Malheur Experiment Station
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Information for Sustainable Agriculture

TOLERANCE OF SEVEN NATIVE FORBS TO PREEMERGENCE AND POSTEMERGENCE HERBICIDES

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Introduction

Native forb seed is needed to restore rangelands of the Intermountain West. Commercial seed production is necessary to provide the quantity of seed needed for restoration efforts. A major limitation to economically viable commercial production of native forb seed is weed competition. Weeds are adapted to growing in disturbed soil, and native forbs are not competitive with these weeds. There is a considerable body of knowledge about the relative efficacy of different herbicides to control target weeds, but few trials have tested native forbs for their tolerance to commercial herbicides.

The trials reported here tested the tolerance of seven native forb species to conventional preemergence and postemergence herbicides in the field. **This work seeks to discover products that could eventually be registered for use for native forb seed production.** The information in this report is for the purpose of informing cooperators and colleagues in other agencies, universities, and industry of the research results. Reference to products and companies in this publication is for the specific information only and does not endorse or recommend that product or company to the exclusion of others that may be suitable. Nor should any information and interpretation thereof be considered as recommendations for the application of any of these herbicides. **Pesticide labels should always be consulted before any pesticide use. Considerable efforts may be required to register these herbicides for use for native forb seed production.**

Materials and Methods

Plant Establishment

Seed of seven Great Basin forb species (Table 1) received in October 2005 was planted November 1, 2005. The field had been disked, ground hogged, and marked out in rows 30 inches apart. The seven forb species were planted in individual rows 435 ft long and 30 inches apart. Planting depths were similar to those used in the irrigation trial and varied by species. The crop preceding forbs was wheat. Prior to planting, one drip tape was inserted 12 inches deep equidistant between pairs of rows to be planted. The drip tape was supplied with irrigation water using filtration and other common drip irrigation practices (Shock 2006).

Preemergence Treatments

The weather was wet and windy, delaying the application of preemergence herbicide treatments. The field was staked out to make 5-ft-wide plots perpendicular to the forb rows, crossing all seven species using the upper 200 ft of the field. Eight treatments (Table 2) including the untreated check were replicated four times in a randomized complete block design. Treatments were applied 5 January 2006 at 30 psi, 2.63 mph, in 20 gal/acre using 8002 nozzles with three nozzles spaced 20 inches apart.

By early January the planted area had volunteer wheat and blue mustard. Roundup® UltraMax at 1.01 lb ai/acre was sprayed 6 January 2006 over the entire area to control the volunteer wheat and other weeds that had emerged. The Roundup was applied at 30 psi, 2.63 mph, in 20 gal/acre using 8002 nozzles with three nozzles spaced 20 inches apart.

On 16 March there was good emergence of the *Lomatium* species. The forbs were cultivated April 13. Cultivation of adjoining areas damaged part of the *Eriogonum umbellatum* that had emerged. Starting April 17 emerged plants were counted in 6 inches of row. Plants were evaluated subjectively for injury on a scale of 0 = no injury to 100 = plants dead.

Postemergence Treatments

Postemergence treatments (Table 3) were applied in the same fashion as the preemergence treatments. The field was staked out to make 5-ft-wide plots perpendicular to the forb rows, crossing all seven species using the lower 200 ft of the field. Eight treatments including the untreated check were replicated four times in a randomized complete block design. Treatments were applied May 24 at 30 psi, 2.63 mph, in 20 gal/acre using 8002 nozzles with three nozzles spaced 20 inches apart. Plant injury was rated on May 31, June 15, and June 30.

General Considerations

The focus of the evaluations was forb tolerance to the herbicides, not weed control. Therefore, weeds were removed as needed. In 2006 the trial was irrigated very little with the drip irrigation system because of ample rainfall.

The effects of herbicides for each species on plant stand and injury were evaluated independently from the effects on other species. Treatment differences were compared using ANOVA and protected least significant differences at the 95 percent confidence LSD (0.05) using NCSS Number Cruncher software (NCSS, Kaysville, UT).

Table 1. Forb species planted at the Malheur Experiment Station, Oregon State University, Ontario, OR and their origins.

Species	Common name	Origin	Year
Eriogonum umbellatum	Sulfur buckwheat	Shoofly Road (ID)	2004
Penstemon acuminatus	Sand penstemon	Bliss Dam (ID)	2004
Penstemon deustus	Hotrock penstemon	Blacks Cr. Rd. (ID)	2003
Penstemon speciosus	Royal or sagebrush penstemon	Leslie Gulch (OR)	2003
Lomatium dissectum	Fernleaf biscuitroot	Mann Creek (ID)	2003
Lomatium triternatum	Nineleaf desert parsley	Hwy 395 (OR)	2004
Lomatium grayi	Gray's lomatium	Weiser R. Rd. (ID)	2004

Results and Discussion

All observations made on the herbicides tested are strictly preliminary observations. Herbicides that were observed to be damaging to the forbs as reported here might be helpful if used at a lower rate or in a different environment. Herbicides that were relatively safe for the forbs in these trials might be harmful if used at higher rates or in a different environment. Nothing in this report should be construed as a recommendation.

Eriogonum umbellatum (Sulfur buckwheat)

Sulfur buckwheat had no statistical differences between the preemergence treatments (Table 2) due to the considerable cultivation injury. Very few of the plants that survived cultivation injury survived the preemergence treatment with Outlook® or Lorox®. Plant stunting was observed in plants where the soil was treated with Kerb® and Outlook. None of the sulfur buckwheat plants receiving Kerb preemergence survived.

Sulfur buckwheat was subject to foliar burn and chlorosis (yellowing) with several postemergence herbicides (Table 3). The buckwheat was sensitive to postemergence applications of Buctril®, Goal®, Caparol®, and Lorox as evidenced by statistically significant foliar damage.

Table 2. Tolerance of *Eriogonum umbellatum* to preemergence herbicides screened at the Malheur Experiment Station, Oregon State University, Ontario, OR, 2006.

	Treatment	Rate	Plant stand			Injury		
			4/26	5/31	6/15	5/31	6/15	7/5
		lb ai/acre	----- counts -----		%	----------- % -----------		
1	Untreated check	--	14.5	14	46	0	0	0
2	Prefar 4.0 EC	5.0	25.5	20	65	0	10	10
3	Kerb 50 WP	1.0	0	0	0	No plants		
4	Treflan HFP	0.375	23.5	20.5	52.5	0	20	17.5
5	Prowl 3.8 SC	0.75	11	10	37.5	0	0	5
6	Balan 60 DF	1.2	25	24	80	0	0	0
7	Outlook 6.0 EC	0.656	2.5	2.5	2	0	35	22.5
8	Lorox 50 DF	1.0	1	1	1	0	0	20
	Mean		12.9	11.4	34.8	0	10.8	10.8
	LSD (0.05)		NS	NS	NS	NS	NS	NS

Table 3. Tolerance of *Eriogonum umbellatum* to postemergence herbicides screened at the Malheur Experiment Station, Oregon State University, Ontario, OR, 2006.

Treatment		Rate	Plant stand %	Injury %		
		lb ai/acre	5/24	5/31	6/15	6/30
1	Untreated	--	70	0	0	0
2	Buctril 2.0 EC	0.125	60	36.3	37.5	23.8
3	Goal 2XC	0.125	62.5	67.5	42.5	23.8
4	Select 2.0 EC + Herbimax	0.094 + 1% v/v	52.5	2.5	2.5	16.3
5	Prowl H_2O 3.8 C	1.0	85	6.3	7.5	0
6	Caparol FL 4.0	0.8	55	40	33.8	28.8
7	Outlook 6.0 EC	0.656	48.8	0	0	3.8
8	Lorox 50 DF	0.5	70	33.8	33.8	27.5
	Mean		63.0	24.0	20.3	16.0
	LSD (0.05)		NS	18.7	12.7	17.4

Penstemon acuminatus (Sand penstemon)

Plant stands of sand penstemon were reduced by preemergence treatments of Prefar®, Kerb, Prowl® and Balan® (Table 4). Where Kerb or Prowl was applied preemergence, almost all sand penstemon plants died during the first growing season. Plant stands were best where Treflan®, Outlook, and Lorox were applied. Scattered areas of stunted plants occurred in several treatments. Foliar damage was minimal by July 5 where Treflan or Lorox had been applied.

Few negative effects were noted on sand penstemon from most of the herbicides used as postemergence applications (Table 5). Symptoms of damage were yellowing and leaf burn. Leaf burn and plant stunting occurred with Caparol, a photosynthetic inhibitor. Less dramatic and temporary leaf damage was noted following the application of Buctril.

Penstemon deustus (Hotrock penstemon)

Hotrock penstemon plant stands were reduced by all the products tested except Treflan (Table 6). No hotrock penstemon plants were observed where the soil was treated with Kerb. The most common damage symptoms were yellowing and stunting.

Hotrock penstemon plant stands were reduced by postemergence applications of Caparol and Outlook (Table 7). Plants treated with Select® and Prowl had no phytotoxic symptoms. Burnt and yellowing foliage were common with Caparol, Lorox, Buctril, and Goal. Burnt and stunted symptoms on plants persisted until June 30 following the application of Caparol and Lorox.

Table 4. Tolerance of *Penstemon acuminatus* to preemergence herbicides screened at the Malheur Experiment Station, Oregon State University, Ontario, OR, 2006.

Treatment		Rate	Plant stand			Injury		
			4/26	5/31	6/15	5/31	6/15	7/5
		lb ai/acre	----- counts -----		%	----------- % -----------		
1	Untreated check	--	21.5	20.5	20.0	0	0	0
2	Prefar 4.0 EC	5.0	5	3.5	8.3	31.3	25	0
3	Kerb 50 WP	1.0	0.3	0.3	0.5	0	0	no plants
4	Treflan HFP	0.375	17.8	18.3	43.7	13.3	10	3.3
5	Prowl 3.8 SC	0.75	3	0.75	0.75	87.5	95	no plants
6	Balan 60 DF	1.2	7.8	7.5	22.5	17.5	10	3.3
7	Outlook 6.0 EC	0.656	17.3	15.5	61.7	25	28.8	17.5
8	Lorox 50 DF	1.0	15.5	12.8	40.0	22.5	15	3.8
	Mean		11.0	9.9	23.1	23.1	20.6	5.3
	LSD (0.05)		12.0	11.2	43.0	27.5	29.6	NS

Table 5. Tolerance of *Penstemon acuminatus* to postemergence herbicides screened at the Malheur Experiment Station, Oregon State University, Ontario, OR, 2006.

	Treatment	Rate	Plant stand %		Injury %	
		lb ai/acre	5/24	5/31	6/15	6/30
1	Untreated	--	83.8	0	0	0
2	Buctril 2.0 EC	0.125	81.3	18.8	5	0
3	Goal 2XC	0.125	77.5	7.5	0	0
4	Select 2.0 EC + Herbimax	0.094 + 1% v/v	46.3	2.5	0	0
5	Prowl H_2O 3.8 C	1.0	77.5	5	5	0
6	Caparol FL 4.0	0.8	71.3	35	55	50
7	Outlook 6.0 EC	0.656	65	0	0	0
8	Lorox 50 DF	0.5	67.5	6.3	7.5	0
	Mean		71.25	9.375	9.0625	6.25
	LSD (0.05)		NS	8.4	6.6	2.1

Table 6. Tolerance of *Penstemon deustus* to preemergence herbicides screened at the Malheur Experiment Station, Oregon State University, Ontario, OR, 2006.

	Treatment	Rate	Plant stand			Injury		
			4/26	5/31	6/15	5/31	6/15	7/5
		lb ai/acre	----- counts -----		%	----------- % ----------		
1	Untreated check	--	37.3	25	68.8	0	0	0
2	Prefar 4.0 EC	5.0	3	2.5	5.0	0	0	7.5
3	Kerb 50 WP	1.0	0	0	0	No plants		
4	Treflan HFP	0.375	27.8	20.3	59.3	0	12.5	0
5	Prowl 3.8 SC	0.75	6.3	4.3	15.3	0	23.3	20
6	Balan 60 DF	1.2	4.8	4.3	10.8	0	16.3	12.5
7	Outlook 6.0 EC	0.656	2	1.5	1.8	0	53	70
8	Lorox 50 DF	1.0	0.8	0.5	1.0	0	20	10
	Mean		10.2	7.3	20.2	0	17.3	13.9
	LSD (0.05)		21.2	14.8	30.6	NS	NS	22.5

Table 7. Tolerance of *Penstemon deustus* to postemergence herbicides screened at the Malheur Experiment Station, Oregon State University, Ontario, OR, 2006.

	Treatment	Rate	Plant stand %		Injury %	
		lb ai/acre	5/24	5/31	6/15	6/30
1	Untreated	--	98.8	0	0	0
2	Buctril 2.0 EC	0.125	82.5	32.5	11.3	10
3	Goal 2XC	0.125	83.8	21.3	13.8	7.5
4	Select 2.0 EC + Herbimax	0.094 + 1% v/v	91.3	0	0	0
5	Prowl H_2O 3.8 C	1.0	95	0	0	0
6	Caparol FL 4.0	0.8	56.3	48.8	55	42.5
7	Outlook 6.0 EC	0.656	70	0	0	0

8	Lorox 50 DF	0.5	86.3	38.8	48.8	42.5	
	Mean		83.0	17.7	16.1	12.8	
	LSD (0.05)		24.5	11.2	17.7	19.5	

Penstemon speciosus (Royal or sagebrush penstemon)

Royal penstemon plant stands were not affected by Treflan, Balan, or Outlook, among others (Table 8). Phytotoxic effects of most herbicides were moderate and diminished with time. Prowl and Balan applied preemergence caused significant negative effects, and there was marked stunting with Prowl. No royal penstemon survived to 2007 where Kerb was applied preemergence.

None of the postemergence herbicides tested reduced the stands of royal penstemon (Table 9). Royal penstemon was sensitive to Lorox and extremely sensitive to Caparol. Symptoms of Caparol damage included yellowing, yellow-purple foliage, and plant death. Where other products damaged plants, symptoms were yellowing, stunting, and leaf burn.

Lomatium dissectum (Fernleaf biscuitroot)

Fernleaf biscuitroot had a very brief growing season, so observations on the effects of preemergence herbicides were ended on May 31. No significant decreases in plant counts were noted due to preemergence herbicides (Table 10); however, phytotoxic symptoms on the foliage were commonly noted. Prefar had significantly more foliar symptoms that the untreated check on April 17, while Kerb, Outlook, Prowl, and Lorox had significantly more symptoms that the untreated check on both April 17 and May 31. None of the herbicides applied preemergence appeared to be totally safe at the rates used in this trial.

Observations of the postemergence herbicides were begun in late May and continued until June 30. The postemergence herbicides had no significant effects on plant stands at the rates tested (Table 11). In contrast to the negative phytotoxic effects observed with the preemergence herbicide applications, none of the herbicides applied postemergence had significant phytotoxic effects on fernleaf biscuitroot at the rates tested.

Table 8. Tolerance of *Penstemon speciosus* to preemergence herbicides screened at the Malheur Experiment Station, Oregon State University, Ontario, OR, 2006.

	Treatment	Rate	Plant stand counts			Injury %		
			4/26	5/31		5/31	6/15	7/5
		lb ai/acre	----- counts -----			----------- counts ----------		
1	Untreated check	--	22.5	20.3		0	0	0
2	Prefar 4.0 EC	5.0	10.3	9		11.7	6.7	0
3	Kerb 50 WP	1.0	0.3	0		------------ No plants ------------		
4	Treflan HFP	0.375	26.3	24.8		20	12.5	8.3
5	Prowl 3.8 SC	0.75	8.8	7		73.8	57.5	41.7
6	Balan 60 DF	1.2	20	20		30	26.3	8.3
7	Outlook 6.0 EC	0.656	19.5	17.3		18.8	7.5	0
8	Lorox 50 DF	1.0	19.8	16.3		2.5	2.5	0
	Mean		15.9	14.3		22.8	16.5	7.6
	LSD (0.05)		NS	15.2		32.2	24.4	16.5

Table 9. Tolerance of *Penstemon speciosus* to postemergence herbicides screened at the Malheur Experiment Station, Oregon State University, Ontario, OR, 2006.

	Treatment	Rate	Plant stand %	Injury %			
		lb ai/acre	5/24	5/31	6/15	6/30	
1	Untreated	--	71.3	0	0	0	
2	Buctril 2.0 EC	0.125	82.5	7.5	7.5	5	
3	Goal 2XC	0.125	83.8	3.8	2.5	2.5	

4	Select 2.0 EC + Herbimax	0.094 + 1% v/v	92.5	3.8	0	2.5	
5	Prowl H_2O 3.8 C	1.0	92.5	2.5	0	10	
6	Caparol FL 4.0	0.8	83.8	45	83.3	81.3	
7	Outlook 6.0 EC	0.656	76.3	0	0	0	
8	Lorox 50 DF	0.5	73.8	25	28.8	33.8	
	Mean		82.0	10.9	15.3	16.9	
	LSD (0.05)		NS	12.1	7.4	9.6	

Table 10. Tolerance of *Lomatium dissectum* preemergence herbicides screened at the Malheur Experiment Station, Oregon State University, Ontario, OR, 2006.

	Treatment	Rate lb ai/acre	Plant stand counts	Injury %	
			4/17	4/17	5/31
1	Untreated check	--	18.5	0	0
2	Prefar 4.0 EC	5.0	19.8	18.8	15
3	Kerb 50 WP	1.0	13.5	38.8	46.3
4	Treflan HFP	0.375	16	11.3	20
5	Prowl 3.8 SC	0.75	16	20	32.5
6	Balan 60 DF	1.2	16	13.8	20
7	Outlook 6.0 EC	0.656	9.5	35	41.3
8	Lorox 50 DF	1.0	14.8	15	27.5
	Mean		15.5	19.1	25.3
	LSD (0.05)		NS	13.9	26.5

Table 11. Tolerance of *Lomatium dissectum* to postemergence herbicides screened at the Malheur Experiment Station, Oregon State University, Ontario, OR, 2006.

	Treatment	Rate	Plant stand %	Injury %		
		lb ai/acre	5/24	5/31	6/15	6/30
1	Untreated	--	96.3	0	0	0
2	Buctril 2.0 EC	0.125	100	3.8	5	2.5
3	Goal 2XC	0.125	95	12.5	7.5	5
4	Select 2.0 EC + Herbimax	0.094 + 1% v/v	97.5	3.8	7.5	8.8
5	Prowl H_2O 3.8 C	1.0	96.3	5	10	7.5
6	Caparol FL 4.0	0.8	90	0	7.5	7.5
7	Outlook 6.0 EC	0.656	100	5	2.5	0
8	Lorox 50 DF	0.5	100	2.5	2.5	5
	Mean		96.9	4.1	5.3	4.5
	LSD (0.05)		NS	NS	NS	NS

Lomatium triternatum (Nineleaf desert parsley)

Plant counts of nineleaf desert parsley were not affected by the preemergence herbicides at the rates tested (Table 12). Outlook caused significant foliar damage compared to the untreated check on all four observation dates. Symptoms included leaf burn, stunting, and plant death. Leaf burn and stunting were also noted for the plants with preemergence Lorox.

None of the postemergence herbicides reduced plant stands as of May 24 (Table 13). Burnt plants and plant death occurred where Buctril was applied postemergence. Other than the very marked damage observed with Buctril, none of the other postemergence herbicides had significant amounts of foliar damage except the Prowl treatment observed on June 30.

Lomatium grayi (Gray's lomatium)

Plant counts of Gray's lomatium were not affected by the preemergence herbicide treatments (Table 14). Stunting and plant death were severe where Kerb was applied preemergence. For the other preemergence treatments, mild stunting was noted but was not significantly different from the untreated check treatment.

As for the other two Lomatiums, none of the postemergence herbicides reduced plant stands of Gray's lomatium as of May 24 (Table 15). Like nineleaf desert parsley, Gray's lomatium showed significantly more damage following postemergence application of Buctril, which resulted in burnt foliage. Some significant foliage symptoms followed postemergence applications of Goal, Caparol, and Lorox, but the symptoms were significantly less than those observed with Buctril.

Table 12. Tolerance of *Lomatium triternatum* to preemergence herbicides screened at the Malheur Experiment Station, Oregon State University, Ontario, OR, 2006.

	Treatment	Rate lb ai/acre	Plant stand counts	Injury %			
			4/18	4/18	5/31	6/15	7/5
1	Untreated check	--	48.5	0	0	0	5
2	Prefar 4.0 EC	5.0	42.5	0	7.5	1.3	0
3	Kerb 50 WP	1.0	37.5	10	10	5	8.8
4	Treflan HFP	0.375	42.5	7.5	10	6.3	7.5
5	Prowl 3.8 SC	0.75	39.8	3.8	5	0	0
6	Balan 60 DF	1.2	48.8	6.3	3.8	6.3	0
7	Outlook 6.0 EC	0.656	41.3	30	40	35	38.8
8	Lorox 50 DF	1.0	43.8	10	11.3	11.3	11.3
	Mean		43.1	8.4	10.9	8.1	8.9
	LSD (0.05)		NS	10.4	14.8	13.7	14.1

Table 13. Tolerance of *Lomatium triternatum* to postemergence herbicides screened at the Malheur Experiment Station, Oregon State University, Ontario, OR, 2006.

	Treatment	Rate lb ai/acre	Plant stand %	Injury %		
			5/24	5/31	6/15	6/30
1	Untreated	--	93.8	0	0	0
2	Buctril 2.0 EC	0.125	96.3	28.3	73	82.5
3	Goal 2XC	0.125	87.5	2.5	2.5	6.3
4	Select 2.0 EC + Herbimax	0.094 + 1% v/v	98.8	0	2.5	3.8
5	Prowl H_2O 3.8 C	1.0	96.3	2.5	5	15
6	Caparol FL 4.0	0.8	98.8	2.5	0	3.8
7	Outlook 6.0 EC	0.656	97.5	2.5	0	3.8
8	Lorox 50 DF	0.5	100	0	0	3.8
	Mean		96.1	4.8	10.4	14.8
	LSD (0.05)		NS	9.8	9.6	11.7

Table 14. Tolerance of *Lomatium grayi* to preemergence herbicides screened at the Malheur Experiment Station, Oregon State University, Ontario, OR, 2006.

	Treatment	Rate lb ai/acre	Plant stand counts	Injury %			
			4/18	4/18	5/31	6/15	7/5
1	Untreated check	--	30.8	0	0	0	0
2	Prefar 4.0 EC	5.0	28.3	7.5	11.3	11.3	8.8
3	Kerb 50 WP	1.0	29.8	28.8	42.5	38.8	42.5
4	Treflan HFP	0.375	30	7.5	7.5	5	12.5

5	Prowl 3.8 SC	0.75	26.3	2.5	8.8	5	6.3
6	Balan 60 DF	1.2	35.3	6.3	0	0	0
7	Outlook 6.0 EC	0.656	30.5	11.3	6.3	5	6.3
8	Lorox 50 DF	1.0	29.8	10	11.3	6.3	8.8
	Mean		30.1	9.2	10.9	8.9	10.6
	LSD (0.05)		NS	12.7	19.5	20.4	24.7

Table 15. Tolerance of *Lomatium grayi* to postemergence herbicides screened at the Malheur Experiment Station, Oregon State University, Ontario, OR, 2006.

	Treatment	Rate	Plant stand %		Injury %		
		lb ai/acre	5/24		5/31	6/15	6/30
1	Untreated	--	100	0	0	0	
2	Buctril 2.0 EC	0.125	98.8	22.5	37.5	30	
3	Goal 2XC	0.125	92.5	10	7.5	5	
4	Select 2.0 EC + Herbimax	0.094 + 1% v/v	96.3	5	0	0	
5	Prowl H_2O 3.8 C	1.0	96.3	5	2.5	2.5	
6	Caparol FL 4.0	0.8	90	10	7.5	7.5	
7	Outlook 6.0 EC	0.656	95	2.5	2.5	3.8	
8	Lorox 50 DF	0.5	98.8	8.85	6.3	6.3	
	Mean		95.9	8.0	8.0	6.95	
	LSD (0.05)		NS	5.3	7.2	15.1	

Spring of 2007

By March 30, 2007, it was difficult if not impossible to distinguish any effects of the 2006 postemergence herbicide applications on any of the seven forb species. Preemergence herbicide effects from 2006 were no longer visible on the *Lomatium* species. Where preemergence herbicides hurt or killed most of the sulfur buckwheat or penstemon plants, the negative effects were permanent. These observations suggest that some degree of phytotoxic damage may be acceptable in establishing native forb seed fields if effective weed control is achieved.

Reference

Shock, C.C. 2006. Drip irrigation: an introduction. Sustainable Agriculture Techniques, Oregon State University Extension Service. EM8782-E Revised October 2006.

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