Presentation on

High Voltage Discharge Switch for Operational Safety of Neutral Beam High Voltage Power Supply System

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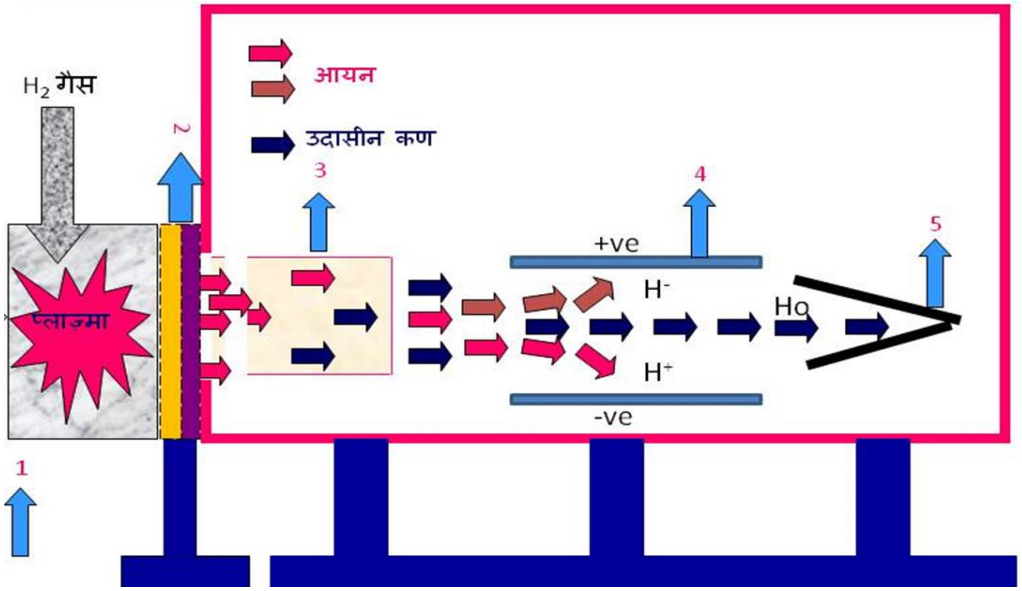
33rd DAE Safety & Occupational Health Professionals Meet 23-25 Nov. 2016

Outline of the Presentation

- Introduction to the Neutral Beam Power Supply System (NBPS)
- Introduction to the High Voltage Discharge Switch (HVDS)
- Deployment of HVDS in NBPS and High Voltage Systems

Introduction to the Neutral Beam Power Supply System (NBPS)

Neutral beam Injection (NBI) is a well established technique for heating and current drive in Tokamak fusion Plasma.
For acceleration of the ions HV Power Supply is used.



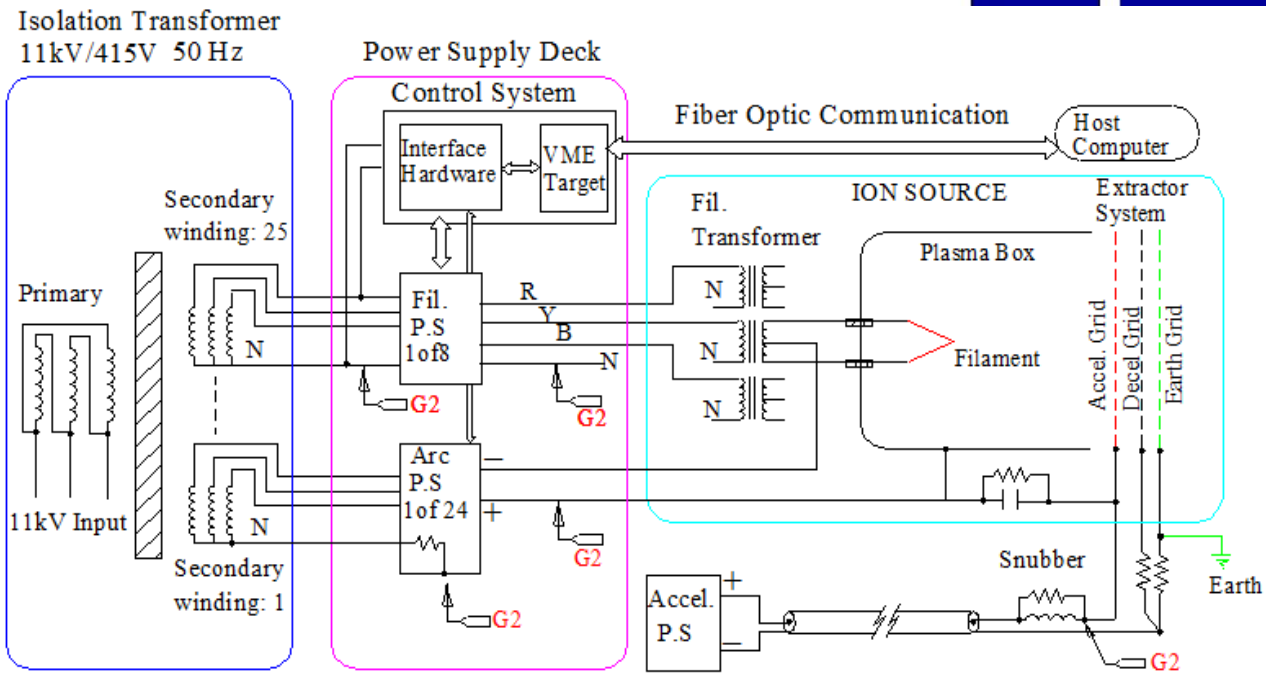
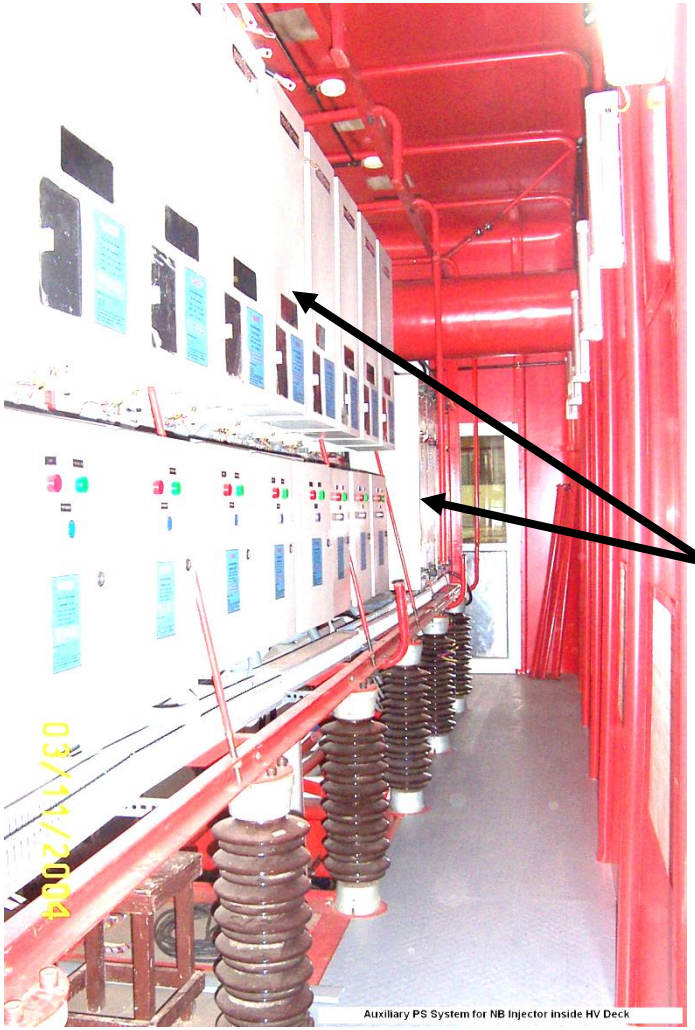


Fig.1 Schematic of Ion Source Power Supply System

Brief specifications of NBPS

Power Supplies	Specifications
Regulated HV power supply for acceleration	80kV, 75A, modular switching topology, rise/fall time 10uS-100mS, regulation 1%
Discharge power supply	24 Nos. of 160V, 100A switching converter, rise time less than 5 micro seconds
Filament power supply	8 Nos. of 7kVA, 15V, 155A, 400Hz inverter, 20S Soft start
HV deck (size) Snubber deck (size)	Air insulated 4x4x9m Air Insulated 4x4x4m

HV deck for NBPS



Arc & fil PS

Loading resistor

Air core Snubbers

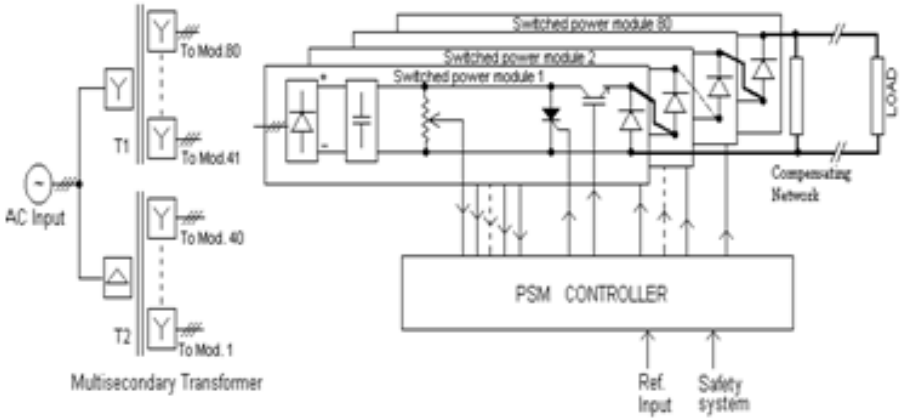
Discharge /Arc Power supply: 160V, 100A (24nos.)

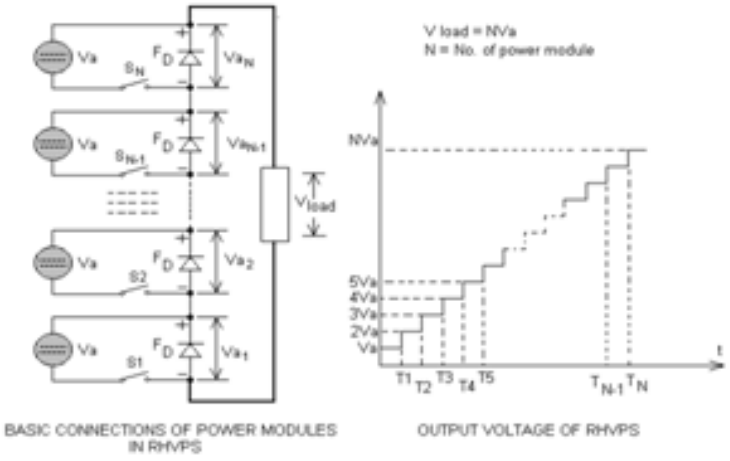
Filament power supply: 15V, 150A (8nos.)

Accelerator power supply: 80kV,75A (Regulated)

Transformers (40 Secondary)

Switched Power Modules on HV Rack





BASIC CONNECTIONS OF POWER MODULES IN RHVPS

OUTPUT VOLTAGE OF RHVPS

Introduction to the High Voltage Discharge Switch (HVDS)

INTRODUCTION

❖HV discharge switch is a safety device mandatory for personnel safety in HV system

❖In the existing HV system (~100kV) at IPR, oil immersed inverted bushing devices were used. Owing to their weight and maintenance requirement these devices are redesigned with air insulation

SWITCH CONFIGURATION

•Electrode system; fixed plate electrode at the top that receives HV and a pneumatic operated moving arm underneath

•FRP studs with sufficient creepage are used to isolate the electrodes and to provide mechanical support.

•An air gap of 100mm is maintained between the electrodes under open condition

Oil Immersed

Air Insulated

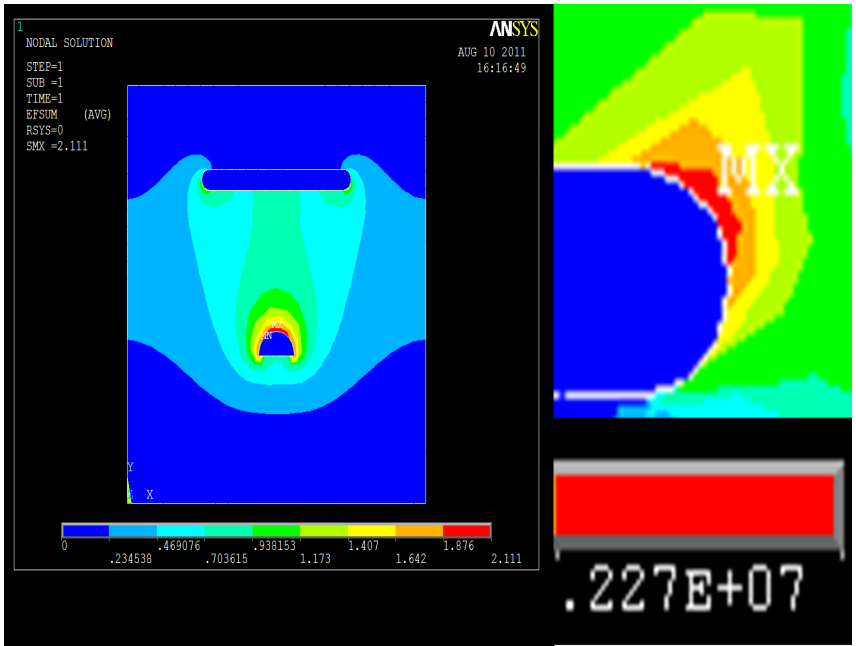
Fabrication and Design

Fabrication

- HV switch is fabricated locally
- surface is polished
- Moving arm is a brass hemi-sphere
- HV switch is assembled for vertical mounting
- Pneumatic cylinder act as the mounting stem with flange at the bottom
- Machined FRP studs at four locations provide necessary electrical isolation and mechanical support

Design Analysis

- FEA analysis of the electrode arrangement depicts the maximum electric field strength of ~ 2 kV/mm in air .
- A higher value of E is also recommended to limit the voltage beyond 100kV that can appear otherwise on the load.



TESTING

1.HV Test

Ambience:% RH- 72, Temp- 25 degree

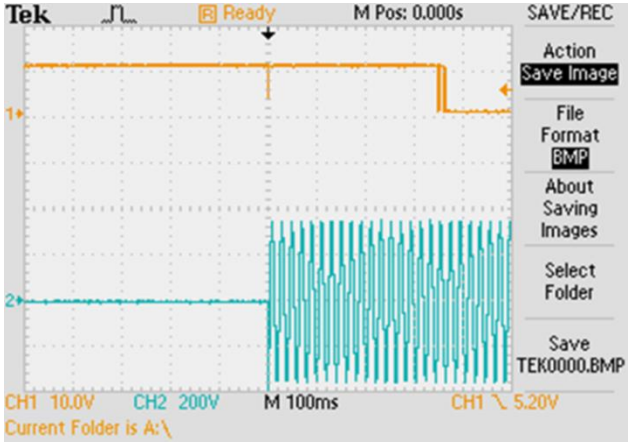
a) Applied HV in steps of 10kV up to 100kV.

b)100 kV kept applied for 2 minuets

c) No Audible Corona at any applied voltage level

2. Closing & Opening time Test

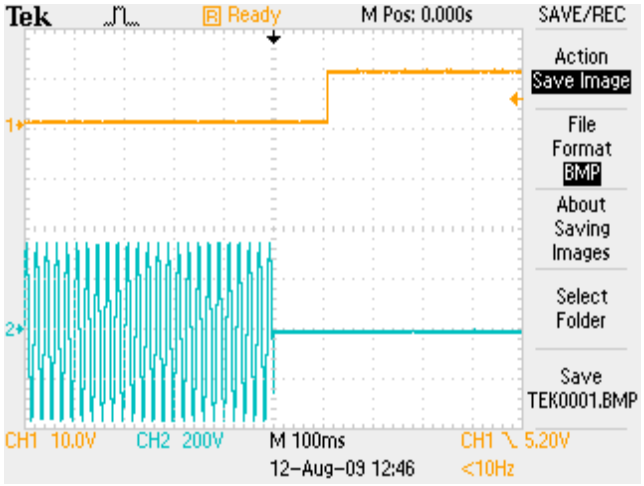
Closing/Opening Time ~350/110 ms @ 2bar Pressure



Closing time (350 m Sec)

3.Contact Resistance Test

Current	Voltage	Resistance in mili ohms
65.8	0.305	4.63
101.4	0.505	4.98
104	0.550	5.28
	Average	4.96



Opening time (110 m Sec)

Usage and Experiences of HVDS in NBPS

As a static off load automatic discharge switch

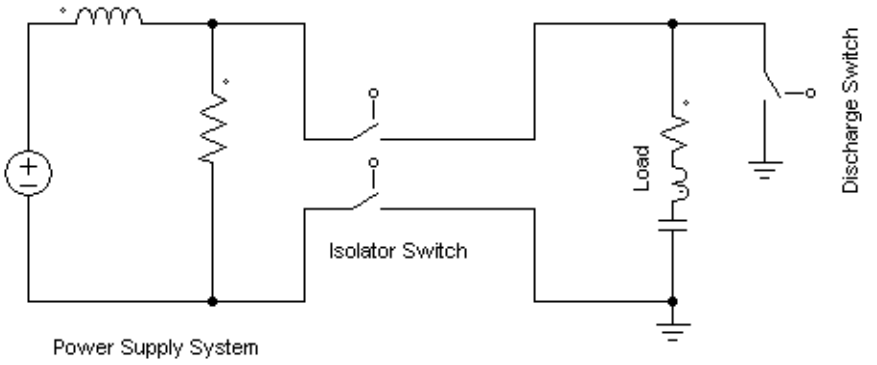
As a safety interlock for High Voltage working Area

As a shorting switch for wire burn test.

HV switches developed in-house look promising, their deployment has also been successful.

Similar HV switches are operational in BARC-RHVPS.

Further, other aspects of the HV switch need to be tested and verified as next course of action viz. endurance for mechanical operation, jittering



Discharge Switch

Isolator Switch

Thank You for Your Kind Attention