```
--- Fault Current Magnitudes (in kA) ---
Bus     3-Phase     LG      LL      LLG
Bus_1   0.769       0.726       0.666       0.676
Bus_2   0.300       0.149       0.260       0.197
Bus_3   0.267       0.125       0.231       0.174
Bus_4   0.378       0.350       0.327       0.329
Bus_5   9.746       7.488       8.440       7.597
Bus_6   0.387       0.580       0.335       0.773
Bus_7   0.436       0.104       0.377       0.246
Bus_8   0.109       0.059       0.094       0.074
Bus_9   0.387       0.580       0.335       0.773

=== Analysis Complete ===
Full-screen tabbed interface created with:
• Tab 1: Fault Current Table with Summary Statistics
• Tab 2: Comparative Bar Graph for All Fault Types
• Tab 3: Relay Coordination Timeline for Bus 5
• Tab 4: Individual Fault Type Analysis
Navigate between tabs to explore different aspects of the analysis.

=== VERIFICATION CHECKLIST ===
Please verify the following results against ETAP simulation:
------------------------------------------------------------

1. 3-PHASE FAULT CURRENT VERIFICATION:
   Bus_1: 0.769 kA - [ ] Matches ETAP results
   Bus_2: 0.300 kA - [ ] Matches ETAP results
   Bus_3: 0.267 kA - [ ] Matches ETAP results
   Bus_4: 0.378 kA - [ ] Matches ETAP results
   Bus_5: 9.746 kA - [ ] Matches ETAP results
   Bus_6: 0.387 kA - [ ] Matches ETAP results
   Bus_7: 0.436 kA - [ ] Matches ETAP results
   Bus_8: 0.109 kA - [ ] Matches ETAP results
   Bus_9: 0.387 kA - [ ] Matches ETAP results

2. LINE-TO-GROUND FAULT CURRENT VERIFICATION:
   Bus_1: 0.726 kA - [ ] Matches ETAP results
   Bus_2: 0.149 kA - [ ] Matches ETAP results
   Bus_3: 0.125 kA - [ ] Matches ETAP results
   Bus_4: 0.350 kA - [ ] Matches ETAP results
   Bus_5: 7.488 kA - [ ] Matches ETAP results
   Bus_6: 0.580 kA - [ ] Matches ETAP results
   Bus_7: 0.104 kA - [ ] Matches ETAP results
   Bus_8: 0.059 kA - [ ] Matches ETAP results
   Bus_9: 0.580 kA - [ ] Matches ETAP results

3. LINE-TO-LINE FAULT CURRENT VERIFICATION:
   Bus_1: 0.666 kA - [ ] Matches ETAP results
   Bus_2: 0.260 kA - [ ] Matches ETAP results
   Bus_3: 0.231 kA - [ ] Matches ETAP results
```

```
   Bus_4: 0.327 kA - [ ] Matches ETAP results
   Bus_5: 8.440 kA - [ ] Matches ETAP results
   Bus_6: 0.335 kA - [ ] Matches ETAP results
   Bus_7: 0.377 kA - [ ] Matches ETAP results
   Bus_8: 0.094 kA - [ ] Matches ETAP results
   Bus_9: 0.335 kA - [ ] Matches ETAP results

4. LINE-TO-LINE-TO-GROUND FAULT CURRENT VERIFICATION:
   Bus_1: 0.676 kA - [ ] Matches ETAP results
   Bus_2: 0.197 kA - [ ] Matches ETAP results
   Bus_3: 0.174 kA - [ ] Matches ETAP results
   Bus_4: 0.329 kA - [ ] Matches ETAP results
   Bus_5: 7.597 kA - [ ] Matches ETAP results
   Bus_6: 0.773 kA - [ ] Matches ETAP results
   Bus_7: 0.246 kA - [ ] Matches ETAP results
   Bus_8: 0.074 kA - [ ] Matches ETAP results
   Bus_9: 0.773 kA - [ ] Matches ETAP results

5. RELAY COORDINATION VERIFICATION (Bus 5):
   Relay2 Operation Time: 20.0 ms - [ ] Matches ETAP results
   T1_HS2 Operation Time: 83.3 ms - [ ] Matches ETAP results
   T1_LS2 Operation Time: 83.3 ms - [ ] Matches ETAP results
   Fault Clearing Time: 83.3 ms - [ ] Matches ETAP results

6. SYSTEM PARAMETERS VERIFICATION:
   Base MVA: 100 MVA - [ ] Matches ETAP system base
   Base kV: 11.33 kV - [ ] Matches ETAP system base
   Base Impedance: 1.284 Ohms - [ ] Matches ETAP calculations

7. CRITICAL BUS ANALYSIS:
   Highest 3-Phase Fault Current: Bus_5 (9.746 kA) - [ ] Matches ETAP critical bus
   Highest LG Fault Current: Bus_5 (7.488 kA) - [ ] Matches ETAP critical bus
   Highest LL Fault Current: Bus_5 (8.440 kA) - [ ] Matches ETAP critical bus
   Highest LLG Fault Current: Bus_5 (7.597 kA) - [ ] Matches ETAP critical bus

8. IMPEDANCE DATA VERIFICATION:
   Verify the following impedance values match ETAP Pages 9 & 11:
   Bus_1: R1=0.249, X1=8.500, R0=8.500, X0=8.500 Ohms - [ ] Matches ETAP
   Bus_2: R1=0.515, X1=21.800, R0=37.100, X0=82.200 Ohms - [ ] Matches ETAP
   Bus_3: R1=0.426, X1=24.500, R0=20.600, X0=106.000 Ohms - [ ] Matches ETAP
   Bus_4: R1=0.477, X1=17.300, R0=17.300, X0=18.400 Ohms - [ ] Matches ETAP
   Bus_5: R1=0.484, X1=0.465, R0=1.363, X0=0.268 Ohms - [ ] Matches ETAP
   Bus_6: R1=0.847, X1=16.900, R0=0.000, X0=0.000 Ohms - [ ] Matches ETAP
   Bus_7: R1=0.571, X1=15.000, R0=57.100, X0=150.000 Ohms - [ ] Matches ETAP
   Bus_8: R1=0.602, X1=60.200, R0=71.600, X0=207.000 Ohms - [ ] Matches ETAP
   Bus_9: R1=0.847, X1=16.900, R0=0.000, X0=0.000 Ohms - [ ] Matches ETAP

9. CALCULATION METHOD VERIFICATION:
   [ ] Positive sequence impedance (Z1) used correctly
   [ ] Negative sequence impedance (Z2 = Z1) assumption verified
   [ ] Zero sequence impedance (Z0) values match ETAP
```

```
   [ ] Fault impedance (Zf = 0) for solid faults confirmed
   [ ] Pre-fault voltage (V = 1.0 pu) assumption verified

10. CONVERSION FACTOR VERIFICATION:
    Current conversion factor: 6.5414 - [ ] Matches ETAP conversion
    Formula: I_actual = I_pu * (base_kV / sqrt(3))

=== END OF VERIFICATION CHECKLIST ===
------------------------------------------------------------
NOTE: Check each box [ ] after verifying against ETAP results
If any values do not match, review impedance data and calculation methods.

=== Analysis Complete ===
Full-screen tabbed interface created with:
• Tab 1: Fault Current Table with Summary Statistics
• Tab 2: Comparative Bar Graph for All Fault Types
• Tab 3: Relay Coordination Timeline for Bus 5
• Tab 4: Individual Fault Type Analysis
Navigate between tabs to explore different aspects of the analysis.
>>
```