SUPPORTING INFORMATION

Cobalt-Catalyzed Direct Carbonylation of Aminoquinoline Benzamides

Liene Grigorjeva and Olafs Daugulis*
Department of Chemistry, University of Houston, Houston, TX 77204-5003

General considerations

Reactions were performed using standard glassware or were run in 2-dram vials with PTFE/Liner screw caps and 8-dram vials using w/polyseal screw caps. Column chromatography was performed on 60Å silica gel (Dynamic Adsorbents Inc.). ^{1}H, ^{13}C, ^{19}F-NMR spectra were recorded on JEOL EC-400 and JEOL EC-500 spectrometers using residual solvent peak as a reference. Compounds for HRMS were analyzed by chemical ionization (CI) using Micromass Autospec Ultima spectrometer at the Mass Spectrometry Facility of the Department of Chemistry and Biochemistry of University of Texas-Austin. IR- spectra were obtained using a Perkin Elmer Spectrum 100 FT-IR spectrometer. Analytical thin layer chromatography was performed on silica gel IB-F (Baker-flex) by J. T. Baker. All procedures were performed under ambient air unless otherwise noted. Reagents and starting materials were obtained from commercial sources and used without further purification unless otherwise noted.

Substrate synthesis

Amides were synthesized according to literature procedures from 8-aminoquinoline and corresponding acyl chlorides (procedure **I**) or acids (procedure **II**).[1]

Procedure **I**.

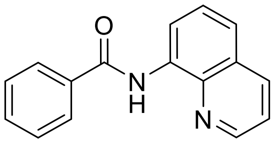
Synthesis of N-(quinolin-8-yl)benzamide is representative.

To a solution of 8-aminoquinoline (3.00 g, 21 mmol) and *N*,*N*-dimethyl-4-aminopyridine (80 mg, 0.65 mmol) in anhydrous CH_2Cl_2 (30 mL) under nitrogen Et_3N (3.3 mL, 24 mmol, 1.2 equiv) was added and resulting solution was cooled to 0 °C. Benzoyl chloride (2.3 mL, 20 mmol) was added dropwise and reaction mixture was stirred at room temperature overnight. The mixture was quenched with water (30 mL) and extracted with CH_2Cl_2 (3 x 20 mL). Combined organic phase was dried over $MgSO_4$ and filtered. Concentration in vacuum followed by recrystallization from toluene afforded 4.6 g (94%) of *N*-(quinolin-8-yl)benzamide as a white solid.

---

[1] Grigorjeva, L.; Daugulis, O. *Angew. Chem., Int. Ed.* **2014**, in press.

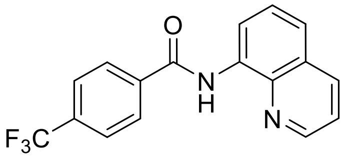
N-(Quinolin-8-yl)benzamide



This compound is known.[1]

^{1}H-NMR (500 MHz, $CDCl_3$, ppm) δ 10.76 (s, 1H), 8.95 (dd, *J* = 7.6, 1.3 Hz, 1H), 8.85 (dd, *J* = 4.2, 1.6 Hz, 1H), 8.19 (dd, *J* = 8.3, 1.6 Hz, 1H), 8.14-8.04 (m, 2H), 7.68 – 7.52 (m, 5H) and 7.48 (dd, *J* = 8.2, 4.2 Hz, 1H).

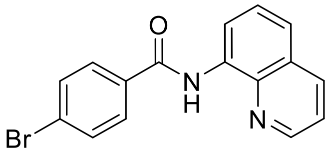
4-Trifluoromethyl-*N*-(quinolin-8-yl)benzamide



8-Aminoquinoline (3.00 g, 21 mmol), *N*,*N*-dimethyl-4-aminopyridine (80 mg, 0.65 mmol), Et_3N (3.3 mL, 24 mmol, 1.2 equiv), 4-trifluoromethylbenzoyl chloride (3.0 mL, 20 mmol), CH_2Cl_2 (30 mL). Recrystallization from hexanes/EtOAc 4:1 afforded 5.50 g (88%) of 4-trifluoromethyl-*N*-(quinolin-8-yl)benzamide as a white solid. This compound is known.[1]

^{1}H-NMR (500 MHz, $CDCl_3$, ppm) δ 10.80 (s, 1H), 8.92 (dd, *J* = 7.2, 1.7 Hz, 1H), 8.86 (dd, *J* = 4.2, 1.7 Hz, 1H), 8.25 – 8.16 (m, 3H), 7.82 (d, *J* = 8.1 Hz, 2H), 7.65 – 7.56 (m, 2H) and 7.51 (dd, *J* = 8.3, 4.2 Hz, 1H).

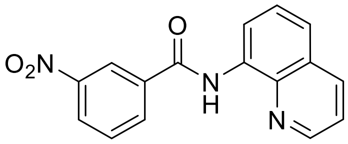
4-Bromo-*N*-(quinolin-8-yl)benzamide



8-Aminoquinoline (3.00 g, 21 mmol), *N*,*N*-dimethyl-4-aminopyridine (80 mg, 0.65 mmol), Et_3N (3.3 mL, 24 mmol, 1.2 equiv), 4-bromobenzoyl chloride (4.39 g, 20 mmol), CH_2Cl_2 (30 mL). Recrystallization from toluene afforded 5.84 g (89%) of 4-bromo-*N*-(quinolin-8-yl)benzamide as a white solid. This compound is known.[1]

^{1}H-NMR (500 MHz, $CDCl_3$, ppm) δ 10.71 (s, 1H), 8.90 (dd, *J* = 7.4, 1.5 Hz, 1H), 8.85 (dd, *J* = 4.2, 1.7 Hz, 1H), 8.19 (dd, *J* = 8.3, 1.6 Hz, 1H), 7.97 – 7.91 (m, 2H), 7.71 – 7.65 (m, 2H), 7.62 – 7.53 (m, 2H) and 7.48 (dd, *J* = 8.3, 4.2 Hz, 1H).

3-Nitro-*N*-(quinolin-8-yl)benzamide



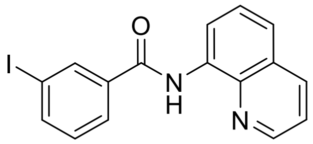
8-Aminoquinoline (1.44 g, 10 mmol), *N*,*N*-dimethyl-4-aminopyridine (40 mg, 0.33 mmol), Et_3N (1.7 mL, 12 mmol, 1.2 equiv), 3-nitrobenzoyl chloride (1.855 g, 10 mmol), CH_2Cl_2 (30 mL). Recrystallization from hexanes/EtOAc 4:1 afforded 2.62 g (90%) of 3-nitro-*N*-(quinolin-8-yl)benzamide as a light yellow solid. This compound is known.[2]

---

[2] Broxton, T. J.; Deady, L. W.; Pang, Y-T. *J. Am. Chem. Soc.*, **1977**, *99*, 2268.

^{1}H-NMR (400 MHz, CDCl$_3$, ppm) δ 10.81 (s, 1H), 8.95 – 8.81 (m, 3H), 8.45 – 8.37 (m, 2H), 8.21 (dd, *J* = 8.3, 1.7 Hz, 1H), 7.75 (t, *J* = 8.0 Hz, 1H), 7.64 – 7.58 (m, 2H), 7.51 (dd, *J* = 8.3, 4.2 Hz, 1H).

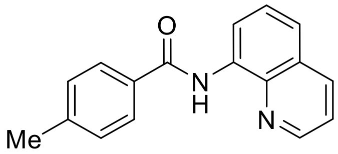
3-Iodo-*N*-(quinolin-8-yl)benzamide



8-Aminoquinoline (1.50 g, 10.5 mmol), *N*,*N*-dimethyl-4-aminopyridine (40 mg, 0.33 mmol), Et$_3$N (1.65 mL, 12 mmol, 1.2 equiv), 3-iodobenzoyl chloride (2.67 g, 10 mmol), CH$_2$Cl$_2$ (15 mL). Recrystallization from hexanes/EtOAc 2:1 afforded 3.46 g (93%) of 3-iodo-*N*-(quinolin-8-yl)benzamide as a white solid. This compound is known.[1]

^{1}H-NMR (500 MHz, CDCl$_3$, ppm) δ 10.67 (s, 1H), 8.90 (dd, *J* = 7.4, 1.6 Hz, 1H), 8.86 (dd, *J* = 4.2, 1.6 Hz, 1H), 8.41 (t, *J* = 1.7 Hz, 1H), 8.20 (dd, *J* = 8.3, 1.6 Hz, 1H), 8.02 (dd, *J* = 7.8, 1.6 Hz, 1H), 7.91 (dd, *J* = 7.8, 1.6 Hz, 1H), 7.63 – 7.54 (m, 2H), 7.49 (dd, *J* = 8.2, 4.2 Hz, 1H) and 7.29 (t, *J* = 7.8 Hz, 1H).

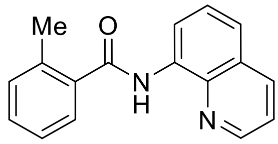
4-Methyl-*N*-(quinolin-8-yl)benzamide



8-Aminoquinoline (6.00 g, 42 mmol), *N*,*N*-dimethyl-4-aminopyridine (160 mg, 1.3 mmol), Et$_3$N (6.6 mL, 48 mmol, 1.2 equiv), 4-toluoyl chloride (5.3 mL, 40 mmol), CH$_2$Cl$_2$ (60 mL). Recrystallization from toluene afforded 9.0 g (86%) of amide 4-methyl-*N*-(quinolin-8-yl)benzamide as a white solid. This compound is known.[1]

^{1}H-NMR (500 MHz, CDCl$_3$, ppm) δ 10.73 (s, 1H), 8.94 (dd, *J* = 7.6, 1.3 Hz, 1H), 8.85 (dd, *J* = 4.2, 1.7 Hz, 1H), 8.18 (dd, *J* = 8.3, 1.7 Hz, 1H), 8.02 – 7.96 (m, 2H), 7.59 (t, *J* = 7.9 Hz, 1H), 7.53 (dd, *J* = 8.3, 1.3 Hz, 1H), 7.47 (dd, *J* = 8.2, 4.2 Hz, 1H), 7.35 (d, *J* = 7.8 Hz, 2H), 2.45 (s, 3H).

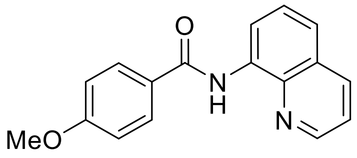
2-Methyl-*N*-(quinolin-8-yl)benzamide



8-Aminoquinoline (3.00 g, 21 mmol), *N*,*N*-dimethyl-4-aminopyridine (80 mg, 0.65 mmol), Et$_3$N (3.3 mL, 24 mmol, 1.2 equiv), 2-toluoyl chloride (2.6 mL, 20 mmol), CH$_2$Cl$_2$ (30 mL). Recrystallization from hexanes/EtOAc 1:1 afforded 3.91 g (75%) of 2-methyl-*N*-(quinolin-8-yl)benzamide as a white solid. This compound is known.[1]

^{1}H-NMR (500 MHz, CDCl$_3$, ppm) δ 10.22 (s, 1H), 8.95 (d, *J* = 7.3 Hz, 1H), 8.78 (dd, *J* = 4.2, 1.7 Hz, 1H), 8.19 (dd, *J* = 8.3, 1.6 Hz, 1H), 7.69 (d, *J* = 7.7 Hz, 1H), 7.63 – 7.54 (m, 2H), 7.46 (dd, *J* = 8.3, 4.2 Hz, 1H), 7.41 (td, *J* = 7.5, 1.4 Hz, 1H), 7.33 (t, *J* = 8.0 Hz, 2H) and 2.61 (s, 3H).

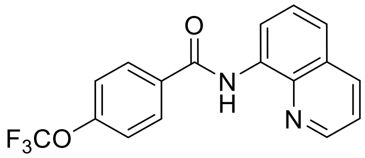
4-Methoxy-*N*-(quinolin-8-yl)benzamide



8-Aminoquinoline (1.44 g, 10 mmol), *N*,*N*-dimethyl-4-aminopyridine (40 mg, 0.33 mmol), Et_3N (1.7 mL, 12 mmol, 1.2 equiv), 4-methoxybenzoyl chloride (1.71 g, 10 mmol), CH_2Cl_2 (40 mL). Recrystallization from hexanes/EtOAc 4:1 afforded 2.31 g (83%) of 4-methoxy-*N*-(quinolin-8-yl)benzamide as a white solid. This compound is known.[2]

^{1}H-NMR (400 MHz, $CDCl_3$, ppm) δ 10.68 (s, 1H), 8.93 (dd, *J* = 7.6, 1.3 Hz, 1H), 8.84 (dd, *J* = 4.2, 1.6 Hz, 1H), 8.17 (dd, *J* = 8.3, 1.6 Hz, 1H), 8.09 – 8.04 (m, 2H), 7.59 (t, *J* = 7.9 Hz, 1H), 7.52 (dd, *J* = 8.3, 1.3 Hz, 1H), 7.47 (dd, *J* = 8.3, 4.2 Hz, 1H), 7.07 – 7.01 (m, 2H), 3.89 (s, 3H).

4-Trifluoromethoxy-*N*-(quinolin-8-yl)benzamide



8-Aminoquinoline (721 mg, 5 mmol), *N*,*N*-dimethyl-4-aminopyridine (20 mg, 0.16 mmol), Et_3N (0.8 mL, 6 mmol, 1.2 equiv), 4-trifluoromethoxybenzoyl chloride (0.8 mL, 5 mmol), CH_2Cl_2 (15 mL). Recrystallization from hexanes/Et_2O 3:1 afforded 1.34 g (81%) of 4-trifluoromethoxy-*N*-(quinolin-8-yl)benzamide as a white solid. R_f = 0.70 (hexanes/EtOAc 4:1), mp 85 – 87 °C (hexanes/Et_2O 3:1).

^{1}H-NMR (500 MHz, $CDCl_3$, ppm) δ 10.71 (s, 1H), 8.90 (dd, *J* = 7.4, 1.4 Hz, 1H), 8.83 (dd, *J* = 4.2, 1.6 Hz, 1H), 8.17 (dd, *J* = 8.3, 1.6 Hz, 1H), 8.14 – 8.08 (m, 2H), 7.61 – 7.52 (m, 2H), 7.46 (dd, *J* = 8.2, 4.2 Hz, 1H), 7.37 (d, *J* = 8.0 Hz, 2H).

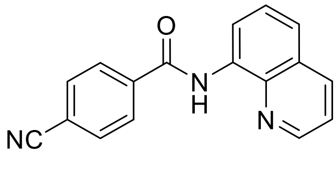
^{13}C-NMR (125 MHz, $CDCl_3$, ppm) δ 164.0, 151.7, 148.3, 138.6, 136.4, 134.2, 133.5, 129.1, 127.9, 127.4, 121.9, 121.7, 120.7, 120.3 (q, J_{C-F} = 260.3 Hz), 116.5.

^{19}F-NMR (470 MHz, $CDCl_3$, ppm) δ -57.51.

HRMS calcd. for $C_{17}H_{11}N_2O_2F_3$ $[M]^+$: 332.0773; found: 332.0773.

FT-IR (neat, cm^{-1}) υ 1716, 1537, 1500, 1397, 1341, 1237, 1205, 1119, 1106.

4-Cyano-*N*-(quinolin-8-yl)benzamide



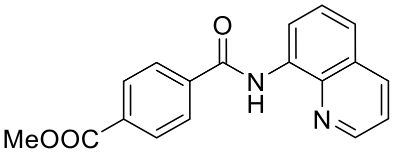
8-Aminoquinoline (1.44 g, 10 mmol), *N*,*N*-dimethyl-4-aminopyridine (40 mg, 0.33 mmol), Et_3N (1.7 mL, 12 mmol, 1.2 equiv), 4-cyanobenzoyl chloride (1.65 g, 10 mmol), CH_2Cl_2 (40 mL). Recrystallization from hexanes/EtOAc 4:1 afforded 2.30 g (84%) of 4-cyano-*N*-(quinolin-8-yl)benzamide as a white solid. This compound is known.[3]

---

[3] Truong, T.; Klimovica, K.; Daugulis, O. *J. Am. Chem. Soc.* **2013**, *135*, 9342.

^{1}H-NMR (500 MHz, $CDCl_3$, ppm) δ 10.80 (s, 1H), 8.90 (dd, *J* = 6.3, 2.7 Hz, 1H), 8.86 (dd, *J* = 4.2, 1.7 Hz, 1H), 8.22 (dd, *J* = 8.3, 1.7 Hz, 1H), 8.20 – 8.16 (m, 2H), 7.88 – 7.82 (m, 2H), 7.64 – 7.58 (m, 2H), 7.51 (dd, *J* = 8.3, 4.2 Hz, 1H).

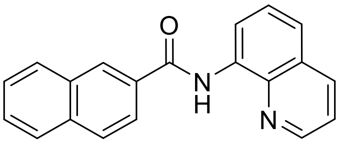
Methyl 4-(quinolin-8-ylcarbamoyl)benzoate



8-Aminoquinoline (721 mg, 5 mmol), *N*,*N*-dimethyl-4-aminopyridine (20 mg, 0.16 mmol), Et_3N (0.8 mL, 6 mmol, 1.2 equiv), acid chloride (993 mg, 5 mmol), CH_2Cl_2 (15 mL). Recrystallization from hexanes/EtOAc 4:1 afforded 1.21 g (79%) of methyl 4-(quinolin-8-ylcarbamoyl)benzoate as a white solid. This compound is known.[4]

^{1}H-NMR (500 MHz, $CDCl_3$, ppm) δ 10.78 (s, 1H), 8.92 (dd, *J* = 7.4, 1.5 Hz, 1H), 8.85 (dd, *J* = 4.2, 1.6 Hz, 1H), 8.25 – 8.15 (m, 3H), 8.15 – 8.11 (m, 2H), 7.63 – 7.54 (m, 2H), 7.48 (dd, *J* = 8.2, 4.2 Hz, 1H), 3.97 (s, *J* = 4.3 Hz, 3H).

***N*-(8-Quinolinyl)-2-naphthamide**



8-Aminoquinoline (1.514 g, 10.5 mmol), *N*,*N*-dimethyl-4-aminopyridine (40 mg, 0.33 mmol), Et_3N (1.7 mL, 12 mmol, 1.2 equiv), naphthoyl chloride (1.906 mg, 10 mmol), CH_2Cl_2 (40 mL). Recrystallization from hexanes/EtOAc 4:1 afforded 2.60 g (87%) of *N*-(8-quinolinyl)-2-naphthamide as a white solid. This compound is known.[2]

^{1}H-NMR (500 MHz, $CDCl_3$, ppm) δ 10.88 (s, 1H), 9.00 (d, *J* = 7.6 Hz, 1H), 8.91 – 8.83 (m, 1H), 8.59 (s, 1H), 8.16 (d, *J* = 8.2 Hz, 1H), 8.13 (d, *J* = 8.5 Hz, 1H), 8.03 (d, *J* = 7.4 Hz, 1H), 7.98 (d, *J* = 8.5 Hz, 1H), 7.91 (d, *J* = 7.5 Hz, 1H), 7.63 – 7.53 (m, 4H), 7.49 – 7.44 (m, 1H).

Procedure **II**.

Synthesis of N-(quinolin-8-yl)cinnamamide is representative.

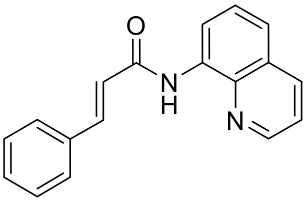
Cinnamic acid (2.22 g, 15 mmol, 1.5 equiv) and Et_3N (4.8 mL, 35 mmol, 3.5 equiv) were dissolved in CH_2Cl_2 (30 mL), flask was flushed with nitrogen and the resulting mixture was cooled to 0 °C. Ethyl chloroformate (1.4 mL, 15 mmol, 1.5 equiv) was added dropwise and solution was stirred at 0 °C for 30 minutes followed by dropwise addition of 8-aminoquinoline (1.44 g, 10 mmol) solution in CH_2Cl_2 (10 mL). The resulting suspension was warmed up to room temperature and stirred overnight.

---

[4] Tran, L. D.; Roane, J.; Daugulis, O. *Angew. Chem., Int. Ed.* **2013**, *52*, 6043.

After completion, water (30 mL) was added to the reaction mixture and the layers were separated. The aqueous layer was extracted with CH_2Cl_2 (2 x 30 mL). The combined organic phase was dried over $MgSO_4$ and filtered, solvent was evaporated. Purification by column chromatography on silica gel (hexanes/EtOAc from 4:1 to 2:1) afforded 1.85 g (67%) *N*-(quinolin-8-yl)cinnamamide as a white solid.

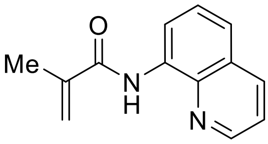
N-(Quinolin-8-yl)cinnamamide



This compound is known.[1]

^{1}H-NMR (400 MHz, $CDCl_3$, ppm) δ 10.02 (s, 1H), 8.92 (dd, *J* = 7.5, 1.5 Hz, 1H), 8.85 (dd, *J* = 4.2, 1.7 Hz, 1H), 8.19 (dd, *J* = 8.3, 1.6 Hz, 1H), 7.83 (d, *J* = 15.6 Hz, 1H), 7.65 – 7.51 (m, 4H), 7.48 (dd, *J* = 8.3, 4.2 Hz, 1H), 7.46 – 7.38 (m, 3H) and 6.82 (d, *J* = 15.5 Hz, 1H).

N-(Quinolin-8-yl)methacrylamide



Methacrylic acid (0.85 mL, 10 mmol), Et_3N (1.7 mL, 12 mmol, 1.2 equiv), ethyl chloroformate (0.96 mL, 10 mmol, 1 equiv), 8-aminoquinoline (1.44 g, 10 mmol), CH_2Cl_2 (30 mL). Purification by column chromatography on silica gel (hexanes/EtOAc 4:1) afforded 1.51 g (71%) of *N*-(quinolin-8-yl)methacrylamide as a colorless oil. This compound is known.[1]

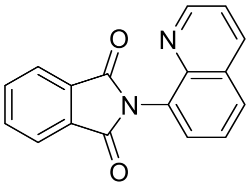
^{1}H-NMR (500 MHz, $CDCl_3$, ppm) δ 10.36 (s, 1H), 8.94 – 8.65 (m, 2H), 8.14 (dd, *J* = 8.2, 1.5 Hz, 1H), 7.60 – 7.48 (m, 2H), 7.44 (dd, *J* = 8.2, 4.2 Hz, 1H), 6.05 (s, 1H), 5.55 (s, *J* = 0.5 Hz, 1H), 2.19 (s, *J* = 0.8 Hz, 3H).

Cobalt-catalyzed carbonylation of aminoquinoline amides

General procedure for cobalt catalyzed carbonylation/cyclization.

A 8 dram vial with septum equipped with a magnetic stir bar was charged with amide (0.5 mmol), $Co(acac)_2$ (0.1 mmol, 20 mol%), NaOPiv (1 mmol, 2 equiv), $Mn(OAc)_3*2H_2O$ (0.5 mmol, 1 equiv), and CF_3CH_2OH (5 mL). Resulting solution was purged with CO gas for 5 min, vial was equipped with CO balloon and stirred at room temperature for indicated time, monitored by TLC after 6 h, 16 h, 20 h. After each opening, the reaction mixture was purged with CO for 1 minute and the vial was equipped with a CO balloon. Reaction solvent was evaporated, product was purified using column chromatography on silica gel using appropriate eluent. After purification product was dried under reduced pressure.

2-(Quinolin-8-yl)isoindoline-1,3-dione (Table 1, Entry 1)

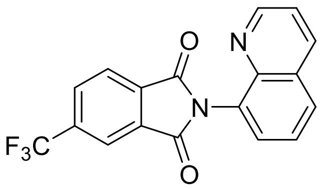


N-(Quinolin-8-yl)benzamide (124 mg, 0.5 mmol), Co(acac)$_2$ (26 mg, 0.1 mmol, 20 mol%), NaOPiv (124 mg, 1 mmol, 2 equiv), Mn(OAc)$_3$*2H$_2$O (134 mg, 0.5 mmol, 1 equiv), and CF$_3$CH$_2$OH (5 mL), 16 h, RT. After column chromatography (gradient hexanes/EtOAc from 4:1 to 2:1) 111 mg (81%) of a white solid was obtained. This compound is known.[5]

^{1}H-NMR (500 MHz, CDCl$_3$, ppm) δ 8.85 (dd, *J* = 4.2, 1.6 Hz, 1H), 8.21 (dd, *J* = 8.3, 1.6 Hz, 1H), 7.99 (dd, *J* = 5.4, 3.1 Hz, 2H), 7.95 (dd, *J* = 8.2, 1.2 Hz, 1H), 7.79 (dd, *J* = 5.4, 3.1 Hz, 2H), 7.76 (dd, *J* = 7.2, 1.3 Hz, 1H), 7.71 – 7.62 (m, 1H), 7.43 (dd, *J* = 8.3, 4.2 Hz, 1H).

^{13}C-NMR (125 MHz, CDCl$_3$, ppm) δ 167.9, 150.9, 144.2, 136.1, 134.2, 132.4, 130.2, 129.7, 129.6, 129.2, 126.1, 123.8, 121.9.

2-(Quinolin-8-yl)-5-(trifluoromethyl)isoindoline-1,3-dione (Table 1, Entry 2)



4-Trifluoromethyl-*N*-(quinolin-8-yl)benzamide (158 mg, 0.5 mmol) Co(acac)$_2$ (26 mg, 0.1 mmol, 20 mol%), NaOPiv (124 mg, 1 mmol, 2 equiv), Mn(OAc)$_3$*2H$_2$O (134 mg, 0.5 mmol, 1 equiv), and CF$_3$CH$_2$OH (5 mL), 16 h, RT. After column chromatography (gradient hexanes/EtOAc from 4:1 to 2:1) 144 mg (83%) of a white solid was obtained. R$_f$ = 0.73 (hexanes/EtOAc 1:1), mp 173 – 175 °C (Et$_2$O).

^{1}H-NMR (500 MHz, CDCl$_3$, ppm) δ 8.84 (d, *J* = 2.8 Hz, 1H), 8.28 (s, 1H), 8.23 (d, *J* = 8.1 Hz, 1H), 8.13 (d, *J* = 7.7 Hz, 1H), 8.09 (d, *J* = 7.7 Hz, 1H), 7.98 (d, *J* = 8.0 Hz, 1H), 7.76 (d, *J* = 6.8 Hz, 1H), 7.68 (t, *J* = 7.7 Hz, 1H), 7.45 (dd, *J* = 8.2, 4.1 Hz, 1H).

^{13}C-NMR (125 MHz, CDCl$_3$, ppm) δ 166.6, 166.5, 151.0, 144.0, 136.2 (q, $J_{C\text{-}F}$ = 33.6 Hz), 136.2, 135.2, 133.0, 131.3 (q, $J_{C\text{-}F}$ = 3.6 Hz), 130.1, 129.9, 129.3, 126.1, 124.4, 123.1 (q, $J_{C\text{-}F}$ = 237.3 Hz), 122.1, 121.1 (q, $J_{C\text{-}F}$ = 3.6 Hz).

^{19}F-NMR (470 MHz, CDCl$_3$, ppm) δ -62.73.

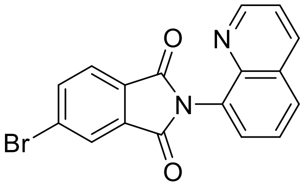
HRMS calcd. for $C_{18}H_9N_2O_2F_3$ [M]$^+$: 342.0616; found: 342.0618.

FT-IR (neat, cm^{-1}) υ 1715, 1396, 1380, 1320, 1165, 1133, 1095.

---

[5] Mullice, L. A.; Thorp-Greenwood, F. L.; Laye, R. H.; Coogan, M. P.; Kariuki, B. M.; Pope, S. J. A. *Dalton Trans.* **2009**, 6836.

5-Bromo-2-(quinolin-8-yl)isoindoline-1,3-dione (Table 1, Entry 3)



4-Bromo-*N*-(quinolin-8-yl)benzamide (164 mg, 0.5 mmol), Co(acac)$_2$ (26 mg, 0.1 mmol, 20 mol%), NaOPiv (124 mg, 1 mmol, 2 equiv), Mn(OAc)$_3$*2H$_2$O (134 mg, 0.5 mmol, 1 equiv), and CF$_3$CH$_2$OH (5 mL), 16 h, RT. After column chromatography (gradient hexanes/EtOAc from 4:1 to 2:1) 141 mg (80%) of a white solid was obtained. R$_f$ = 0.68 (hexanes/EtOAc 1:1), mp 208 – 210 °C (Et$_2$O).

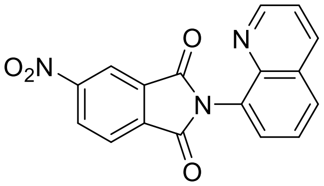
^{1}H-NMR (500 MHz, CDCl$_3$, ppm) δ 8.84 (dd, *J* = 4.2, 1.7 Hz, 1H), 8.22 (dd, *J* = 8.3, 1.7 Hz, 1H), 8.13 (d, *J* = 1.4 Hz, 1H), 7.96 (dd, *J* = 8.3, 1.4 Hz, 1H), 7.94 (dd, *J* = 7.9, 1.7 Hz, 1H), 7.85 (d, *J* = 7.7 Hz, 1H), 7.74 (dd, *J* = 7.3, 1.4 Hz, 1H), 7.67 (dd, *J* = 8.2, 7.4 Hz, 1H), 7.43 (dd, *J* = 8.3, 4.2 Hz, 1H).

^{13}C-NMR (125 MHz, CDCl$_3$, ppm) δ 167.1, 166.6, 150.9, 144.0, 137.2, 136.2, 134.0, 130.9, 130.1, 129.8, 129.4, 129.2, 129.1, 127.2, 126.1, 125.2, 122.0.

HRMS calcd. for $C_{17}H_9N_2O_2{}^{79}Br$ [M]$^+$: 351.9847; found: 351.9846.

FT-IR (neat, cm^{-1}) υ 1712, 1500, 1473, 1416, 1395, 1377, 1261, 1236, 1111, 1100, 1067.

5-Nitro-2-(quinolin-8-yl)isoindoline-1,3-dione (Table 1, Entry 4)



3-Nitro-*N*-(quinolin-8-yl)benzamide (147 mg, 0.5 mmol), Co(acac)$_2$ (26 mg, 0.1 mmol, 20 mol%), NaOPiv (124 mg, 1 mmol, 2 equiv), Mn(OAc)$_3$*2H$_2$O (134 mg, 0.5 mmol, 1 equiv), and CF$_3$CH$_2$OH (5 mL), 32 h, RT. After column chromatography (gradient hexanes/CH$_2$Cl$_2$ from 2:1 to 1:1, then CH$_2$Cl$_2$/MeOH 95:5) 110 mg (69%) of a yellow solid was obtained. R$_f$ = 0.50 (hexanes/EtOAc 1:1), mp 229 – 231 °C (Et$_2$O).

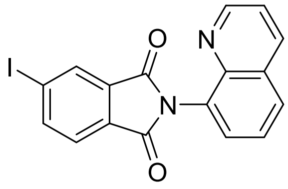
^{1}H-NMR (500 MHz, CDCl$_3$, ppm) δ 8.85 (dd, *J* = 4.1, 1.4 Hz, 1H), 8.81 (d, *J* = 1.8 Hz, 1H), 8.69 (dd, *J* = 8.1, 1.8 Hz, 1H), 8.26 (dd, *J* = 8.3, 1.4 Hz, 1H), 8.19 (d, *J* = 8.1 Hz, 1H), 8.01 (d, *J* = 8.2 Hz, 1H), 7.77 (dd, *J* = 7.2, 0.9 Hz, 1H), 7.70 (t, *J* = 7.8 Hz, 1H), 7.47 (dd, *J* = 8.3, 4.2 Hz, 1H).

^{13}C-NMR (125 MHz, CDCl$_3$, ppm) δ 165.8, 165.5, 151.9, 151.1, 143.8, 136.8, 136.3, 133.8, 130.1, 130.0, 129.4, 129.3, 129.0, 126.2, 125.1, 122.2, 119.3.

HRMS calcd. for $C_{17}H_9N_3O_4$ [M]$^+$: 319.0593; found: 319.0596.

FT-IR (neat, cm^{-1}) υ 1717, 1537, 1499, 1397, 1379, 1341, 1237, 1119, 1106.

5-Iodo-2-(quinolin-8-yl)isoindoline-1,3-dione (Table 1, Entry 5)



3-Iodo-*N*-(quinolin-8-yl)benzamide (187 mg, 0.5 mmol), Co(acac)$_2$ (26 mg, 0.1 mmol, 20 mol%), NaOPiv (124 mg, 1 mmol, 2 equiv), Mn(OAc)$_3$*2H$_2$O (134 mg, 0.5 mmol, 1 equiv), and CF$_3$CH$_2$OH (5 mL), 16 h, RT. After column chromatography (gradient hexanes/EtOAc from 4:1 to 2:1) 169 mg (84%) of a white solid was obtained. R$_f$ = 0.69 (hexanes/EtOAc 1:1), mp 202 – 204 °C (Et$_2$O).

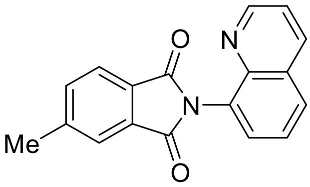
^{1}H-NMR (500 MHz, CDCl$_3$, ppm) δ 8.84 (d, *J* = 2.8 Hz, 1H), 8.34 (s, 1H), 8.21 (d, *J* = 8.0 Hz, 1H), 8.16 (d, *J* = 7.8 Hz, 1H), 7.95 (d, *J* = 8.1 Hz, 1H), 7.76 – 7.64 (m, 3H), 7.43 (dd, *J* = 8.1, 4.1 Hz, 1H).

^{13}C-NMR (125 MHz, CDCl$_3$, ppm) δ 167.3, 166.5, 150.9, 144.0, 143.1, 136.1, 133.7, 132.9, 131.5, 130.1, 129.7, 129.4, 129.2, 126.1, 125.1, 122.0, 101.1.

HRMS calcd. for $C_{17}H_9N_2O_2I$ $[M]^+$: 399.9709; found: 399.9703.

FT-IR (neat, cm^{-1}) υ 1714, 1410, 1395, 1374, 1362, 1236, 1109, 1097.

5-Methyl-2-(quinolin-8-yl)isoindoline-1,3-dione (Table 1, Entry 6)



Experiment 1.

4-Methyl-*N*-(quinolin-8-yl)benzamide (131 mg, 0.5 mmol), Co(acac)$_2$ (26 mg, 0.1 mmol, 20 mol%), NaOPiv (124 mg, 1 mmol, 2 equiv), Mn(OAc)$_3$*2H$_2$O (134 mg, 0.5 mmol, 1 equiv), and CF$_3$CH$_2$OH (5 mL), 16 h, RT. After column chromatography (gradient hexanes/EtOAc from 4:1 to 2:1) 121 mg (84%) of a white solid was obtained. R$_f$ = 0.49 (hexanes/EtOAc 1:1), mp 229 – 231 °C (Et$_2$O).

Experiment 2 (5 mmol scale).

A 100 mL flask with septum equipped with a magnetic stir bar was charged with 4-methyl-*N*-(quinolin-8-yl)benzamide (1.31 g, 5 mmol), Co(acac)$_2$ (257 mg, 1 mmol, 20 mol%), NaOPiv (1.240 g, 10 mmol, 2 equiv), Mn(OAc)$_3$*2H$_2$O (1.340 g, 5 mmol, 1 equiv), and CF$_3$CH$_2$OH (50 mL). Resulting solution was cooled to 0 °C and purged with CO gas for 10 min, after that flask was equipped with CO balloon and stirred at room temperature. After 16 h reaction progress was checked by TLC (hexanes/EtOAc 1:1). Reaction mixture was flushed with air, cooled to 0 °C and purged with CO gas for 10 minutes, flask was equipped with CO balloon and stirred at room temperature for another 16 h. Reaction solvent was evaporated, product was purified using column chromatography on silica gel (gradient hexanes/EtOAc from 4:1 to 2:1). After recrystallization from Et$_2$O and drying under reduced pressure 1.31 g (91%) of 2-(quinolin-8-yl)isoindoline-1,3-dione was obtained as a white solid.

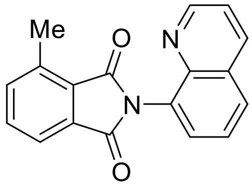
^{1}H-NMR (500 MHz, $CDCl_3$, ppm) δ 8.85 (dd, *J* = 4.1, 1.5 Hz, 1H), 8.21 (dd, *J* = 8.3, 1.4 Hz, 1H), 7.94 (d, *J* = 8.1 Hz, 1H), 7.87 (d, *J* = 7.6 Hz, 1H), 7.80 (s, 1H), 7.75 (dd, *J* = 7.3, 1.0 Hz, 1H), 7.69 – 7.64 (m, 1H), 7.59 (d, *J* = 7.6 Hz, 1H), 7.42 (dd, *J* = 8.2, 4.1 Hz, 1H), 2.55 (s, 3H).

^{13}C-NMR (125 MHz, $CDCl_3$, ppm) δ 168.1, 168.0, 150.9, 145.4, 144.3, 136.1, 134.7, 132.8, 130.2, 129.9, 129.8, 129.5, 129.2, 126.1, 124.3, 123.7, 121.8, 22.0.

HRMS calcd. for $C_{18}H_{12}N_2O_2$ $[M]^+$: 288.0899; found: 288.0899.

FT-IR (neat, cm^{-1}) υ 1709, 1395, 1376, 1364, 1100.

4-Methyl-2-(quinolin-8-yl)isoindoline-1,3-dione (Table 1, Entry 7)



2-Methyl-*N*-(quinolin-8-yl)benzamide (131 mg, 0.5 mmol), $Co(acac)_2$ (26 mg, 0.1 mmol, 20 mol%), NaOPiv (124 mg, 1 mmol, 2 equiv), $Mn(OAc)_3$*$2H_2O$ (134 mg, 0.5 mmol, 1 equiv), and CF_3CH_2OH (5 mL), 24 h, RT. After column chromatography (gradient hexanes/EtOAc from 4:1 to 1:1) 104 mg (72%) of a white solid was obtained. R_f = 0.52 (hexanes/EtOAc 1:1), mp 203 – 205 °C (Et_2O).

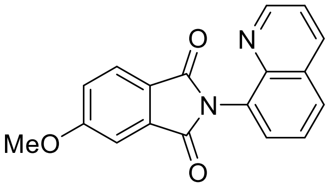
^{1}H-NMR (500 MHz, $CDCl_3$, ppm) δ 8.87 (dd, *J* = 4.1, 1.6 Hz, 1H), 8.21 (dd, *J* = 8.4, 1.6 Hz, 1H), 7.95 (dd, *J* = 8.2, 1.3 Hz, 1H), 7.82 (d, *J* = 7.3 Hz, 1H), 7.74 (dd, *J* = 7.2, 1.3 Hz, 1H), 7.67 (d, *J* = 8.4 Hz, 1H), 7.64 (d, *J* = 7.7 Hz, 1H), 7.54 (d, *J* = 7.9 Hz, 1H), 7.43 (dd, *J* = 8.3, 4.2 Hz, 1H), 2.76 (s, 3H).

^{13}C-NMR (125 MHz, $CDCl_3$, ppm) δ 168.7, 168.0, 150.9, 144.3, 138.5, 136.5, 136.2, 133.7, 132.8, 130.3, 129.9, 129.5, 129.2, 129.0, 126.1, 121.8, 121.5, 17.7.

HRMS calcd. for $C_{24}H_{12}N_2O_2$ $[M]^+$: 288.0899; found: 288.0900.

FT-IR (neat, cm^{-1}) υ 1707, 1500, 1473, 1394, 1377, 1263, 1240, 1103, 1030.

5-Methoxy-2-(quinolin-8-yl)isoindoline-1,3-dione (Table 1, Entry 8)



4-Methoxy-*N*-(quinolin-8-yl)benzamide (139 mg, 0.5 mmol), $Co(acac)_2$ (26 mg, 0.1 mmol, 20 mol%), NaOPiv (124 mg, 1 mmol, 2 equiv), $Mn(OAc)_3$*$2H_2O$ (134 mg, 0.5 mmol, 1 equiv), and CF_3CH_2OH (5 mL), 30 h, RT. After column chromatography (gradient hexanes/EtOAc from 4:1 to 1:1) 143 mg (94%) of a white solid was obtained. R_f = 0.39 (hexanes/EtOAc 1:1), mp 195 – 197 °C (Et_2O).

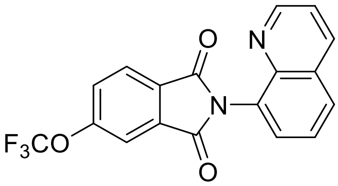
^{1}H-NMR (500 MHz, $CDCl_3$, ppm) δ 8.86 (d, *J* = 3.4 Hz, 1H), 8.21 (d, *J* = 8.1 Hz, 1H), 7.95 (d, *J* = 8.2 Hz, 1H), 7.89 (d, *J* = 8.3 Hz, 1H), 7.75 (d, *J* = 7.2 Hz, 1H), 7.66 (t, *J* = 7.7 Hz, 1H), 7.47 (d, *J* = 1.4 Hz, 1H), 7.43 (dd, *J* = 8.2, 4.1 Hz, 1H), 7.25 (dd, *J* = 8.5, 1.7 Hz, 1H), 3.95 (s, 3H).

^{13}C-NMR (125 MHz, $CDCl_3$, ppm) δ 167.8, 167.7, 164.8, 150.9, 144.3, 136.1, 135.0, 130.2, 129.9, 129.5, 129.2, 126.1, 125.5, 124.3, 121.8, 120.2, 108.2, 56.1.

HRMS calcd. for $C_{18}H_{12}N_2O_3$ $[M]^+$: 304.0848; found: 304.0841.

FT-IR (neat, cm^{-1}) υ 1716, 1537, 1499, 1474, 1397, 1379, 1342, 1237, 1119, 1105.

2-(Quinolin-8-yl)-5-(trifluoromethoxy)isoindoline-1,3-dione (Table 1, Entry 9)



4-Trifluoromethoxy-*N*-(quinolin-8-yl)benzamide (166 mg, 0.5 mmol), Co(acac)$_2$ (26 mg, 0.1 mmol, 20 mol%), NaOPiv (124 mg, 1 mmol, 2 equiv), $Mn(OAc)_3*2H_2O$ (134 mg, 0.5 mmol, 1 equiv), and CF_3CH_2OH (5 mL), 40 h, RT. After column chromatography (gradient hexanes/EtOAc from 4:1 to 1:1) 118 mg (66%) of a yellowish oil was obtained. $R_f = 0.76$ (hexanes/EtOAc 1:1).

^{1}H-NMR (500 MHz, $CDCl_3$, ppm) δ 8.88 (d, *J* = 2.4 Hz, 1H), 8.22 (d, *J* = 7.9 Hz, 1H), 8.04 (d, *J* = 8.0 Hz, 1H), 7.96 (d, *J* = 8.0 Hz, 1H), 7.85 (s, 1H), 7.74 (d, *J* = 6.8 Hz, 1H), 7.67 (t, *J* = 7.6 Hz, 1H), 7.61 (d, *J* = 7.7 Hz, 1H), 7.44 (dd, *J* = 7.9, 3.9 Hz, 1H).

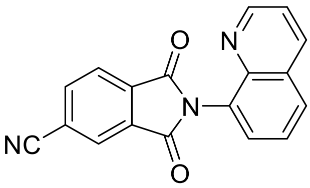
^{13}C-NMR (125 MHz, $CDCl_3$, ppm) δ 166.6, 166.3, 153.5, 151.0, 143.9, 136.3, 134.6, 130.2, 130.1, 129.8, 129.3, 129.2, 126.2, 126.1, 125.8, 122.0, 120.2 (q, $J_{C\text{-}F}$ = 261.5 Hz), 116.0.

^{19}F-NMR (470 MHz, $CDCl_3$, ppm) δ -57.61.

HRMS calcd. for $C_{18}H_9N_2O_3F_3$ $[M]^+$: 358.0565; found: 358.0566.

FT-IR (neat, cm^{-1}) υ 1720, 1502, 1475, 1399, 1379, 1367, 1243, 1206, 1164, 1106.

5-Cyano-2-(quinolin-8-yl)isoindoline-1,3-dione (Table 1, Entry 10)



4-Cyano-*N*-(quinolin-8-yl)benzamide (137 mg, 0.5 mmol), Co(acac)$_2$ (26 mg, 0.1 mmol, 20 mol%), NaOPiv (124 mg, 1 mmol, 2 equiv), $Mn(OAc)_3*2H_2O$ (134 mg, 0.5 mmol, 1 equiv), and CF_3CH_2OH (5 mL), 30 h, RT. After column chromatography (gradient hexanes/EtOAc from 4:1 to 1:1, then CH_2Cl_2) 112 mg (75%) of a white solid was obtained. $R_f = 0.41$ (hexanes/EtOAc 1:1), mp 303 – 305 °C (Et_2O).

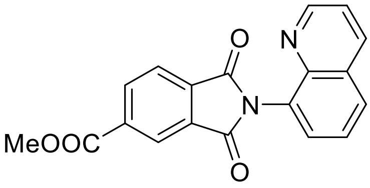
^{1}H-NMR (400 MHz, DMSO-d_6, ppm) δ 8.86 (dd, *J* = 4.1, 1.5 Hz, 1H), 8.59 (s, 1H), 8.54 (dd, *J* = 8.3, 1.4 Hz, 1H), 8.45 (dd, *J* = 7.7, 1.2 Hz, 1H), 8.24 – 8.19 (m, 2H), 7.95 (dd, *J* = 7.2, 1.1 Hz, 1H), 7.81 (t, *J* = 7.8 Hz, 1H), 7.64 (dd, *J* = 8.3, 4.2 Hz, 1H).

^{13}C-NMR (100 MHz, DMSO-d_6, ppm) δ 166.2, 165.9, 151.4, 143.5, 139.2, 136.7, 135.0, 132.3, 130.7, 130.1, 129.0, 128.7, 127.6, 126.4, 124.5, 122.5, 117.6, 117.1.

HRMS calcd. for $C_{18}H_9N_3O_2$ $[M]^+$: 299.0695; found: 299.0697.

FT-IR (neat, cm^{-1}) υ 1716, 1537, 1500, 1474, 1397, 1380, 1341, 1237, 1117, 1106.

Methyl 1,3-dioxo-2-(quinolin-8-yl)isoindoline-5-carboxylate (Table 1, Entry 11)



Methyl 4-(quinolin-8-ylcarbamoyl)benzoate (153 mg, 0.5 mmol), $Co(acac)_2$ (26 mg, 0.1 mmol, 20 mol%), NaOPiv (124 mg, 1 mmol, 2 equiv), $Mn(OAc)_3$*$2H_2O$ (134 mg, 0.5 mmol, 1 equiv), and CF_3CH_2OH (5 mL), 40 h, RT. After column chromatography (gradient hexanes/EtOAc from 4:1 to 1:1) 99 mg (60%) of a white solid was obtained. R_f = 0.43 (hexanes/EtOAc 1:1), mp 186 – 188 °C (Et_2O).

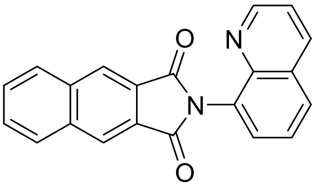
^{1}H-NMR (500 MHz, $CDCl_3$, ppm) δ 8.84 (dd, *J* = 4.2, 1.6 Hz, 1H), 8.64 (s, 1H), 8.50 (dd, *J* = 7.8, 1.2 Hz, 1H), 8.23 (dd, *J* = 8.3, 1.5 Hz, 1H), 8.08 (d, *J* = 7.8 Hz, 1H), 7.98 (dd, *J* = 8.2, 1.1 Hz, 1H), 7.76 (dd, *J* = 7.3, 1.2 Hz, 1H), 7.70 – 7.66 (m, 1H), 7.45 (dd, *J* = 8.3, 4.2 Hz, 1H), 4.01 (s, 3H).

^{13}C-NMR (125 MHz, $CDCl_3$, ppm) δ 167.1, 165.4, 151.1, 144.2, 136.3, 135.9, 135.8, 135.7, 132.8, 130.2, 130.0, 129.6, 129.4, 126.3, 126.2, 125.1, 124.1, 122.1, 53.0.

HRMS calcd. for $C_{19}H_{12}N_2O_4$ $[M]^+$: 332.0797; found: 332.0791.

FT-IR (neat, cm^{-1}) υ 1716, 1537, 1397, 1380, 1342, 1236, 1120, 1105.

2-(Quinolin-8-yl)-1H-benzo[f]isoindole-1,3(2H)-dione (Table 1, Entry 12)



N-(Quinolin-8-yl)-2-naphthalenecarboxamide (149 mg, 0.5 mmol), $Co(acac)_2$ (26 mg, 0.1 mmol, 20 mol%), NaOPiv (124 mg, 1 mmol, 2 equiv), $Mn(OAc)_3$*$2H_2O$ (134 mg, 0.5 mmol, 1 equiv), and CF_3CH_2OH (5 mL), 30 h, RT. After column chromatography (gradient hexanes/EtOAc from 4:1 to 2:1) 124 mg (77%) of a white solid was obtained. R_f = 0.59 (hexanes/EtOAc 1:1), mp 278 – 280 °C (Et_2O).

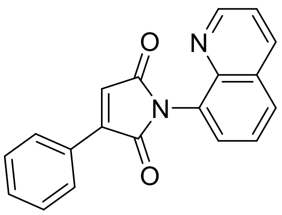
^{1}H-NMR (500 MHz, $CDCl_3$, ppm) δ 8.87 (dd, *J* = 4.1, 1.5 Hz, 1H), 8.50 (s, 2H), 8.24 (dd, *J* = 8.3, 1.5 Hz, 1H), 8.11 (dd, *J* = 6.1, 3.3 Hz, 2H), 7.98 (dd, *J* = 8.3, 1.0 Hz, 1H), 7.81 (dd, *J* = 7.2, 1.2 Hz, 1H), 7.74 – 7.68 (m, 3H), 7.45 (dd, *J* = 8.3, 4.1 Hz, 1H).

^{13}C-NMR (125 MHz, $CDCl_3$, ppm) δ 167.7, 151.0, 144.2, 136.2, 135.6, 130.3, 130.1, 130.0, 129.7, 129.3, 129.2, 128.1, 126.2, 125.3, 121.9.

HRMS calcd. for $C_{21}H_{12}N_2O_2$ $[M]^+$: 324.0899; found: 324.0897.

FT-IR (neat, cm^{-1}) υ 1717, 1557, 1375, 1264, 1136, 1031.

3-Phenyl-1-(quinolin-8-yl)-1H-pyrrole-2,5-dione (4, Scheme 3)



Experiment 1.

N-(Quinolin-8-yl)cinnamamide (137 mg, 0.5 mmol), Co(acac)$_2$ (26 mg, 0.1 mmol, 20 mol%), NaOPiv (124 mg, 1 mmol, 2 equiv), Mn(OAc)$_3$*2H$_2$O (134 mg, 0.5 mmol, 1 equiv), and CF$_3$CH$_2$OH (5 mL), 24 h, RT. After column chromatography (gradient hexanes/EtOAc from 4:1 to 1:1) 90 mg (60%) of a yellow oil was obtained. R$_f$ = 0.67 (hexanes/EtOAc 1:1).

Experiment 2.

N-(Quinolin-8-yl)cinnamamide (137 mg, 0.5 mmol) Co(acac)$_2$ (64.3 mg, 0.25 mmol, 50 mol%), NaOPiv (124 mg, 1 mmol, 2 equiv), Mn(OAc)$_3$*2H$_2$O (134 mg, 0.5 mmol, 1 equiv), and CF$_3$CH$_2$OH (5 mL). After 24h at RT additional portion of Co(acac)$_2$ (64.3 mg, 0.25 mmol, 50 mol%) was added and reaction mixture was stirred at RT for another 16h. After column chromatography (gradient hexanes/EtOAc from 4:1 to 1:1) 72 mg (48%) of a yellow oil was obtained.

Experiment 3.

N-(Quinolin-8-yl)cinnamamide (137 mg, 0.5 mmol) Co(acac)$_2$ (26 mg, 0.1 mmol, 20 mol%), NaOPiv (124 mg, 1 mmol, 2 equiv), Mn(OAc)$_3$*2H$_2$O (134 mg, 0.5 mmol, 1 equiv), and CF$_3$CH$_2$OH (5 mL). After 24h at 60 °C additional portion of Co(acac)$_2$ (26 mg, 0.1 mmol, 20 mol%) was added and reaction mixture was stirred at 60 °C for another 16h. After column chromatography (gradient hexanes/EtOAc from 4:1 to 1:1) 79 mg (53%) of a yellow oil was obtained.

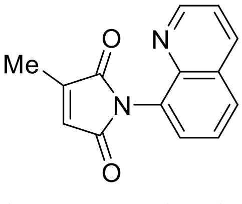
^{1}H-NMR (500 MHz, CDCl$_3$, ppm) δ 8.88 (dd, *J* = 4.2, 1.7 Hz, 1H), 8.21 (dd, *J* = 8.3, 1.7 Hz, 1H), 8.06 – 8.02 (m, 2H), 7.94 (dd, *J* = 8.2, 1.4 Hz, 1H), 7.73 (dd, *J* = 7.3, 1.4 Hz, 1H), 7.68 – 7.64 (m, 1H), 7.52 – 7.47 (m, 3H), 7.44 (dd, *J* = 8.3, 4.2 Hz, 1H), 7.01 (s, 1H).

^{13}C-NMR (125 MHz, CDCl$_3$, ppm) δ 170.2, 169.9, 150.9, 144.3, 144.1, 136.2, 131.1, 130.3, 129.6, 129.5, 129.3, 128.9, 128.8, 126.1, 124.6, 121.9.

HRMS calcd. for $C_{19}H_{12}N_2O_2$ $[M]^+$: 300.0899; found: 300.0901.

FT-IR (neat, cm^{-1}) υ 1710, 1537, 1499, 1474, 1397, 1379, 1341, 1236, 1119, 1106.

3-Methyl-1-(quinolin-8-yl)-1H-pyrrole-2,5-dione (6, Scheme 3)



N-(Quinolin-8-yl)methacrylamide (106 mg, 0.5 mmol) Co(acac)$_2$ (26 mg, 0.1 mmol, 20 mol%), NaOPiv (124 mg, 1 mmol, 2 equiv), Mn(OAc)$_3$*2H$_2$O (134 mg, 0.5 mmol, 1 equiv), and CF$_3$CH$_2$OH (5 mL). After 24 h at 60 °C additional portion of Co(acac)$_2$ (26 mg, 0.1 mmol, 20 mol%) was added and reaction mixture was stirred at 60 °C for another 16 h. After column chromatography (gradient hexanes/EtOAc from 4:1 to 1:1) 39 mg (33%) of a yellow oil was obtained.

R_f = 0.34 (hexanes/EtOAc 1:1).

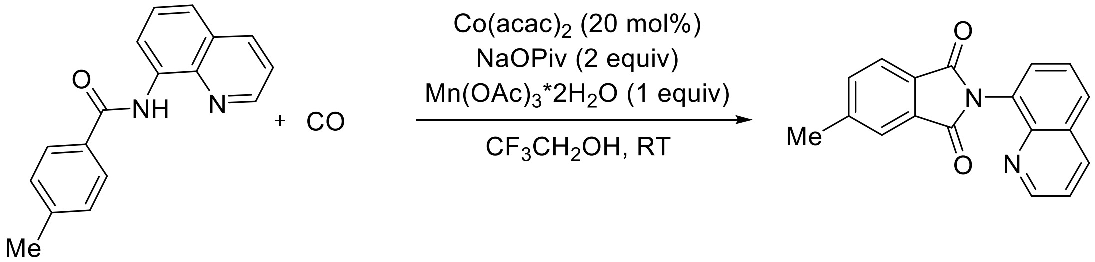
^{1}H-NMR (500 MHz, $CDCl_3$, ppm) δ 8.88 (d, *J* = 2.9 Hz, 1H), 8.21 (d, *J* = 8.1 Hz, 1H), 7.93 (d, *J* = 6.3 Hz, 1H), 7.68 – 7.60 (m, 2H), 7.44 (dd, *J* = 8.2, 4.1 Hz, 1H), 6.60 (s, 1H), 2.24 (s, *J* = 0.9 Hz, 3H).

^{13}C-NMR (125 MHz, $CDCl_3$, ppm) δ 171.4, 170.4, 150.9, 146.2, 144.3, 136.2, 130.2, 129.7, 129.4, 129.3, 128.1, 126.1, 121.9, 11.4.

HRMS calcd. for $C_{14}H_{10}N_2O_2$ $[M]^+$: 238.0742; found: 238.0738.

FT-IR (neat, cm^{-1}) υ 1709, 1537, 1499, 1474, 1397, 1379, 1341, 1237, 1059.

Control experiments



Experiment ***a*** **(Scheme 2)**

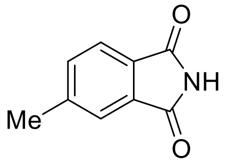
A 25 mL Schlenk flask with septum equipped with a magnetic stir bar was charged with 4-methyl-*N*-(quinolin-8-yl)benzamide (131 mg, 0.5 mmol), $Co(acac)_2$ (25.7 mg, 0.1 mmol, 20 mol%), NaOPiv (124 mg, 1.0 mmol, 2 equiv), $Mn(OAc)_3*2H_2O$ (134 mg, 0.5 mmol, 1 equiv). Resulting solids was flushed with nitrogen for 5 min (vigorous stirring). Under nitrogen deoxygenated CF_3CH_2OH (5 mL) was added, and solution was purged with CO gas for 10 min. After that flask was equipped with CO balloon and stirred at room temperature for 16 h. Reaction solvent was evaporated. Potassium sodium tartrate (10 mL of 1M aqueous solution) was added to the residue and mixture was extracted with CH_2Cl_2 (3 x 20 mL). Combined organic phase was dried over $MgSO_4$, filtered, and solvent was evaporated. 1,1,2-Trichloroethane (46.5 µL, 0.5 mmol, 1 equiv) internal standard was added to the crude reaction mixture. Methyl group signal of product was integrated. **NMR yield: 83%**

Experiment ***b*** **(Scheme 2)**

A 25 mL Schlenk flask with septum equipped with a magnetic stir bar was charged with 4-methyl-*N*-(quinolin-8-yl)benzamide (131 mg, 0.5 mmol), $Co(acac)_2$ (25.7 mg, 0.1 mmol, 20 mol%), NaOPiv (124 mg, 1.0 mmol, 2 equiv), $Mn(OAc)_3*2H_2O$ (134 mg, 0.5 mmol, 1 equiv). Resulting solids was flushed with nitrogen for 5 min (vigorous stirring). Under nitrogen deoxygenated CF_3CH_2OH (5 mL) was added, and solution was purged with CO gas for 10 min. After that flask was sealed with PTFE tape and stirred at room temperature for 16 h. Reaction solvent was evaporated. Potassium sodium tartrate (10 mL of 1M aqueous solution) was added to the residue and mixture was extracted with CH_2Cl_2 (3 x 20 mL). Combined organic phase was dried over $MgSO_4$, filtered, and solvent was evaporated. 1,1,2-Trichloroethane (46.5 µL, 0.5 mmol, 1 equiv) internal standard was added to the crude reaction mixture. Methyl group signal of product was integrated. **NMR yield: 20%**

Removal of aminoquinoline directing group

4-Methylphtalimide (2, Eq 1)



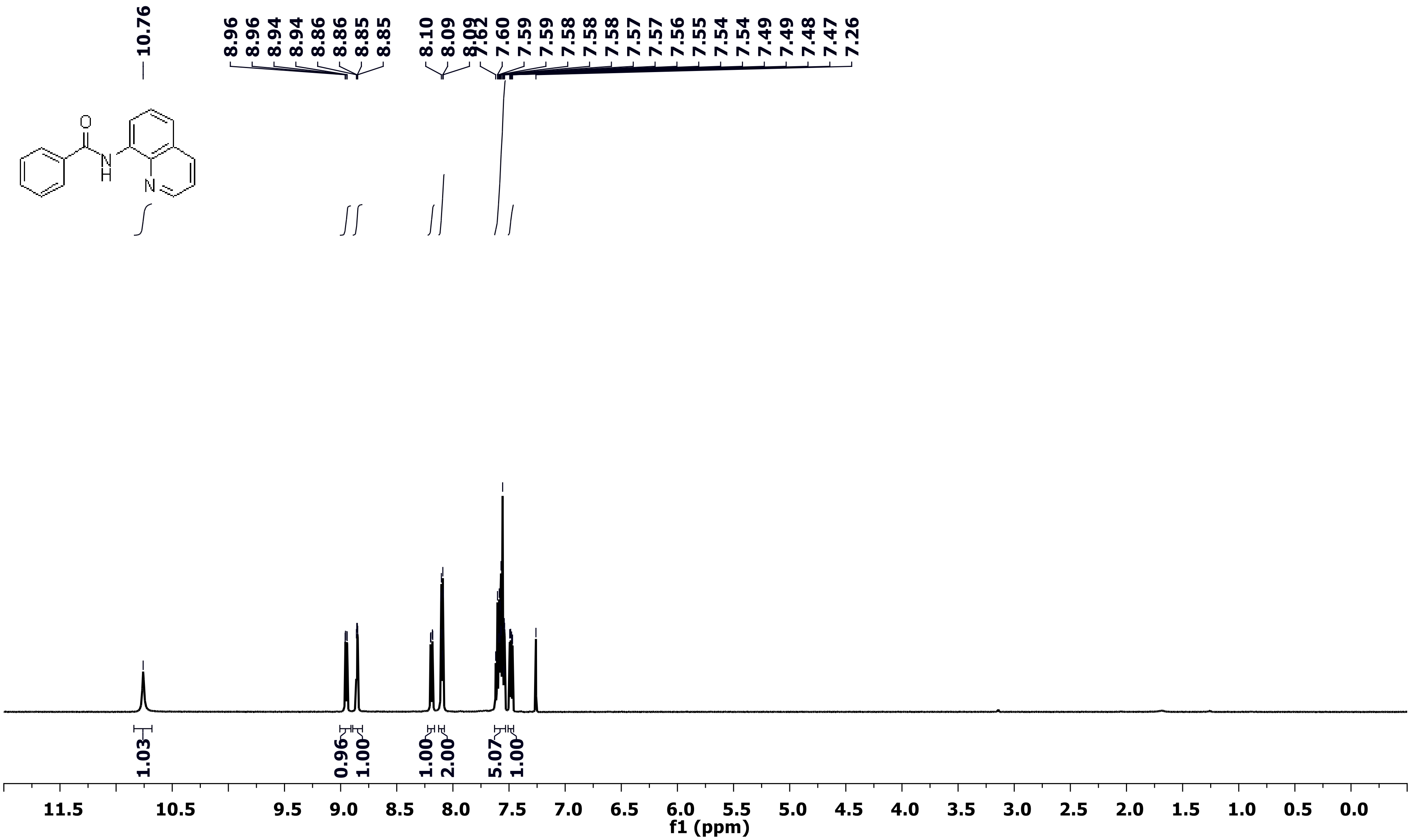
A 50 mL flask with septum equipped with magnetic stirrer was charged with 5-methyl-2-(quinolin-8-yl)isoindoline-1,3-dione (288 mg, 1 mmol). Under inert atmosphere 2M NH_3 in MeOH (10 mL) was added and resulting suspension was stirred at RT for 14 h. Reaction solvent was evaporated, product was purified using column chromatography on silica gel (gradient hexanes/EtOAc from 6:1 to 2:1). After recrystallization from hexanes/EtOAc 4:1, product was dried under reduced pressure to afford 117 mg (73%) of 4-methylphthalimide as a white solid. This compound is known (CAS 40314-06-5).[6]

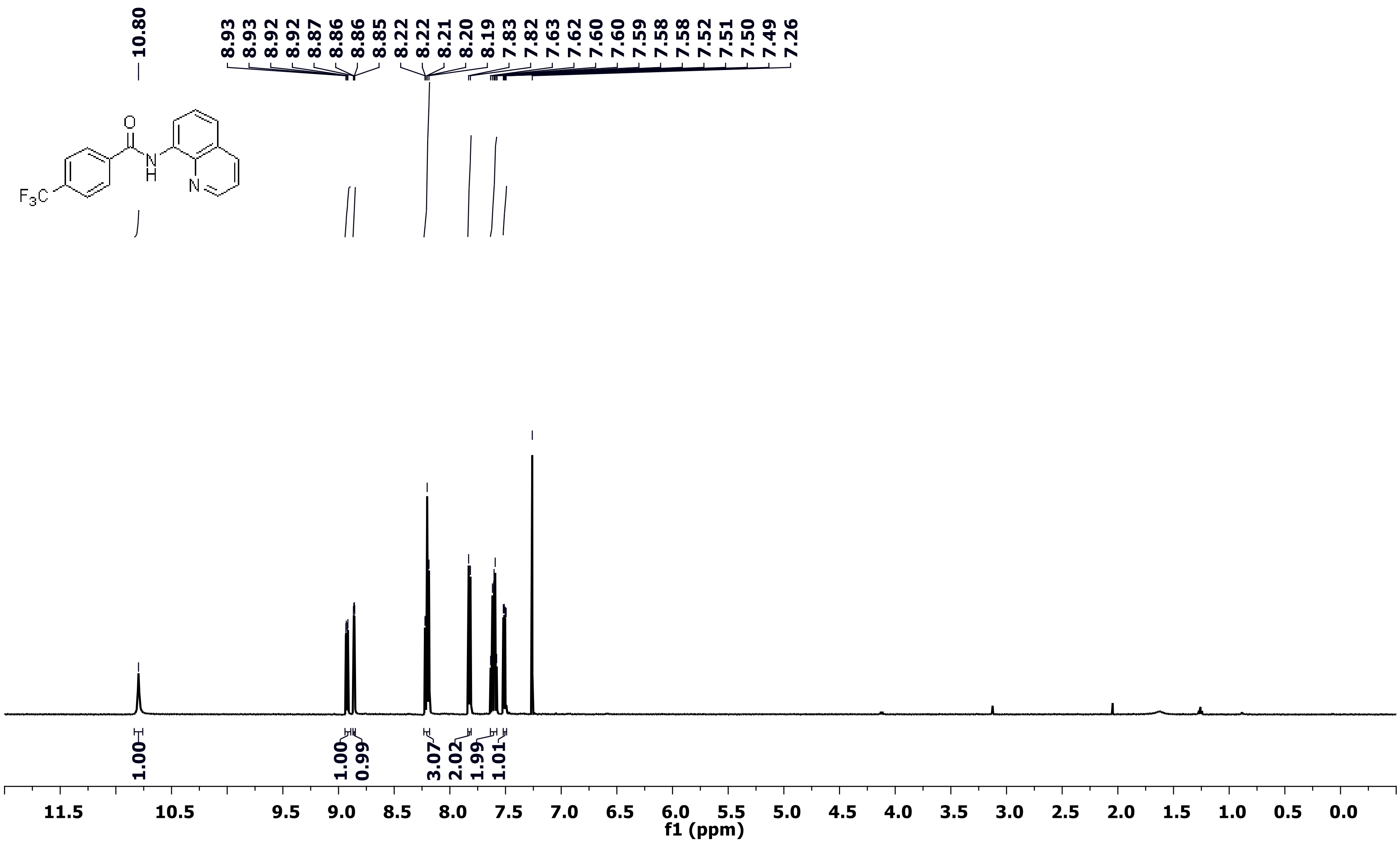
^{1}H-NMR (400 MHz, $CDCl_3$, ppm) δ 7.75 (d, J = 7.7 Hz, 1H), 7.66 (s, 1H), 7.62 (s, 1H), 7.55 (dd, J = 7.6, 0.7 Hz, 1H), 2.53 (s, 3H).

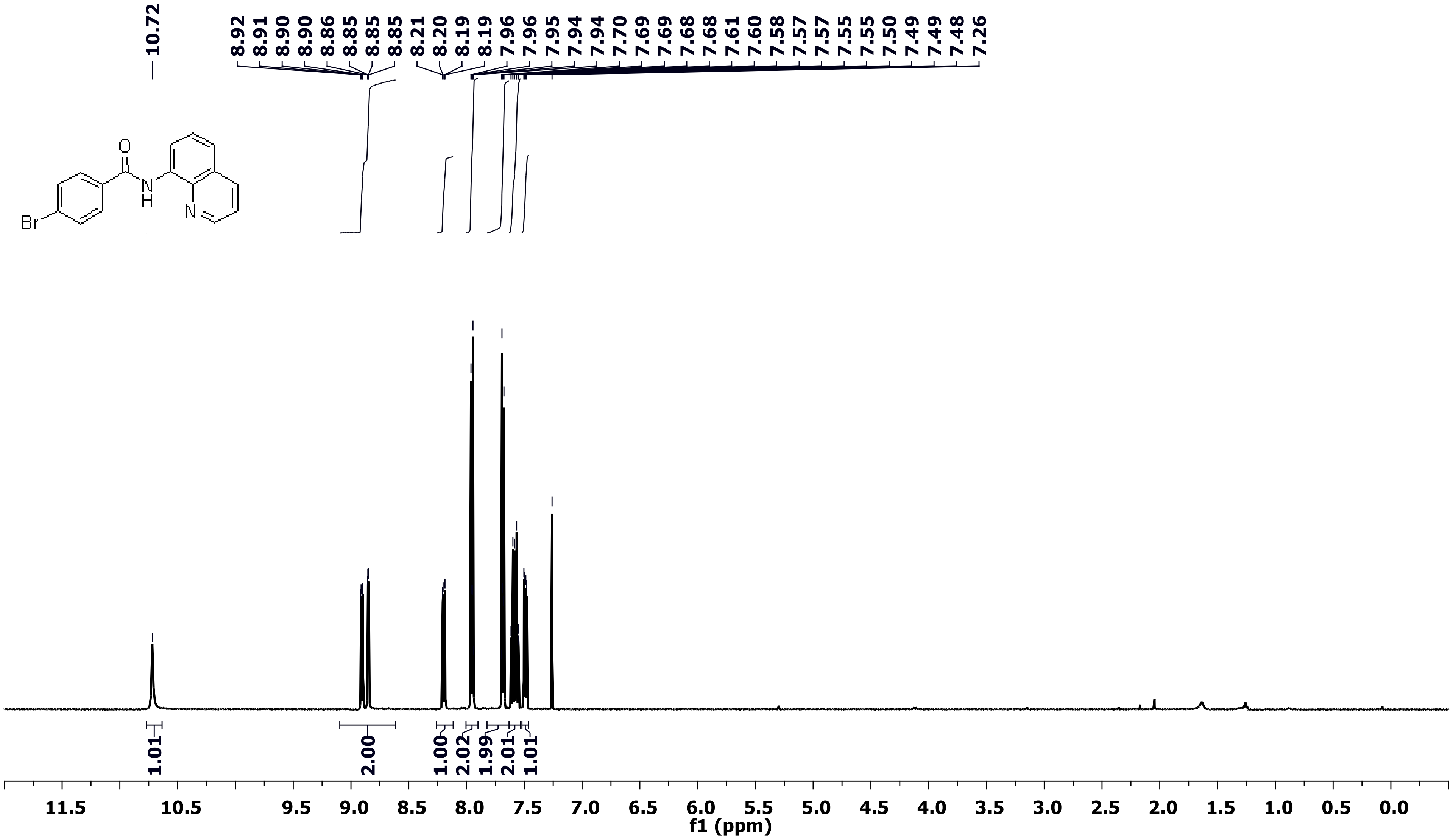
---

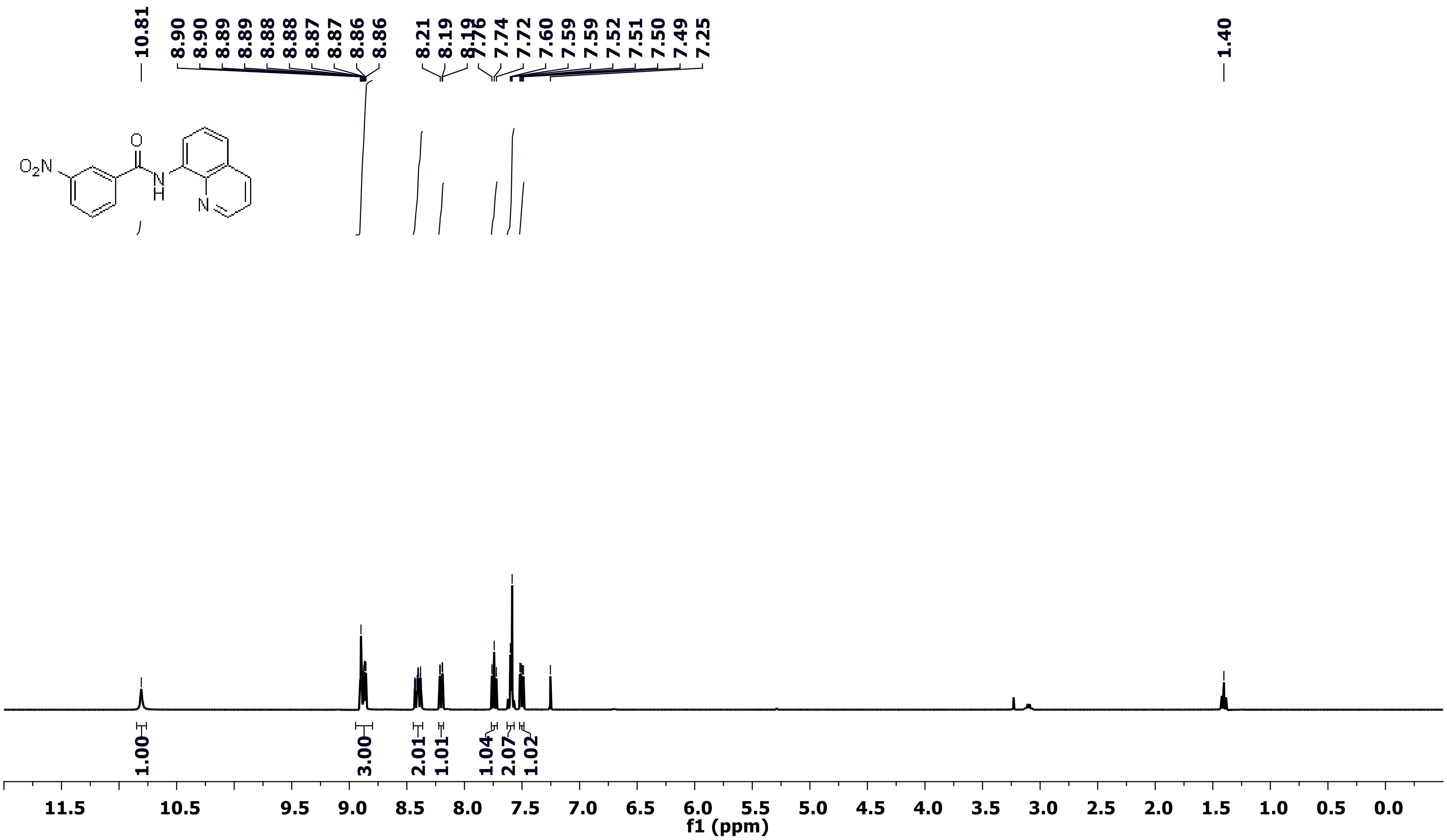
[6] Mazzocchi, P. H.; Wilson, P.; Khachik, F.; Klingler, L.; Minamikawa, S. *J. Org. Chem.*, **1983**, *48*, 2981.

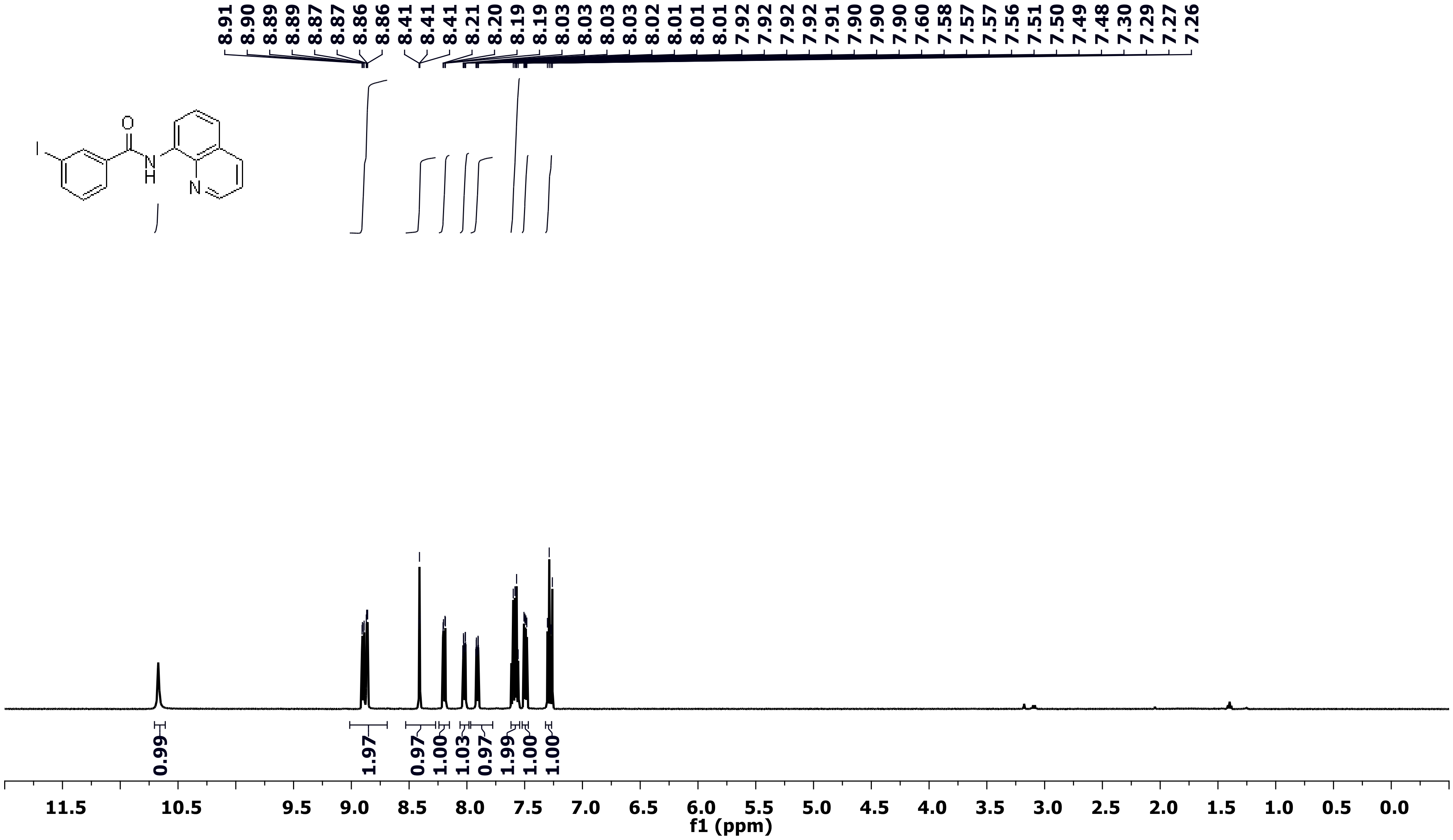
NMR spectra

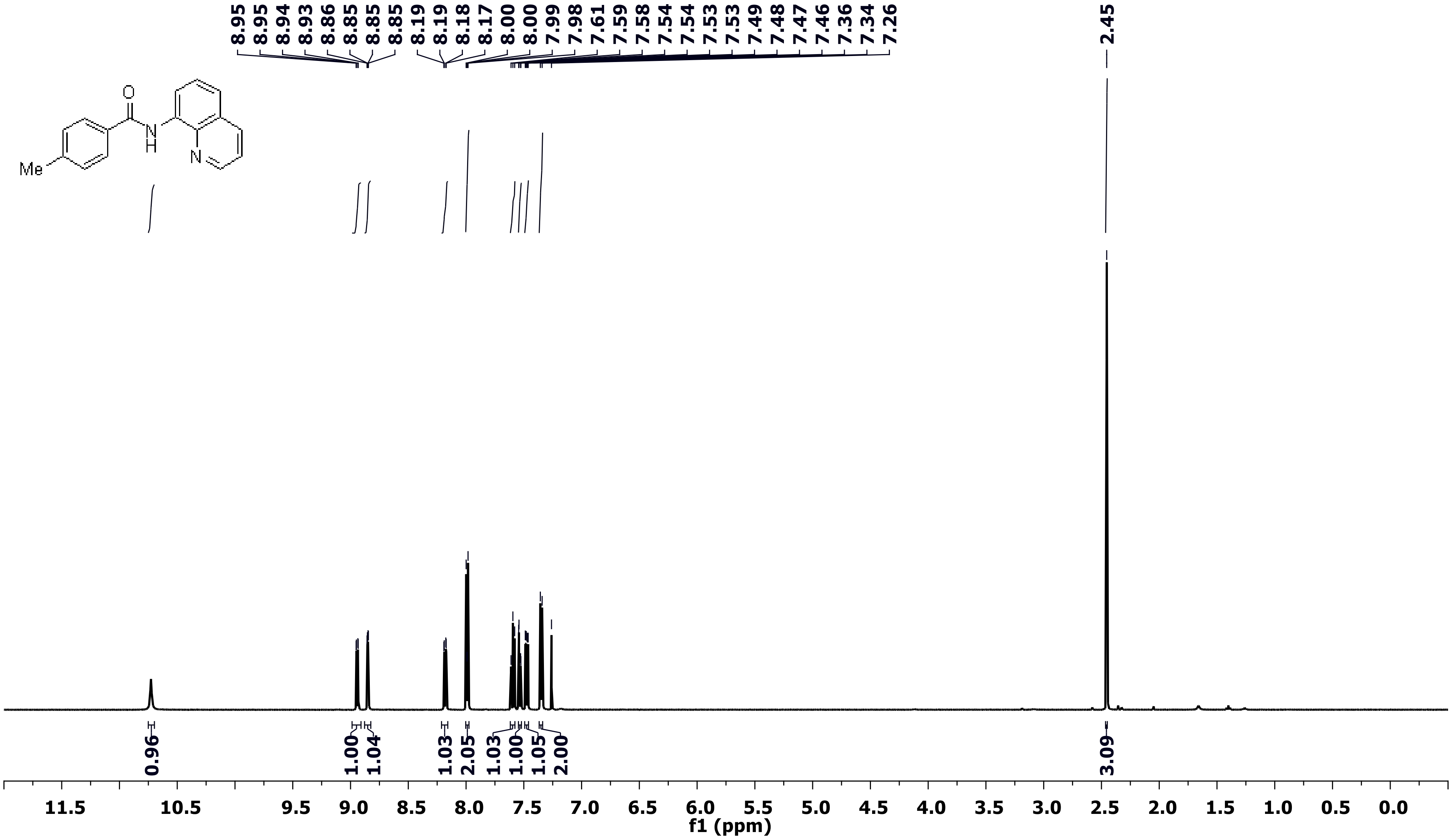

10.76
8.96
8.96
8.94
8.94
8.86
8.86
8.85
8.85
8.10
8.09
8.09
7.62
7.60
7.59
7.59
7.58
7.58
7.58
7.57
7.57
7.56
7.55
7.54
7.54
7.49
7.49
7.48
7.47
7.26
O
N
H
N
1.03
0.96
1.00
1.00
2.00
5.07
1.00
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

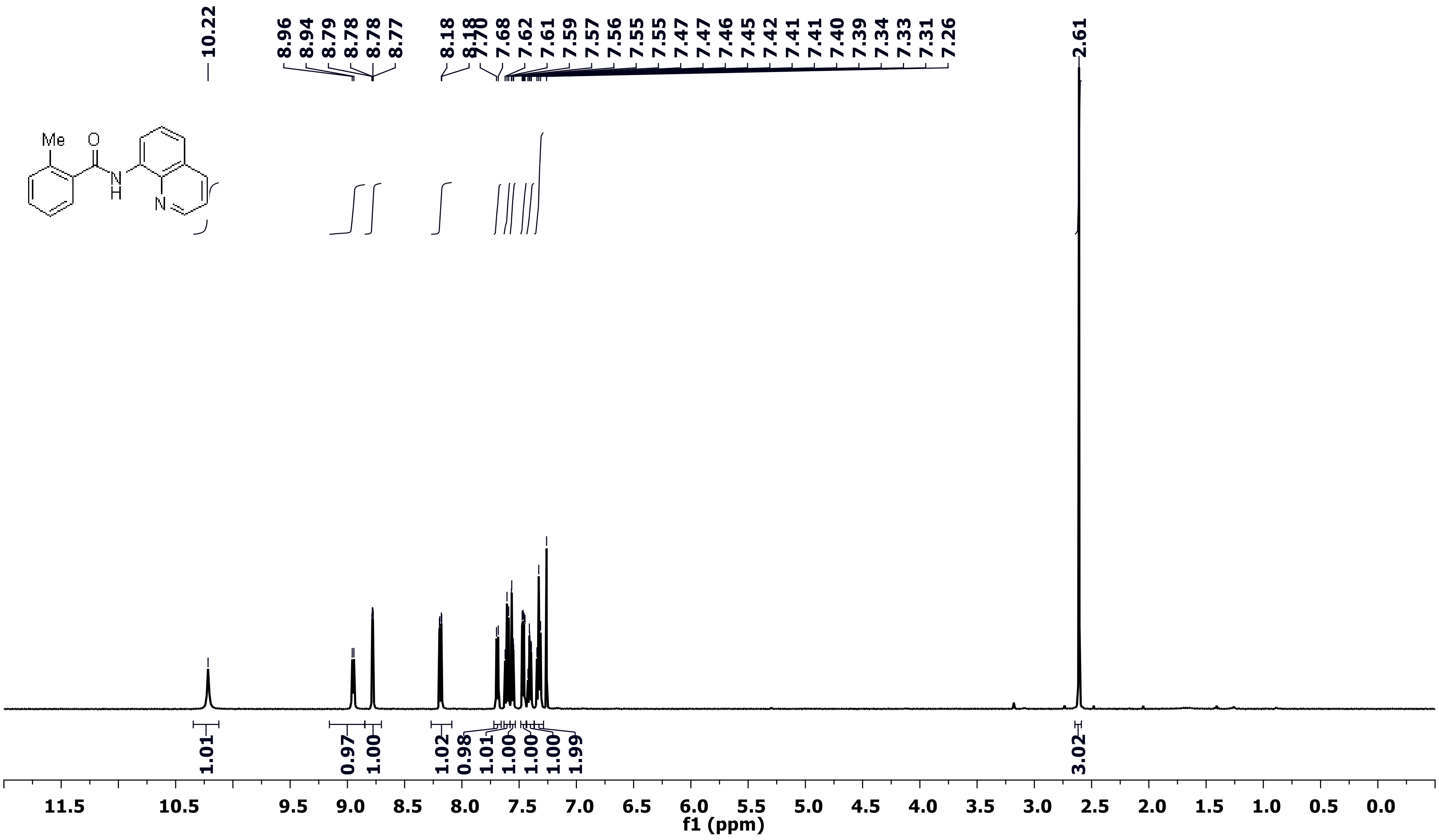

10.80
8.93
8.93
8.92
8.92
8.87
8.86
8.86
8.85
8.22
8.22
8.21
8.20
8.19
7.83
7.82
7.63
7.62
7.60
7.60
7.59
7.58
7.58
7.52
7.51
7.50
7.49
7.26
O
N
H
N
F3C
1.00
1.00
0.99
3.07
2.02
1.99
1.01
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

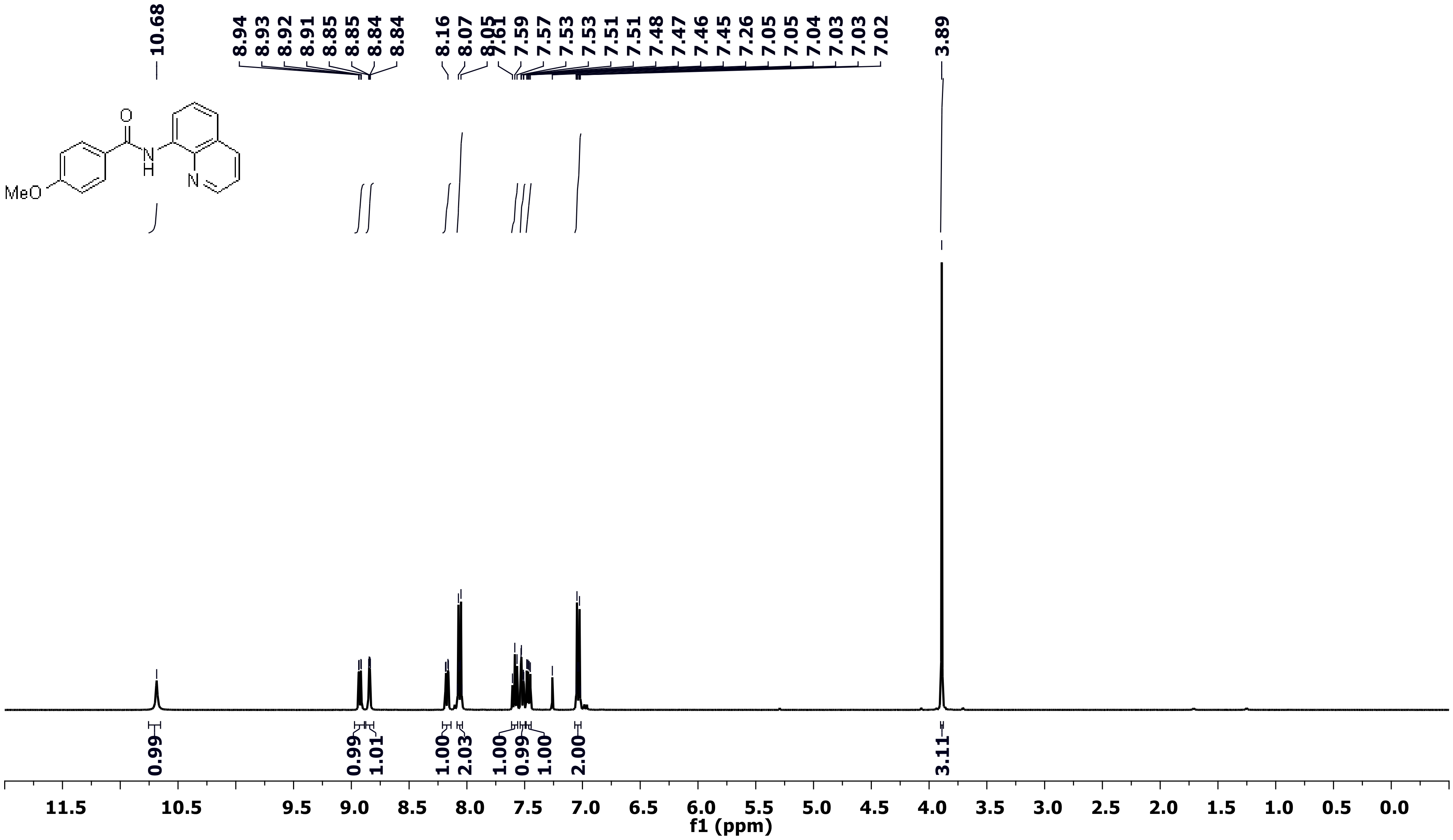

10.72
8.92
8.91
8.90
8.90
8.86
8.85
8.85
8.85
8.21
8.20
8.19
8.19
7.96
7.96
7.95
7.94
7.94
7.70
7.69
7.69
7.68
7.68
7.61
7.60
7.58
7.57
7.57
7.55
7.55
7.50
7.49
7.49
7.48
7.26
O
N
H
N
Br
1.01
2.00
1.00
2.02
1.99
2.01
1.01
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

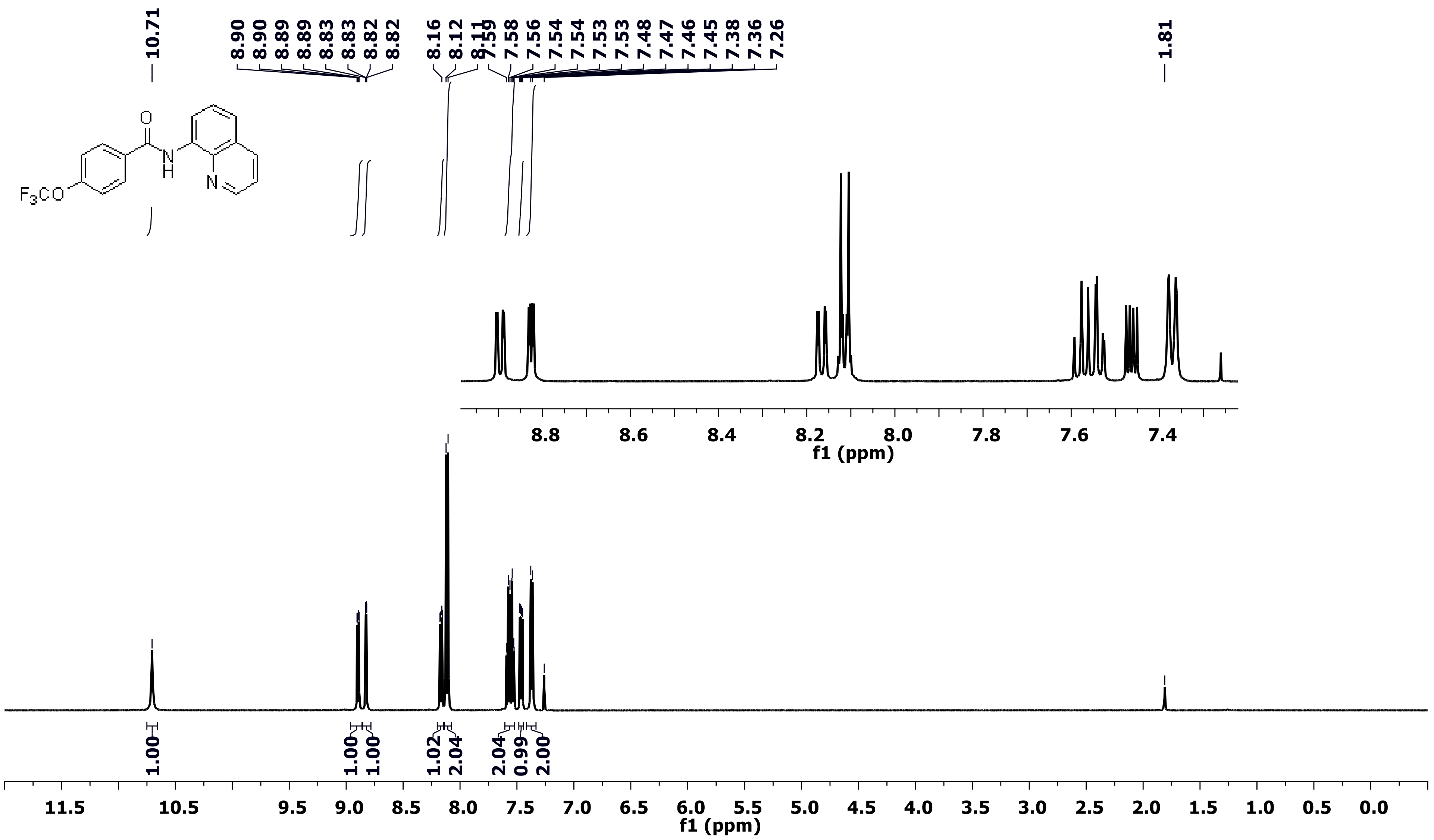

10.81
8.90
8.90
8.89
8.89
8.88
8.88
8.87
8.87
8.86
8.86
8.21
8.19
8.19
7.76
7.74
7.72
7.60
7.59
7.59
7.52
7.51
7.50
7.49
7.25
1.40
O_2N
O
N
H
N
1.00
3.00
2.01
1.01
1.04
2.07
1.02
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

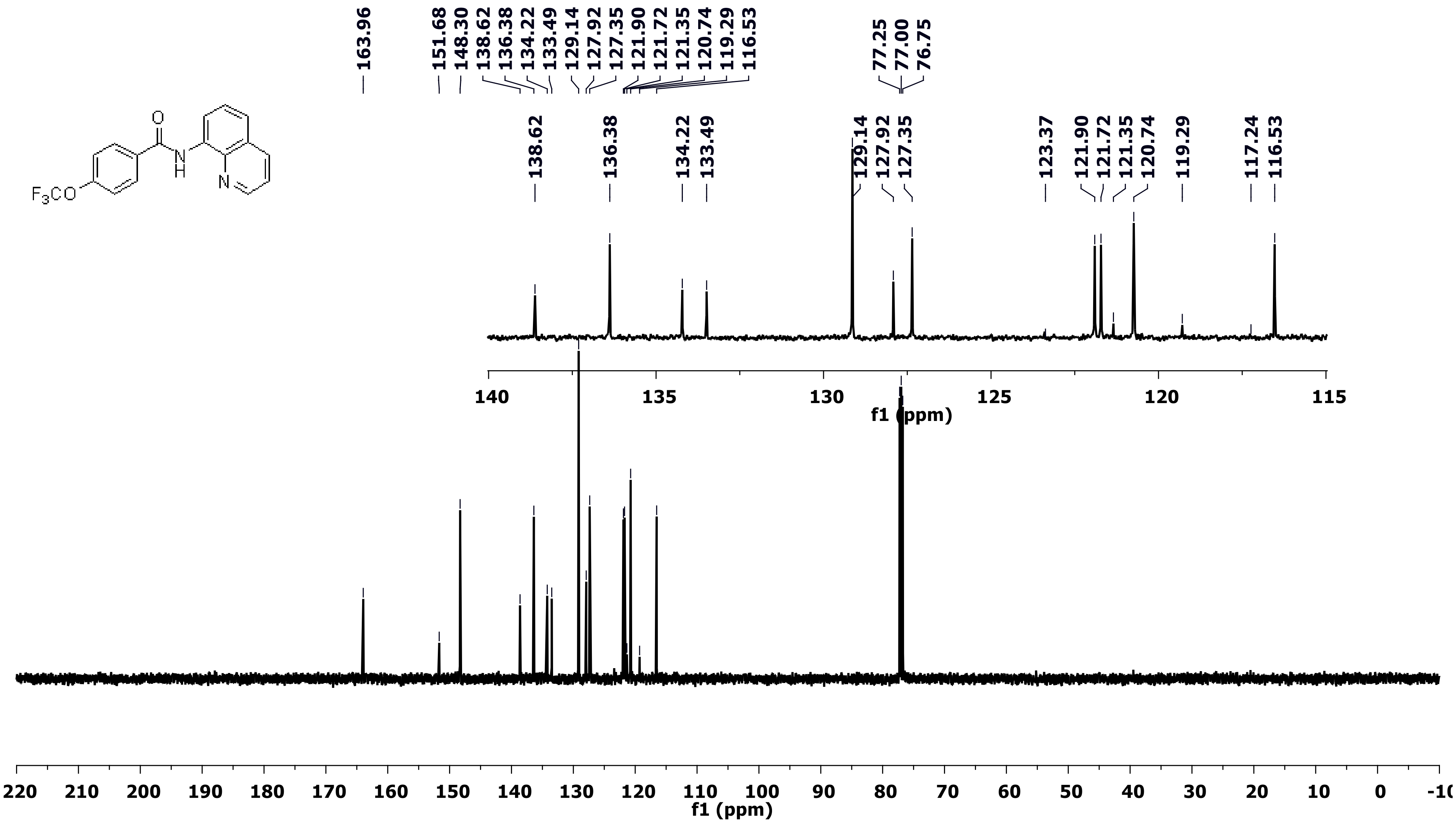

8.91
8.90
8.89
8.89
8.87
8.87
8.86
8.86
8.41
8.41
8.41
8.21
8.20
8.19
8.19
8.03
8.03
8.03
8.02
8.01
8.01
8.01
7.92
7.92
7.92
7.92
7.91
7.90
7.90
7.90
7.60
7.58
7.57
7.57
7.56
7.51
7.50
7.49
7.48
7.30
7.29
7.27
7.26
I
O
N
H
N
0.99
1.97
0.97
1.00
1.03
0.97
1.99
1.00
1.00
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

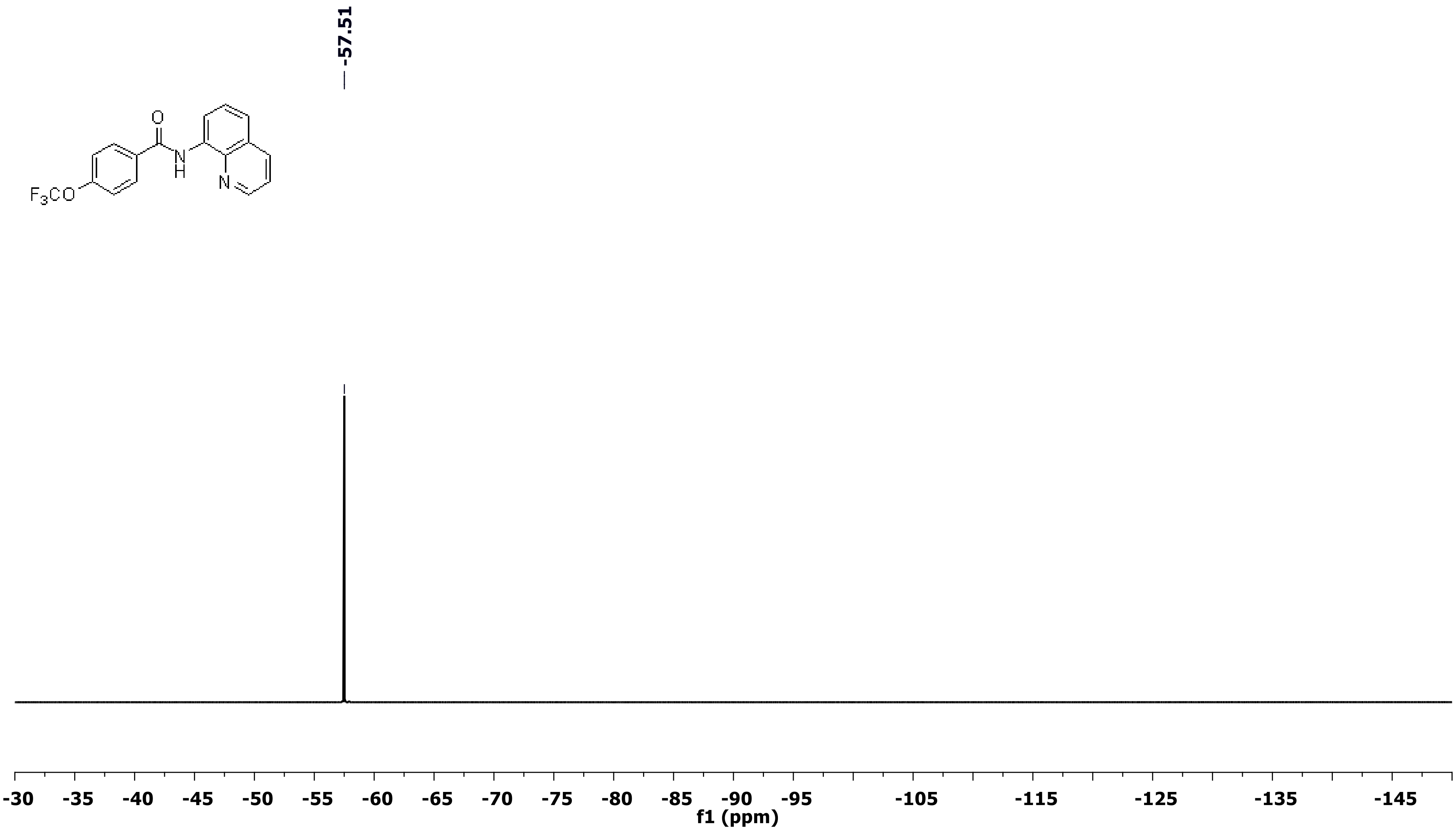

8.95
8.95
8.94
8.93
8.86
8.85
8.85
8.85
8.19
8.19
8.18
8.17
8.00
8.00
7.99
7.98
7.61
7.59
7.58
7.54
7.54
7.53
7.53
7.49
7.48
7.47
7.46
7.36
7.34
7.26
2.45
O
N
H
N
Me
0.96
1.00
1.04
1.03
2.05
1.03
1.00
1.05
2.00
3.09
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

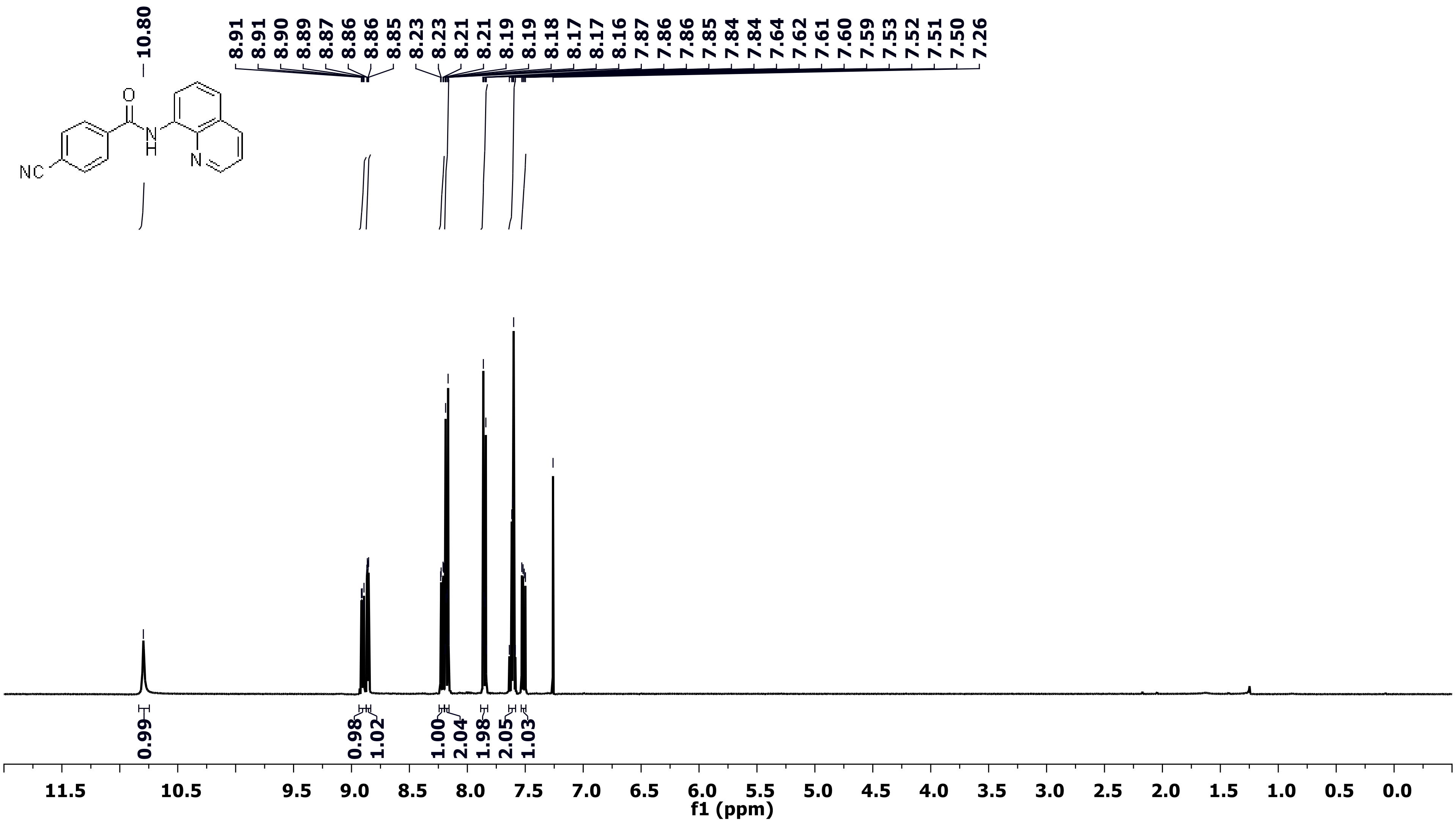

10.22
8.96
8.94
8.79
8.78
8.78
8.77
8.18
8.18
7.70
7.68
7.62
7.61
7.59
7.57
7.56
7.55
7.55
7.47
7.47
7.46
7.45
7.42
7.41
7.41
7.40
7.39
7.34
7.33
7.31
7.26
2.61
Me
O
N
H
N
1.01
0.97
1.00
1.02
0.98
1.01
1.00
1.00
1.00
1.99
3.02
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

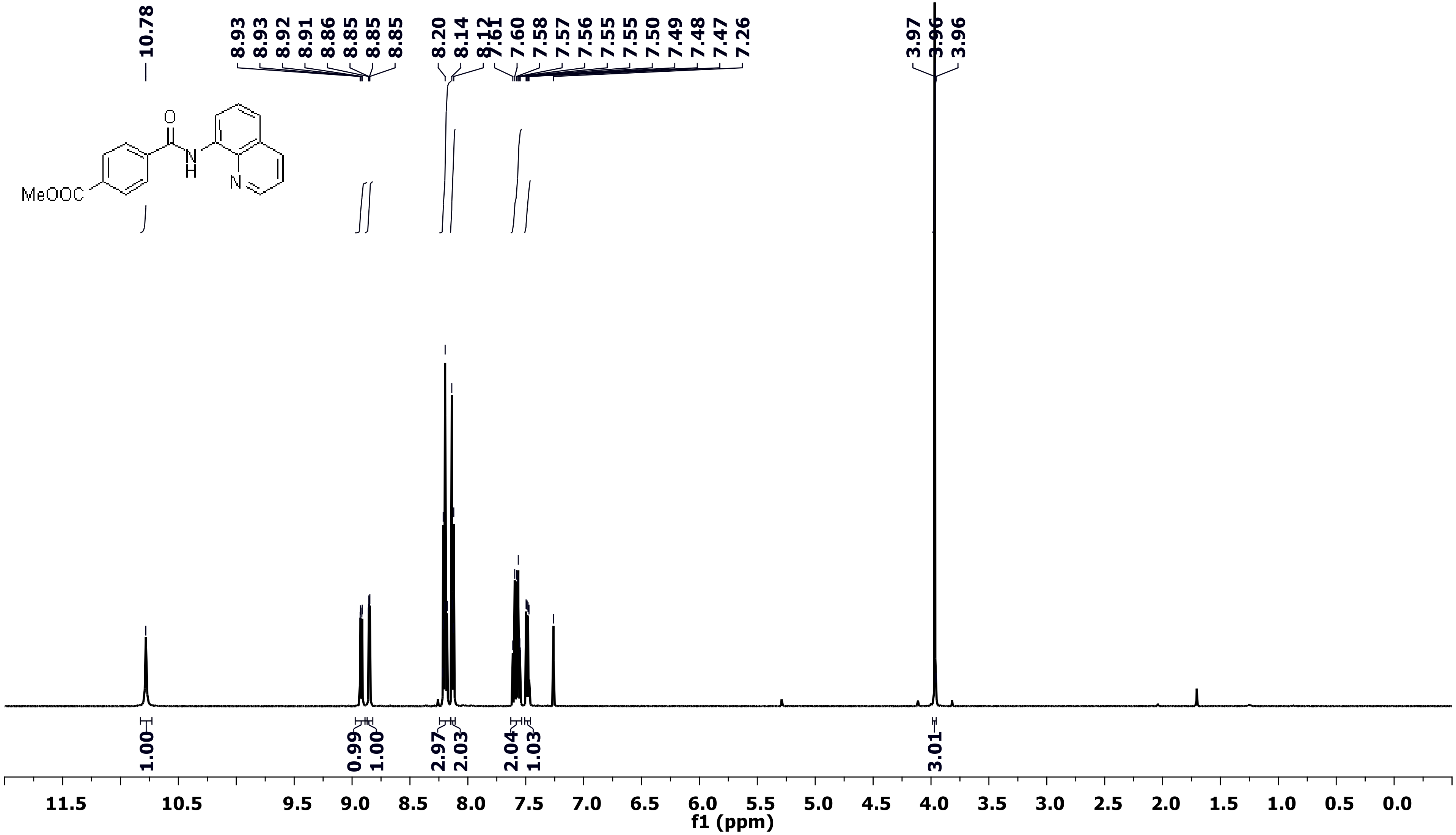

10.68
8.94
8.93
8.92
8.91
8.85
8.85
8.84
8.84
8.16
8.07
8.05
7.61
7.59
7.57
7.53
7.53
7.51
7.51
7.48
7.47
7.46
7.45
7.26
7.05
7.05
7.04
7.03
7.03
7.02
3.89
MeO
O
N
H
N
0.99
0.99
1.01
1.00
2.03
1.00
0.99
1.00
2.00
3.11
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

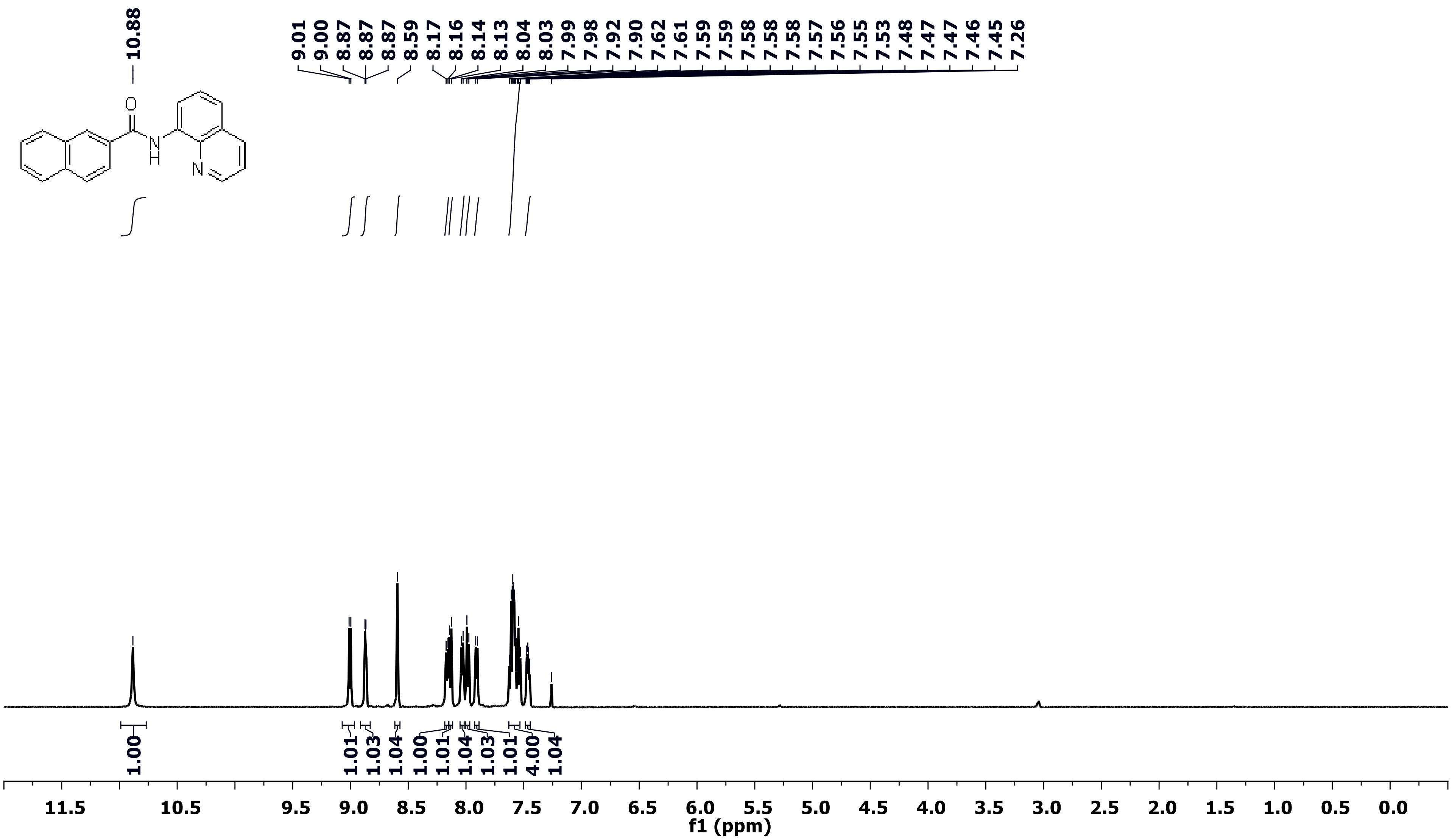

10.71
8.90
8.90
8.89
8.89
8.83
8.83
8.82
8.82
8.16
8.12
8.11
7.59
7.58
7.56
7.54
7.54
7.53
7.53
7.48
7.47
7.46
7.45
7.38
7.36
7.26
1.81
O
N
H
N
F3CO
8.8
8.6
8.4
8.2
8.0
7.8
7.6
7.4
f1 (ppm)
1.00
1.00
1.00
1.02
2.04
2.04
0.99
2.00
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

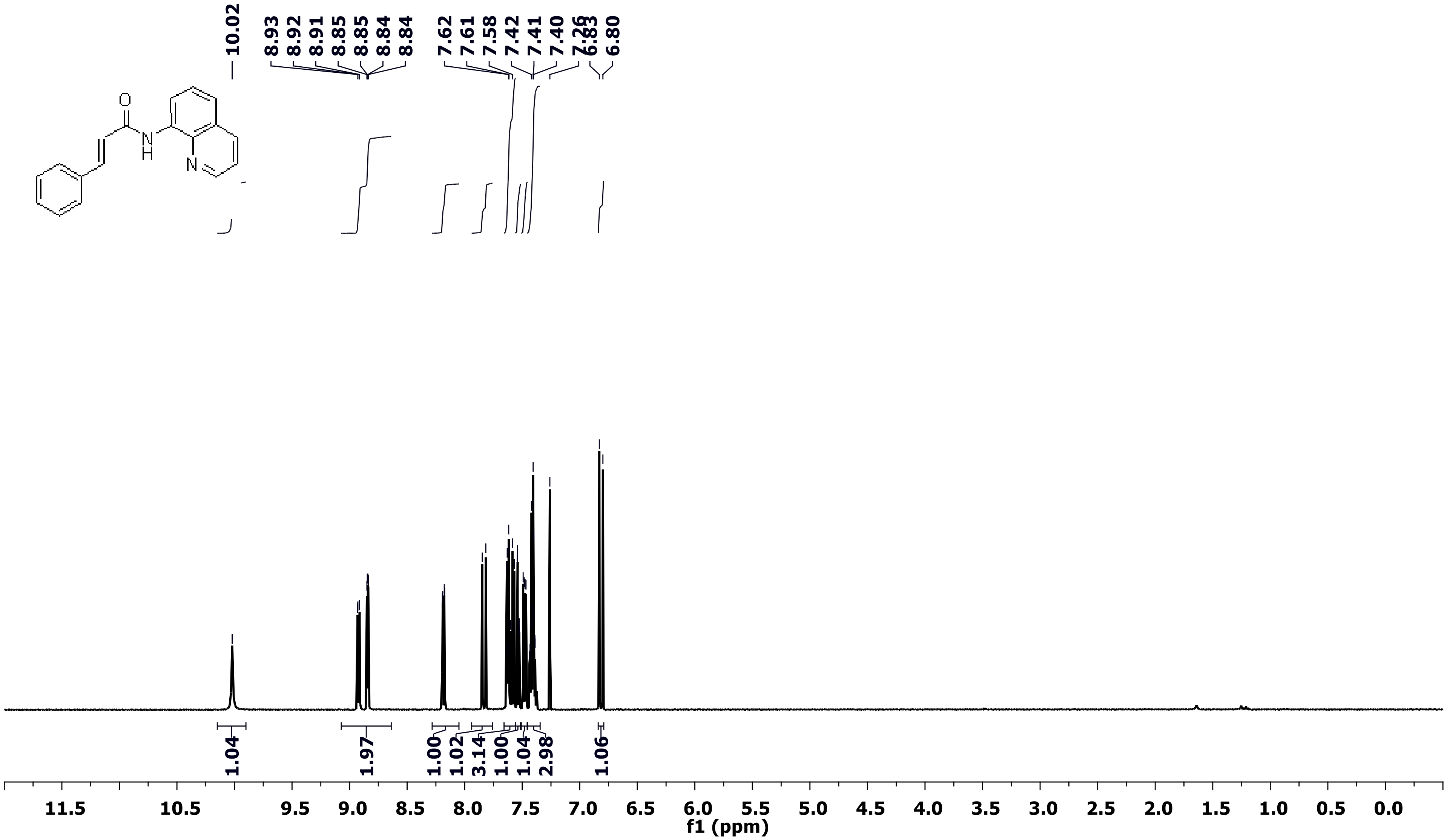

F3CO
O
N
H
N
163.96
151.68
148.30
138.62
136.38
134.22
133.49
129.14
127.92
127.35
121.90
121.72
121.35
120.74
119.29
116.53
77.25
77.00
76.75
138.62
136.38
134.22
133.49
129.14
127.92
127.35
123.37
121.90
121.72
121.35
120.74
119.29
117.24
116.53
140
135
130
125
120
115
f1 (ppm)
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


-57.51
F3CO
O
N
H
N
-30
-35
-40
-45
-50
-55
-60
-65
-70
-75
-80
-85
-90
-95
-105
-115
-125
-135
-145
f1 (ppm)


10.80
8.91
8.91
8.90
8.89
8.87
8.86
8.86
8.85
8.23
8.23
8.21
8.21
8.19
8.19
8.18
8.17
8.17
8.16
7.87
7.86
7.86
7.85
7.84
7.84
7.64
7.62
7.61
7.60
7.59
7.53
7.52
7.51
7.50
7.26
O
N
H
N
NC
0.99
0.98
1.02
1.00
2.04
1.98
2.05
1.03
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


10.78
8.93
8.93
8.92
8.91
8.86
8.85
8.85
8.85
8.20
8.14
8.12
7.61
7.60
7.58
7.57
7.56
7.55
7.55
7.50
7.49
7.48
7.47
7.26
3.97
3.96
3.96
MeOOC
O
N
H
N
1.00
0.99
1.00
2.97
2.03
2.04
1.03
3.01
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


O
N
H
N
10.88
9.01
9.00
8.87
8.87
8.87
8.59
8.17
8.16
8.14
8.13
8.04
8.03
7.99
7.98
7.92
7.90
7.62
7.61
7.59
7.59
7.58
7.58
7.58
7.57
7.56
7.55
7.53
7.48
7.47
7.47
7.46
7.45
7.26
1.00
1.01
1.03
1.04
1.00
1.01
1.04
1.03
1.01
4.00
1.04
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


10.02
8.93
8.92
8.91
8.85
8.85
8.84
8.84
7.62
7.61
7.58
7.42
7.41
7.40
7.26
6.83
6.80
O
N
H
N
1.04
1.97
1.00
1.02
3.14
1.00
1.04
2.98
1.06
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

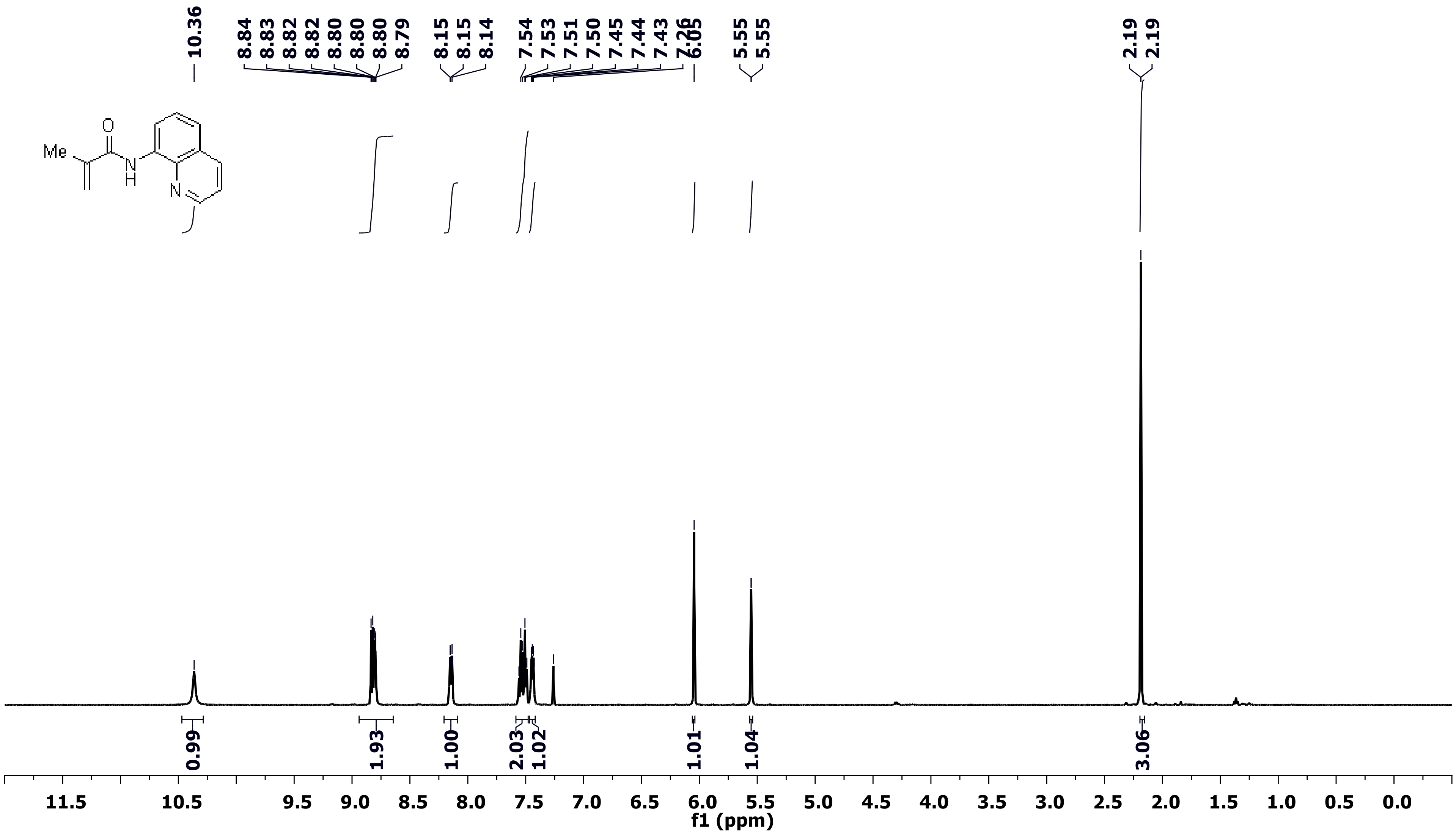
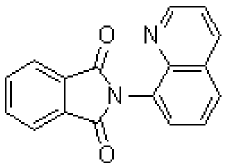
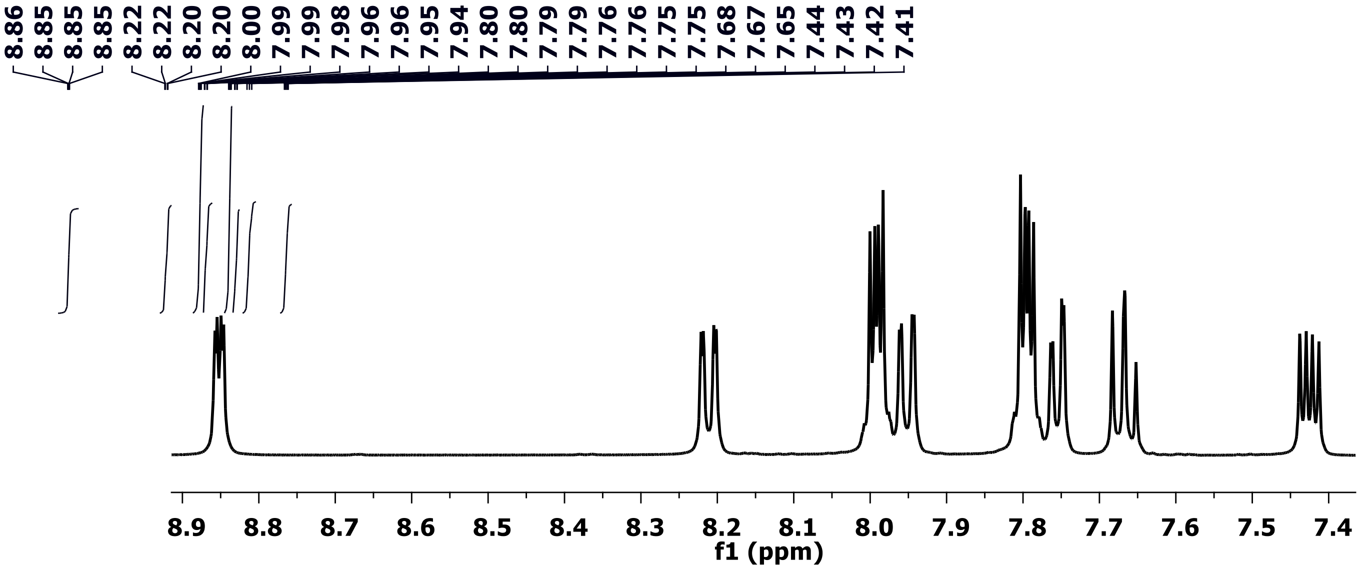

10.36
8.84
8.83
8.82
8.82
8.80
8.80
8.80
8.79
8.15
8.15
8.14
7.54
7.53
7.51
7.50
7.45
7.44
7.43
7.26
6.05
5.55
5.55
2.19
2.19
Me
O
N
H
N
0.99
1.93
1.00
2.03
1.02
1.01
1.04
3.06
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

Table 1, Entry 1





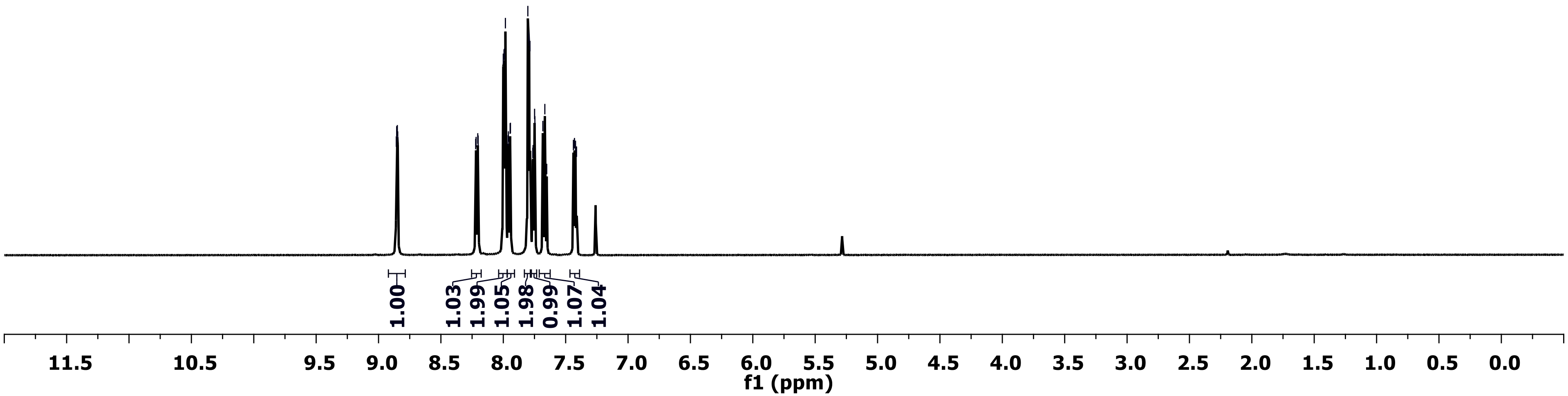


Table 1, Entry 1

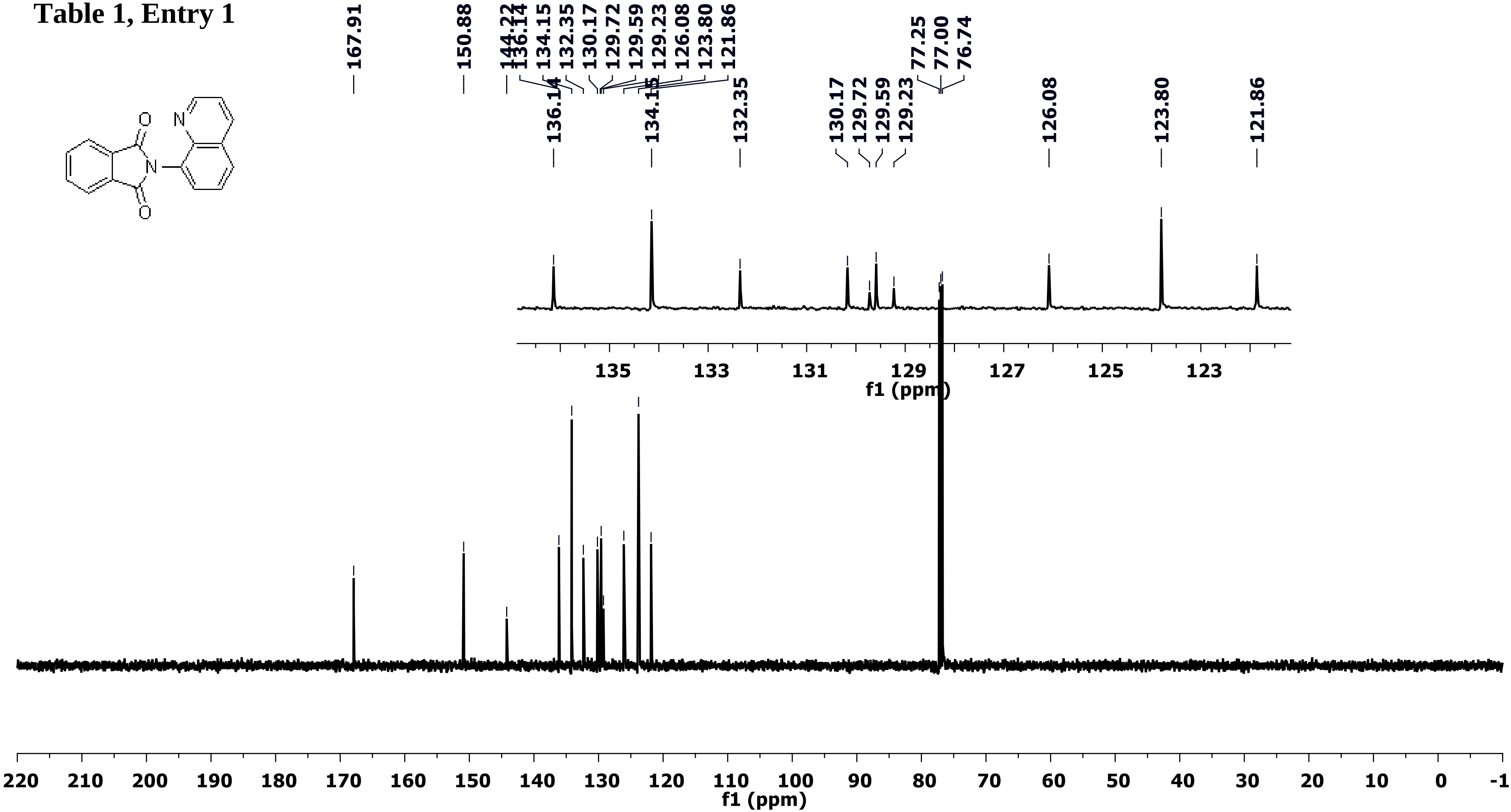
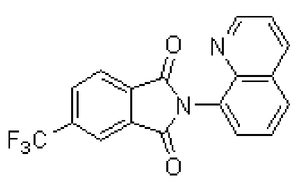
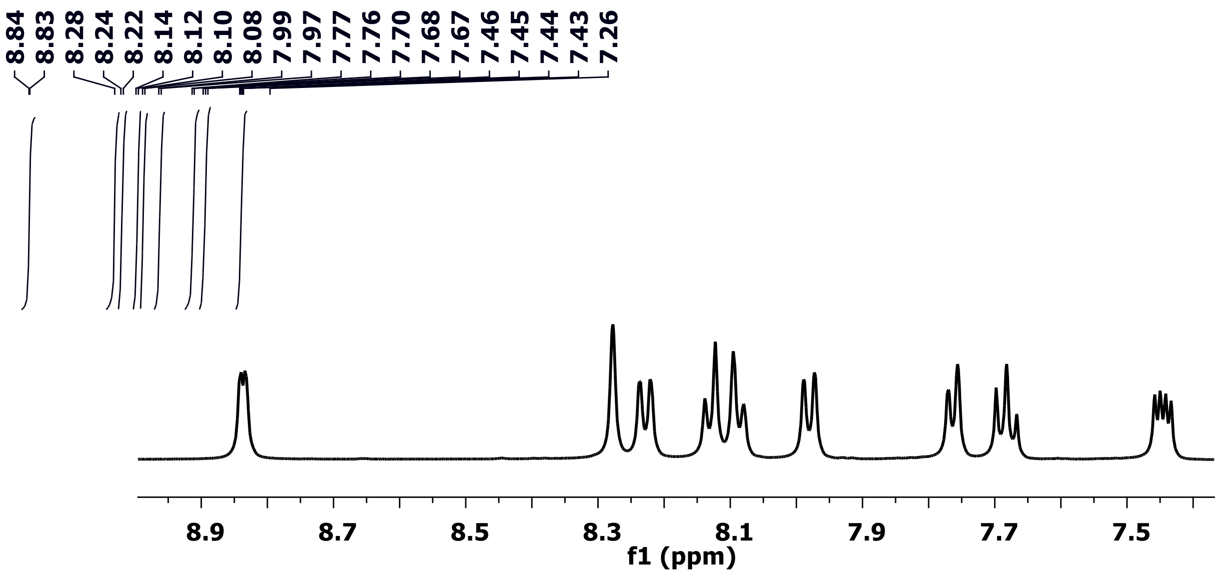


Table 1, Entry 2





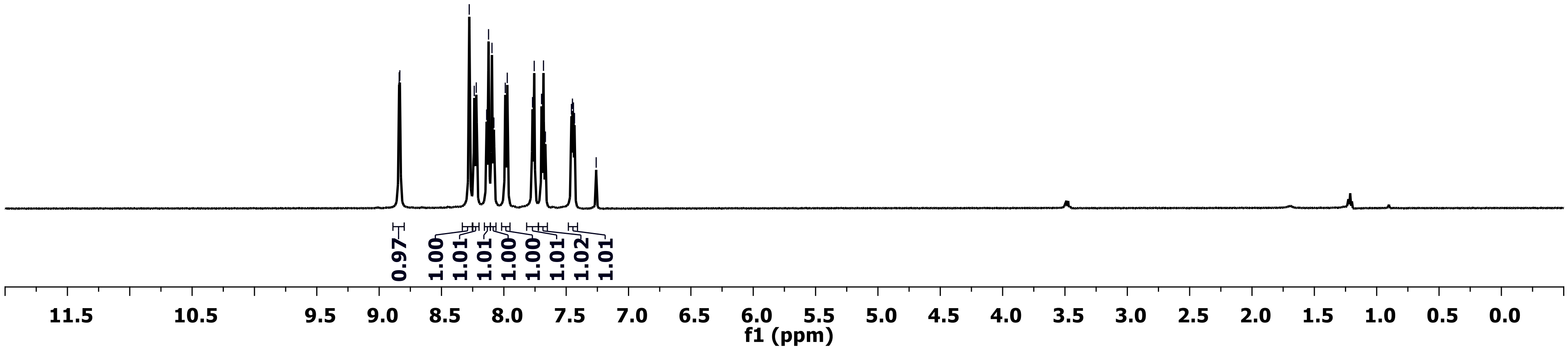


Table 1, Entry 2

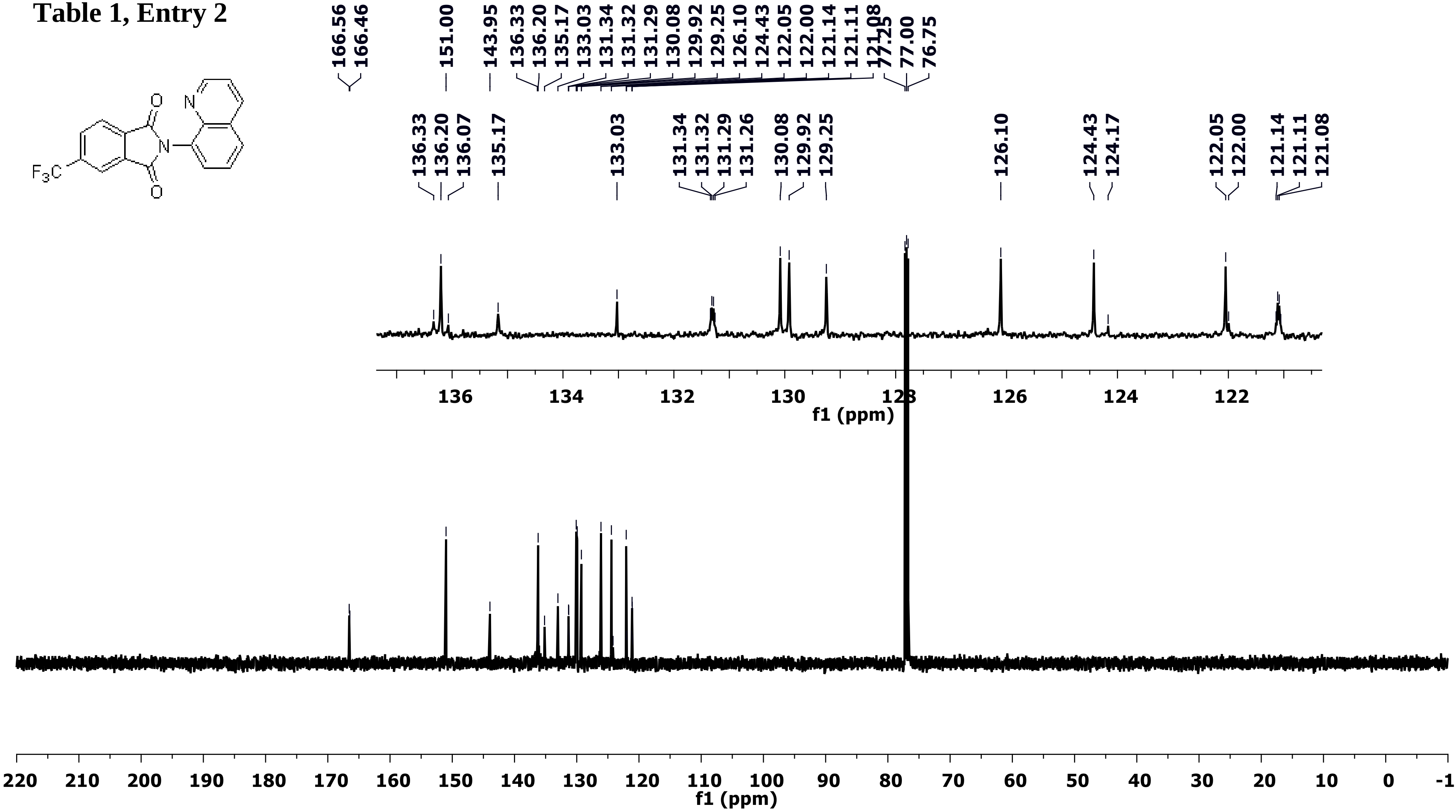


Table 1, Entry 2

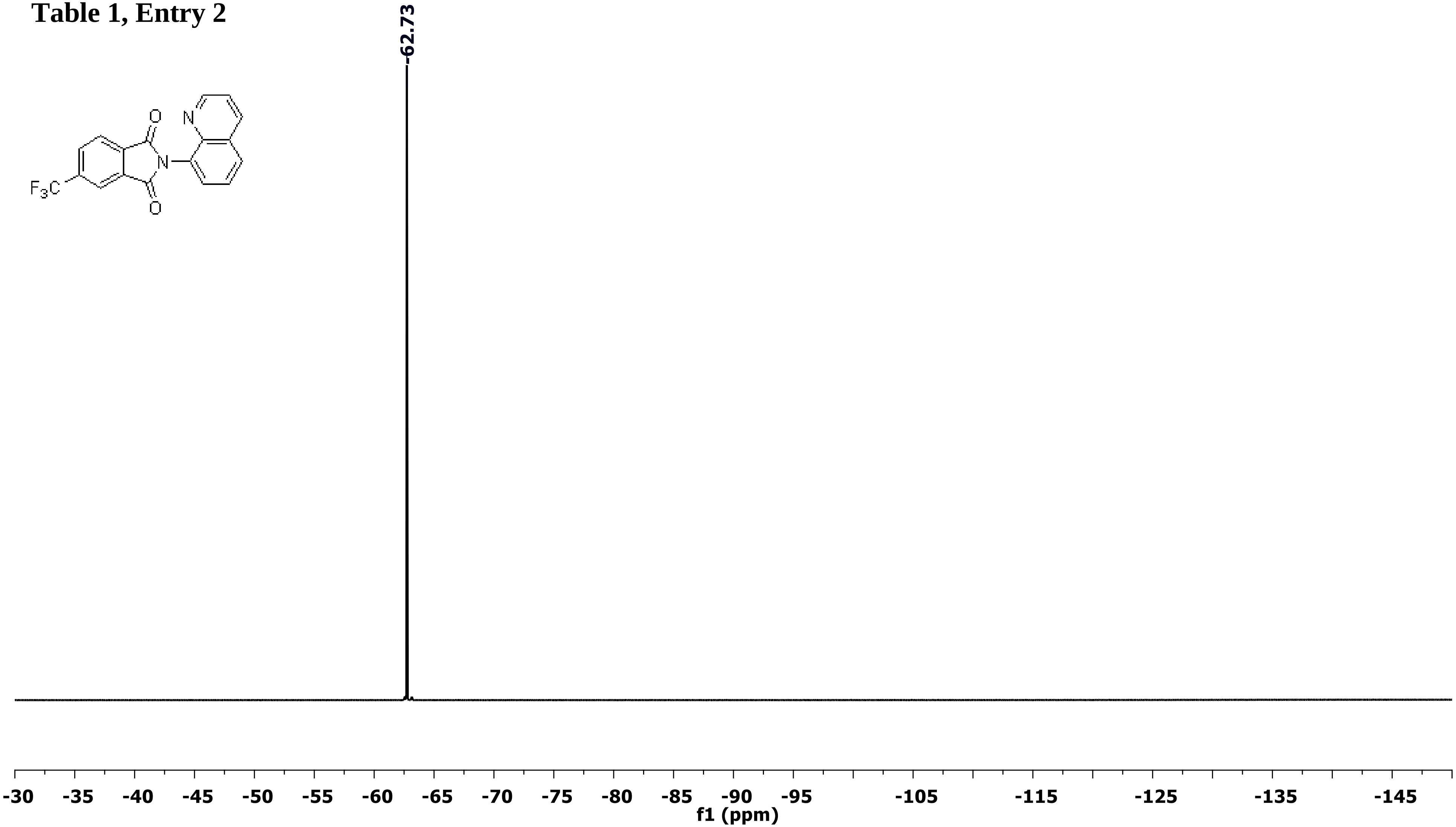
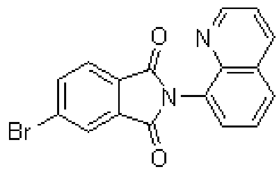
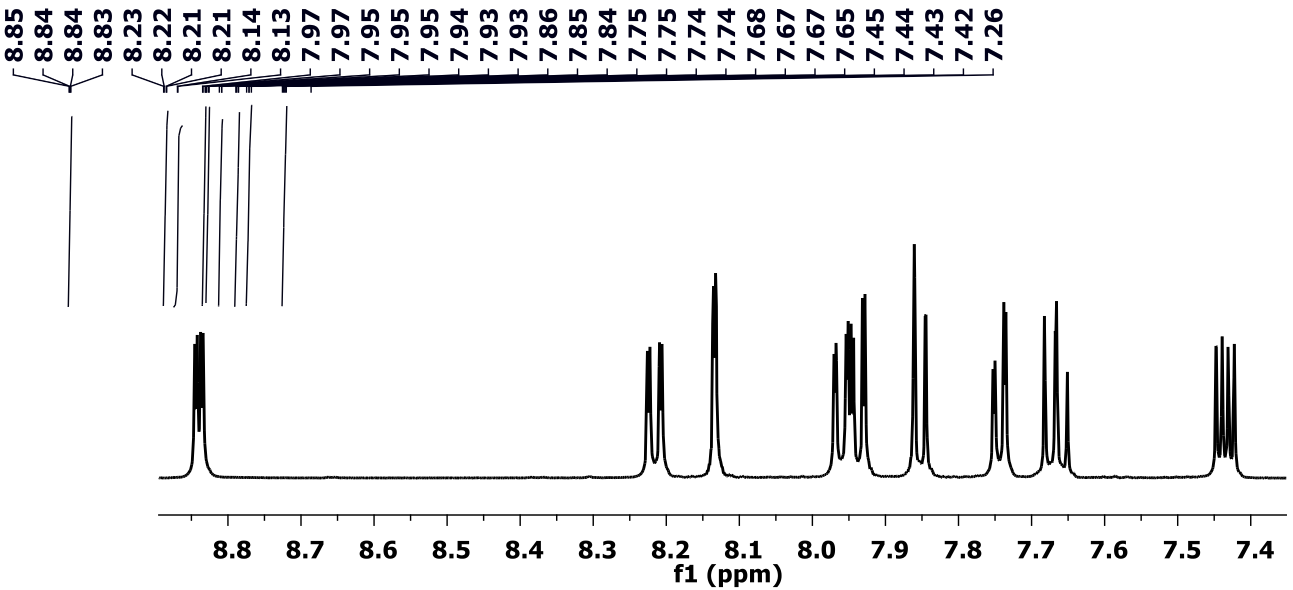


Table 1, Entry 3





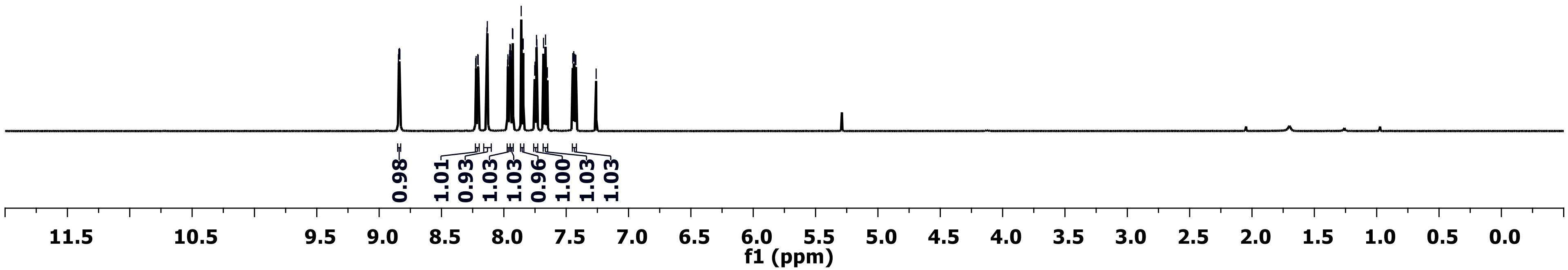
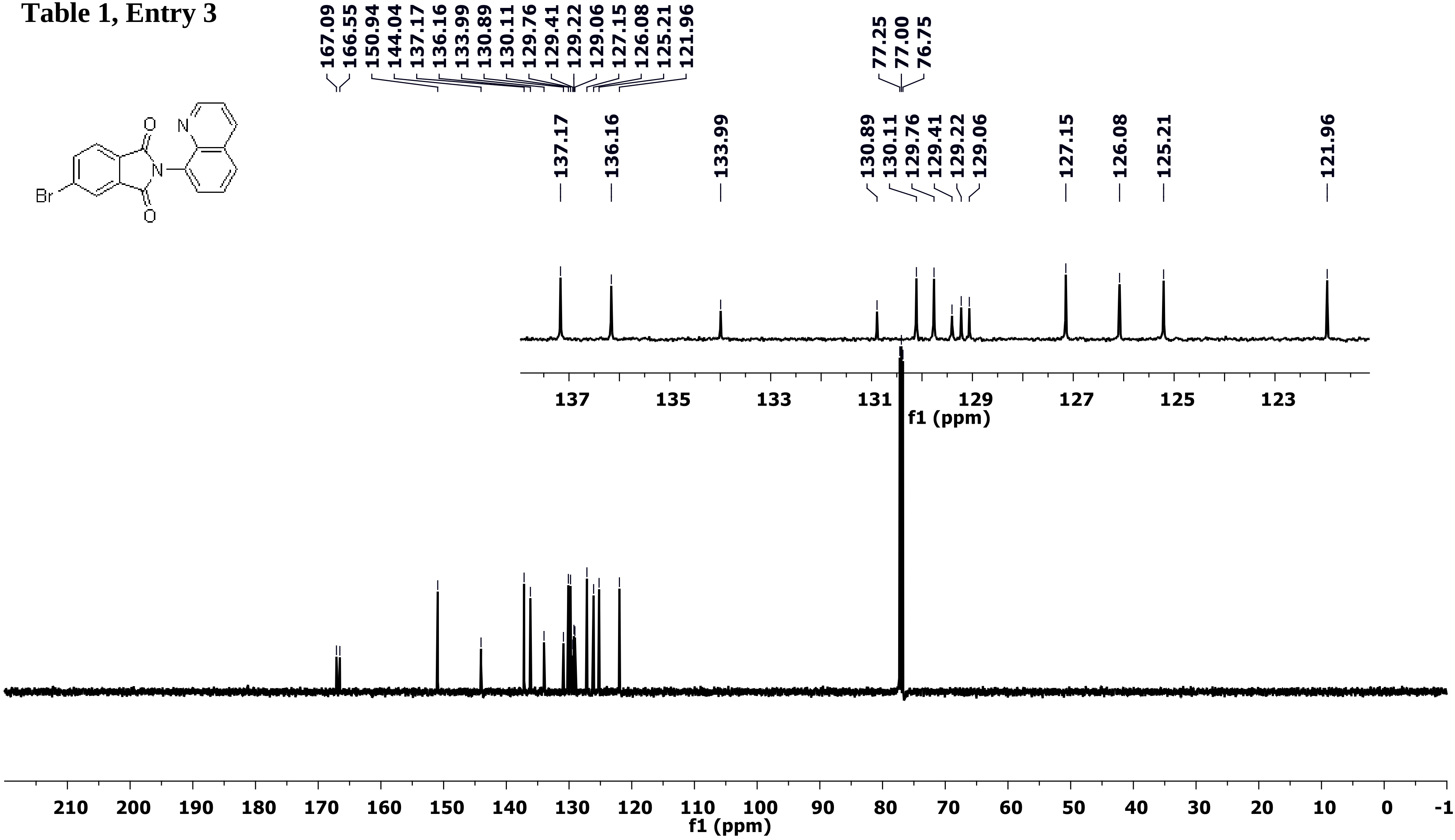


Table 1, Entry 3



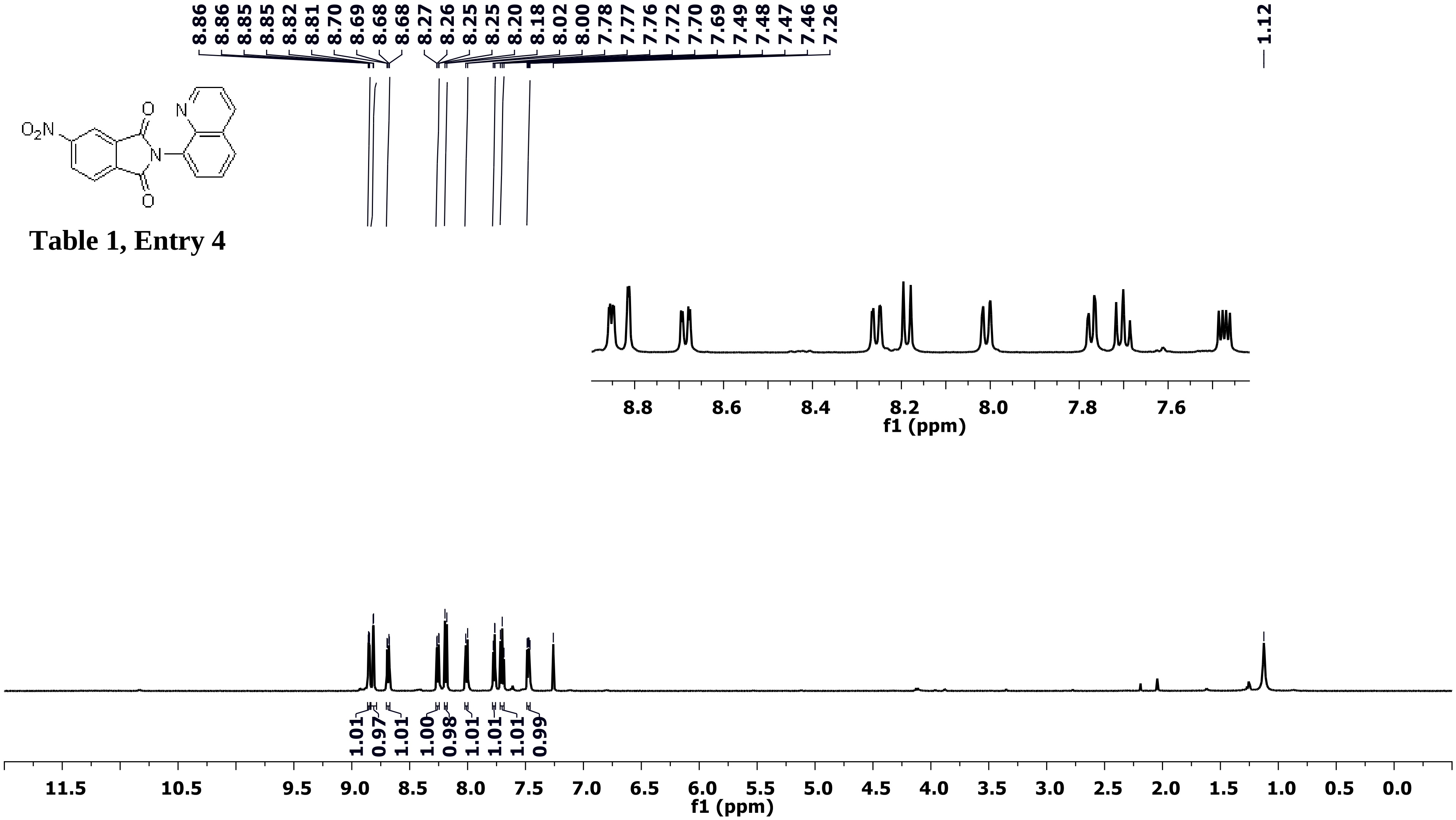


Table 1, Entry 4

Table 1, Entry 4

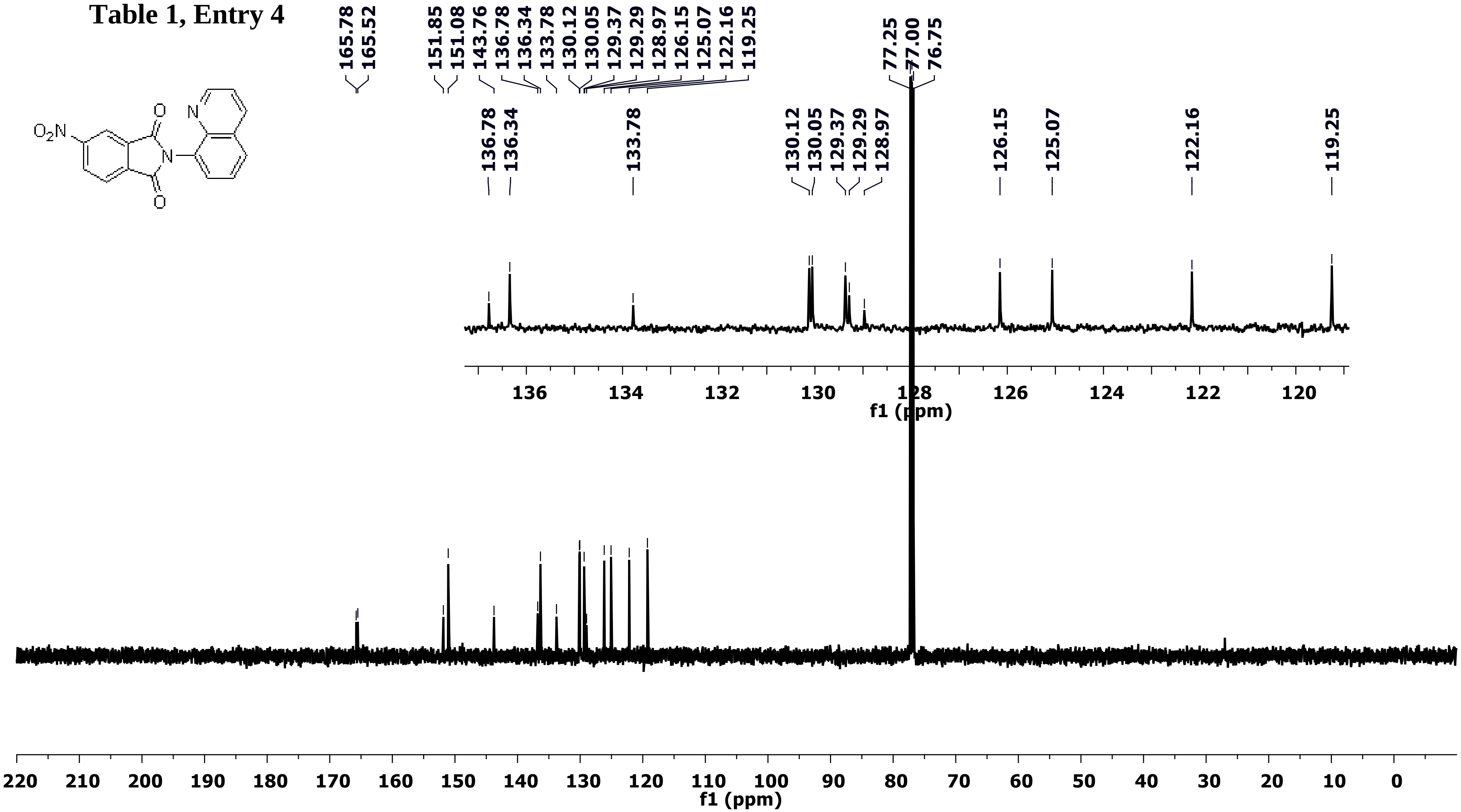


Table 1, Entry 5

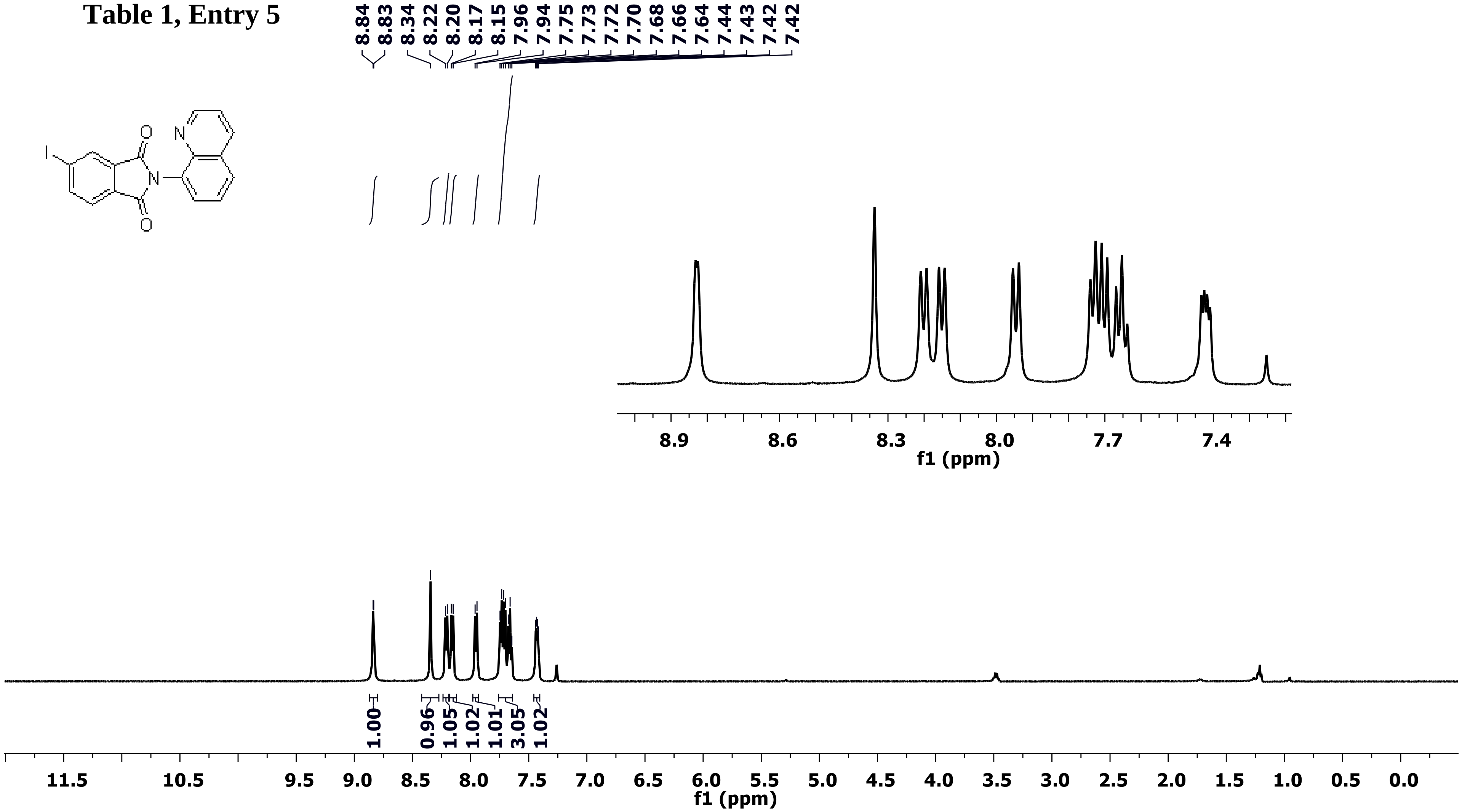


Table 1, Entry 5

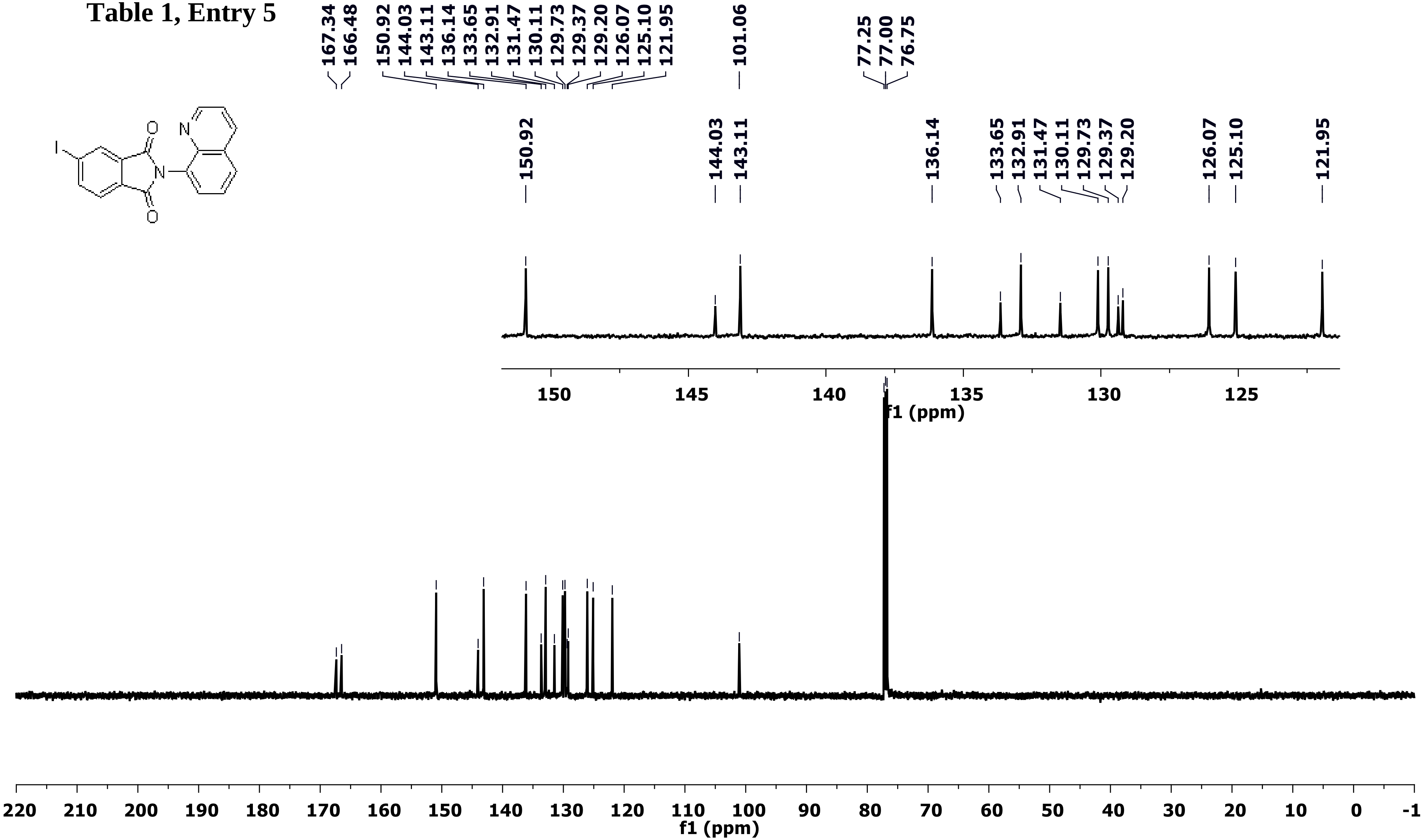


Table 1, Entry 6

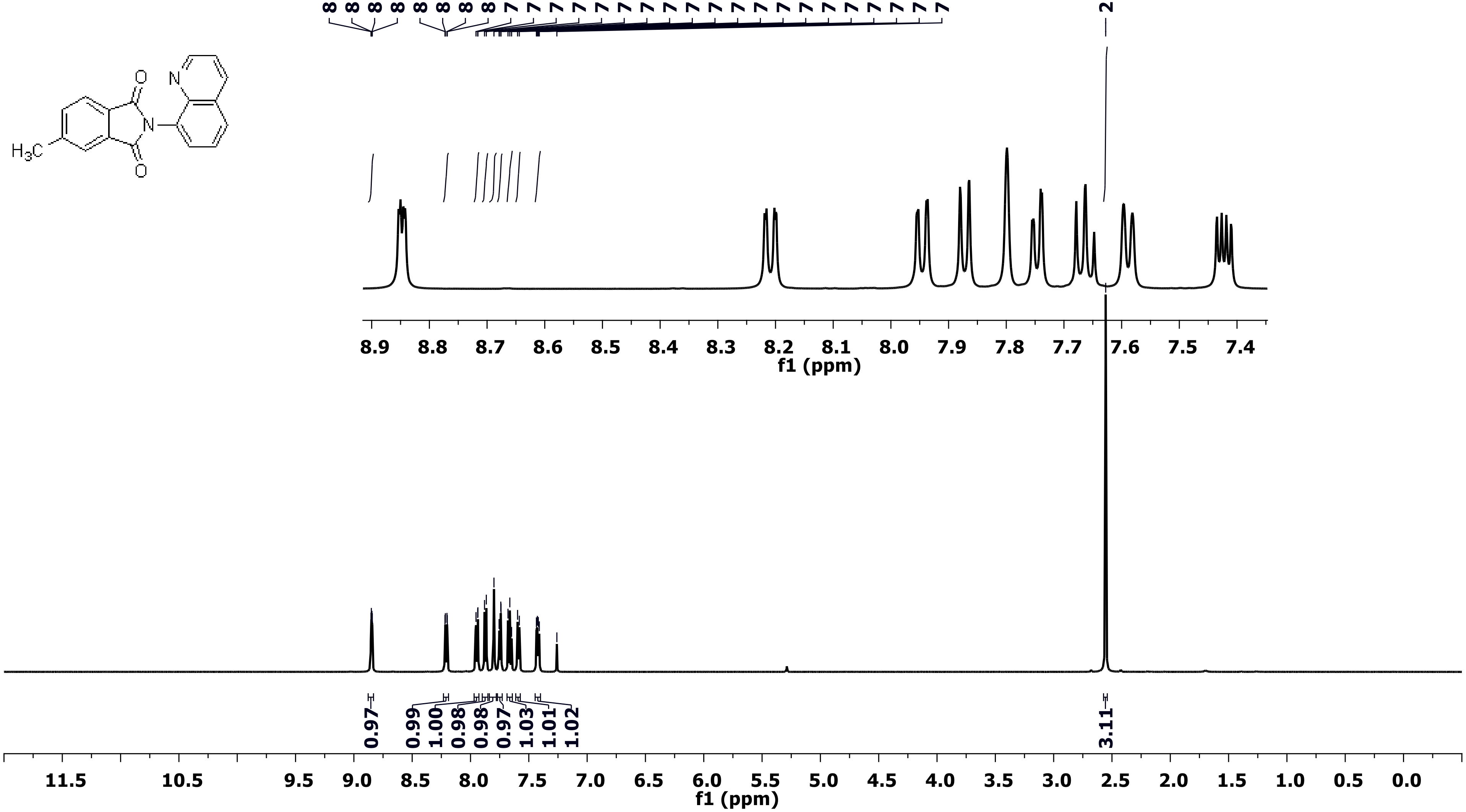


Table 1, Entry 6

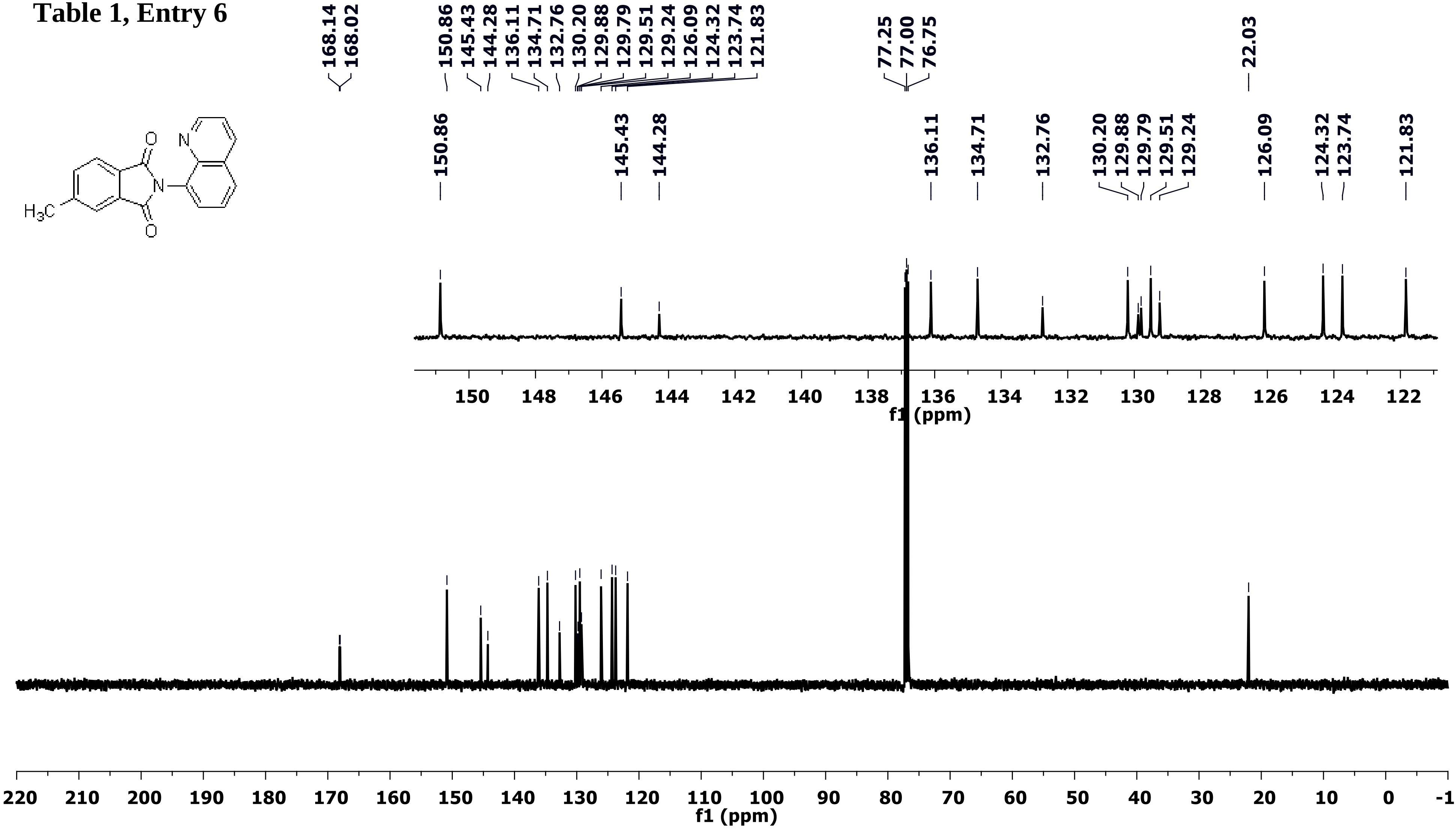


Table 1, Entry 7

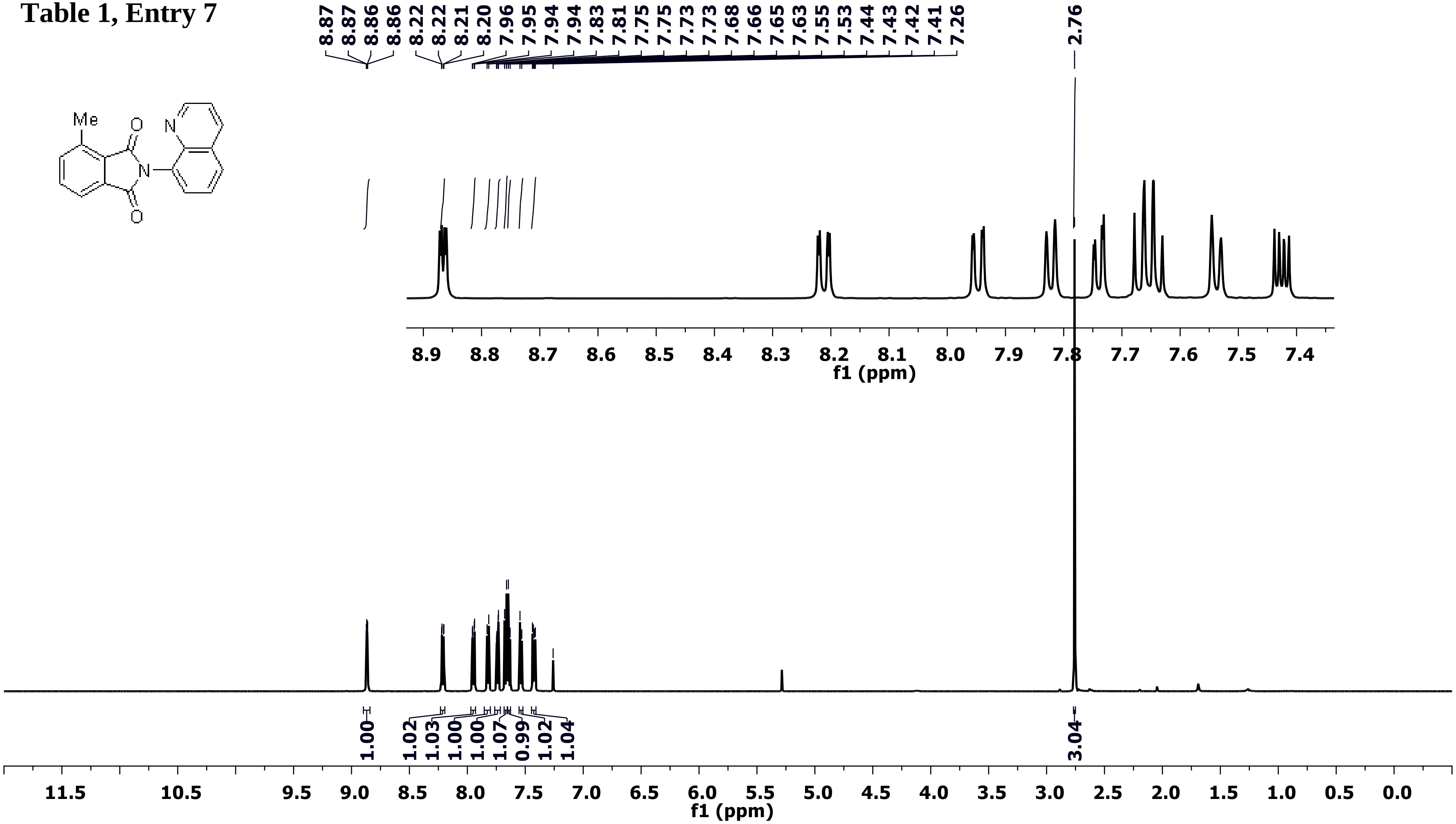


Table 1, Entry 7

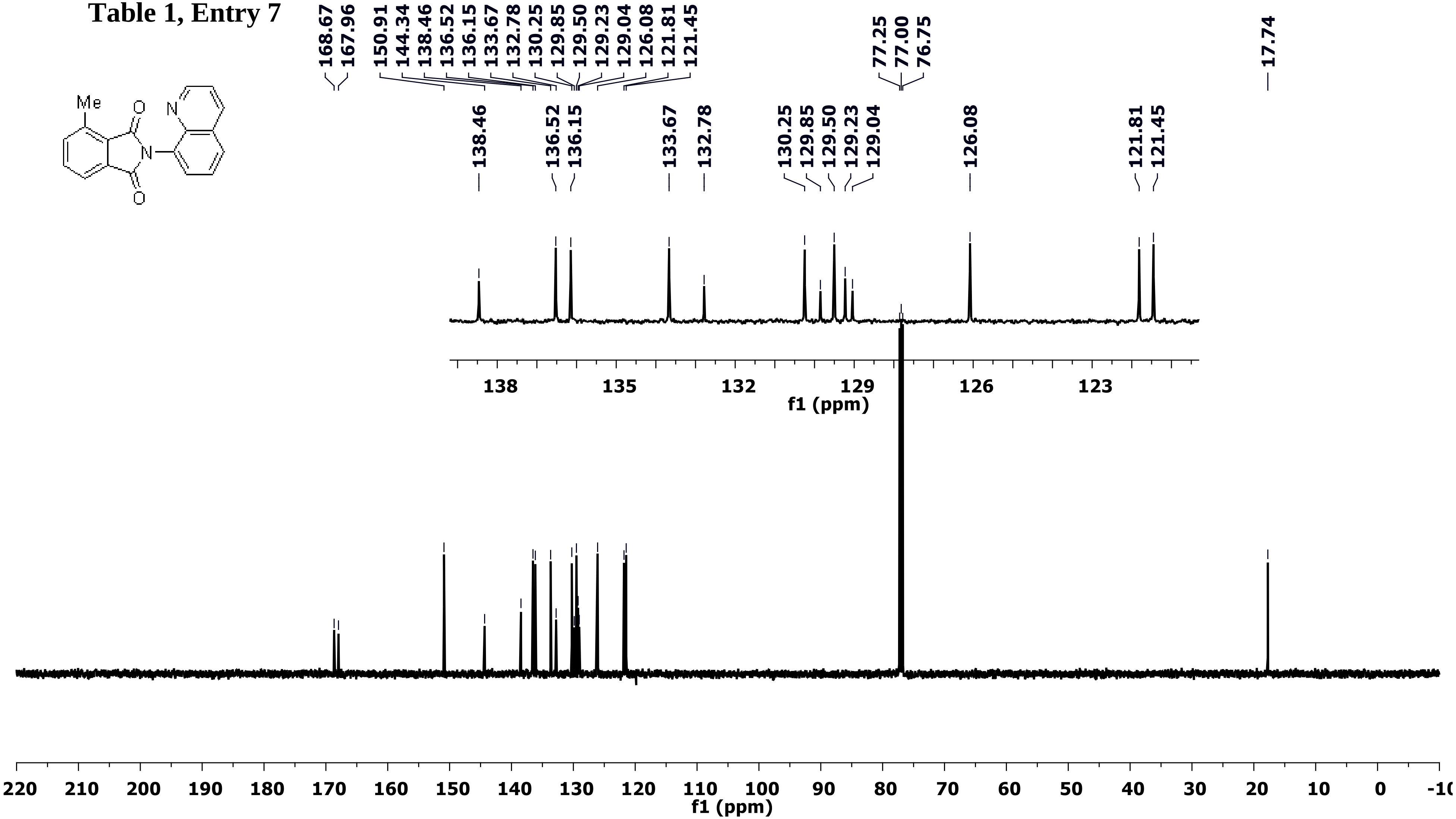


Table 1, Entry 8

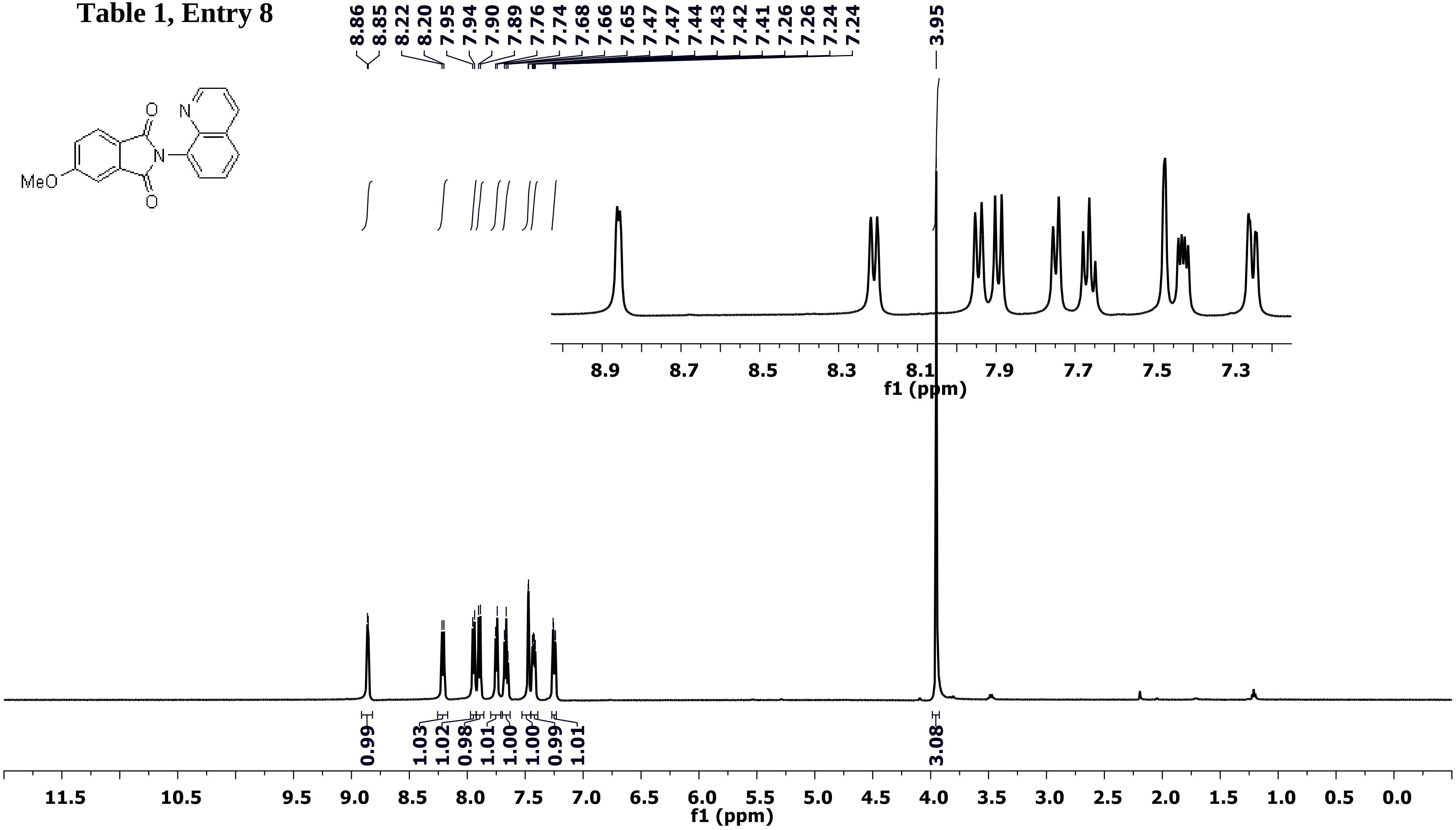


Table 1, Entry 8

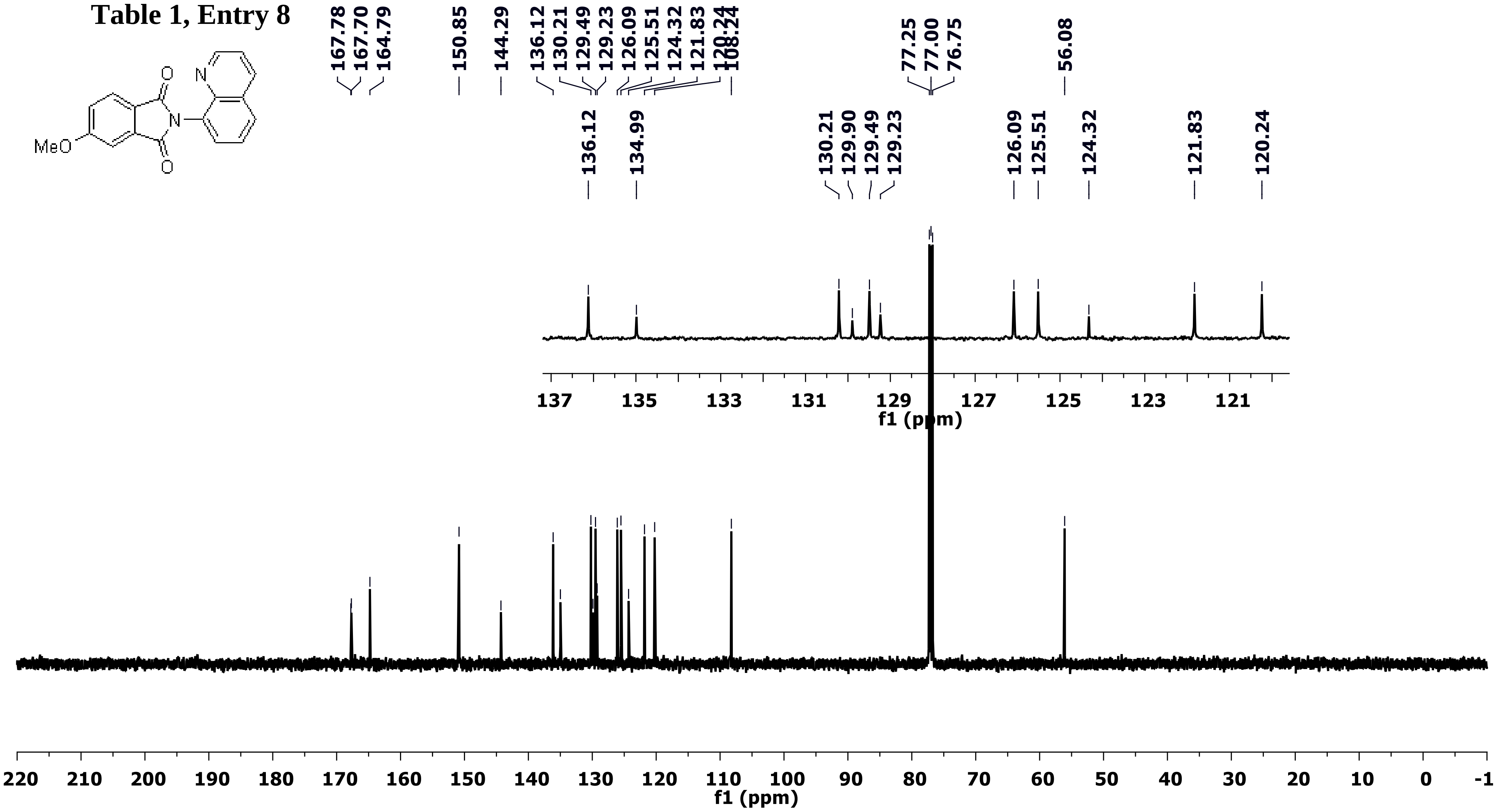


Table 1, Entry 9

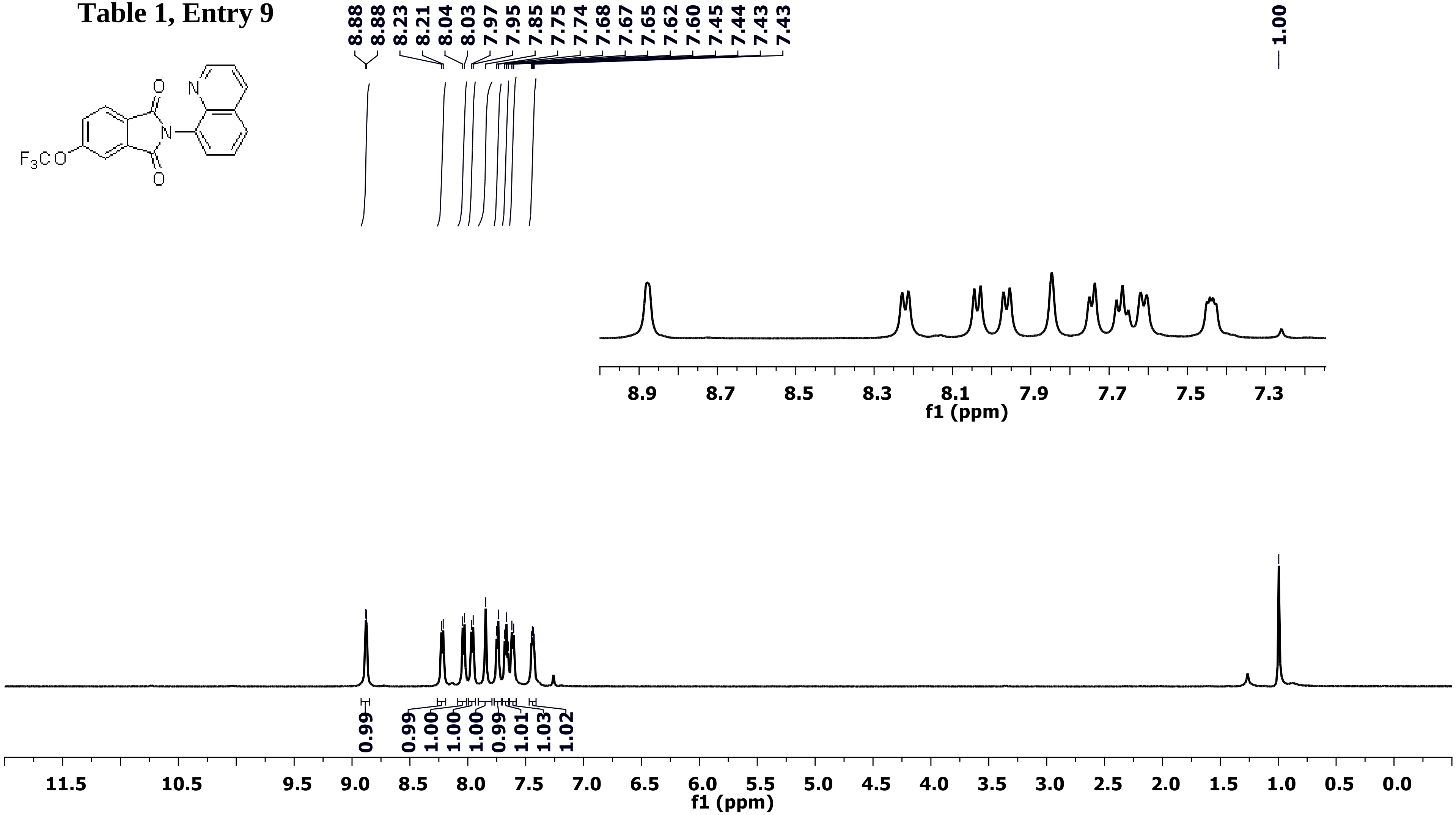


Table 1, Entry 9

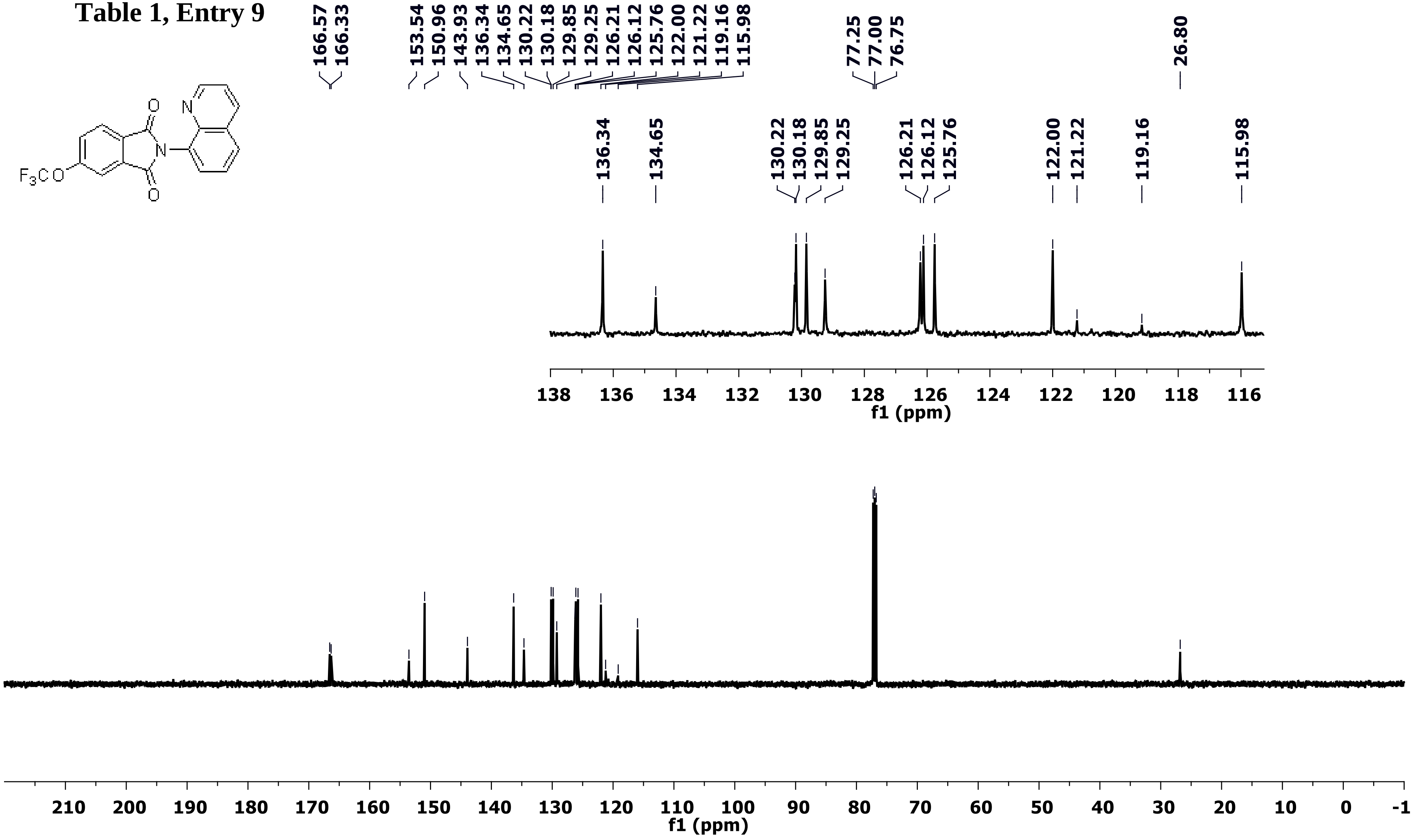
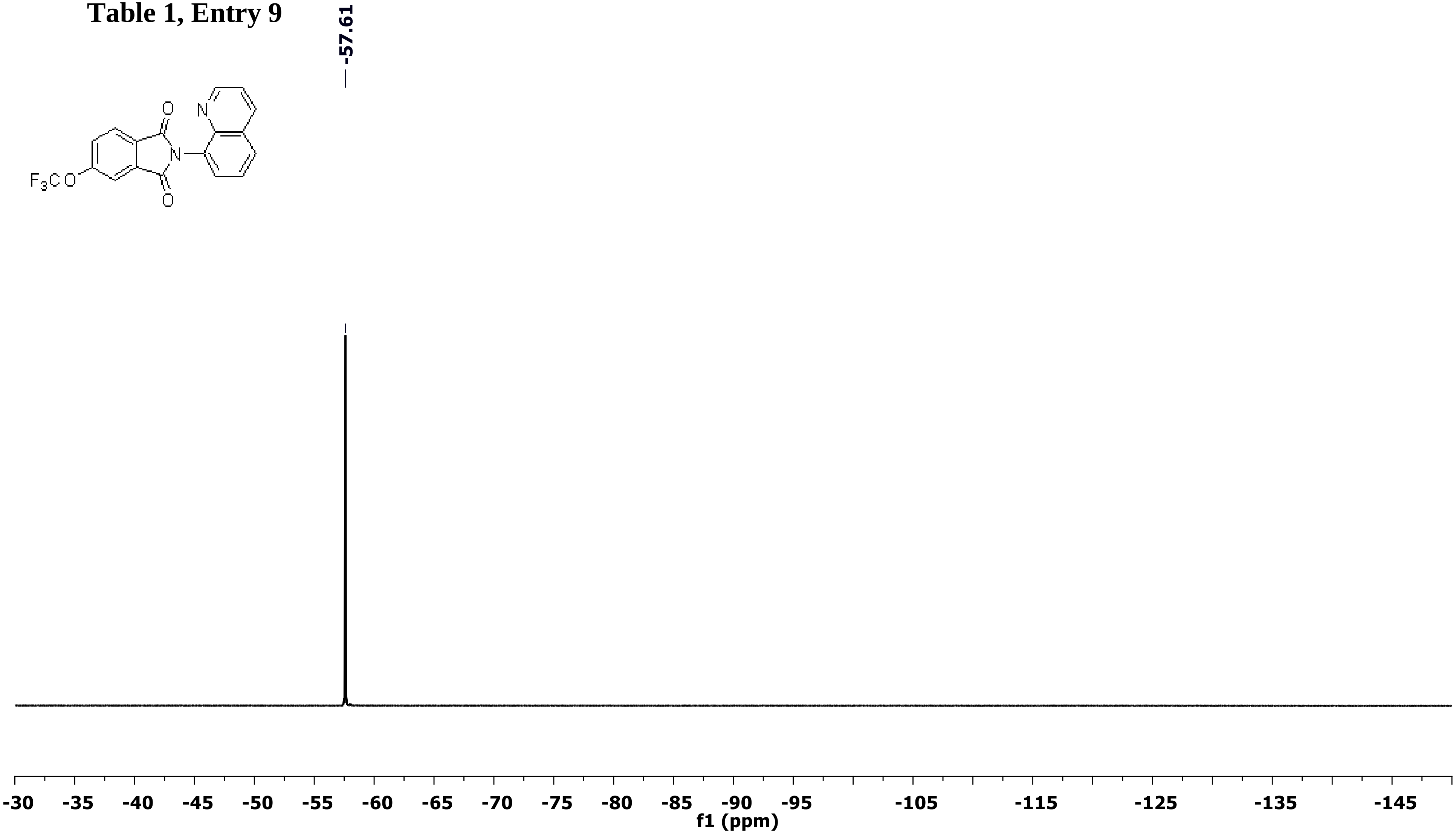


Table 1, Entry 9



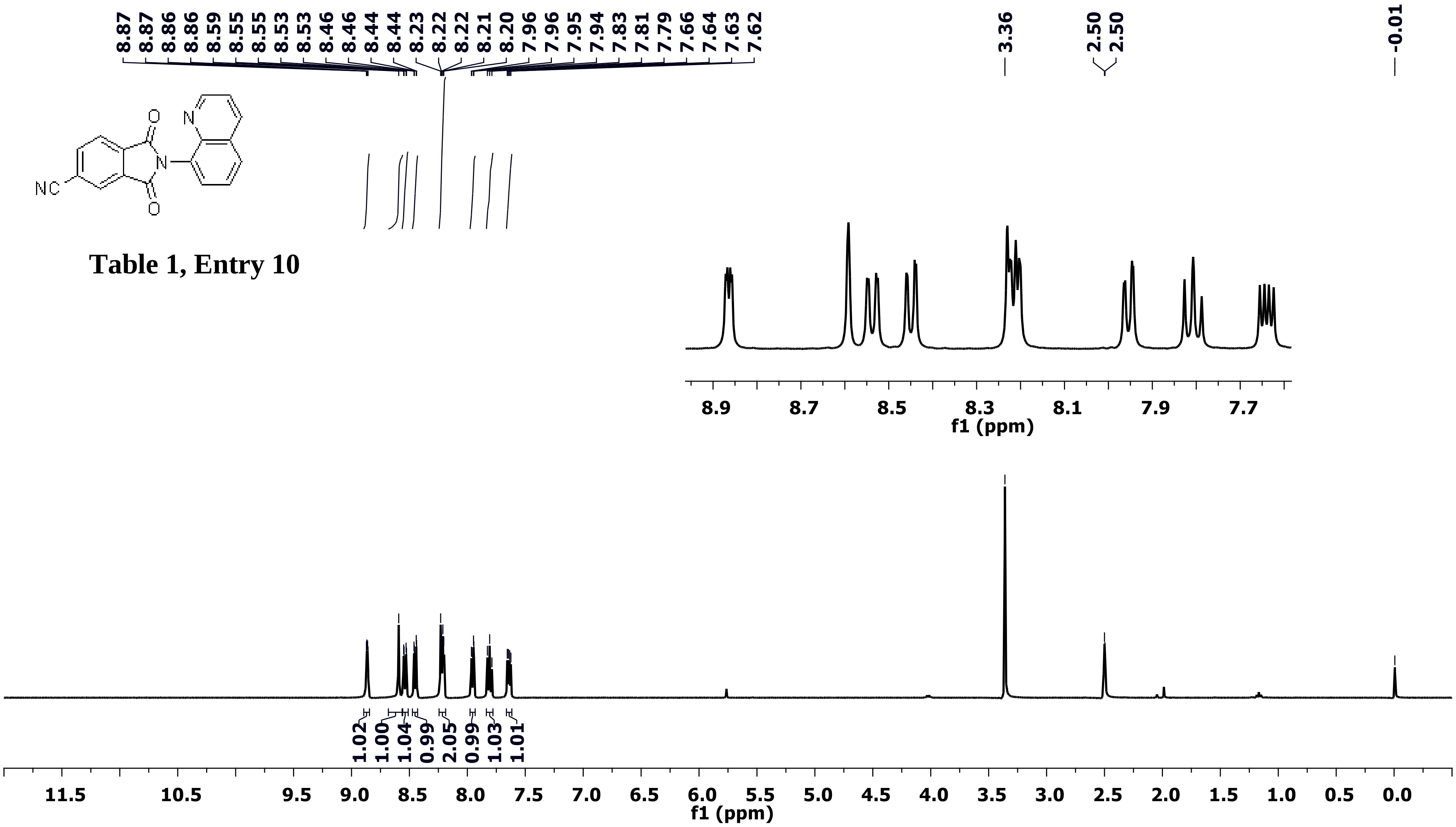
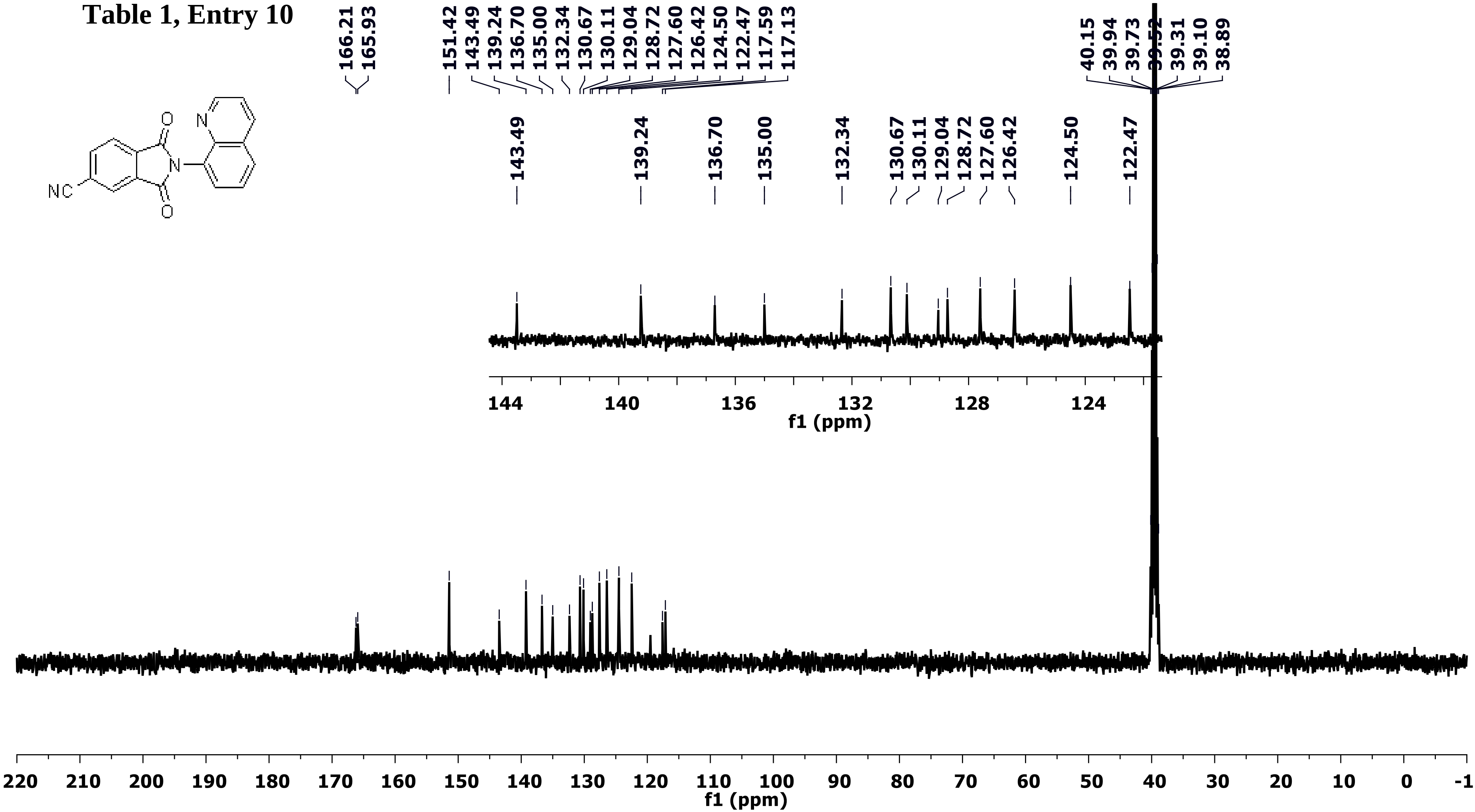


Table 1, Entry 10

Table 1, Entry 10



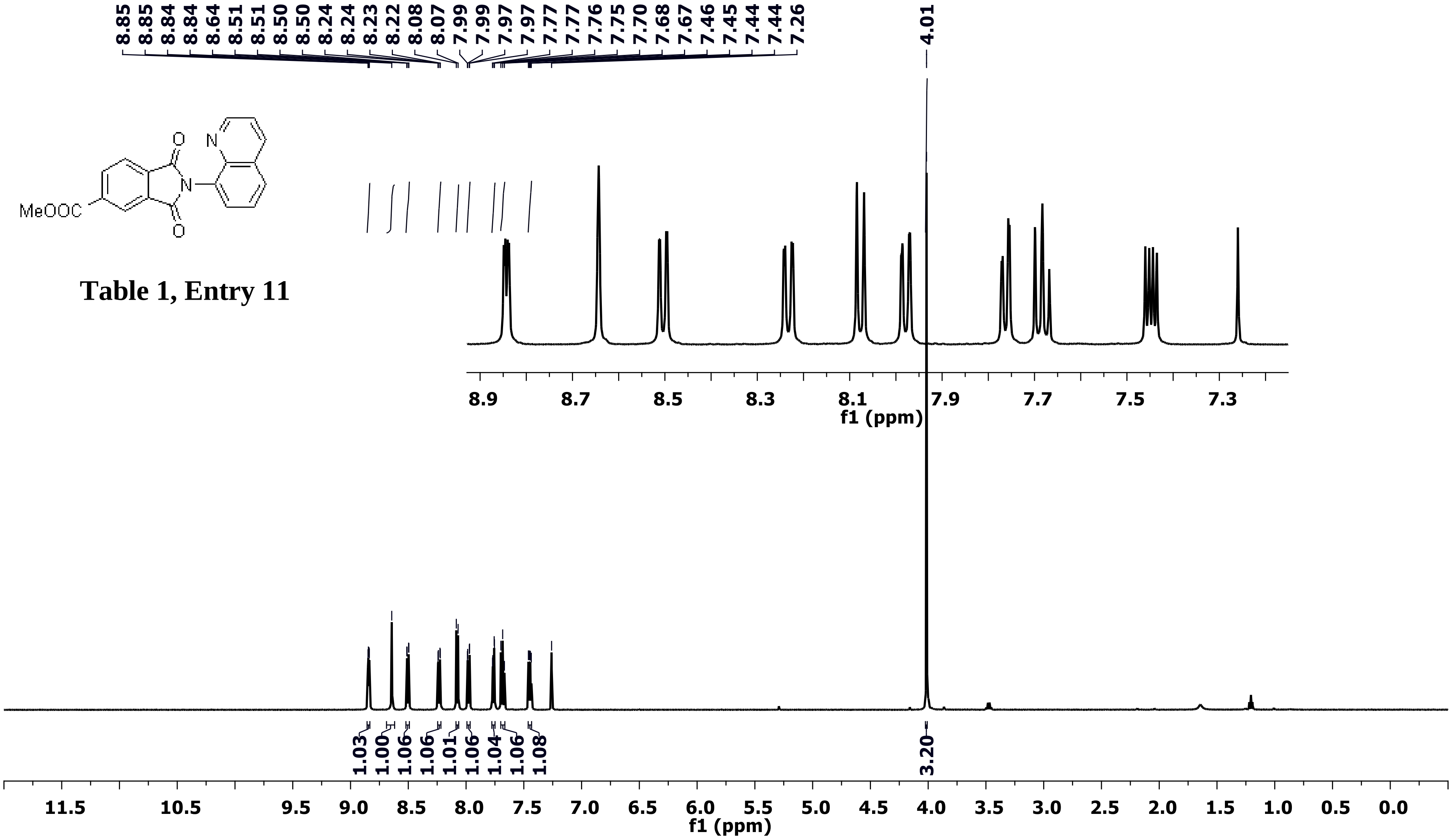
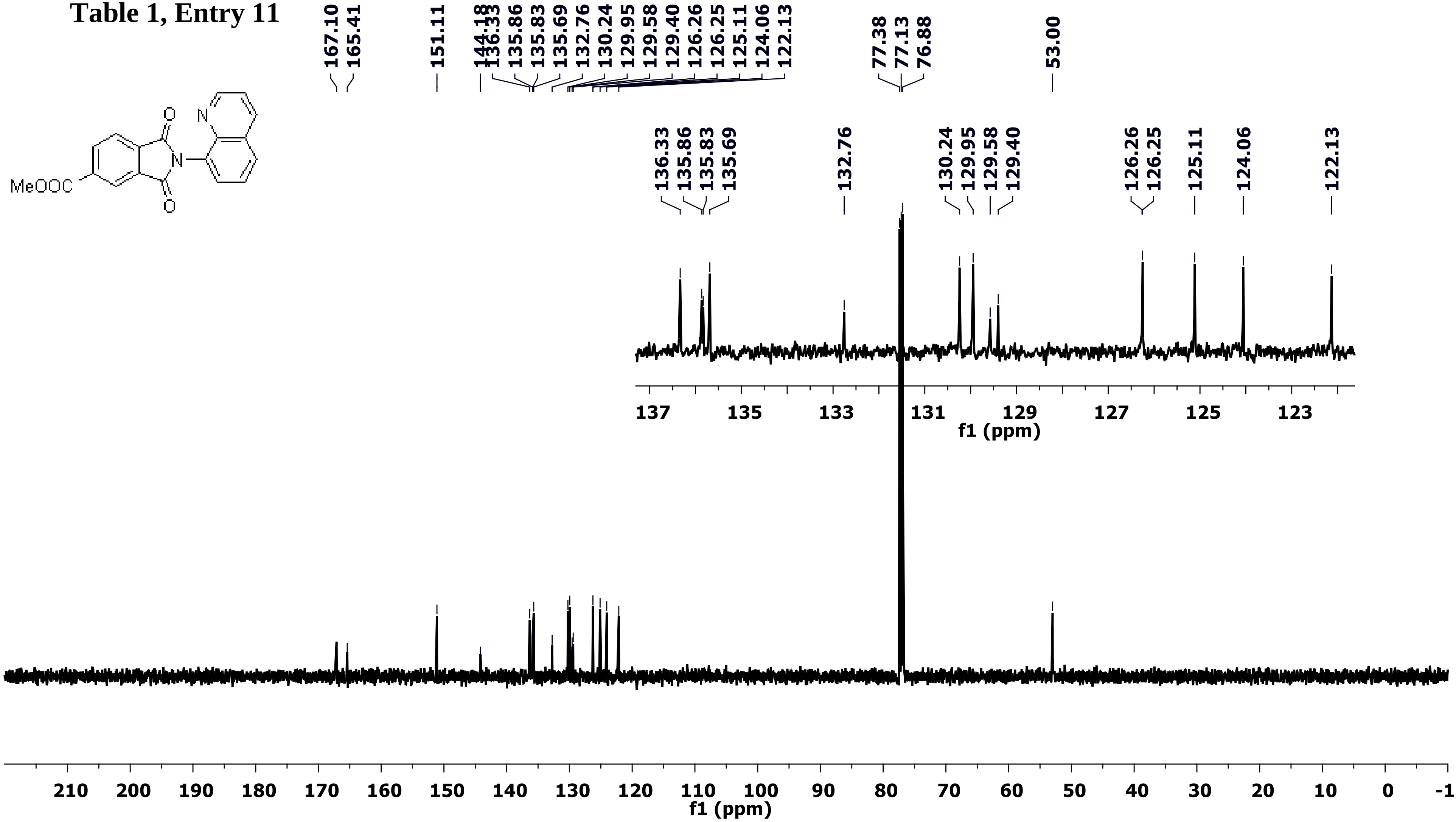


Table 1, Entry 11

Table 1, Entry 11



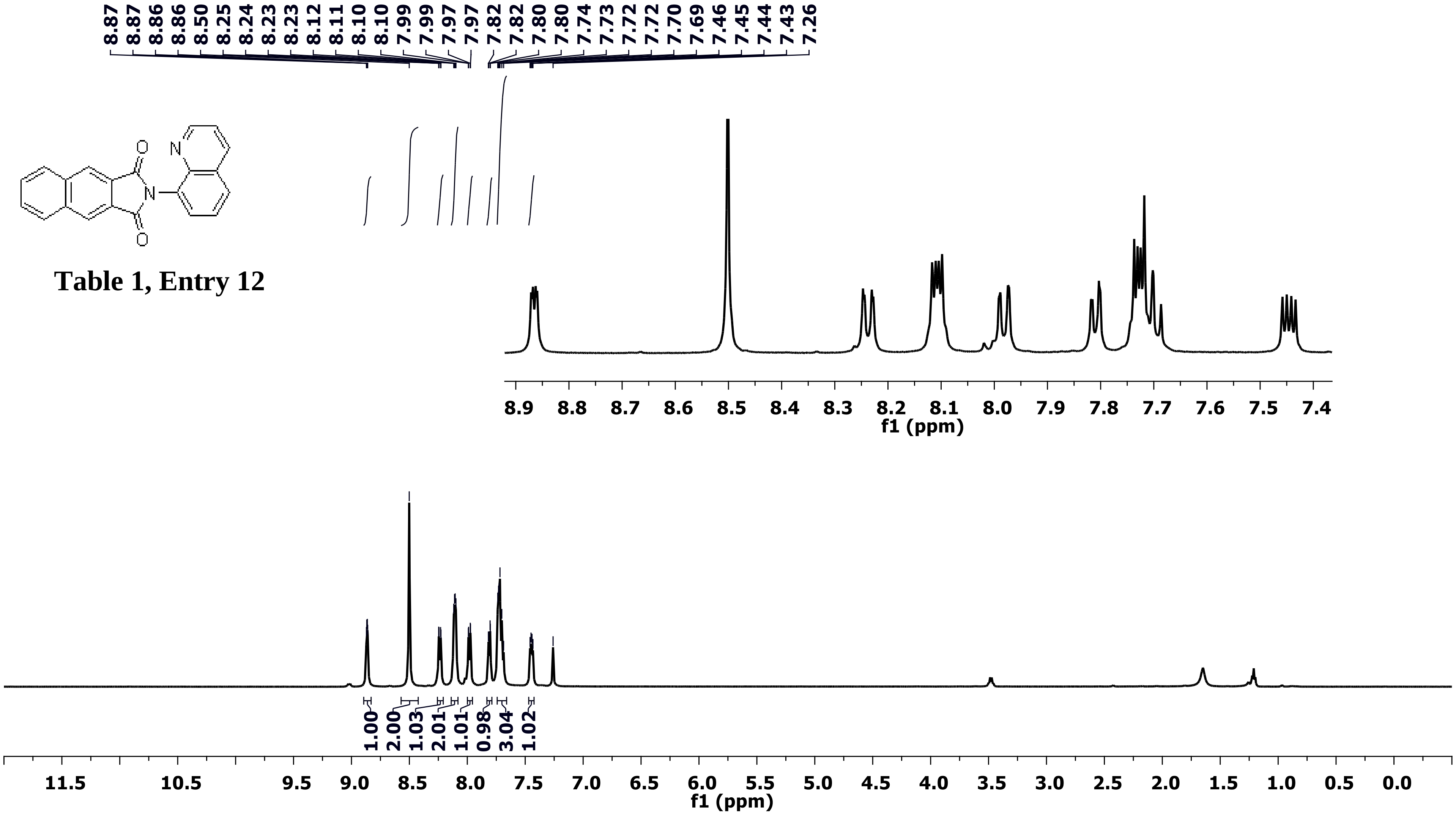
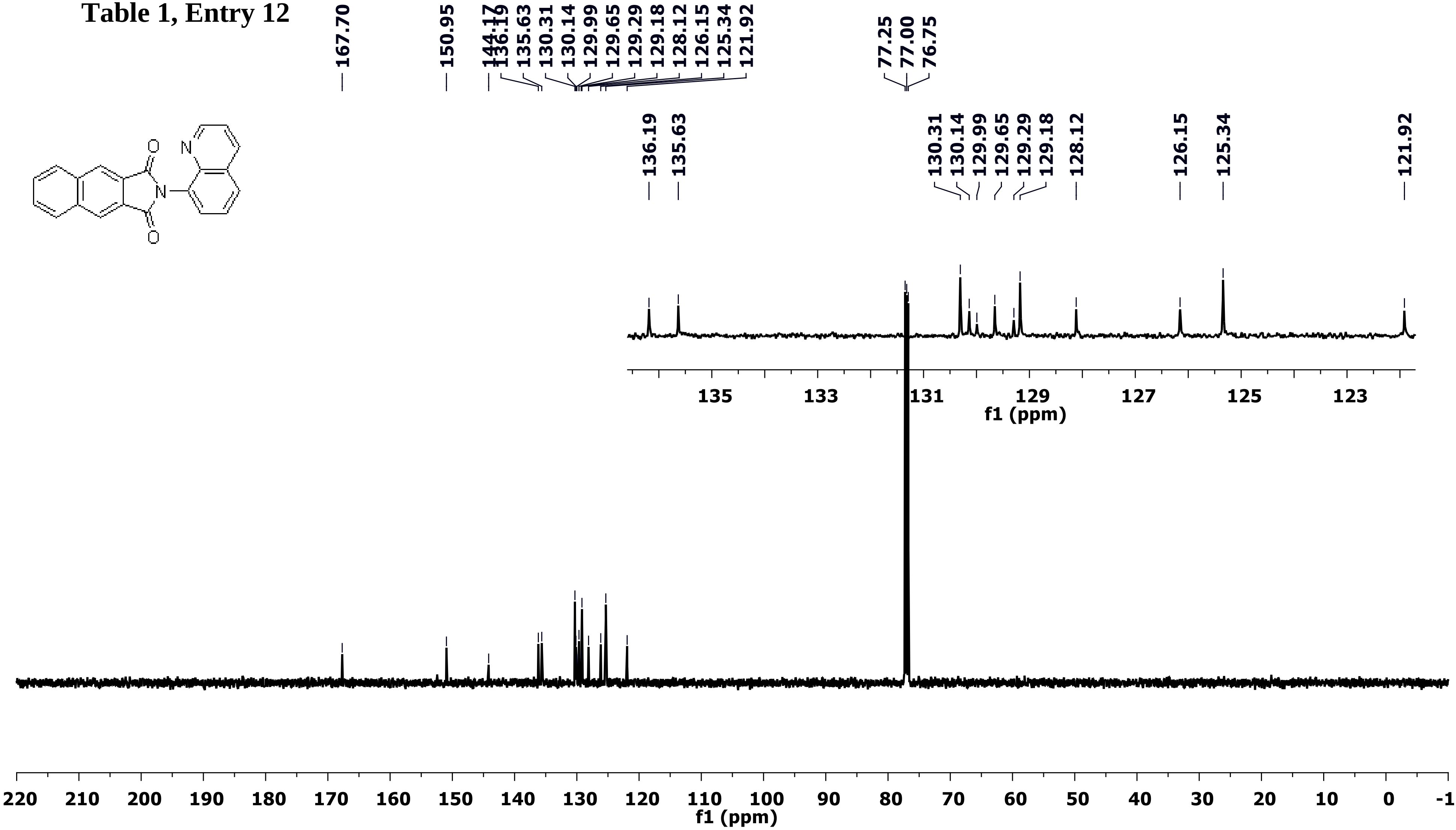
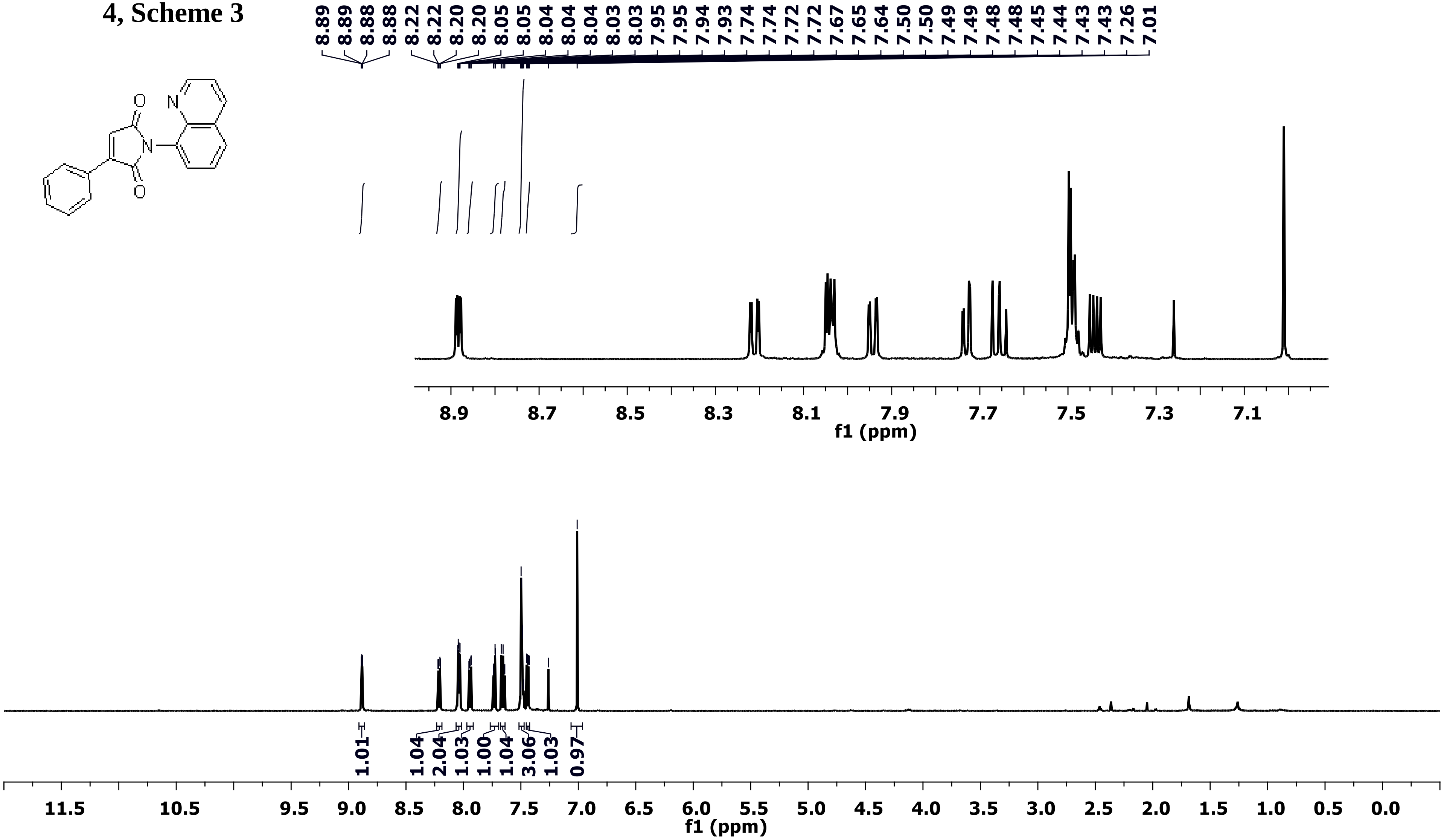


Table 1, Entry 12

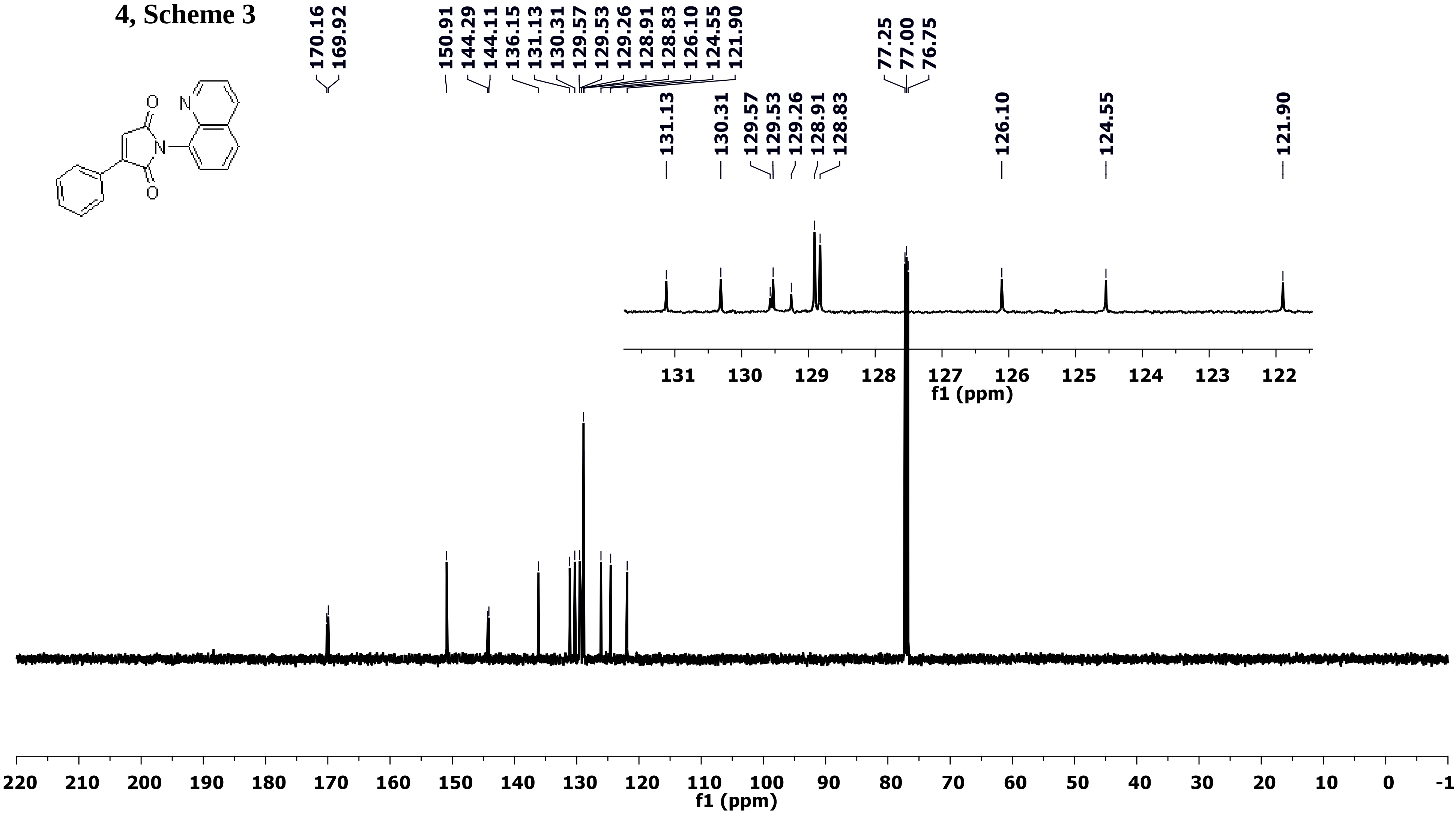
Table 1, Entry 12



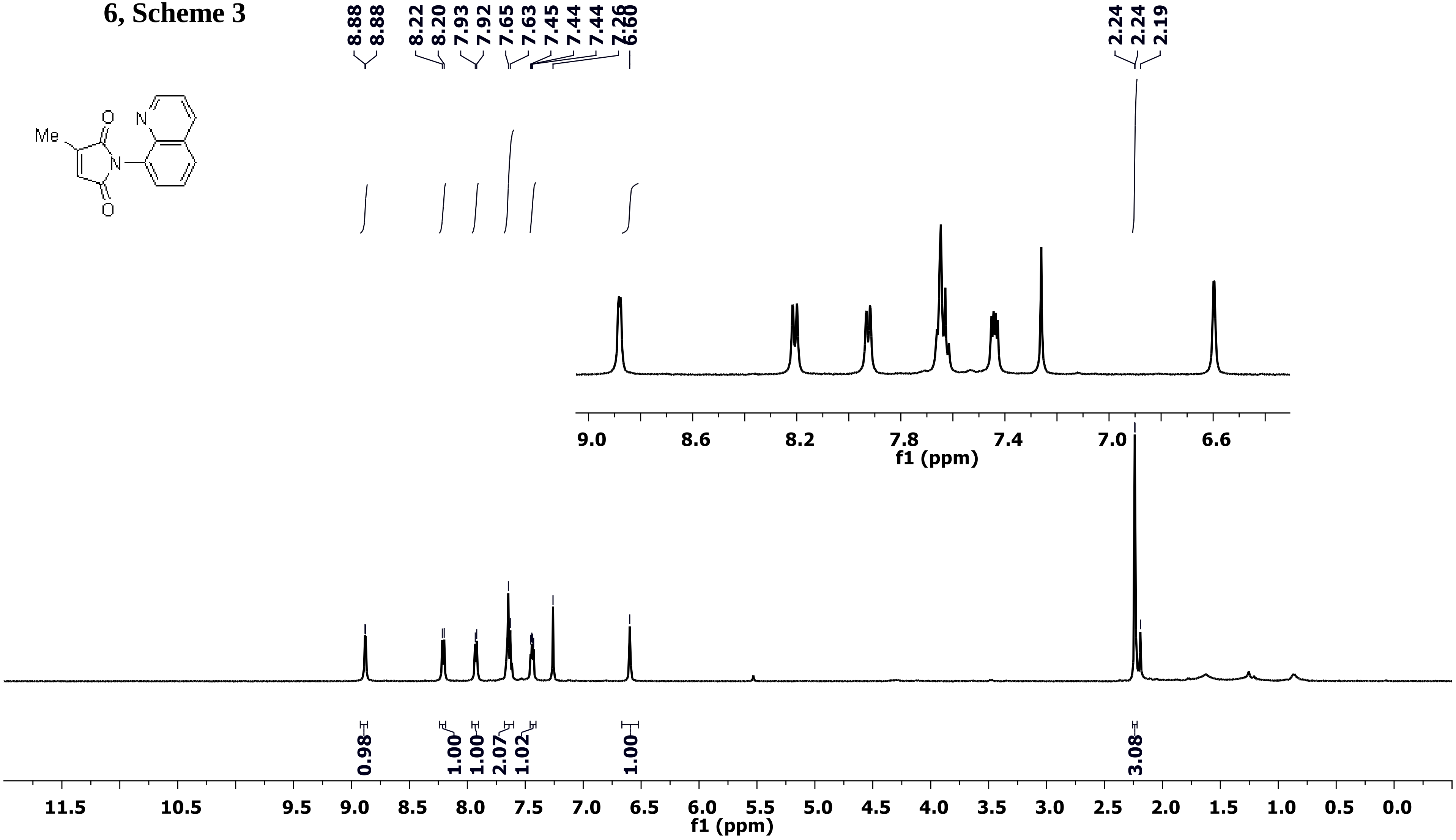
4, Scheme 3


8.89
8.89
8.88
8.88
8.22
8.22
8.20
8.20
8.05
8.05
8.04
8.04
8.04
8.03
8.03
7.95
7.95
7.94
7.93
7.74
7.74
7.72
7.72
7.67
7.65
7.64
7.50
7.50
7.49
7.49
7.48
7.48
7.45
7.44
7.43
7.43
7.26
7.01
N
O
N
O
8.9
8.7
8.5
8.3
8.1
7.9
7.7
7.5
7.3
7.1
f1 (ppm)
1.01
1.04
2.04
1.03
1.00
1.04
3.06
1.03
0.97
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

4, Scheme 3

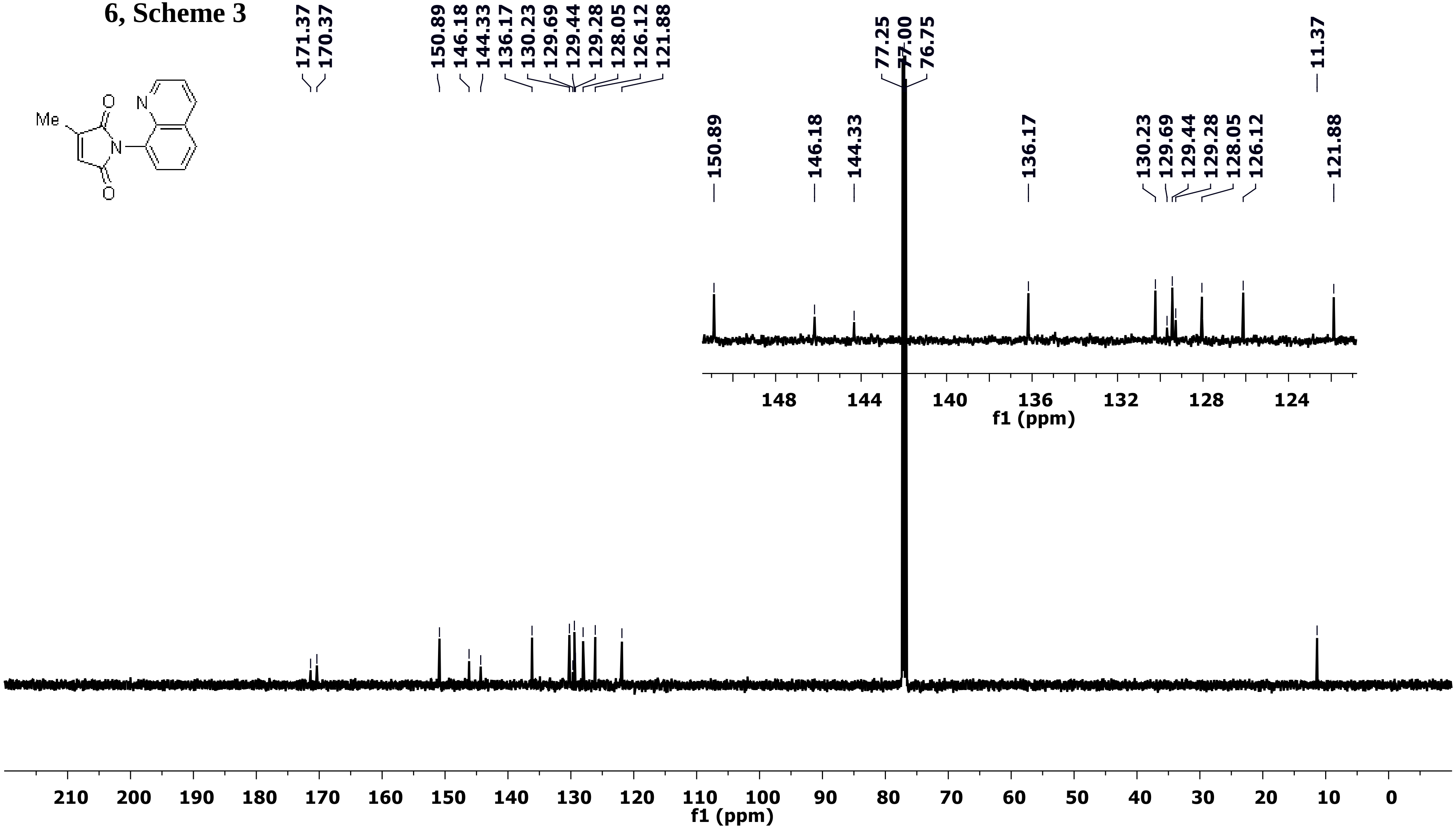

O
N
N
O
170.16
169.92
150.91
144.29
144.11
136.15
131.13
130.31
129.57
129.53
129.26
128.91
128.83
126.10
124.55
121.90
77.25
77.00
76.75
131.13
130.31
129.57
129.53
129.26
128.91
128.83
126.10
124.55
121.90
131
130
129
128
127
126
125
124
123
122
f1 (ppm)
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

6, Scheme 3

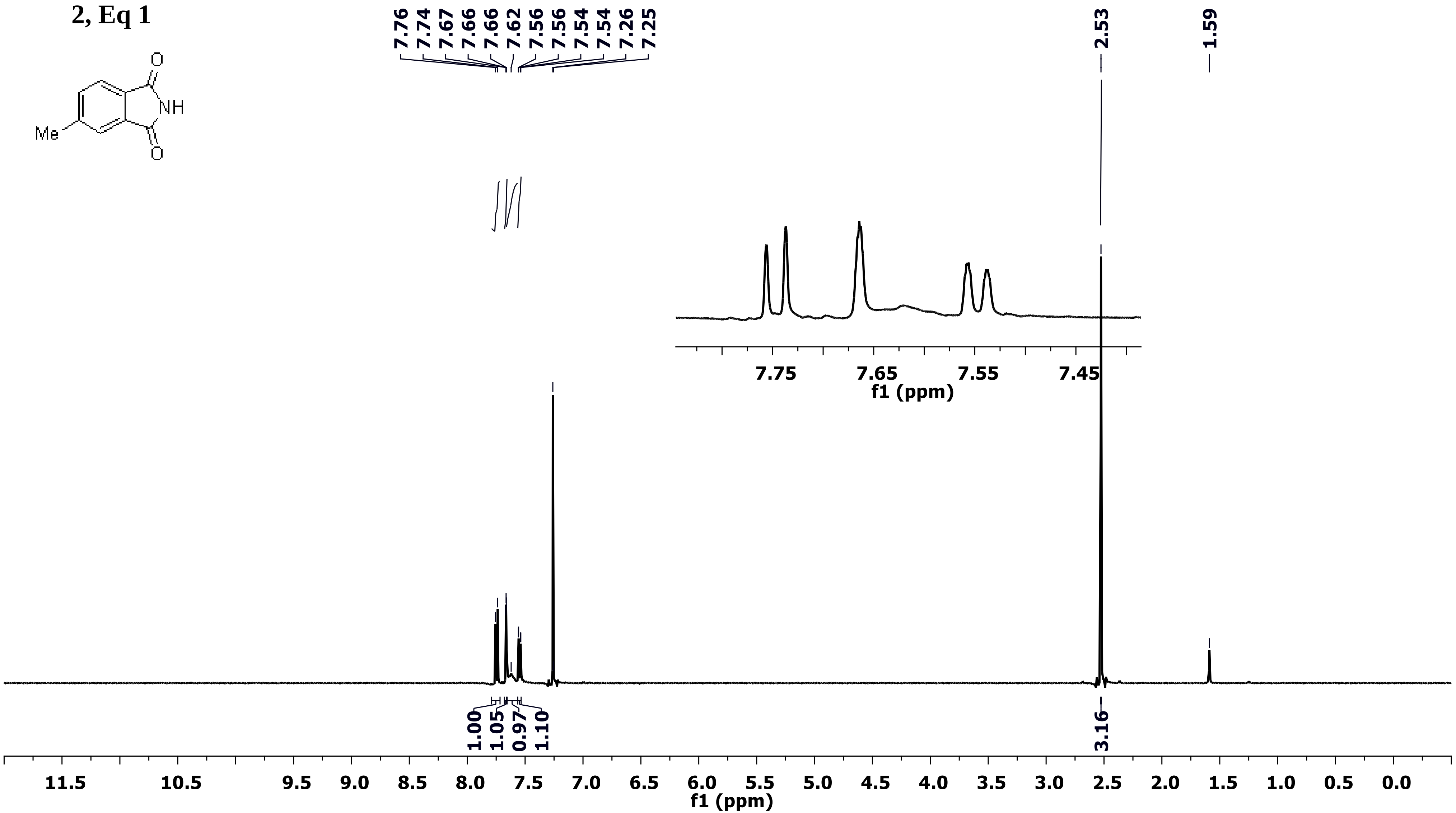


Me
O
N
O
N
8.88
8.88
8.22
8.20
7.93
7.92
7.65
7.63
7.45
7.44
7.44
7.26
6.60
2.24
2.24
2.19
9.0
8.6
8.2
7.8
7.4
7.0
6.6
f1 (ppm)
0.98
1.00
1.00
2.07
1.02
1.00
3.08
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

6, Scheme 3


Me
O
N
N
O
171.37
170.37
150.89
146.18
144.33
136.17
130.23
129.69
129.44
129.28
128.05
126.12
121.88
77.25
77.00
76.75
11.37
150.89
146.18
144.33
136.17
130.23
129.69
129.44
129.28
128.05
126.12
121.88
148
144
140
136
132
128
124
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

2, Eq 1


O
NH
O
Me
7.76
7.74
7.67
7.66
7.66
7.62
7.56
7.56
7.54
7.54
7.26
7.25
2.53
1.59
7.75
7.65
7.55
7.45
f1 (ppm)
1.00
1.05
0.97
1.10
3.16
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)