

Under frequency load shedding scheme

in

Northern Region (NR)

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NRPC New Delhi

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1.0 Background

- 1.1** Under frequency load shedding scheme (UFLS) was implemented in the NR in 1987 to take care of sudden outage of largest generating station i.e. 2000 MW Singrauli STPS. The UFLS was provided with two steps i.e. load relief of 1000 MW at 48.4 Hz and 2000 MW at 48.2 Hz. With the increase in size of the Northern grid, the UFLS was reviewed by the then NREB secretariat (now NRPC) and finalised after deliberation with the constituents of NR. A Chronology indicating the setting of UFRs and df/dt relays is given at Annexure I.
- 1.2** The Indian Electricity Grid Code (effective from 1st April 2006) highlight operating code for regional grid (chapter 5) under Para 5.2 (M) as under.

All Regional constituents shall provide automatic under-frequency and df/dt load shedding in their respective systems, to arrest frequency decline that could result in a collapse/disintegration of the grid, as per the plan separately finalized by the concerned RPC forum, and shall ensure its effective application to prevent cascade tripping of generating units in case of any contingency. All Regional constituents shall ensure that the above under-frequency and df/dt load shedding/islanding schemes are always functional. However, in case of extreme contingencies, these relays may be temporarily kept out of service with prior consent of RLDC. RLDC shall inform RPC Secretariat about instances when the desired load relief is not obtained through these relays in real time operation.

RPC Secretariat shall carry out periodic inspection of the under frequency relays and maintain proper records of the inspection.

- 1.3** Accordingly NRPC (earlier NREB) has been deliberating the implementation of subject matter with the all the constituents of NR in OCC and NRPC meetings of NR. It is being ensured that all the constituents implemented the under frequency load shedding scheme as agreed in the RPC forum. The RPC Secretariat is also carrying out inspection of UFRs installed in the system by the constituents. A sample format for the inspection being carried out by NRPC secretariat is enclosed at Annexure-II.

2.0 Revision of UFR Settings Before Synchronization of NR CENTRAL GRID

UFRs Setting

- 2.1 Before synchronization of NR-Central Grid a special NRPC meeting was convened for implementation of new proposed settings of UFRs in NR and WR because of increase in the system size. As decided in the meeting taken by Member (GO&D), on 5th July 2006, the three settings of UFRs for NR-WR are 48.8, 48.6 and 48.2 Hz, and for ER the settings are 48.4, and 48.1 Hz.
- 2.2 It was decided in the 4th OCC meeting held on 7th July, 2006 that the existing settings of 48.5Hz and 48.4 Hz be revised as 48.8 Hz and 48.6 Hz respectively. The third setting set at 48 Hz and fourth settings set at 47.9 Hz are clubbed and set at 48.2 Hz. These settings were implemented w.e.f. 19th August 2006.

State wise load relief to be provided by UFRs in NR is as given below.

STATES	Peak MW Met 2008-09	Load relief in MW			
		48.8 Hz	48.6 Hz	48.2 Hz	Total
Punjab	7309	180	220	400	800
Haryana	4791	110	140	350	600
Rajasthan	6101	120	150	425	695
Delhi	4034	110	140	350	600
UP	8248	190	240	475	905
Uttarakhand	1267	30	30	100	160
HP	1014	20	20	75	115
J & K	1380	40	50	75	165
Chandigarh	279	0	10	0	10
TOTAL	29504	800	1000	2250	4050

Df/dt relay settings

- 2.3 The df/dt settings were carried out for the individual regions separately in the past as a safety net of the respective regions. The settings of the df/dt relays were at 48.8 Hz initiating frequency and 0.125 Hz/sec slope, 49.2 Hz initiating frequency and 0.2 Hz/sec slope 49.6 Hz initiating frequency and 0.3 Hz/sec slope and 50 Hz initiating frequency and 0.4 Hz/sec slope. The total load relief of df/dt relays was 5000 MW. However, with the synchronous interconnection of Northern Regional grid and Central grid comprising of Eastern Region, Western Region and North-Eastern Region (NEW Grid) on 26th August 2006 at 1222 hrs, the installed capacity in

NEW Grid has increased over 100000 MW in 2008-2009. Consequently inertia of the combined system has increased, resulting into lower rate of change of frequency for a given loss of generation or load. Therefore, the existing defense mechanism based on rate of change of frequency relay (or df/dt relay) for protecting the system from collapse, following a loss of generation has become practically ineffective.

2.4 A sub-group was constituted by the Operation Co-ordination Sub-Committee (OCC) of the Northern Region Power Committee (NRPC) in its 9th meeting held on 15th Dec, 2006 to review the setting of df/dt relays, comprising of Members from NRLDC, UPPCL, DTL, RVPN & NRPC.

2.5 A meeting was held among the representatives the ERPC, ERLDC, NRPC, NRLDC, and WRPC on 27th November 2007 to discuss the issues regarding finalization of df/dt relay settings. After detailed deliberations, following relay settings were decided upon:

Stage –1 of df/dt to protect the combined NEW grid from loss of generation of a large power station.

Stage – 2 of df/dt to protect the split grid from loss of generation of a large power station in NR, WR, ER.

Setting of df/dt relay	NR	WR	ER
STAGE - 1	2000 MW at 0.1 Hz/Sec. at 49.9Hz.	2000 MW at 0.1 Hz/Sec. at 49.9Hz	800MW (600MW ER+ 200MW SR) at 0.125 Hz/Sec. at 49.9Hz.
STAGE- 2	2000 MW at 0.2 Hz/Sec. at 49.9Hz.	2000 MW at 0.2 Hz/Sec. at 49.9Hz.	Nil

Stage – 3 (or Stage-4) of df/dt to protect the individual regional grid/ state grid from loss of generation in the event of isolation. The setting and quantum of relief through df/dt relay may be decided by the respective region/ state on its own.

During the discussion it was also decided to continue the existing UFR settings in the Northern and Western Regions. However, it was agreed to raise 1st stage UFR relay setting in the Eastern Region to 48.6 Hz instantaneous from 48.5 Hz.

2.6 NRPC/ NRLDC provided state wise breakup of load (2000 MW) in NR system for the proposed 3rd stage of df/dt relay scheme. 3rd stage of df/dt relay scheme is decided at 0.3 Hz/sec at 49.9 Hz.

The basis of the same is as under:

- a) For Stage-I at 0.1 Hz/sec, the same has been uniformly distributed in Northern Region in the ratio of peak MW load met in 2006-07. In UP it might be ensured that 50% of these relays are installed in western UP. (West of Lucknow/Panki/Unnao axis).
- b) For Stage-II and Stage-III at 0.2 Hz/sec and 0.3 Hz/sec respectively, the same should act when there is an East-West separation within NR. Therefore these have been distributed in the ratio of loads in western part of the Northern Grid only. (Taking western UP load as 50% of UP load).
- c) Uttarakhand, HP, J&K and UT Chandigarh have been included in the list. These were not there earlier. The df/dt quantum for Punjab, Haryana, HP, J&K, UT Chandigarh as a whole would also take care of the winter off-peak conditions when hydro generation in this pocket is almost NIL leading to heavy imports from rest of the grid.

2.7 OCC in its meeting held on 7th January, 2008 approved the following settings in the Northern Region.

State wise load relief of df/dt relays is as given below.

STATES	Load relief in MW			Total
	Stage-I 49.9Hz& 0.1Hz/sec	Stage-II 49.9Hz& 0.2Hz/sec	Stage-III 49.9Hz& 0.3Hz/sec	
Punjab	430	490	490	1410
Haryana	280	310	310	900
Rajasthan	330	370	370	1070
Delhi	250	280	280	810
UP	500	280	280	1060
Uttarakhand	70	70	70	210
HP	50	70	70	190
J & K	90	90	90	270
Chandigarh	0	50	50	100
TOTAL	2000	2010	2010	6020

- 2.8** The df/dt relays should not overlap the areas under flat UFRs / Rotational Load Shedding Equipment (RLSE) scheme as well as the System Protection Scheme (SPS) loads identified as well as manual load shedding.

3.0 Major Decisions regarding UFRs and df/dt relays

The constituent States were requested to submit the details of the UFR's operations during each month to NRPC Secretariat. Based on the analysis of the data submitted by the constituent States, deliberations are held in the OCC meetings. The issue is also flagged in the NRPC meeting in case of those constituent States who do not provide the desired relief in the Grid. The major decisions taken regarding operation of UFR and df/dt relays in the NRPC meetings are as under.

- a) As decided in the 7th NRPC meeting held on 21-12-2007 adequate load relief was to be provided by installing 30% additional UFRs, to compensate the manual load shedding on feeders connected to UFRs.
 - b) The UFRs installed in the system should be tele-metered and mapped to SCADA system (as per decision of the 14th NRPC meeting held on 19th Sept, 2009).
 - c) Constituent States have been requested to supply data on load relief through UFRs, rotational load shedding scheme and manual load shedding on typical days and time in each month when frequency falls below 48.8 Hz.
 - d) The load relief by UFR should not be counted for those feeders which are already on manual load shedding of statutory power cuts. As UFRs are the defense mechanism for the system and it should be ensured that whenever required, these operate successfully.
- 4.0** State wise summary of UFR & df/dt Relays is at Annexure-III.

The setting of UFR and df/dt relays in NR- A chronology

Year	
1987	1000 MW at 48.4 Hz. 2000 MW at 48.2 Hz.
Nov. 2000	1500 MW at 48.2 Hz.
Feb. 2005	800 MW at 48.5 Hz. 1000 MW at 48.4 Hz. 1250 MW at 48 Hz. 1000 MW at 47.9 Hz.
Total load relief	4050 MW
df/dt relays setting	0.125 Hz/sec slope at 48.8 Hz 0.2 Hz/sec slope at 49.2 Hz. 0.3 Hz/sec slope at 49.6 Hz. 0.4Hz/sec slope at 50 Hz
Total load relief of df/dt relays	5000 MW
August. 2006	800 MW at 48.8 Hz. 1000 MW at 48.6 Hz. 2250 MW at 48.2 Hz.
df/dt relays setting	
Stage I	2000 MW at 0.1 Hz/sec. at 49.9 Hz.
Stage II	2000 MW at 0.2 Hz/sec. at 49.9 Hz.
Stage III	2000 MW at 0.3 Hz/sec. at 49.9 Hz.