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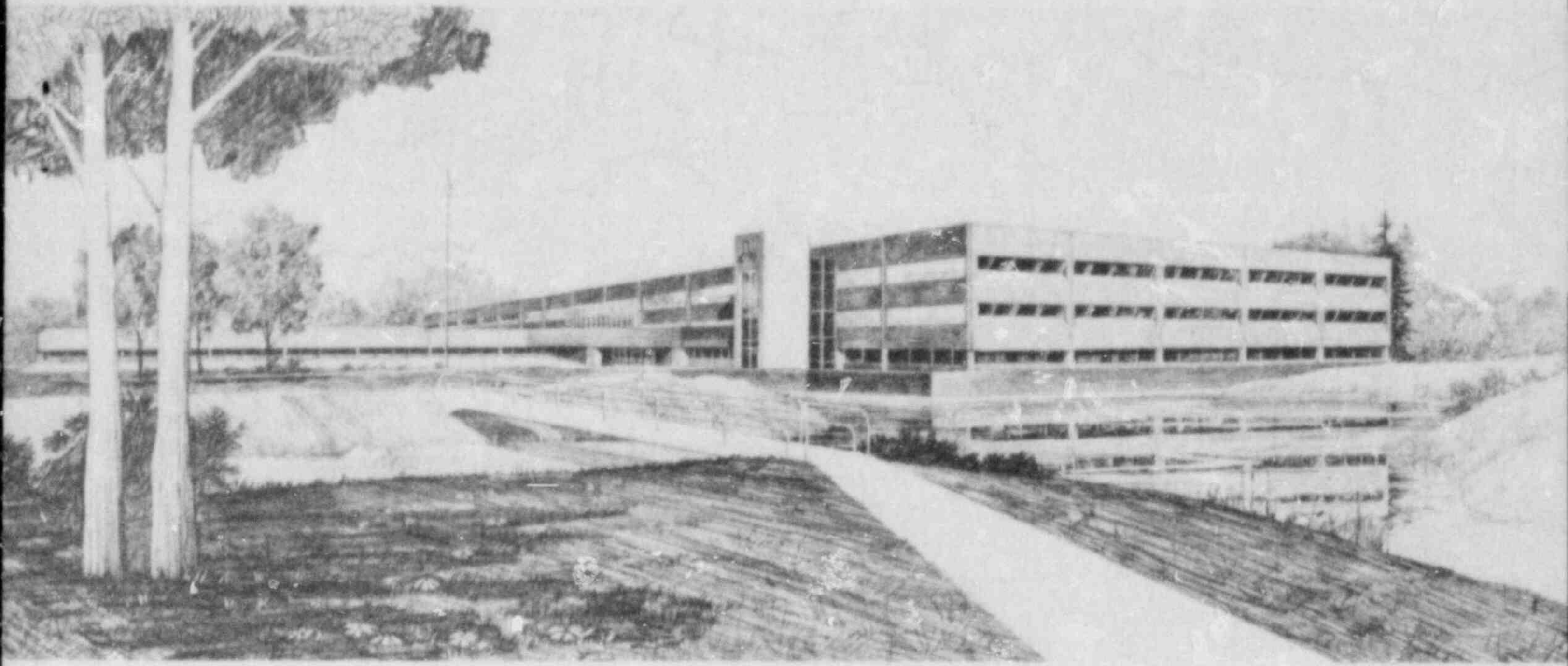

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Experiment Data Report For Semiscale Mod-2A Steam Line Break Experiments (Tests S-SF-4 and S-SF-5)

Ronald A. Larson

October 1982

Prepared for the
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EXPERIMENT DATA REPORT FOR SEMISCALE MOD-2A STEAM LINE BREAK EXPERIMENTS (TESTS S-SF-4 AND S-SF-5)

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ABSTRACT

This report presents test data recorded for Tests S-SF-4 and S-SF-5 of the Semiscale Mod-2A Primary Steam and Feedwater Line Break Experiment Series. These tests are part of a series of Semiscale tests that investigate the thermal-hydraulic phenomena resulting from operational transients involving rupture of the steam line piping on the secondary side of a pressurized water reactor. Experimental data from the tests are used to develop and assess the analytical capabilty of computer models used to predict the results of such a rupture in the steam line piping and evaluate the operational procedures involved in system recovery.

The primary objectives of the tests were to determine the effects of a secondary-side transient on the primary side of the system, with 100% (S-SF-4) and 50% (S-SF-5) ruptures of the main steam line piping, and to provide data for water reactor safety codes and scoping for future tests.

This report presents the uninterpreted data from Tests S-SF-4 and -5 for analysis. The data, presented as graphs in engineering units, have been analyzed only to the extent necessary to ensure that they are reasonable and consistent.

FIN No. A6038—Semiscale Program

SUMMARY

Tests S-SF-4 and S-SF-5 were steam line break tests associated with the Semiscale Mod-2A Steam and Feedwater Line Break Experiment Series conducted by EG&G Idaho, Inc., for the United States Government. These tests investigated the thermal-hydraulic phenomena resulting from various size ruptures in the main steam line of a pressurized water reactor (PWR). Specifically, Tests S-SF-4 and -5 simulated a transient which resulted in overcooling of the primary side of a PWR system due to the temporarily enhanced heat sink during secondary side blowdowns.

The Semiscale Mod-2A system is equipped with a pressure vessel that contains an electrically heated core, other simulated reactor internals, and an external downcomer assembly; an intact loop with steam generator, pump, and pressurizer; and a broken loop with steam generator, and pump.

The main steam line break tests were initiated from hot standby conditions, which results in the greatest cooldown prediction. The break nozzle sizes were scaled to represent 100% (S-SF-4) and 50% (S-SF-5) of the area of a Westinghouse four-loop PWR. These tests duplicated, as nearly as possible, the conditions of a typical PWR system. In addition, a long-term recovery procedure was attempted using a primary feed and bleed during the tests.

Generally, Tests S-SF-4 and -5 proceeded as specified. Conditions that did not conform to the specified test configuration were considered acceptable for analysis within the test objectives.

This report presents the digital data from Tests S-SF-4 and -5 with brief comment. The data are presented in the form of graphs in engineering units, and are also available from the NRC/DAE Data Bank at the Idaho National Engineering Laboratory. Address inquiries to NRC/DAE Data Bank Administrator, EG&G Idaho, Inc., P.O. Box 1625, Idaho Falls, Idaho 83415.

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232. Liquid level in intact loop steam generator secondary side riser, Test S-SF-4 (LI1117S836) ....

233. Liquid level in intact loop steam generator secondary side riser, Test S-SF-4 (LIS836 + 463) ....

234. Liquid level in intact loop steam generator secondary side riser, Test S-SF-4 (LIS + 463 + 89) ....

235. Liquid level in intact loop steam generator secondary side across flow shutter, Test S-SF-4 (LIS + 89 + 50) ....

236. Liquid level in broken loop steam generator primary tube, Test S-SF-4 (LBP838-57E) ....

237. Liquid level in broken loop steam generator secondary side downcomer, Test S-SF-4 (LBS1117 + 50) ....

238. Liquid level in broken loop steam generator secondary side downcomer, Test S-SF-4 (LB1117S825) ....

239. Liquid level in broken loop steam generator secondary side riser, Test S-SF-4 (LB1117S836) ....

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240. Liquid level in broken loop steam generator secondary side riser, Test S-SF-4 (LBS836 + 463) ....

241. Liquid level in broken loop steam generator secondary side downcomer, Test S-SF-4 (LBS + 825 + 50) ....

242. Liquid level in broken loop steam generator secondary side riser, Test S-SF-4 (LBS + 463 + 89) ....

243. Liquid level in broken loop steam generator secondary side, across flow shutter, Test S-SF-4 (LBS + 89 + 50) ....

244. Liquid level in pressurizer, Test S-SF-4 (LPRZ146 + 25) ....

245. Liquid level in Catch Tank 1, Test S-SF-4 (L1CT23 + 462) ....

246. Liquid level in Catch Tank 2, Test S-SF-4 (L2CT23 + 462) ....

247. Liquid level in feedwater tank, Test S-SF-4 (LSCT488 + 97) ....

248. Volumetric flow rate in intact loop hot leg, Test S-SF-4 (QI*1) ....

249. Volumetric flow rate in intact loop pump suction leg, Test S-SF-4, (QI*15) ....

250. Volumetric flow rate in intact loop cold leg, Test S-SF-4 (QI*21) ....

251. Volumetric flow rate in broken loop hot leg, Test S-SF-4 (QB*50) ....

252. Volumetric flow rate in broken loop hot leg, Test S-SF-4 (QB*57) ....

253. Volumetric flow rate in broken loop cold leg, Test S-SF-4 (QB*79) ....

254. Volumetric flow rate in core vessel downcomer, Test S-SF-4 (QV*DC-423) ....

255. Volumetric flow rate in core vessel guide tube, Test S-SF-4 (QV*GT + 321) ....

256. Volumetric flow rate in core vessel downcomer to upper head bypass, Test S-SF-4 (QV*BYPASS) ....

257. Volumetric flow rate in pressurizer surge line, Test S-SF-4 (Q*PRZ-30) ....

258. Volumetric flow rate of intact loop steam generator auxiliary feed supply, Test S-SF-4 (QSC*IGAXFW) ....

259. Volumetric flow rate of broken loop steam generator auxiliary feed supply, Test S-SF-4 (QSC*BGAXFW) ....

260. Volumetric flow rate from intact loop high pressure injection system, Test S-SF-4 (QCI*ILHPIS) ....

261. Density in intact loop hot leg, Test S-SF-4 (RI*5M) ....

262. Density in broken loop hot leg, Test S-SF-4 (RB*57M) ....

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263. Density in core vessel downcomer, Test S-SF-4 (RV*DC-72)

264. Density in core vessel downcomer, Test S-SF-4 (RV*DC-260)

265. Density in core vessel downcomer, Test S-SF-4 (RV*DC-456)

266. Density in core vessel, Test S-SF-4 (RV*AB-6)

267. Density in core vessel, Test S-SF-4 (RV*23 + 13)

268. Density in core vessel, Test S-SF-4 (RV*23 + 113)

269. Density in core vessel, Test S-SF-4 (RV*AB + 173)

270. Density in core vessel, Test S-SF-4 (RV*23 + 183)

271. Density in core vessel, Test S-SF-4 (RV*23 + 253)

272. Density in core vessel, Test S-SF-4 (RV*23 + 342)

273. Density in core vessel upper plenum, Test S-SF-4 (RV*UP-11)

274. Density in core vessel upper head, Test S-SF-4 (RV*UH + 173)

275. Density in core vessel upper head, Test S-SF-4 (RV*UH + 339)

276. Core heater current, high power bus, Test S-SF-4 (IV*HIPWBUS)

277. Core heater voltage, high power bus, Test S-SF-4 (EV*HIPWBUS)

278. Core heater current, low power bus, Test S-SF-4 (IV*LOPWBUS)

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279. Core heater voltage, low power bus, Test S-SF-4 (EV*LOPWBUS)

280. Core heater power, high power bus, calculated, Test S-SF-4 (KWH*HIC)

281. Core heater power, low power bus, calculated, Test S-SF-4 (KWH*LOC)

282. Core heater power, total, calculated, Test S-SF-4 (LWH*TOTC)

283. External heater current, core vessel, Test S-SF-4 (IH*UNIT357)

284. External heater voltage, core vessel, Test S-SF-4 (EH*UNIT357)

285. External heater power, calculated, core vessel, Test S-SF-4 (KW*EH*VESS)

286. External heater current, intact loop pump suction, Test S-SF-4 (IH*UNIT358)

287. External heater voltage, intact loop pump suction, Test S-SF-4 (EH*UNIT358)

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288. External heater power, calculated, intact loop pump suction, Test S-SF-4 (KW*EH*ILPS) ....

289. External heater current, broken loop pump suction, Test S-SF-4 (EH*UNIT359) ....

290. External heater voltage, broken loop pump suction, Test S-SF-4 (EH*UNIT359) ....

291. External heater power, calculated, broken loop pump suction, Test S-SF-4 (KW*EH*BLPS) ....

292. External heater current, intact and broken loop cold leg, Test S-SF-4 (IH*UNIT360) ....

293. External heater voltage, intact and broken loop cold leg, Test S-SF-4 (EH*UNIT360) ....

294. External heater power, calculated, intact and broken loop cold leg, Test S-SF-4 (KW*EH*IBCL) ....

295. External heater current, intact and broken loop hot leg, Test S-SF-4 (IH*UNIT361) ....

296. External heater voltage, intact and broken loop hot leg, Test S-SF-4 (EH*UNIT361) ....

297. External heater power, calculated, intact and broken loop hot leg, Test S-SF-4 (KW*EH*IBHL) ....

298. Intact loop pump current, Test S-SF-4 (II*PUMP) ....

299. Intact loop pump voltage, Test S-SF-4 (EI*PUMP) ....

300. Intact loop pump angular velocity, Test S-SF-4 (WI*PUMP) ....

301. Broken loop pump angular velocity, Test S-SF-4 (WB*PUMP) ....

302. Broken loop pump power, Test S-SF-4 (KWB*PUMP) ....

303. Valve position, intact loop steam generator steam exhaust, Test S-SF-4 (XSC*IGSTM) ....

304. Fluid temperature in intact loop hot leg, Test S-SF-5 (TFI*1) ....

305. Fluid temperature in intact loop steam generator inlet leg, Test S-SF-5 (TFI*5) ....

306. Fluid temperature in intact loop steam generator outlet leg, Test S-SF-5 (TFI*9) ....

307. Fluid temperature in intact loop pump suction, Test S-SF-5 (TFI*17) ....

308. Fluid temperature in intact loop cold leg, Test S-SF-5 (TFI*21) ....

309. Fluid temperature in intact loop cold leg, Test S-SF-5 (TFI*22) ....

310. Fluid temperature in broken loop hot leg, Test S-SF-5 (TFB*50) ....

311. Fluid temperature in broken loop steam generator inlet leg, Test S-SF-5 (TFB*57) ....

312. Fluid temperature in broken loop steam generator outlet leg, Test S-SF-5 (TFB*62) ....

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313. Fluid temperature in broken loop pump suction, Test S-SF-5 (TFB*64) . . . .

314. Fluid temperature in broken loop pump suction, Test S-SF-5 (TFB*73) . . . .

315. Fluid temperature in broken loop cold leg, Test S-SF-5 (TFB*74) . . . .

316. Fluid temperature in broken loop cold leg, Test S-SF-5 (TFB*79) . . . .

317. Fluid temperature in vessel downcomer, Test S-SF-5 (TFV*DC-84) . . . .

318. Fluid temperature in vessel downcomer, Test S-SF-5 (TFB*DC-436) . . . .

319. Fluid temperature in vessel upper plenum, Test S-SF-5 (TFV*UPM-13) . . . .

320. Fluid temperature in vessel upper plenum, Test S-SF-5 (TFV*UP+79) . . . .

321. Fluid temperature in vessel upper head, Test S-SF-5 (TFV*UHQ180) . . . .

322. Fluid temperature in vessel upper head, Test S-SF-5 (TFV*UH+343) . . . .

323. Fluid temperature in vessel upper head, Test S-SF-5 (TFV*UH+402) . . . .

324. Fluid temperature in vessel upper plenum bypass line, Test S-SF-5 (TFV*BYPASS) . . . .

325. Fluid temperature in core, Grid Spacer 2, Test S-SF-5 (TFV*B3+46) . . . .

326. Fluid temperature in core, Grid Spacer 4, Test S-SF-5 (TFV*D1+126) . . . .

327. Fluid temperature in core, Grid Spacer 4, Test S-SF-5 (TFV*A4+126) . . . .

328. Fluid temperature in core, Grid Spacer 4, Test S-SF-5 (TFB*B3+126) . . . .

329. Fluid temperature in core, Grid Spacer 5, Test S-SF-5 (TFV*B3+166) . . . .

330. Fluid temperature in core, Grid Spacer 7, Test S-SF-5 (TFV*B3+246) . . . .

331. Fluid temperature in core, Grid Spacer 8, Test S-SF-5 (TFV*A4+286) . . . .

332. Fluid temperature in core, Grid Spacer 9, Test S-SF-5 (TFV*B3+326) . . . .

333. Fluid temperature in core, Grid Spacer 10, Test S-SF-5 (TFV*A4+366) . . . .

334. Fluid temperature in intact loop steam generator, primary side, Test S-SF-5 (TFIP+LH30) . . . .

335. Fluid temperature in intact loop steam generator, primary side, Test S-SF-5 (TFIP+LH84) . . . .

336. Fluid temperature in intact loop steam generator, primary side, Test S-SF-5 (TFIP+LH452) . . . .

337. Fluid temperature in intact loop steam generator, primary side, Test S-SF-5 (TFIP+SH815) . . . .

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338. Fluid temperature in intact loop steam generator, primary side, Test S-SF-5 (TFIP + LH922) ....

339. Fluid temperature in intact loop steam generator, primary side, Test S-SF-5 (TFIP + LC785) ....

340. Fluid temperature in intact loop steam generator, primary side, Test S-SF-5 (TFIP + SC668) ....

341. Fluid temperature in intact loop steam generator, primary side, Test S-SF-5 (TFIP + LC333) ....

342. Fluid temperature in intact loop steam generator, primary side, Test S-SF-5 (TFIP + LC211) ....

343. Fluid temperature in intact loop steam generator, primary side, Test S-SF-5 (TFIP + SC211) ....

344. Fluid temperature in broken loop steam generator, primary side, Test S-SF-5 (TFBP + LH152) ....

345. Fluid temperature in broken loop steam generator, primary side, Test S-SF-5 (TFBP + SH211) ....

346. Fluid temperature in broken loop steam generator, primary side, Test S-SF-5 (TFBP + LH211) ....

347. Fluid temperature in broken loop steam generator, primary side, Test S-SF-5 (TFBP + LH272) ....

348. Fluid temperature in broken loop steam generator, primary side, Test S-SF-5 (TFBP + LH394) ....

349. Fluid temperature in broken loop steam generator, primary side, Test S-SF-5 (TFBP + LH452) ....

350. Fluid temperature in broken loop steam generator, primary side, Test S-SF-5 (TFBP + LH785) ....

351. Fluid temperature in broken loop steam generator, primary side, Test S-SF-5 (TFBP + LH922) ....

352. Fluid temperature in broken loop steam generator, primary side, Test S-SF-5 (TFBP + LC785) ....

353. Fluid temperature in broken loop steam generator, primary side, Test S-SF-5 (TFBP + SC452) ....

354. Fluid temperature in broken loop steam generator, primary side, Test S-SF-5 (TFBP + LC452) ....

355. Fluid temperature in broken loop steam generator, primary side, Test S-SF-5 (TFBP + LC211) ....

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356. Fluid temperature of feedwater for intact loop steam generator at flow orifice, Test S-SF-5 (TFSC*IGFDW) ....

357. Fluid temperature of feedwater at injection point for intact loop steam generator, Test S-SF-5 (TFSC*IGFWL) ....

358. Fluid temperature of auxiliary feedwater for intact loop steam generator, Test S-SF-5 (TFSC*IAXFW) ....

359. Fluid temperature in intact loop steam generator, secondary side downcomer, Test S-SF-5 (TFIS*D+152) ....

360. Fluid temperature in intact loop steam generator, secondary side downcomer, Test S-SF-5 (TFIS*D+457) ....

361. Fluid temperature in intact loop steam generator, secondary side downcomer, Test S-SF-5 (TFIS*D+609) ....

362. Fluid temperature in intact loop steam generator, secondary side downcomer, Test S-SF-5 (TFIS*D+761) ....

363. Fluid temperature in intact loop steam generator, secondary side, Test S-SF-5 (TFIS+LH30) ....

364. Fluid temperature in intact loop steam generator, secondary side, Test S-SF-5 (TFIS*SH84) ....

365. Fluid temperature in intact loop steam generator, secondary side, Test S-SF-5 (TFIS*LH84) ....

366. Fluid temperature in intact loop steam generator, secondary side, Test S-SF-5 (TFIS+LC84) ....

367. Fluid temperature in intact loop steam generator, secondary side, Test S-SF-5 (TFIS*LH152) ....

368. Fluid temperature in intact loop steam generator, secondary side, Test S-SF-5 (TFIS+LC211) ....

369. Fluid temperature in intact loop steam generator, secondary side, Test S-SF-5 (TFIS+LC333) ....

370. Fluid temperature in intact loop steam generator, secondary side, Test S-SF-5 (TFIS+SC333) ....

371. Fluid temperature in intact loop steam generator, secondary side, Test S-SF-5 (TFIS+LH394) ....

372. Fluid temperature in intact loop steam generator, secondary side, Test S-SF-5 (TFIS+SH452) ....

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373. Fluid temperature in intact loop steam generator, secondary side, Test S-SF-5 (TFIS+LH452) ....

374. Fluid temperature in intact loop steam generator, secondary side, Test S-SF-5 (TFIS+LC452) ....

375. Fluid temperature in intact loop steam generator, secondary side, Test S-SF-5 (TFIS+LH785) ....

376. Fluid temperature in intact loop steam generator, secondary side, steam dome, Test S-SF-5 (TFIS+1117) ....

377. Fluid temperature of feedwater at injection point for broken loop steam generator, Test S-SF-5 (TFSC*BGFWL) ....

378. Fluid temperature of auxiliary feedwater for broken loop steam generator, Test S-SF-5 (TFSC*BAXFW) ....

379. Fluid temperature in broken loop steam generator, secondary side downcomer, Test S-SF-5 (TFBS*D+152) ....

380. Fluid temperature in broken loop steam generator, secondary side downcomer, Test S-SF-5 (TFBS*D+304) ....

381. Fluid temperature in broken loop steam generator, secondary side downcomer, Test S-SF-5 (TFBS*D+457) ....

382. Fluid temperature in broken loop steam generator, secondary side downcomer, Test S-SF-5 (TFBS*D+610) ....

383. Fluid temperature in broken loop steam generator, secondary side downcomer, Test S-SF-5 (TFBS*D+761) ....

384. Fluid temperature in broken loop steam generator, secondary side, Test S-SF-5 (TFBS+LH61) ....

385. Fluid temperature in broken loop steam generator, secondary side, Test S-SF-5 (TFBS+LC84) ....

386. Fluid temperature in broken loop steam generator, secondary side, Test S-SF-5 (TFBS+LH211) ....

387. Fluid temperature in broken loop steam generator, secondary side, Test S-SF-5 (TFBS+LC211) ....

388. Fluid temperature in broken loop steam generator, secondary side, Test S-SF-5 (TFBS+LH333) ....

389. Fluid temperature in broken loop steam generator, secondary side, Test S-SF-5 (TFBS+SC333) ....

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390. Fluid temperature in broken loop steam generator, secondary side, Test S-SF-5 (TFBS+LC333) ....

391. Fluid temperature in broken loop steam generator, secondary side, Test S-SF-5 (TFBS+LH394) ....

392. Fluid temperature in broken loop steam generator, secondary side, Test S-SF-5 (TFBS+SH452) ....

393. Fluid temperature in broken loop steam generator, secondary side, Test S-SF-5 (TFBS+LH452) ....

394. Fluid temperature in broken loop steam generator, secondary side, Test S-SF-5 (TFBS+LC452) ....

395. Fluid temperature in broken loop steam generator, secondary side, Test S-SF-5 (TFBS+LH536) ....

396. Fluid temperature in broken loop steam generator, secondary side, Test S-SF-5 (TFBS+LH668) ....

397. Fluid temperature in broken loop steam generator, secondary side, Test S-SF-5 (TFBS+LC785) ....

398. Fluid temperature in broken loop steam generator, secondary side, Test S-SF-5 (TFBS+SH815) ....

399. Fluid temperature in broken loop steam generator, secondary side, Test S-SF-5 (TFBS+LH922) ....

400. Fluid temperature in broken loop steam generator, secondary side, steam dome, Test S-SF-5 (TFBS+1117) ....

401. Fluid temperature in pressurizer, Test S-SF-5 (TF*PRZ+132) ....

402. Fluid temperature in pressurizer, Test S-SF-5 (TF*PRZ-73) ....

403. Fluid temperature of pressurizer at injection point to Spool Piece 3, Test S-SF-5 (TF*PRZ*13) ....

404. Fluid temperature upstream of break nozzle in intact loop steam generator, Test S-SF-5 (TFSC*IGSTM) ....

405. Fluid temperature upstream of break nozzle in broken loop steam generator, Test S-SF-5 (TFSC*BGSTM) ....

406. Fluid temperature in Catch Tank 1, Test S-SF-5 (TF*CT1+0) ....

407. Fluid temperature in Catch Tank 2, Test S-SF-5 (TF*CT2+0) ....

408. Fluid temperature of broken loop steam generator effluent out of condensate coils, Test S-SF-5 (TF*BGCON*0) ....

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409. Fluid temperature of cooling water going into condensate coils, Test S-SF-5 (TFIC*SBIN) ....

410. Fluid temperature of cooling water coming out of condensate coils, Test S-SF-5 (TFIC*SBOUT) ....

411. Metal temperature of core vessel upper head filler piece, Test S-SF-5 (TMV*FPD + 79) ......

412. Metal temperature of core vessel upper head filler piece, Test S-SF-5 (TMV*FPF221) ....

413. Metal temperature of core vessel upper head thermal shield, Test S-SF-5 (TMV*TSQ221) ....

414. Metal temperature of intact loop steam generator tube, Test S-SF-5 (TMIG + LH452) ....

415. Metal temperature of broken loop steam generator tube, Test S-SF-5 (TMBG + LC84) .. ....

416. Metal temperature of broken loop steam generator tube, Test S-SF-5 (TMBG + LH452) ......

417. Metal temperature of intact loop cold leg, under external heaters, Test S-SF-5 (TMEH*16) ....

418. Metal temperature of intact loop cold leg, under external heaters, Test S-SF-5 (TMEH*22) ....

419. Metal temperature of broken loop cold leg, under external heaters, Test S-SF-5 (TMEH*72M) ....

420. Metal temperature of broken loop cold leg, under external heaters, Test S-SF-5 (TMEH*73) ....

421. Metal temperature of core vessel under external heaters, Test S-SF-5 (TMEH*V-196) ....

422. Metal temperature of core vessel under external heaters, Test S-SF-5 (TMEH*V-30) ....

423. Material temperature of intact loop hot leg external heaters, under insulation, Test S-SF-5 (TEH*3) ....

424. Material temperature of intact loop hot leg external heaters, under insulation, Test S-SF-5 (TEH*7) ....

425. Material temperature of intact loop cold leg external heaters, under insulation, Test S-SF-5 (TEH*8) ....

426. Material temperature of intact loop cold leg external heaters, under insulation, Test S-SF-5 (TEH*13) ....

427. Material temperature of intact loop cold leg external heaters, under insulation, Test S-SF-5 (TEH*16) ....

428. Material temperature of intact loop cold leg external heaters, under insulation, Test S-SF-5 (TEH*17) ....

429. Material temperature of intact loop cold leg external heaters, under insulation, Test S-SF-5 (TEH*19) ....

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430. Material temperature of intact loop cold leg external heaters, under insulation, Test S-SF-5 (TEH*22) ....

431. Material temperature of broken loop hot leg external heaters, under insulation, Test S-SF-5 (TEH*50) ....

432. Material temperature of broken loop hot leg external heaters, under insulation, Test S-SF-5 (TEH*55A) ....

433. Material temperature of broken loop hot leg external heaters, under insulation, Test S-SF-5 (TEH*59) ....

434. Material temperature of broken loop pump suction external heaters, under insulation, Test S-SF-5 (TEH*60) ....

435. Material temperature of broken loop pump suction external heaters, under insulation, Test S-SF-5 (TEH*64T) ....

436. Material temperature of broken loop pump suction external heaters, under insulation, Test S-SF-5 (TEH*64M) ....

437. Material temperature of broken loop pump suction external heaters, under insulation, Test S-SF-5 (TEH*64B) ....

438. Material temperature of broken loop pump suction external heaters, under insulation, Test S-SF-5 (TEH*72M) ....

439. Material temperature of broken loop pump suction external heaters, under insulation, Test S-SF-5 (TEH*73) ....

440. Material temperature of broken loop cold leg external heaters, under insulation, Test S-SF-5 (TEH*74) ....

441. Material temperature of broken loop cold leg external heaters, under insulation, Test S-SF-5 (TEH*79) ....

442. Material temperature of core vessel downcomer external heater, under insulation, Test S-SF-5 (TEH*D-237) ....

443. Material temperature of core vessel external heater, under insulation, Test S-SF-5 (TEH*V-360) ....

444. Material temperature of core vessel external heater, under insulation, Test S-SF-5 (TEH*V-196) ....

445. Material temperature of core vessel external heater, under insulation, Test S-SF-5 (TEH*V-30) ....

446. Material temperature of core vessel upper plenum external heater, under insulation, Test S-SF-5 (TEH*V+101) ....

447. Material temperature of core vessel upper head external heater, under insulation, Test S-SF-5 (TEH*V+249) ....

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448. Material temperature of core vessel upper head external heater, under insulation, Test S-SF-5 (TEH*V+386)

449. Core heater temperature, Rod B-3, Test S-SF-5 (THV*B3+114)

450. Core heater temperature, Rod B-3, Test S-SF-5 (THV*B3+184)

451. Core heater temperature, Rod B-3, Test S-SF-5 (THV*B3+229)

452. Core heater temperature, Rod B-4, Test S-SF-5 (THV*B4+140)

453. Core heater temperature, Rod C-2, Test S-SF-5 (THV*C2+137)

454. Core heater temperature, Rod C-3, Test S-SF-5 (THV*C3+140)

455. Core heater temperature, Rod C-4, Test S-SF-5 (THV*C4+142)

456. Core heater temperature, Rod C-4, Test S-SF-5 (THV*C4+187)

457. Core heater temperature, Rod D-2, Test S-SF-5 (THV*D2+16)

458. Core heater temperature, Rod D-2, Test S-SF-5 (THV*D2+254)

459. Core heater temperature, Rod D-2, Test S-SF-5 (THV*D2+321)

460. Core heater temperature, Rod D-3, Test S-SF-5 (THV*D3+109)

461. Core heater temperature, Rod D-4, Test S-SF-5 (THV*D4+179)

462. Core heater temperature, Rod A-2, Test S-SF-5 (THV*A2+353)

463. Core heater temperature, Rod A-3, Test S-SF-5 (THV*A3+76)

464. Core heater temperature, Rod A-3, Test S-SF-5 (THV*A3+157)

465. Core heater temperature, Rod A-3, Test S-SF-5 (THV*A3+208)

466. Core heater temperature, Rod A-3, Test S-SF-5 (THV*A3+228)

467. Core heater temperature, Rod A-3, Test S-SF-5 (THV*A3+291)

468. Core heater temperature, Rod B-1, Test S-SF-5 (THV*B1+183)

469. Core heater temperature, Rod B-1, Test S-SF-5 (THV*B1+253)

470. Core heater temperature, Rod C-1, Test S-SF-5 (THV*C1+79)

471. Core heater temperature, Rod C-1, Test S-SF-5 (THV*C1+211)

472. Core heater temperature, Rod C-1, Test S-SF-5 (THV*C1+292)

473. Core heater temperature, Rod C-5, Test S-SF-5 (THV*C5+133)

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474. Core heater temperature, Rod C-5, Test S-SF-5 (THV*C5 + 228)

475. Core heater temperature, Rod D-1, Test S-SF-5 (THV*D1 + 131)

476. Core heater temperature, Rod E-2, Test S-SF-5 (THV*E2 + 109)

477. Core heater temperature, Rod E-2, Test S-SF-5 (THV*E2 + 181)

478. Core heater temperature, Rod E-3, Test S-SF-5 (THV*E3 + 211)

479. Core heater temperature, Rod E-5, Test S-SF-5 (THV*E5 + 227)

480. Pressure in intact loop hot leg, Test S-SF-5 (PI*1)

481. Pressure in broken loop hot leg, Test S-SF-5 (PB*50)

482. Pressure in broken loop cold leg, Test S-SF-5 (PB*79)

483. Pressure in core vessel upper plenum, Test S-SF-5 (PV*UP-13)

484. Pressure in core vessel upper head, Test S-SF-5 (PV*UH + 421)

485. Pressure in intact loop steam generator steam dome, Test S-SF-5 (PIS + 1117)

486. Pressure in broken loop steam generator steam dome, Test S-SF-5 (PBS + 1117)

487. Pressure in pressurizer, Test S-SF-5 (P*PRZ + 158)

488. Pressure in intact loop steam generator steam exhaust at flow orifice, Test S-SF-5 (PSC*IGSTM)

489. Pressure in broken loop steam generator steam exhaust at flow orifice, Test S-SF-5 (PSC*BGSTM)

490. Pressure in broken loop steam generator effluent into condensate coils, Test S-SF-5 (PSC*BGCON)

491. Pressure of cooling water to condensate coils, Test S-SF-5 (PIC*SBP8)

492. Differential pressure in intact loop hot leg, Test S-SF-5 (D-V13A*I5)

493. Differential pressure through intact loop steam generator primary side, Test S-SF-5 (DPI*5*9)

494. Differential pressure in intact loop pump suction leg, Test S-SF-5 (DPI*9*14)

495. Differential pressure in intact loop pump suction leg, Test S-SF-5 (DPI*14*18)

496. Differential pressure through intact loop pump, Test S-SF-5 (DPI*21*18)

497. Differential pressure in intact loop cold leg, Test S-SF-5 (D*121 + VD29)

498. Differential pressure in broken loop hot leg, Test S-SF-5 (D-V13A*B57)

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499. Differential pressure through broken loop steam generator primary side, Test S-SF-5 (DPB*57*62) ....

500. Differential pressure in broken loop pump suction leg, Test S-SF-5 (DPB*62*65) ....

501. Differential pressure in broken loop pump suction leg, Test S-SF-5 (DPB*65*73) ....

502. Differential pressure through broken loop pump, Test S-SF-5 (DPB*74*73) ....

503. Differential pressure in broken loop cold leg, Test S-SF-5 (D*B74 + VD29) ....

504. Differential pressure through core vessel downcomer to upper head bypass, Test S-SF-5 (DVD + 29 + 160) ....

505. Differential pressure in intact loop steam generator feedwater supply, across flow orifice, Test S-SF-5 (DPSC*IGFDW) ....

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533. Liquid level in broken loop steam generator secondary side riser, Test S-SF-5 (LBS + 463 + 89) ....

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EXPERIMENT DATA REPORT FOR SEMISCALE MOD-2A MAIN STEAM LINE BREAK EXPERIMENTS (Tests S-SF-4 and S-SF-5)

INTRODUCTION

The Semiscale Mod-2A experiments represent the current phase of the Semiscale Program conducted by EG&G Idaho, Inc., for the United States Government. The program, sponsored by the Nuclear Regulatory Commission (NRC) through the Department of Energy, is part of the overall NRC Water Reactor Research Program to investigate the response of a pressurized water reactor (PWR) system to hypothesized loss-of-coolant accidents (LOCAs) or abnormal operating transients. The underlying objectives of the Semiscale Program are to quantify the physical processes that control system behavior and to provide an experimental data base for assessing reactor safety evaluation models. The program has the further objective of providing support to other experimental programs in the forms of instrument assessment, test series optimization, selection of test parameters, and comparative evaluation of test results.

The Steam and Feedwater Line Break Scoping Experiment Series (Series SF) was formulated in response to NRC needs concerning specific licensing issues centered around PWR transient response during steam generator secondary side main steam line or main feedwater line ruptures.

Tests S-SF-4 and S-SF-5 were conducted in the Semiscale Mod-2A facility on May 26, 1982 and June 3, 1982, respectively, as part of the main steam line break in the SF test series. The steam line break tests investigate the thermal and hydraulic phenomena that occur when overcooling of the primary side takes place due to the temporarily enhanced heat sink caused by a secondary side blowdown. The tests were initiated from hot standby conditions because it was predicted to be a more limiting case for excessive primary side cooldown. The primary objectives of Tests S-SF-4 and -5 were fourfold: to determine the primary-to-secondary heat transfer characteristics as a function of time and steam generator inventory; to provide a reference data base for assessing the capabilities of water reactor safety codes to predict integral system behavior in response to secondary side transients; to provide a data base for specifying future experiments; and to characterize the influence of boundary conditions such as break size, loss of offsite power assumptions for Test S-SF-5, and emergency core cooling and feedwater train performance.

The break sizes for Tests S-SF-4 and -5 were scaled from a Westinghouse four-loop plant. The break nozzle was sized to provide the scaled critical flow rate reported for the main steam line flow restrictors at normal operating pressure. The scaling basis for Tests S-SF-4 and -5 were 100% and 50%, respectively, of the 16-in.-inner-diameter main steam line flow restrictor. Due to the "scoping" nature of these experiments, it is realized that they will not simulate the exact response of a Westinghouse plant to these transients. However, these experiments will identify the dominant parameter trends which ultimately control the severity of the transient.

This report presents the data from Tests S-SF-4 and -5 in an uninterpreted, but readily useable form, for use by the nuclear community in advance of detailed analysis and interpretation. A brief description of the system configuration, procedures, and sequence of events for Tests S-SF-4 and -5 is presented, followed by the data graphs, comments, and supporting information necessary for interpretation of the data. An overall description of the Semiscale Program and test series, with a more detailed description of the Steam and Feedwater Line Break Series are contained in References 1 and 2. Preliminary analysis and interpretation of the data are presented in Reference 3.

Information on the data acquisition system, posttest adjustments made to the data, and the methodology used to establish measurement uncertainty limits are presented and explained in Reference 4.

SYSTEM PROCEDURES, CONDITIONS, AND EVENTS FOR TESTS S-SF-4 AND S-SF-5

System Configuration

The Semiscale Mod-2A primary system was scaled using a four-loop Westinghouse design as the reference. The system used for these tests consists of a core vessel with simulated reactor internals, including an electrically powered 25-rod core and an external downcomer; an intact loop with steam generator and reactor coolant pump (RCP), with pressurizer connected, through an orificed surge line, to the hot leg of the intact loop, at Spool Piece 3; and a broken loop with steam generator and RCP, as shown in Figures 1 and 2. Figure 3 shows a cross section of the core vessel and external downcomer. The vessel core consists of a 5 x 5 array of internally heated electric rods, 23 of which were powered (Rods A1 and E-5 were unpowered). The rods are geometrically similar to nuclear fuel rods, with a heated length of 3.66 m and an outside diameter of 1.072 cm. The core power was set up to provide a symmetric chopped cosine axial power distribution with a peak-to-average power ratio of 1.25 between the low and high power bus to provide a total core power of 30 kW, plus heat loss. (The high power bus consisted of the 9 center rods; the low power bus consisted of the 14 peripheral rods.) Figures 4 and 5 show the instrumentation penetrations of the core vessel and downcomer, respectively. A plan view of the core and the locations of the heater rod thermocouples are shown in Figure 6. Table 1 presents a comparison of the elevation differences between the major components.

The intact and broken loop steam generators are of the same two-pass, tube-and-shell design. Primary fluid flows through vertical, inverted-U-shaped tubes, and secondary coolant passes from bottom to top through the shell side. The intact loop steam generator has two short, two medium, and two long tubes representative of the range of bend elevations in PWR steam generators. The broken loop steam generator utilizes only one long and one short tube. An "off-center" arrangement of the tubes was required to provide better volume scaling of the secondary. The same tube stock (2.22-cm OD x 0.124-cm wall) and tube spacing (3.175-cm triangular pitch) used for PWR U-tubes were used in the Semiscale steam generators. Since the heat transfer area was specified by the ratio of PWR-to-Semiscale core power, the number of tubes was thereby fixed by the specified tube diameter and lengths. Fillers were installed in the shell side to provide a more properly scaled secondary fluid volume. Elevations of the Semiscale Mod-2A steam generator nozzles, plenums, and tubes are similar to those of a PWR; however, the steam dome is shorter than that of a PWR, and the steam drying equipment is of a simpler and less efficient design.

The steam generator primary and secondary sides are extensively instrumented, as shown in Figures 7 and 8 for the intact and broken loop, respectively. At several axial locations, pairs of primary and secondary fluid thermocouples, along with primary tube wall metal thermocouples have been attached to the tube walls. One long and one short tube in each steam generator are instrumented; the middle tubes of the intact loop steam generator have no thermocouples installed. In addition to the tube thermocouples, the steam domes have fluid thermocouples, and the downcomers have fluid thermocouples at several axial locations. Other steam generator instrumentation includes primary tube (primary side) and secondary (shell side) differential pressure ports at several elevations, allowing measurement of collapsed liquid levels in the inlet side of the primary tubes and in the secondary downcomer and riser.

Separate auxiliary feedwater pumps were lined up to discharge into the upper feed ring of each steam generator. Flow and temperature measurements are provided.

The steam line break simulation assembly was connected to the intact and broken loop steam generators as shown in Figure 9. The break effluent from the intact loop steam generator was routed to the pressure suppression header, and the break effluent from the broken loop steam generator was routed through the condensing coils into the catch tanks. The condensing system is shown in Figure 10.

Safety injection pumps were lined up to discharge only into the cold leg of the intact loop, at Spool Piece 22. Flow and temperature measurements were provided.

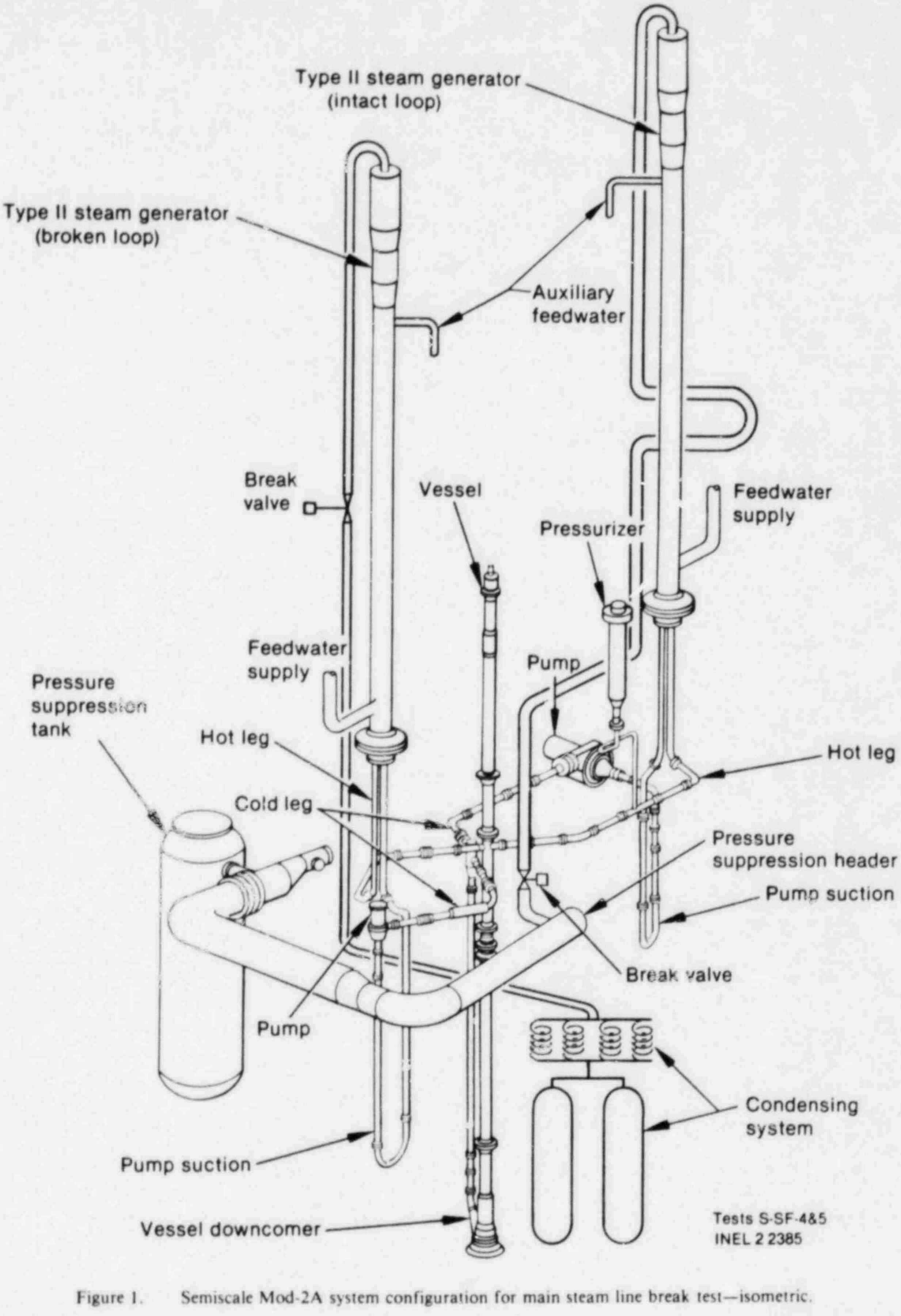


Figure 1. Semiscale Mod-2A system configuration for main steam line break test—isometric.

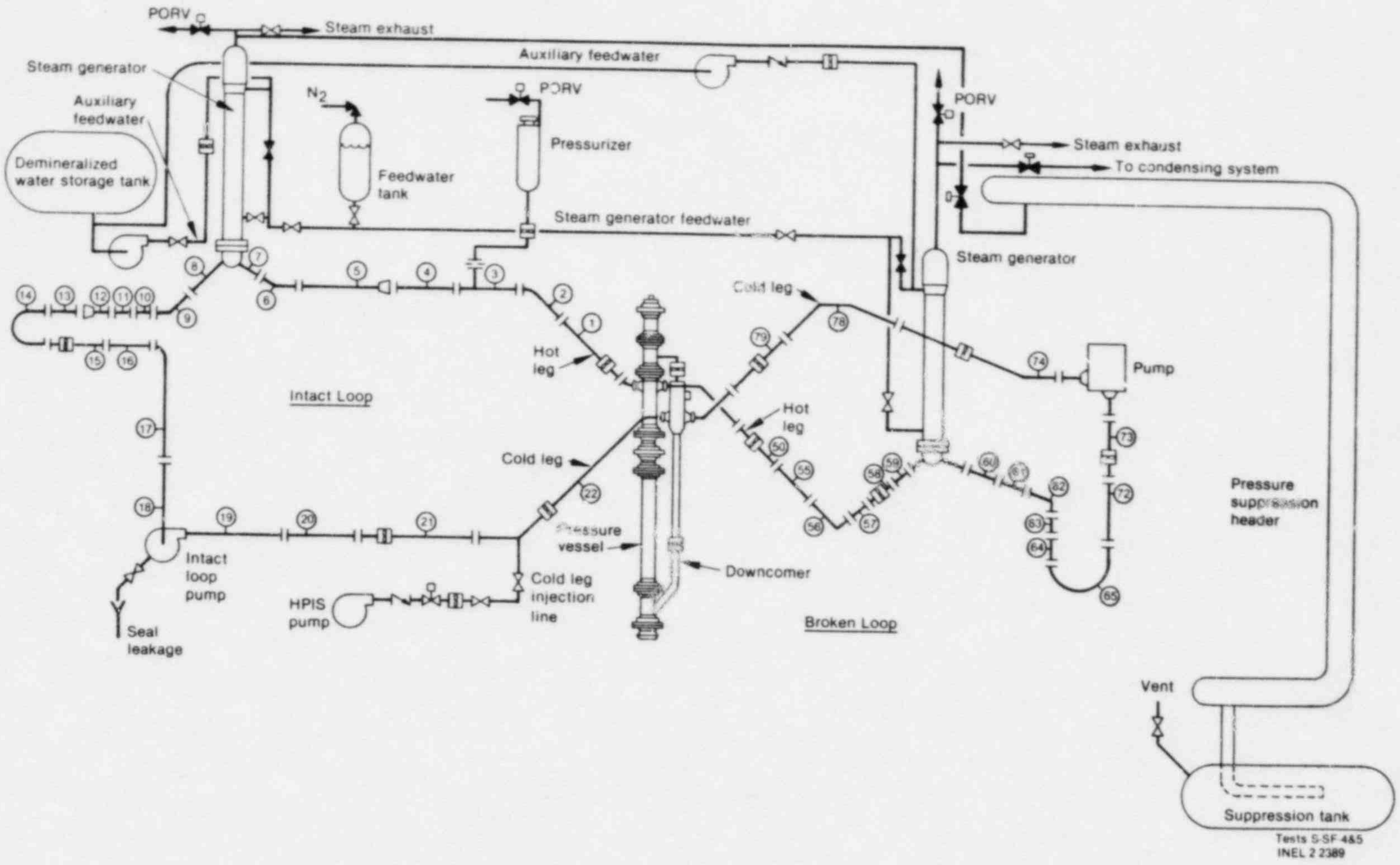


Figure 2. Semiscale Mod-2A system configuration for main steam line break test—schematic.

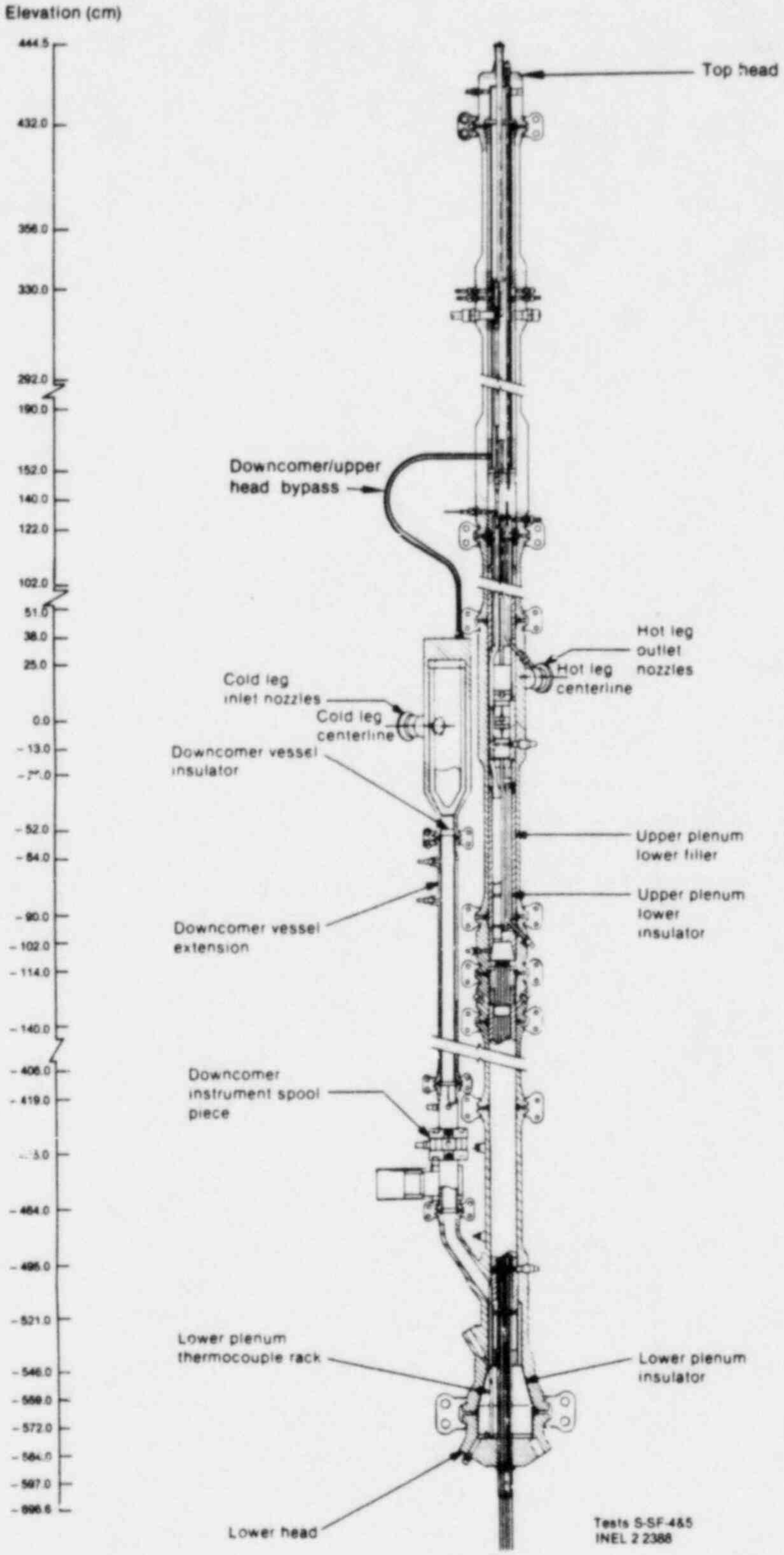
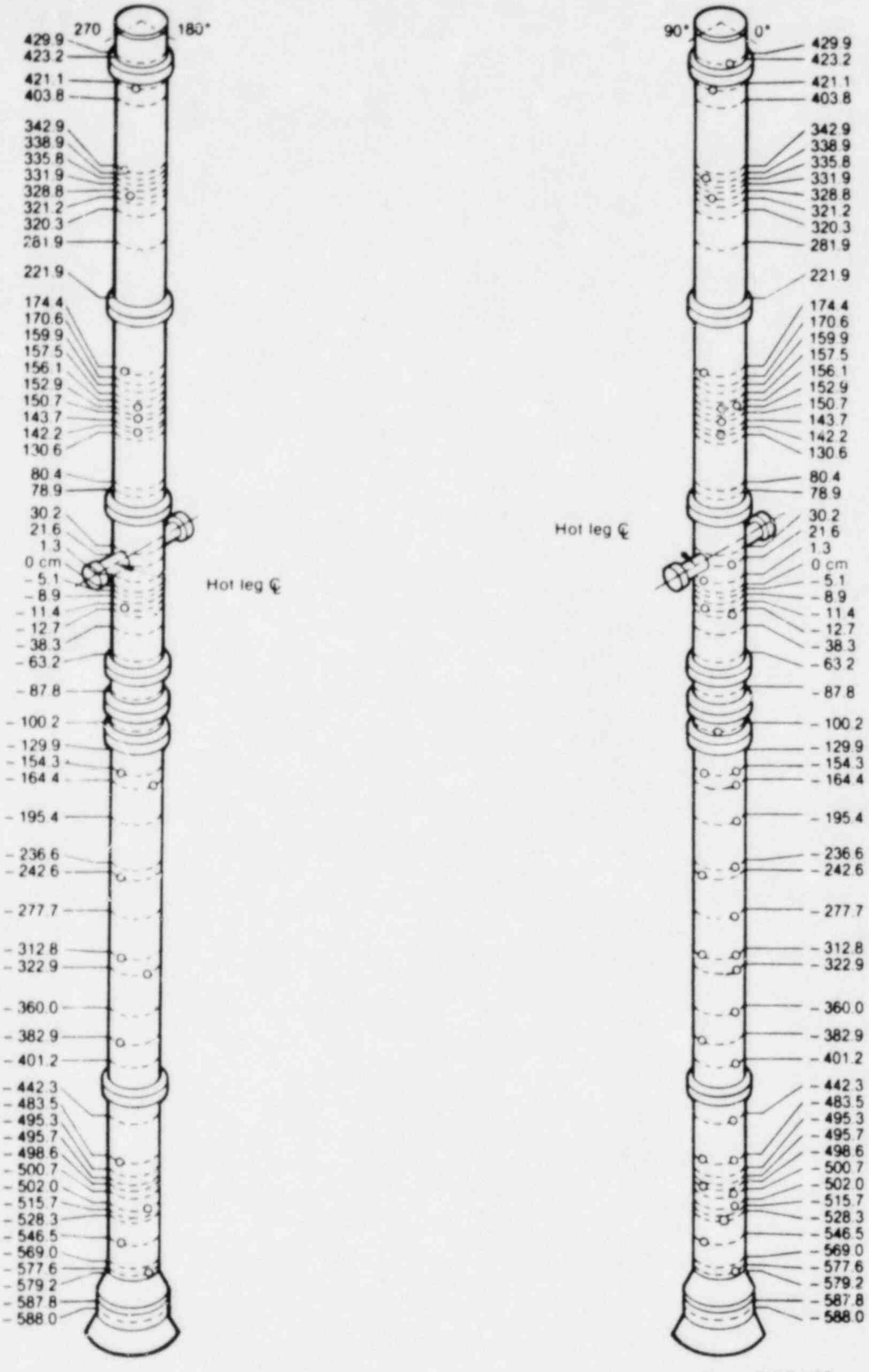


Figure 3. Semiscale Mod-2A pressure vessel and downcomer—cross section.



Tests S-SF-4&5
INEL 2 2384

Figure 4. Semiscale Mod-2A pressure vessel—isometric showing penetrations.

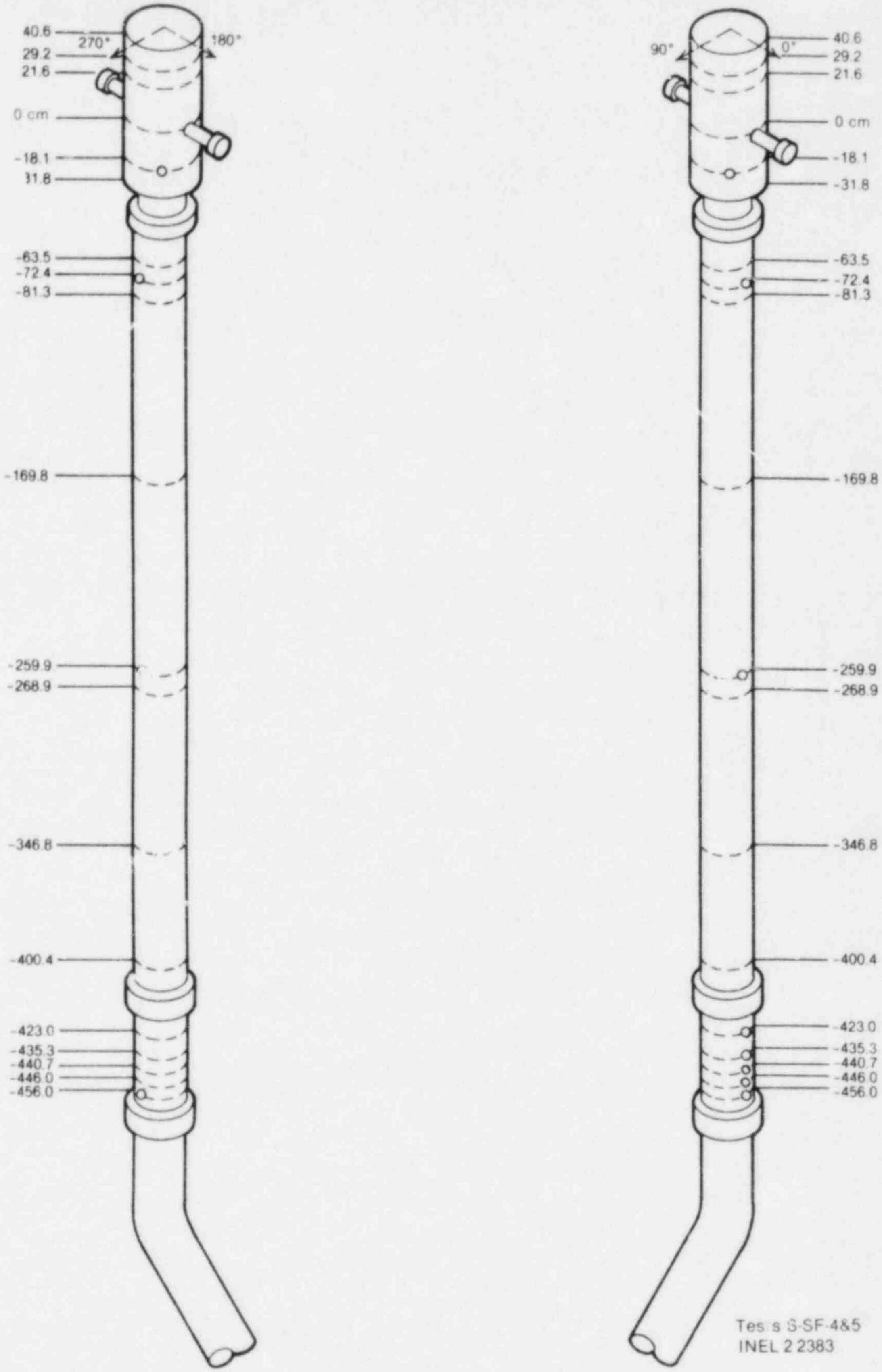
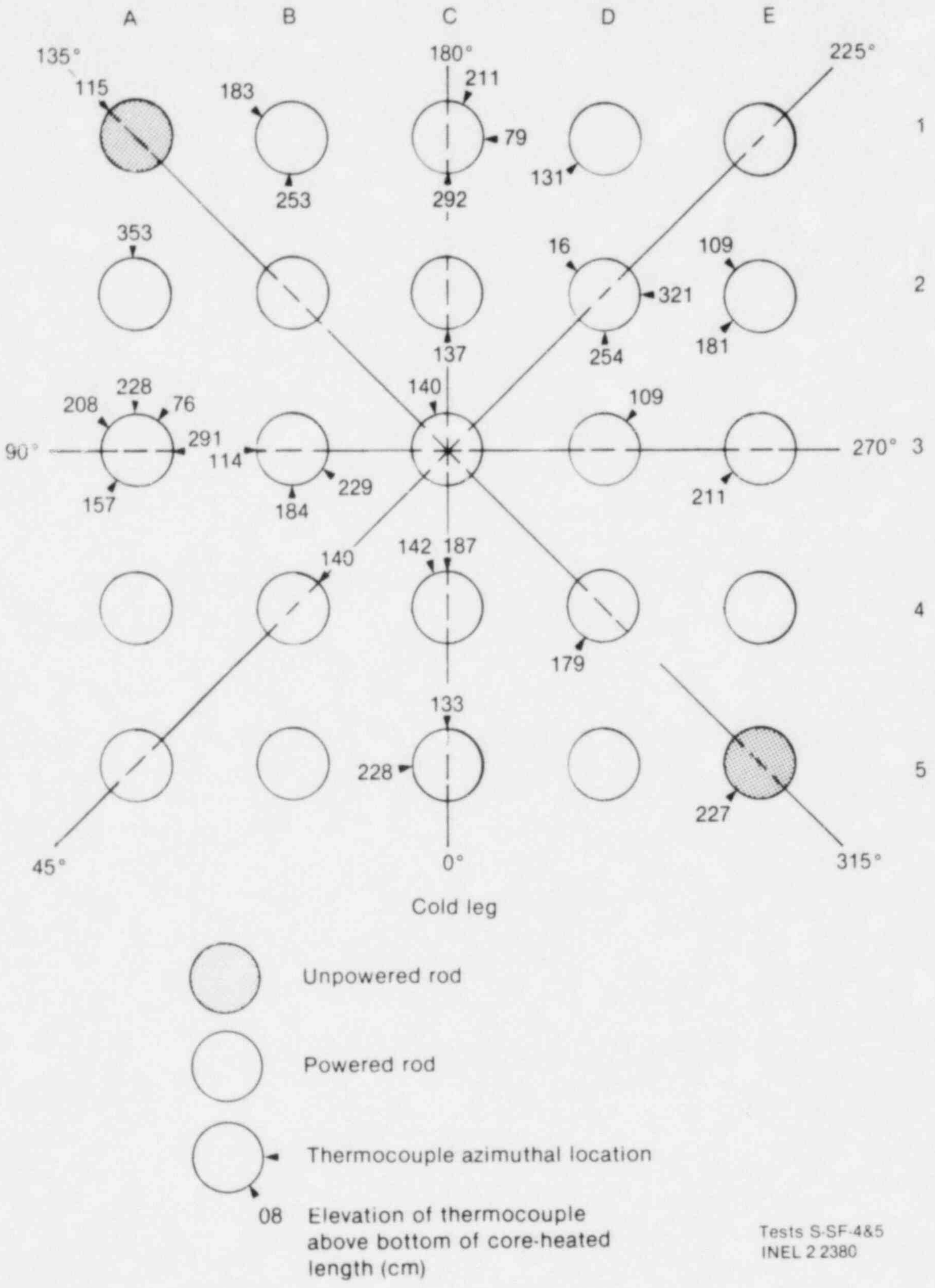


Figure 5. Semiscale Mod-2A downcomer—isometric showing penetrations.



Tests S-SF-4&5
INEL 2 2380

Figure 6. Semiscale Mod-2A heated core plan view.

Table 1. Semiscale Mod-2A system reference elevations[a]

	Centerline			Top of Tube Sheet[b]		
	Cold Leg	Hot Leg	Pressurizer Exit	I.S.G.	B.S.G.	Bottom of Core Heated Length
Cold leg centerlines	0	-20	-150	-260	-260	+496
Hot leg centerlines	+20	0	-130	-240	-240	+516
Pressurizer exit flange face	+150	+130	0	-130	-130	+646
I.S.G. top of tube sheet	+260	+240	+130	0		+756
B.S.G. top of tube sheet	+260	+240	+130	0	0	+756
Bottom of core heated length	-496	-516	-646	-756	-756	0

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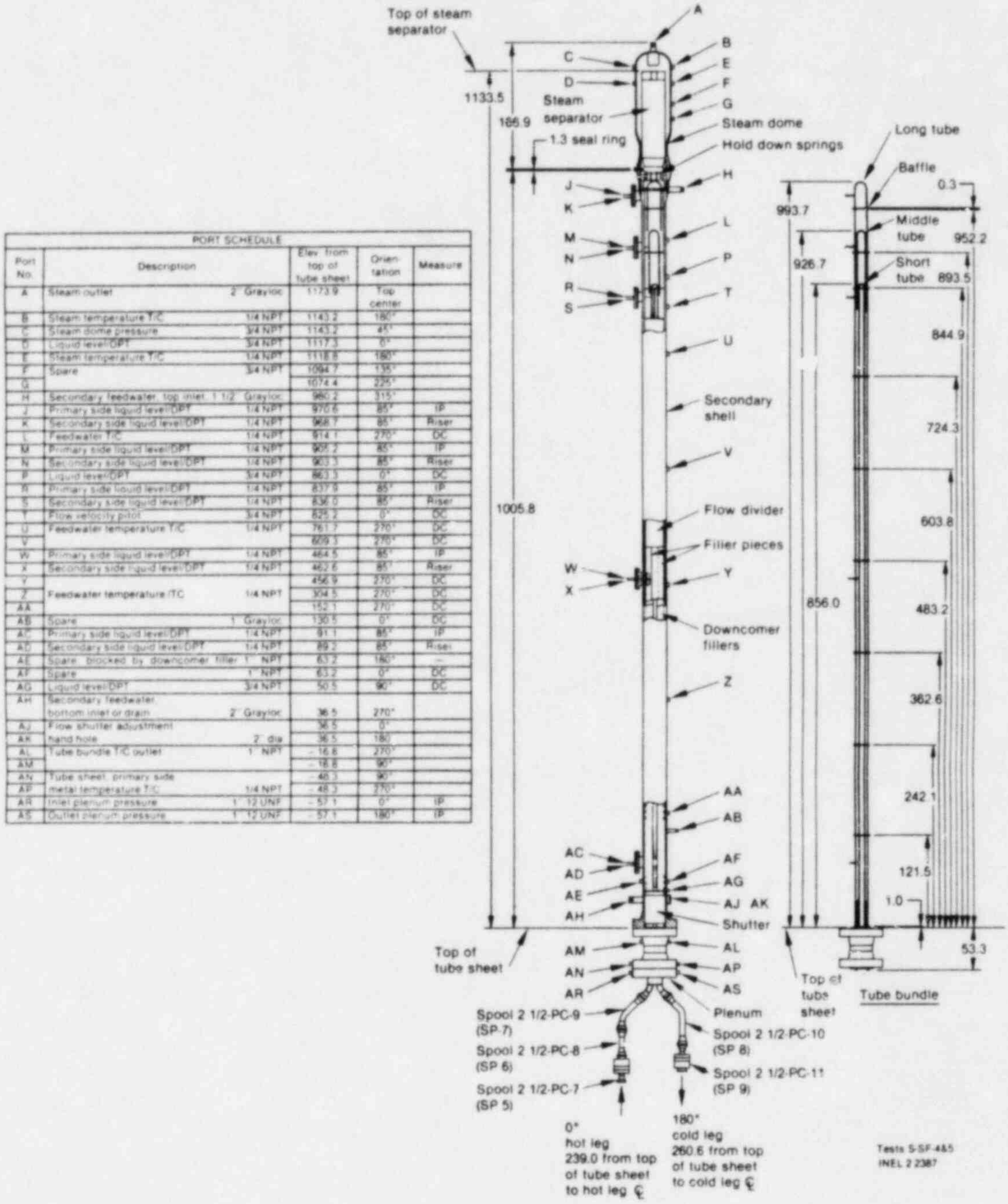
a. All dimensions in centimeters.

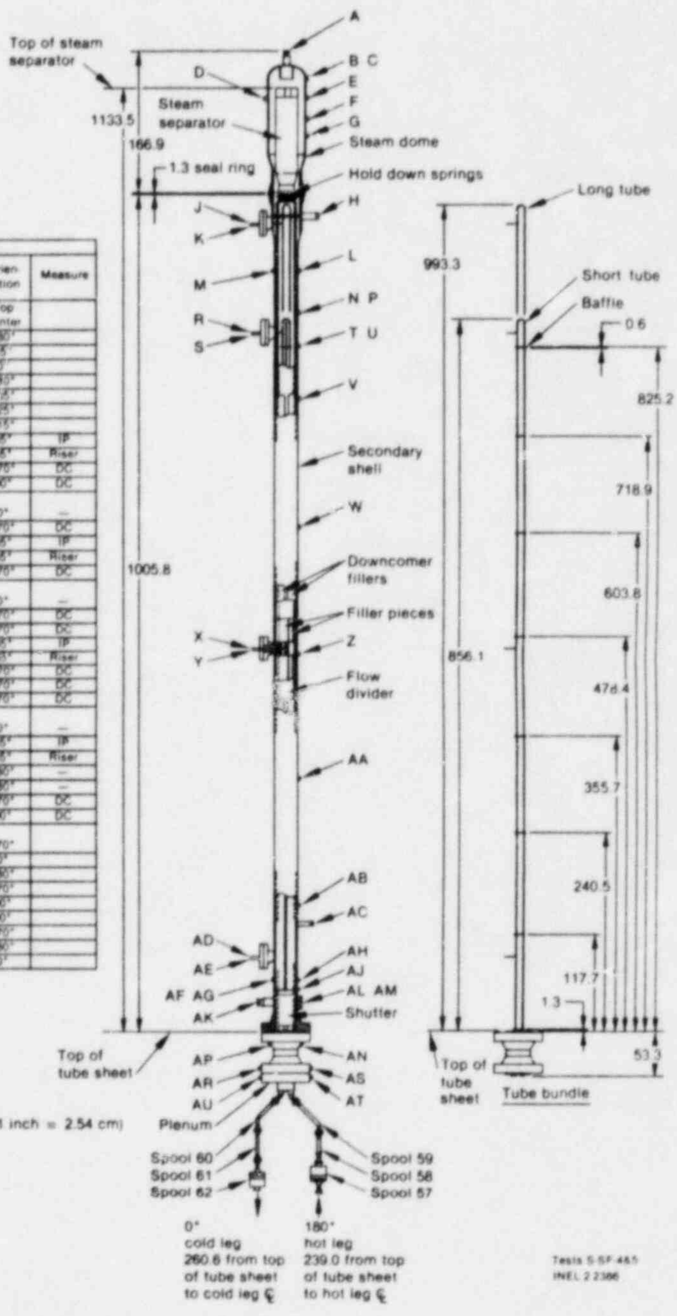
b. I.S.G. = intact loop steam generator; B.S.G. = broken loop steam generator.



PORT SCHEDULE				
Port No.	Description	Elev. from top of tube sheet	Orientation	Measure
A	Steam outlet 2" Grayloc	1173.9	Top center	
B	Steam temperature T/C 1/4 NPT	1143.2	180°	
C	Steam dome pressure 3/4 NPT	1143.2	45°	
D	Liquid level/DPT 3/4 NPT	1117.3	0°	
E	Steam temperature T/C 1/4 NPT	1118.8	180°	
F	Spare 3/4 NPT	1094.7	135°	
G		1074.4	225°	
H	Secondary feedwater, top inlet 1 1/2" Grayloc	980.2	315°	
J	Primary side liquid level/DPT 1/4 NPT	970.6	85°	IP
K	Secondary side liquid level/DPT 1/4 NPT	968.7	85°	Riser
L	Feedwater T/C 1/4 NPT	914.1	270°	DC
M	Primary side liquid level/DPT 1/4 NPT	905.2	85°	IP
N	Secondary side liquid level/DPT 1/4 NPT	903.3	85°	Riser
P	Liquid level/DPT 3/4 NPT	863.3	0°	DC
R	Primary side liquid level/DPT 1/4 NPT	837.9	85°	IP
S	Secondary side liquid level/DPT 1/4 NPT	836.0	85°	Riser
T	Flow velocity pitot 3/4 NPT	825.2	0°	DC
U	Feedwater temperature T/C 1/4 NPT	761.7	270°	DC
V		609.3	270°	DC
W	Primary side liquid level/DPT 1/4 NPT	464.5	85°	IP
X	Secondary side liquid level/DPT 1/4 NPT	462.6	85°	Riser
Y	Feedwater temperature T/C 1/4 NPT	456.9	270°	DC
Z		304.5	270°	DC
AA		152.1	270°	DC
AB	Spare 1" Grayloc	130.5	0°	DC
AC	Primary side liquid level/DPT 1/4 NPT	91.1	85°	IP
AD	Secondary side liquid level/DPT 1/4 NPT	89.2	85°	Riser
AE	Spare, blocked by downcomer filler 1" NPT	63.2	180°	—
AF	Spare 1" NPT	63.2	0°	DC
AG	Liquid level/DPT 3/4 NPT	50.5	90°	DC
AH	Secondary feedwater, bottom inlet or drain 2" Grayloc	36.5	270°	
AJ	Flow shutter adjustment hand hole 2" dia	36.5	0°	
AK		36.5	180	
AL	Tube bundle T/C outlet 1" NPT	−16.8	270°	
AM		−16.8	90°	
AN	Tube sheet, primary side metal temperature T/C 1/4 NPT	−48.3	90°	
AP		−48.3	270°	
AR	Inlet plenum pressure 1"-12 UNF	−57.1	0°	IP
AS	Outlet plenum pressure 1"-12 UNF	−57.1	180°	IP

Figure 7. Semiscale Mod-2A intact loop steam generator instrumentation.

PORT SCHEDULE				
Port No.	Description	Elev. from top of tube sheet	Orientation	Measure
A	Steam outlet 2" Grayloc	1173.9	Top center	
B	Steam temperature T/C 1/4 NPT	1143.2	180°	
C	Steam dome pressure 3/4 NPT	1143.2	45°	
D	Liquid level/DPT 3/4 NPT	1117.3	0°	
E	Steam temperature T/C 1/4 NPT	1118.8	180°	
F	Spare 3/4 NPT	1094.7	135°	
G		1074.4	225°	
H	Secondary feedwater, top inlet 1 1/2" Grayloc	980.2	315°	
J	Primary side liquid level/DPT 1/4 NPT	970.6	85°	IP
K	Secondary side liquid level/DPT 1/4 NPT	968.7	85°	Riser
L	Feedwater T/C 1/4 NPT	914.1	270°	DC
M	Liquid level/DPT 3/4 NPT	914.1	90°	DC
N	Liquid level/DPT. Blocked by downcomer filler 3/4 NPT	863.3	0°	—
P	Liquid level/DPT 3/4 NPT	863.3	270°	DC
R	Primary side liquid level/DPT 1/4 NPT	837.9	85°	IP
S	Secondary side liquid level/DPT 1/4 NPT	836.0	85°	Riser
T	Flow velocity pitot 3/4 NPT	825.2	270°	DC
U	Flow velocity pitot Blocked by downcomer filler 3/4 NPT	825.2	0°	—
V	Feedwater temperature T/C 1/4 NPT	761.7	270°	DC
W		609.3	270°	DC
X	Primary side liquid level/DPT 1/4 NPT	464.5	85°	IP
Y	Secondary side liquid level/DPT 1/4 NPT	462.6	85°	Riser
Z	Feedwater temperature /TC 1/4 NPT	456.9	270°	DC
AA		304.5	270°	DC
AB		152.1	270°	DC
AC	Spare Blocked by downcomer filler 1" Grayloc	130.5	0°	—
AD	Primary side liquid level/DPT 1/4 NPT	91.1	85°	IP
AE	Secondary side liquid level/DPT 1/4 NPT	89.2	85°	Riser
AF	Spare blocked by downcomer filler 1" NPT	63.2	180°	—
AG		63.2	180°	—
AH	Spare 1" NPT	63.2	270°	DC
AJ	Liquid level/DPT 3/4 NPT	50.5	90°	DC
AK	Secondary feedwater, bottom inlet or drain 2" Grayloc	36.5	270°	
AL	Flow shutter adjustment hand hole 2" dia	36.5	0°	
AM		36.5	180°	
AN	Tube bundle T/C outlet 1" NPT	− 16.8	270°	
AP		− 16.8	90°	
AR	Tube sheet, primary side metal temperature T/C 1/4 NPT	− 48.3	90°	
AS		− 48.3	270°	
AT	Inlet plenum pressure 1"-12 UNF	− 57.1	180°	
AU	Outlet plenum pressure 1"-12 UNF	− 57.1	0°	



Notes:
All dimensions are cm reference (1 inch = 2.54 cm)

Figure 8. Semiscale Mod-2A broken loop steam generator instrumentation.

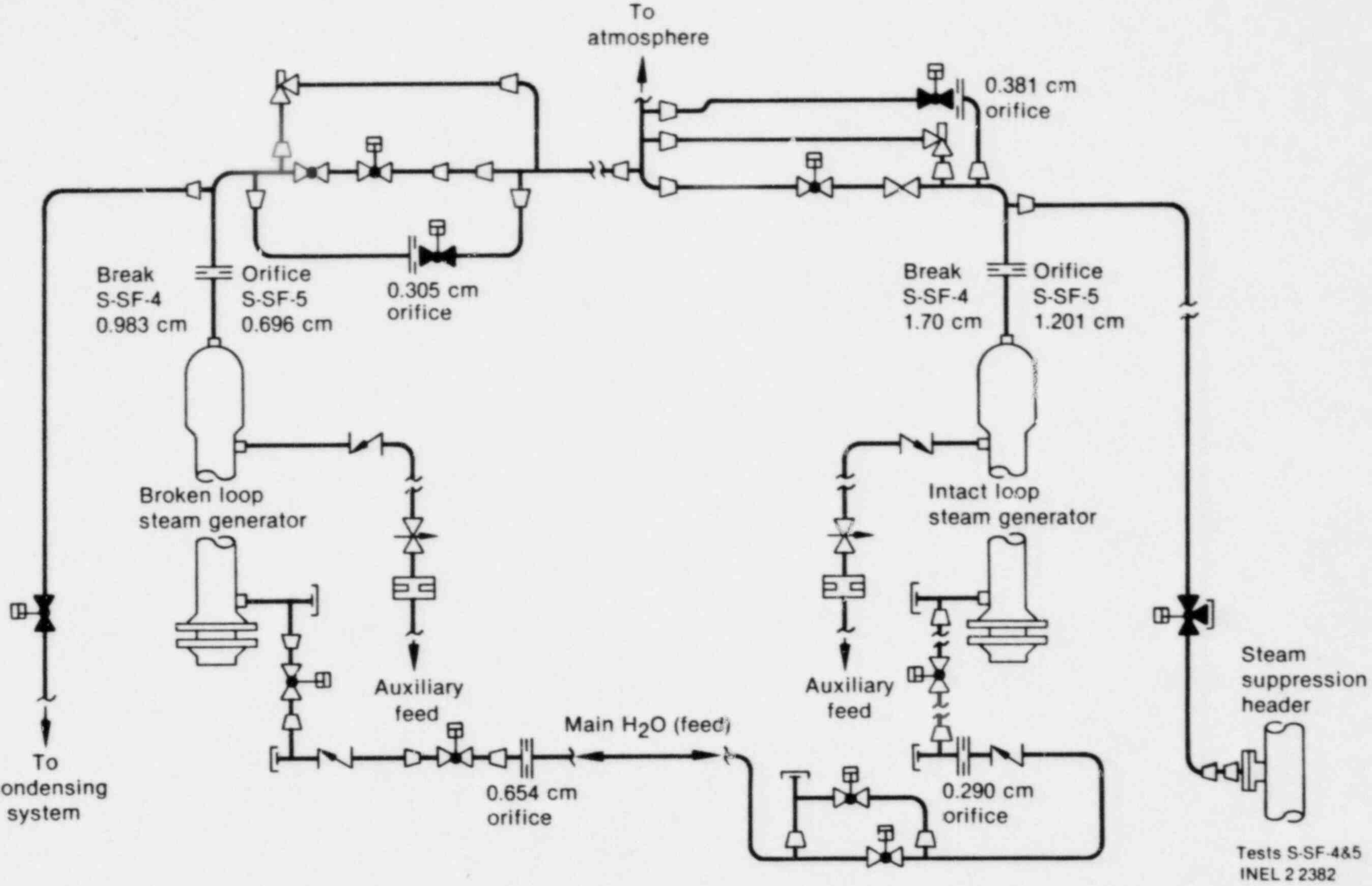


Figure 9. Semiscale Mod-2A break piping for main steam line break Tests S-SF-4 and -5.

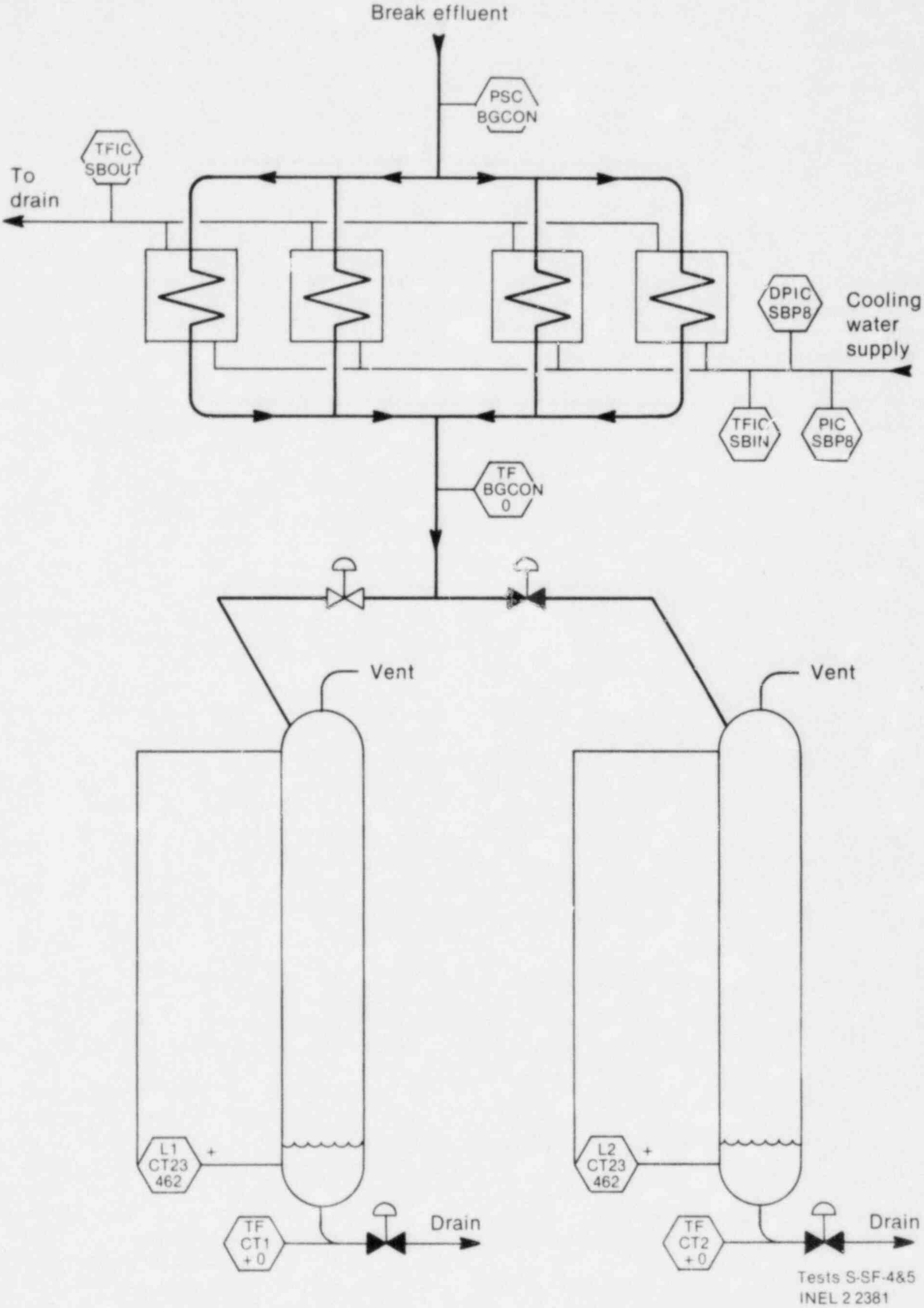


Figure 10. Semiscale Mod-2A break effluent measurement system (condensate system) for Tests S-SF-4 and -5.

External band heaters on the loop piping, downcomer, and core vessel were powered continuously to maintain an adiabatic primary pressure boundary.

Test Preparation

In preparation for each of the two tests, the primary system was filled with treated demineralized water and vented at all high points to ensure a liquid solid condition. A leak check was performed and all measurement transducers were vented and their conditioners/amplifiers were balanced and zeroed. The feedwater supply tank was filled and heated, and initial levels were established in the steam generator secondaries. All auxiliary system valve liquids were set and verified, as were all process alarm, trip, and control functions.

Warmup

Warmup of the primary system to initial test conditions was accomplished using the core heaters, pressurizer heaters, external band heaters, and RCPs, in a sequence that closely resembled a full-scale PWR system, but that is much shorter due to the electric core. The purification and sampling systems were valved-in during warmup to maintain water chemistry and to obtain primary coolant samples at initial conditions for subsequent analysis. At 50-K intervals, detector readings were sampled to check measurement transducer integrity and data acquisition system performance. Also, other checks were performed at various times during warmup to verify total system operational integrity.

Test Sequence

Initial conditions for the two tests were specified to conform to typical PWR operating values for hot standby conditions. Table 2 presents the specified values versus the actual measured values for selected parameters at the start of each test.

Once initial conditions were achieved, they were held long enough to assure reasonably steady state operation of the reactor coolant system (RCS). The data acquisition system was then started on a continuous data scan to record the initial test values and to verify the steady state condition; it then remained on throughout the tests, with time zero designated as the instant the quick-opening break valve was energized to start the main steam line rupture simulation.

Two seconds prior to rupture initiation (-2 s), the closed-loop purification system was isolated from the RCS, and the pressurizer level-controlled charging pumps were disabled. Also at this time, feedwater valve closure was initiated on both steam generators, so that the valves would be shut by zero seconds.

The operation of active components in the system during the transient was by prespecified control curves (except for core power control) that simulate the operation expected to occur during a transient in a PWR plant. Control curves are specified in Reference 2.

The core power for Test S-SF-4 was computer controlled to perform on-line calculations and adjust the power in response to measured conditions. The controller samples information during a transient from internal rod cladding thermocouples, in-core fluid thermocouples, and the core power supply. For each time increment, the equivalent power was calculated for a nuclear core subjected to the same thermal-hydraulic conditions and the Semiscale core power was adjusted accordingly. For Test S-SF-5, the core power was set at 30 kW, plus allowing for heat loss, and was manually controlled throughout the test so as to provide a more severe cooldown than that which occurred during Test S-SF-4.

The main coolant pumps maintained their initial speed until 594 s after transient initiation for Test S-SF-4 and 404 s for Test S-SF-5, at which time the broken loop pump began a 60-s decay and the intact loop pump began a 120-s decay.

The safety injection (SI) pump flow rate was controlled to simulate the injection systems of a PWR plant. For both tests, the SI began by following a high head injection curve and then switching to a low head SI curve. For Tests S-SF-4 and -5, the high head SI started at 32 and 74 s and terminated at 510 and 404 s, respectively. The low head SI was manually started at 3487 and 1715 s,

Table 2. Specified versus actual initial conditions for Tests S-SF-4 and S-SF-5

Parameter	Specified Value	Actual Values[a]	
		S-SF-4	S-SF-5
Pressurizer pressure (MPa) P*PPZ+158	15.5 ± 2	15.5	15.6
Pressurizer liquid mass (kg) LPRZ146+25	10.4 ± 0.2	—[b]	—[b]
Total core power (kW)[c] KWH*TOTC	30	97	108
Cold leg fluid temperature (K) TFI*22/TFB*79	557/557	555/556	557/555
Cold leg volumetric flows (L/s) QI*21/QB*79	—[d]/—[d]	9.4/3.1	9.4/3.2
Steam Generator			
Secondary pressure (MPa)[e] PIS*1117/PBS*1117	5.85/5.85	6.8/6.8	6.8/6.4
Collapsed liquid level (cm)[e]			
LIS1117+50 S-SF-4/S-SF-5	1020/950	1067	969
LBS1117+50 S-SF-4/S-SF-5	1020/500	933	480
Feedwater temperature (K) TFSC*IGFWL/TFSC*BGFWL	495/495	556/556	503/553

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[a] As recorded and averaged from -20 to -3 s by the DDAPS.

[b] DDAPS pressurizer level measurement was erroneous. Process measurement indicated the specified level.

[c] Core power was adjusted to compensate for environmental heat loss.

[d] A 3:1 ratio was specified. Actual values depend only on achieving the specified core differential temperature.

[e] Secondary side conditions were adjusted to obtain required primary side temperature.

respectively, and continued to the end of the tests. For S-SF-4 the high head SI was set to actuate by a low pressure signal of 14.4 MPa from the pressurizer. Test S-SF-5 had a programed 25-s delay after 14.4 MPa before SI actually commenced.

Auxiliary feedwater to both the intact and broken loop steam generators was set to be initiated when the pressure in the broken loop steam generator steam dome reached 4.13 MPa, and the feed continued until 516 s for Test S-SF-4 and 404 s for Test S-SF-5, at which times the steam generator auxiliary flow was terminated. The operational events for both tests are listed in Tables 3 and 4.

For each test, the basic recovery mode was to establish and maintain adequate core cooling by RCS feed and bleed using the SI system and the pressurizer power-operated relief valve (PORV). This is an alternate method of decay heat removal, which is useful in accidents in which the steam generator secondaries are not available as heat sinks.

Table 3. Sequence of events, Test S-SF-4

Plot Time (s)	Event
-30	Data acquisition system began recording test data
-2	Closed-loop purification system isolated; automatic charging pumps, pressurizer heaters, and intact and broken loop steam generator feed valves disabled.
0	Broken loop steam valve closed; intact loop steam valve opened; intact and broken loop main steam line break valve opened—start of transient
+32	High head safety injection started
+68	Auxiliary feedwater started to both steam generators
+483	PORV reset to 14.48 and 14.34 MPa[a]
+510	High head safety injection terminated
+516	Auxiliary feedwater terminated
+560	Core power switched to manual
+578	Drain of steam generators started
+594	120-s intact loop and 60-s broken loop pump coastdown started
+1000	Core power increased to 100 kW
+1402	Core power increased to 150 kW
+1946	PORV reset to 13.79 and 13.65 MPa
+1989	Core power decreased to 100 kW
+2611	PORV reset to 11.03 and 10.89 MPa
+2689	Core power decreased to 90 kW
+2778	Core power decreased to 80 kW
+3459	Core power decreased to 70 kW
+3487	Low head safety injection started
+3504	Core power decreased to 60 kW
+3613	Core power decreased to 50 kW

Table 3. (continued)

Plot Time (s)	Event
+3678	PORV reset to 9.65 and 9.51 MPa
+3804	PORV reset to 8.27 and 8.14 MPa
+3875	Core power decreased to 40 kW
+4534	Test S-SF-4 terminated

a. At the start of test, PORV was set to open at 16.2 MPa and close at 16.03 MPa.

Table 4. Sequence of events, Test S-SF-5

Plot Time (s)	Event
-30	Data acquisition system began recording test data
-2	Closed-loop purification system isolated; automatic charging pumps, pressurizer heaters, intact and broken loop steam generator feed values disabled
0	Broken loop steam valve closed; intact loop steam valve opened; intact and broken loop main steam line break valve opened—start of transient
+74	High head safety injection started
+85	Auxiliary feedwater started to both steam generators
+240	PORV reset to 15.09 and 13.79 MPa[a]
+404	High head safety injection terminated; auxiliary feedwater terminated; drain of steam generators started; 120-s intact loop pump and 60-s broken loop pump coastdown started
+1705	PORV reset to 8.96 and 8.89 MPa.
+1715	Low head safety injection started
+1920	Leak in intact loop between Spool Pieces 21 and 22 developed
+2510	Test S-SF-5 terminated

a. At the start of test, PORV was set to open at 16.2 MPa and close at 16.03 MPa.

DATA PRESENTATION

This section discusses the digital data[a] from Semiscale Mod-2A Main Steam Line Break Tests S-SF-4 and S-SF-5, which are presented as graphs in engineering units. Processing analysis serves only to obtain the proper engineering units and to ensure that the data are reasonable and consistent. In all cases, a homogeneous fluid was assumed when converting the transducer output to engineering units. The scales selected for the data graphs do not reflect the obtainable resolution of the measurements.

The performance of the Mod-2A system during Tests S-SF-4 and -5 was monitored by 308 and 309 measurement detectors, respectively. Of these, approximately 20 per test are not presented in this report because they were either installed on auxiliary systems that were not used, used solely for in-house processing and control, or had failed before or during the test.

The output of each detector/transducer passes through a signal conditioner and amplifier where the signal is converted to a dc voltage compatible with the Digital Data Acquisition and Processing System (DDAPS). The DDAPS accepts the voltage inputs through analog-to-digital converters and, using previously entered coefficients, converts the input to appropriate engineering units. These data are then recorded on magnetic disks, at intervals dependent on the scan rate.

Dual scan rates were used to sample the detector outputs during both tests. During the first 570 s of DDAPS operation, each channel was scanned once every 0.05 s, yielding an effective sample rate of 20 samples per second per channel. The sample rates were then reduced to accommodate the expected duration of the individual tests, and the scan was slowed to 0.55 s per channel, for an effective sample rate of 1.82 samples per second per channel.

Posttest data review and qualification were conducted by a Data Integrity Review Committee. Erroneous and superfluous measurements were identified and deleted, and the necessary adjustments and calculations were performed on the remaining measurements. Ambiguous measurements, where the exact engineering unit value could not be verified, were retained because they can provide important information on parameter trends and timing functions. These measurements are labeled "trend information only" on the data graphs, rather than assigning a value to the uncertainty range of the measurement.

Immediately prior to each test, numerous calibration checks are performed and the data recorded. This information is used, after the fact, to adjust specific test data to offset such effects as pressure sensitivity, amplifier zero offset, and core power sensitivity.

The necessary posttest calculations include converting the voltage outputs of the densitometers to actual density (kg/m^3). This is done by setting the measured low voltage output during a subcooled condition equal to the known density at that time, and by setting the measured high voltage output during a vapor condition to the known density at that time. The density at all other times is then computed using an inverse ratio of voltage to density with the two known points used to define the values. The nonlinearity of this method across a phase change is recognized and incorporated into the derivation of the measurement uncertainty value.

In much the same manner, the valve position transducer outputs are converted from voltage to percent open, this being a direct, linear relationship.

The power "measurements" for the core and the external band heaters are not actual measurements, but are calculated from the measured voltage and current output of the individual power supplies.

The above noted adjustments and calculations were the only ones performed on the data presented herein. References 1 and 4 further describe the Semiscale data processing techniques; Reference 4 also explains the capabilities of the DDAPS and presents an analysis of the uncertainties associated with measurement data from the Mod-2A system. Figures 1 through 10 provide

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[a] The digital data are available from the NRC/Division of Accident Evaluation (DAE) Data Bank at the Idaho National Engineering Laboratory. Address data inquiries to NRC/DAE Data Bank Administrator, EG&G Idaho, Inc., P.O. Box 1625, Idaho Falls, Idaho, 83415.

measurement geometry information needed for interpretation of the data. Table 5 groups the measurements according to type or location, identifies the location and range of the detector, gives the actual recording range of the DDAPS, provides brief comments on the data, and references the detector and comments to their corresponding figure. Figures 11 through 592 (data graphs) present all the data obtained, including the noted calculated parameters. These data graphs are presented on microfiche sheets, attached to the inside back cover of this report.

Table 5. Data presentation for Semiscale Mod-2A Tests S-SF-4 and S-SF-5

Measurement	Location and Comments[a]	Data Acquisition Range[a] Detector	 System	Figure[a]	Measurement Comments[b]
FLUID TEMPERATURE	Chromel-Alumel thermocouples unless specified otherwise.				
Intact Loop		0 to 1533 K	0 to 820 K		
TFI*1	Hot leg, Spool 1, 50 cm from vessel center.			11, 304	
TFI*5	Hot leg, Spool 5, 363 cm from vessel center.			12, 305	
TFI*9	Cold leg, Spool 9, 1017 cm from downcomer center.			13, 306	
TFI*17	Cold leg, Spool 17, 338 cm from downcomer center.			14, 307	
TFI*21	Cold leg, Spool 21, 138 cm from downcomer center.			15, 308	
TFI*22	Cold leg, Spool 22, 48 cm from downcomer center.			16, 309	
Broken Loop					
TFB*50	Hot leg, Spool 50, 73 cm from vessel center.			17, 310	
TFB*57	Hot leg, Spool 57, 278 cm from vessel center.			18, 311	
TFB*62	Cold leg, Spool 62, 962 cm from downcomer center.			19, 312	
TFB*64	Cold leg, Spool 64, 638 cm from downcomer center.			20, 313	
TFB*73	Cold leg, Spool 73, 337 cm from downcomer center.			21, 314	
TFB*74	Cold leg, Spool 74, 220 cm from downcomer center.			22, 315	
TFB*79	Cold leg, Spool 79, 78 cm from downcomer center.			23, 316	
Vessel					
Vessel Downcomer		0 to 1533 K	0 to 820 K		
TFV*DC-84	Downcomer extension, 84 cm below cold leg centerline.			24, 317	
TFV*DC-436	Downcomer extension, 436 cm below cold leg centerline.			25, 318	
Vessel Lower Plenum		0 to 1533 K	0 to 820 K		
Vessel Upper Plenum		0 to 1533 K	0 to 820 K		
TFV*UPM-13	In vessel upper plenum, 13 cm below cold leg centerline at 180°.			26, 319	
TFV*UP+79	In vessel upper plenum, 79 cm above cold leg centerline.			27, 320	
Vessel Upper Head		0 to 1533 K	0 to 820 K		
TFV*UHQ180	In vessel upper head, 180 cm above cold leg centerline at 225°.			28, 321	
TFV*UH+343	In vessel upper head, 343 cm above cold leg centerline.			29, 322	
TFV*UH+402	In vessel upper head, 402 cm above cold leg centerline.			30, 323	
TFV*BYPASS	In bypass line connecting upper plenum to downcomer.			31, 324	
Core Grid Spacers		0 to 1533 K	0 to 1580 K		
Grid Spacer 2	450 cm below cold leg centerline, 46 cm above bottom of heated length.				
TFV*B3+46	Thermocouple in space defined by Columns B and C, Rows 3 and 4.			32, 325	

Table 5. (continued)

		Data Acquisition Range[a]			
Measurement	Location and Comments[a]	Detector	System	Figure[a]	Measurement Comments[b]
FLUID TEMPERATURE (continued)					
Core Grid Spacers (continued)					
Grid Spacer 4	370 cm below cold leg centerline, 126 cm above bottom of heated length.				
TFV*D1+126	Thermocouple in space defined by Columns D and E, Rows 1 and 2.			33, 326	
TFV*A4+126	Thermocouple in space defined by Columns A and B, Rows 4 and 5.			34, 327	
TFV*B3+126	Thermocouple in space defined by Columns B and C, Rows 3 and 4.			35, 328	
Grid Spacer 5	330 cm below cold leg centerline, 166 cm above bottom of heated length.				
TFV*B3+166	Thermocouple in space defined by Columns B and C, Rows 3 and 4.			36, 329	
Grid Spacer 7	250 cm below cold leg centerline, 246 cm above bottom of heated length.				
TFV*B3+246	Thermocouple in space defined by Columns B and C, Rows 3 and 4.			37, 330	
Grid Spacer 8	210 cm below cold leg centerline, 286 cm above bottom of heated length.				
TFV*A4+286	Thermocouple in space defined by Columns A and B, Rows 4 and 5.			38, 331	
Grid Spacer 9	170 cm below cold leg centerline, 326 cm above bottom of heated length.				
TFV*B3+326	Thermocouple in space defined by Columns B and C, Rows 3 and 4.			39, 332	
Grid Spacer 10	130 cm below cold leg centerline, 366 cm above bottom of heated length.				
TFV*A4+366	Thermocouple in space defined by Columns A and B, Rows 4 and 5.			40, 333	
Steam Generator		0 to 1533 K	0 to 823 K		
Intact Loop, Primary Side	Between Spools 7 and 8.				
TFIP+LH30	In long tube, hot side, 30 cm above top of tube sheet.			41, 334	
TFIP+LH84	In long tube, hot side, 84 cm above top of tube sheet.			42, 335	
TFIP+LH152	In long tube, hot side, 152 cm above top of tube sheet.			43	Failed during S-SF-5
TFIP+LH452	In long tube, hot side, 452 cm above top of tube sheet.			44, 336	
TFIP+SH815	In short tube, hot side, 815 cm above top of tube sheet.			45, 337	
TFIP+LH922	In long tube, hot side, 922 cm above top of tube sheet.			46, 338	
TFIP+LC785	In long tube, cold side, 785 cm above top of tube sheet.			47, 339	
TFIP+SC668	In short tube, cold side, 668 cm above top of tube sheet.			48, 340	
TFIP+LC333	In long tube, cold side, 333 cm above top of tube sheet.			49, 341	
TFIP+LC211	In long tube, cold side, 211 cm above top of tube sheet.			50, 342	
TFIP+SC211	In short tube, cold side, 211 cm above top of tube sheet.			51, 343	

Table 5. (continued)

Measurement	Location and Comments[a]	Data Acquisition Range[a]		Figure[a]	Measurement Comments[b]
		Detector	System		
FLUID TEMPERATURE (continued)					
Broken Loop, Primary Side	Between Spools 59 and 60.	0 to 1533 K	0 to 820 K		
TFBP+LH152	In long tube, hot side, 152 cm above top of tube sheet.			52, 344	
TFBP+SH211	In short tube, hot side, 211 cm above top of tube sheet.			53, 345	
TFBP+LH211	In long tube, hot side, 211 cm above top of tube sheet.			54, 346	
TFBP+LH272	In long tube, hot side, 272 cm above top of tube sheet.			55, 347	
TFBP+LH394	In long tube, hot side, 394 cm above top of tube sheet.			56, 348	
TFBP+LH452	In long tube, hot side, 452 cm above top of tube sheet.			57, 349	
TFBP+LH785	In long tube, hot side, 785 cm above top of tube sheet.			58, 350	
TFBP+LH922	In long tube, hot side, 922 cm above top of tube sheet.			59, 351	
TFBP+LC785	In long tube, cold side, 785 cm above top of tube sheet.			60, 352	
TFBP+SC452	In short tube, cold side, 452 cm above top of tube sheet.			61, 353	
TFBP+LC452	In long tube, cold side, 452 cm above top of tube sheet.			62, 354	
TFBP+LC211	In long tube, cold side, 211 cm above top of tube sheet.			63, 355	
Intact Loop, Secondary Side		0 to 1533 K	0 to 820 K		
TFSC*IGFDW	Feedwater temperature at flow orifice.			64, 356	
TFSC*IGFWL	Feedwater temperature at lower injection port.			65, 357	
TFSC*IAXFW	Auxiliary feedwater at entrance to upper feed ring.			66, 358	
TFIS*D+152	In downcomer, 152 cm above top of tube sheet.			67, 359	
TFIS*D+457	In downcomer, 457 cm above top of tube sheet.			68, 360	
TFIS*D+609	In downcomer, 609 cm above top of tube sheet.			361	Test S-SF-5 only
TFIS*D+761	In downcomer, 761 cm above top of tube sheet.			69, 362	
TFIS+LH30	On long tube, hot side, 30 cm above top of tube sheet.			70, 363	
TFIS+LC30	On long tube, cold side, 30 cm above top of tube sheet.			71	Failed during S-SF-5
TFIS+SH84	On short tube, hot side, 84 cm above top of tube sheet.			72, 364	
TFIS+LH84	On long tube, hot side, 84 cm above top of tube sheet.			73, 365	
TFIS+LC84	On long tube, cold side, 84 cm above top of tube sheet.			74, 366	
TFIS+LH152	On long tube, hot side, 152 cm above top of tube sheet.			75, 367	
TFIS+LC211	On long tube, cold side, 211 cm above top of tube sheet.			76, 368	
TFIS+LC333	On long tube, cold side, 333 cm above top of tube sheet.			77, 369	

Table 5. (continued)

Measurement	Location and Comments[a]	Data Acquisition Range[a]		Figure[a]	Measurement Comments[b]
		Detector	System		
FLUID TEMPERATURE (continued)					
Intact Loop, Secondary Side (continued)					
TFIS+SC333	On short tube, cold side, 333 cm above top of tube sheet.			78, 370	
TFIS+LH394	On long tube, hot side, 394 cm above top of tube sheet.			79, 371	
TFIS+SH452	On short tube, hot side, 452 cm above top of tube sheet.			80, 372	
TFIS+LH452	On long tube, hot side. 452 cm above top of tube sheet.			81, 373	
TFIS+LC452	On long tube, cold side, 452 cm above top of tube sheet.			82, 374	
TFIS+LH785	On long tube, hot side, 785 cm above top of tube sheet.			83, 375	
TFIS+1117	In steam dome, 1117 cm above top of tube sheet.			84, 376	
Broken Loop, Secondary Side		0 to 1533 K	0 to 820 K		
TFSC*BGFWL	Feedwater temperature at lower injection port.			85, 377	
TFSC*BAXFW	Auxiliary feedwater at entrance to upper feed ring.			86, 378	
TFBS*D+152	In downcomer, 152 cm above top of tube sheet.			87, 379	
TFBS*D+304	In downcomer, 304 cm above top of tube sheet.			88, 380	
TFBS*D+457	In downcomer, 457 cm above top of tube sheet.			89, 381	
TFBS*D+610	In downcomer, 610 cm above top of tube sheet.			90, 382	
TFBS*D+761	In downcomer, 761 cm above top of tube sheet.			91, 383	
TFBS+LH61	On long tube, hot side, 61 cm above top of tube sheet.			92, 384	
TFBS+LC84	On long tube, cold side, 84 cm above top of tube sheet.			93, 385	
TFBS+LH211	On long tube, hot side, 211 cm above top of tube sheet.			94, 386	
TFBS+LC211	On long tube, cold side, 211 cm above top of tube sheet.			95, 387	
TFBS+LH333	On long tube, hot side, 333 cm above top of tube sheet.			96, 388	
TFBS+SC333	On short tube, cold side, 333 cm above top of tube sheet.			97, 389	
TFBS+LC333	On long tube, cold side, 333 cm above top of tube sheet.			98, 390	
TFBS+LH394	On long tube, hot side, 394 cm above top of tube sheet.			99, 391	
TFBS+SH452	On short tube, hot side, 452 cm above top of tube sheet.			100, 392	
TFBS+LH452	On long tube, hot side, 452 cm above top of tube sheet.			101, 393	
TFBS+LC452	On long tube, cold side, 452 cm above top of tube sheet.			102, 394	
TFBS+LH536	On long tube, hot side, 536 cm above top of tube sheet.			103, 395	
TFBS+LH668	On long tube, hot side, 668 cm above top of tube sheet.			104, 396	

Table 5. (continued)

Measurement	Location and Comments[a]	Data Acquisition Range[a]		Figure[a]	Measurement Comments[b]
		Detector	System		
FLUID TEMPERATURE (continued)					
Broken Loop, Secondary Side (continued)					
TFBS+LC785	On long tube, cold side, 785 cm above top of tube sheet.			105, 397	
TFBS+SH815	On short tube, hot side, 815 cm above top of tube sheet.			106, 398	
TFBS+LH922	On long tube, hot side, 922 cm above top of tube sheet.			107, 399	
TFBS+1117	In steam dome, 1117 cm above top of tube sheet.			108, 400	
Pressurizer		0 to 1533 K	0 to 820 K		
TF*PRZ+132	In top of pressurizer, 132 cm above exit to surge line.			109, 401	
TF*PRZ-73	In surge line, 73 cm below pressurizer exit.			110, 402	
TF*PRZ*13	In surge line at entrance to intact loop Spool 3.			111, 403	
Break Nozzle		0 to 1533 K	0 to 820 K		
TFSC*ICSTM	In intact loop steam generator, upstream of break nozzle.			112, 404	
TFSC*BGSTM	In broken loop steam generator, upstream of break nozzle.			113, 405	
Break Effluent Condensate System		0 to 1533 K	0 to 820 K		
TF*CT1+0	In bottom of condensate Catch Tank 1, zero cm above drain outlet.			114, 406	
TF*CT2+0	In bottom of condensate Catch Tank 2, zero cm above drain outlet.			115, 407	
TF*BGCON*0	In break effluent line at outlet of condensing coils.			116, 408	
TFIC*SBIN	Cooling water supply at inlet to condensing coils.			117, 409	
TFIC*SBOUT	Cooling water at outlet of condensing coils.			118, 410	
METAL TEMPERATURE	Chromel-Alumel thermocouples unless specified otherwise.				
Vessel	Internals.	0 to 1533 K	0 to 820 K		
TMV*FPD+79	In vessel on upper plenum filler piece, 79 cm above cold leg centerline at 45°.			119, 411	
TMV+FPF221	In vessel on upper head filler piece, 221 cm above cold leg centerline at 75°.			120, 412	
TMV*TSO221	In vessel on thermal shield, 221 cm above cold leg centerline at 225°.			121, 413	
Intact Loop, Steam Generator	Tubes.	0 to 1533 K	0 to 820 K		
TMIG+LH452	On long tube, hot (inlet) side of U-tubes, 452 cm above top of tube sheet.			122, 414	
Broken Loop, Steam Generator	Tubes.	0 to 1533 K	0 to 820 K		
TMBG+LC86	On long tube, cold (outlet) side of U-tubes, 86 cm above top of tube sheet.			123, 415	
TMBG+LH452	On long tube, hot (inlet) side of U-tubes, 452 cm above top of tube sheet.			124, 416	

Table 5. (continued)

		Data Acquisition Range[a]			
Measurement	Location and Comments[a]	Detector	System	Figure[a]	Measurement Comments[b]
METAL TEMPERATURE (continued)					
External Heaters	Thermocouples on pipe outside surface under an external band heater.	0 to 1533 K	0 to 820 K		
Intact Loop					
TMEH*16	Pump suction leg, Spool 16, 542 cm from downcomer center.			125, 417	
TMEH*17	Pump suction leg, Spool 17, 402 cm from downcomer center.			126	Failed during S-SF-5
TMEH*22	Cold leg, Spool 22, 42 cm from downcomer center.			127, 418	
Broken Loop		0 to 1533 K	0 to 820 K		
TMEH*72M	Pump suction leg, Spool 72, middle, 405 cm from downcomer center.			128, 419	
TMEH*73	Pump suction leg, Spool 73, 321 cm from downcomer center.			129, 420	
Vessel		0 to 1533 K	0 to 820 K		
TMEH*V-196	Core housing, 196 cm below cold leg centerline.			130, 421	
TMEH*V-30	Upper plenum, 30 cm below cold leg centerline.			131, 422	
MATERIAL TEMPERATURE	Chromel-Alumel thermocouples unless specified otherwise.				
External Heaters	Thermocouples on external heater outside surface, under insulation.	0 to 1533 K	0 to 820 K		
Intact Loop					
TEH*3	Hot leg, Spool 3, 174 cm from vessel center.			132, 423	
TEH*7	Hot leg, Spool 7, 447 cm from vessel center.			133, 424	
TEH*8	Cold leg, Spool 8, 1082 cm from downcomer center.			134, 425	
TEH*13	Cold leg, Spool 13, 798 cm from downcomer center.			426	**Failed during S-SF-4**
TEH*16	Cold leg, Spool 16, 542 cm from downcomer center.			135, 427	
TEH*17	Cold leg, Spool 17, 402 cm from downcomer center.			136, 428	
TEH*19	Cold leg, Spool 19, 243 cm from downcomer center.			137, 429	
TEH*22	Cold leg, Spool 22, 42 cm from downcomer center.			430	Failed during S-SF-4
Broken Loop		0 to 1533 K	0 to 820 K		
TEH*50	Hot leg, Spool 50, 6 cm from vessel center.			138, 431	
TEH*55A	Hot leg, Spool 55, 240 cm from vessel center.			139, 432	
TEH*59	Hot leg, Spool 59, 389 cm from vessel center.			140, 433	
TEH*60	Cold leg, Spool 60, 1042 cm from downcomer center.			141, 434	
TEH*64T	Cold leg, Spool 64, top, 885 cm from downcomer center.			142, 435	
TEH*64M	Cold leg, Spool 64, middle, 784 cm from downcomer center.			143, 436	
TEH*64B	Cold leg, Spool 64, bottom, 662 cm from downcomer center.			144, 437	
TEH*72M	Cold leg, Spool 72, middle, 405 cm from downcomer center.			145, 438	

Table 5. (continued)

		Data Acquisition Range[a]			
Measurement	Location and Comments[a]	Detector	System	Figure[a]	Measurement Comments[b]
MATERIAL TEMPERATURE (continued)					
Broken Loop (continued)					
TEH*73	Cold leg, Spool 73, 321 cm from downcomer center.			146, 439	
TEH*74	Cold leg, Spool 74, 196 cm from downcomer center.			147, 440	
TEH*79	Cold leg, Spool 79, 98 cm from downcomer center.			148, 441	
Vessel		0 to 1533 K	0 to 820 K		
TEH*D-237	On downcomer, 237 cm below cold leg centerline.			149, 442	
TEH*V-360	Core housing, 360 cm below cold leg centerline.			150, 443	
TEH*V-196	Core housing, 196 cm below cold leg centerline.			151, 444	
TEH*V-30	Upper plenum, 30 cm below cold leg centerline.			152, 445	
TEH*V+101	Upper plenum, 101 cm above cold leg centerline.			153, 446	
TEH*V+249	Upper head, 249 cm above cold leg centerline.			154, 447	
TEH*V+386	Upper head, 386 cm above cold leg centerline.			155, 448	
CORE HEATER CLADDING TEMPERATURE	Thermocouples located inside sheath of electric core heater rods.				
High Power Bus Heaters	Nine rods in center of core.	0 to 1533 K	0 to 1580 K		
THV*B3+114 THV*B3+184 THV*B3+229	Heater at Column B, Row 3, thermocouples 114 cm (97°), 184 cm (353°), and 229 cm (304°) above bottom of heated length.			156, 449 157, 450 158, 451	
THV*B4+140	Heater at Column B, Row 4, thermocouple at 140 cm (228°) and above bottom of heated length.			159, 452	
THV*C2+137	Heater at Column C, Row 2, thermocouple at 137 cm (351°) above bottom of heated length.			160, 453	
THV*C3+140	Heater at Column C, Row 3, thermocouple at 140 cm (174°) above bottom of heated length.			161, 454	
THV*C4+142 THV*C4+187	Heater at Column C, Row 4, thermocouples at 142 cm (171°) and 187 cm (182°) above bottom of heated length.			162, 455 163, 456	
THV*D2+16 THV*D2+254 THV*D2+321	Heater at Column D, Row 2, thermocouples at 16 cm (115°), 254 cm (351°), and 321 cm (270°) above bottom of heated length.			164, 457 165, 458 166, 459	
THV*D3+109	Heater Column D, Row 3, thermocouple at 109 cm (217°) above bottom of heated length.			167, 460	
THV*D4+179	Heater at Column D, Row 4, thermocouple at 179 cm (26°), above bottom of heated length.			168, 461	
Low Power Bus Heaters	Sixteen rods on periphery of core bundle.	0 to 1533 K	0 to 1580 K		
THV*A1+115	Heater at Column A, Row 1, thermocouple at 115 cm (126°) above bottom of heated length.			169	Failed during S-SF-5
THV*A2+353	Heater at Column A, Row 2, thermocouple at 353 cm (180°) above bottom of heated length.			170, 462	

Table 5. (continued)

Measurement	Location and Comments[a]	Data Acquisition Range[a]		Figure[a]	Measurement Comments[b]
		Detector	System		
CORE HEATER CLADDING TEMPERATURE (continued)					
Low Power Bus Heaters (continued)					
TVH*A3+76 THV*A3+157 THV*A3+208 THV*A3+228 THV*A3+291	Heater at Column A, Row 3, thermocouples at 76 cm (232°), 157 cm (18°), 208 cm (121°), 228 cm (174°), and 291 cm (270°) from bottom of heated length.			171, 463 172, 464 173, 465 174, 466 175, 467	
THV*B1+183 THV*B1+253	Heater at Column B, Row 1, thermocouples at 183 cm (171°) and 253 cm (1°) above bottom of heated length.			176, 468 177, 469	
THV*C1+79 THV*C1+211 THV*C1+292	Heater at Column C, Row 1, thermocouples at 79 cm (291°) 211 cm (212°) and 292 cm (0°) above bottom of heated length.			178, 470 179, 471 180, 472	
THV*C5+133 THV*C5+228	Heater at Column C, Row 5, thermocouples at 133 cm (180°) and 228 cm (70°) above bottom of heated length.			181, 473 182, 474	
THV*D1+131	Heater at Column D, Row 1, thermocouple at 131 cm (60°) above bottom of heated length.			183, 475	
THV*E2+109 THV*E2+181	Heater at Column E, Row 2, thermocouples at 109 cm (117°) and 181 cm (67°) above bottom of heated length.			184, 476 185, 477	
THV*E3+211	Heater at Column E, Row 3, thermocouple at 211 cm (45°) above bottom of heated length.			186, 478	
THV*E5+227	Heater at Column E, Row 5, thermocouple at 227 cm (45°) above bottom of heated length.			187, 479	
PRESSURE					
Intact Loop					
PI*1	Hot leg, Spool 1, 60 cm from vessel center.	0 to 17.24 MPa	0 to 21.96 MPa	188, 480	
Broken Loop					
PB*50	Hot leg, Spool 50, 74 cm from vessel center.	0 to 17.24 MPa	0 to 21.89 MPa	189, 481	
PB*79	Cold leg, Spool 79, 96 cm from downcomer center.	0 to 17.24 MPa	0 to 21.72 MPa	190, 482	
Vessel					
PV*UP-13	In core vessel upper plenum, 13 cm below cold leg centerline.	0 to 17.24 MPa	0 to 21.64 MPa	191, 483	
PV*UH+421	In core vessel upper head, 421 cm above cold leg centerline.	0 to 17.24 MPa	0 to 20.26 MPa	192, 484	
Intact Loop Steam Generator	Secondary side.				
PIS+1117	In steam dome, 1117 cm above top of tube sheet.	0 to 6.90 MPa	0 to 8.722 MPa	193, 485	
Broken Loop Steam Generator	Secondary side.				
PBS+1117	In steam dome, 1117 cm above top of tube sheet.	0 to 6.90 MPa	0 to 8.304 MPa	194, 486	
Pressurizer					
P*PRZ+158	In pressurizer steam dome, 158 cm above exit to surge line.	0 to 17.24 MPa	0 to 22.84 MPa 0 to 20.66 MPa	195, 487	

Table 5. (continued)

		Data Acquisition Range[a]			
Measurement	Location and Comments[a]	Detector	System	Figure[a]	Measurement Comments[b]
PRESSURE (continued)					
Intact Loop Steam Generator	Steam exhaust.				
PSC*IGSTM	In steam discharge line, at flow orifice.	0 to 17.24 MPa	0 to 20.69 MPa	196, 488	
Broken Loop Steam Generator	Steam exhaust.				
PSC*BGSTM	In steam discharge line, at flow orifice.	0 to 17.24 MPa	0 to 20.03 MPa	197, 489	
Condensate System					
PSC*BGCON	Broken loop effluent downstream of break valve at entrance to condensing coils.	0 to 3.45 MPa	0 to 3.44 MPa	198, 490	
Cooling Water					
PIC*SRPR	In supply line at entrance to condensing coils.	0 to 0.69 MPa	0 to 0.688 MPa	199, 491	
DIFFERENTIAL PRESSURE	Elevation difference between transducer taps is zero and cells read zero when full cold, at no flow, unless specified otherwise. Cell positive (high pressure) side is plumbed to the first tap designated by the measurement alphanumeric name.				
Intact Loop					
D-V13A*15	Vessel upper plenum, 13 cm (0") below cold leg centerline, to hot leg, Spool 5, 347 cm from vessel center. Spool 5 tap is 96 cm above upper plenum tap.	±124.4 kPa	±168.3 kPa	492	Failed during S-SF-4
DPI*5*9	Hot leg, Spool 5, 347 cm from vessel center, to cold leg, Spool 9, 1030 cm from downcomer center across the intact loop steam generator primary tubes. Spool 9 tap is 16 cm above Spool 5 tap.	±344.75 kPa	±342.4 kPa	200, 493	
DPI*9*14	Cold leg, Spool 9, 1030 cm from downcomer center, to cold leg, Spool 14, 655 cm from downcomer center. Spool 9 tap is 355 cm above Spool 14 tap.	±344.75 kPa	±345.2 kPa	201, 494	
DPI*14*18	Cold leg, Spool 14, 655 cm from downcomer center, to cold leg, Spool 18, 325 cm from downcomer center. Spool 18 tap is 210 cm above Spool 14 tap.	±74.61 kPa	±102.0 kPa	202, 495	
DPI*21*18	Cold leg, Spool 21, Tap B, 127 cm from downcomer center to cold leg, Spool 18, Tap B, 325 cm from downcomer center, across intact loop pump. Spool 21 tap is 25 cm above Spool 18 tap.	±689.5 kPa	±690.1 kPa	203, 496	
D*121+VD29	Cold leg, Spool 21, 127 cm from downcomer center to vessel downcomer, 29 cm above cold leg centerline. Vessel downcomer tap is 29 cm above Spool 21 tap.	±24.87 kPa	±33.73 kPa	204, 497	
Broken Loop					
D-V13A*B57	Vessel upper plenum, 13 cm (0") below cold leg centerline, to hot leg, Spool 57, 306 cm from vessel center. Spool 57 tap is 93 cm above upper plenum tap.	±74.61 kPa	±99.98 kPa	205, 498	
DPB*57*62	Hot leg, Spool 57, 306 cm from vessel center, to cold leg, Spool 62, 947 cm from downcomer center, across broken loop steam generator primary tubes. Spool 62 tap is 9 cm above Spool 57 tap.	±689.5 kPa	±689.1 kPa	206, 499	

Table 5. (continued)

Measurement	Location and Comments[a]	Data Acquisition Range[a]		Figure[a]	Measurement Comments[b]
		Detector	System		
DIFFERENTIAL PRESSURE (continued)					
Broken Loop (continued)					
DPB*62*65	Cold leg, Spool 62, 947 cm from downcomer center, to cold leg, Spool 65, 566 cm from downcomer center. Spool 62 tap is 370 cm above Spool 65 tap.	±74.61 kPa	±104.3 kPa	207, 500	
DPB*65*73	Cold leg, Spool 65, 566 cm from downcomer center, to cold leg, Spool 73, 341 cm from downcomer center. Spool 73 tap is 233 cm above Spool 65 tap.	±74.61 kPa	±101.3 kPa	208, 501	
DPB*74*73	Cold leg, Spool 74, Tap B, 202 cm from downcomer center, to cold leg, Spool 73, 341 cm from downcomer center, across broken loop pump. Spool 74 tap is 70 cm above Spool 73 tap.	±1379 kPa	±1379 kPa	209, 502	
D*B74+VD29	Cold leg, Spool 74, 202 cm from downcomer center, to vessel downcomer, 29 cm above cold leg centerline. Vessel downcomer tap is 29 cm above Spool 74 tap.	±124.35 kPa	±170.3 kPa	210, 503	
Vessel					
DVD+29+160	Vessel downcomer, 29 cm above cold leg centerline, to vessel upper head, 160 cm above cold leg centerline, across the downcomer to upper head bypass line. Upper head tap is 131 cm above downcomer tap.	±344.75 kPa	±344.8 kPa	211, 504	
Intact Loop Steam Generator	Secondary side.				
DPSC*IGFDW	Across flow orifice in feedwater supply line.	±198.96 kPa	±348.16 kPa	212, 505	
DPSC*IGSTM	Across flow orifice in steam exhaust line.	±198.96 kPa	±348.16 kPa	213	Test S-SF-4 only
Broken Loop Steam Generator	Secondary side.				
DPSC*BGFDW	Across flow orifice in feedwater supply line.	±124.35 kPa	±217.61 kPa	214, 506	
DPSC*BGSTM	Across flow orifice in steam exhaust line.	±138.53 kPa	±242.47 kPa	215	Test S-SF-4 only
Pressurizer					
DP*PRZ*13C	In surge line, from 25 cm above pressurizer outlet, to surge line inlet, to intact loop hot leg, Spool 3, Port C. Pressurizer tap is 157 cm above Spool 3 tap.	±3447.5 kPa	±3445. kPa	216, 507	
Steam Line Break Assembly					
DPSC*SLB1	From broken loop steam generator steam dome, Port D (1117 cm), to upstream of break orifice.	±344.7 kPa	±344.8 kPa	217, 508	
DPSC*SLB2	Across broken loop break orifice.	±6895 kPa	±9169 kPa	218, 509	
DPSC*SLB3	From intact loop steam generator steam dome, Port D (1117 cm), to upsteam of break orifice.	±344.7 kPa	±344.9 kPa	219, 510	
DPSC'..	Across intact loop break orifice.	±6895 kPa	±9276 kPa	220, 511	
DPIC*SBPB	Across flow orifice in cooling water line to condensate coils.	±74.61 kPa	±100.7 kPa	221, 512	

Table 5. (continued)

Measurement	Location and Comments[a]	Data Acquisition Range[a] Detector	 System	Figure[c]	Measurement Comments[b]
LIQUID LEVEL	Transducers read zero when system is full cold, at no flow, unless specified otherwise. Cell positive (high pressure) side is plumbed to the first tap designated by the measurement alphanumeric name.				
Vessel					
LVD+29-578	Vessel downcomer, 29 cm above cold leg centerline, to vessel lower plenum, 578 cm below cold leg centerline. Tap elevation difference is 607 cm.	±344.75 kPa	±343.2 kPa	222, 513	
LV-13M-578	Vessel upper plenum, 13 cm (180°) below cold leg centerline, to vessel lower plenum, 578 cm below cold leg centerline. Tap elevation difference is 565 cm.	±124.35 kPa	±176.1 kPa	223, 514	
LV-105-501	Vessel core housing, 105 cm below cold leg centerline, to vessel lower plenum, 501 cm below cold leg centerline. Tap elevation difference is 396 cm.	±74.61 kPa	±101.3 kPa	224, 515	
LV+160-13M	Vessel upper head, 160 cm above cold leg centerline, to vessel upper plenum, 13 cm (180°) below cold leg centerline. Tap elevation difference is 173 cm.	±24.87 kPa	±33.09 kPa	225, 516	
LV+421+160	Vessel upper head, 421 cm to 160 cm above cold leg centerline. Tap elevation difference is 261 cm.	±24.87 kPa	±33.60 kPa	226, 517	
Intact Loop Steam Generator	Level of primary fluid inside vertical U-tubes.				
LIP838-57E	In short tube, hot side of apex, at 838 cm above top of tube sheet, to entrance plenum, 57 cm below top of tube sheet. Tap elevation difference is 895 cm.	±198.96 kPa	±266 kPa	227, 518	
LIP905-57E	In medium tube, hot side of apex, at 905 cm above top of tube sheet, to entrance plenum, 57 cm below top of tube sheet. Tap elevation difference is 962 cm.	±124.35 kPa	±167.4 kPa	228, 519	
LIP971-57E	In long tube, hot side of apex, at 971 cm above top of tube sheet, to entrance plenum, 57 cm below top of tube sheet. Tap elevation difference is 1028 cm.	±124.35 kPa	±170.2 kPa	229, 520	
Intact Loop Steam Generator	Levels of secondary fluid in downcomer and riser sections.				
LIS1117+50	From steam dome at 1117 cm, to downcomer at 50 cm, above top of tube sheet.	±344.75 kPa	±344.2 kPa	230, 521	
LI1117S825	From steam dome at 1117 cm, to downcomer at 825 cm, above top of tube sheet.	±74.61 kPa	±115.2 kPa	231, 522	
LI1117S836	From steam dome at 1117 cm, to riser at 836 cm, above top of tube sheet.	±74.61 kPa	±105.9 kPa	232, 523	
LIS836+463	From riser at 836 cm, to riser at 463 cm, above top of tube sheet.	±74.61 kPa	±100.1 kPa	233, 524	
LIS+463+89	From riser at 463 cm, to riser at 89 cm, above top of tube sheet.	±74.61 kPa	±102.3 kPa	234, 525	
LIS+89+50	From riser at 89 cm, to downcomer at 50 cm, above top of tube sheet. Across flow shutter.	±12.43 kPa	±18.51 kPa	235, 526	
Broken Loop Steam Generator	Level of primary fluid inside vertical U-tubes.				
LBP838-57E	In short tube, hot side of apex, at 838 cm above top of tube sheet, to entrance plenum, 57 cm below top of tube sheet. Tap elevation difference is 895 cm.	±124.35 kPa	±170.3 kPa	236, 527	

Table 5. (continued)

Measurement	Location and Comments[a]	Data Acquisition Range[a]		Figure[a]	Measurement Comments[b]
		Detector	System		
LIQUID LEVEL (continued)					
Broken Loop Steam Generator (continued)	Levels of secondary fluid in downcomer and riser sections.				
LBS1117+50	From steam dome at 1117 cm, to downcomer at 50 cm, above top of tube sheet.	±124.35 kPa	±169.8 kPa	237, 528	
LB1117G825	From steam dome at 1117 cm to downcomer at 825 cm, above top of tube sheet.	±124.35 kPa	±168.8 kPa	238, 529	
LB1117B836	From steam dome at 1117 cm, to riser at 836 cm, above top of tube sheet.	±74.61 kPa	±107.6 kPa	239, 530	
LBS836+463	From riser at 836 cm, to riser at 463 cm, above top of tube sheet.	±124.35 kPa	±170.2 kPa	240, 531	
LBS+825+50	From downcomer at 825 cm, to downcomer at 50 cm, above top of tube sheet.	±124.35 kPa	±168.2 kPa	241, 532	
LBS+463+89	From riser at 463 cm, to riser at 89 cm, above top of tube sheet.	±74.61 kPa	±101.1 kPa	242, 533	
LBS+89+50	From riser at 89 cm, to downcomer at 50 cm, above top of tube sheet. Across flow shutter.	±24.87 kPa	±34.79 kPa	243, 534	
Pressurizer					
LPRZ146+25	From steam dome at 146 cm, to bottom at 25 cm, above pressurizer outlet to surge line.	±12.43 kPa	±16.73 kPa	244, 535	Trend data only
Condensate Tanks	Cells zeroed with tanks empty. Tanks are 15.41-cm ID.				
L1CT23+462	Level in Condensate Tank 1, from 23 cm to 462 cm above the tank bottom drain line.	±68.95 kPa	±92.35 kPa	245, 536	
L2CT23+462	Level in Condensate Tank 2, from 23 cm to 462 cm above the tank bottom drain line.	±68.95 kPa	±92.76 kPa	246, 537	
Feedwater Tank					
LSCT488+97	Level in feedwater tank, from 97 cm to 488 cm above tank inlet flange.	±37.57 kPa	±37.6 kPa	247, 538	
VOLUMETRIC FLOW RATE	Turbine flowmeter, bidirectional.				
Intact Loop	Primary coolant.				
QI*1	Hot leg at Spool 1, 38 cm from vessel center.	±1.9 to 19 L/s	±14 L/s	248, 539	
QI*15	Cold leg at Spool 15, 629 cm from downcomer center.	±5.6 to 56 L/s	±14 L/s	249	Failed during S-SF-5
QI*21	Cold leg at Spool 21, 151 cm from downcomer center.	±1.9 to 19 L/s	±14 L/s	250, 540	
Broken Loop	Primary coolant.				
QB*50	Hot leg at Spool 50, 100 cm from vessel center.	±1.3 to 12.6 L/s	±6.0 L/s	251	Failed during S-SF-5
QB*57	Hot leg at Spool 57, 200 cm from vessel center.	±1.3 to 12.7 L/s	±6.0 L/s	252	Failed during S-SF-5
QB*73	Cold leg at Spool 73, 305 cm from downcomer center.	±1.25 to 12.5 L/s	±6.0 L/s	541	Test S-SF-5 only
QB*79	Cold leg at Spool 79, 116 cm from downcomer center.	±1.25 to 12.5 L/s	±5.0 L/s	253, 542	
Vessel	Primary coolant.				
QV*DC-423	Vessel downcomer, 423 cm below cold leg centerline.	±1.5 to 15 L/s	±19 L/s	254, 543	

Table 5. (continued)

		Data Acquisition Range[a]			
Measurement	Location and Comments[a]	Detector	System	Figure[a]	Measurement Comments[b]
VOLUMETRIC FLOW RATE (continued)					
Vessel (continued)					
QV*GT+321	In vessel guide tube at 321 cm above the cold leg centerline.	±0.035 to 0.35 L/s	±2.5 L/s	255, 544	
QV*BYPASS	In vessel downcomer to upper head bypass line.	±0.07 to 0.7 L/s	±3.0 L/s	256, 545	
Pressurizer	Primary coolant.				
Q*PRZ-30	In pressurizer surge line, 30 cm from pressurizer exit. Positive reading indicates an outsurge from the pressurizer.	±0.32 to 3.2 L/s	±3.0 L/s	257, 546	
Auxiliary Feedwater	Emergency secondary coolant.				
QSC*ICAXFW	In discharge line of intact loop steam generator, auxiliary feedwater supply pump.	±0.0064 to 0.064 L/s	±0.0624 L/s	258, 547	
QSC*BGAXFW	In discharge line of broken loop steam generator, auxiliary feedwater supply pump.	±0.0051 to 0.051 L/s	±0.0503 L/s	259, 548	
QCI*ILHPIS	In line leading from high pressure injection pump for intact loop.	±0.0157 to 0.157 L/s	±0.30 L/s	260, 549	
DENSITY	Gamma attenuation technique.				
Intact Loop	Primary coolant.				
RI*5M	Horizontal beam through the middle of hot leg vertical Spool 5 at entrance to steam generator.	1.6 to 1600 kg/m^3	0 to 1600 kg/m^3	261, 550	
Broken Loop	Primary coolant.				
RB*57M	Horizontal beam through the middle of hot leg vertical Spool 57 at entrance to steam generator.	1.6 to 1600 kg/m^3	0 to 1600 kg/m^3	262, 551	
Vessel	Primary coolant.	1.6 to 1600 kg/m^3	0 to 1600 kg/m^3		
RV*DC-72	Vessel downcomer, 72 cm below cold leg centerline.	1.6 to 1600 kg/m^3	0 to 1600 kg/m^3	263, 552	
RV*DC-260	Vessel downcomer, 260 cm below cold leg centerline.	1.6 to 1600 kg/m^3	0 to 1600 kg/m^3	264, 553	
RV*DC-456	Vessel downcomer, 456 cm below cold leg centerline.	1.6 to 1600 kg/m^3	0 to 1600 kg/m^3	265, 554	
RV*AB-6	6 cm below bottom of core heated length, 502 cm below cold leg centerline, between heater rod Columns A and B.	1.6 to 1600 kg/m^3	0 to 1600 kg/m^3	266, 555	
RV*23+13	13 cm above bottom of core heated length, 483 cm below cold leg centerline, between heater rod Rows 2 and 3.	1.6 to 1600 kg/m^3	0 to 1600 kg/m^3	267, 556	
RV*23+113	113 cm above bottom of core heated length, 383 cm below cold leg centerline, between heater rod Rows 2 and 3.	1.6 to 1600 kg/m^3	0 to 1600 kg/m^3	268, 557	
RV*AB+173	173 cm above bottom of core heated length, 323 cm below cold leg centerline, between heater rod Columns A and B.	1.6 to 1600 kg/m^3	0 to 1600 kg/m^3	269, 558	
RV*23+183	183 cm above bottom of core heated length, 313 cm below cold leg centerline, between heater rod Rows 2 and 3.	1.6 to 1600 kg/m^3	0 to 1600 kg/m^3	270, 559	
RV*23+253	253 cm above bottom of core heated length, 243 cm below cold leg centerline, between heater rod Rows 2 and 3.	1.6 to 1600 kg/m^3	0 to 1600 kg/m^3	271, 560	

Table 5. (continued)

Measurement	Location and Comments[a]	Data Acquisition Range[a]		Figure[a]	Measurement Comments[b]
		Detector	System		
DENSITY (continued)					
Vessel (continued)					
RV*23+342	342 cm above bottom of core heated length, 153 cm below cold leg centerline, between heater rod Rows 2 and 3.			272, 561	
RV*UP-11	In vessel at base of core flow instrument housing, 11 cm below cold leg centerline.			273, 562	
RV*UH+173	In vessel upper head, 173 cm above cold leg centerline.			274, 563	
RV*UH+339	In vessel upper head, 339 cm above cold leg centerline.			275, 564	
CORE POWER CHARACTERISTICS					
High Power Bus	Nine rods in center of core bundle.				
IV*HIPWBUS	Total current from high power bus power supplies.	0 to 10000 A	0 to 5000 A	276, 565	
EV*HIPWBUS	Total voltage from high power bus power supplies.	0 to 400 V	0 to 499.75 V	277, 566	
Low Power Bus	Sixteen rods on periphery of core bundle.				
IV*LOPWBUS	Total current from low power bus power supplies.	0 to 10,000 A	0 to 5000 A	278, 567	
EV*LOPWBUS	Total voltage from low power bus power supplies.	0 to 400 V	0 to 499.75 V	279, 568	
Calculated Power	Posttest calculations performed on recorded core voltage and current.				
KWH*HIC	Total power on rods of the high power bus.			280, 569	
KWH*LOC	Total power on rods of the low power bus.			281, 570	
KWH*TOTC	Total power on all core rods.			282, 571	
Power Supply 357	Core vessel and downcomer.				
IH*UNIT357	Heater current.	0 to 400 A	0 to 300 A	283, 572	
EH*UNIT357	Heater voltage.	0 to 200 V	0 to 250 V	284, 573	
KW*EH*VESS	Calculated power.			285, 574	
Power Supply 358	Intact loop pump suction (Spools 13 through 16).				
IH*UNIT358	Heater current.	0 to 500 A	0 to 400 A	286, 575	
EH*UNIT358	Heater voltage.	0 to 200 V	0 to 250 V	287, 576	
KW*EH*ILPS	Calculated power.			288, 577	
Power Supply 359	Broken loop pump suction (Spools 64, 65, 72, 73).				
IH*UNIT359	Heater current.	0 to 150 A	0 to 200 A	289, 578	
EH*UNIT359	Heater voltage.	0 to 200 V	0 to 250 V	290, 579	
KW*EH*BLPS	Calculated power.			291, 580	
Power Supply 360	Intact and broken loop cold legs. (Spools 18, 21, 22, 74, 76, 79).				
IH*UNIT360	Heater current.	0 to 100 A	0 to 200 A	292, 581	
EH*UNIT360	Heater voltage.	0 to 200 V	0 to 250	293, 582	
KW*EH*IBCL	Calculated power.			294, 583	

Table 5. (continued)

Measurement	Location and Comments[a]	Data Acquisition Range[a]		Figure[a]	Measurement Comments[b]
		Detector	System		
CORE POWER CHARACTERISTICS (continued)					
Power Supply 361	Intact and broken loop hot legs (Spool 1 through 12, and 50 through 64.)				
IH*UNIT361	Heater current.	0 to 200 A	0 to 150 A	295, 584	
EH*UNIT361	Heater voltage.	0 to 200 V	0 to 250 V	296, 585	
KW*EH*IBHL	Calculated power.			297, 586	
PUMP CHARACTERISTICS	Primary coolant pumps.				
Intact Loop					
II*PUMP	Pump motor current.	0 to 250 A	0 to 250 A	298, 587	
EI*PUMP	Pump motor voltage.	0 to 502 V	0 to 502 V	299, 588	
WI*PUMP	Pump shaft angular velocity.	0 to 3820 rad/s	0 to 400 rad/s	300, 589	
Broken Loop					
WB*PUMP	Pump shaft angular velocity.	0 to 2618 rad/s	0 to 2618 rad/s	301, 590	
KWB*PUMP	Pump motor power.	0 to 82 kW	0 to 20 kW	302, 591	Trend data only
VALVE POSITION	Steam position by linear potentiometers.				
Intact Loop	Secondary coolant valves.				
KSC*ICSTM	Steam exhaust valve.	0 to 10 V	±0 to 10 V	303, 592	Trend data only

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a. Statements at the beginning of a measurement category regarding location and comments, range, and figure apply to all subsequent measurements within the given category unless specified otherwise.

b. Detectors subjected to overrange conditions during portions of the test were capable of withstanding those conditions without change in operating or measuring characteristics when the physical conditions were again within the detector range.

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