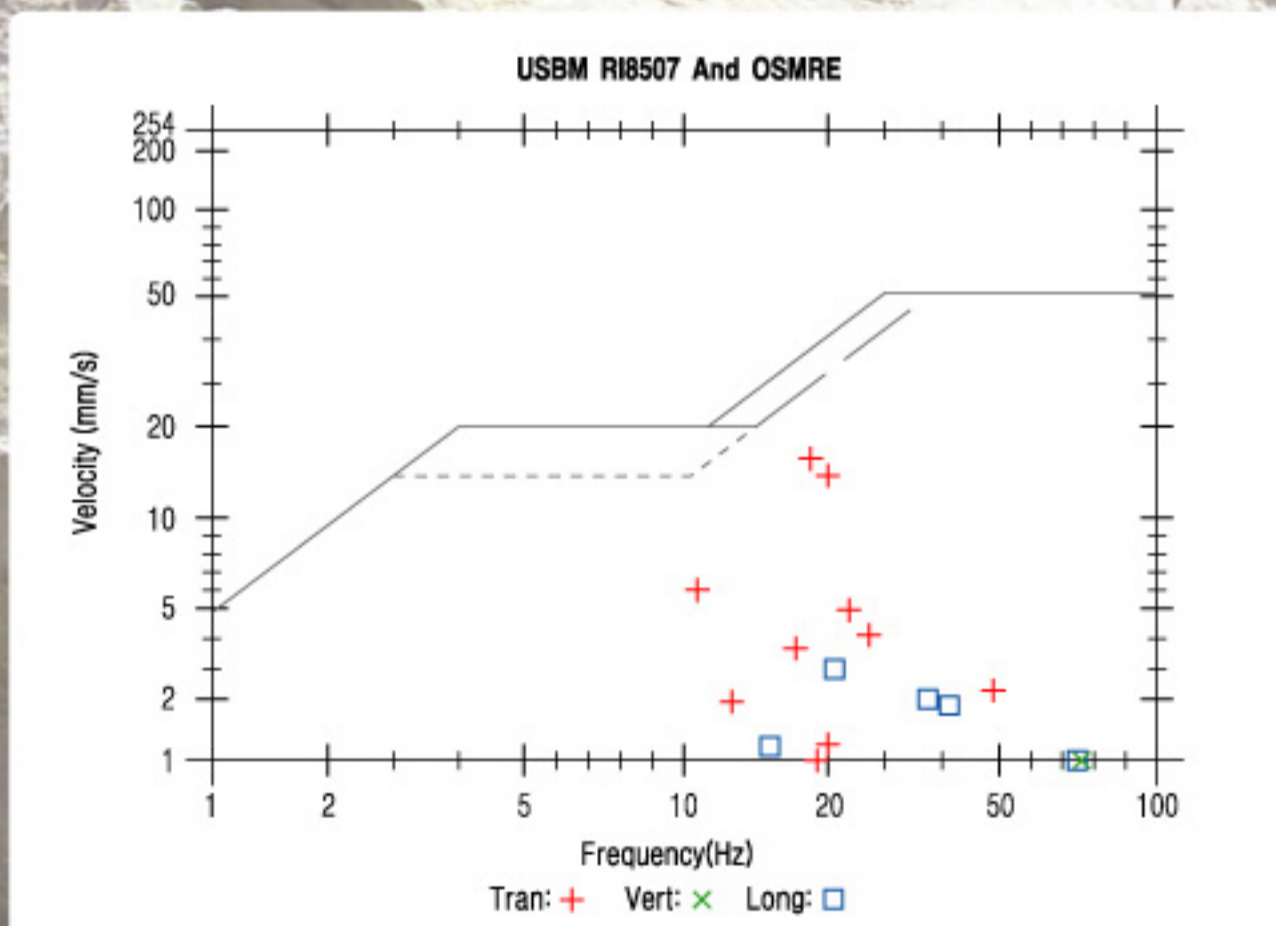
[Sound Level Comparison Table]

Distance	EPI	Controlled Powder Blasting (CPB)	EPI / CPB
20m	67.6 dB	83.2 dB	About 1/36
30m	65.3 dB	78.9 dB	About 1/23
40m	65.8 dB	73.3 dB	About 1/6

※ 10dB difference of Sound level means 10 times difference.



Rock Fragmentation Yield and Measurements of Vibrations



Sample Event Report of an Experiment

Chemical explosive blasting(left) VS. Electro-Power Impact Technology(right)

R Results of Performance Test of Impact Cell

Main Materials	Parameters	Soft rock (700~1000kg/cm ²)	Medium rock (1000~1300kg/cm ²)	Hard rock (1300~1600kg/cm ²)
37φ-600	Hole Diameter	51φ	51φ	51φ
	W*S*H Burden Volume	0.8*0.9*2.5	0.7*0.8*2.5	0.6*0.7*2.3
	Design Vol. Of Rock Target(m ³)	1.80	1.40	0.97
	Splitting Vol. Of Rock Efficiency 90%(m ³)	1.62	1.26	0.87
37φ-800	Hole Diameter	51φ	51φ	51φ
	W*S*H Burden Volume	0.9*1.0*2.7	0.8*0.9*2.7	0.7*0.8*2.5
	Design Vol. Of Rock Target(m ³)	2.43	1.94	1.40
	Splitting Vol. Of Rock Efficiency 90%(m ³)	2.19	1.75	1.26
37φ-1000	Hole Diameter	51φ	51φ	51φ
	W*S*H Burden Volume	1.0*1.1*3.0	0.9*1.0*3.0	0.8*0.9*3.0
	Design Vol. Of Rock Target(m ³)	3.30	2.70	2.16
	Splitting Vol. Of Rock Efficiency 90%(m ³)	2.97	2.43	1.94

※ Note - W :Resistance Line, S :Practical Spacing of Holes, H :Hole Depth(Distance btw. Hole & Free Surface)

- Important things of Leader's Skill & Talent.
(Working Speed, Fragmentation Rock Volume, Safety Operation, Economic Gain)
- Splitting Volume of Rock Mean the Volume of Per 1 Cell and Per 1 Hole.
- It is Possible to Fragmentate the Rock Simultaneously by multi series
& parallel connections of the Impact Cell & the Hole. If no any restrictions.

Comparison Table (Gun-powder / EPI Method)

	Gun-powder Explosion (Dynamite, Emulsion-powder, ANFO)	EPI Plasma Process	
Main Materials	Nitrates $M(NO_3)_N$ + aids		
	Nitroglycerine	: $C_3H_5(NO_3)_3$	Al powder + CuO powder (Impactor "CELL")
	Nitric-ammonium	: NH_4NO_3	
	Nitric-sodium	: $NaNO_3$	
	Nitric-potassium	: KNO_3	
Explosion Method	Detonator : Low sensitive powders Booster(Primer) : Use when detonator is weak.	Generate plasma from the cell by high-voltage and high-current	
Blasting Energy	Exploded powder generates high heat and massive gases and these heat help the gases expand rapidly, which makes high pressure to break the rocks.	At plasma state, high heat and high pressure Impact Pulse Wave generated by Thermit reaction breaks the rock.	
Chemical Reaction	$2NH_4NO_3 \rightarrow 2N_2 + 4H_2O + O_2 + 238.9kJ$	$2Al + 3CuO \rightarrow Al_2O_3 + 3Cu + 1,197kJ$	
Vibration Noise Flying Rock	After reaction, the generated energy from the gases (Oxygen, Hydrogen, nitrogen, Carbon etc.) bring forth noise, vibration and blasting pressure.	After reaction, only solid materials, i.e. aluminum oxide and copper remains which bring forth low noise, low vibration, low dust and low fly rocks.	
Vibration Characteristics	As the earth vibration from the rapid gas expansion is periodical and multiplied waves, it is slowly reduced and has a long propagation distance.	As the Impact pulse wave by Thermit reaction is a kind of pulse passing through the vibration medium in a moment, its vibration is reduced and disappeared very rapidly.	
Resonance	As the powder vibration frequency is 20~30Hz and the unique vibration frequency of general building is 15~20Hz, they are overlapped and resonance is generated, which affects nearby buildings.	As EPI method vibration frequency is 50~120Hz(4times of the power), EPI does not generate resonance and does not affect building nearby.	
Permission from Gov.	Permission is needed. Powder-dealing licensor has to report to the police station for the explosion works.	No need for permission. No need for the powder-dealing licensor.	

Characteristics

Contents	
Pro-environment	Low-vibration, Low-noise, Low-dust. Broken rocks are small sizes.
Safety	No fly rocks. No toxic fumes. No hindrance to the other nearby works.
Workability	Can use from weak rocks to hard rocks. Breakage capacity is minimum 5 times higher than machine breakage. Can explode up to 7 holes simultaneously. Can explode even at the place where underground water comes out.
Economic effect	EPI Plasma method is the most effective and economical. When considering 2nd-breakage, loading, and working period.
High-technology	Patented in Korea, USA, Japan and EU. Recognized as one of the best environment-friendly method at BAUMA International Fair for Construction Machinery, Building Materials Machinery and Construction Vehicle and equipment in Munich, Germany.

Patents

Contents	Country	APP. No.	Reg. No.	Owner
High Electro-Power Pulse Switch	Korea	99-6820	0290828	KAPRA
Pulse Power System	Korea	99-6822	0304757	KAPRA
Electro-Power Impactor Cell for Pulse Plasma Rock Fragmentation	Korea	99-6821	0308081	KAPRA
High Electro-Power Spiral-Arc Switch	Korea	99-27818	0308542	KAPRA
Continuous Control Plasma Rock Fragmenter	Korea	2001-0060796	0363017	KAPRA
Rock Fragmenter Process using the EPI	Korea	99-27819	0378513	KAPRA
Pulse Power System	Japan	11-0240023	3338409	KAPRA
Electro-Power Impactor Cell for Pulse Plasma Rock Fragmentation	Japan	11-0240022	3338408	KAPRA
Pulse Power System	USA	09/516,919	US 6,455,808B1	KAPRA
Electro-Power Impactor Cell for Pulse Plasma Rock Fragmentation	USA	09/516,899	US 6,457,448B1	KAPRA
Pulse Power System	EU	00104169.4-2207	EP 1 033 797B1	KAPRA
Electro-Power Impactor Cell for Pulse Plasma Rock Fragmentation	EU	00104368.6-2316	Pending	KAPRA

EU : Austria, U.K., France, Italy, German

APPLICATIONS



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