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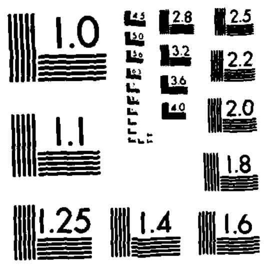

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ANALYSIS OF DIRECT COMMISSARY SUPPORT SYSTEM (DICOMSS) RECEIPT AND ISSUE WORKLOAD

DEFENSE
LOGISTICS
AGENCY

Operations Research and Economic Analysis Office

APRIL 1986

Analysis of Direct Commissary Support System (DICOMSS) Receipt and Issue Workload

April 1986

RE: Distribution Statement
Approved for Public Release, Distribution Unlimited.
Per Ms. Cleo Ridgeway, DLA/LO

A-1

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DLA-LO

Apr 1986

FOREWORD

The Depot Operations Division (DLA-OW) requested the Defense Logistics Agency Mechanization Support Office (DLA-DMECSO) to assist Defense Depot Mechanicsburg Pennsylvania (DDMP) with the design of DDMP's modernized Direct Commissary Support System (DICOMSS) warehousing facilities. The purpose of this study was to assist DLA-DMECSO by providing them with receiving and shipping workload data and analysis.

Purchase order listing files and emergency locator listing files were analyzed to track receiving and shipping workload patterns for twelve 14-day cycles from 10 September 1985 through 25 February 1986. Minimum pallet size, item receipt categories, shipment categories, pick to belt location stockage criteria, and bulk location storage criteria were operationally defined based on DLA-DMECSO's specifications.

The results indicated that item receipt patterns were stable. The majority of items were received and shipped in less than the minimum pallet size lots. Storage location requirements were reasonably stable under normal operating circumstances.

It is recommended that most orders be processed by the case rather than the current procedure of building pallets from case lots. Storage location requirement recommendations are given and are based on average requirement calculations plus additional space for unusual or emergency situations.

ROGER C. ROY
Acting Assistant Director,
Policy and Plans

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I. INTRODUCTION. By memorandum dated 2 August 1985, the Depot Operations Division (DLA-OW) requested an analysis of the Direct Commissary Support System (DICOMSS) shipments through the Defense Depot Mechanicsburg, Pennsylvania (DDMP).

A. Background. An economic analysis estimated that the DICOMSS warehousing operations could be modernized with an investment of approximately $8 million. The Defense Logistics Agency Mechanization Support Office (DMECSO) was requested to assist DDMP with the design of the modernized facilities.

B. Purpose. The purpose of this study was to assist DMECSO in designing facilities by providing them with receiving and shipping workload data.

C. Objectives. The objectives were to track current workload to analyze that data and to provide the data in a format appropriate for design requirements.

D. Scope

1. The study was limited to DICOMSS purchase orders going through Mechanicsburg. Federal Supply Class 8975, Tobacco Products, were excluded from statistics in this report since this material will not be stored in the modernized warehouses.

2. The time period of the data is from 10 September 1985 through 25 February 1986. This provided 12 material release order cycles to analyze.

II. METHODOLOGY

A. Data Collection and Preparation

Data calls were sent to Defense Depot Mechanicsburg for a tape copy of the Emergency Locator Listing File and to Defense Personnel Support Center for tape copies of the Purchase Order Listing Reports. The Purchase Order Listing is produced on the 10th and 25th of each month. Only one copy of the Emergency Locator Listing File was requested; it had a cutoff date of 25 October 1985.

Programs were run against the raw data files to remove titles, to select Mechanicsburg purchase orders, and to sort the files. The processed Purchase Order Listing File was matched against the processed Emergency Locator Listing File to append case weight, case cube, case pack, and nomenclature data. The matched file was aggregated (rolled-up) by NSN.

From these data, cubic feet calculations were made as follows:

$$C = (Q / CP) * CC$$

where C = the cubic feet of the MRO
Q = the MRO quantity in units of issue
CP = case pack (the number of units of issue contained in each case)

CC = case cube (the cubic feet occupied by a single case)

B. Definitions. Specified criteria and assumptions were required to reformat the data. The following operational definitions were used in the analysis.

1. Pallets. Definitions were set for a standard pallet based on Department of Defense policies and engineering specifications for the proposed DICOMSS storage facilities. The standard pallet size is 46.7 cubic feet. However, it was estimated that a maximum of 58.3 cubic feet could be placed into a pallet rack. The minimum pallet threshold was 35.0 cubic feet. Each Material Release Order (MRO) was compared to this minimum pallet size. MROs less than 35 cubic feet were assumed to be too small to process in pallet lots. It is more advantageous to handle these small orders by the case than to palletize them. Variables were created to count the number of MROs which were less than the pallet threshold (# case MROs). The "# pallets in" variable is computed as follows:

$$P = C/S$$

where P = the number of pallets received.
C = the total cube received for the NSN
S = the standard pallet size (46.667 cubic feet)

In order to compute integer values rounding was done as follows:

a. If the remainder was greater than 11.667, the number of pallets was rounded up.

b. If the remainder was less than or equal to 11.667, the number of pallets was rounded down.

2. Type NSN Categories. NSNs were classified into four mutually exclusive type NSN categories according to their MRO shipment cube as follows:

a. All Pallets Out: NSNs with all their MROs equalling or exceeding the minimum pallet threshold.

b. Primarily Pallet Out: NSNs with 50% or more, but not all, their MROs equalling or exceeding the minimum pallet threshold.

c. Primarily Cases Out: NSNs with 50% or more, but not all, their MROs below the minimum pallet threshold.

d. All Cases Out: NSNs with all their MROs below the minimum pallet threshold.

3. Dedicated versus Variable Locations

After evaluating some preliminary data, DLA-DMECSO determined that variable item location assignments would utilize available cube more efficiently than dedicating locations to particular NSNs. Although dedicated locations would have advantages in consistency and simplicity, these benefits are outweighed by the savings in cube realized by assigning NSNs to the optimal sized location. Therefore, a belt versus bulk location assignment algorithm was defined by DLA-DMECSO. Consequently this final report excludes consideration of dedicated locations.

4. Determination of Belt Versus Bulk Locations. The determination of belt versus bulk storage is based on MRO cube. Stock with MRO cubes less than 35 cubic feet was assigned to belt locations. Stock with MRO cubes greater than or equal to 35 cubic feet was assigned to bulk locations. Each NSN was assigned one belt location code, one bulk location code, or a combination of one belt and one bulk location code.

5. Belt Cube. Belt cube is the total cube for all the item's MROs assigned to belt locations.

6. Bulk Cube. Bulk cube is the total cube for all the item's MROs assigned to bulk locations.

7. Belt Location Codes

Belt location codes were assigned to stocks which were picked in less than pallet sized lots. The five types of belt locations considered in this analysis were carton flow racks, single deep small pallet racks, single deep large pallet racks, double deep small pallet racks, and double deep large pallet racks. Items were assigned to belt locations or a combination of belt locations based upon the items belt cube. The belt location assignment algorithm attempted to conserve pick faces and storage space by assigning items to the smallest total cube storage without intermixing items in locations. The algorithm did not allow NSNs to share locations because locations should hold only one type of item at a given time to simplify picking.

Table 1 displays the belt location codes, code descriptions, minimum belt cubes, and maximum belt cubes. Belt location codes, F1, F2, and F3 had additional restrictions in that items assigned to carton flow racks were required to have case cubes less than one cubic foot. NSNs with belt cubes less than 19.99 cubic feet and case cubes greater than or equal to one cubic foot were assigned to single deep small pallet locations. Items with belt cubes greater than 213.32 cubic feet were not assigned locations. These items must be reviewed on a case by case basis to determine location assignment combinations.

Table 1

Belt Location Code Definitions

Belt Location Code	Description	Minimum Belt Cube*	Maximum Belt Cube
F1	One Lane carton flow rack**	0	6.66
F2	Two Lane carton flow rack	6.67	13.32
F3	Three lane carton flow rack	13.33	19.98
A	Single deep small pallet rack	19.99	40.00
B	Single deep large pallet rack	40.01	53.33
C	Double deep small pallet rack	53.34	80.00
AB	Single deep small plus single deep large pallet racks	80.01	93.33
D	Double deep large pallet rack	93.34	106.66
AC	Single deep small plus double deep small pallet racks	106.67	120.00
BC	Single deep large plus double deep small pallet racks	120.01	133.33
AD	Single deep small plus double deep large pallet racks	134.34	146.66
BD	Single deep large plus double deep large pallet racks	146.67	158.99
CC	Double deep small plus double deep small pallet racks	159.00	160.00
CD	Double deep small plus double deep large pallet racks	160.01	186.66
DD	Double deep large plus double deep large pallet racks	186.67	213.32
E	Greater than 2 double deep large--assign location manually	213.33	------

* Belt cube is the total cubic feet for all the item's material release orders with less than 35 cubic feet.

** Items assigned to carton flow racks must have case cubes less than one cubic foot.

8. Bulk Location Codes. The bulk locations were determined by the items bulk cube. Table 2 lists the bulk location codes, code descriptions, minimum bulk cubes, and maximum bulk cubes. Bulk locations were assigned for stocks which were both stored and picked in pallet sized lots.

C. Biweekly Statistics. NSN frequencies were run on the number of pallets received each cycle to evaluate incoming workload. Cross tabulations evaluated how items were received (number of pallets received) against how items went out (type NSN categories).

Table 2

Bulk Location Code Definitions

Bulk Location Code	Description	Minimum Bulk Cube*	Maximum Bulk Cube
K	1 bulk pallet	35.00	53.33
L	2 bulk pallets	53.34	106.66
M	3 bulk pallets	106.67	159.99
N	4 to 6 bulk pallets	160.00	319.98
P	7 to 9 bulk pallets	319.99	479.97
Q	10 to 12 bulk pallets	479.98	639.96
R	13 to 15 bulk pallets	639.97	799.95
S	16 to 18 bulk pallets	799.96	959.94
T	19 to 21 bulk pallets	959.95	1119.93
V	22 to 24 bulk pallets	1119.94	1279.92
W	Greater than 24 bulk pallets--assign location manually	1279.93	______

*Bulk cube is the total cubic feet for all the item's material release orders with greater than or equal to 35 cubic feet.

D. Evaluation of Stability. The biweekly aggregated NSN files were merged, aggregated, and analyzed for stability by individual NSN and stability for all NSNs combined. Crosstabulations of the average number of pallets received versus type of shipment categories were produced. Four reports listing individual NSN data were produced by type NSN category. These reports listed the NSN, an abbreviated nomenclature, average case quantity, standard deviation case quantity, average cubic feet, standard deviation cube, average number of pallets received, number of cycles that the item received stock, and the number of cycles that stock went out in the four type NSN categories. Averages and standard deviation were calculated on the cycles where stock was received. Cycles in which no stock was received were not included in the average and standard deviation calculations. The average number of pallets received may not equal the average cube divided by the average standard pallet size due to partial pallets and rounding. For example, if an NSN received a 35-cubic feet pallet one cycle and a 1-cubic foot case in another cycle, the average cube is 18 cubic feet, but the average number of pallets is 0.5 rounded to 1. The "# cycles received" is a count of cycles with an NSN cube greater than zero. The listings are sorted by NSN within the categories of "number of pallets received."

E. Sensitivity of Pallet Size Criteria. A sensitivity study was performed to test the validity of the pallet size threshold criteria. Sensitivity to changes in the pallet-size threshold criteria was evaluated by examining relative percentage and cumulative percentage distributions of the MRO cube for the first cycle. The purpose was to test the hypothesis that small changes in the minimum, average, and maximum pallet-size thresholds would not significantly affect the results.

III. ANALYSIS

A. Biweekly Statistics. In order to evaluate incoming workload, NSN frequency distributions were run on the number of pallets received in each cycle. The distributions of pallets received were nonsymmetrical. Over half of the NSNs were received in less than pallet-size lots while a few NSNs were received in quantities of over 100 pallets in a single cycle. However, Tables 3 and 4 show that the majority of NSNs were both received and shipped in less than pallet-size lots.

B. *Analysis of Stability*

DICOMSS vendors are typically split so that one set of vendors receives purchase orders during the first half of the month and another set receives purchase orders during the last half of the month. This ordering policy is reflected in the slight cyclical fluctuations in MRO workload (Table 3). An average of 53,973 MROs were processed at the beginning of the month and an average of 47,253 MROs were processed at the end of the month. These averages were not significantly different at the .05 significance level. The pattern appears to be relatively stable except for the 25 December and 10 January cycles.

Table 3

NSN RECEIPT SUMMARY REPORT EXCLUDING TOBACCO ITEMS

	10 SEP	25 SEP	10 OCT	25 OCT	10 NOV	25 NOV	10 DEC	25 DEC	10 JAN	25 JAN	10 FEB	25 FEB	AVE	STANDARD DEVIATION
# DICOM NROG	61,577	34,661	59,856	42,643	59,771	44,081	59,834	81,875	20,774	41,025	62,030	39,235	50,614	15,691
# DICOM NSNS	4751	2821	5272	2961	3983	4086	4375	5350	4015	2894	4471	2911	3,991	878
% NSNS WITH < 1 PALLET IN	61	54	63	52	53	66	57	48	73	54	57	54	58	7
% NSNS WITH 1 PALLET IN	9	10	9	11	11	7	10	13	9	10	10	10	10	1
% NSNS WITH 2 PALLETS IN	11	11	10	12	14	8	11	14	9	10	11	11	11	2
% NSNS WITH 3 PALLETS IN	6	7	5	7	5	4	6	7	3	7	6	6	6	1
% NSNS WITH 4 PALLETS IN	3	3	3	4	4	4	4	5	2	4	4	4	4	1
% NSNS WITH > 4 PALLETS IN	11	15	10	15	13	11	12	13	4	14	12	15	12	3

Table 4

NSN SHIPMENT SUMMARY REPORT EXCLUDING TOBACCO ITEMS

	10 SEP	25 SEP	10 OCT	25 OCT	10 NOV	25 NOV	10 DEC	25 DEC	10 JAN	25 JAN	10 FEB	25 FEB	AVE	STANDARD DEVIATION
# DICOM MROS	61,577	34,661	59,856	42,643	59,771	44,081	59,834	81,875	20,774	41,025	62,030	39,235	50,614	15,691
# DICOM NSNS	4751	2821	5272	2961	3983	4086	4375	5350	4015	2894	4471	2911	3,991	878
% ALL PALLETS OUT	1.2	1.3	1.2	1.5	0.6	1.2	1.2	0.7	1.2	0.9	1.4	1.3	1.1	0.3
% PRIMARILY PALLETS OUT	1.2	1.9	1.2	1.9	1.2	1.1	1.2	1.6	1.4	2.2	1.3	2.3	1.5	0.4
% PRIMARILY CASES OUT	8.0	13.3	7.7	10.9	9.6	8.6	9.0	10.5	6.5	10.8	8.8	11.6	9.4	1.8
% ALL CASES OUT	89.6	83.6	89.9	85.6	88.7	89.1	88.6	87.2	91.0	86.2	88.5	84.7	87.7	2.2

On the 25 December cycle, purchase orders were sent to both sets of vendors instead of just the end-of-month vendors resulting in a heavy workload cycle. MRO workload in the 10 January cycle was reduced by the heavy ordering in the 25 December cycle. The cyclical pattern recovered to a more normal level by the 25 January cycle.

The 25 December and 10 January cycles data were included in the average and standard deviation statistics in order to evaluate the effects of unusual circumstances on workload and storage capacity. The inclusion of these two unusual cycles tends to balance each other and, therefore, produces little effect on the average but increases the standard deviation.

Despite the cyclical fluctuations in workload, the percentage distributions of how NSNs went out were very consistent. Table 4 shows the number of MROs, the number of NSNs, and the type NSN category distribution by cycle. Approximately 1% of the NSNs had all their MROs shipped in pallet-sized lots, 10% of the NSNs MROs were shipped primarily in less than pallet-sized lots, and 88% of the items had all their MROs shipped in less than pallet-sized lots. The small standard deviations for these percentage distributions indicated that this shipment pattern was stable.

The receipt pattern for NSNs was also very stable. Table 5 presents counts of the number of items received in only one cycle, two cycles, three cycles, and so on up to 12 cycles. NSNs tend, on the average, to be received approximately once a month.

Table 5

NSN Receipt Patterns
10 September 1985 to 25 February 1986

# Cycles with Stock Received	NSN Frequency	Percent
1	530	6.3
2	569	6.8
3	593	7.1
4	584	6.9
5	707	8.4
6	1761	21.0
7	1834	21.8
8	1449	17.2
9	246	2.9
10	98	1.2
11	30	.4
12	4	.0
Total	8405	100.0

Frequency distributions were run on the belt location codes and the bulk location codes to approximate how many of each location type will be required. Table 6 displays the number of items in each location code for the 12 cycles. The final column, the average plus two standard deviations, estimates the number of locations sufficient for 98% of the cycles. Due to the effects of the 25 December and 10 January cycles, the average standard deviation plus the two standard deviation statistics tend to slightly exceed the maximum for the twelve cycles. However, if the intention is to build enough locations to handle emergency situations, the average plus two standard deviations may be a reasonable target.

Table 7 lists the number of belt locations required for each cycle. Combined location codes such as location code AB, single deep small plus single deep large pallet rack, were added to both location code A and to location code B to determine the total number of single deep small pallet racks and single deep large pallet racks required. The belt location requirement appears to be reasonably stable except for the 25 December and the 10 January cycles.

C. Sensitivity of Pallet Size Criteria

A frequency distribution was run on the MRO cube to determine if small changes in the minimum, average, and maximum pallet-size cube thresholds would substantially affect the results. The first cycle, 10 Sep 85, was chosen to evaluate the pallet size thresholds. The distribution indicated that the minimum pallet-size threshold (35 cubic feet) was at the 96.8 percentile. The minimum pallet cube would have to be reduced to approximately 18 cubic feet to reduce the percentage of MROs meeting the minimum pallet cube by 5%. Likewise, increasing the minimum pallet cube has little effect on the percentage of MROs meeting the pallet threshold.

The average pallet cube threshold (46.667) and the maximum pallet threshold are even more insensitive to change since the cumulative distribution flattens (slope decreases) as MRO cube increases. The results appeared to be relatively insensitive to changes in the pallet thresholds.

IV. CONCLUSIONS

1. Despite the fluctuation in workload, the percentage distributions of type NSN categories (all pallet MROs out, primarily pallet MROs out, primarily case MROs out, and all case MROs out) were fairly consistent.

Table 6

LOCATION CODE SUMMARY REPORT EXCLUDING TOBACCO ITEMS

	10 SEP	25 SEP	10 OCT	25 OCT	10 NOV	25 NOV	10 DEC	25 DEC	10 JAN	25 JAN	10 FEB	25 FEB	AVE	STANDARD DEVIATION	AVE + 2 STD
# DICOM MROS	61,577	34,661	59,856	42,643	59,771	44,081	59,834	81,875	20,774	41,025	62,030	39,235	50,614	15,691	81,996
# DICOM NSNS	4,751	2,821	5,272	2,961	3,983	4,086	4,375	5,350	4,015	2,894	4,471	2,911	3,991	.878	5,747
# NSNS WITH NO BELT LOCATIONS	55	36	63	46	23	49	52	36	48	29	61	39	45	12	69
# BELT LOCATIONS = A	817	500	981	567	715	763	790	1,098	832	625	797	635	760	162	1,084
# BELT LOCATIONS = B	228	174	269	184	252	166	242	405	217	167	245	165	226	65	356
# BELT LOCATIONS = C	368	230	345	238	353	223	341	551	272	218	320	222	307	92	491
# BELT LOCATIONS = D	121	59	111	74	105	58	115	142	71	66	108	70	92	27	146
# BELT LOCATIONS = E	369	271	371	311	381	313	382	468	30	289	404	283	326	108	541
# BELT LOCATIONS = AB	127	80	158	89	175	106	134	200	69	71	137	87	119	41	202
# BELT LOCATIONS = AC	84	70	87	69	92	56	101	144	67	67	85	59	82	23	128
# BELT LOCATIONS = AD	66	44	64	53	38	59	43	101	26	59	84	45	57	20	96
# BELT LOCATIONS = BC	86	68	74	63	72	56	77	117	37	55	73	56	70	19	107
# BELT LOCATIONS = BD	53	31	53	36	47	44	53	94	31	46	55	46	49	16	81
# BELT LOCATIONS = CC	5	4	4	3	6	6	3	9	1	7	3	3	5	2	9
# BELT LOCATIONS = CD	79	69	107	72	100	83	97	140	43	67	99	87	87	23	134
# BELT LOCATIONS = DD	73	56	67	60	76	62	83	112	24	63	89	63	69	20	109
# BELT LOCATIONS = F1	1,405	680	1,734	615	970	1458	1,175	883	1,371	632	1,202	581	1,061	380	1,821
# BELT LOCATIONS = F2	452	276	520	307	364	385	430	480	536	260	463	280	396	94	584
# BELT LOCATIONS = F3	263	173	264	174	264	199	257	350	340	173	246	190	241	59	359
# NSNS WITH NO BULK LOCATIONS	4,256	2,357	4,736	2,533	3,526	3,638	3,869	4,658	3,646	2,492	3,947	2,467	3,510	824	5.158
# BULK LOCATIONS = K	156	134	156	133	146	139	171	238	123	123	161	119	150	31	212
# BULK LOCATIONS = L	113	118	126	101	98	111	127	145	106	89	105	111	113	14	141
# BULK LOCATIONS = M	47	69	62	51	49	50	52	89	46	49	74	53	58	13	83
# BULK LOCATIONS = N	79	64	88	66	68	61	66	96	55	58	96	80	73	14	101
# BULK LOCATIONS = P	38	25	38	24	37	29	34	47	18	24	29	21	30	8	47
# BULK LOCATIONS = Q	24	14	17	18	20	18	16	19	5	18	19	12	17	5	26
# BULK LOCATIONS = R	7	9	11	6	10	9	9	12	3	7	12	10	9	3	14
# BULK LOCATIONS = S	6	4	9	7	3	7	4	10	7	9	5	8	7	2	11
# BULK LOCATIONS = T	3	10	9	2	8	4	8	5	1	6	4	6	6	3	11
# BULK LOCATIONS = V	5	2	3	2	3	8	1	3	0	3	2	7	3	2	8
# BULK LOCATIONS = W	17	15	17	18	15	12	18	28	5	16	17	17	16	5	26

Table 7

BELT LOCATION SUMMARY REPORT EXCLUDING TOBACCO ITEMS

	10 SEP	25 SEP	10 OCT	25 OCT	10 NOV	25 NOV	10 DEC	25 DEC	10 JAN	25 JAN	10 FEB	25 FEB	AVE	STANDARD DEVIATION	AVE + 2 STD
ONE LANE CARTON FLOW RACK	1485	680	1734	615	920	1458	1175	883	1371	632	1202	581	1,061	380	1,821
TWO LANE CARTON FLOW RACK	452	276	520	307	164	385	430	480	536	260	463	260	396	94	584
THREE LANE CARTON FLOW RACK	263	173	264	174	264	199	257	350	340	173	246	190	241	59	359
SINGLE DEEP SMALL PALLET RACK	1094	694	1290	778	1020	984	1068	1543	994	822	1103	826	1,018	224	1,467
SINGLE DEEP LARGE PALLET RACK	494	353	554	372	546	372	506	816	354	339	510	354	464	133	730
DOUBLE DEEP SMALL PALLET RACK	627	445	621	448	629	430	622	970	421	421	583	430	554	154	861
DOUBLE DEEP LARGE PALLET RACK	465	315	469	355	442	368	474	701	219	364	524	374	423	116	654
ASSIGN LOCATION MANUALLY	389	271	371	311	381	313	382	488	30	289	404	283	326	108	541

2. DICOMSS is currently operating in a pallet-in, pallet-out mode. The data indicates that the majority of NSNs come in and go out in less than pallet-size lots. It may be more advantageous to process these small orders by the case rather than to palletize them.

3. Only 1 percent of the NSNs had all their MROs shipped in pallet-size lots. Another 1 percent of the NSNs had their MROs shipped primarily in pallet-size lots. The other 98% of the NSNs were shipped completely or primarily in less than the minimum pallet-size lots. It is assumed that NSNs which are shipped in less than 35-cubic feet lots should be handled by the case rather than by the pallet.

V. RECOMMENDATIONS

1. Location assignments were reasonably stable under normal operating circumstances. We recommend, however, that extra space be reserved for unusual or emergency situations. We suggest that the average plus two standard deviations is a reasonable target level to provide for emergency space.

2. Simplified operational definitions were used to make location assignments in this analysis. Real world assignments will be more complex. Detailed information listed by item was provided under separate cover in the DICOM NSN Summary Report. We recommend that the modernized operation be designed to take into account those items requiring special consideration due to storage compatibility and item characteristics.

END

DATE FILMED

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