Acknowledgments

The data, analysis and conclusions presented come from many people and departments in order to carefully and accurately describe the events of the 16 house quench on December 5, 2003. I would like to thank and acknowledge all those who contributed. The list is of personnel is long but these are the main contributors: J. Annala, B. Hanna, T. Johnson, D. Wolff, B. Flora, N. Mohkov, S. Drozhdin, B. Hendricks and Mechanical support, CDF pot personnel.
Addition of A48 Collimator to Protect against A0 abort kicker prefires

Add .5 m Collimator at A48 to shield against prefires
CDF Pot 3 Position

Pots have been found in additional failure test to move at 1200mils/sec.

Reproduced after quench
On Dec 5, 2003

Similar incident on
~ 3/17/03
Pot 3 Pictures

Pots did NOT sustain any damage: Can conclude that they did not hit primary beam.

These are pictures before Dec 5, 2003

(Courtesy CDF Pot Personnel)
T44 loss of Quench
QPM Over Sample Buffer

Development of Quench:
A48U 16msec
D48L 13.5msec
F17L 13msec
E11U 12.5 msec

Before abort

Quenched 5 dipoles at A48; DI/Dt = .5A/msec

(Courtesy D. Wolff & EE Support)
A48 Bus Drawing

Protons

Pot 3 location

A48U quenching dipoles: Looses current At .5A/msec
Displacement at D49 Target due to A48 Dipole Quench

Using Dan Wolff's estimate that the current was coming out of A48U at a rate of 1/2 amp/msec.

A Dipole give 8 mrad of bend at 4350 amps, so we get 1.8 mrad of bend per amp.

The dipoles in the half cell are losing .9 mrad of kick per msec.

The displacement at the collimator is given by the sum of

\[ D_x = q \sqrt{\beta_1 b^2} \sin(Y_2 - Y_1) \]

Where location 2 is the collimator, and location 1 is each of the dipoles in cell A48U

(Courtesy J. Annala Tevatron Dept.)
Damage to D49 Target

Damage to D49 estimated
Took 20-30 turns
To create hole.

Once the hole was open allowed
Beam to travel to next limiting
horizontal aperture which is E03
Simulation of losses on collimators

D49 target

Figure 14: Particle hits at the collimators D49, E02, E03, F172 and at Roman Pot No.3 at dynamic simulations of quench of 5 main dipoles at A48 region. Time histogram of hits is shown on bottom-right of figure. Field degradation rate is $dR/R = 2.386 \times 10^{-7}$. Horizontal collimator F172(2) is retracted from working positions by 3 mm back, all others are retracted by 1 mm. The collimator D49 is assumed is melting with a rate of 0.04 mm per turn.

(Courtesy S. Drohzdin)
Damage to E03 1.5m Collimator

Protons
2 Stage Collimator System


- 6 inch Target w/ 5mm Tungsten Wing
- 1.5 m collimator
12 collimators total:
4 Targets
8 Secondary collimators

Arranged in 4 sets:
2 proton sets
2 pbar sets

Proton Set 1
D49 Tar, E03 & F172 2nd
Proton Set 2
D171 Tar, D173 & A0
Pbar Set 1
F49 Tar, F48 & D172
Pbar Set 2
F173 Tar, F171 & E02
Tevatron Ring Wide Loss Plot
Result of quench at C19.

Conning tower correction element damage requiring C1 to be warmed to room temp for repair.
Conclusion:

1) The current Quench Protection System would NOT be able to catch this type of event because it processes data at 60Hz /16.67 msec.

2) It might have been possible to stop damage to collimators with different loss monitor protection system other than SVX. This needs discussion and possible loss monitor hardware system upgrade.

3) Even though 2 collimator devices were damaged, these devices defined the limiting aperture and are easy to change and provided protection to other components.