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AMPGARD Integrated Control-Gear

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Introduction

It is currently common industry practice to install standard full voltage starters and variable frequency drives in distinctly different configurations. Full voltage starters are usually contained within the same medium voltage MCC lineup and fed by common bus in order to save space and the extra cost of installation. Adjustable frequency drives are often installed individually and treated as independent systems.

As the industry continues to see an increase in the technology and number of medium voltage drives, it becomes increasingly necessary to integrate drives into motor control centers. Instead of a lineup of full voltage motor starters and separate independent drives, it is advantageous to create lineups of motor starters that include medium voltage drives. The integration of these different technologies yields many benefits including: decreased footprint, quicker installation time, less installation labor, less equipment to buy and maintain, and less cable connections.

System Data

In order to show the advantages of creating a single lineup, it is necessary to obtain a baseline for comparing different installation configurations. This case will address the specific requirement of 6 motor controllers fed from a common transformer. The transformer and its protection as well as the size and control requirements of the motors will not change. The specific area addressed will be the feeder portion between the transformer and the individual motor controllers. (Figure 1)

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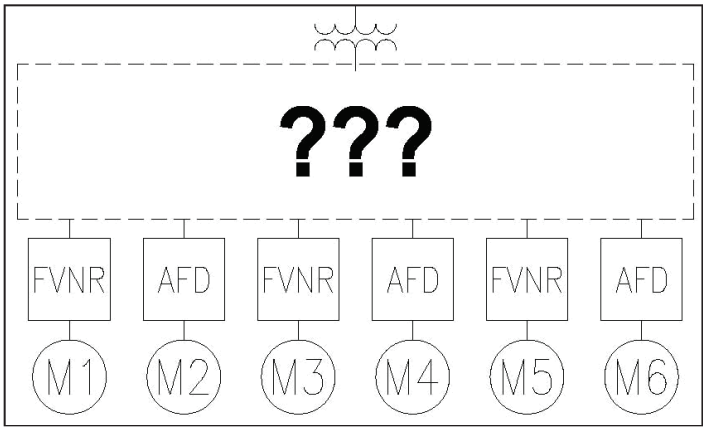


Figure 1. Feeder Portion Between the Transformer and the Individual Motor Controllers

The system receives its input power through a 10MVA 4160v transformer. The transformer load is protected by a 2000A breaker. The transformer, its protection, and the feed to the 2000A breaker are not addressed here since they remain constant for all scenarios.

The load for the system will be 3 FVNR starters and 3 AFDs that range from 1000HP to 2500HP. Each motor is a typical medium voltage induction motor. A detailed explanation of each motors control requirements are listed in Table 1.

Table 1. Motors Control Requirements

Motor Number	HP	Control Method	Frequency	Voltage	RPM	Load Current	Line Current
1	2500	FVNR 36"w 30"d	60	4160	1800	310	310
2	2500	AFD 131"w 50"d	60	4160	1800	310	277
3	2000	FVNR 36"w 30"d	60	4160	1800	248	248
4	2000	AFD 95"w 50"d	60	4160	1800	248	222
5	1000	FVNR 36"w 30"d	60	4160	1800	124	124
6	1000	AFD 65"w 50"d	60	4160	1800	124	111

When viewing footprint we must consider not only the size of the gear, but the additional space required for installation and maintenance. The floor space cost is based on $150 per square foot.

Another important consideration is the cost and labor involved in installing the cable. Each motor controller is fed by a 50' cable run, with the cable sized appropriately for the load. Each cable is terminated with crimp type lugs and stress cones. A detailed explanation of the cable sizes and costs (including labor) are in Table 2.

Table 2. Cable Sizes and Costs

Cable Size	Max Current	Cost Per Ft	Cost Per Wire Connectors	Cost Per Wire Termination	Cost Per 50 Ft Feeder
2X500	900	$120.00	$405	$207	$13,344
500	536	$60.00	$405	$207	$6,672
4/0	310	$29.00	$269	$207	$4,306
1/0	124	$19.50	$185	$207	$3,327

Scenario #1

In the first scenario, the only common buses that exist are in the medium voltage switchgear and the starter MCC. The medium voltage switchgear has 1 main and 4 individual feeder breakers that supply the stand-alone AFDs and the starter MCC. This scenario requires that 4 feeder cables be installed from the feeder breakers. This is the industry standard today. Costs (not including the motor starters and AFDs) for this feeder system are:

Distribution gear	
18" incoming section	$ 2,000
5 breaker switchgear	$ 134,695
Cabling (4)	$ 25,283
Floor space cost (102.65 sqft)	$ 15,398
Total	$ 177,376

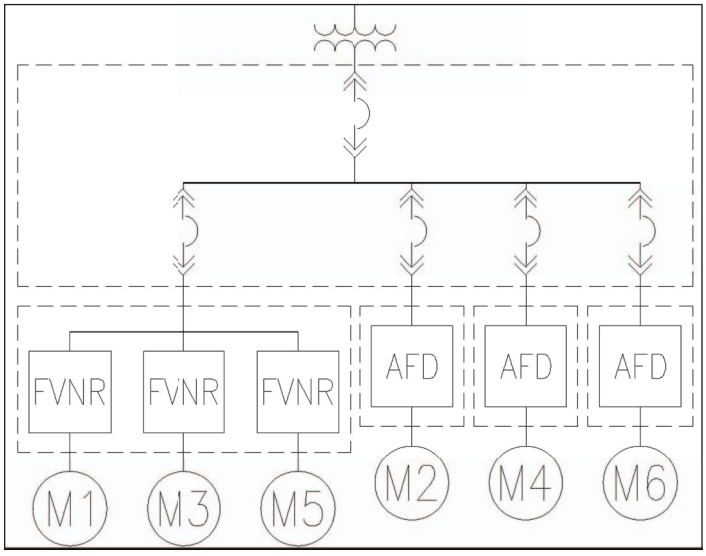


Figure 2. Scenario 1

Scenario #2

Scenario 2 provides a more concise layout. Instead of individual adjustable frequency drives cabled separately, there are now two lineups (one of FVNR starters and one of drives), each with 18" incoming sections. The medium voltage switchgear has 1 main and 2 feeder breakers that supply the motor starter and drive lineups. This allows for only one set of cables to be run from the switchgear to each lineup. Costs (not including the motor starters and AFDs) for this feeder system are:

Distribution gear	
2 x 18" incoming section	$ 4,000
3 breaker switchgear	$ 93,980
Cabling (2)	$ 26,688
Floor space cost (82.15 sqft)	$ 12,323
Total	$ 136,991
Percent of scenario 1	77.2%

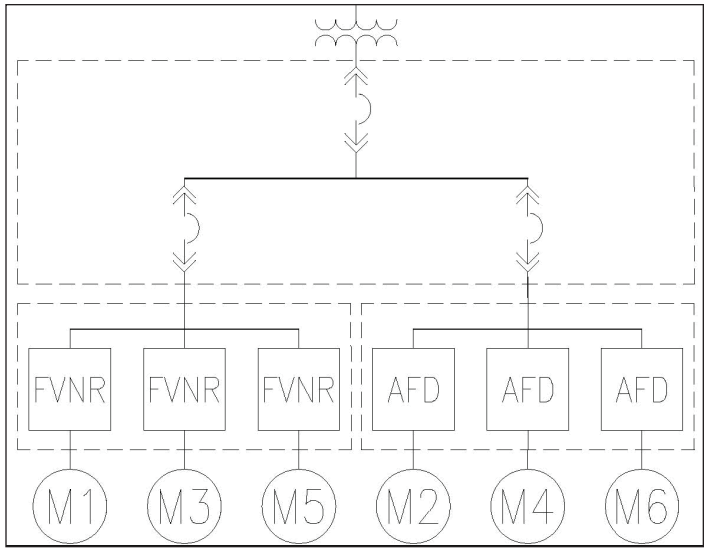


Figure 3. Scenario 2

Scenario #3

This is the cleanest layout. By configuring the main breaker, motor starters, and drives to use a common bus, we are able to remove the medium voltage switchgear and have a single point of feed. There is a main breaker that distributes the power to all eight motor controllers through an integrated bus. Costs (not including the motor starters and AFDs) for this feeder system are:

Distribution gear	
2000A Ampgard main breaker	$ 39,500
Cabling	$ 0
Floor space cost (42 sqft)	$ 6,293
Total	$ 45,793
Percent of scenario 1	25.8%

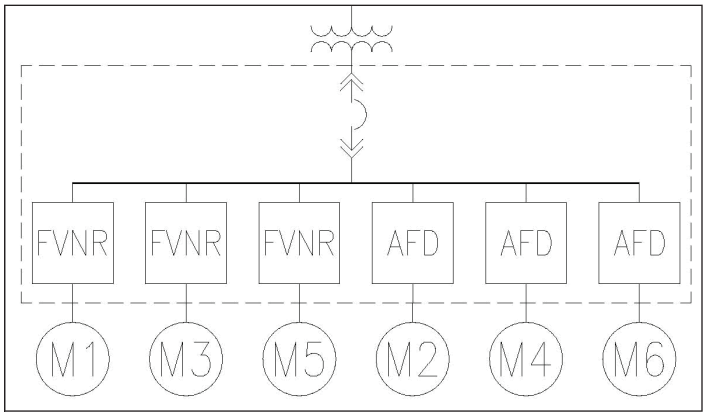
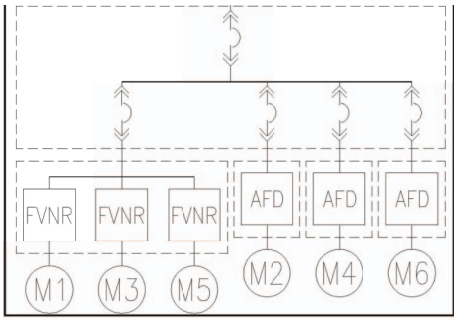
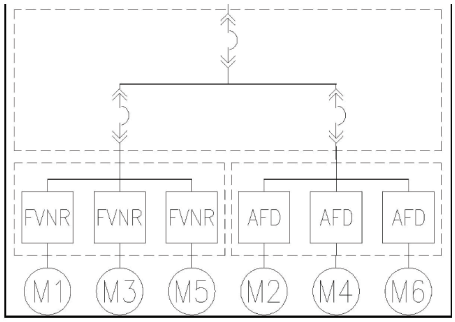
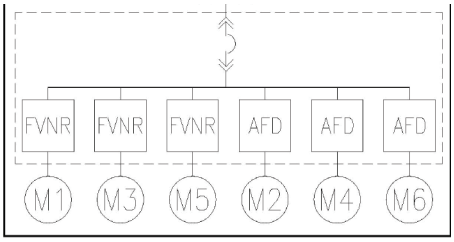


Figure 4. Scenario 3

Table 3. Advantages and Disadvantages of Scenarios 1, 2, and 3

Scenario #1	Scenario #2	Scenario #3
Advantages: • Industry standard today	Advantages: • 80% of scenario 1 footprint • Only 2 feeder runs are required • Industry standard for motor starters	Advantages: • Smallest footprint, 41% of scenario 1 • Most economical solutions • Single electrical connection • Quickest installation time of all scenarios • One point of responsibility for the line up • Fewest parts • New industry standard
Disadvantages: • Largest footprint • Most expensive installation costs • 4 feeder runs are required to feed power through the system • Longest installation time • There may be multiple equipment designer/testers/warranty coordinators for the system	Disadvantages: • There may be multiple equipment designer/testers/warranty coordinators for the equipment • Not industry standard for drives	Disadvantages: • One manufacturer can offer this package • Does not stimulate the economy by wasting installation time, floor space, and material!
Highest Feeder Cost **100%**	**Lower Feeder Cost** **77.2%**	**Lowest Feeder Cost** **25.8%**
		

Ampgard Integrated Control - Gear Capabilities:

Motor Controls: FVNR, FVR, RVAT, RVPR, RVSS, Synchronous starters/controllers, Adjustable Frequency Drive up to 5750hp, AFD sync transfer, AFD sync motor control, and AFD bypass

Input options: 12" to 36" incoming section, up to 3000A main and feeder breakers, main bus from 1000A to 3000A, Main tie Main, Bus duct connections, and LBS.

Line voltages: 2400v through 13.8kv, 50/60 Hz, 50ka

AFD output voltages: 2400v, 3300v, and 4160v. 0-90hz

Arc resistant AFD: 30ka or 50ka. (preliminary development)

Arc resistant motor controls: 30ka or 50ka (This feature is fully developed.)

Optional motorized handle operators for Isolation switch to increase operator safety.

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