

Proposed Challenge & End Point Concentrations for Respirator Canisters

Draft for Discussion

CBRN APR Test Challenge

Guidelines for determining test challenge concentrations:

1. $(REL) \times (Full\ Face\ APF) \times (Safety\ Factor)$
2. Set $APF = 50$
3. Set Safety Factor, $S.F. = 2.0$
4. Minimum Test Challenge = $3 \times (IDLH)$
5. Breakthru = $(REL) / 2$

Calculated Test Challenge

	REL	APF	S.F.	1. (REL) X (F.F.APF) X (SF)	IDLH	3(IDLH)	Test Conc. Initial	Brkthru Conc. Initial
Ammonia	25	50	2	2500	300	900	2500	12.5
Carbon Monoxide	35	50	2	3500	1200	3600	3600	17.5
Carbon Tetrachloride	2	50	2	200	200	600	600	1
Cyanogen Chloride	0.03	50	2	3	-----	-----	3	0.02
Cyclohexane	300	50	2	30000	1300	3900	30000	150
Formaldehyde	1.5	50	2	150	20	60	150	0.016
Hydrogen Cyanide	4.7	50	2	470	50	150	470	2.35
Hydrogen Sulfide	10	50	2	1000	100	300	1000	5
Nitrogen Dioxide	1	50	2	100	20	60	100	0.5
Phosgene	0.2	50	2	20	2	6	20	0.1
Phosphine	0.3	50	2	30	50	150	150	0.15
Sulfur Dioxide	2	50	2	200	100	300	300	1

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4. Minimum Test Challenge = 3 X (IDLH)
5. Breakthru = (REL) / 2

Calculated Test Challenge

	Test Conc. Initial	Test Conc. Draft	Bkthru Conc. Initial	Bkthru Conc. Draft
Ammonia	2500	2500	12.5	12.5
Carbon Monoxide	3600	3600	17.5	17.5
Carbon Tetrachloride	600	3000	1	5
Cyanogen Chloride	3	300	0.02	2
Cyclohexane	30000	3000	150	10
Formaldehyde	150	1000	0.016	1
Hydrogen Cyanide	470	940	2.35	4.7
Hydrogen Sulfide	1000	1000	5	5
Nitrogen Dioxide	100	200	0.5	1
Phosgene	20	250	0.1	1.25
Phosphine	150	1500	0.15	5
Sulfur Dioxide	300	1500	1	5

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1. $(REL) \times (\text{Full Face APF}) \times (\text{Safety Factor})$
2. Set APF= 50
3. Set Safety Factor, S.F. = 2.0
4. Minimum Test Challenge = $3 \times (\text{IDLH})$
5. Breakthru = $(REL) / 2$

	Calculated Test Challenge		Survey Tests	
	Test Conc. Draft	Bkthru Conc Draft	Test Conc.	Brkthru Conc
Ammonia	2500	12.5	2000	50
Carbon Monoxide	3600	17.5	Not Tested	Not Tested
Carbon Tetrachloride	3000	5	5000	5
Cyanogen Chloride	300	2	1590	1.98
Cyclohexane	3000	10	5000	10
Formaldehyde	1000	1	1000	1
Hydrogen Cyanide	940	4.7	5000	4.7
Hydrogen Sulfide	1000	5	5000	10
Nitrogen Dioxide	200	1	2500	1
Phosgene	250	1.25	4500	1.24
Phosphine	1500	5	1500	5
Sulfur Dioxide	1500	5	2000	5

Benchmark Study

Canister Survey of Existing “First Responder” Type Products



Draft for Discussion

Canister Description

- “First Responder” / Multi-gas Canisters
- All use 40 mm “NATO” threads
- All use P-100 or equivalent particulate filter



Canister Details

Canister Description	Carbon Type (Fill Volume)	Fill (ml)	Bed Depth (cm)	Bed Diameter (cm)	Linear Flow @ 64 l/m (cm/m)
Commerical First Responder	ASZM-T (178 ml)	178	2.1	10.5	0.67
Special Canister (Cr ⁺⁶)	ASC-1%T (248 ml)	248	2.6	11.0	0.67
Commerical First Responder	IMP (250 ml)	250	2.6	10.0	0.67
Commerical First Responder	IMP/2 (260 ml)	260	3.3	11.0	0.82
EN Multi-Gas Canister ABEK2Hg/St	IMP (Cr ⁺⁶) + Others (355 ml)	355	4	10.6	0.73



Testing Conditions

- Air Flow Rate = 64 l/m
- Temperature = 25 ± 3 °C
- Humidity Conditions
 - Dry = 25% Relative Humidity
 - Wet = 80% Relative Humidity

Challenge Gases/Vapors

- Ammonia (NH_3)
- Carbon Tetrachloride (CCl_4)
- Cyanogen Chloride (CNCl)
- Cyclohexane (C_6H_{12})
- Formaldehyde (HCHO)
- Hydrogen Cyanide (HCN)
- Hydrogen Sulfide (H_2S)
- Nitrogen Dioxide (NO_2)
- Phosgene (COCl_2)
- Phosphine (PH_3)
- Sulfur Dioxide (SO_2)



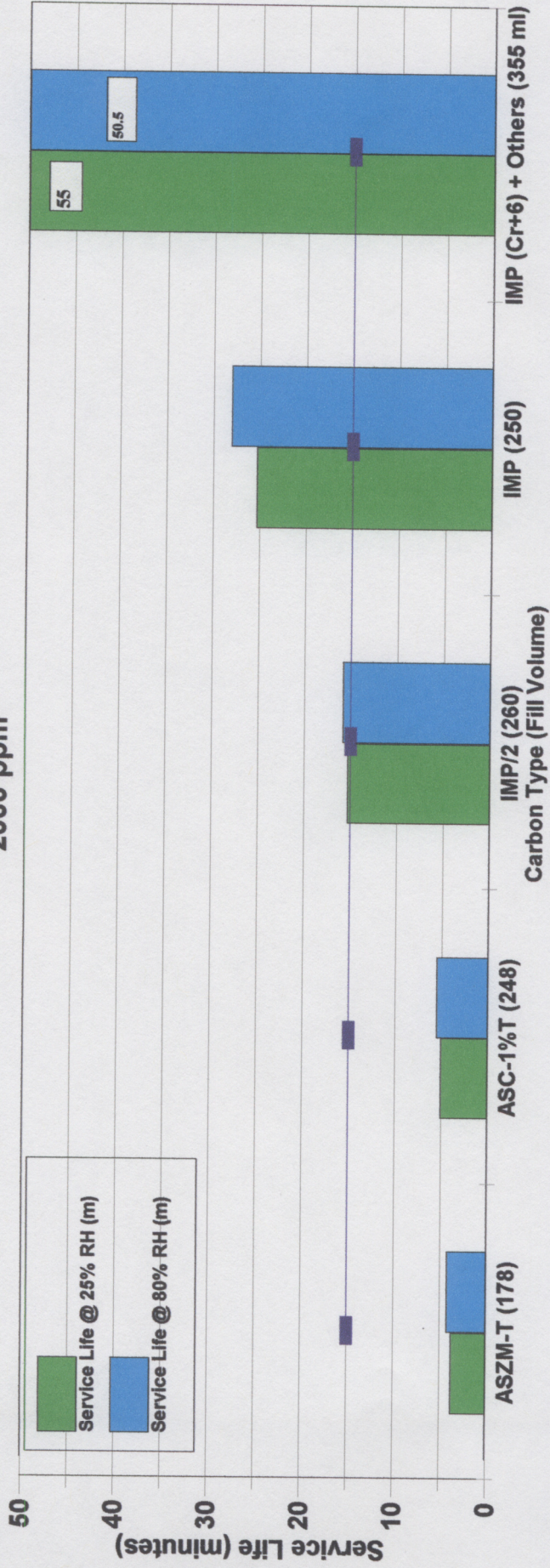
Challenge Gas/Vapor vs. Canisters



Draft for Discussion



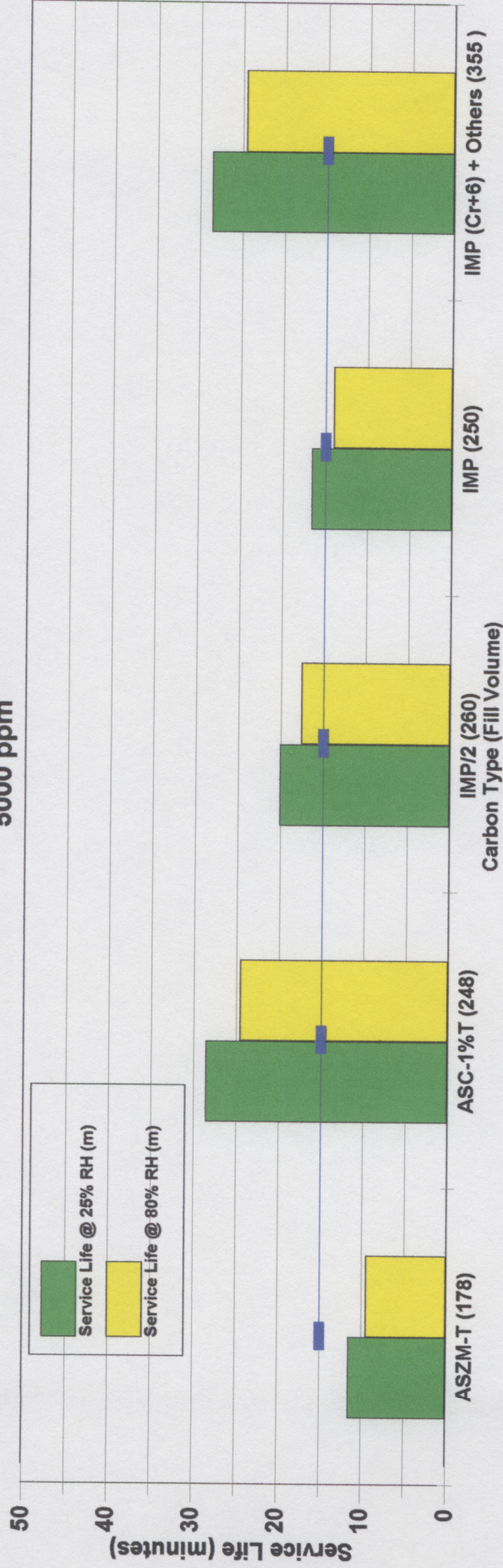
Ammonia 2000 ppm



Challenge Gas	Challenge Conc. (ppm)	End Pt. Conc. (ppm)	Draft CBRN Standard Challenge Conc. (ppm)	Draft CBRN Standard End Pt. Conc. (ppm)
Ammonia (NH ₃)	2000	50	2500	12.5



Carbon Tetrachloride 5000 ppm

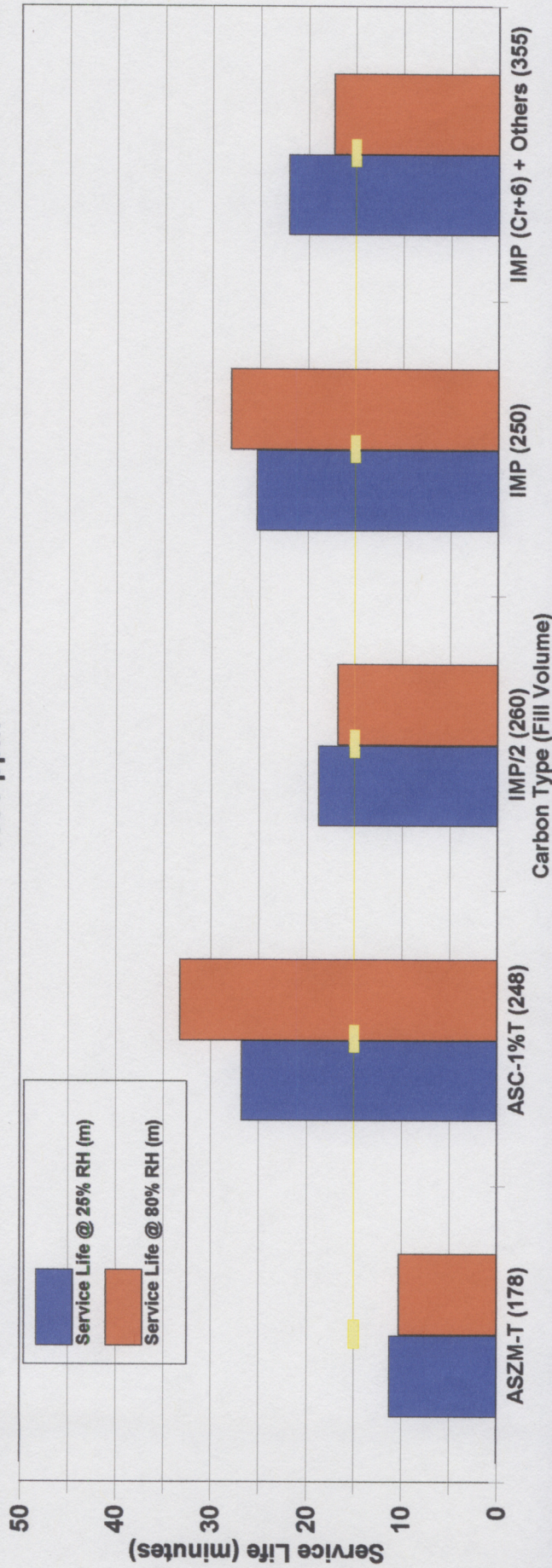


Challenge Gas	Challenge Conc. (ppm)	End Pt. Conc. (ppm)	Draft CBRN Standard Challenge Conc. (ppm)	Draft CBRN Standard End Pt. Conc. (ppm)
Carbon Tetrachloride (CCl4)	5000	5	3000	5



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Cyanogen Chloride 1590 ppm

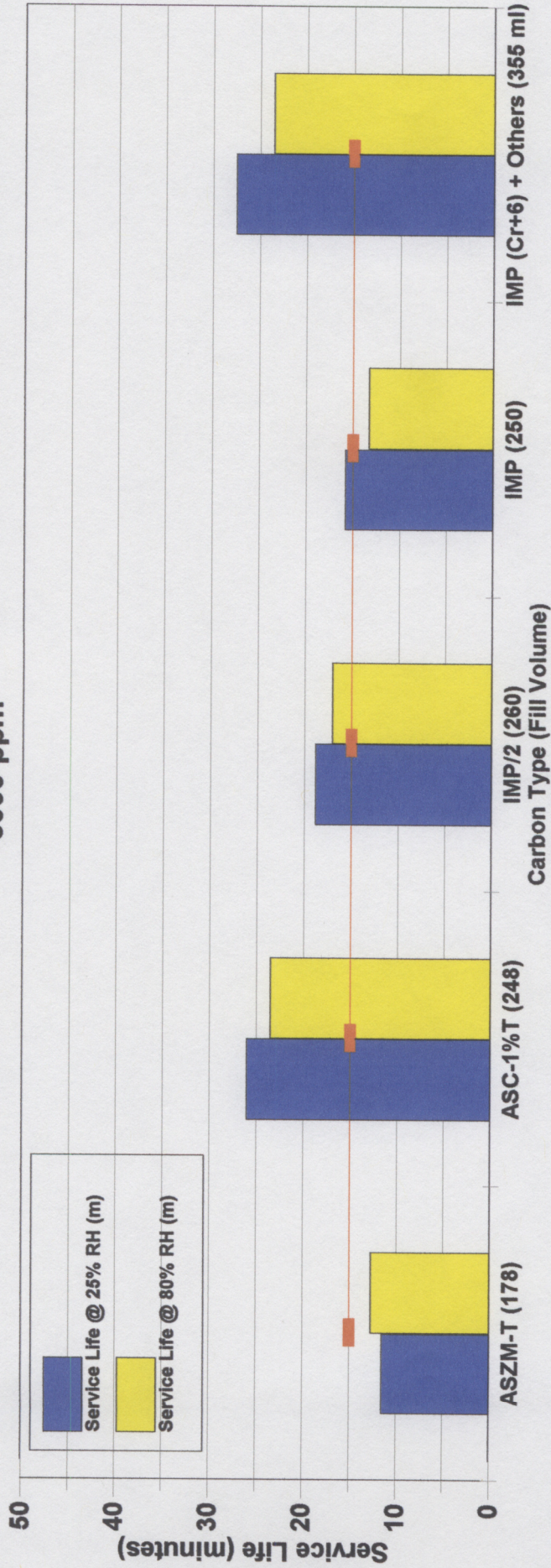


Challenge Gas	Challenge Conc. (ppm)	End Pt. Conc. (ppm)	Draft CBRN Standard Challenge Conc. (ppm)	Draft CBRN Standard End Pt. Conc. (ppm)
Cyanogen Chloride (CNCl)	1590	1.98	300	2



Draft for Discussion

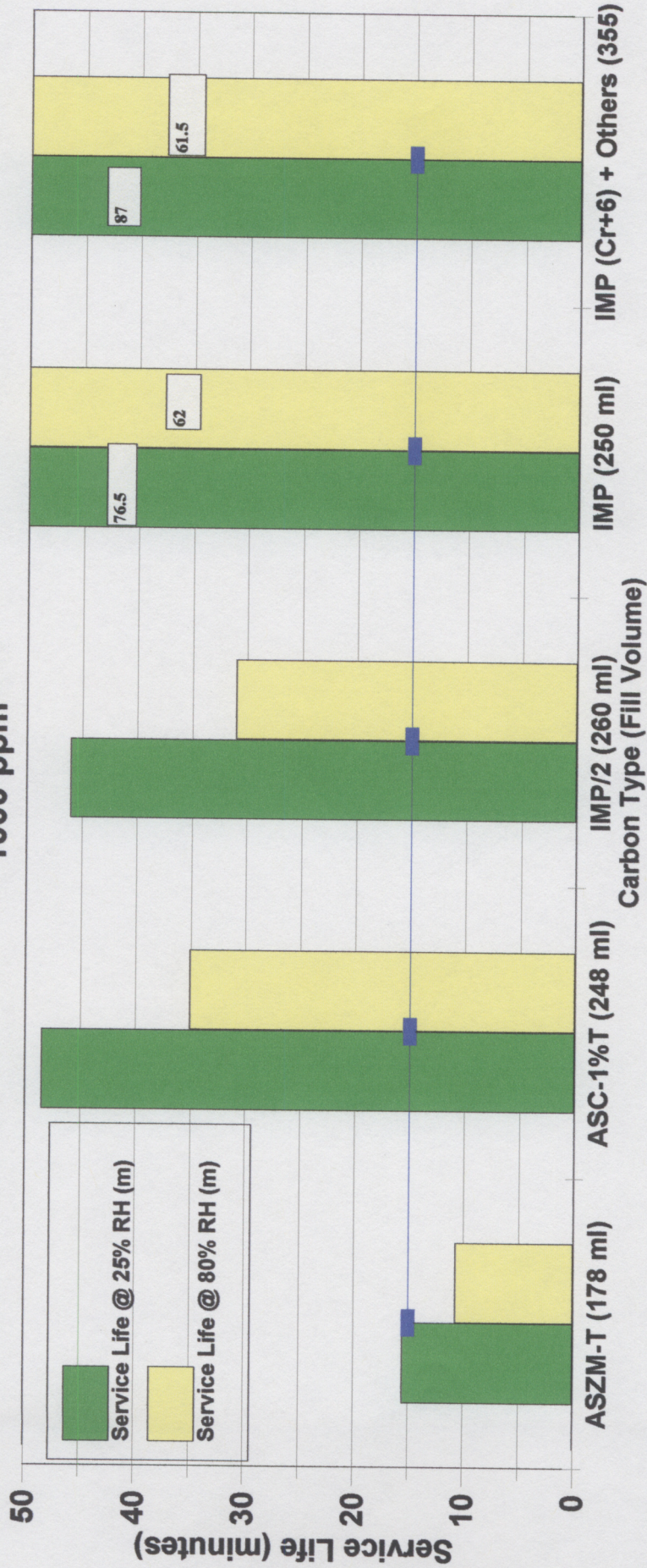
Cyclohexane 5000 ppm



Challenge Gas	Challenge Conc. (ppm)	End Pt. Conc. (ppm)	Draft CBRN Standard Challenge Conc. (ppm)	Draft CBRN Standard End Pt. Conc. (ppm)
Cyclohexane (C6H12)	5000	10	3000	10



Formaldehyde 1000 ppm



Challenge Gas	Challenge Conc. (ppm)	End Pt. Conc. (ppm)	Draft CBRN Standard Challenge Conc. (ppm)	Draft CBRN Standard End Pt. Conc. (ppm)
Formaldehyde (HCHO)	1000	1	1000	1



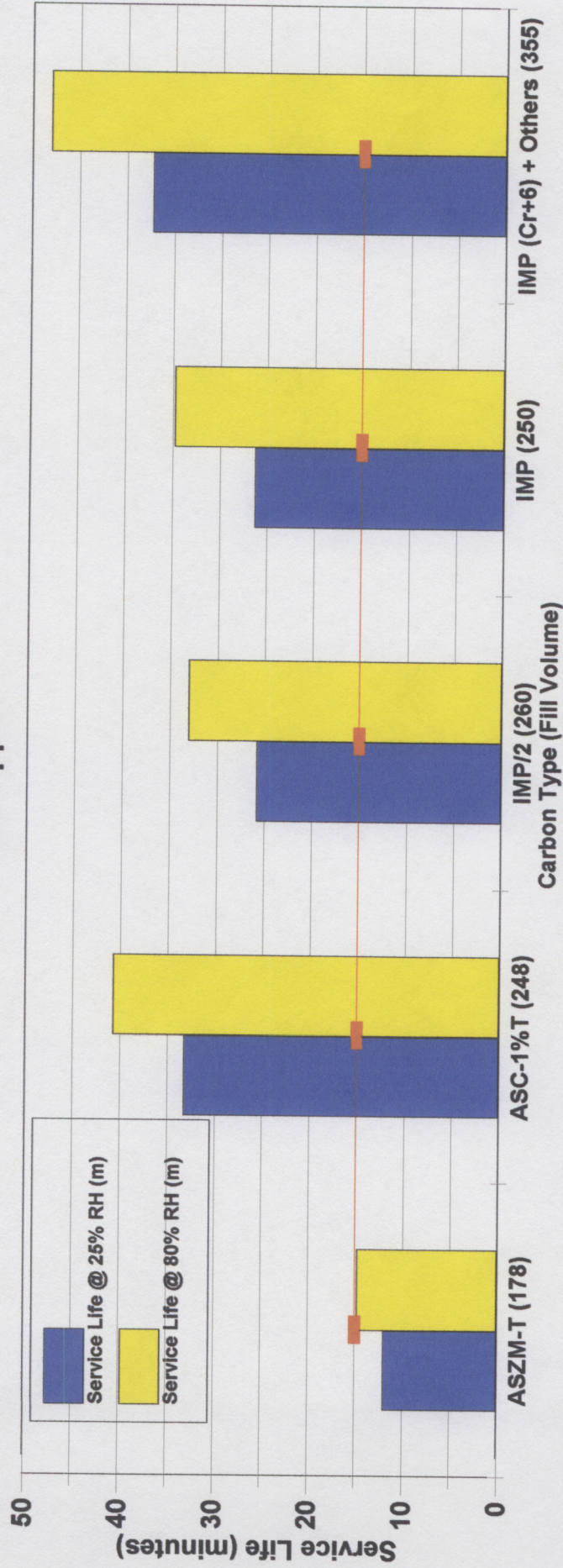
Draft for Discussion

Hydrogen Cyanide 5000 ppm



Challenge Gas	Challenge Conc. (ppm)	End Pt. Conc. (ppm)	Draft CBRN Standard Challenge Conc. (ppm)	Draft CBRN Standard End Pt. Conc. (ppm)
Hydrogen Cyanide (HCN)	5000	4.70	940	4.70

Hydrogen Sulfide 5000 ppm

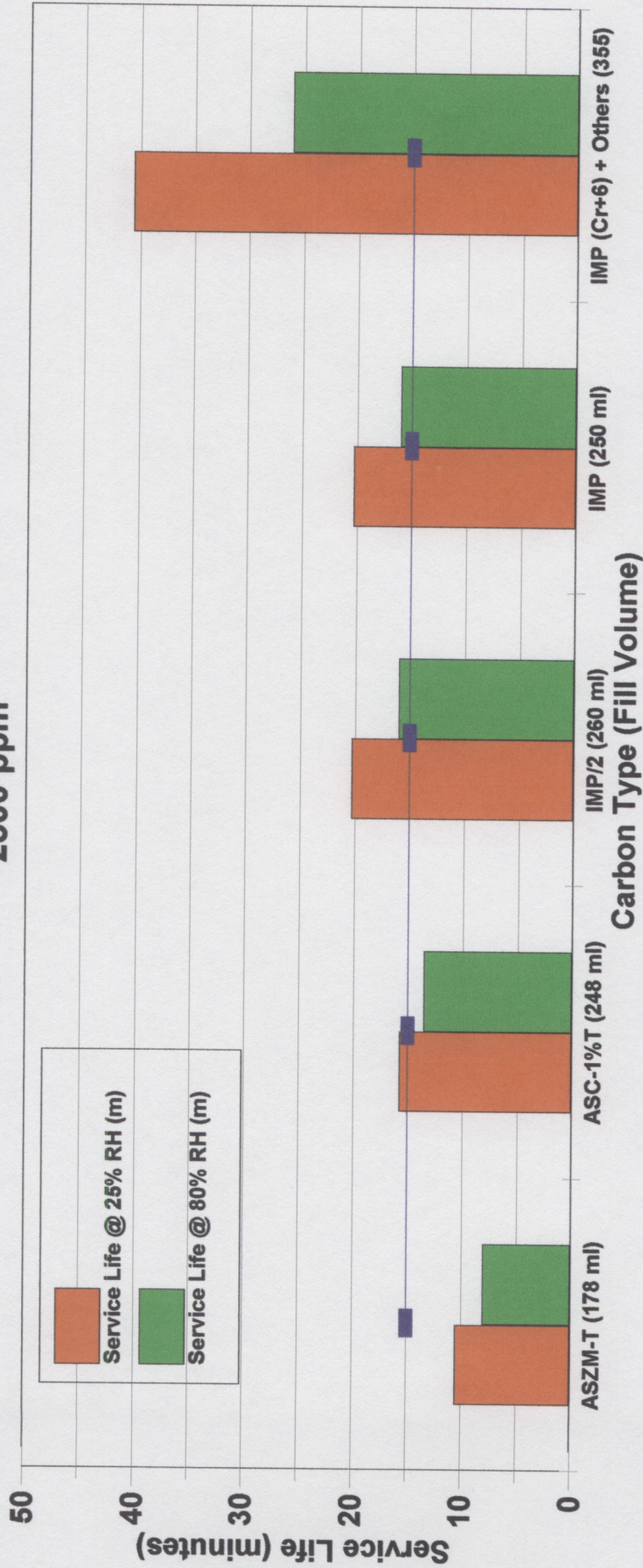


Challenge Gas	Challenge Conc. (ppm)	End Pt. Conc. (ppm)	Draft CBRN Standard Challenge Conc. (ppm)	Draft CBRN Standard End Pt. Conc. (ppm)
Hydrogen Sulfide (H ₂ S)	5000	10	1000	5



Draft for Discussion

Nitrogen Dioxide 2500 ppm

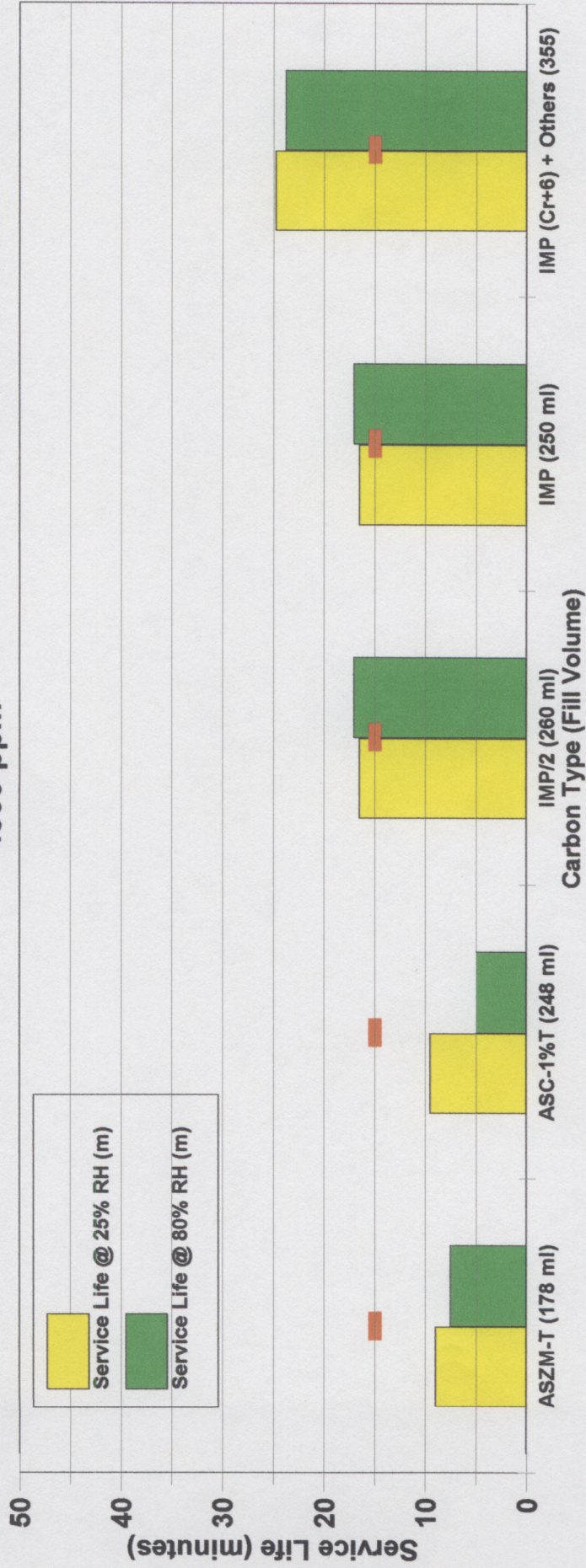


Challenge Gas	Challenge Conc. (ppm)	End Pt. Conc. (ppm)	Draft CBRN Standard Challenge Conc. (ppm)	Draft CBRN Standard End Pt. Conc. (ppm)
Nitrogen Dioxide (NO2)	2500	1	200	1



Draft for Discussion

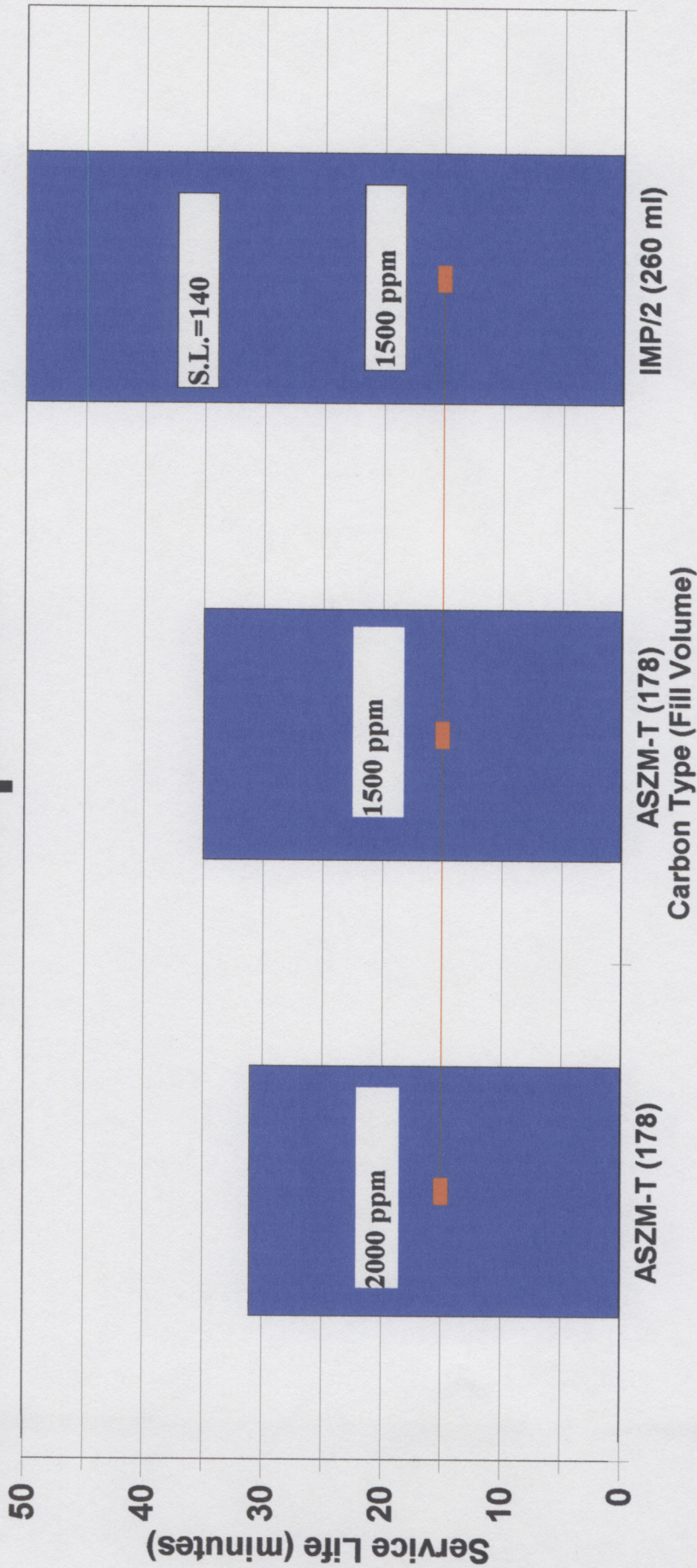
Phosgene 4500 ppm



Challenge Gas	Challenge Conc. (ppm)	End Pt. Conc. (ppm)	Draft CBRN Standard Challenge Conc. (ppm)	Draft CBRN Standard End Pt. Conc. (ppm)
Phosgene (COCl ₂)	4500	1.24	250	1.25



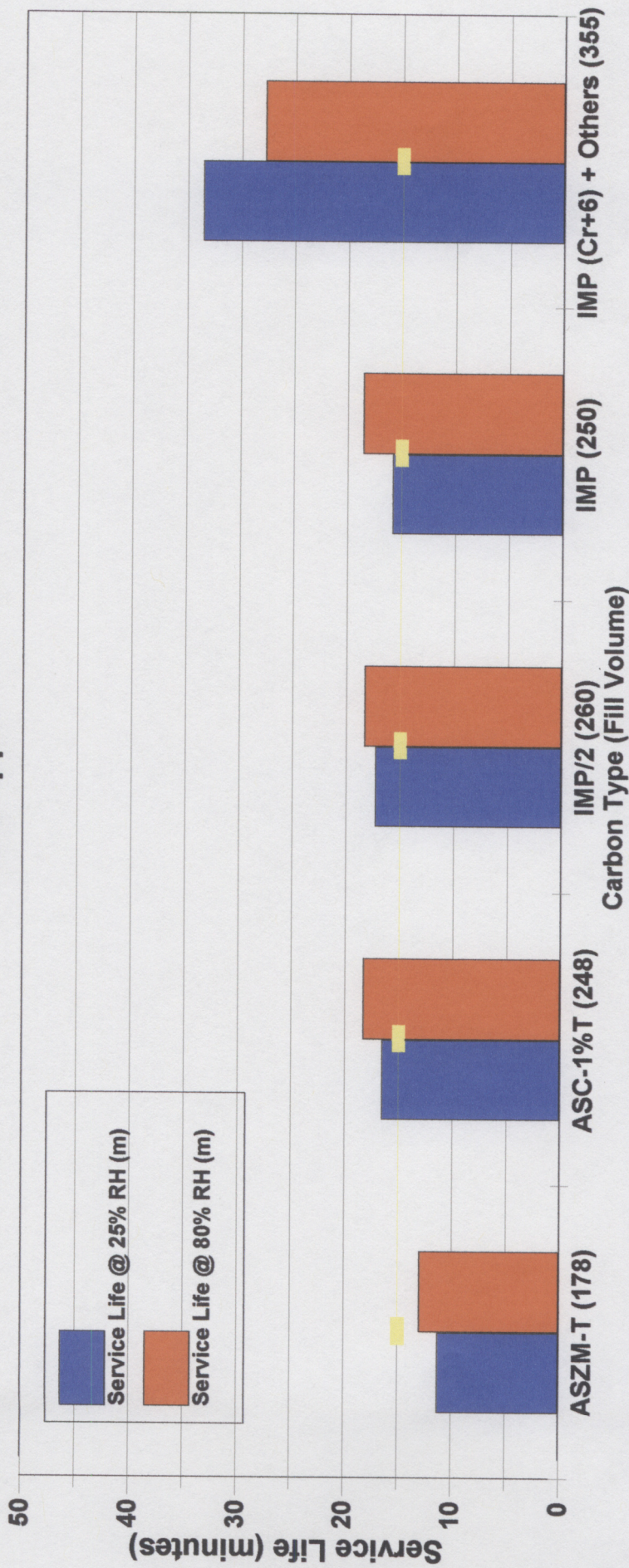
Phosphine



Challenge Gas	Challenge Conc. (ppm)	End Pt. Conc. (ppm)	Draft CBRN Challenge Conc. (ppm)	Draft CBRN Standard End Pt. Conc. (ppm)
Phosphine (PH3)	1500	5	1500	5
Phosphine (PH3)	2000	5	1500	5



Sulfur Dioxide 2000 ppm

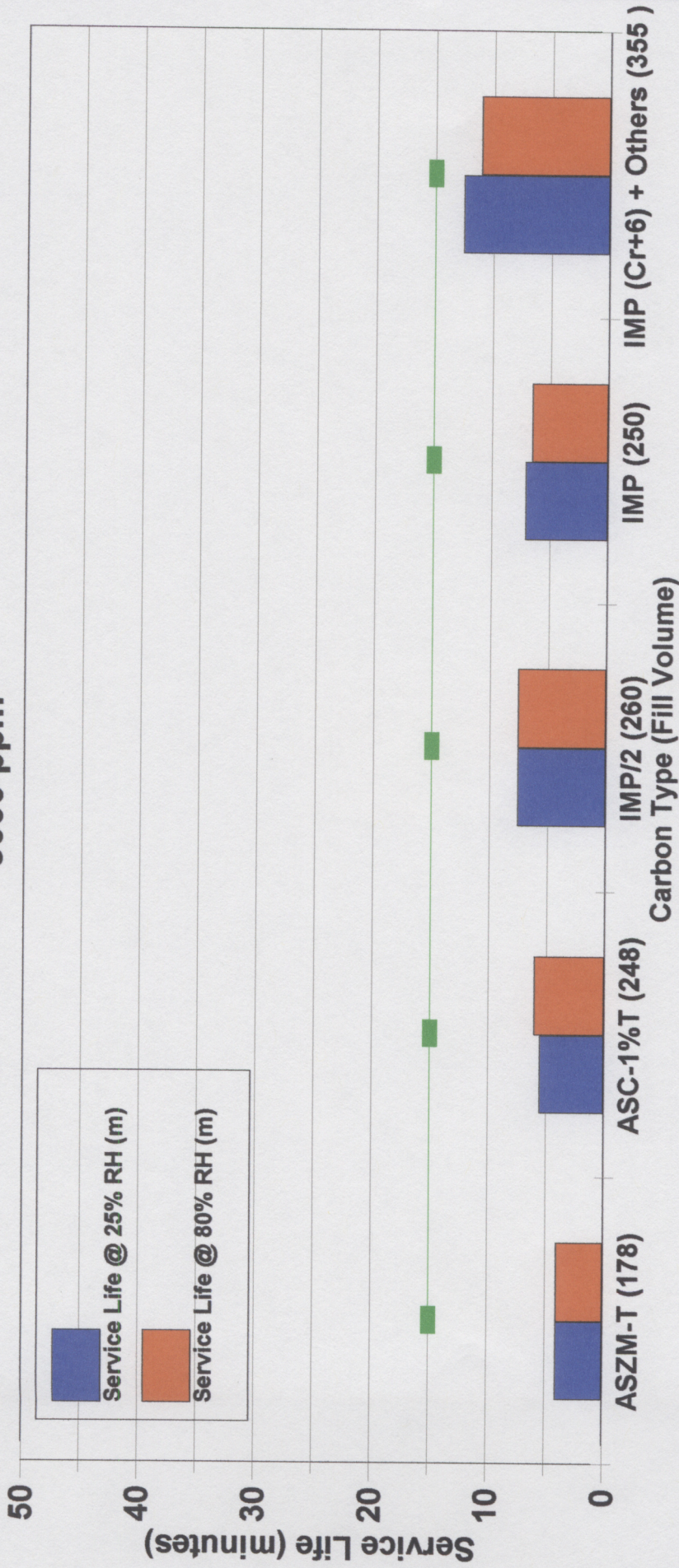


Challenge Gas	Challenge Conc. (ppm)	End Pt. Conc. (ppm)	Draft CBRN Standard Challenge Conc. (ppm)	Draft CBRN Standard End Pt. Conc. (ppm)
Sulfur Dioxide (SO ₂)	2000	5	1500	5



Draft for Discussion

Sulfur Dioxide 5000 ppm

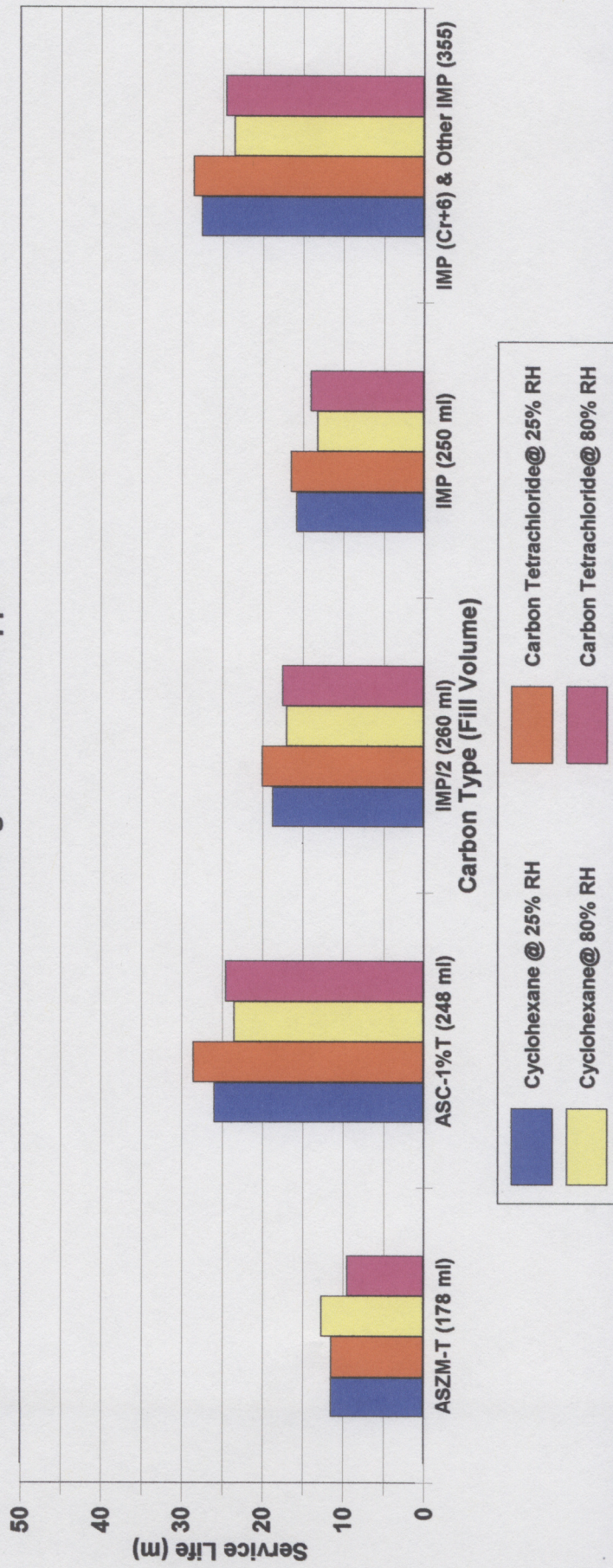


Challenge Gas	Challenge Conc. (ppm)	End Pt. Conc. (ppm)	Draft CBRN Standard Challenge Conc. (ppm)	Draft CBRN Standard End Pt. Conc. (ppm)
Sulfur Dioxide (SO ₂)	5000	5	1500	5



Draft for Discussion

Cyclohexane vs Carbon Tetrachloride Challenge Conc. 5000 ppm



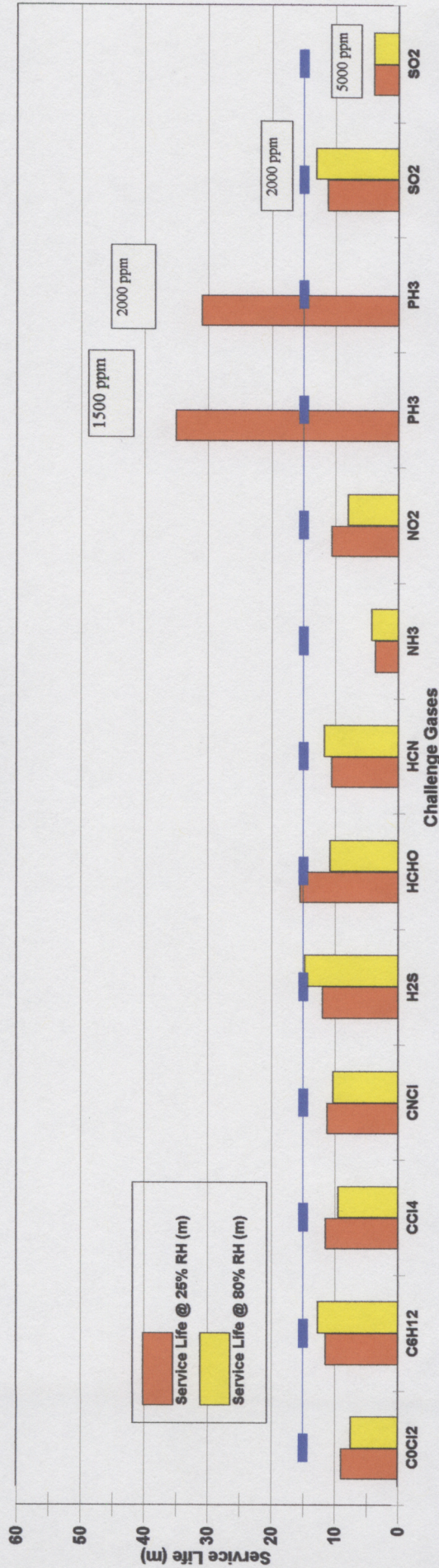
Canister Type vs. Challenge Gas/Vapors



Draft for Discussion



ASZM-T Cooperite 178 ml Fill Volume



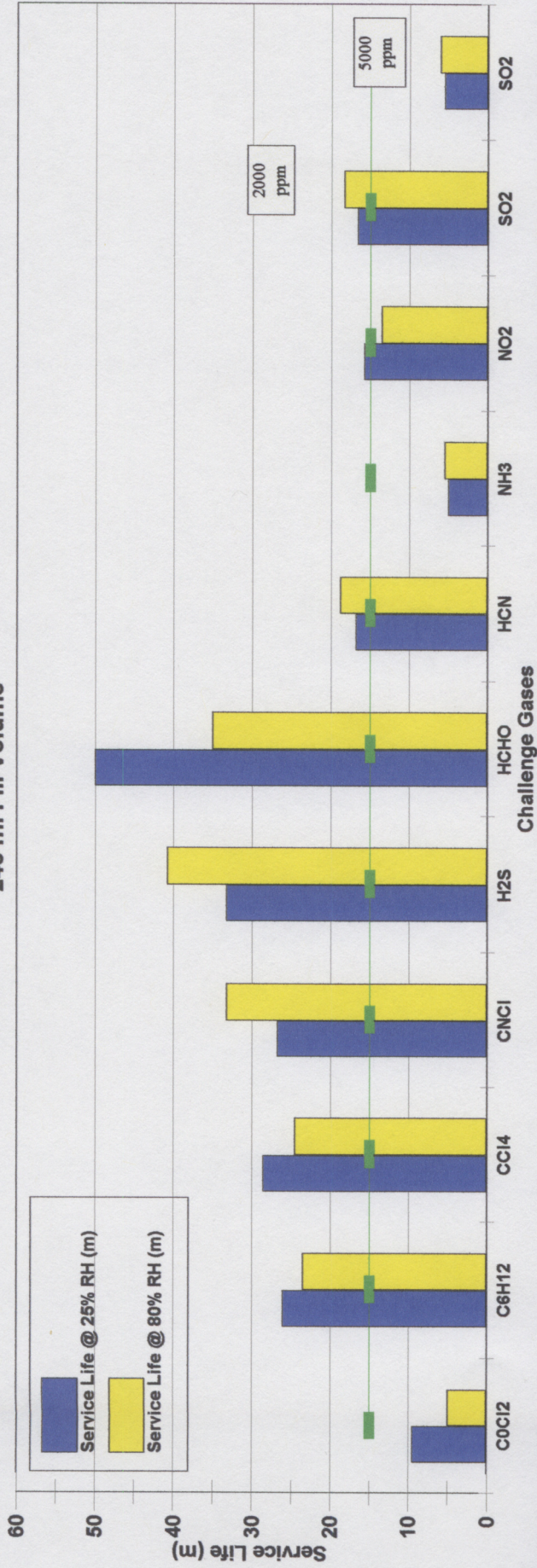
Challenge Gas	Challenge Conc. (ppm)	End Pt. Conc. (ppm)	Draft CBRN Standard Challenge Conc. (ppm)	Draft CBRN Standard End Pt. Conc. (ppm)
Phosgene (COCl ₂)	4500	1.24	250	1.25
Cyclohexane (C ₆ H ₁₂)	5000	10	3000	10
Carbon Tetrachloride (CCl ₄)	5000	5	3000	5
Cyanogen Chloride (CNCl)	1590	1.98	300	2
Hydrogen Sulfide (H ₂ S)	5000	10	1000	5
Formaldehyde (HCHO)	1000	1	1000	1
Hydrogen Cyanide (HCN)	5000	4.70	940	4.70
Ammonia (NH ₃)	2000	50	2500	12.5
Nitrogen Dioxide (NO ₂)	2500	1	200	1
Phosphine (PH ₃)	1500	5	1500	5
Phosphine (PH ₃)	2000	5	1500	5
Sulfur Dioxide (SO ₂)	2000	5	1500	5
Sulfur Dioxide (SO ₂)	5000	5	1500	5



Draft for Discussion



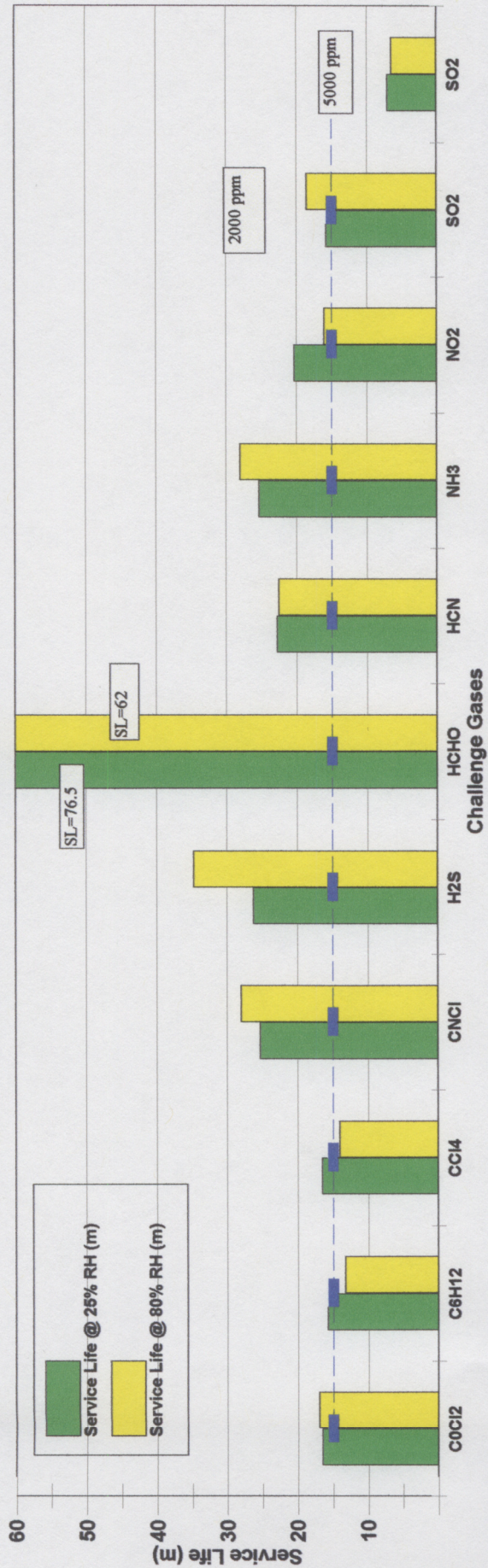
ASC WHETLERITE (Cr+6) - 1% TEDA 248 ml Fill Volume



5000	10	3000	10
5000	5	3000	5
1590	1.98	300	2
5000	10	1000	5
1000	1	1000	1
5000	4.70	940	4.70
2000	50	2500	12.5
2500	1	200	1
2000	5	1500	5
5000	5	1500	5



Impregnated Carbon 250 ml Fill Volume

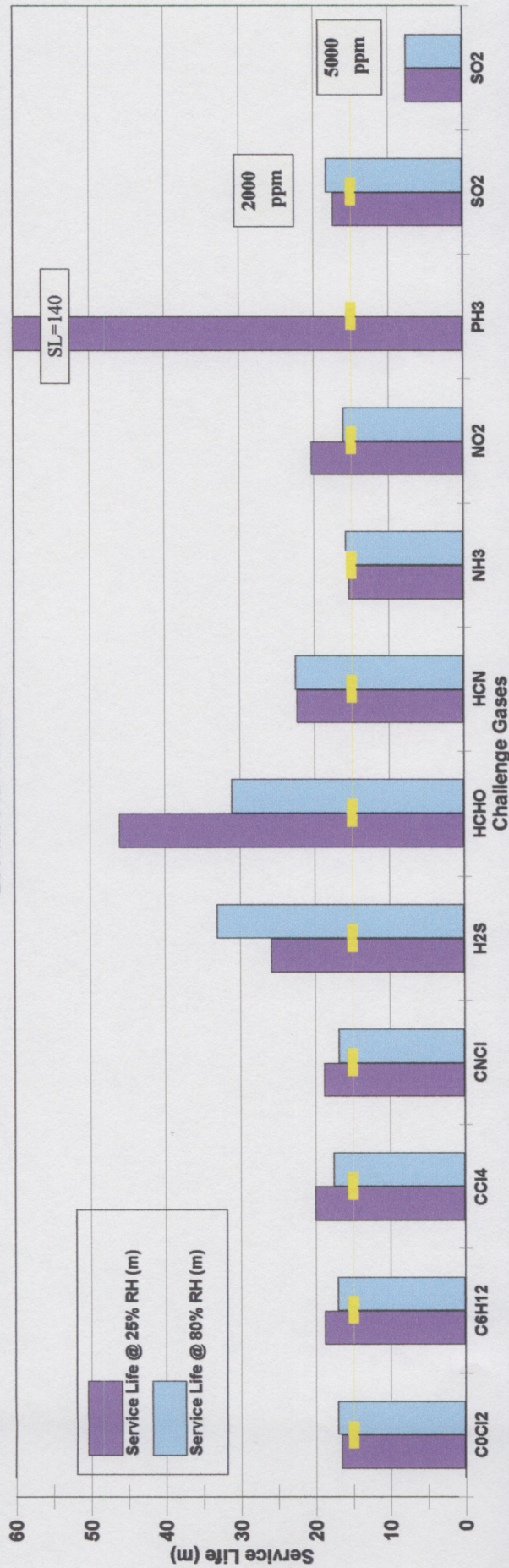


Challenge Conc. (ppm)	End Pt. Conc. (ppm)	Draft CBRN Standard Challenge Conc. (ppm)	Draft CBRN Standard End Pt. Conc. (ppm)
4500	1.24	250	1.25
5000	10	3000	10
5000	5	3000	5
1590	1.98	300	2
5000	10	1000	5
1000	1	1000	1
5000	4.70	940	4.70
2000	50	2500	12.5
2500	1	200	1
2000	5	1500	5
5000	5	1500	5



Draft for Discussion

IMPREGNATES-2 260 ml Fill Volume



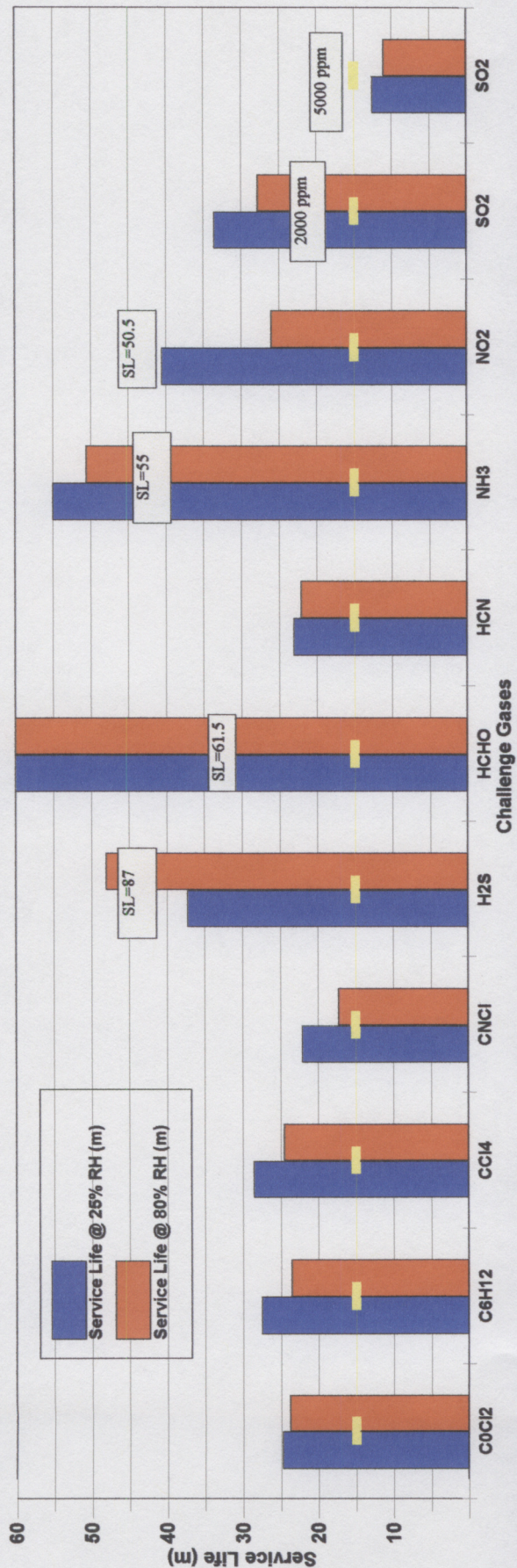
Challenge Conc. (ppm)	End Pt. Conc. (ppm)	Draft CBRN Standard Challenge Conc. (ppm)	Draft CBRN Standard End Pt. Conc. (ppm)
4500	1.24	250	1.25
5000	10	3000	10
5000	5	3000	5
1590	1.98	300	2
5000	10	1000	5
1000	1	1000	1
5000	4.70	940	4.70
2000	50	2500	12.5
2500	1	200	1
1500	5	1500	5
2000	5	1500	5
5000	5	1500	5



Draft for Discussion



ABEK2Hg/St (Impreg Cr+6 & other Imp)
366 ml Fill Volume



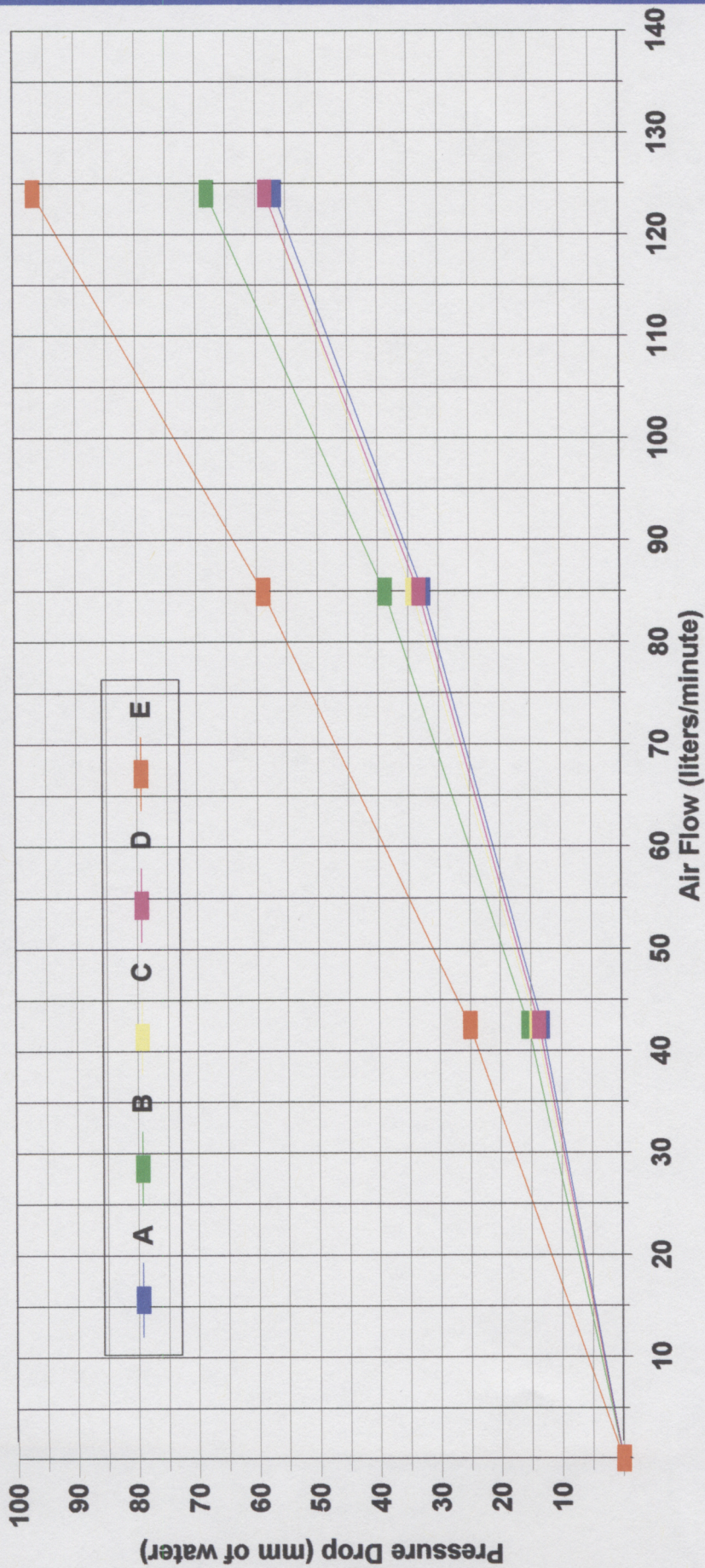
Challenge Gas	Challenge Conc. (ppm)	End Pt. Conc. (ppm)	Draft CBRN Standard Challenge Conc. (ppm)	Draft CBRN Standard End Pt. Conc. (ppm)
Phosgene (COCl ₂)	4500	1.24	250	1.25
Cyclohexane (C ₆ H ₁₂)	5000	10	3000	10
Carbon Tetrachloride (CCl ₄)	5000	5	3000	5
Cyanogen Chloride (CNCl)	1590	1.98	300	2
Hydrogen Sulfide (H ₂ S)	5000	10	1000	5
Formaldehyde (HCHO)	1000	1	1000	1
Hydrogen Cyanide (HCN)	5000	4.70	940	4.70
Ammonia (NH ₃)	2000	50	2500	12.5
Nitrogen Dioxide (NO ₂)	2500	1	200	1
Sulfur Dioxide (SO ₂)	2000	5	1500	5
Sulfur Dioxide (SO ₂)	5000	5	1500	5



Draft for Discussion



Cartridge Resistance



Legend I.D.	Carbon Type (Fill Volume)
A	ASZM-T (170 ml Fill Vol)
B	Whetlerite(Cr+6)-1% TEDA (248 ml Fill Vol.)
C	Impreg. Carbon (250 ml Fill Vol.)
D	Impreg. Carbon - 2 (260 ml Fill Vol.)
E	ABEK2Hg/St (355 ml Fill Vol.)

